University of Novi Sad | Faculty of Sciences
DEPARTMENT OF GEOGRAPHY, TOURISM AND HOTEL MANAGEMENT

THE 5TH SERBIAN CONGRESS
OF GEOGRAPHERS, 2021

INNOVATIVE APPROACH AND PERSPECTIVES OF THE APPLIED GEOGRAPHY

Collection of Papers

NOVI SAD | VOJVODINA | SERBIA | 2021

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ISBN 978-86-7031-589-1

The Conference has been supported by:

- Provincial Secretariat for Higher Education and Scientific Research, Autonomous Province of Vojvodina, Republic of Serbia
- Ministry of Education, Science and Technological Development, Republic of Serbia

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AGENT-BASED ANALYSIS OF CONTAGION EVENTS ACCORDING TO SOURCING LOCATIONS

Mijat Kustudic[A], Ben Niu[A*], Qianying Liu[A]

Abstract

The first human infected with the Covid-19 virus was traced to a seafood market in Wuhan, China. Research shows that there are comparable types of viruses found in different and mutually distant areas. This raises several questions: what if the virus originated in another location? How will future waves of epidemics behave if they originate from different locations with a smaller/larger population than Wuhan? To explore these questions, we implement an agent-based model within fractal cities. Cities radiate gravitational social attraction based on their Zipfian population. The probability and predictability of contagion events are analyzed by examining fractal dimensions and lacunarity. Results show that weak gravitational forces of small locations help dissipate infections across country quicker if the pathogen had originated from that location. Gravitational forces of large cities help contain infections within them if they are the starting locations for the pathogen. Greater connectedness and symmetry allow for a more predictable epidemic outcome since there are no obstructions to spreading. To test our hypothesis, we implement datasets from two countries, Sierra Leone and Liberia, and two diseases, Ebola and Covid-19, and obtain the same results.

Keywords: Agent-Based Model, Reservoir Infection, SIR Model, Fractal Epidemics, Epidemic Spreading, Population Model

Introduction

As the world struggles with the Covid-19 pandemic researchers are left asking numerous questions. These questions can be directed towards the past, for example, which species are the source of the virus [Latinne et al., 2020], towards the present regarding what countermeasures should be implemented [Ferguson et al., 2020] or the future, by trying to predict the economic consequences of pandemics [Stoop et al., 2020].

To prevent similar events in the future we must understand how this virus jumped from bats to humans. The first infected human was traced back to a seafood market in Wuhan, China [WHO, 2020]. Research shows that a similar type of bat lives in Yunnan province and China shares 96% of its genetic sequence with SARS-CoV-2 [Zhou et al., 2020]. According to these facts, we must ask a question regarding the starting scenario of the virus: what if the virus originated from another location, with a smaller/larger population than Wuhan?

Research points to a possibility for managing the risk of pandemics following the extreme value theory (EVT) manifested through power laws [Cirillo and Taleb, 2020]. It considers that extremes and not averages are fundamental sources of risk. An exploration of these phenomena has prompted the use of fractal geometry [Mandelbrot, 1982] and fractal reaction principles [Kopelman, 1988]. In simple terms, fractals are pattern-like shapes that can be seen in snowflakes, lightning, clouds, and numerous plants such as broccoli or ferns. There is proof that this pandemic follows some fractal structure rules and shows a similar pattern in different regions of the world [Materassi, 2020] [Abbasi et al., 2020].

The first question in this paper examines disease dynamics and cross-country disease spreading when

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the disease originates from different sized source populations. The second question analyses event probability, predictability, and emergent behaviors of agents as they navigate across cities.

To answer these questions, we use two main methodological innovations and approaches. The first one comes from implementing an agent-based compartmental, and reservoir arrangement of fractal cities. All cities radiate gravitational social attraction based on their Zipfian distributed population. The second methodological innovation is based on implementing fractal dimensions and lacunarity for analyzing event probability and its consequences.

To test our hypothesis, we implement real datasets from two countries, Sierra Leone and Liberia, and two diseases, Ebola and Covid-19. Ebola started in the rural areas with a small populace [WHO, 2015a] while Covid-19 started in China [WHO, 2020] and was imported to the capital cities of respected countries. This difference in starting location makes for a perfect ground to test our hypothesis.

The remainder of the paper is structured as follows. Section 2 focuses on reviewing literature according to different disease modeling approaches. Section 3 describes the implemented framework based on multidimensional spatial distribution coupled with a compartmental aspect. Section 4 describes experimental results while section 5 shows how real diseases spread according to obtained datasets. Section 6 discusses and compares predicted with real disease dynamics. Section 7 discusses future research directions and concludes the paper.

Literature review

Disease Modeling Approaches

Disease modeling is a useful tool that can give insight into disease dynamics so that an effective response can be developed. The basic notions were defined by [Kermack and McKendrick, 1927] through their compartmental model that uses linear equations. New and more flexible approaches often implement some variant of artificial intelligence one of them being agent-based modeling (ABM). The modeled disease can be unspecified [Mei et al., 2015] or use exact pathogen characteristics, such as the case of Ebola [Stoop et al., 2020] or Covid-19 [Fanelli and Piazza, 2020]. Observations can be made according to the governmental action and individual reaction [Lin et al., 2020], self-initiated preventive actions [Mao L., 2015], or according to disease-carrying vectors [Hunter et al., 2017]. AB models have been used to define country-level epidemiological control and prevention measures [Halloran et al., 2008], recently a strategy developed in this manner [Ferguson et al., 2020] has been implemented in the United Kingdom. An important topic regarding Covid-19 is the research of the economic effects of crises caused by countermeasures such as lockdowns [Manotosh et al., 2020]. Research can go into such details to explore how better handwashing can significantly affect epidemiological outcomes [Mao L., 2015] [Poletti et al., 2009].

Role of Geographical Factors on Disease Spreading

Epidemics can be viewed as diffusion waves and should be modeled similarly to other spread and change processes [Haggett, 2000]. Therefore, the key factors for disease spreading can be narrowed down to the spatial (geographical) factors, human behavior, and time dependence factors [Gonçalves, 2016]. When observing distances between cities or countries, a strong explanatory potential for their populations' behavior can be found in the models that are based on Newton's gravity law, where the sizes of these elements play the role of mass [Carrothers, 1958]. Smaller cities are characterized by a smaller population, however, on average, all cities have similar sizes of social groups [Mao, 2015]. In general, large cities have a greater probability to become large spreaders compared to smaller locations because of their international connectedness and tight commuting relationships [Hamidi et al. 2020].

In standard economic practice, this form has been used for analyzing migration [Karemera et al. 2000], urban population density [Wang and Guldmann, 2005], transportation [Jung et al. 2008], and so on. The gravitational approach is commonly implemented along with epidemiological models for disease prediction or analysis where the observation focus can be on different diseases, such as measles [Xia et al. 2004] and influenza [Li et al. 2011] or to observe disease waves, and their spatial hierarchies of concentration [Parker and Epstein, 2011] [Viboud et al. 2006] [Barrios et al., 2012]. Analysis can be focused on urban disease spreading [Hackl and Dubernet, 2019] and discovering possible solutions for its suppression [Halloran et al., 2008]. Due to Covid-19's prevalence, containment needs to be done by implementing non-pharmaceutical measures such as lockdowns to prevent cross-country spreading [Ferguson et al., 2020].

Fractal Patterns of Diseases

One approach for managing limitations of modeling comes by observing event probabilities and their "contagion event sets" [Materassi, 2020] where the idea of

fractality greatly helps. Due to the relative mathematically based similarities with epidemiological modeling, pandemics caused by Covid-19 have conceived some fractal observations. Repeating patterns, power-law behaviors and scaling properties across different regions of the world have been noted [Abbasi et al., 2020]. Scalability is also explored through different sized social networks and clusters pointing out the fractal dimensions [Materassi, 2020]. We note a definite lack of literature in this area requiring further exploration due to the present and future dangers of the Covid-19 pandemic as well as other possible ones.

An important class of models that introduces realism through heterogeneity is based on metapopulations [Hackl and Dubernet, 2019] also referred to as fractality [Abbasi et al., 2020]. These models divide the network of agents into subpopulations of different sizes. This feature is important because it allows for the implementation of cities of different sizes which is an important aspect because it sets the limit on how large a fraction of the population a single individual might meet within a given period [Lund et al. 2013].

There are two main reasons why the epidemic spreading is likely to follow a fractal pattern, both in line with the main characteristics of fractals, recursiveness, and self-similarity. Recursiveness can be traced to the underlying framework of epidemics, namely the population, which tends to follow a power-law function in its self-organization [Batty, 1994]. These aspects of human activity in urban centers have been analyzed in the science of cities that show how people live and interact in urban environments. The reason for recursiveness lies in the scalability of spreading where the transmission dynamics of the individual level (Fig 1.) is the same as the one in the subpopulation, metapopulation, or city to city level [Abbasi et al., 2020]. Since all of these levels have the same transmission dynamics it leaves the scale of observation invariant, which is in line with the inherent behavior of cities [Batty, 1994].

Self-similarity patterns of the epidemic appear all over the world and have been identified in Romania, Italy, Spain, Germany [Păcurar and Necula, 2020], as well as in China, the USA, Brazil, and Europe [Abbasi et al., 2020]. This self-similarity of epidemics can be viewed as a useful feature because it allows researchers to assess the current condition and predict the next modifications in the epidemiological curves [Păcurar and Necula, 2020].

Framework description

The used framework consists of two parts, the spatial element, and the compartmental element. The spatial part is used to observe the movement and dynamics of the population and their cross-city behavior during epidemics. The compartmental element enables pathogen transmission and its observation.

Spatial dynamics of fractal cities

People can live in a city for a long time, meeting some inhabitants often and others, not at all [Abbasi et al., 2020]. This isolation feature of social clusters prevents the exponential spreading of diseases since greater numbers of infected do not directly correlate with a greater probability of getting infected. Therefore, the probability of infection refers more to social groups and not individuals because through an individual the entire group of closest contacts is in contact with another group.

Although the fractal scale range can be infinite, we define the lowest scale value as an individual agent. This agent is an integer and is in one of the compartmental states. A higher scale of observation comes from incorporating the surrounding metapopulation and subpopulation of multiple cities within a country, as defined by [Hackl and Dubernet, 2019] [Abbasi et al., 2020]. Agents are distributed across social groups of different sizes with the average one having 10 close individuals [Mao, 2015]. Fig 1. Shows the highly clus-

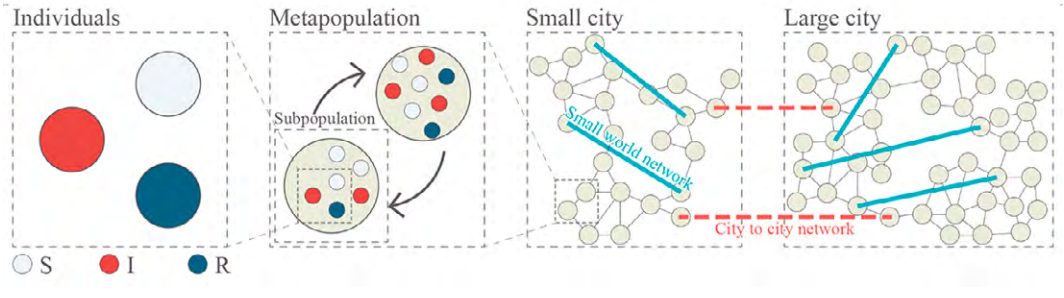

Figure 1. Shows different sized cities acting as reservoirs, they are distributed across a country. A bottom-up approach is obtained by implementing individuals, metapopulation, and subpopulations within cities. Small-world networks are implemented for obtaining circulatory dynamics

tered network with a short average path length that is also highly intertwined hence it also can be defined as a network with a small-world structure (SWN) [Watts and Strogatz, 1998].

Cities are geographically and epidemiologically separate with the distance between them acting as a barrier inhibiting disease transmission. Since this observation coincides with the definition of epidemiological reservoirs [Haydon et al., 2002] we use the same terminology. There are several population types based on the location of infected individuals. If there is an infected individual inside a city and the disease spreads within it, the population (city) is considered as host. Population from which the infection starts, meaning that it transmits the infection directly to another population, we define as a source population. The target population is the population of interest to the observer.

Compartmental organization

The compartmental organization is based on the SIR model [Kermack and McKendrick, 1927] that consists of susceptible (S), infected (I), and recovered (R) individuals, where the can become while the does not return to the previous stages ($S_t \rightarrow I_t \rightarrow R_t$). Models may incorporate more compartments (quarantine, treated, or vaccinated individuals) as well as recurring movement across compartments. The total population of each model is considered to be constant, as noted

$$N = S_t + I_t + R_t \tag{1}$$

Where the total population is, note that we incorporate time since the compartments may differ while still having susceptible (S_t), infected (I_t) and recovered (R_t) individuals. Formulas presented next define change between compartments:

$$S_t = -\beta S_t I_t \tag{2}$$

$$I_t = \beta S_t I_t - \gamma I_t \tag{3}$$

$$R_t = \gamma I_t \tag{4}$$

So that shows the rate of infection, while is the removal rate of infected individuals. City observations are treated percentage-wise since commuting from and to a city due to mutual gravitational forces changes the population of the city but the country stays constant. The city-specific susceptible population can be calculated as:

$$St = \sum_{c=1}^{cities} S_t^c \tag{5}$$

This formulation defines as a function of all susceptible individuals spatially distributed across cities at a certain moment, other compartments use the same principle. To define and distribute the population size we use Zipf's law [Zipf, 1949]. To calculate the population of each city we use the following equation:

$$f(k;s,N) = \frac{1}{k_s H_{N,s}} \tag{6}$$

So that is the total population size of a country, is the rank of the city and exponent represents the value that characterizes the distribution which is 1.07 according to [Zipf, 1949]. The calculation begins with the largest city and percolates to smaller cities so that the n^{th} the city population is the $1/n^s$ of the largest city. Varying population sizes can depict different phenomena by implementing a multilayered observation instead of a node-based one.

Different population sizes are important for predicting population movement, as described by the law of demographic gravitation [Stewart, 1948]. The law is based on Newtonian principles of distance and mass and explains how cities have attraction forces that draw individuals to migrate or visit them, as shown by the following formula:

$$F_c = \frac{N_c^o \cdot N_c^d}{d^2} \tag{7}$$

Where presents the force of attraction, is the size of the city population of origin, is the destination city population and is the distance between the two cities. Cities interact via migrating agents and daily migrations do not influence their overall gravitational attraction.

Fractal dimensions

Natural and biological features are often fragmented implying the existence of a fractal dimension. Since for each naturally occurring fractal, there is a finite scaling range (zoom), the structure can become smooth (Euclidean) or rough and random (non-self-similar). In Euclidean n-space, a bounded set S can be considered statistically self-similar if S is the union of N_r non-intersecting subsets for a scaling factor r, each of which is of the form $r(S_n)$ where the N_r and S_n sets are congruent in distribution to S. We can use the fractal dimension to measure the same way as we use a measurement tool in the Euclidean (discrete) space [Mandelbrot, 1982], it is calculated:

$$FD = \frac{\log N_r}{\log \frac{1}{r}} \tag{8}$$

So that is the number of self-similar (invariant) shapes and is the corresponding scaling factor. On the Hausdorff Dimension scale (HD), a smooth line has a dimension of 1 which is a low value while the high values are present in the Mandelbrot or the Julia set with the complexity of 2. Thus, often the fractal dimension is 1 < HD < 2.

Fractal dimension calculation

To understand the complexity of a shape we use fractal dimensions as a measure, for calculating it we will use the "Minkowski-Bouligand dimension," or the "box-counting method", its pseudocode is presented in Table 1. Calculations can be made with different sized boxes for more or less accurate representation potentially giving different results [Mandelbrot, 1967]. The number of boxes, for proportion, used in this paper is 160 obtaining a fractal dimension of 1.25 as in [Mandelbrot, 1967]. The calibration image is listed in references [19].

Table 1. Pseudocode for the box-counting approach for calculating fractal dimensions

```
For each shape
 Divide the shape into boxes of size
     For each box size r
          Count the occupied boxes:
          Calculate the magnitude factor ()
          Implement equation X
     End
End
```

With lower HD numbers we examine the speed and impact of the infection, a single wave it will be shown by lower numbers. If it is rebounding and multivalve it will show more complexity and thus greater numbers. Another dimension is observed through the total mean (cross country) HD where higher numbers show greater dynamics and more diversified results. To further differentiate results, we will calculate lacunarity which is a measure of the gap structure in patterns and coincides with abrupt declines in dispersal success on fractal landscapes [With and King, 1999]. It can be also be viewed as a measure of "gappiness" and heterogeneity, higher numbers showing greater emptiness. Lower numbers imply a slow and steady infection while higher ones a dynamic and/or rebounding one.

$$L = \frac{1/MN \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} I(m,n)^2}{1/MN \sum_{k=0}^{M-1} \sum_{l=0}^{N-1} I(k,l)^2} - 1 \tag{9}$$

It is defined in terms of the ratio of the variance over the mean value of the function where M and N are the sizes of the HD for the processed graph (image) [Petrou and Sevilla, 2006]. We will use it for analyzing the numbers of infected.

Experimental Parameters

Table 2. shows experimental parameters that are applied for all scenarios. Implemented disease characteristics are based on [Lin et al., 2020] with the infecting probability being 5% per contact and disease duration 10 days. The population of the largest city is trickled down by using Eq. 7 to define the populations of other cities.

Table 2. Parameters for the simulations

c	Number of Cities	10
	Largest city population	10.000
N	Total Population	42811
k	Zipf exponent	1.07
	Default nr. of connections	20

The number of simulation runs for each scenario (3) and each source (2), giving 6 in total, is 50 with each run having 350 iterations. For the spatial component, we use a 10-city setting. Since spatial organization and interconnectedness play an important role, we use three different scenarios as in fig 2. with the average network length of 1.5, 1.48, and 1.4 respectfully.

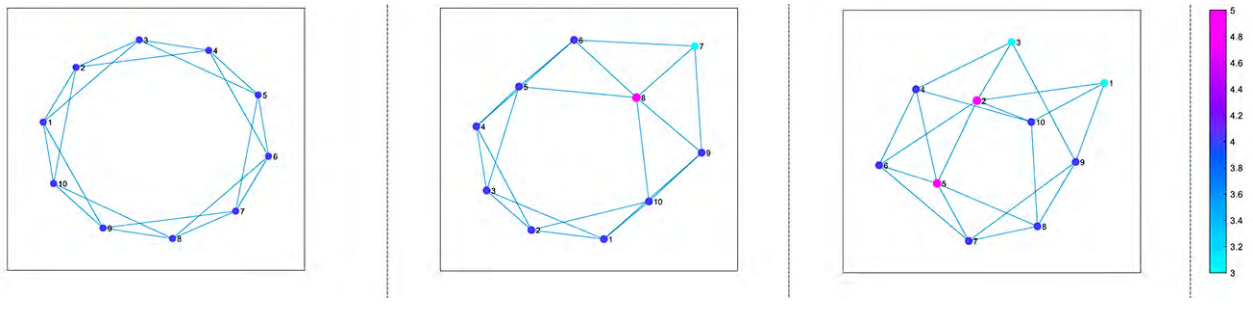

Figure 2. Spatial distributions of the three scenarios. Each scenario figure shows the sizes of the cities, by circles, and by the color bar on the right. Lines present the connections between cities that the agents may use for commuting

The first scenario is based on an SWN with high interconnectedness of cities, as in [Watts and Strogatz, 1998]. All cities are equally distant from one another, no city is better connected or presents a networking hub, the only difference is the population distribution. The second scenario has a semi-circular SWN orientation. Some cities are more isolated from the largest one, making them more difficult to reach. The third scenario has better connectedness across all city sizes and is more random in its orientation than the first two. Each city is easier to reach than in other cases.

Experimental results

To discover emergent behavior, we compare intra-scenario results. We check cross scenario results to see how disease spreading is affected by the interconnectedness of cities. We observe the maximum number of infected at a single moment which shows the burden on the health system. The standard deviation of infected population presents the dynamics of infecting. With greater incidence comes greater deviation. The total number of infected is a key indicator of the epidemic spreading, although alone it doesn't show the timeframe and dynamics.

Fig 3. is divided into two parts, the top part displays cumulative simulation results (each graph has 50) while the bottom contains the mean results of all simulations respectively. From left to right different scenarios are shown (1-3) while top to bottom is

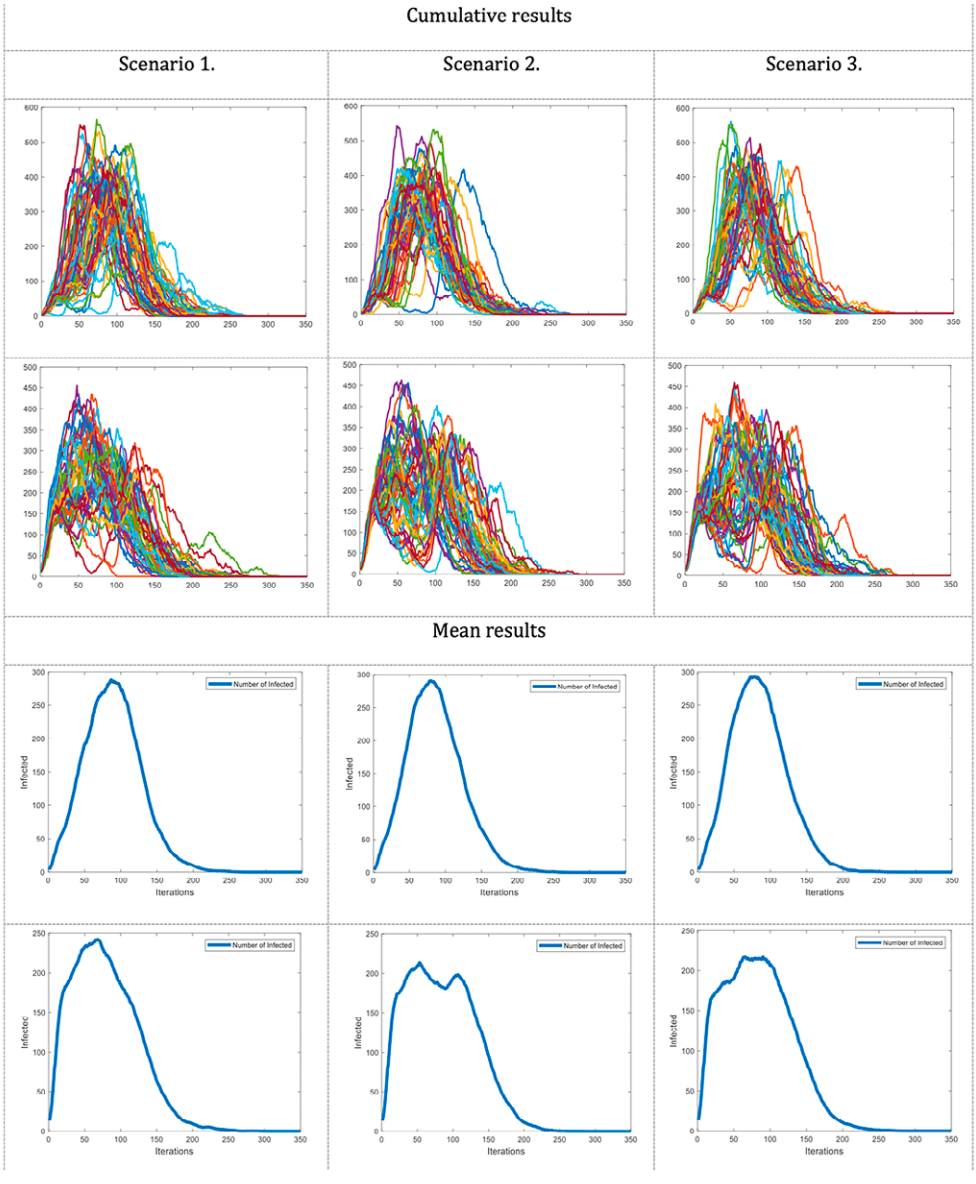

Figure 3. Shows Graphical results of simulations. Top to bottom for both cumulative and mean results are according to the sourcing (starting) positions of the pathogen, smallest and largest city, respectively

the sourcing positions of the pathogen, that being the smallest or largest city, respectively.

First scenario

We see that the situation is less favorable when sourcing from the smallest city, compared to the largest one. Furthermore, the mean HD shows that the dynamics is more predictable and "gravitates" towards the same outcome. Higher lacunarity numbers show the changing incidence rates indicating complexity and dynamics. There is a noticeable jump when infected advance from a small full reservoir to a new large one, similar to the "honeymoon effect" phenomenon [Hollingsworth et al., 2019] when effective control is used against an endemic infection resulting in an initial drop in prevalence to well below the endemic level. Afterward, it is followed by outbreaks that periodically increase prevalence above the endemic level as a consequence of a build-up of susceptible individuals [McLean and Anderson, 1988].

Greater infection intensity depletes the susceptible population eradicating the disease quicker. "In smaller populations, the number or density of infected hosts frequently falls to low levels, random extinction (fadeout) becomes inevitable, and the pathogen cannot persist" [Haydon et al., 2002]. Smaller sites are monitored and tested less often. The potential benefit of a disease spreading from a small location is that it is easier to control and put on lockdown blocking further propagation.

Second scenario

We see that the smallest city as a source causes higher maximum infected, standard deviation, and the total number of infected. The reason for this comes from the gravitational pull F_c of a large city since $F_c^{Large} > F_c^{Small}$ when squared distances are adequately the same, according to (Eq. 7). It will attract potential commuters from smaller cities around its vicinity and will keep the natives within it. Migrants from (other) smaller cities will return to their place of origin and locally spread the disease. The small reservoir is filled quicker so the infection spreads faster across smaller populations. This is combined with the higher probability of people moving from smaller to other cities, due to the small gravity, additionally increasing chances of spreading.

Third scenario

This scenario shows a lower number of max infected along with a lower standard deviation. Higher interconnectedness allows for disease to spread evenly across a country, so its moment of infection peaking is not concentrated. Although dispersed, it gives the same total number as in other scenarios. When the disease sources from a large city its population presents a large pool for potentially infected individuals. As its gravitational pull attracts individuals from other smaller locations they too participate in the social interactions of the large city and commute back to their place of origin which will help propagate the disease top-down. Due to the Zipfian distribution [Zipf, 1949] (Eq. 6.) more small cities are making it more likely for people to commute from small to a large city.

Cross country comparison

Differences between scenarios are observed via the maximum number of infected at a single moment and the standard deviation values while lacunarity shows the influence of gravity. Unpredictable outcomes come from the second scenario because the lower network connectedness keeps the infection within a city.

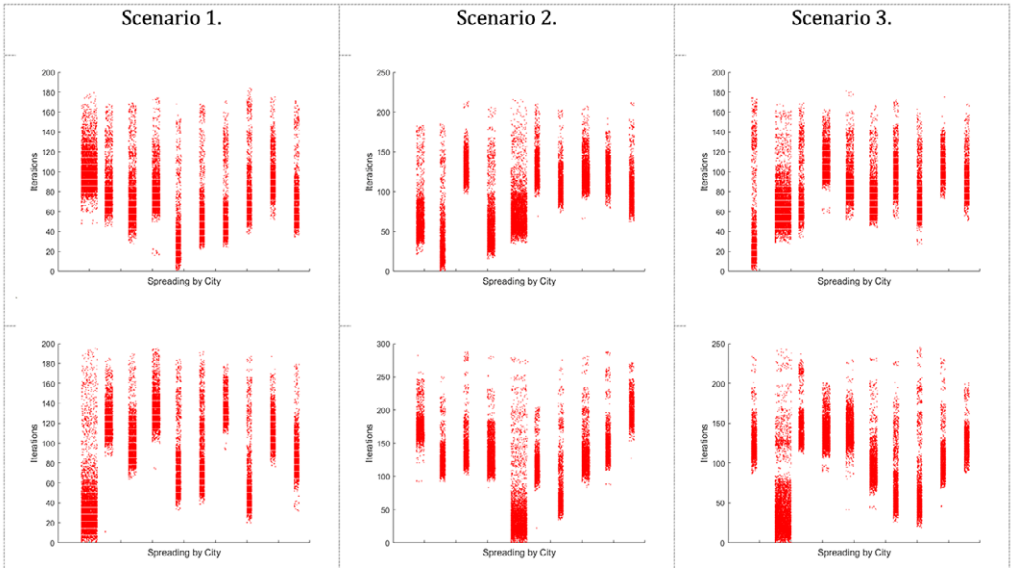

Figure 4. Shows the dynamics of simulations. Top to bottom results are according to the sourcing (starting) positions of the pathogen, smallest and largest city, respectively

Table 3. Numerical results of simulations

	Scenario 1.		Scenario 2.		Scenario 3.	
Source City	**Small**	**Large**	**Small**	**Large**	**Small**	**Large**
Maximum Infected	287.78	242.22	300.84	293.52	213.68	216.92
Standard deviation of Infected	100.0444	90.3565	105.3512	102.5832	84.2937	86.1186
Total Infected	27471	27465	27552	27609	27656	27585
Hausdorff Dimension	1.2374	1.2727	1.2365	1.24	1.279	1.2782
Lacunarity	2.1112	1.775	2.1042	2.0317	1.6787	1.6569

Higher connectedness helps spread the disease quicker [Watts and Strogatz, 1998] as in the third scenario. This combined with less isolation of other cities gives more predictable outcomes when the infection is sourced from the largest city because there are fewer boundaries for disease spreading so the outcomes are difficult to change and therefore influence.

Fig 4. shows simulation dynamics and cross-country disease spreading. A country is divided into 10 cities, width presenting the population, agents are tracked by their daily interactions. The results depict a single simulation.

In Table 3. When observing differences between HD in the 1st scenario we see lower values when the smallest city is the place of origin, pointing to the self-similarity of results. It means that this scenario is the most often repeated, and therefore probable. Greater lacunarity points to spikes of infected at a certain moment, they can be seen via the maximum infected at a single moment. Both are present in every scenario with the small city as the origin. This points to greater incidence due to the infection advancing from a small reservoir to a new large one [Hollingsworth et al., 2019], also observable through the standard deviation values. By performing the same simulations on more cities with different spatial orientations and population numbers we obtained the same results, note that initial scenario conditions are important.

Comparison with real datasets

To test our hypothesis, we implement real datasets from two countries, Sierra Leone and Liberia, and two diseases, Ebola and Covid-19. Ebola started in the rural areas with a small populace while Covid-19 started in China was imported to their capital cities. This difference in starting location makes for a perfect ground for test our hypothesis. Our AB model observes cities while datasets observe districts. Characteristics of the two diseases will be examined in the discussion part.

The dataset used for Covid-19 in Liberia is based on the reports published by the National Public Health Institute of Liberia. For Sierra Leone, the data is according to the reports by The Ministry of Information and Communication. The data for Ebola is based on the Ebola World Health Organization (WHO) situation reports for respected countries. Fig 5. shows new cases of Covid-19 and Ebola in Liberia and Sierra Leone cumulatively.

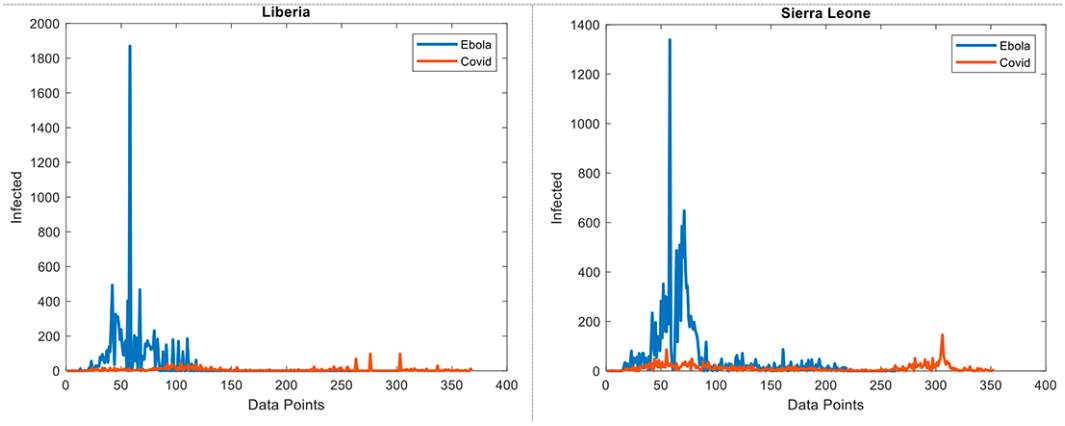

Figure 5. Shows the greater incidence of Ebola compared to Covid-19. Note that the epidemic of Ebola data points cutoff while the Covid-19 continue, the reason being is that the outbreak of Ebola lasted from 25th of March 2014. until the 30th of November 2015. Covid-19 epidemic data points start from the 15th of March 2020 until the 16th of March 2021, with an ongoing pandemic

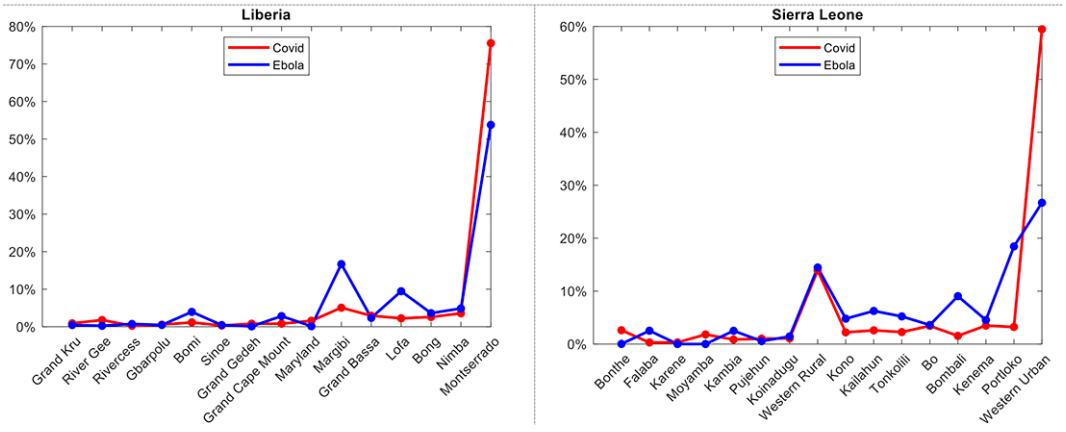

Figure 6. Observes the distribution of infected across country districts, the numbers are presented as a percentage of the total number of infected for easier comparison. The figure points to Ebola being more dispersed across districts, which is observable point by point and percentage-wise

Fig 6. observes the distribution of infected across country districts. Districts are sorted according to their population, with the least populated on the left, country capital cities are in the most populated districts. The starting point for Ebola was in a rural of Guinea in Guéckédou district [WHO, 2015a], neighboring districts Lofa (Liberia) and Kailahun (Sierra Leone).

Covid-19 is much more present in the capital districts of Montserrado and Western Urban with high numbers appearing in their closest districts, Margibi and Western Rural respectfully. The Lofa district (Liberia) is fitting for disease transmission due to its proximity to the location of disease origin. Secondly, it has a well-developed road network further increasing dissemination [Jung et al. 2008].

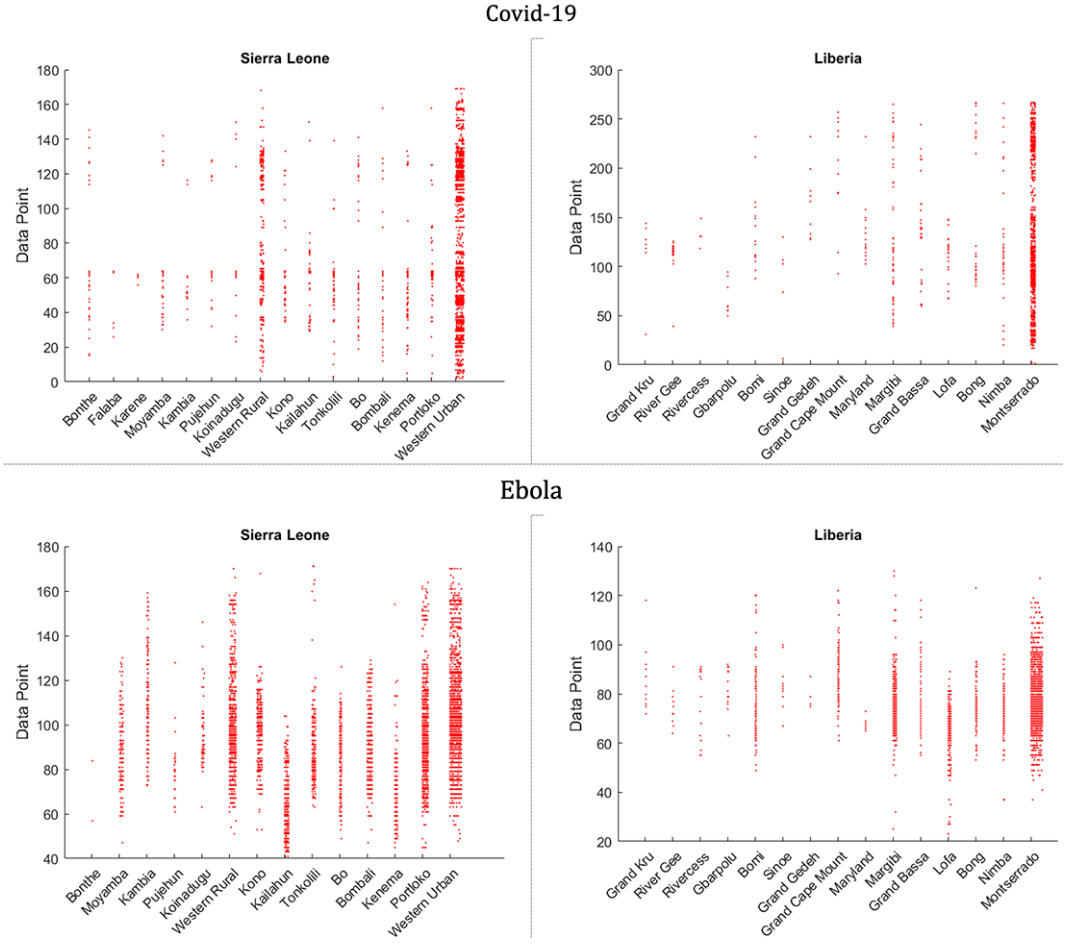

Figure 7. shows the frequency of newly reported cases in Liberia and Sierra Leone across their districts

Table 4. Numerical results of diseases based on real datasets

Disease	Ebola		Covid-19	
Country	Liberia	Sierra Leone	Liberia	Sierra Leone
Maximum Infected	1870	1339	97	146
Standard deviation of Infected	137.24	127.91	10.725	14.794
Total Infected	10678	14124	2042	3947
Hausdorff Dimension	1.1403	1.1535	1.296	1.1309
Lacunarity	14.02	14.953	6.1716	3.6046

Fig 7. shows that even though there are sparingly new cases in other districts the majority is located in the initial, largest, ones keeping to their gravitational attraction. Regarding Ebola, the reservoir nature of districts can be seen in Kailahun and Lofa. We see that the reservoir contains newly infected individuals for some time before the disease spreads to other districts.

Table 4. shows numerical standpoints of diseases. Our focus is on fractal characteristics for discerning dynamics enabling the prediction of future epidemiological curves [Păcurar and Necula, 2020]. Low HD values of Ebola in both countries point to self-similarity and combined with high lacunarity point to high disease dynamics at a certain point, as seen in Fig 3. For Ebola in both countries, the initial spike peaked with the maximum number of infected and was not repeated. Covid-19 has lower lacunarity values showing no significant spikes of infected. Higher HD values show an existing turmoil and dynamics of susceptibility to infection.

Discussion

Demographic gravitation has been used for analyzing disease spreading the focus was not on their potential for containment. Although diseases used for testing our hypothesis are not the same, they present the most documented and concentrated disease (epidemic) observation dynamics in recent decades.

Covid-19 and Ebola are Zoonoses, infectious diseases that originate from wildlife, which represents 60% of known emerging infectious diseases with their numbers growing fast [Stoop et al., 2020]. Both of them most likely originated from bats [Zhou et al., 2020] [WHO, 2015a]. Differences between the observed diseases should have led to a different turn of events. Theoretically, these differences should enable Covid-19 to be more prevalent than Ebola because it is considerably more transmissible [Stoop et al., 2020]. Being exposed to speaking or coughing is more common than to blood or secretions, which are necessary for the transmission of Ebola. Individuals might be asymptomatic and infectious while Ebola patients are not contagious until they develop symptoms [Dean et al., 2016]. Greater lethality of Ebola [Stoop et al., 2020] should have slowed down its progress. Ebola aftermath shows that it has hit more districts and has spread quicker. Even though Covid-19 has started from the largest reservoir it still has not reached its prevalence as Ebola did.

Disease sourcing from rural areas points to behaviors described by our model, those being higher values of lacunarity and maximum infected indicating spikes of infected at a certain period. Ebola also has low HD values in both countries pointing to self-similarity, which is also evident in our simulations. Covid-19 is sourced from capital cities and has lower lacunarity values and no significant spikes of infection. Higher HD values show an existing turmoil and dynamics of susceptibility to infection. The majority of infected are located in the initial cities which keeps to our notion of their gravitational attraction.

Research shows that connectivity matters more than density in the spread of the Covid-19 pandemic [Hamidi et al. 2020] [Therese et al. 2020]. Large cities have a greater probability to become large spreaders compared to smaller locations, namely because of their international connectedness and tight commuting relationships [Hamidi et al. 2020]. On the other hand, porous land borders, as in the observed countries [WHO, 2015b], enable more population movement compared to airports.

In the case of this paper, both diseases have been introduced from abroad but to different sized locations. This puts high emphasis on connectivity and commuting, but the discussion regarding commuting must be linked with its direction. Demographic gravitation explains that large numbers of people act as an attractive force towards other people to migrate in that direction which is further strengthened by economic factors [Therese et al. 2020]. This is in line with our gravitational observation where small locations that have less attractional force are not able to stop people migrating towards larger locations. Large locations keep individuals within them due to the same

force. When daily commute is introduced individuals from smaller locations more often go to large ones than otherwise. All locations have similar sizes of social groups [Mao, 2015] because they depend not on the size of the location but individuals. When an infected is introduced to a small reservoir, the reservoir is filled quicker because of the greater infection probability per capita, as can be seen in several locations [NY Times, 2020] [LA Times, 2020] [Ziff, 2020]. Now, this small reservoir has greater per capita infection probability, and individuals that are drawn by the greater attraction force of larger locations making them a more dangerous place for the infection to start from.

There are several limitations to our study. Disease spreading is influenced by other important factors that we did not describe. Two diseases under scrutiny are not the same and behave differently in different locations. Although the current situation points to our findings being correct, the Covid-19 pandemic is ongoing and the numbers will continue to change. Circumstances in Liberia and Sierra Leone do confirm our findings but they are relatively small-sized and disease dynamics might not fold the same way in other countries. Finally, our findings are based on numerous simulations which are averaged. Real events happen once and can come out of the most unpredictable sources. Nonetheless, our findings point in the same direction.

Conclusion

In this paper, we combine a spatial agent-based model with a compartmental (SIR) model to observe multi-city and cross-country epidemics. We observe that gravity maintains the infection inside the city when the sourcing position of the pathogen is the largest city. Sourcing from the smallest city quickly dissipates the infection across a country. To test our hypothesis, we implement datasets from two countries and two diseases. Disease sourcing from rural areas points to the same behaviors as described by our model.

Our future research will be based on implementing different scenarios regarding infection transmission rates and source population locations expanding them to cities of various sizes and levels of connectedness. We will continue to monitor the Covid-19 pandemic and will compare outcomes with our predictions.

Acknowledgement

The work described in this paper was supported by The Natural Science Foundation of China (Grant No.71971143, 71571120), Natural Science Foundation of Guangdong Province (2020A1515010749), Key Research Foundation of Higher Education of Guangdong Provincial Education Bureau (2019KZDXM030), Guangdong Province Soft Science Project (2019A101002075), Guangdong Province Educational Science Plan 2019 (2019JKCY010) and Guangdong Province Postgraduate Education Innovation Research Project (2019SFKC46).

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APPLICATION OF GIS IN THE ANALYSIS OF LANDSLIDE AND FLASH FLOOD VULNERABILITY ON THE EXAMPLE OF LUŽNICA RIVER BASIN

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Abstract

The application of GIS enables easier and more efficient spatial analysis, modelling of phenomena and processes, as well as predicting future events, and is especially important when investigating processes that degrade environment and endanger humans, other living beings and material goods. Landslides and flash floods are among the natural disasters that cause enormous consequences and often cause human casualties in the territory of the Republic of Serbia. In spite of this fact, for the most part of its territory vulnerability assessment zoning to these disasters was not carried out. The basin of Lužnica River, the right tributary of Vlasina River, is located in the southeast of Serbia, in one of the poorest parts of Serbia. The occurrence of the aforementioned disasters would further burden local communities, which is why a vulnerability analysis in order to reduce the risk is necessary. Using GIS, landslide and flash flood susceptibility zoning was carried out, and based on that, the vulnerability of settlements and road infrastructure was then analyzed. Very high landslide susceptibility was determined on 23.5% of the total basin area, while high landslide susceptibility have share of 20.5%. About 47.4% of the Lužnica River basin territory belongs to the classes of very high and high flash flood susceptibility. Territories of 19 settlements were determined to be of very high or high landslide vulnerability, and it is similar in the case of flash flood vulnerability. Almost 44% of total state roads length is in the very high and high landslide susceptibility classes, and almost all intersections between rivers and roads are considered to be in the class of very high and high flash flood vulnerability.

Keywords: GIS, Lužnica River, Landslide Susceptibility Index (LSI), Flash Flood Potential Index (FFPI), Probability Method (PM)

INTRODUCTION

Landslides and flash floods are the most significant natural hazards within the territory of the Republic Serbia. About 25% of its territory is affected by landslide process (Dragićević et al., 2011), and there are more than 12,000 torrential watercourses (Kostadinov, 2007). Even in recent past, this natural disasters have very often, directly and indirectly affected the environment, population, material and non-material goods. One of the major problems for natural disaster management in Serbia represents the fact that there is no landslide and torrential watercourses cadasters for the entire territory of the Republic of Serbia. In order to reduce risk from this disasters, and to manage hazard and risk in an adequate way, it is very important to allocate zones with a different degree of landslide and flash flood susceptibility and vulnerability. Both processes largely depend

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on natural conditions that are landslide-related and flood-related factors. GIS based analysis of those factors is very important and inevitable part of landslide and flash flood susceptibility assessment, which should mandatory be part of all spatial and urban plans, as well as other planning documents, from the state level to the level of local governments. It should also be part of river basin management, as is the case with the study area of this research.

The Vlasina basin is known for extreme torrential floods, and one of the most devastating occurred on the Vlasina River, on June 26, 1988. The rainfall in certain places in the basin reached up to 220 mm in 4 hours (Gavrilovic et al., 2004), when a third of the average annual amount of precipitation fell on the basin. This caused the formation of a torrent of catastrophic proportions, which carried large masses of surface sediments. The debris made congestion on all profiles of the bridges, which caused a pronounced slowdown in front of them. The flood wave destroyed about 500 houses, 80 km of regional roads, 32 bridges, a dam, a shopping center and a bus station in Vlasotince. (Dragicevic and Filipovic, 2016).

The paper represents a significant step towards for a better understanding of unfavorable natural conditions in the Luznica River Basin, and the obtained results are significant for numerous human activities in the study area, such as environmental protection, sustainable management of agricultural plots and road infrastructure, etc.

MATERIAL AND METHODS

Study area

The Lužnica River is the right tributary of Vlasina River, which is the right tributary of Južna Morava river. Its basin is located in the southeastern Serbia, on the area of 323.94 square kilometers. The highest point of basin has the altitude of 1406 m a.s.l., and lowest 305 m a.s.l., with an average basin altitude of 713 meters.

The territory of Lužnica River basin belongs to the municipalities of Babušnica, Vlasotince, Bela Palanka and Pirot. According to the census of 2011, it had a population of about 9,700 inhabitants, with a population density of about 30 inhabitant per km^2. It is located in one of the poorest parts of Serbia, with very big depopulation problem.

The occurrence of the landslides and flash floods would further burden local communities, which is why a vulnerability analysis in order to reduce the risk is necessary. Previous research, maps and terrain research determined that there are active and inactive landslides in Lužnica River basin that cover area of 49.45 km2, which is 15.24% of total basin area. Also, there were numerous flash flood occurrences in the past.

Methods

First step in determining landslide vulnerability, hazard and risk is landslide susceptibility zonation. For the landslide susceptibility zonation of the Lužnica River basin Probability method (PM) is used. It is based on the presumption that landslide occurrence is determined by landslide-related factors, and relationship between landslides occurring in an area and the landslide-related factors is expressed as a frequency ratio that represents the quantitative relationship between landslide occurrences and different causative parameters (Lee & Pradhan, 2006). The frequency ratio is defined in following formula:

$$W_{ij} = (A_{ij}' \cdot (A - A'))/(A' \cdot (A_{ij} - A_{ij}'))$$

Where: W_{ij} – the weight of class i in parameter j; A_{ij}' – landslide area in a class i of parameter j; A_{ij} – area of a class i of parameter j; A' – total landslide area in the entire study area; A – total study area. The greater the ratio above unity, the stronger the relationship between landslide occurrence and the given factor's attribute (Lee & Pradhan, 2006).

The application of the PM was carried out on the basis of data on lithology of the study area, terrain slope, aspect, curvature classes, distance from the watercourses, and Bare Soil Index (BSI). Lithology data was obtained by digitalization of contents from geological maps (scale 1:100,000) in QGIS software. Terrain slope, aspect and curvature were derived from the 25 m cellsize Digital Elevation Model – EUDEM of the European Environment Agency's Copernicus program. Slope values were classified to 6 classes, aspect values to 8 clasess (N, NE, E, SE, S, SW, W, NW), and curvature to 9 classes acording to values of planar and profile curvature, which can be convex (X), concave (V) or straight (Ge/Gr) (Wilson, 2018).

Distance from watercourses was obtained first by digitalization of all watercourses in the basin from topographic map (scale 1:25,000) in QGIS software, and then appropriate buffer zones were created.

BSI was obtained using the following formula (Diek et al., 2017) on the LANDSAT 8 multispectral imagery:

$$BSI = ((SWIR+R)-(NIR+B))/((SWIR+R)+(NIR+B))$$

Where SWIR is the shortwave infrared spectral channel, R is the red spectral channel, NIR is the near-infrared spectral channel, and B is the blue spectral channel.

Landslide susceptibility index (LSI) is equal to the sum of all parameters weighted values. After LSI value calculation, values were classified into four susceptibility classes (very high, high, medium and low susceptibility), and according to those values in QGIS software the entire Lužnice River basin area was classified to four zones of landslide susceptibility.

Based on and average values of LSI and the share of very high and high classes area in the total territory of the settlements on the territory of Lužnica River basin, classification of the settlement teritories on the four classes of landslide vulnerability (very high, high, medium and low) was performed.

Also, landslide susceptibility zones were intersected with state roads of first and second order in the Lužnica River basin for the determination of their vulnerability to landslide process.

For the flash flood vulnerability assessment the Flash Flood Potential Index method (Smith, 2003) was used, based on the following formula:

FFPI = (M+S+L+V)/4

Where M is terrain slope index, S represents soil type index, L is land use index and V represents vegetation density index. For every index values are within the range 1 to 10 (from least to most susceptible).

Terrain slope (M) index was obtained using GIS, based on a EUDEM and accordnig to folowing formula:

M = 10^(n/30)

Where n is terrain slope expressed in percentage. If n is greater than or equal to 30%, then the value of M is always 10.

Soil type index was obtained by digitizing content from geological maps (scale 1:100,000) in QGIS. Land use index is calculated on the basis of CORINE Land Cover 2018 database of Copernicus program, and vegetation type index is calculated from BSI. For indexes that were based on geological data, CORINE Land Cover data and BSI, values from 1 to 10 were given, depending on the characteristics important for the the emergence and development torrential processes.

Based on the analysis of the obtained values of FFPI the classification of results on the four classes was made (very high, high, medium and low), according to the degree of susceptibility to torrential floods. The results indicate the possibility of a torrential flood emergence in appropriate conditions. Will it be so, depends on many factors, and this is only a predisposition or the susceptibility of territory for the occurrence and development of this disaster (Novković et al., 2018).

Flash flood vulnerability of the settlements was determined based on the FFPI values on their territory and on the relation between watercourses and FFPI spatial distribution. Also, state roads vulnerability to flash floods was determined based on FFPI values upstream from road/river intersection

RESULTS AND DISCUSSION

Lithology is the primary factor of landslide process, because geological formation determines the possibility of landslide occurrence, as well as the process scale. Landslide hazard zones in Serbia are mostly developed on the slopes of Tertirary basins which consist heterogeneous sediment complexes, with complex hydrologic characteristics and unfavourable morphologic conditions (Dragićević et al., 2012). These sediments, occupy 28.6% of the Lužnica River basin, and 87% of the total landslide affected areas in the basin are located in these rocks (Table 1).

Most landslides occur in terrains that are inclined 5 to 10 degrees. In this slope class, which covers 27.6% of the total basin, there is 54% of total landslide area (Table 1). Most landslides are located on the slopes that are inclined to southwest, west and nortwest. On the surfaces of the Lužnica river basin that are 100 meters distant from the watercourses there is 36.9% of the total landslide area, and at a distance of 100 to 200 meters that share is 28.3%. In terrains that are 200 to 300 meters away from rivers there are 17.2% of a total landslide area (Table 1). Most landslides areas are located on the terrains that have BSI+1 value from 0.7 to 1.

Weighted values were used to calculate LSI, and after that classification to zones of different landslide susceptibility was performed. Very high susceptibility class is present on the 23.5% of the total river basin, and in the case of high susceptibility class that share is 20.5% (Table 2).

Table 2. Landslide susceptibility zones in the Lužnica River basin

Landslide susceptibility	km²	%
very high	76.12	23.50
high	66.29	20.46
medium	130.24	40.21
low	51.30	15.83
total	323.94	100.00

LSI and landslide susceptibility classes data were used to classify settlement territories of the on the

Table 1. Total area, landslide area, and weighted values of classes of parameters for LSI calculation

Classes of parameters	Total area		Landslide area		W_{ij}
	km²	%	km²	%	
Lithological types					
Alluvial sediments	13.04	4.02	0.26	0.53	0.1135
River terrace sediments	3.76	1.16	0.81	1.64	1.5290
Rock creeps	3.71	1.14	0.37	0.76	0.6240
Tertiary clastic sediments	92.76	28.59	43.07	87.10	4.8207
Flysch	94.63	29.17	2.05	4.14	0.1231
Mesozoic clastic sediments	22.98	7.08	1.52	3.06	0.3924
Mesozoic clastic and carb. sed.	7.88	2.43	0.62	1.24	0.4707
Mesozoic carbonate sediments	56.17	17.31	0.38	0.77	0.0381
Palaeozoic clastic sediments	3.72	1.15	0.00	0.00	0.0000
Palaeozoic carbonate sediments	2.14	0.66	0.00	0.00	0.0000
Volcanoclastic rocks	0.29	0.09	0.03	0.05	0.5590
Igneous rocks	9.67	2.98	0.34	0.69	0.2047
Ultramaphites	0.30	0.09	0.00	0.00	0.0000
Metamorphic rocs	13.37	4.12	0.00	0.00	0.0000
Slope [°]					
<2	9.26	2.85	0.80	1.61	0.5233
2-5	32.11	9.90	4.34	8.78	0.8690
5-10	89.59	27.62	26.68	53.95	2.3580
10-15	80.05	24.68	14.08	28.47	1.1864
15-20	63.43	19.55	2.95	5.97	0.2716
20-30	45.69	14.09	0.57	1.16	0.0706
>30	4.26	1.31	0.03	0.06	0.0378
Aspect					
N	37.38	11.52	5.28	10.69	0.9155
NE	40.89	12.61	4.23	8.55	0.6416
E	41.17	12.69	2.93	5.92	0.4256
SE	34.42	10.61	3.57	7.23	0.6439
S	39.94	12.31	6.04	12.21	0.9902
SW	51.73	15.95	11.43	23.11	1.5764
W	44.33	13.66	9.86	19.95	1.5917
NW	34.52	10.64	6.10	12.34	1.1941
Curvature classes					
1 - V/V	66.54	20.51	12.63	25.54	1.3028
2 - Ge/V	21.34	6.58	4.89	9.90	1.6545
3 - X/V	21.77	6.71	2.65	5.36	0.7712
4 - V/Gr	22.50	6.93	4.88	9.87	1.5412
5 - Ge/Gr	22.89	7.06	2.87	5.81	0.7978
6 - X/Gr	22.00	6.78	3.47	7.01	1.0408
7 - V/X	25.29	7.80	3.43	6.95	0.8739
8 - Ge/X	28.69	8.84	4.78	9.67	1.1129
9 - X/X	93.39	28.79	9.83	19.88	0.6542
Distance from watercourses [m]					
<100	98.91	30.49	18.26	36.92	1.2588
100-200	80.87	24.93	14.01	28.33	1.1650

Classes of parameters	Total area		Landslide area		W_{ij}
	km²	%	km²	%	
200-300	55.95	17.25	8.50	17.19	0.9959
300-400	32.78	10.11	4.60	9.30	0.9075
400-500	17.52	5.40	1.84	3.72	0.6520
>500	38.37	11.83	2.25	4.54	0.3455
BSI + 1					
<0.5	0.003	0.001	0.00	0.00	0.0000
0.5-0.6	0.51	0.16	0.01	0.02	0.0968
0.6-0.7	11.49	3.54	0.75	1.52	0.3888
0.7-0.8	141.44	43.62	14.06	28.45	0.6137
0.8-0.9	101.07	31.17	18.65	37.74	1.2584
0.9-1.0	55.91	17.24	14.51	29.36	1.9487
1.0-1.1	13.15	4.06	1.41	2.86	0.6695
>1.1	0.66	0.20	0.0304	0.0615	0.2669

Lužnica River basin territory to four vulnerability classes. At 9 settlement territories very high landslide vulnerability was determined: Dučevac, Aleksandrovac, Kaluđerovo, Raljin, Gornje Krnjino, Donji Striževac, Gornje Krnjino, Draginac and Valniš (all in Babušnica Municipality). At 10 settlement territories high landslide vulnerability was determined: Radoševac, Izvor, Babušnica, Stol, Kambelevac, Veliko Bonjince, Gornji Striževac, Vava, Bratiševac and Provaljenik (all in Babušnica Municipality). On these settlements, from the risk reduction point of view, the greatest attention should be paid in the future.

State roads of Ib category in Lužnica river basin have total length of 32.62 km. Of that length, 3.56 km is in the class of very high landslide susceptibility, and 14.45 km in the class of high susceptibility (Table 3). State roads of IIa category have total length of 27.42

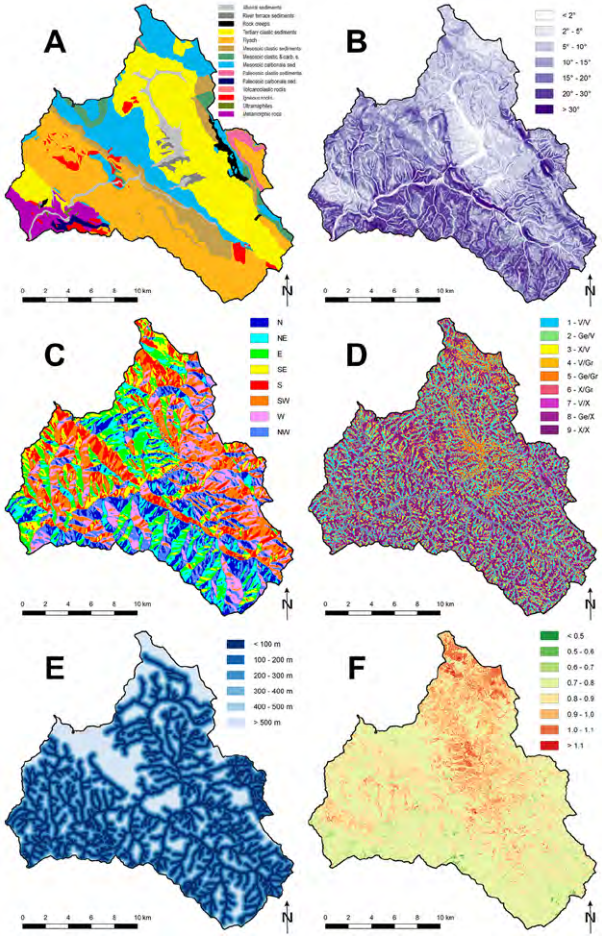

Figure 1. Spatial distribution of parameters in the Lužnica River basin: A – lithology, B – slope, C – aspect, D – curvature classes, E – distance from watercourses, F – BSI+1 [click on figure to enlarge]

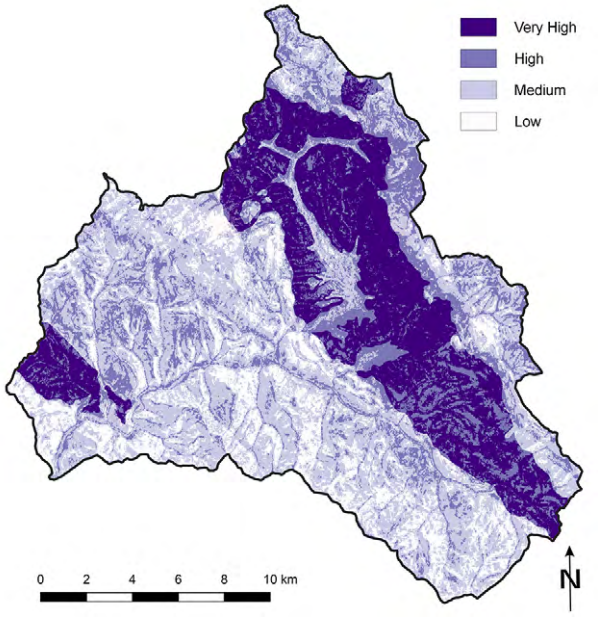

Figure 2. Landslide susceptibility zones in the Lužnica River basin [click on figure to enlarge]

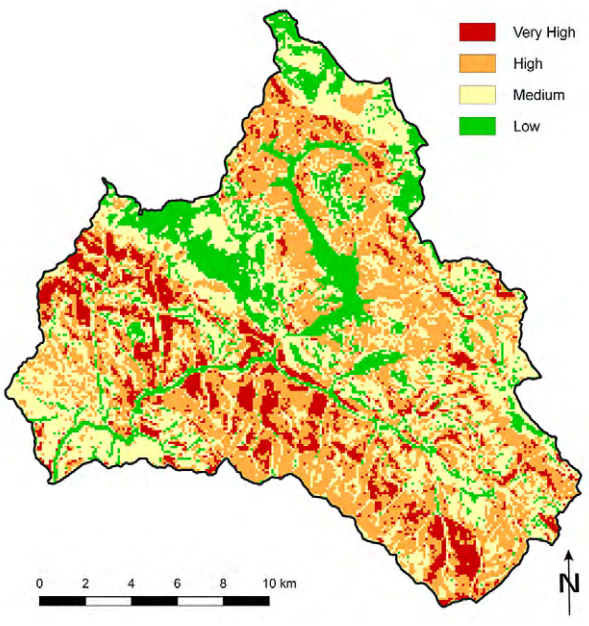

Figure 3. Flash flood susceptibility zones in the Lužnica River basin [click on figure to enlarge]

found that the class of very high susceptibility covers 9.65% of the basin area, the category of high susceptibility 31.21%, medium susceptibility occurs at 39.81% and low at 19.33% of thanalised territory (Lovrić et al., 2019) . In the Bâsca River Basin in Romania (area 785.1 km²), the class of high susceptibility to torrential floods covers an area of 0.85%, medium susceptibility 28.07%, low susceptibility 71.05% and minimum 0.03% (Minea, 2013).

Considering FFPI values, and relation between FFPI spatial distribution and watercourses, most vulnerable to flash floods are territories of following settlements: Gornje Krnjino, Kaluđerovo, Donje Krnjino, Donji Striževac, Ostatovica, Dučevac, Dol, Aleksandrovac, Draginac, Malo Bonjince and Stol (all in Babušnica Municipality).

There were total 45 intersections between watercourses and state roads (Table 5), and 17 of them were classifed in the class of very high flash flood vulerability, with 27 more in the class of high vulnerability. Considering that fact, and the fact that there were no intersections in the class of low vulnerability, and only one in the class of medium vulnerability, it is necessary to pay great attention to risk reduction measures in the future.

Table 3. State road landslide vulnerability in the Lužnica River basin

State road category	Low [km]	Medium [km]	High [km]	Very high [km]	Total length [km]
I b	1.42	13.19	14.45	3.56	32.62
II a	0.05	2.45	7.77	16.97	27.24
Total	1.47	15.64	22.22	20.63	59.86

km in the Lužnica River basin, and 16.97 km of that length is in the class of very high landslide susceptibility, with 7.77 km in the class of high susceptibility.

The analysis of the results after the classification of obtained values of FFPI, showed that a class of very high susceptibility is represented at 39.72 km², or on 12.3% of the Lužnica River basin area, a high susceptibility on 113.74 km², which represents 35.1% of total basin area. A class of medium susceptibility occupies 36.4%, and a low susceptibility class 16.3% of the total basin area (Table 4).

Table 4. Flash flood potential zones in the Lužnica River basin

Flash flood potential	km²	%
very high	39.72	12.26
high	113.74	35.11
medium	117.83	36.38
low	52.65	16.25
total	323.94	100.00

Susceptibility to torrential floods by FFPI method was also analyzed in the region, Republika Srpska (BiH), for the Ukrina river basin. In Ukrina river basin, which covers an area of 1498.81 km2, it was

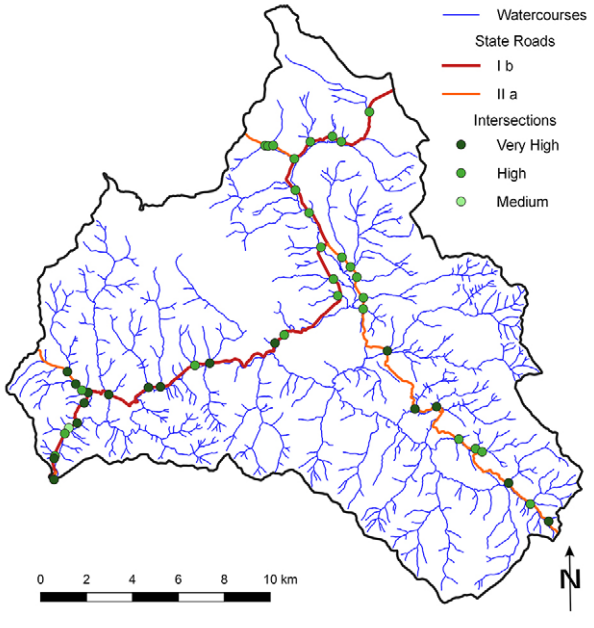

Figure 4. State roads flash flood vulnerability on intersections with rivers [click on figure to enlarge]

Table 5. State road flash flood vulnerability in the Lužnica River basin

State road category	Low	Medium	High	Very high	Total locations
I b	0	1	14	9	24
II a	0	0	13	8	21
Total	0	1	27	17	45

CONCLUSION

The landslide and flash flood susceptibility and vulnerability assessment and zonation are very important elements of the decision making process in natural hazard management. They should represent mandatory part of all documents related to spatial planning and management, especially in vulnerable areas. Application of GIS in such cases is of utmost importance because it is the only possible way to integrate and analyze all relevant spatial data, and make decisions according to those analysis.

This research have shown that the Lužnica River basin is vulnerable to landslide and flash flood occurrence. Very high landslide susceptibility was determined on 23.5% of the total basin area, while high landslide susceptibility have share of 20.5%. In 19 settlement territories very high or high landslide vulnerability was determined, and large parts of state roads that run through basin are also in the classes of very high and high landslide susceptibility. Large part of teritory is also vulnerable to flash flood occurrence. About 47.4% of the Lužnica River basin territory belongs to the classes of very high and high flash flood susceptibility, there a lot of vulnerable settlements, and state road network is particularly vulnerable to occurrence of this disaster.

Obtained data must be taken into account when measures in the areas that are identified as vulnerable are conducted, when further development of the basin territory is being planned, all in order to prevent damage from this disasters in the future.

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SHORT-TERM FORECAST IN FUNCTION OF ADAPTATION TO A POTENTIALLY DANGEROUS TIME: CASE OF HURRICANE WIND GUST (MONTENEGRO)

Dragan Burić[A*], Miroslav Doderović[A], Jovan Dragojlović[B], Ivana Penjević[B]

Abstract

In the last two decades, there has been no year in Montenegro in which some weather extreme has not been registered. The aim of this paper is to highlight the importance of an short-term forecasts of potentially dangerous weather phenomena in the example of one case in Montenegro. Based on the analysis of the synoptic material, the warning of the expected weather conditions was given two days before. In this particular case, on December 4, 2008, a gust of 234 km/h was registered in the Herceg Novi area (Bay of Kotor) - the strongest wind gust ever measured in Montenegro. The warnings of the competent institutions should be respected in order to adapt the population to the expected extreme weather situations and thus avoid or mitigate the negative consequences.

Keywords: early announcement, weather extremes, Montenegro

Introduction

With very high reliability, the IPCC indicates that human influence has been the main cause of observed warming since the mid-20th century (IPCC, 2014). In both the IPCC Fifth Report and earlier, it was pointed out that changes in the intensity and frequency of extreme weather events such as droughts, floods, extreme temperatures, heat waves, stormy weather followed by the hailstones, heavy short-term rainfall were recorded in many regions of the world etc. There are numerous works highlighting the increase in the frequency of extreme weather and climate events in almost all parts of the world. Research by Vose et al. (2005) indicates that the minimum rather than the maximum temperature increases more intensively in most of the planet. In New Zealand, the opposite is happening (Caloiero, 2017).

It is worth mentioning that in the territory of Montenegro, for the period 1951-2010, there is a more intense increase of maximum than minimum temperature (Buric et al., 2011). The warming of the Northern Hemisphere was reported in the paper by Alexander et al. 2006. Rainfall is increasing in Pakistan (Ahmed et al., 2017), and heavy droughts are recorded in the west of Patagonia (Garreaud, 2018). Extreme rainfall and droughts in northeast China are reported in the paper by Faiz et al. (2018). In recent decades, the southeast of the United States has been repeatedly hit by severe droughts (Engström, & Keellings, 2018).

The Mediterranean region is also affected by extreme temperatures and precipitation (Efthymiadis et al., 2011; Kostopoulou and Jones, 2005; Brunetti, 2006; Del Rio et al., 2012; Caloiero et al., 2017). Extremes are also registered in the Balkans, so Tosic and Unkasevic (2014) indicate that Serbia has more frequent droughts in the southern part of the country than in other regions. Analyzing 6 indices of climate extremes, Unkasevic and Tosic (2013) indicate that the trend of increasing maximum and minimum temperatures in Serbia in the period 1949-2009 is registered, to be precise; the climate in this country be-

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comes warmer. In the territory of Slovenia, the survey results for the period 1963-2012 indicate a significant decrease in precipitation (Milosevic et al., 2016), or a significant trend of temperature increase in the period 1963-2014 (Milosevic et al., 2017). Over the past few decades (1961-2015), the warming trend has been present throughout neighboring Bosnia and Herzegovina (Trbić et al., 2017).

Accordingly, we are witnessing a high incidence of weather extremes. Montenegro is not spared from extreme weather events. In the last two decades, this small Mediterranean country registers at least one time extreme each year. A propos, the region of Southeastern Europe, to which Montenegro belongs, is one of the most vulnerable areas of climate change (IPCC, 2014; Marx et al., 2017). In an era of modern climate change and the increased incidence of extreme weather events, it is indisputable that the role of national meteorological services, above all weather forecasters, will be increasingly important in the future. In this regard, the main aim of this paper is to emphasize the importance of short-term weather forecast, which will increasingly be in the function of adaptation to potentially dangerous weather. That is why this paper deals with a synoptic analysis of a potentially dangerous weather phenomenon that occurred on December 4, 2008, which is, among other things, a hurricane wind with gusts reaching speeds in excess of 200 km/h. Two days earlier, the products of numerical models indicated potential extreme weather. Timely warnings of potentially hazardous weather events, given by the competent services, are of great importance for the local community and should be respected in order to avoid human casualties and mitigate material damage.

Research area, databases and methodology

Research area

The study covers the area of Montenegro, with special reference to the Boka Bay, where the strongest wind gusts were recorded during instrumental measurements. Montenegro is very heterogeneous in relief and the configuration and orography of the Bay of Kotor are very complex. In geomorphological terms, Boka Bay is a unique entity of the Adriatic Sea. The bay is surrounded by slopes of mountains whose peaks rise above 1500 m (Orjen, 1894 m; Lovćen, 1749 m) and has a specific shape with two narrows and two extensions (Figure 1). The shape of the bay has quite a strong impact on wind speed and direction. Specifically, the south quadrant winds are getting stronger in the Bay as the currents are tight. In the southern currents, the air forcibly rises along the slopes of the mountains, that is, its cooling, the condensation of water vapor, the formation of frequent thunder-storm clouds, and the precipitation of typical orographic types. The north and northeast wind (bora) in the winter cools the air in the bay, while in summer it can raise its temperature. Due to the configuration of the terrain, stronger winds in the Bay often form eddy currents.

In the immediate hinterland of the Bay of Kotor is Mount Orjen, on whose slopes is the site of Crkvice, known for its heavy rainfall. The average annual rainfall in Crkvice is about 4622 mm - probably the wettest place in Europe. Such a large amount of precipitation is undoubtedly due to the position of the Crkvice in relation to the dominant moist air masses from the south, so Ducić et al. (2012) relate extreme rainfall in this mass to certain types of atmospheric circulation, shown by the "SynopVisGrosswetterlagen" (SVG) series, which is part of the Hess and Brezowsky Grosswetterlagen (GWL) system.

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Figure 1. Location of the Boka Bay in Montenegro

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Materials and methods

For the purposes of analysis, we used data on the ground and altitude structure of the atmosphere, the outputs of global (GFS and ECMWF) and operational (WRF-NMM) models, then the synoptic instability parameters, the SYNOP report from the meteorological station in Herceg Novi, and other analytical and prognostic material. Except for methods of analysis and synthesis, categorization of precipitation was done by percentile and standard deviation method.

Results and Discussion

On December 4, 2008, Montenegro was hit by a severe storm. Particularly affected was the coastal part of Montenegro, where in a short time a large amount of rainfall was emitted, there were locally stormy and hurricane-force wind gusts, and severe thunderstorms were recorded. Two days prior to the storm, the Center for Weather Forecast of the Institute of Hydrometeorology and Seismology of Montenegro (IHMS) announced that there is a possibility of strong local instability in the form of short-term rainfall, hurricane-force winds and thunderstorms. The day before (December 3, 2008), the weather models confirm the variability of the atmosphere and the IHMS provides a red meteorological alarm for the coast of Montenegro, that is, the highest level of warning of expected weather conditions. On the same day (December 4, 2008), an orange or yellow meteoalarm (middle and lower alert levels) was given for the area of the central and northern region of Montenegro.

On the AT 500 hPa altitude map from 00h UTC, the vast valley from the north in the direction of the Tyrrhenian Sea can be seen. The pressure at the center of the ground cyclone, located above the Ionian Sea, was lower than 990 hPa (Figure 2 - a). So, it is a deep depression with an increased barometer gradient in the south of Italy and Montenegro, which already indicated that an increased wind was to be expected. Analysis of synoptic material 6 hours later (12h UTC) for December 4, 2008 shows that the structure of the atmosphere did not change much, except that the center of the ground cyclone moved slightly north - above the south of Italy (Figure 2 - b). There was still an influx of moist and unstable air across the southern Balkans and the Montenegrin region both in height and in the ground layer. As a consequence of such an atmosphere structure, occasional rain, moderate to intensified, with gusts and strong wind from the east direction and thunderstorms, should have been expected in the territory of Montenegro.The synoptic maps from 12h UTC show that the pressure field shifted east-northeast, so that the axis of the altitude valley extended through Italy and the center of the terrestrial cyclone was above the southern Adriatic (Figure 2 - c). Such an atmosphere structure suggested that intensification of the instability process should be accounted for, which later analysis of SYNOP reports from meteorological stations confirmed.

After 6 hours (18h UTC), the center of the ground cyclone with the frontal wave moved across Montenegro and further to the north and its filling was observed, i.e. its gradual weakening and disappearance thereafter. The axis of the altitude valley then extended from Britain through the Western Balkans (Figure 2 - d). Thus, the analysis of the global GFS model for Europe clearly indicated that the bulk of the instability process in Montenegro was expected between 12-18h UTC December 4, 2008, that is, the rapid development of storm-thunder clouds (cumulonimbus) should be counted. SYNOP material from meteorological stations confirmed this, because in the mentioned period there was moderate to heavy rain, short periods of showers and heavy thunderstorms. Almost all meteorological stations in Montenegro registered and increased gusts and strong east winds, and the coastal and central parts of the country storm and hurricane-force winds.

Analyzing the cloud maps, it was clear that this was a frontal disorder, because during the previous day (December 3), the cloud system had changed properly - from high cirrus clouds (Ci and Cs - cirrus and cirrostratus), to medium clouds (As and Ac - altostratus and altocumulus) to low (Cu - cumulus and Sc - stratocumulus) and eventually the appearance of cumulonimbus (Cb). Further analysis of the products of the GFS model confirms that the strongest instability should be expected precisely between 12-18h UTC on December 4, 2008, because during that period the zone of extreme humidity was reaching over Montenegro - 90-95% (Figure 3).

The previously discussed prognostic maps clearly indicated that Montenegro was under the influence of moist and unstable southwest, south and south-east currents within the pressure altitude valley, i.e. ground cyclone. It could further be concluded that the cold

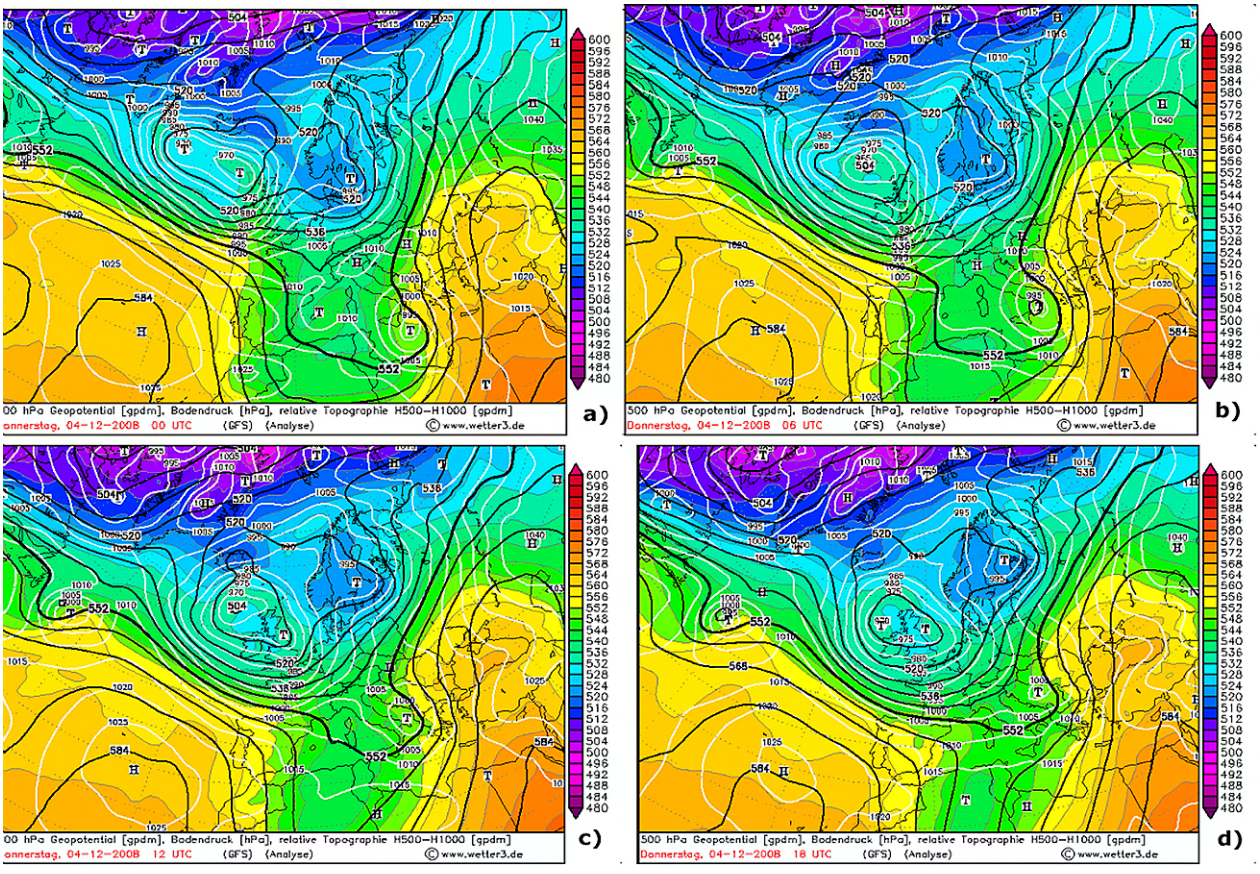

Figure 2. Structure of the atmosphere at ground and at 500 hPa December 4, 2008. (a - 00h, b - 06h, c - 12h and d - 18h UTC)

front would cross Montenegro just between 12-18h UTC on December 4, 2008. It is interesting that one of the best indicators of instability, the CAPE index, did not indicate such a turbulent process. The projected convective available potential energy (CAPE) was projected to be below 1000 J/kg (700-900 J/kg), which by gradation is an indicator of poor instability (Figure 4, a and b). Ulbrich (2016) gives the possibility that this index does not show high values precisely when there is a so-called MU CAPE, which occurs under conditions where the air mass comes from the zone of maximum instability and passes over a given area.

Even the Lifted index (LI index) did not indicate strong instability - the forecast value for the territory of Montenegro is about -2, which means that, according to this indicator, a poorly developed thunderstorm process was possible. The LI index values of -4 to -2 are indicative of probable thunderstorms, and if LI < -4 this indicates a stormy development of Cb clouds and severe thunderstorms. Nevertheless, the nega-

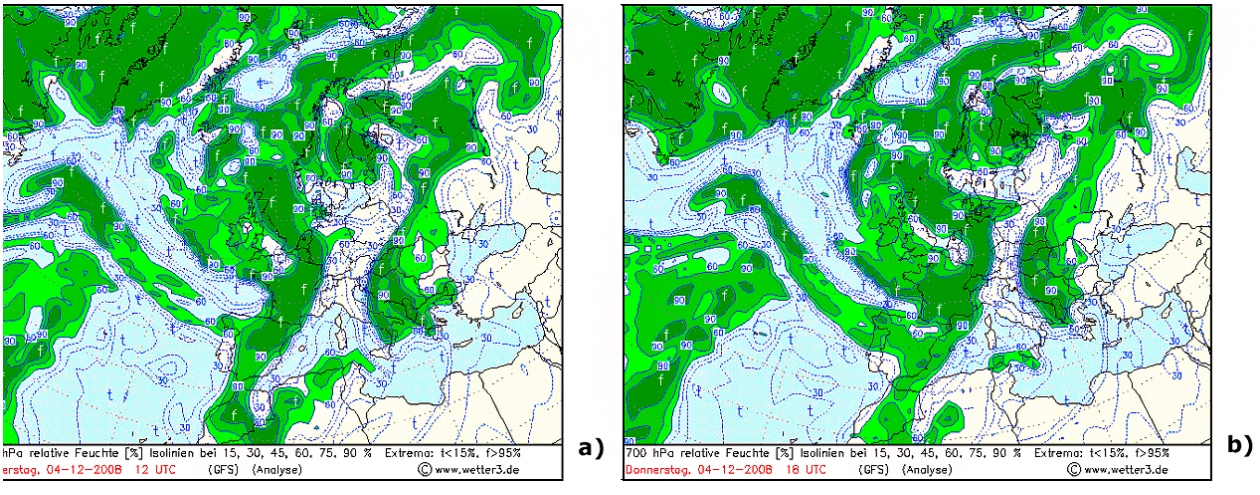

Figure 3. Relative humidity at 700 hPa at 12h (a) and 18h (b) UTC December 4, 2008

tive value of the Li index (Figure 4, a and b) indicated that the ground air rises warm and less densely than the higher layers of the troposphere, which means that the atmosphere is unstable. Otherwise, when the temperature difference between the high altitude and ground air is positive (Li index positive), then the air is stable (the case of temperature inversion).

However, two other indices indicated that stormy thunderstorms should be expected to develop rapidly. One is the KO index, an indicator of the potential adiabatic stability of the air mass. If the value of the KO index is> 6, no storm is to be expected, and if from 2 to 6 rare, isolated thunderstorms are possible, whereas KO < 2 indicates a high probability of strong thunderstorms (Kunz, 2007). Between 12-18h UTC December 4, 2008, the estimated value of the KO index along the Montenegrin coast was about 0 (Figure 4, under c and d), which indicated the turbulence of the process.

Another index considered also indicated a tumultuous development of time, namely the Soaring Index (Figure 4, under e and f). This index shows the turbulence of the rising air due to thermal convection and the formation of convective clouds (Cu and Cb). The kelvin (K) temperature at 850 hPa and 500 hPa surface is taken into account for calculating this index. Soaring index is a good indicator of flight conditions, so it is used in aviation meteorology. This index is rarely used in the weather forecast, but experience shows that it is a pretty good indicator of atmospheric instability. In the territory of Montenegro, between

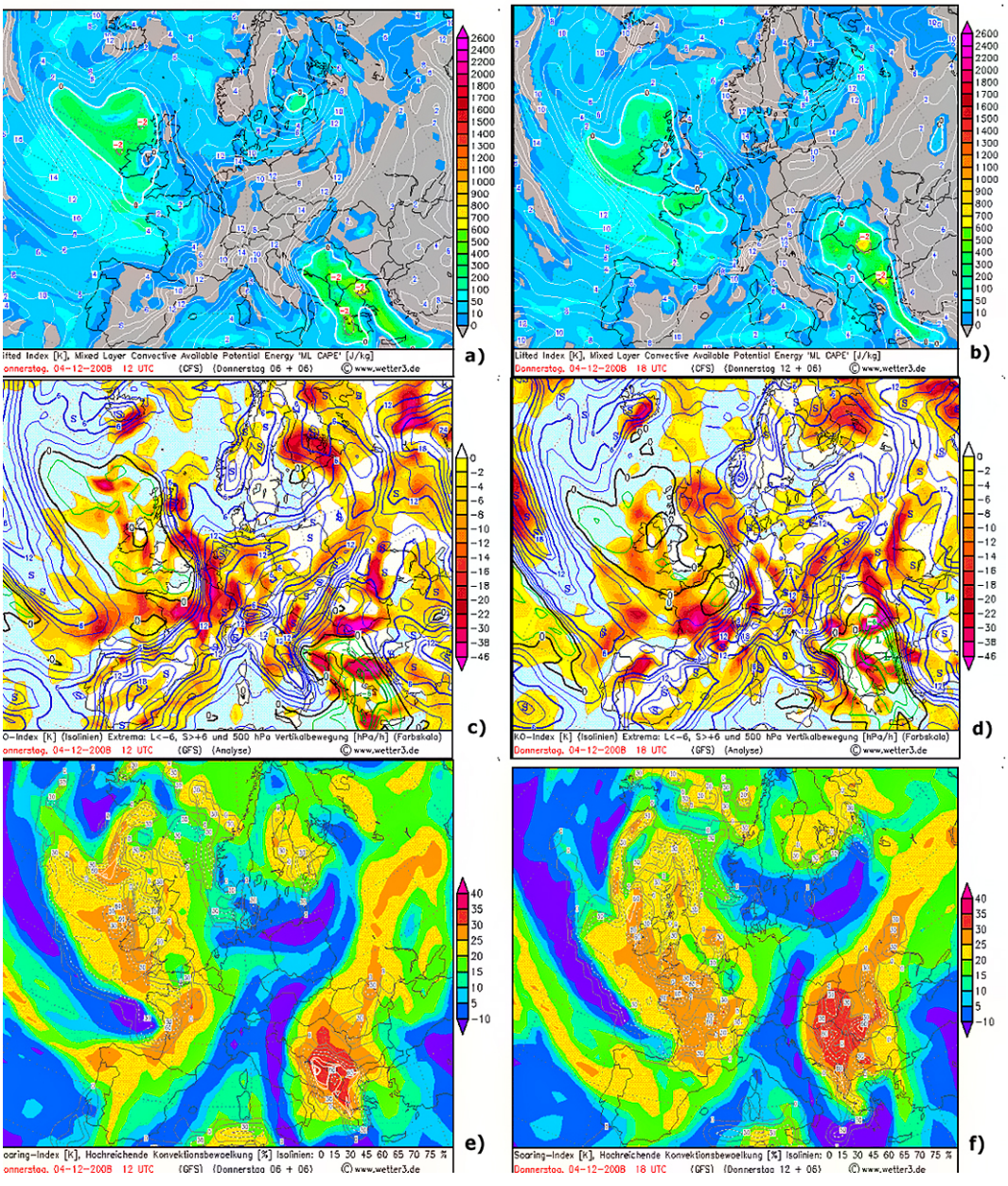

Figure 4. Instability indices: CAPE and LI (a and b), KO (c and d) and Soaring Index (e and f) at 12h and 18h UTC December 4, 2008w

12-18h UTC, the forecast value of the Soaring index was above 35 K, which according to the gradation (Table 1) indicates that with over 80% probability we can expect thunderstorms (strong wind, showers and thunderstorms).

Table 1. Critical values for the Soaring Index

Soaring Index	Convective potential
15-20	Isolated showers, 20% risk for thunderstorms
20-25	Occasionally showers, 20-40% risk for thunderstorms
25-30	Frequent showers, 40-60% risk for thunderstorms.
30-35	60-80% risk for thunderstorms.
35 +	>80% risk for thunderstorms

https://www.weatheronline.co.uk/cgi-bin/expertcharts?MODELL=gfs&MODELLTYP=1&VAR=soin&INFO=1

The analysis of better resolution synoptic maps of the regional WRF-NMM model, which is in operational use in IHMS, also indicated that potentially dangerous weather events should be expected. However, IHMS has only had an archive of forecast material available since 2012. According to the forecaster, the maximal intensity of reflexivity was particularly striking, which was around 40 dbZ (decibels) between 12-18h UTC (December 4th, 2008), and the Cb reflection on the Montenegrin coast at that time reached close to 50 dbZ. Such high Cb-reflection values are an indicator of the stormy development of thunderstorms.

As confirmation of the analysis of the prognostic material, we also considered the analytical material. On the 12h and 18h UTC press maps, UTC 4 December 2008 at 12h UTC, the center of a deep cyclone above the south of Italy could be observed and within it a cold front crossing the southern Adriatic, coastal Montenegro, Albania and western Greece (Figure 5, under a). Already at 6pm UTC the frontal wave crossed over Montenegro and was transformed into an occlusion front, which was in line with the aforementioned that then cyclone filling and gradual attenuation occur (Figure 5, under b).

Finally, the analysis of SYNOP reports from meteorological stations in Montenegro for 4 December 2008 confirmed almost completely the accuracy of the weather forecast from the previous two days. The forecast was confirmed the day before (December 3, 2008). According to measured data given in the form of an encrypted SYNOP, heavy rainfall fell on December 4, 2008, storms were recorded, and hurricane-force winds occurred on the coast. On that day, over 50 mm of rain fell in some places, and in the southwest of Montenegro (Cetinje, Crkvice, Herceg Novi), rainfall between 60-91 mm was measured. In Herceg Novi, 40 mm of rain fell in less than 3 hours (15-18h). The percentile and standard deviation methods showed that in December 4, 2008, rainfall in many places in Montenegro was in the category of extreme rainfall - above 3 standard deviations, that is, deviations greater than the 98th percentile of the normal distribution. The Herceg Novi Meteorological Station, shortly before 16h UTC, registered a gust east

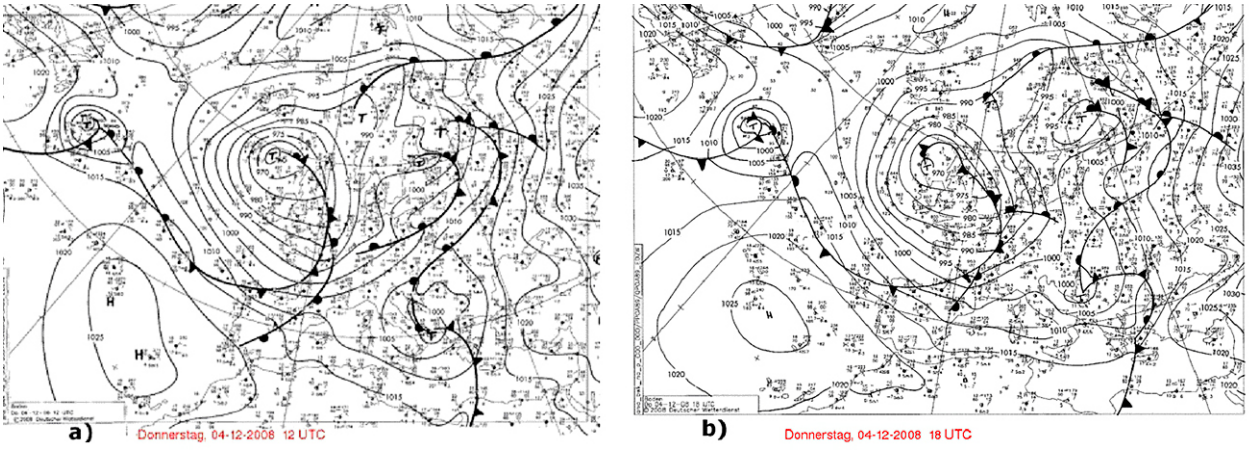

Figure 5. Ground analysis map above Europe at 12h (a) and 18h (b) UTC December 4, 2008

wind of 65 m/s or 234 km/h (Figure 6) - the strongest wind gust ever measured in Montenegro. According to the Torro Scale, which is used to evaluate tornado and leech strength (Meaden, 1976; Meaden,1985), a gust of 234 km/h classifies 5 out of a possible 11 classes. Fortunately, there were no human casualties or much material damage. It is possible that this kind of wind blow is the result of strong leverage. Namely, there was overheating of the ground air and its sudden rise and cooling, the variability of the atmosphere in height, that is, sufficient moisture and latent energy. Such conditions are favorable for the rapid development of storm-thunder clouds (Cb), that is, the formation of leeches or thrombus. True, the meteorological technician on duty did not record the occurrence of

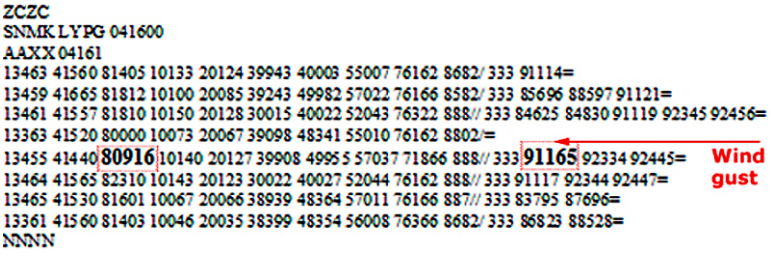

Figure 6. SYNOP report for major meteorological stations in Montenegro for December 4, 2008 (Meteorological station Herceg Novi - 13455: group in SYNOP 80916 - mean wind speed 16 m/s; group in SYNOP 91165 - wind gust of 65 m/s)

a Cb swirl (leech or thrombus), which does not mean that it was absent, since it is a purely local phenomenon.

Some extreme weather events in Montenegro have been written in the works of Burić et al. (2011; 2014; 2016; 2019). In the period 1951-2018, in Podgorica the number of days with extreme rainfall ≥ 40 and 50 mm is increasing (Burić and Doderović, 2019). The results presented in this paper were intended to indicate the reliability of numerical modeling products for the purposes of short-term weather forecasting. Thanks to more reliable numerical modeling products (prognostic or synoptic material); the degree of accuracy of the short-term weather forecast is very high today.

Conclusion

The aim of this research was to highlight the importance of a short-term weather forecast, which will be of increasing importance in the era of contemporary climate change and extreme weather phenomena, based on a specific weather disaster, which occurred on December 4, 2008. The analysis of prognostic and analytical maps, the instability index of the atmosphere and other synoptic matter, indicated the storm in Montenegro and the potentially dangerous incidents in the afternoon on December 4, 2008, initialization two days before the storm. The prognosis was almost fully realized - there were short periods of heavy rain, heavy rainfall, storm and hurricane-force winds, and strong thunderstorms. The Herceg Novi Meteorological Station registered a gust of 65 m/s or 234 km/h - the strongest wind gust ever measured in Montenegro.

The aim of the analysis in this paper was also to point out the need to heed the warnings given by the competent services in order to preserve human lives and avoid unintended consequences. Namely, in the last two decades there has not been a year in Montenegro where no time extreme has been registered - high temperatures, heat waves, floods, prolonged droughts, fires. Thanks to more reliable numerical modeling products (prognostic or synoptic material), the degree of accuracy of the short-term weather forecast is very high today, which will be of great importance in the future, as projections indicate an intensification of the frequency and intensity of dangerous weather phenomena. Therefore, short-term weather forecasts will increasingly serve the purpose of adapting to potentially dangerous weather. When a warning is issued on the expected time extremes, there is a great potential for avoiding or at least mitigating the negative consequences, first of all, of human lives.

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CLIMATE CHANGE AND GLOBAL ECONOMIC CONSEQUENCES

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Abstract

Climate change is perhaps one of the greatest global challenges of the 21st century since it could threaten and change the structure of biodiversity of an entire ecosystem. All the above-mentioned is mainly caused by human activities and adapting nature to human needs. Humans want to live as comfortably as possible, which means that the roots of the problems are economic in their essence, or more precisely it could be said that they are related to the manner of production and striving for faster economic growth. Paradoxically, climate change will have the greatest impact on the economy, in addition to the deterioration of overall well-being. Although the largest greenhouse gas (GHG) emissions mainly originate from the richest countries, the poorer ones will be the most affected by these changes, as they have less adaptability. However, climate change is a global problem and these changes do not distinguish national or administrative boundaries. Not all countries are equally threatened, and climate reactions will not occur equally everywhere, but no single country could solve this problem on its own. Global issues can only be solved through a global strategy involving both rich and poor people's united efforts.

Keywords: climate change, global warming, economic growth, EKC

INTRODUCTION

The increasing scope of production, which represents the economic reality of post-industrial society, necessarily causes more intensive usage of natural resources. A traditional anthropological approach to economics cannot address the issues of overusing natural resources, so there is a need for moving from an anthropological to a holistic approach in business management and economic development.

In a contemporary context, climate change becomes intensive after the industrial revolution of the 18th century. They represent the consequences of predominantly anthropogenic forms of pollution. The consequences of climate change cannot be fully understood, but it is obvious that they include various problems, such as threatened population health, changes in global temperature, damage of the ozone layer, changes in the environment, and similar problems. All the above-mentioned problems affect the economic development directly or indirectly, as they affect the raw material base, the state of flora and fauna, the health status of the working contingent and customers, the forms of production and consumption, the relocation of the capital, which ultimately affects height and structure of social wealth.

The relation between climate change, as a very broad concept on the one hand, and the economy, on the other, is two-sided and interdependent. The entire nature, understood in its broadest sense, was always the basis for survival and, later, for economic development. Primary economic activities, such as agriculture, forestry, hunting, and fishing, are involved in creating social wealth and mostly depend on the state and changes in climate. Secondary activities, including mining, industry (which cannot survive without a raw material base from nature), manufacturing, and construction, are also directly dependent on climat-

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ic characteristics of the area where they are operating. Tourism, catering, and other service or tertiary activities are also (in)directly dependent on climate (Bakić & Hrabovski Tomić, 2010).

Scope and the quality of production and consumption directly depend on nature, as it is the source of the raw material base, but also the agent of absorbing the produced waste and pollution (water, air, soil, noise…). For these reasons, when certain localities became over-polluted or the raw material base became depleted, production (of the capital) moves into a new area, which becomes a new object of economic exploitation. The dependence of the economy and its further development on the state of the natural environment is rather obvious. Economic dependence on nature is a global characteristic of both developed and underdeveloped countries. However, developed countries cope with these problems more easily, by moving their capital to underdeveloped countries where environmental regulations are minimal or even non-existent (Munitlak Ivanović & Mitić, 2018).

As already mentioned, the economy draws the resources from nature, but it also emits residues of production, all kinds of waste, and it mainly causes negative externalities for nature itself (Mitić, Munitlak Ivanović & Zdravković, 2017). Attempts to reduce the effects of pollution are usually related to superficial changes. Proponents of the pessimistic view find the arguments in the fact that there is still no adequate solution for the most environmental problems caused by the accelerated development of the economy. Most technical solutions resulted in transferring pollution from one medium to another. For example, the paper industry might set water filters to solve the problem of water pollution, which produces large quantities of toxic sludge that must be burned in special stoves or disposed of in special places. Thereby, the problem of water pollution is transformed into the problem of air or soil pollution (Jost, 1996).

CLIMATE CHANGES AND GLOBAL WARMING

There are different ways in which climate changes could be defined, depending on what is being emphasized and what is being analyzed. For this paper, related to climate change and economic development, climate change will be defined as a long-term following of statistics on the movement of the climate system, depending on the sources causing the changes (Theodore, 2001). A statistical measurement of the climate system should cover all available data (depending on the cause of climate changes). Climate change occurrence that is less than a few decades old is not considered climate change per se. This paper considers the impact of humans on the climate and the event of global warming. Some general characteristics would be related to the rise of the global temperature and changes in long-term weather conditions, scarcity of clean drinking water, but also the groundwater, more frequent occurrence of large forest fires, warming of large water surfaces and raising the sea level, an extension of the cold season, amount of snowfall and snow cover, etc. All the aforesaid problems affect the life of flora and fauna worldwide.

Meteorological term - climate, as a system of meteorological factors that represent the average characteristics of the atmosphere over a period of time knows no national or administrative boundaries. Any climate problem will not only economically affect a narrow geographical area. Specific problematic climate phenomena will not respect international agreements and national borders; they will expand depending on non-anthropogenic factors. For example, a forest fire occurring in a border area of one country could easily cover the other countries, without considering political and economic relations between those countries. There is a synergy in nature, which is also one of the main characteristics of the effects of natural phenomena, including climate change. For this reason, approaching climate changes from a global perspective and considering this phenomenon as a significant global problem might produce concrete and long-term results.

Inevitable trend accompanying the climate change and global warming in our part of the world is hitting the Danube-Carpathian basin the fastest. It has simultaneously affected all countries covered by the basin, including Serbia, where climate changes became clear.

It could be said that global warming is an increase in the average temperature of the Earth's atmosphere and oceans in the observed period, but it could also be considered by a projected increase in average temperature in the future (NASA, 2018). It is a change in the Earth's climate system resulting from a long-term rise in average temperature. From the abovementioned facts it is evident that, in this context, the terms climate change and global warming are used almost synonymously (NASA, 2018). However, these are not synonyms, as climate change represents a much broader term encompassing global warming and its negative consequences (melting the huge ice masses such as glaciers, lack of water rainfall, or excessive water rainfall). 'Global warming is one of the symptoms of

a much larger problem of climate changes caused by human activities' (NOAA Climate, 2015).

The following Figure 1 is indicating the temperature anomalies and deviations from the average, measured by degrees Celsius, which clearly shows an increase in global temperature throughout the observed period. Previous research showed that over the last 100 years, Earth's temperature increased, slowly but steadily. Nowadays, temperatures are 0.74 degrees

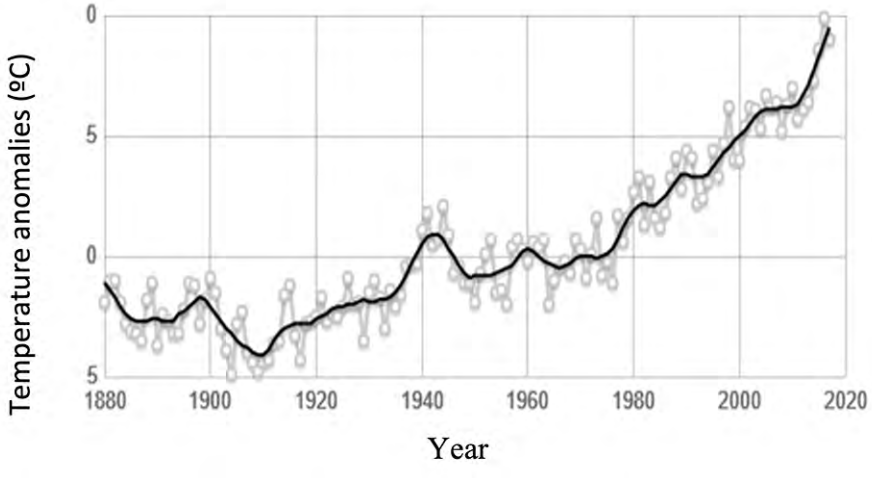

Figure 1. Temperature anomalies and deviations from the average measured by °C
Source: Global surface temperature. (03.05.2018). Global surface temperature | NASA Global Climate Change. Retrieved 15/11/2019: https://climate.nasa.gov/vital-signs/global-temperature/

Celsius higher than 150 years ago (Global surface temperature, 2018).

An analysis of global warming indicated that there are several main causes:

1. Deforestation of the forests, which, on the one hand, produces the oxygen necessary for life and on the other hand absorbs a significant amount of carbon from the atmosphere. Therefore, the global temperature is rising, as deforestation affects carbon absorption, which has a direct effect on the rise in global temperature.
2. Creating the greenhouse effect that reflects radiation emitted by the Earth and prevents it from leaving the atmosphere. On the one hand, without greenhouse gases, the Earth's temperature would be extremely low for most species, but on the other hand, economic activities that add large amounts of greenhouse gases to the atmosphere are contributing to an increase in the Earth's temperature.
3. Through their activities, people release carbon dioxide (CO_2) into the atmosphere. It could be released through the combustion of fossil fuels (oil, coal, or natural gas). The intensification of livestock production increases the emission of methane (CO_4) into the atmosphere. Secondary economic activities, such as mining and certain industrial processes, release the stored carbon from the Earth into the atmosphere. It is a process of extraction of fossil fuels that affect global warming (Lerche, 2001).

No matter what causes global warming, the most significant negative consequences are:

1. *Intense melting* of large ice surfaces on the Earth's poles, but also in the Andes, Himalayas, Alaska, Alps, etc.
2. *Sea level rise* because of melting the large ice surfaces whose water affects the growth of its quantity in the oceans. On the other hand, increased average temperatures affect the thermal expansion of these waters.
3. *Desertification* of semi-arid and arid regions, which are further drying up because of global warming, thereby altering the patterns of rainfall, are leading to the undesirable occurrence of water shortages.
4. Frequent *occurrence of severe and devastating hurricanes and cyclones.*
5. Expansion of disease, due to rising pollution levels, increased pollen production (allergies and asthma), and other conditions suitable for expansion of various pathogens (Lee & Roland-Holst, 1997).

Based on the current knowledge of temperature developments for the reason of global warming, it is possible to predict future temperature movements, for 2025 and 2050. Figure 2 is a prediction of temperature changes, based on a recognized trend of extrapolation.

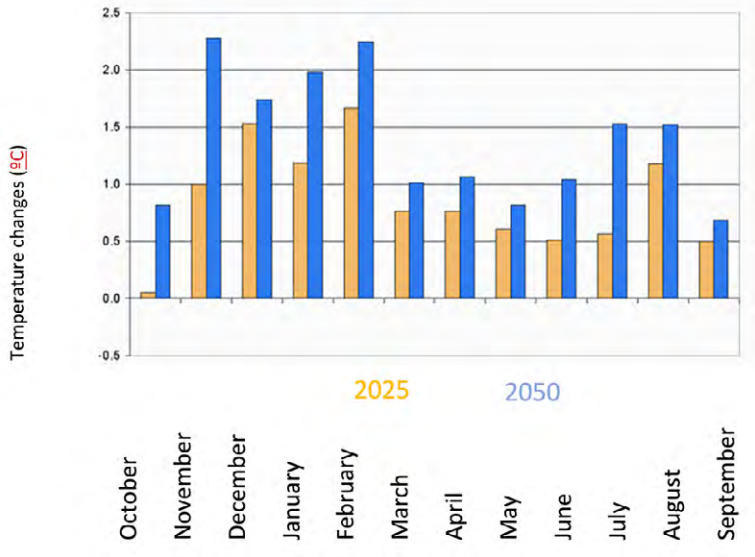

Figure 2. Prediction of temperature changes: a comparison of 2025 and 2050
Source: International Research Institute, ENSO, Columbia University, Forecast, adapted by authors https://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/

IMPACT OF ECONOMIC ACTIVITIES ON ENVIRONMENTAL DEGRADATION

Relations between different indicators of environmental degradation and incomes per capita were established in the mid-twentieth century. This resulted in the creation of the environmental Kuznets curve (Munitlak Ivanović, 2017).

Table 1 is indicating relations between CO_2 emissions and the country's wealth, measured by its share in global GDP. A higher level of participation in the global GDP usually means higher GDP of society, or more precisely, it could be said that such a society is richer. According to data represented within Table 1, it could be noticed how the amount of CO_2 emissions, as a consequence of economic activities, affects the climate change caused by the observed country. Looking at the share of individual countries in the world's wealth, as a percentage share in global GDP, it is ev-

Table 1. Key data for 10 countries, the highest emitters of CO_2
Source: Climate Change Performance Index, (01/04/2019), adapted by authors https://www.climate-change-performance-index.org/. Retrieved: 18/11/2019

Table 1: Key Data for the 10 Largest CO_2 Emitters

Country	CCPI Rank 2015	CCPI Rank 2014	Share of Global GDP	Share of World Population	Share of Global CO_2 Emissions*	Share of Global Primary Energy Supply
Germany	22	22	3.44%	1.16%	2.23%	2.34%
Indonesia	23	26	2.35%	3.51%	2.31%	1.60%
India	31	36	6.72%	17.57%	5.70%	5.89%
United States	44	44	17.17%	4.47%	14.69%	16.01%
China	45	46	16.03%	19.30%	23.43%	21.76%
Brazil	49	35	3.05%	2.82%	4.17%	2.11%
Japan	53	52	4.82%	1.81%	3.61%	3.38%
Korea	55	55	1.69%	0.71%	1.75%	1.97%
Russian Federation	56	56	2.63%	2.04%	4.87%	5.66%
Canada	58	58	1.56%	0.50%	1.57%	1.88%
Total			59.45%	53.89%	64.32%	62.59%

*energy-related emissions and emissions from deforestation
© Germanwatch 2014

Performance: Very good | Good | Moderate | Poor | Very poor

ident that throughout two observed years (2017 and 2018), United States (17.17%) and China (16.03%) have the highest share, but both of these countries are in the zone of intense CO_2 emissions. This level of CO_2 emissions has a very harsh impact on climate change. It is also interesting that both countries did not change their CCPI rank throughout the observed years with such economic behaviour. Such a position is marked in orange and it represents a poor ranking. It could be noticed that neither one of the observed countries is marked by any shade of green, whose characteristics are a very good or good influence of economic activities on climate changes. The impact of medium intensity on climate changes is characteristic for three countries whose share in global GDP is not particularly high. Those countries are Germany with a share of 3.44% in total GDP and rank 22, Indonesia with a share of 2.35% in global GDP and rank 23 (or 26 in 2018), and overpopulated India (17.25% of the world population) with a share of 6.72% in global GDP and declining rank from 31st to 36th place.

Lower CCPI rank is indicating to more environmentally responsible country, because its economic activity, regardless of its intensity, is less affected by climate changes. Kuznets environmental curve deals with this legality.

SIGNIFICANCE OF THE ENVIRONMENTAL KUZNETS CURVE

'Environmental Kuznets curve represents a hypothetical link between different indicators of environmental degradation and incomes per capita' (Stern, 2004). The original version of the author himself (Kuznets, 1955) dealt with different relations. Simon Kuznets was interested in changing relations between income and inequality *per capita*. By establishing this relation, he established a curve with the form of inverted Latin letter 'U', just as the environmental Kuznets curve looks like (authored by Panayotou, 1993).

However, the Kuznets curve gained a new point of view in the early 1990s. The empirical studies of Grossman and Kruger (1991) and Shafik and Bandyopadhyay (1992) proved the existence of a curve in the form of an inverted Latin letter 'U'.

The original empirically tested environmental Kuznets curve analyzed the impact of income growth on levels of pollution. Grossman and Kruger (1991) pointed out that the concentration of environmental pollution (smoke and SO_2) rises with the increase in income *per capita* as a consequence of economic growth, and then pollution begins to decline with further increase in income. This confirmed the hypothesis that, in this case, there is an inverted curve 'U'. This happens because over time companies are beginning to invest in technology that could be termed as a green technology, or "environmentally friendly" (Munitlak Ivanović, & Mitić, 2017). Thus, the environmental Kuznets curve became a tool for defining relations between the quality of the whole environment and climate changes caused by increasingly intensive economic activities on a global scale (Dinda, 2002).

Figure 3 is indicating that environmental pollution is significantly and rapidly increasing in the first stages of industrialization. People are not so interested in the state of the environment, but in increasing material production and maximizing their income as a result of growth (Dasgupta et al. 2002). Therefore, in this phase, there are positive linear relations between economic growth and pollution to achieve rapid economic growth, and natural resources are intensively drawn and negative externalities are occurring. This results in increased pressure on environmental quality. In the early stages of economic growth, people are poor to invest in the ecologically friendly mode of production and, therefore, ignore environmental problems (Sarkodie & Strezov, 2019). Along with the progress of industrialization, pollution starts to reduce. This is mainly because new technical and technological processes and other improvements in the production process are being developed while the service sector is also growing (Panayotou, 1993). This means that pressure on the environment in the early stages increases faster than incomes and then slows down with GDP growth at higher levels of income.

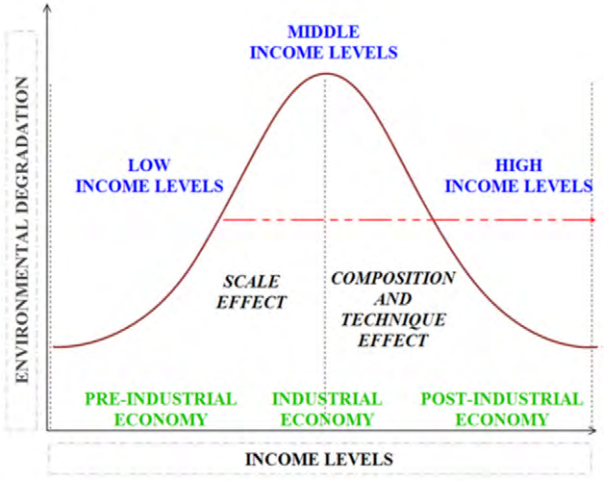

Figure 3. Kuznets environmental curve
Source: Sarkodie, S. A., & Strezov, V. (2019). A review on Kuznets Environmental Curve hypothesis using bibliometric and meta-analysis. ***Science of the total environment****. 649, 128-145. https://doi.org/10.1016/j.scitotenv.2018.08.276*

Reduction of environmental degradation occurs in later stages of economic development. Increased levels of income, strengthen institutions, developed environmental awareness and technology are leading to a reduction in environmental pollution (Sarkodie & Strezov, 2019).

GLOBAL ECONOMIC IMPACTS AND CONSEQUENCES

The environmental Kuznets curve had a significant impact on economic policymaking in both developed and developing countries. Developing countries want to strengthen economically as soon as possible without too much consideration of environmental protection. Initially, both the World Bank and the IMF prioritized economic growth. The technology they use is usually outdated, which in other words means that it is most often "dirty". That is why they are pleased to accept the capital from developed countries that carries "dirty" technologies.

High environmental standards and developed environmental awareness are more elevated in developed countries. They achieved an adequate level of economic development that they could think of high environmental standards and high environmental taxes and penalties for those who do not adhere to these standards. That is why they move their "dirty" technologies and often export the waste to developing countries. On the other hand, developing countries have neither high environmental standards nor high penalties.

For example, *Cap and trade* system is a form of organizing the trade in harmful emissions that have a bad impact on climate change. It is about trading in emissions allowances. The right on pollution is an amount of pollution emissions from a particular polluter, at the state or organizational level. In this way, an economic instrument, namely the market, is trying to influence the level of pollution. More precisely, any right on pollution is a permit in physical units, which is determined by the state authorities for the enterprises based on the presumption of pollution and damage that particular enterprises could cause by their production. It is a market-based approach to pollution control (Stavins, 2003). In addition to portable emissions permits, there are two other instruments to reduce the economic impact of climate change: environmental regulations and environmental taxes.

When it comes to transferable permits, the state determines the total number of permits to be granted and decides how it will allocate the original pollution permits. That decision should be based on the society as a whole, by considering pollution damage and the cost of control from the society's point of view. Specific public authority allocates or sells a limited number of pollution permits that are transferable in terms of their sale. Those who are granted or purchased for a specific quantity of a pollution permit, expressed in the amount of permissible emission of pollutants, must purchase more pollution permits, according to the scope of production to operate within the specialized market. The role of the seller of pollution permits includes pollutants that do not need permits to that extent because their scope of production is not so intensive. Therefore, it could be said that this is an economic instrument that requires good organization of a specific market. The total amount of pollution at the level of society must remain the same. This means that if the producer increases pollution due to the increased scope of production, at the same time, it must be accompanied by a reduction of pollution. In the first case, it is about the buyer of permits and in the second it is about the seller of pollution permits (Munitlak Ivanović, Raspopović & Mitić, 2014). The purpose of this economic instrument is to define an acceptable level of pollution at the level of society then, through permits, to distribute the right to pollution among known pollutants.

The largest pollution trading system is the European Union Emissions Trading Scheme (EU ETS). The functioning of this Scheme could be monitored Since 1992. That year, 180 UN members signed the United Nations Framework Convention on Climate Changes (UNFCCC). In 1997, the Kyoto Protocol was adopted as a more specific document defining the activities that should be taken to reduce pollution and global emissions. This document established two principles on which functioning of the EU ETS is based:

1. Emission targets were set for highly developed countries.
2. A set of variable mechanisms was created that enabled the exchange of licenses, or more precisely cross-country emission units.

These two principles form the basis for the international emissions trading system (Climate Policy Info Hub, 2019). The importance of the Kyoto Protocol and the European Union Emissions Trading Scheme is that it is the first global system for emissions trading and pollution. It started with operating on 1st January in 2005. Implementation in practice was unequal across countries due to the different time it took for the EU Member States to distribute transferable emission permits and to install the electronic trading platform (Golušin, Munitlak Ivanović

& Vučenov, 2012). It is important to note that this was the first time of installing a quantitative restriction of environmental pollution in any form. Since then, CO2 emissions have been paid a market price by all potential pollutants (Ellerman & Buchner, 2007). The EU ETS is an irreplaceable part of the European climate change policy. This is the primary instrument by which EU member states fulfil their obligations under the Kyoto Protocol. The EU ETS is a significant part of EU law, so important that its implementation is independent of the Kyoto protocol (Ellerman & Buchner, 2007). Countries committed to reducing pollution, by the time the Kyoto Protocol was signed, emitted about two-thirds of GHG emissions globally. All of the abovementioned provided an excellent starting point for improving the climate through the application of the protocol (Golušin & Ivanović, 2011).

Under the Kyoto Protocol, the states were divided into two groups. Developed countries committed to reducing GHG emissions by about 5% less than 1990, in the period between 2008 and 2012. The second group consisted of the poorest countries and developing countries, which were not obliged to take on any obligations. This should have encouraged them to intensify economic development and reduce the gap between developed and underdeveloped countries.

At that moment, the largest polluter is the United States, which never ratified the agreement, while Canada abandoned the protocol in late 2011. At the same time, GHG emissions from developing countries increased, leading to a situation that, at the end of the protocol in 2012, countries that were obliged to reduce emissions were responsible for just over one-fifth of the world's annual emissions. This is too small a reduction for slowing down the climate changes.

The Kyoto Protocol did not provide desired results for several reasons. One of the serious reasons lies in the fact that too many signatories of the protocol did not take over essential obligation. Short deadlines for fulfilling commitments to prescribed goals are also a significant reason for failure in implementation. Adequate sanctions in case of protocol breach were not defined, which posed another problem. Although it was a legally binding document, the abandonment of the protocol by Canada was not accompanied by any sanction. On the other hand, examples of successful protocol implementation are the United Kingdom and Germany, countries that adopted such environmental macro policies, that reduced their GHG emissions in the long term. These two countries achieved the best results in the observed period.

Although there were negotiations on the further functioning of the protocol and the possibility of signing a new agreement that would be an upgrade to cover the largest emitters, the Kyoto Protocol stopped operating upon its expiry in 2012 (Rosen, 2015). At the global level, the looking for solutions through collective responsibility and joint activities was continued. These attempts resulted in the Paris Agreement on Climate Changes, which was created in December of 2015 (United Nations, 2015).

The Paris Agreement has a different starting point and it is based on a different principle - voluntary accession to agreement, which does not define the deadlines and the validity period, and there is no legal sanction since this did not provide results in the case of the Kyoto Protocol. After a quarter of a century, this was a significant change, and this agreement on climate change was accepted globally by all countries. The Paris agreement was also accepted by the least developed countries because they were given more time to reduce GHG emissions. Developed countries are given the time (as short as possible) to start reducing emissions in a few years, using the latest scientific advances, to set the aim of lower GHG emissions in the meantime. The global goal of the agreement is to keep the average temperature rise below 2°C as compared to the pre-industrial period.

The logical question is that if there are no binding rules or specific goals, how could this globally important result be achieved? Previous experience was related to the fact that hard rules did not provide adequate results. In respect to that, this new agreement is, therefore, based on the principle of voluntariness and the promise of reducing emissions, while the main instrument is peer pressure to deliver promised results. States included in this agreement are required to draw up five-year national plans for GHG emissions consistent with other plans and capabilities. These countries should submit a regular report on the realization of the promise, keeping track of the results (Obergassel et al., 2016).

The biggest challenge was to include the largest gas emitters in the agreement, or more precisely to coordinate attitudes regarding the promises of each country and the question of what is 'right'. The idea is that the global fight against climate change became a matter of ethical commitment, pride, and prestige that would affect individual countries to achieve the best results. This encourages international cooperation, which is the goal of any global agreement, although the success of the Paris Agreement cannot be predicted. The main progress comparing to other international agreements is people's awareness regarding the threatening global problems of climate change and joint agreement that something must be done.

CONCLUSION

Climate change is a global problem that, like any other problem, must first be addressed locally. A significant number of natural disasters are related to climate change. Huge natural disasters are consequences of climate change. However, it took a long time for people to became aware of the fact that this problem could and must be solved. The authors outlined which countries are the largest emitters of pollution, explained the macro-level behaviour by using the environmental Kuznets curve and finally pointed to potential solutions through the Kyoto Protocol and the Paris Agreement, which again requires a global approach to the problem.

In its initial stages of development, each country gives preference to economic development over environmental protection and thus climate. The well-being of the population is a primary task, not taking into account the after-effects that became more than obvious and alarming. However, countries begin to think gradually about the environmental consequences of their accelerated development, but only when they reach a certain level of economic development. Then various economic and flat instruments are introduced to solve the environmental problems. Introduction of environmental penalties, taxes, fees, and trading with pollution emissions are just some of them. However, these are all national attempts to tackle the global problem - climate change.

Acceptable solutions could be expected only by creating international instruments focused on global participation. However, countries raise the questions of fairness and rights for the amount of pollution relative to the degree of its economic development and the well-being of its residents. The implementation of the Kyoto Protocol, although well thought out, did not produce expected results, although it was legally binding for the signatories. The protocol was abandoned even before it was fully implemented. Announced as a major success of the global compact and awareness of climate changes in 2015, the Paris Agreement was accepted by all countries of the world. It is not legally binding and therefore falls under the "soft agreements". The question is, how much are we aware of enormous problems of climate change when economic wealth found a way to again be at an advantage over the survival of future generations.

Acknowledgement

This paper is funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia. The paper uses parts of the doctoral dissertation authored by Petar Mitić, "The Interdependence of Economic Growth and Environmental Pollution in Southeast European Countries", defended at the Faculty of Economics, University of Niš, February 2020.

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CHANGES IN THE SOCIO-ECONOMIC SYSTEM IN AGRICULTURE OF THE REPUBLIC OF SERBIA CAUSED BY CLIMATE CHANGE

Srđan Timotijević[A]

Abstract

World population growth and rapid urbanization require increased agricultural production for food production, with constant land degradation. Therefore, the primary task of the work is to establish a balance between eating habits of the population and environment sustainability. The pattern of precipitation has also changed and dry period is accompanied by extreme temperatures, which further amplifies negative impact. The work methodology is based on the analysis of long-term climate observations in Serbia with an impact on agriculture and labour productivity in which the rural area is burdened by depopulation and aging, with an unsustainable structure of agricultural production. The aim of this paper is to show the state of accelerated need for intensive cross-sectoral cooperation, changing social habits and educational capacities, in order to reduce the destruction of the planetary system and preserve human society with sustainable demographic growth, cultural progress and security.

Keywords: agriculture, climate change, rural area, socio-economic changes, Republic of Serbia

Introduction

Evidence of climate change is strong: the world sea level is rising, glaciers are retreating, intensity and precipitation patterns are changing, world is getting warmer. According to a report by the Intergovernmental Panel on Climate Change (IPCC), the current greenhouse gas emission rate will cause average temperatures to rise by 0.2°C per decade, reaching 2°C by 2050, more than in the pre-industrial period. There are scenarios for even faster growing changes that will greatly, and in some cases irreversibly affect people, plant and animal species and ecosystems (Adedeji et al., 2014), because climate change erodes agroecosystems. Once a natural resource is lost, it cannot be technologically re-created (Stričević et al., 2019).

Reduction of arable land, increasing water shortages, declining food and fish stocks, increasing floods and prolonged droughts are already happening in many parts of the world with the potential to cause civil unrest, economic losses, international and geopolitical conflicts (Cvetković et al., 2015).

Around the world as well in Serbia, a large number of people are employed directly or in some way depend on agriculture; and yet, the establishment of any model of economic development, to improve living standards, implies and depends on the increase of agricultural production (Knox et al., 2014).

Discussing about climate change, agriculture and biotechnology, it should be considered that agricultural products are not only available on the domestic market but also internationally spreaded. Keeping this in mind, changes in agriculture caused by climate change in one part of the world, or in one country, affect the food quality and dietary habits in that part of the world as well as in all other distribution areas (Miltojević, Ilić Krstić, 2020).

It is clearly necessary to count on climate change in planning sectoral development and infrastructure, bearing in mind that the total material damage caused by extreme climate conditions in Serbia, from 2000 to 2015, exceeded five billion euros, and that is more than 70% of losses associated with drought and

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high temperatures. Since the growth trend of the average temperature in Serbia is three times higher than the growth trend of the average global temperature and the average global temperature of the land, it is not surprising that *"Serbia is more affected by climate change than most places on Earth"* (Božanić, Mitrović, 2019).

According to many projections, global agriculture will be under significant pressure to meet the demands of a growing population using finite, often degraded soil and water resources, which are predicted to be further emphasised by the impact of climate change (Rosegrant et al., 2008).

Climate change pose a serious threat to the basic elements of human life in the world and they are multiple (from drought to flood) and multidimensional (from local to global) hazards that have short-term, medium-term and long-term security implications, as well as necessary outcomes.

Climate observations in Serbia, in the period 1950-2017, showed that 9 of the 10 warmest years are after 2000. The warmest year was 2014, when the deviation of the average annual temperature in relation to the reference period was +2.33°C. The second warmest year was 2015 with a deviation higher than +2°C, while the other eight have a temperature deviation higher than +1.5°C (Đurđević et al., 2018). It should be added that the Republic Hydrometeorological Service of Serbia in January 2019 officially declared 2018 the warmest year in Serbia.[1]

Methodology

Analyses of global trends and scenarios on climate change and their attitude on Serbia are based on the observations of existing data. For the purposes of this analyses it is used the available published scientific literature, international and national legal and strategic documents and statistical data that are important for individual sectors. The results of several climate change scenario models were used with reference to changes in the socio-economic system in agriculture and the current state of depopulation and deagrarization of rural areas of the Republic of Serbia, with prospects for its improvement and sustainable agrarian-demographic development.

Theoretical background of climate change scenarios

In Serbia, according to regional climate models, it is predicted that an average annual temperature increase by the end of the 21st century will be from 2.4°C to 2.8°C, according to the optimistic scenario (A1B), or from 3.4°C up to 3.8°C counting on pessimistic, more aggressive scenario (A2). Both scenarios predict an increase in average temperature in all parts of Serbia, with some regional differences. Less significant predictions are related to precipitation values. Following the A1B scenario, decrease in the amount of precipitation is expected on the entire territory of Serbia, with a less emphasised decrease in the amount of precipitation in Vojvodina and some parts of Eastern Serbia. If the predictions for the A2 scenario are correct, the amount of precipitation in Vojvodina will increase while in other parts of Serbia it will remain the same or will decrease (Sekulić et al., 2012).

There is a high probability that Serbia will face an increasing number of natural disasters in the near future, primarily floods, droughts and fires. The number of natural disasters on the territory of Serbia is obviously increasing. At the beginning of the 19th century it was 100 disasters in ten years, the number rose to 2,800 disasters in 10 years at the end of the 20th century (Sekulić et al., 2012).

The precipitation deficit, followed with the increased number of intense rainfall, is noticed during the summer season. Dry periods and extreme temperatures usually coincide with the summer period, which increases the strength of the impact. The number of days with heavy rainfall is constantly growing. During the period 2008-2017, the number of days with precipitation over 40 mm was twice as high in most parts of Serbia, with the exception of the southern parts with an increase of five times (Božanić, Mitrović, 2019).

Considering that agricultural production (especially crop farming, which is predominant in Serbia) means an "open-air factory", it is particularly vulnerable to climate change. The choice of optimal cultivated crops and the choice of optimal planting and harvesting time directly depend on the weather conditions present in each region (Nastis, 2012), and there are serious indicators that the challenges of agriculture and its planning are a planned response to climate change.

[1] (http://www.hidmet.gov.rs/podaci/meteorologija/ciril/2018.pdf).

Agriculture according to climate change

The world's population will increase to over nine billion by the middle of the 21st century. It is equally certain that most of the population growth will take place in the least developed countries (LDC), which are economist predictions that developing countries are more dependent on agriculture, most of them are already too hot or dry, where the poor farmer is less able to adapt (Mendelsohn, 2009). Consequently, these countries will have to increase food production in order to supply and feed the population and increase their standard of living. However, they face two major constraints at the same time: the land is not fertile enough for cultivation, and their participation in the world economy often reduces their independence in food without sufficient compensation in other sectors (Knox et al., 2014).

Land and water resources used in agricultural production are constantly degraded. On the other hand, insisting on reducing environmental pressures can have negative consequences for developing countries. However, reducing the intensity of agricultural production in order to preserve natural resources for developing countries would mean the impossibility of achieving a positive rate of economic growth and overcoming poverty. The transition of underdeveloped countries to more intensive use of available resources in order to be able to provide enough food for their growing population, at the same time requires a significant increase in energy intensity, which results in further pressure on the environment. Faced with the problem of malnutrition and chronic poverty, this group of countries justifiably accepts the concept according to which engaging in agriculture poses a greater threat than it creates hope for the preservation of the environment (Đurić, 2015).

Similar conclusions are drawn by Xie, Zhao (2019), where on the one hand, climate change puts pressure on food production and safety, and on the other hand, agricultural activities contribute to anthropogenic greenhouse gas emissions.

Various technological solutions are developed and applied with the aim of reducing the dependence of agricultural production on future climate. This primarily refers to protective measures against adverse weather conditions (greenhouses, hail protection), irrigation, or new plant species that are more resistant to unstable conditions. Despite all that, it can be said that agriculture is still very sensitive to unstable climate conditions, and thus to long-term climate change (Sekulić et al., 2012). The length of the vegetation period is important for plant growth and crop production, both in natural and agricultural systems. The standard vegetation period begins when the average daily temperatures during the year become more than 5°C (first five consecutive days that meet this criterion) and lasts until the temperatures fall below this value (also the first five consecutive days that meet this criterion, but in the second half of the year). On average, during the last 20 years (1998-2017), the vegetation period was extended by over five days, and in some areas, mostly at lower altitudes, even over 10 days in relation to the reference research period (1961-1990), (Đurđević et al., 2018). By the end of the 21st century, the length of the vegetation period on average on the territory of Serbia will be at least about a month, but in the case of the RCP8.5 scenario, even up to two months.

More important than the average air temperatures for a certain area are the frequency and average date of occurrence of extreme temperatures. For agriculture, autumn and spring frosts are considered the most dangerous when the plant is not protected by a snow cover so that its temperature can drop below 0°C or even below the critical temperature for particular plant. Based on the observed minimum air temperatures and appropriate climate simulations, it is expected that during 2040 the number of frost days will decrease about 10 days, and during 2080 about 20 days, compared to the period 1985-2005. The number of icy days, according to the projections obtained from climate model is going to reduce. Namely, the number of icy days is expected to decrease five days around 2040 and nine days in 2080, which is a clear indicator of climate change trends (Lalić et al., 2011).

Climate conditions that cannot be fully influenced by the farmer play a major role in crop yields. Temperature and precipitation are of great importance for agricultur-

Table 1. Changes in temperature and precipitation according to seasons and scenarios

	A1B 2001-2030.		A1B 2071-2100.		A2 2071-2100.	
	T °C	Amount of precipitation %	T °C	Amount of precipitation %	T °C	Amount of precipitation %
Winter	0,5-1,0	-10-5	1,8-2,2	-20-0	2,6-3,6	-15-15
Spring	1,0-1,2	-15-15	2,4-2,8	-15-10	3,6-4,0	-30-0
Summer	1,2-1,4	-5-30	3,2-3,6	-30-5	4,2-4,6	-50-10
Autumn	0,5-0,9	-10-20	1,8-2,2	-30-5	2,6-3,2	-30-10
annual level	0,8-1,1	-5-10	2,4-2,8	-10-0	3,4-3,8	-15-5

Source: (Đorđević et al., 2013)

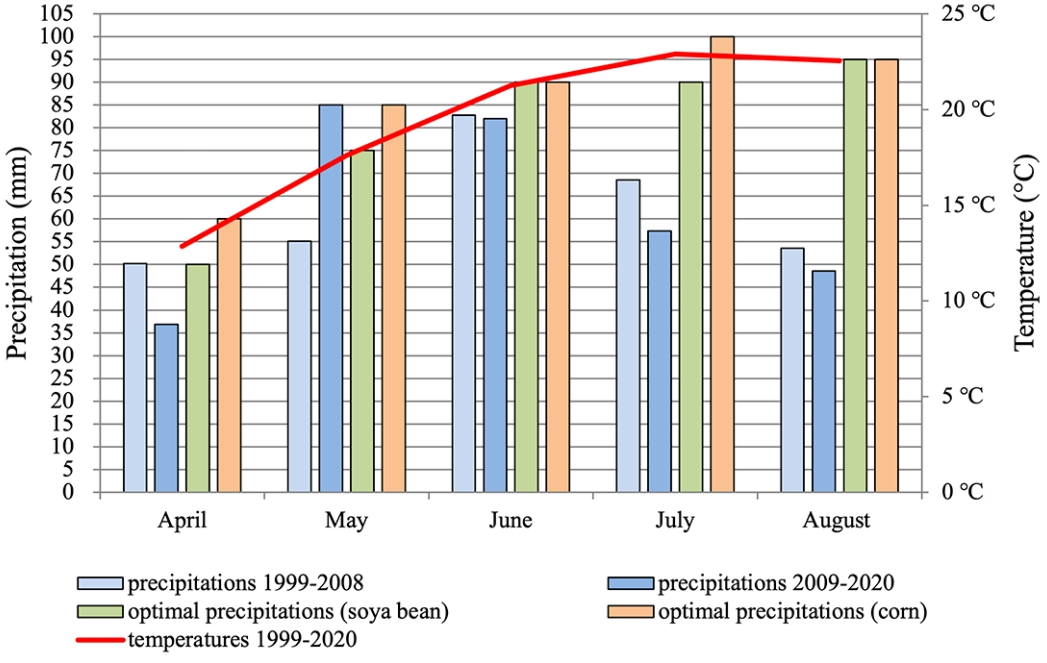

Figure 1. Optimal and actual precipitation and temperatures for individual crops
Source: Republic Hydrometeorological Service of Serbia

al production, not only their height during the year, but also the distribution during certain months (Table 1), thus influencing the phenological phases (growth, development and maturation). Duration of high temperatures, especially in dry years, negatively affects yeald formation, which is why omissions in agro-technical measures have to be minimized (Hrustić et al., 2009).

The IPCC made assumptions with medium confidence that projections in temperature change and precipitation could lead to changes in food production and an increase in its price by 2050. Global estimates show that yields reduction by 2050 could affect the increase in hunger by 10-20%. In other words, by 2060 the prices some of the key cereals, such as corn, wheat and rice, could grow by as much as 150%. It is clear, therefore, that the effects of climate change on the agricultural sector have a direct impact on the rural population, but also an indirect impact on the population of urban areas (Božanić, Mitrović, 2019). In Serbia, climate change will hit mostly corn yields. If adaptation measures are not applied, by 2030 the yield is expected to be reduced in conditions without irrigation up to 58%. In the same period, the reduction in wheat yield will be up to 16%, which will happen with soybeans and vines too.

Figure 1 shows a comparative analyses of climate data over the last 20 years (1999-2020). The key segment is the frequency of precipitation and air temperature by months, and taking into account the territories with the most represented areas under soybeans and corn and the best yields according to Bošnjak (2012). Since the territory of AP Vojvodina covers the largest part with soybean, the municipalities that were separated and whose data were analyzed were: Sremska Mitrovica, Sombor, Kikinda, Zrenjanin and Bač. Bearing in mind that in these areas, soybeans is harvested at the end of August or the beginning of September, the data for the month of September have been left out. During the entire period, it is easy to notice increase in the difference between optimal and actual amount of precipitation, with special reference to the period July-August, when the plants need water the most for pouring grain.

Temperature increase of 2°C (for corn), by Lobell and Burke (2010) causes a greater decrease in yield than a lack of precipitation of 20%, ie each degree above 30°C causes a decrease in yield of 1% in optimal and 1.7% in arid conditions (Anđelković et al., 2012).

However, it is now recognised that modern agriculture has to be considered as „source of environmental pressure" such as energy, transport, chemicals and heavy industry. The prospects for the implementation of environmental measures in agriculture are improved. Even though it is generally accepted that the biosphere has to be preserved, not only for the present but also for future generations (Hrubesch, 1986), but mainly because food production, processing and food preparation a long time ago acquired the character of a lucrative, profitable business. Today, food production has become a source of geopolitical power (Vujović, Vujović, 2015).

Socio-economic aspects

During the period 2002-2015, agricultural production in Serbia participated with an average of 11.1% in the total gross value added, which is an indicator of a significant share of agricultural production. The impor-

Table 2. Economically active population in agriculture by Censuses 1953-2011

1953	1961	1971	1981	1991	2002	2011
2,248,946	2,010,754	1,749,006	1,292,735	890,586	506,685	271,195

Source: (Bogdanov, Babović, 2014)

tance of agricultural production is even greater, if we take into account the fact that a large part of trade made agricultural products with manufacturing industry and food industry. Observed by activities, the most significant share in 2018, in GDP has the manufacturing industry, while the sector of agriculture, forestry and fisheries fell to 6.3% (Republic Statistical Office of Serbia, 2019b).

The importance of agricultural production is reflected in the whole play role in economic development, and therefore it is necessary to look at agricultural activity in a broader context. The contribution of agricultural production is seen through the share of agricultural in the total population, as well as active agricultural in the total economically active population (labour force), (Table 2). Without planned work on returning of young people to the countryside (Table 3), whose greatest basis is engaging in agriculture, with a strategy of education and spreading a positive awareness of agriculture in a sustainable way, there are great prospects for poor results.

The largest share in the total agricultural production has the farming (crop) production with 53.2%, which clearly indicates not very enviable position of thus achieving higher gross value added (Stričević et al., 2019).

The modern concept of agricultural production certainly does not imply exclusively the development of primary agricultural activity. However, as state's economy "grows stronger", the relative importance of agricultural production decreases due to the development of the secondary (industry) and tertiary (services) sectors. On the other hand, agricultural production finds its absolute significance even in such proportions, because improving living standards increases the demand for food products.

Research at the Faculty of Economics in Belgrade indicates the state of agricultural activity in the Republic of Serbia, which in accordance with the dominant role of extensive production is not at an enviable level. In this way, it is possible to identify potential directions of development that are certainly aimed at intensifying agricultural production, all in accordance with local environment. As an example, it is expected that the total agricultural production could get an higher level with more intensive fruit, vineyard and vegetable production. Also, it is important to point out that in accordance with this step, it would further increase the

Table 3. Age structure of agricultural holders, by regions

Age structure	Republic of Serbia	Belgrade region	Region of Vojvodina (Northern Serbia)	Region of Šumadija and Western Serbia	Region of Southern and Eastern Serbia	Region of Kosovo and Metohija
up to 35 years	4.8	4.3	7.4	4.0	3.8	...
35-44	11.1	9.7	14.2	10.5	10.0	...
45-54	20.9	20.8	24.4	20.4	19.0	...
55-64	30.4	33.5	29.4	30.5	30.4	...
65 and older	32.8	31.7	24.6	34.6	36.9	...

Source: (Bogdanov, Babović, 2014)

agricultural production in Serbia. Still dominant crop production evidently means that agricultural activity largely relies on an extensive mode of production, which further limits the profit at the end of the production cycle. Crop production means the production of cereals, industrial plants and vegetables. All plant production made 69% while 31% made livestock production. As the main condition for the development of a state's economy is the production of final products, not raw materials, it is clear that there is a lot of space for improving agricultural production and production of food products, unlike the current trade based on agricultural raw materials (Novaković, 2019).

Heat stress is increasingly becoming one of the main factors of work efficiency and productivity in Serbia, but also in the world. Injuries and illnesses, reduced work capacity and lower productivity are increasingly the result of heat waves. It doesn't affect all occupations and types of work equally. Jobs that require a lot of physical activity, as well as long time spent outside, are primarily affected, which refers most to farmers. Therefore, they belong to particular-

Table 4. Number of agricultural holdings (farms), by regions

	Republic of Serbia	Belgrade region	Region of Vojvodina (Northern Serbia)	Region of Šumadija and Wester Serbia	Region of Southern and Eastern Serbia	Region of Kosovo and Metohija
Number of agricultural holdings (farms)	564.541	30.033	127.070	242.636	164.802	...
Registered AH	301.028	11.916	83.790	131.293	74.029	...
AH that use computer	11.149	768	6.636	2.485	1.260	...

Source: (Bogdanov, Babović, 2014)

ly vulnerable groups in the aspect of climate change (Božanić, Mitrović, 2019).[2]

Although climate change may increase unemployment in one, it also opens up job opportunities in another "climate-oriented" sector. In other words, it should be borne in mind that lost jobs in one sector do not necessarily mean absolutely lost jobs. Looking at the Figure 2 we understand why education, both formal and non-formal, plays an important role, as good as to be in line with current events. According to that it is easy to compare results of computer users on their agriculture holdings (Table 4). Those results are an indicator of insufficient commitment to a step forward, but also a reflection of the age structure on the farms.

In addition to irrigation, the selection of new species more adaptable to climate conditions is an important measure of adaptation. This requires research and development of new species, which at the same time represents a sector in which new jobs are created. Also, organic agricultural production implies a larger labour force, which automatically attracts new jobs, both seasonal and permanent workers. New crops require new knowledge, which can be difficult to accept, especially for low-income producers, in far away areas, the elderly and the poor. In some parts of the country, it will be almost impossible to continue with agricultural production, which may lead to migration to urban areas (Božanić, Mitrović, 2019).

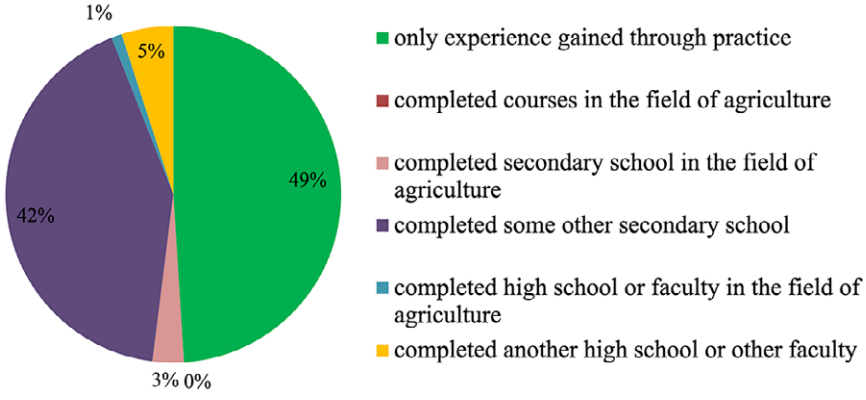

Figure 2. Level of training of AH managers in the Republic of Serbia
Source: (Statistical Office of the Republic of Serbia, 2019a)

With Beck (2014), we come across claims that we live in a risky society based on an anthropogenic factor. However, exactly that modern society made an factor of possible progress. As a result, climate change can contribute to creating a "cosmopolitan community of shared risks", better cooperation between states and governments, overcoming neoliberalism, practicing new forms of transnational responsibility, but also the responsibility of all economic and public actors, empowering poor countries, incorporating cosmopolitan justice into international policy, lifestyle changes and consumption patterns, and to encourage "new understandings and care for nature". In that sense, climate change has an emancipatory character (Miltojević, Ilić Krstić, 2020).

[2] The biggest decrease in labour productivity can be expected in the southern parts of Europe, including Serbia. It is estimated that in 1995, on average, 0.01% of working time was lost in the countries of this region due to heat stress (which is equal to the loss of 6,300 jobs), estimating in 2030 lost of 0.02% (about 14,400 jobs). (Božanić, Mitrović, 2019).

Adaptation measures and proposed solutions

Climate changes can manifest themself locally or regionally, while the direction of impact can be direct or indirect. Some adaptation measures are multifunctional, such as anti-hail nets, which lower the temperature in the orchard, reduce water consumption, and thus mitigate the impact of drought, water consumption is more efficient. In this regard, the priorities of adaptation measures should be adopted on the basis of multi-criteria analyses. Therefore, in order to mitigate the consequences of climate change, it is necessary to engage the entire community at the strategic level, from the state administration to small and large local farmers. Each of the participants has a significant role in increasing the adaptive capacity, and their continuous cooperation is the basis for agricultural production in which the risk is minimised. In such a system, the improvement of farmers' knowledge is a key factor, and it is achieved through the establishment of a system of information and early warnings (Lalić et al., 2015).

Agriculture is characterised by biological specifics, with high risks in production, on the basis of which, from the aspect of insurance, it is more complex than many other activities. According to Toscano (2011), weather conditions are the main factor in the instability of agricultural production, which is necessary to manage this risk, in order to "at least partially compensate consequences of weather conditions", (Radović, 2017).

Step forward and direct connection with climate change that farmers made is the number of agricultural areas insured against disasters, which has certainly increased (Figure 3). Analysing data during the period 2006-2015, the highest value of insured areas was in 2015, with 481,765 hectares insured. This represents 9.5 percent of the total agricultural area, or 13.74 percent of the total arable agricultural area in the Republic of Serbia (Radović, 2017).

Developed countries have more capacity to adapt. They can afford the cost of new systems to reduce harmful effects, as well as replacing old systems and infrastructure that become insufficient due to climate change or compensate for losses through disasters, internal migration, employment program. An example from an IPCC meeting may clarify the point of this behavior. A participant in the meeting from Saudi Arabia questioned the statement that global warming would cause heat stress in dairy cows, reducing milk production. He argued, no doubt, that this was not a problem, as cattle could be chilled in air-conditioned barns. Later, with the story of the potential water shortage due to the increased drought in some countries, he claimed that desalination could easily solve this problem. In both cases this was true in his experience in Saudi Arabia, but such adaptations are too expensive for most developing countries (Pittock, 2005), because according to Höjer, Wangel (2014), sustainability can only be achieved if we view the planet as unique.

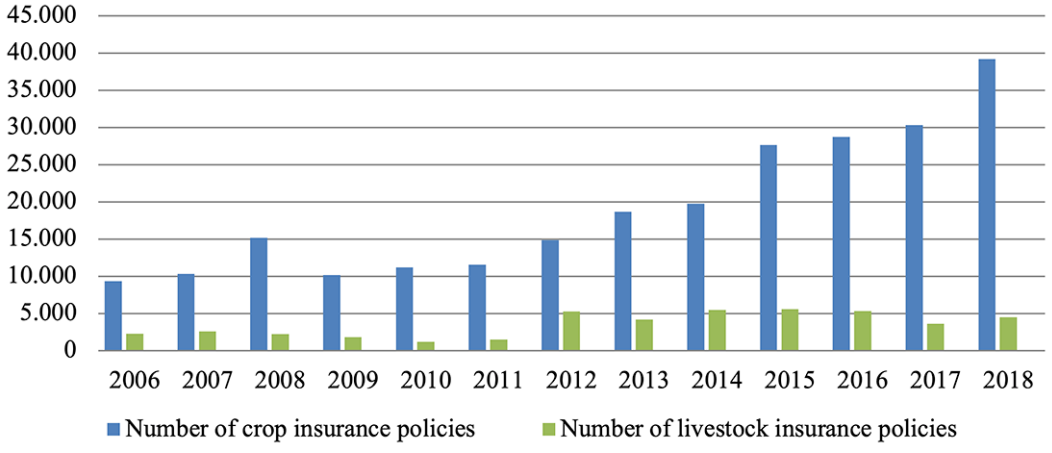

Figure 3. Number of insurance policies in Serbia
Source: (Radović, 2020)

The control and adaptation of agricultural resources is a complex process due to the fragmentation of land properties. One of the important measures is the preservation of suitable (arable) agricultural land from urbanization (Đorđević et al., 2013), because Serbian agriculture lost ¼ since 1960-2012, it is excluded more than a million hectares of utilized agricultural land (Vujović, Vujović, 2015).

Despite the problems such as depopulation, aging and extinction of countyside, unsustainable structure

and share of crops and livestock production, dominance of cereals and insufficient information in line with the upcoming changes, there are some possible measures to adapt climate change. Some of the most important measures are: increasing irrigated areas and flood defense systems; adaptation of the calendar of works in the field; implementation of legal measures for poor agricultural practice, as well as the planting and restoration of natural vegetation around agricultural areas and the prevention of soil erosion. Also, agricultural crop insurance has been recognized as one of the important mechanisms of adaptation to climate change (Đorđević et al., 2013).

As stated by Ristic et al. (2020), there is no universal approach recommended for all farms in the Republic of Serbia, but certainly the future development of many farms could be based on specialisation, with a well-designed production structure and market orientation, instead of the previous so-called, little bit of everything. The production of healthy food, not through the formula of organic products with an expensive certificate, but within small family farms, which avoid crop treatment with chemicals (close to the concept of integrated production), which is well positioned on the market, does not involve high costs and risks for producers, nor high prices for consumers, which fully corresponds to the condition and structure of many small agricultural farms in the Republic of Serbia (Ristić et al., 2020).

Sociologists have also questioned the link between climate change and lifestyle, especially in consumer society. It was determined that the higher carbon dioxide emission is related to the place of residence, the size of the apartment, the way of spending free time. It means, the richer individuals or societies, the higher carbon emissions (Miltojević, Ilić Krstić, 2020). Therefore, the solution is the return of young people to the countryside and education in line with climate change. Nevertheless, returning to or staying in the countryside does not necessarily mean engaging in agriculture.

Dwelling (urban or rural areas) has their own forms and manifestations, but it is certainly affected by climate change. According to the previous analyses, the effects of climate change on the population in rural areas are mostly seen through the reduction of income due to the decline in agricultural production, but also increased health risks due to reduced water availability and more difficult access to health care. Among them, agricultural producers with minimal capital propery are certainly the most vulnerable because, most often, they are completely dependent on agricultural production.

Agriculture has always been considered as the primary branch of any economy. As such, it is of paramount importance to any society, both past and present. What makes agriculture more and more important today and in the future is the modern demographic explosion that marked the last century of the second millennium, whose contradictory consequences are expected in the near future. Simply put: more and more people are looking for more and more food, which can only be produced by even more developed agriculture (Mitrović, 2015).

Conclusion

Agriculture is an inseparable part of the environment, and anomalies that occur in nature, affect all production cycles in agriculture. All segments of agricultural production will be affected to a greater or lesser extent by climate change. The greatest impact will be on crop production, due to the length of the vegetation period, which can last a couple of months, half a year, several seasons, a couple of years or several decades.

Serbian agriculture records a positive foreign trade balance. However, the structure of exports and imports is unsuitable, because export from Serbia dominates over raw agricultural products.

The model of rural development through the concept of "smart villages" is in the initial stage in the Republic of Serbia, and it is desirable to direct through the development with small businesses and households producing healthy food and specialized high value products, keeping in that way local products, local culture and tradition, creating a brand. This type of rural development implies new knowledge, with the empowerment of younger population to return and stay in the countryside. Rural development policy with the local treatment is closer to the local people and the democratic decision-making system through better knowledge of local opportunities and skills. With the foundation in republican authorities, support is necessary for young farmers through professional trips, seminars, trainings, regional and foreign exchange of experiences and knowledge, introduction to interregional cooperation programs for agricultural improvement.

Challenges posed by climate change to agriculture, require large investments in rural areas that have to be useful and appropriate, and agriculture cannot employ only the rural population or even the majority of the rural population in hope to be competitive.

According to that adaptation to climate change has to be set as one of the priorities. Adaptations are not only about reducing the damage, but also about find-

ing and using the positive effects. This new approach should feed a growing population while reducing the current impact on the ecosystem. Therefore, it is necessary to change the system of agricultural production and to devise an alternative direction of sustainable development.

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HYDROGEOLOGICAL CATEGORIZATION OF TERRAIN IN THE VRBANJA RIVER BASIN AND ENDANGERMENT OF GROUND AND SURFACE WATER

Vesna Rajčević[A]

Abstract

The paper outlines the hydrological categorization of the terrain in the Vrbanja River basin. The evaluation of sensitivity of groundwater is provided in line with determined categories. Special attention is paid to the design of hydrogelogical maps of the Vrbanja River basin. The map of potential pollutants in the basin provides us with an insight into spatial distribution of pollutants of both ground and surface water. The aim of the paper is to determine spatial distribution of water in the basin and exposure to anthropogenic impact, but also to provide recommendations with a goal to preserve and protect ground and surface water in the Vrbanja River basin which should be regarded as primary and permanent.

Keywords: the Vrbanja River basin, hydrogeological categorization, aquifer, water pollution, water protection.

INTRODUCTION

The Vrbanja River basin, as a unique hydrological system, has a complex physical-geographical position. One part belongs to the edge of the Pannonian Basin, while the other part of the basin is within the Mountain-Valley area. The Vrbanja basin is located in the central part of Bosnia and Herzegovina, i.e. in the western part of the Republic of Srpska. The watershed was determined from the lowest spot (147 m - estuary - Česma) to the spot (1580 m - spring - Kvrkuša) on the right side of the basin, and then from the highest spot 1597 m - Javorak to the spot 147 m - estuary (Česma) on the left side of the basin. The watersheds of the Vrbanja basin consist mainly of elevations of the mountainous and intermountain area of the basin.

In the southeast, the Vrbanja basin borders the Bila River basin (Central Bosnia Canton of the Federation of Bosnia and Herzegovina), in the east with the Velika Usora basin, in the northeast with the Ukrina River basin, in the north with the Turjanica basin, in the west with the Vrbas basin and in the southwest with the basin of Ugar River. The Vlašić mountain massif (Opaljenik peak - 1933 m) is a watershed between the Vrbanja basin, the Ugar basin and the Lašva River basin. Spot Velika Runjavica (1078 m), the highest peak of the mountain Borje, is a hydrographic hub for the basins of Velika and Mala Usora, the basin of Ukrina (Velika Ukrina) and the basin of Vrbanja. The dominant direction of the elongated Vrbanja basin is southeast - northwest, and this is, at the same time, the predominant direction of the Vrbanja watercourse. The Vrbanja River is one of the largest right tributaries of the Vrbas and at the same time one of the most important autochthonous flows of the geographical area of the Republic of Srpska. This fact significantly facilitates the rational use of the water resource of the Vrbanja basin, the regulation of the Vrbanja basin and watercourse, as well as the protection and development of the water resource of the studied basin.

The Vrbanje basin has a topographic area of 803.77 km² and it covers the administrative territory of the municipalities of Kotor Varoš, Kneževo, Čelinac, Mrkonjić Grad, Teslić, Laktaši and Banja Luka (The

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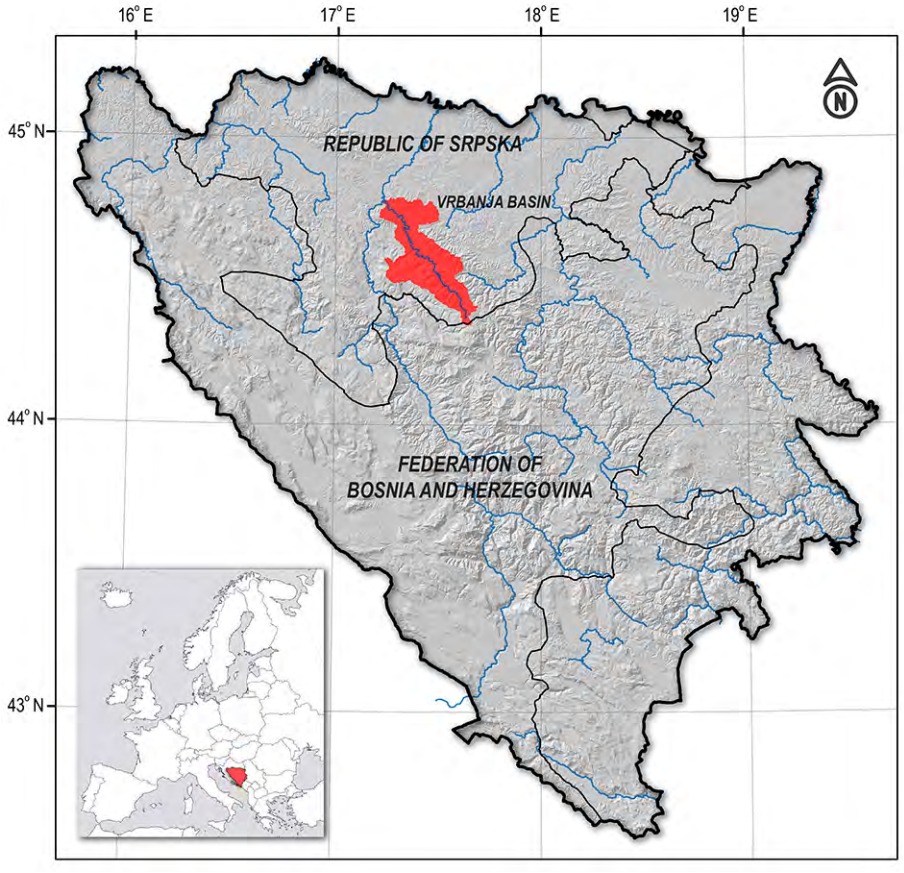

Figure 1. Position of the Vrbanja River basin in Bosnia and Herzegovina
Source: Prepared by author based on a set of topographic maps at a scale of 1: 25 000

Republic of Srpska) and the municipality of Travnik (Federation of Bosnia and Herzegovina). Approximately 99.7% of the catchment area is located in the Republic of Srpska and about 0.3% (spring part) belongs to the Federation of Bosnia and Herzegovina (Rajčević, Crnogorac, 2011).

The geological structure of the basin is complex (stratigraphic and lithological) and has a great influence on the consolidation of ground and surface water (Hrelja, 2007). The depth of water-resistant layers, their position and lithological composition of rocks affect the conditions of accumulation and runoff of groundwater, and thus, the geological structure affects the formation of the river basin network. The greatest influence of geological material on precipitation runoff is in the southwestern part of the Vrbanja basin, which is exposed to the process of shortening (karst erosion) with a sparse network of surface flows.

In the hydrogeological sense, the area of the Vrbanja River basin is built of watertight Mesozoic and Miocene rocks. Given their low porosity, there is practically no possibility of forming significant accumulations of groundwater. Favourable conditions for the formation of groundwater accumulations exist at hypsometrically lower stretches of contact of limestone with impermeable rocks. That is why there are karst springs on these stretches.

This paper aims to indicate the spatial distribution of waters in the basin, their exposure to various anthropogenic pressures as well as recommendations for the preservation and protection of groundwater and surface water in the Vrbanja basin, which should be primary and permanent.

BASIC GEOLOGICAL CHARACTERISTICS IN THE VRBANJE RIVER BASIN

The Vrbanja catchment area was first geologically processed by Friedrich Kacer (1921). After F. Kacer, an almost half-century vacuum is created in the geological papers of the studied basin. Within the project of making the Basic Geological Map of SFRY, R 1: 100,000 (OGK 1: 100,000,1977, 1981a, 1981b), the geological area of the Vrbanja basin is mapped in more detail.

The geological history of the terrain of the Vrbanja catchment area is quite complex and is certainly closely related to the geological evolution of the Dinar-

ides. The geological history of the Vrbanje basin can be traced, chronologically, to the Triassic. The Vrbanja basin area within Bosnia and Herzegovina belongs mostly to the Dinaric mountain system, which is located between the Adriatic massif in the south and the Pannonian massif in the north (Hrvatović, 1999).

The basic characteristics of the Dinarides are given by lithofacial complexes whose formation is related to alpine orogeny. The oligomyocene-neogene and marine-freshwater sediments of the southern parts of the Pannonian Basin, as well as the neogene freshwater basins formed during the Pyrenean phase, i.e. after the consolidation of the Dinarides, play an important role in the basin (Čičić, Pamić, 1978-1984).

The Vrbanja River basin basically consists of two formations. The first is of Mesozoic age (Triassic - Jurassic, Jurassic, Jurassic - Cretaceous and Cretaceous formations), which builds most of the catchment area. The second formation is younger (Neogene and Quaternary formations) and builds the peripheral part of the basin, especially at the foot of the Uzlomac and Čemernica massifs (Dimitrijević, 1982).

In the geological pillar of the Vrbanja catchment area, the oldest formations, the Triassic-Jurassic, are present in the northern and north-eastern parts of the basin. The basic petrographic structure consists of hornblende and radiolarites, which alternate in laminas or in the form of layers and their structure consists of fine-grained chalcedony aggregates. The north-western part of the Vrbanja catchment area is characterized by diabase - hornblende formations. The Jurassic-Cretaceous flysch series in the geographical area of Bosnia and Herzegovina represents the north-western part of the flysch complex Banja Luka - Vranduk – Sarajevo. When it comes to the Vrbanja basin, this series occupies the central and south-eastern parts of the basin area, i.e. most of the upper and middle part of the Vrbanja watercourse, but it is also present in the lower part of the watercourse. The Jurassic - Cretaceous flysch series extends in the northwest - southeast direction. Lower Cretaceous sediments in the Vrbanja basin are present in the northwest of the basin, but occupy the western and southwestern parts of the upper course of the Vrbanja River. They consist of: sandstones, marls and clays, with a capacity of about 200 m, and carbonate breccias, calcarenites and marls, with a capacity of 500 - 800 m. Upper Cretaceous sediments are located within the transition zone of "Paleozoic shales and Mesozoic limestones", as a marine flysch zone in the "Banja Luka - Vranduk - Sarajevo triangle". Upper Cretaceous sediments are widespread in the southwestern parts of the Vrbanja basin.

Neogene deposits occupy a relatively large area within the Vrbanja River basin. They are widespread in the wide vicinity of Banja Luka (Banja Luka basin) and Kotor Varoš (Kotor Varoš basin). The Neogene is represented by Miocene sediments. Quaternary formations occupy a relatively small area in the Vrbanja basin. They are represented by terrace sediments, proluvial, deluvial, deluvial-proluvial and alluvial deposits and sipars. They are more significantly represented in the middle part of the Vrbanja river (northwest and southeast of Kotor Varoš and southeast of Banja Luka).

The area of the Vrbanja River basin in geotectonic terms belongs to the zone of the Inner Dinarides, i.e. the zone of Paleozoic shales and Mesozoic limestones and the Central ophiolite zone, between which lie freshwater Neogene basins (Petković, Nikolić, 1981).

The Kotorvaroš Neogene basin occupies the central parts of the basin. It is tectonically clearly predisposed and its north-eastern rim is essentially a large Vareš-Nemila fault zone. Since the width of this basin does not exceed three kilometers and the capacity (thickness) of the unit is up to 800 m, we can conclude that during the Neogene of this depression it constantly and intensely sank.

The Banja Luka Neogene basin occupies the northernmost part of the basin. It is a rather narrow syncline, formed by descending along the vertical faults of Vrbanja, Banja Luka and Šeher (Srpske Toplice).

HYDROGEOLOGICAL CHARACTERISTICS IN THE VRBANJA RIVER BASIN

Hydrogeological characteristics of rocks and hydrogeological function of rock masses affect the movement of water underground and on the surface, and play a significant role in differentiating and directing the process of relief formation (Temimović, Džaferagić, 2017). The geological structure of a basin has a great influence on the consolidation of ground water and surface water. Petrographic complex, its chemical and mineralogical composition, structure and texture significantly affect the conditions of aquifer formation, and thus the formation of surface flows in the basin (Miošić, 1982).

In the Vrbanja River basin, hydrogeological features are conditioned by the lithological composition and composition of the terrain, as well as the distribution of precipitation. The overall appearance of the terrain in the Vrbanja basin is the result of the existence of rocks of different ages and composition.

Forms of Mesozoic age, which form most of the Vrbanja basin, are mostly watertight environments. They are characterized by low infiltration of precipitation and a small volume of pores in the rock mass. The groundwaters formed here are discharged via a source

of yield below 0.5 l / s ("Interpreter for the hydrogeological map", 1983). Slightly stronger springs appear less frequently and groundwater is mostly directed to discharge bases.

Low-yielding and waterless terrains in the Vrbanja basin are mostly connected to igneous rocks. In the case of the breakthrough of rhyolite and quartz porphyrite, they are interesting aquifers. Significant amounts of water can accumulate in such igneous formations (sources up to 0.5 l / s, rarely up to 10 l / s) ("Interpreter for the hydrogeological map", 1983).

The most intense infiltration of atmospheric precipitation is in the parts of the basin where karst is dominant. Karst relief in the Vrbanja basin has a significant share and is dominant in the basin area with a surface distribution of a series of Jurassic and Cretaceous limestones. The topographic surface, in the karst relief, consists mainly of sinkholes. Together with numerous fissures, they cause accelerated sinking of precipitation, especially in the western part of the basin. When it comes to hydrological specifics in the karst of the basin, we can talk about the appearance of a small number of underground rivers, which sink at the edge of the basin and then appear as sources of strong yield in the Vrbanja valley ("Spatial plan of Republic of Srpska until 2015", 2005).

In the part of the basin, with the predominant karst, there is a strongly pronounced aridity on the topographic surface and a significant presence of water in the interior of the limestone mass. The appearance of occasional currents is also characteristic, mainly at the time of intense precipitation and melting snow. A large number of fissures (abysses) cannot receive all the rain and snow, so the riverbeds feed intensively on water and form occasional streams. Another feature of the karst in the Vrbanja basin is its uneven power. In the western part of the basin, the karst is extremely shallow, and this results in the formation of karst outcrops and the appearance of a number of springs. Constant and abundant springs provide a continuous water supply, so it is not surprising that a large num-

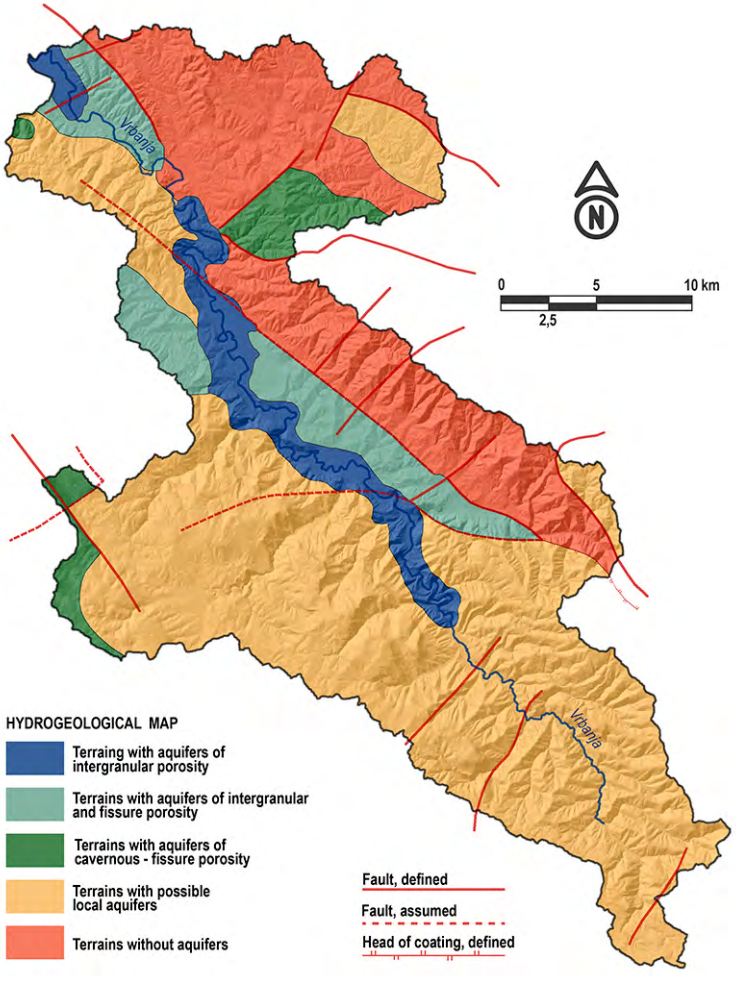

Figure 2. Hydrogeological map of the Vrbanja River basin
Source: Prepared by author on the basis of the Spatial Plan of the Republic of Srpska until 2025
(Amendments to the Spatial Plan of the Republic of Srpska until 2025)

ber of settlements have emerged in the western part of the Vrbanja basin.

Sediments of the older Neogene, represented by a complex of solid rocks, from the hydrogeological point of view are mostly not particularly interesting.

Alluvial sediments stand out among the Quaternary formations according to their water abundance. Horizontal and water layers in rock depressions are mainly present in the alluvial plains of the Vrbanja watercourse, but also in most of its tributaries. The existence of wells was registered at those locations. The water level in the wells varies depending on the water level of the river and the amount and type of precipitation. Inclined groundwaters are significantly present in the peripheral area of the Vrbanja basin.

Feeding of these groundwaters is compatible with the amount of atmospheric precipitation, but also the amount of water in the riverbed Vrbanja and its tributaries.

According to the conducted hydrogeological categorization of rock masses, five basic hydrogeological units have been identified in the investigated area. The first category is represented by terrains with aquifers of intergranular porosity. These are mostly densely populated areas and these aquifers are the most susceptible to pollution. The second category is represented by terrains with aquifers of intergranular and fissure porosity. Terrains with aquifers of cavernous-fissure porosity have the smallest presence in the basin. It is an intensively karstified area of high water resistance. There are several smaller underground rivers in this area, which classifies it as a sensitive area from the aspect of groundwater protection. Terrains with possible local aquifers have the largest share in the basin, as the fourth hydrogeological category and terrains with practically no aquifers, as the fifth category. It is clearly noticeable that the most vulnerable hydrogeological environment in the Vrbanje basin is the area of alluvial deposits along rivers and karst areas ("Amendments to the Spatial Plan of the Republic of Srpska until 2025", 2013).

Terrains with aquifers of intergranular porosity

This hydrogeological category occupies 55.29 km² or 7.25% of the Vrbanja River basin. This category includes alluvial gravelly sandy sediments, occasionally clayey sands, fine-grained Neogene sands, deluvial sediments, gravelly sands and clays of river terraces and myopliocene sediments, as well as gravels with marls and clays, and in some places coal. Given the relatively large thickness of gravelly-sandy alluvial formations and the spatial position towards the river, we can say that the presence of these aquifers below the local erosion base is a regular occurrence. This is especially characteristic of Quaternary sediments associated with the Vrbanja River (alluvium and river terrace).

In these sediments, a compacted type of groundwater with a free level was formed. The direction of underground water movement depends on the water level in surface streams, so that in the period of high waters the river "feeds" the groundwater, while in the period of low waters the groundwater "feeds" the river. The feeding of the groundwater is made on the expense of infiltration of atmospheric sediments, and by feeding from a river or other groundwater. Drainage is performed artificially through wells or other water intake facilities, such as draining water into a river. In these aquifers, the quantities of groundwater are very renewable, both on the basis of precipitation that infiltrates underground, and on the basis of surface flows, with which they are most often in direct hydraulic contact. The quality of water from these aquifers depends on the hinterland from which they come but they are mostly suitable for drinking. Groundwater protection in this environment is difficult due to direct contact between surface and ground water, so that pollution directly infiltrates underground. Protection zones in these areas are determined on the basis of the groundwater model, i.e. on the basis of the groundwater velocity under exploitative conditions. For rational management of springs open in the intergranular environment, it is necessary to develop a hydrodynamic model of groundwater that would provide guidelines for protection and the basis of self-sustainable development of the same ("Integral water and energy study", 2013). Aquifers of this group are mostly large. The water conductivity coefficient (T) ranges from 10 -3 to 10 -4 m / s2 and even T> 10 -3 m / s2.

Terrains with aquifers of intergranular and fissure porosity

This hydrogeological category occupies 72.69 km² or 9.06% of the Vrbanja River basin. Only the Miocene and Oligomiocene complex is classified in this category of terrain, in which clays, sands and gravels, sandstones, conglomerates, marls and limestones alternate. These formations represent the lower parts of Neogene complexes, so some lithological subjects have hardened, due to diagenesis. Within this hydrogeological group, mostly discontinuous aquifers (unconnected aquifers) were realized. They have different, but mostly low water conductivity coefficient (T) mostly <10 -4 m / s2, so they have mostly low water abundance and have no greater practical significance for water supply ("Integral water-energy study", 2013). According to the hydraulic mechanism, the waters from these aquifers are mostly under pressure, and in terms of quality they are mostly satisfactory. Since the aquifer is under a certain pressure in these environments, protection against groundwater

pollution is facilitated. When protecting these and other environments, it is necessary to know the zone of recharge, distribution and discharge of groundwater.

Terrains with aquifers of caverous-fissure porosity

This hydrogeological category occupies 32.84 km2 or 4.08% of the Vrbanja River basin. This category includes large limestone masses represented by the following lithological subjects: marly thin-layered limestones, marbles, limestones and dolomites in mutual alternation, dolomites and dolomitic limestones, limestone conglomerates and breccias and Neogene limestones in which sandstone lots occur to a lesser extent ("Integral water-energy study", 2013).

It is an environment of high yield and mostly large expanse. Aquifers of this group play a major role in the water supply of many settlements in the Vrbanja River basin, because the quality of their water is satisfactory. The hydraulic mechanism in aquifers of cavernous-fissure porosity is mostly free, and the presence of aquifers below the local erosion base is possible. Of course, this depends on the depth to which the karstification has descended in some specific cases. Groundwater protection in these aquifers is extremely difficult. In these regions, it is necessary to protect the entire area, i.e. the parts where the mentioned units come to the surface.

Terrains with possible local aquifers and terrains practically without aquifers

These two hydrogeological categories cover the largest part of the Vrbanja basin, 639.95 km2 or 79.61%. This terrain category includes all flysch and flysch-like complexes, volcanogenic-sedimentary complexes, clays, marly clays, sand and gravel clays, marls, clays and marly limestones, massive dolomites, igneous and metamorphic rocks.

They are built mostly of impermeable rock masses, although local aquifers are possible in them, with extremely low productivity. From a hydrogeological point of view, they can play a major role as an impermeable floor or side barrier of significant or leading aquifers. Hydrogeological subjects that build this category within the Vrbanja River basin are classified into two groups. Within the first group, discontinuous aquifers (local aquifers) are possible, mostly at shallower depths. As a rule, they have extremely low transmissibility and very low yields. The second group is generally without aquifers (practically impermeable terrains). However, in some places practically insignificant accumulations of extremely low transmissibility can be formed. Within both groups, the yields of springs are very small, only in some places they can be larger (3-4 l / s) ("Integral water-energy study", 2013). The appearance of slightly higher yields is attributed to fault zones or limestone lenses in crystalline shale complexes and diabase-hornblende formation. Also, seprentinite masses can have increased water abundance in extremely favourable hydrogeological conditions.

Given that these two hydrogeological categories represent areas with possible local aquifers and practically without aquifers, i.e. without significant underground accumulation, the protection of groundwater is relatively simple. From this area in the basin most of the precipitation flows on the surface so that the (potential) pollution from this area is washed away. It is necessary to say that at the contact of this region with the region built of carbonate deposits there are abysses, i.e. places where surface water directly enters the underground and thus the pollution that this water brings with it directly pollutes the groundwater of the neighbouring region.

ENDANGERMENT OF SURFACE AND GROUND WATER FROM POLLUTION

Mankind is increasingly aware of the fact that the future of the Earth depends on the quantity and quality of water that we will have in the future. We must face the fact that the problem of water is becoming more and more pronounced, both at the local and regional level, and at the global level. We do not link this problem to the water deficit, but to the possibility of using water (usable water). However, we should be objective and say that the "water problem" is already present in those basins where the amount of usable water is not able to meet the growing needs of water supply of the population and the economy.

The Vrbanja River, with its tributaries, is the primary recipient of wastewater from numerous settlements and commercial facilities in the basin. The basin itself is characterized by dispersive and major pollutants. Dispersive springs, in the lower and middle part of the basin, are the result of dominant farming activity. The main (stationary) pollutants are: industrial wastewater, municipal water, illegal waste dumps, septic tanks, landslides and small hydropower plants (Rajčević, Crnogorac, 2011).

According to water analyses, the Vrbanja River is (occasionally) one of the most polluted streams in Republic of Srpska. In terms of water quality, it is often outside the prescribed second class ("Surface water quality monitoring", 2017). The highest degree of water pollution in the Vrbanja River is compatible with low water levels, i.e. low river flow. One of the measures to improve the water quality in the Vrbanja basin

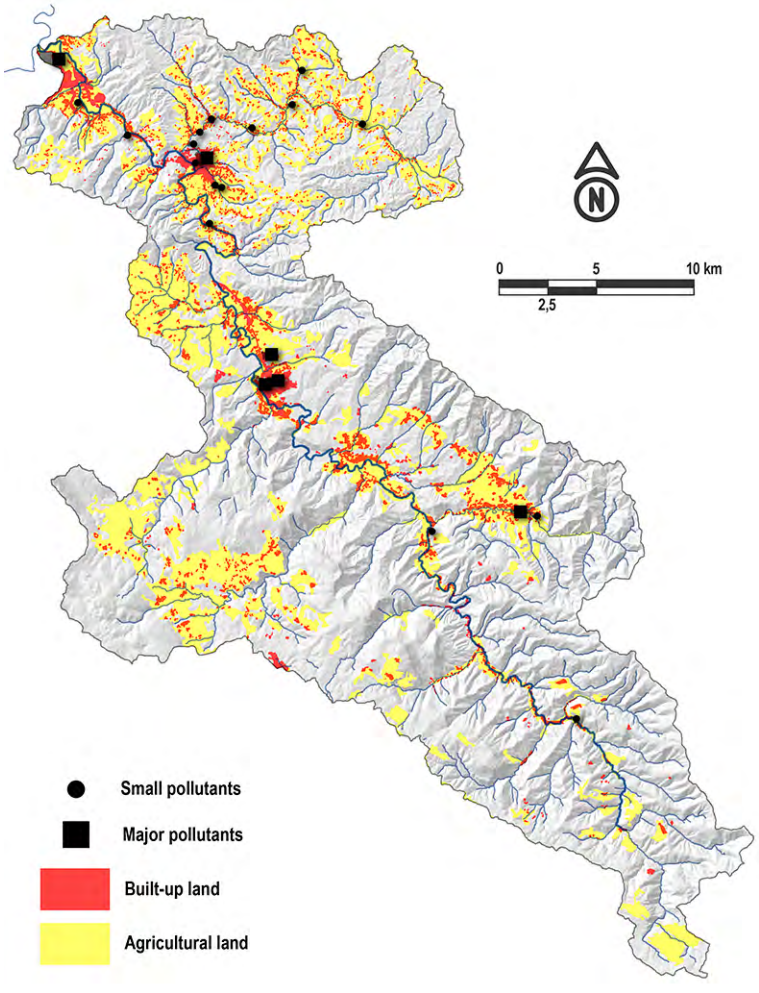

Figure 3. Map of potential pollutants in the Vrbanja River basin
Source: Personally prepared based on data from the Spatial Plan of the City of Banja Luka, the municipalities of Čelinac and Kotor Varoš

would be the construction of reservoirs for water improvement of the Vrbanja River in the upper course, i.e. in the Kruševica, Demićka, Grabovička river and Uzlomac stream (Spatial plan of the municipality of Kotor Varos 2009-2030).

A special feature of the upper course of the Vrbanja is the large number of springs and spring zones (mostly contact springs), which form short and occasional watercourses, often of a torrential character, with a pronounced erosion effect (linear erosion). Very few of these springs is captured. Their number as well as basic data (position, type of spring, yield) are not known.

Therefore, it is necessary to make a cadastre of all sources of the entire upper course of the Vrbanja in order to obtain data on their spatial distribution, basic data on the regime as well as the conditions of use and their protection. In the area of Kruševo Brdo towards Šiprage, forest exploitation is evident, which leads to occasional turbidity of both individual tributaries (Kilavac and Ćorkovića streams with their tributaries) and the water of the Vrbanja River.

In the upper course of the Vrbanja, SHPP "Divič" was built with a water intake and a fish farm. Certainly, this facility should also be under the supervision of the competent authorities in terms of water use in accordance with the regulations on water use (ensuring the ecological minimum of water).

In the overall course of Vrbanja, there are several pronounced influences on the chemical regime, which are especially pronounced in urban areas. Of these impacts, it is important to mention the problem of sewage spills in rural areas, wastewater from urban settlements (faecal and industrial), the occurrence of river sediment exploitation in the riverbed and water land, impacts from wood processing and agricultural production and waste disposal.

There is a real danger for groundwater in the Vrbanja basin. This danger is related to the fact that most rural settlements do not have sewerage connections, so that all faecal waters are filtered into groundwater, and urban settlements (Kotor Varos and Celinac) discharge faecal water directly into the Vrbanja watercourse. Groundwater, as part of the total water

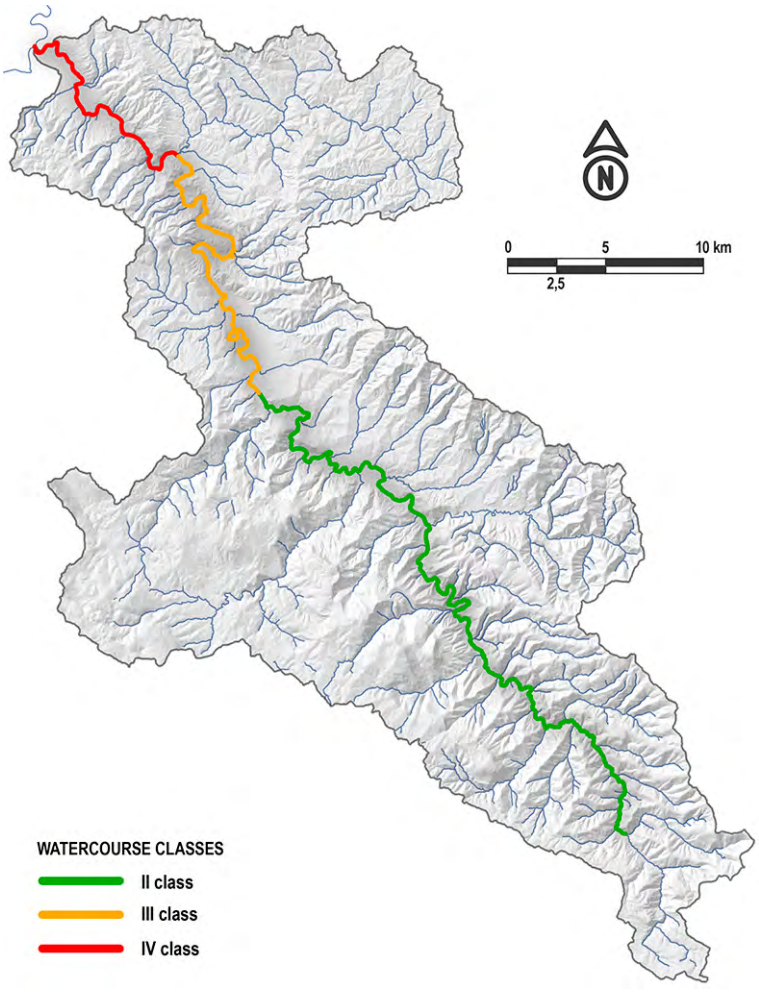

Figure 4. Categories of Vrbanja river pollution
Source: Personally prepared based on data from "Integral water-energy study of Vrbas River basin development"

fund, is endangered by pollution that occurs mainly through faulty septic tanks and through damage to the city and industrial sewerage network.

From the aspect of the overall water protection of the Vrbanja River, it is necessary to accelerate the development of plans and the implementation of the construction of faecal sewage and wastewater treatment plants on the downstream part of the flow and larger local communities. In this way, this constant negative impact on the quality of surface and groundwater in the Vrbanja River basin would be minimized.

CONCLUSION

The Vrbanja River basin, as a unique hydrological system, has a complex physical-geographical position. One part belongs to the edge of the Pannonian Basin, while the other part of the basin is within the Mountain-Valley area. The physical-geographical properties of the basin determined the geodiversity of geological phenomena and tectonic relations, but also the geodiversity of water phenomena and water bodies. The favourable geographical position of the Vrbanja basin is determined by the spatial affiliation of most of the basin to one entity, which provides the possibility of rational management of resources of this area but also the possibility of defining and implementing adequate measures to protect surface and groundwater as a whole.

The research, which preceded this work, established that the hydrogeological characteristics in the Vrbanja basin are conditioned by the geological structure, structural relations, tectonics and distribution of precipitation. The geological composition of the basin is diverse and complex (stratigraphic and lithological). The analysis identified five basic hydrogeological categories. The first category is terrains with aquifers of intergranular porosity (7.25% of the basin). These are

mostly densely populated areas and these aquifers are the most susceptible to pollution. The second category is terrains with aquifers of intergranular and fissure porosity (9.06% of the basin). Within this hydrogeological group, mainly discontinuous aquifers are present. When protecting these as well as other regions, it is necessary to know the zone of recharge, distribution and discharge of groundwater. Terrains with aquifers of cavernous - fissure porosity have the lowest representation in the basin (4.08%). This is an intensively karstified medium with high water conductivity. There are several smaller abysses in this area, which classifies it as a sensitive area from the aspect of groundwater protection. Terrains with possible local aquifers have the largest share in the basin (55.35%), as the fourth hydrogeological category, and terrains practically without aquifers (24.26%), as the fifth category. It is clearly noticeable that the most vulnerable hydrogeological environment in the Vrbanje basin is the area of alluvial deposits along rivers and karst areas. The main pollutants of groundwater and surface water in the Vrbanja basin are industrial wastewater, urbanization in the basin as a result of the development of urban settlements, but also settlements in rural areas that do not have sewage connections, so all faecal water is filtered into groundwater, and urban settlements (Kotor Varoš and Čelinac) discharge faecal water directly into the Vrbanja watercourse.

In order to protect water resources in the Vrbanja basin from anthropogenic pressures, water must be viewed as an ecosystem and not just as a resource. In order to successfully achieve this goal, it is necessary to pay special attention to the study and protection and sustainable use of water in the Vrbanja River basin.

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STATISTICAL ANALYSIS OF ANNUAL WATER DISCHARGE OF THE JOVANOVAČKA RIVER

Ljiljana Stričević[A], Milena Gocić[A], Nataša Martić Bursać[A]

Abstract

The basin of the Jovanovačka river is situated in the southern part of middle Serbia on the surface of 241.8 km². The goal of this paper is the trend analysis of the mean annual river discharges in the Jovanovačka river basin and their changes in a longer series of time, as well as determining their intensity. To determine the trend of discharge alteration we used Mann-Kendall test, whereas to determine the trend of the break point, that is, the year in which statistically significant discharge alteration happened, we used Pettit test, the standard normal homogeneity test (SNHT) and the Buishand range test. This study classifies the years by water richness, so as to perform more detailed analysis of the occurrence of dry and wet periods in the basin. For the needs of identification of medium watery, wet and dry years, the Streamflow Drought Index (SDI) has been used on the data examples from the town of Ćićevac. The obtained results imply that mean annual discharges in Ćićevac have a growing trend. The break point, that is, the years when significant increase in mean discharge occurred, are 1995, 2001 and 2003. The most years in Ćićevac are slightly dry in water.

Keywords: Jovanovačka river, Statistical analysis, Classification of years by water richness

INTRODUCTION

Study of water resources and their rational use in accordance with the contemporary society needs have been a very present topic in scientific literature, which imposes the need to review this problem both globally and locally. Due to constant demographic economic development, the need for quality, clean water is constantly increasing, but water exploitation is often followed by negative consequences, manifested through deterioration of water quality, increased flood risk, irrational consumption... In order to solve water management problems (water use, water protection) researches based on observation and noticing changes are of great importance in longer hydrological time series (Langović i dr, 2017).

One of the basic indicators of the water regime of a basin is the mean discharge. This paper analyzes mean annual and monthly discharges of the Jovanovačka river, through the analysis of change trend. Statistical analysis of trends of annual, seasonal and monthly discharges has been a subject of many hydrological studies both in domestic and foreign literature (Zelenakova et al., 2012, Jeneiova et al., 2014, Kovačević-Majkić et al., 2014 Čanjevac et al., 2015; Đokić, 2015, Gocić et al., 2016, Filipović et al., 2017, Langović et al., 2017...). Knowledge of changes in annual discharge values is very important, because these data indicate the water richness of the entire basin, which can be of great significance in the future planning and water resource management.

The purpose of this paper is to determine the existence of a trend in discharge change, but also if the trend is positive or negative. Apart from defining changes which happened in a series, the purpose of the analysis is to single out the precise year or years when the significant change occurred. The fluctuations of mean annual discharges, as well as the ranking of years by water richness were also analyzed,

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which determined how much the mean annual values of discharge deviate from the mean perennial value, i.e., what the frequency of occurrence of more or less rich in water years is.

The analysis was done based on the data of Republic Hydro-meteorological Institute of Serbia for hydrological station Ćićevac on the Jovanovačka river in the period 1979-2009. After 2009, there have been no discharge measurements on the analyzed hydrological station.

MATERIAL AND METHODS

The Jovanovačka river is the first right tributary of the Velika Morava. It flows into the Velika Morava 2 km downstream from the village of Donji Katun at 130 m above sea level. The Jovanovačka river originates from the Krčeva and Velika river, which meet near the village of Novi Bračin at 171 m above sea level. The Krčeva river springs on the southeast slopes of Samanjac, while the Velika river springs under Beljavski peak, among Samanjac, Rožanj and west parts of the mountain of Rtanj. Downstream from the place where the Krčeva and the Velika river meet, the Jovanovačka river flows towards south-west, up to Pojate, from where it curves slightly to the north-west and retains that direction to its confluence into the Velika Morava. Downstream from Novi Bračin the Jovanovačka river breaks through the Gradac gorge cut into crystal schist, and then the valley broadens like a funnel towards the Morava. Following the movement of the Velika Morava, the river has frequently changed its confluence. It is now regulated along its entire course across the Moravian alluvial plane so that it flows at the right angle on the river course (Gavrilović, Dukić, 2014). The length of the Jovanovačka river is 39 km and it comprises the basin surface of which is 241,8 km² (Stričević, 2015).

For determining the existence of a trend in changing the discharge values, we used the Mann-Kendall test. This test is non – parametric, i.e. it does not require the normal data distribution and it is based on comparison of all the data in a time series. It is a test that identifies the trend of a series, based on comparison of the relative magnitudes of the data change. If the trend value is less than 0, then a decreasing trend exists in the time series, but if the trend value is bigger than 0, it represents a growing trend. The zero hypothesis of the Mann-Kendall test works under the assumption that there is no monotony trend in a time series. For the zero hypothesis testing, control statistics is used. If the value Z (level of the significance) is bigger than 1.96 (which corresponds to the significance level of 0.05), we can conclude that the monotony trend exists in the time series. Otherwise, if the value is smaller, the trend does not exist (Kendall, 1962).

For homogeneity of series and change points we used three tests: Pettitt's test, Standard Normal Homogeneity test (SNHT) and Buishand range test.

The Pettitt's test is a non-parametric test, meaning that its application requires no assumption about the distribution of the data. This test provides assessment of the null hypothesis H0 implying that the data are ho-

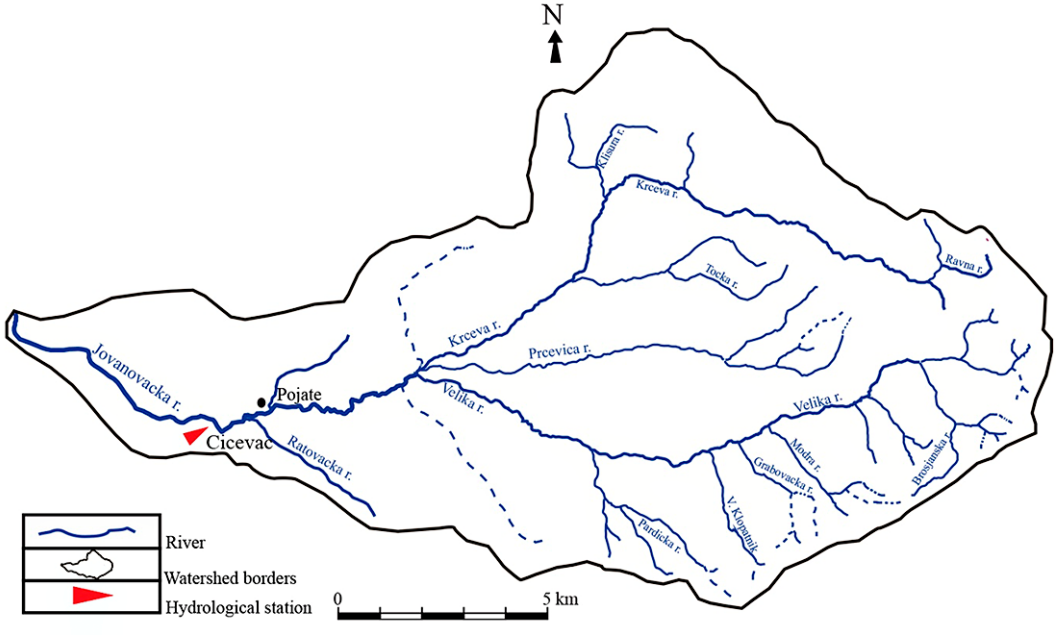

Figure 1. Map of catchment area of Jovanovačka river

mogeneous throughout the period of observation, i. e. that the data have been obtained from a single or several distributions with the same location parameter (average values). The alternative hypothesis implies the presence of a non-accidental component among the data causing a shift of the location parameter at a particular moment. Aside from providing for a data homogeneity check, the Pettitt's test also determines existence of the moment (year) t_c when the obvious mean annual discharge alteration occurs. If the test defines the moment tc, then average discharges in the period before the moment tc significantly differ statistically-wise from average discharges in the period after the moment t_c (Pettitt, 1979, Radivojević et al., 2015).

The SNHT homogeneity test is a statistical test which also checks if the data originate from the same population with the same distribution or indicate presence of a significant difference in the location parameter between the data before and after a specific change-point tc bringing an increase or decrease of the value of the observed feature. The null hypothesis in this test H_0 implies that the data are homogeneous, i.e. that they originate from the same population, while the alternative hypothesis H_1 implies the presence of a significant difference in the location parameter in the period before and after the moment t_c.

The Buishand range test is also a non-parametric test which checks the presence of a change-point in the given data, marking a change of the location parameter (average values) distribution. The null hypothesis implies data homogeneity in terms of the location parameter, i.e. absence of a change regarding the said parameter over time. The alternative hypothesis implies presence of a change-point involving an increase or decrease of the average value of the observed feature (Buishand, 1982).

In addition to the aforementioned analyses of the mean annual discharges, we also ranked the years by water richness using the Streamflow Drought Index (SDI), which points to a trend in the multi-year flow regime. The obtained positive values of SDI indicate that the values of the analyzed discharges are above the mean discharge during the analyzed period, while the negative values indicate that the discharges obtained have below average values. The higher the index values, the more water the year is, and vice versa. Based on the calculated SDI values, there are eight categories of years by water richness: extremely rich in water, rich in water, very rich in water, moderately rich in water, slightly rich in water, slightly dry, moderately dry, very dry and extremely dry years.

RESULTS AND DISCUSSION

For the analyzed period, the value of mean annual discharge of the Jovanovačka river in Ćićevac was 0.77m³/s. Maximum mean monthly discharge in Ćićevac was recorded in March and it amounted to 1.89 m³/s, while minimum monthly discharge was recorded in August and September – 0.14 m³/s. The amplitude between the recorded maximum and minimum mean monthly discharges is 1.75 m³/s. The ratio between the highest and lowest mean discharge values during a year on the Jovanovačka river in the analyzed period (31 years) was 1:13.5. The highest amount of water flows through the Jovanovačka river to Ćićevac during the spring months – 49.84 %, while the lowest amount flows during the autumn - 7 %.

Rain and snow regime is present in the Jovanovačka river basin, with large amounts of water in late winter and during spring. Those waters occur due to snow melting and heavy spring rains. The largest amounts of water in the rivers which belong to the basin of the Jovanovačka river flow from February to May. Other, significantly lower maximums occur from November to December, while the period July – October is characterized by small discharges.

To determine the existence of a trend of mean annual discharges, we used non-parametric Mann-Kendall test. The results of this test point to the trend of increase in mean annual discharges of the Jovanovačka river in Ćićevac, with the significance trend of α = 0,05 (5%) (Table 1, Figure 2). The average rate of discharge increase is 0.013m3/s per year.

Results of the Pettit test are shown in Table 2 and Figure 3. On the basis of the obtained values, we can conclude that the test defines 1995 as a breaking point from which there is an increase in mean annual discharges on the Jovanovačka river in the analyzed period. Up to the year in question, mean discharge was 0.588m³/s, while in the period after 1995 mean discharge increased to 0.993 m³/s.

The results of SNHT test are shown in Table 2 and Figure 4. The test determines 2003 as a breaking point from which there is an increase in mean annual discharges in Ćićevac. Mean discharge before 2003 was

Tabele 1. The results of Mann-Kendall test for mean annual discharges of the Jovanovačka river in Ćićevac

Variable	Min.	Max.	Mean	Standard deviation	Z	Q↑	B	Trend significance (α)
Q	0.2	2.0	0.77	0.4059	2.32	0.013	0.56	Yes α=0.05

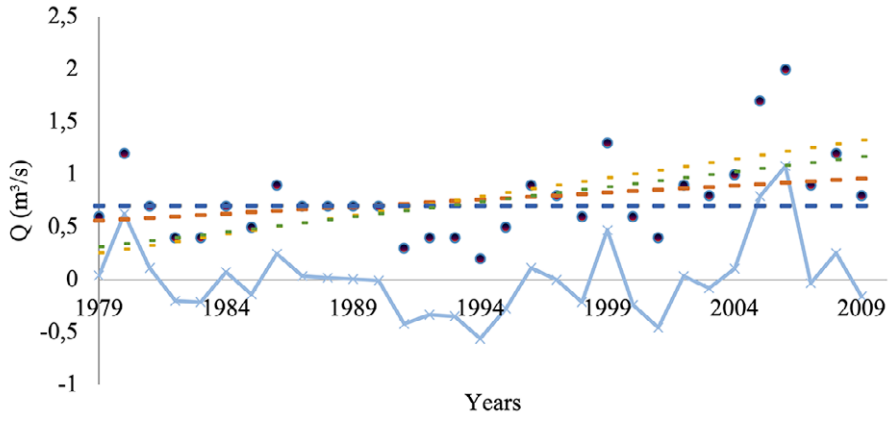

Figure 2. Trend of annual water discharge of the Jovanovačka river (Ćićevac) for the period 1979 – 2009.

Table 2. Homogeneity test - statistics

Station	t_c	average value before t_c (m³/s)	average value after t_c (m³/s)	p – significance of the test	Difference	
					m³/s	%
Pettitt	1995.	0.588	0.993	0,0127	0.405	40.79
SNHT	2003.	0.652	1.267	0,0077	0.615	48.54
Buishand's test	2001.	0.635	1.163	0.0094	0.528	45.40

0.652 m³/s, and in the period after the breaking point – 1.267 m³/s.

Results obtained by using Buishand test also point to accepting the alternative hypothesis of the test, which is the existence of a point in the series at which there is a change in the value of mean annual discharges. Buishand test defines 2001 as a point at which an increase in mean annual discharges of the Jovanovačka river in Ćićevac.

The analysis of annual water discharge recorded over 31-year period for the hydrological stations on Jovanovačka river on the basis of used statistical tests, it can be concluded that there is a change-point marking occurrence of a increase in average water discharge in Ćićevac. The results obtained should be applied in the improving of the model for predicting river discharge, which is very important for water management and agriculture, but also for the society as a whole.

When it comes to mean monthly discharges, according to Pettitt's and Buishand's test results from the first half of the 1990s there is a growing trend of discharges in January, April and December. In those months, mean monthly discharges were almost two times higher than in the previous period. In the other months, breaking points were not determined, i.e., there was no point at which there was a change in mean monthly discharges when either of the tests was applied.

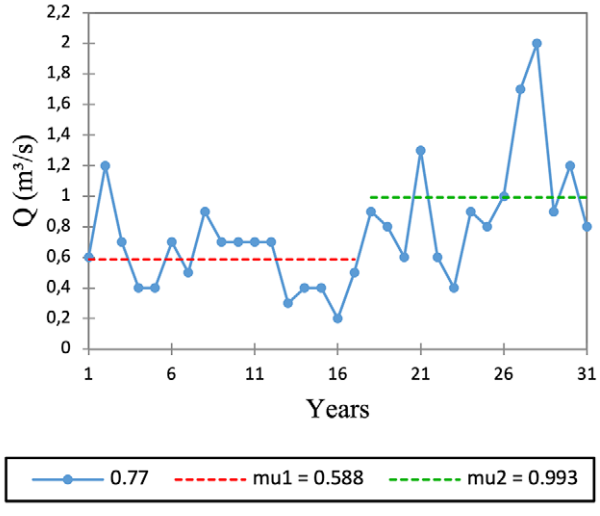

Figure 3. Pettit test for the Jovanovačka river

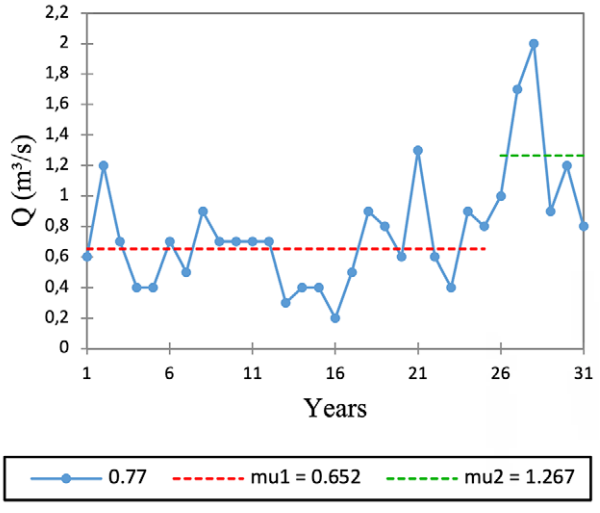

Figure 4. Standard normal homogeneity test (SNHT) for the Jovanovačka river

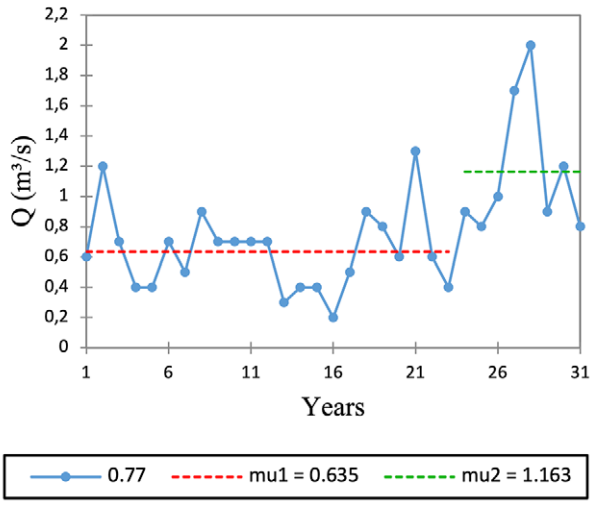

Figure 5. Buishand's test for the Jovanovačka river

by numerous factors, most important of which are precipitation and air temperature. Both the trend of increasing air temperature in the Jovanovačka river basin and the increase in the amount of rainfall discharged into the basin were recorded in the analyzed period. In meteorological stations (Ćuprija and Kruševac) there has been a significant increase in mean annual precipitation since 1995. Karst springs at the source of the Krčeva river have had a great significance in improving the water regime during the year.

In the analysis of mean annual flows it can be noted that during certain years the rivers are rich in water, while there are years in which some of the riverbeds of the water courses remain dry in the summer period. In order to get an insight into how much the discharges deviate from some average, expected values, how often high or low waters occur in the studied period, we performed a ranking of years by water richness from 1979 to 2009. Figure 6 shows mean annual discharges of the Jovanovačka river in Ćićevac,

Table 3. Homogeneity test's statistics of the values of mean monthly discharges, for the period from 1979 to 2009.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Pettitt,s	1995-	-	-	1993 -	-	-	-	-	-	-	-	1994-
p value	0.0382	-	-	0.0309	-	-	-	-	-	-	-	0.0468
Q_{av} before t_c (m³/s)	0.622	-	-	1.211	-	-	-	-	-	-	-	0.462
Q_{av} after t_c (m³/s)	1.271	-	-	2.320	-	-	-	-	-	-	-	0.970
SNHT	2002-	-	-	-	-	-	-	-	-	-	-	-
p value	0.0270	-	-	-	-	-	-	-	-	-	-	-
Q_{av} before t_c (m³/s)	0.703	-	-	-	-	-	-	-	-	-	-	-
Q_{av} after t_c (m³/s)	1.610	-	-	-	-	-	-	-	-	-	-	-
Buishand's test	1996-	-	-	1994-	-	-	-	-	-	-	-	1994-
p value	0.0248	-	-	0.0379	-	-	-	-	-	-	-	0.0278
Q_{av} before t_c (m³/s)	0.622	-	-	1.234	-	-	-	-	-	-	-	0.462
Q_{av} after t_c (m³/s)	1.271	-	-	2.377	-	-	-	-	-	-	-	0.970

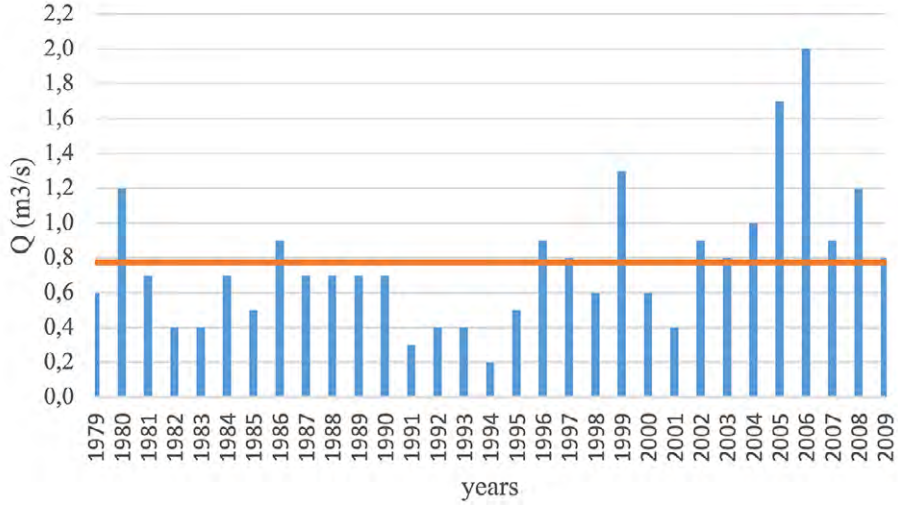

Figure 6. Mean annual discharge values of the Jovanovačka river in Ćićevac (1979-2009)

Table 4. Ranking the years by water richness of the Jovanovačka river in the period 1979 -2009.

Water richness of the year	Streamflow Drought Index (SDI)	Years	Number of years
Extremely dry	SDI < -2.0	-	-
Very dry	-2.0 ≤ SDI < -1.5	-	-
Moderately dry	-1.5 ≤ SDI < -1.0	1991, 1994	2
Slightly dry	-1.0 ≤ SDI ≤ 0.0	1979, 1981, 1982, 1983, 1984, 1985, 1987, 1988, 1989, 1990, 1992, 1993, 1995, 1998, 2000, 2001	16
Slightly rich in water	0.0 < SDI ≤ 1.0	1986, 1996, 1997, 2002, 2003, 2004, 2007, 2009	8
Moderately rich in water	1.0 < SDI ≤ 1.5	1980, 1999, 2008	3
Very rich in water	1.5 < SDI ≤ 2.0		0
Extremely rich in water	SDI > 2.0	2005, 2006	2

and their average value, as well as the boundary dividing below and above average years in water richness.

Maximum mean annual discharge of 2.0 m^3/s was recorded in 2006, while minimum discharge was recorded in 1994, and it amounted to 0.2 m^3/s, which shows the ratio of 1:10. Out of 31 analyzed years, during 13 the discharge was above, while during 18 years the discharge was below mean values. From 1995 (breaking point according to Pettitt test), during 11 years above average annual mean annual discharge values were recorded, while after 2001 (breaking point according to Buishand test), discharges higher than mean perennial value were recorded each year.

The largest number of years on the Jovanovačka river in Ćićevac belongs to the group of slightly dry years (16) and they occur almost each second year, usually for two consecutive years or more frequently. Extremely dry, very dry and very rich in water years were not recorded on this profile during the analyzed period, while years 2005 and 2006 were extremely reach in water, when the mean annual discharge was 1.2 and 2 m^3/s. In the analyzed period, there was a greater number of dry years.

CONCLUSION

This paper analyzes the changes in mean annual and monthly discharges of the Jovanovačka river, as well as defining trends and years in which there were statistically significant changes in the discharge. Nonparametric tests determined that the growing trend of discharge values. Years with significant changes are 1995. (Pettitt test) and 2001. (Buishand test). The analysis of year by water richness point to certain cycles of alteration between dry and wet periods. There is a small number of years extremely and very rich in water, as well as greater number of dry years compared to the years rich in water.

Based on the obtained results, we can conclude that the water amount the Jovanovačka river has slightly increased since th first half of the 1990s. Apart from the analysis of changes and noticing trends in the analyzed hydrological series both on annual and monthly level, future hydrological research should focus on detailed analysis of all the factors (both natural and anthropogenic) which can affect the changes in the water richness of the basin.

Acknowledgements

The paper shows the results obtained within the Project No. 176008, financed by the Ministry of Education and Science of the Republic of Serbia.

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MONITORING SPATIAL CHANGES USING HISTORICAL AERIAL IMAGES

Saša T. Bakrač[A], Dejan Đorđević[A], Viktor Marković[A], Siniša Drobnjak[A], Marko Stojanović[A]

Abstract

Analyzing historical aerial images can provide high-quality and important data for environmental and geographical surface research in general. Determination of human and other impacts in rural or urban areas, such as surface changes: on land (erosion or landslides), in vegetation (forests, meadows, various agricultural crops, etc.), hydrography (watercourses, lakes, ponds, etc.) may be the subject of research based on historical aerial images. This method provides an opportunity to determine the state of spatial elements over a long period of time. This especially includes the time when it was not possible to obtain data from satellite images. Aerial images can analyze spatial details, and as such are especially suitable for tracking and mapping smaller spatial phenomena. The analysis of aerial images, from the past and recent ones, can provide information on the nature and trend of some phenomena, as well as conclusions for taking preventive and corrective measures. The Military Geographical Institute of the Serbian Armed Forces has a rich collection of surveys of the territory of the Republic of Serbia and wider, since the 1950s.

Keywords: geography, environment, photogrammetry, mapping, remote sensing.

Introduction

The use of remote sensing in environmental research is a proven and scientifically recognized method. Aerial images from previous and present epochs give the possibility of multi-purpose use in research. By analyzing the previous and current state of the environment gives the images a good basis for insight into the previous and current state as well as the extent and continuity of the changes. (Peng Gong, 2012; Liu et al. 2018). Aerial images have advantages over other forms of spatial data collection. These advantages are: cost, autonomy in operation, data quality (image quality), and the ability to analyze environment condition from significantly earlier aerial imaging periods. It is especially suitable to use these images for analyzes of surface elements such as: soil, vegetation, settlements, communications, hydrography (Morgan, 2013).

The paper gives a general outline of how to prepare and use aerial images for the purposes of retrospective research explaining the individual phases. First, through the process of primary image processing, digitization of images and the production of orthophoto is carried out. Then, the content of the selected area is mapped through defined aerial imaging epochs. This is done through the processes of 3D and 2D photogrammetric processing. Finally, data are obtained for relevant analyzes of spatial entities. These activities require dedicated software and standardized methods. The MGI Photodocumentation Archive has a large collection of aerial imaging since the 1950s - over 3800 films. (Bakrač et al., 2017; Bakrač et al., 2018). These are the territories of the Republic of Serbia and other republics of the former Socialist Federal Republic of Yugoslavia.

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Selection and primary processing of images

The aim of primary image processing is to produce orthophoto maps for selected aerial imaging epochs (Figure 1). Scanning of aerial images and conversion from analog to digital is an initial step (Wrobel, 1991; [1]; Bakrač et al., 2017). The procedure is performed through the following activities: providing a digital altitude model, determining landmarks and checkpoints, orthorectification of aerial images, radiometric correction of DOFs, mosaic of orthorectified aerial imaging, making orthophoto map, and orthophoto map quality control (Wolf et al., 2014).

It is noted that aerial images cannot be used as a measuring base because of the deformations caused by the central projection, the non-verticality of the image and the different height of the terrain and objects on it (Redecker, 2008). Therefore, the orthorectification of each aerial imaging should be performed (Figure 1).

The orthorectification process involves performing aerotriangulation and collecting 3D data to generate a digital terrain model (DTM). Vectorized contour lines and heigh points from topographic maps can also be used to generate DTM. Aerotiangulation is performed through the phase of internal orientation (determining the image coordinates of the main point by measuring the edges in the image) and external orientation (matching identical details on overlap images and determining the tie points and orientation points). After the measurements are made, the measurement is smoothed out, resulting in a spatial model that existed during the aerial imaging. When such points are added to the DTM, this is an ortho-

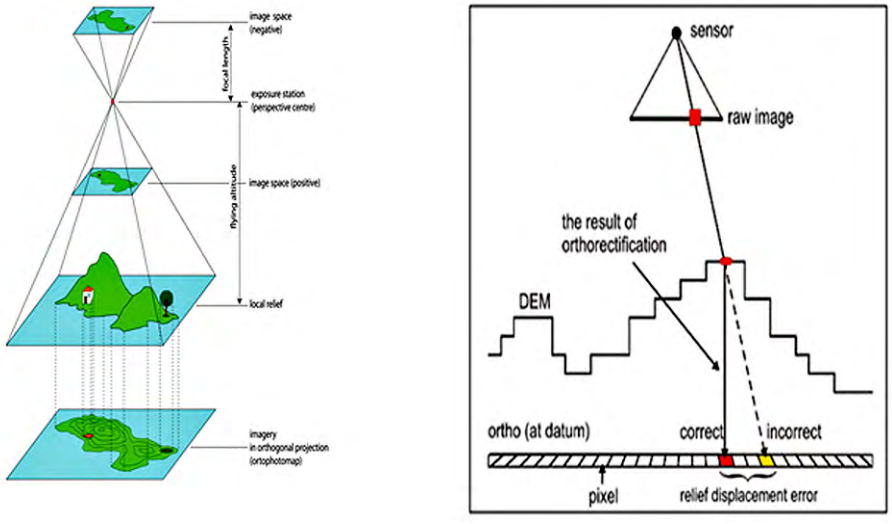

Figure 1. Orthorectification Principle
Sources: https://ncsu-geoforall-lab.github.io and https://gisisit.files.wordpress.com)

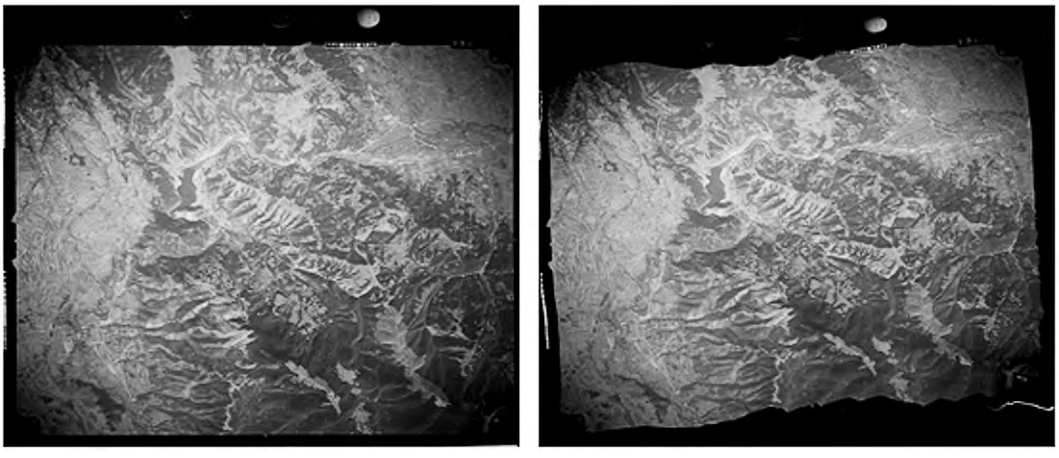

Figure 2. Example of the raw image on the left and orthorectified image on the right show intensite of the "creasing" and displacement of details towards the center of the image , which is the main consequence of the transformation of the image created by the rule of the central projection

rectification procedure. By performing these procedures, the image was converted from central to orthogonal projection, which in other words means that each terrain point was re-projected to a projection plane (map, plan, etc.). This process eliminate linear displacements of the position of the points and inhomogeneous scale on different parts of the image frame, as well (Fig. 2).

For the purpose of monitoring spatial changes, unless a greater level of detail is required, a DTM generated from vectorized isohypsis from topographic maps of the Military Geographical Institute in the scale 1: 25000 may be used. When the need for a higher level of detail, e.g. more detailed and accurate DTM is required in analyzes to undertake flood protection measures. Modern tendencies are to use a LiDAR system to produce higher-level DTM accuracy but smaller areas. LiDAR data, combined with other aerial image data collection, provides accurate, three-dimensional information about spatial entities and their characteristics, whether they are natural (terrain, vegetation) or artificial (objects).

Data processing in the 3D and 2D restitution process

Photogrammetric 3D data restitution is performed to produce terrain elevation (Wolf et al., 2014; Linder, 2009, Pinto et al., 2019) in the form of a digital terrain model (DTM) and to collect data in 3D for elements that require terrain elevation data or relative height relative to the terrain.

At the Military Geographical Institute, the photogrammetric 3D restitution procedure is performed on the basis of created stereomodels in the stage of processing aerial image data. For photogrammetric 3D mapping an add-on (extension) for ArcGIS - ERDAS Stereo Analyst for ArcGIS is used. Photogrammetric 3D restitution is performed in accordance with the adopted logical data structure (LDS) with respect to the basic cartographic and topological rules, as well as the symbology of the mapped elements.

For DTM production, data can be collected semi-automatically in the form of a "grid" and manually in the form of structural and fractured terrain lines. At the same time the hydrographic lines and surfaces are also collected. The entire process is also followed by the input of appropriate attributes according to the physical data model.

For the purposes of 2D mapping (restitution), further mapping processing from the original DTM generates angles and isohypses and adapts the mapped content in 3D restitution processing in the 2G CGTBP environment in ArcGIS - ArcEditor software.

After the 3D photogrammetric restitution phase, the photogrammetric 2D restitution (mapping) phase of the content is realized. First, it is necessary to adapt and download data from the 3D environment and import it into a 2D environment in which the other elements are mapped and processed according to the adopted LDS, physical data model and adopted symbology in the standard 2D window of ArcGIS - ArcEditor software. The attributes required for certain elements are entered into the database. In 2D restitution, standard cartographic sources are used and standard cartographic rules are followed, so that the

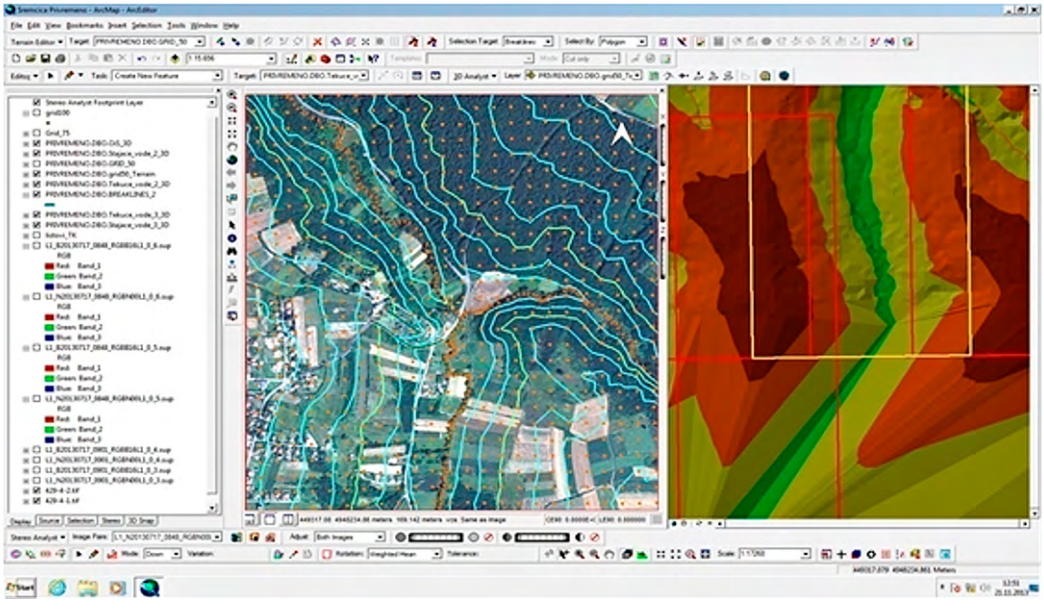

Figure 3. Photogrammetric 3D Restitution - Terrain shown in 3D and 2D windows

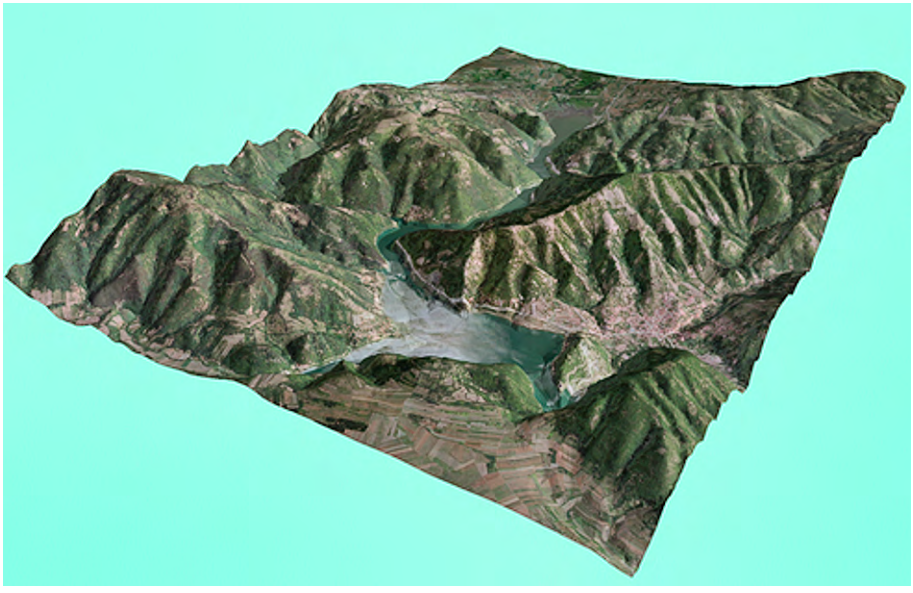

Figure 4. Perspective view of the space created by "dragging" the image onto the DEM (Digital Elevation Model)

elements of hydrography, railways, roads as well as communication parts and objects on them are then downloaded and mapped, then the situation (objects - point, line and area) and elements of vegetation.

Organization of data through Geodatabase

The process of map production and analysis of this kind was organized by the Military Geographical Institute through the Geodatabase (GDB). It is designed to form a unified set of all spatial data in a single database from which a series of topographic and thematic maps or other surveys are derived. Process based on the GDB alows greater data availability, multidimensional data presentation, easier data administration, reduced data redundancy and standardization, which ultimately contributes to reducing the time required to produce spatial products (Shekhar& Chawla, 2003; Atzeni et al., 2000).

In the case of spatial analyzes based on the use of historical and current aerial images, it is necessary to establish a logical data structure (LDS) and a physical data model so that they are structured in such a way as to cover as many aspects and spatial indicators as possible. This enables a relevant analysis of the situation, from which adequate measures of improvement emerge. For the purposes of some research, by analyzing historical aerial images, a division is made into basic entities. For example, vegetation is divided into forest, orchard, vineyard and shrubs (low vegetation); communications to main and local roads. If there are conditions for a more detailed classification of entities, then better conditions are created for a more comprehensive analysis of the situation. It is important to make a preliminary analysis of the data that is to be collected and analyzed, as well as to clearly define the monitoring objective. The LDS can be upgraded, with additional time spent adjusting the data to the new structure.

Analysis of collected data

After primary mapping and attribution of each attribute to each charted entity, thematic maps are created according to the selected aerial imaging epochs. Since the mapping is done directly at the base, surfaces for polygons and lengths for line elements are automatically calculated.

Figure 5 gives an example of mapped spatial entities. Such a product follows the possibility of analyzing the following mapped entities: facilities, communications (main and side roads), hydrography (rivers and lakes), vegetation (shrubs, orchards and forests).

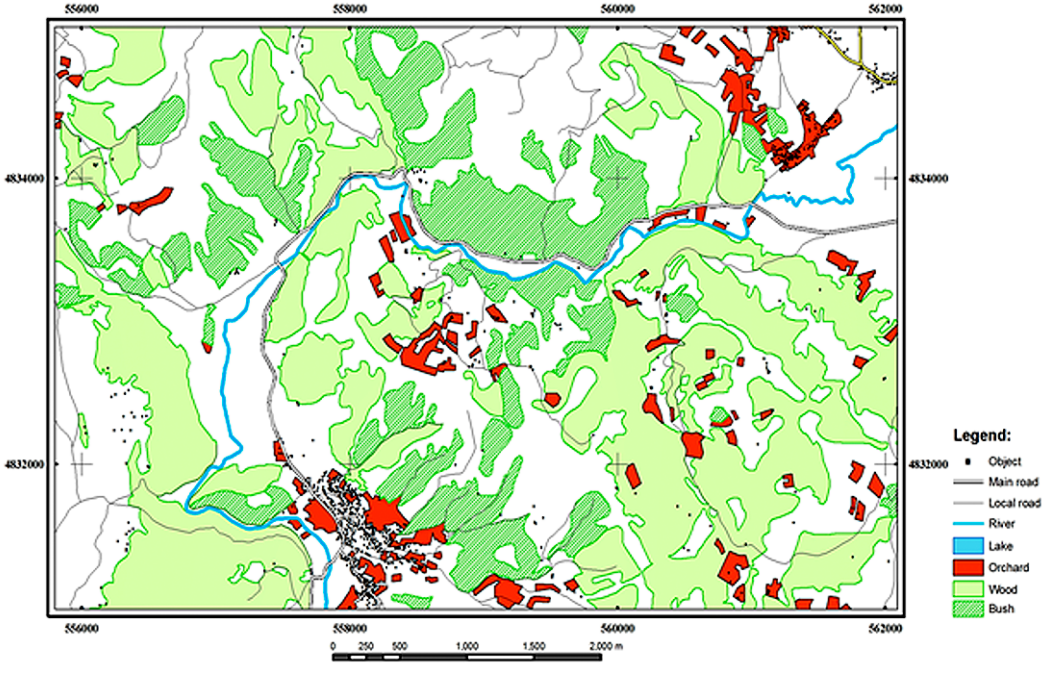

Figure 5. Map of the 1969 situation

Conclusions

From historical aerial images, spatial data can be analyzed. By comparing the previous and current condition of some elements of surface, the amount and continuity of their changes can be determined, which provides a good basis for predicting further changes. This paper presents the possibility of using historical aerial images for spatial analysis through: the method of preparing and processing the images, the organization and analysis of the data. The paper offers a clear demonstration of how to apply historical aerial images to analyze elements of surface and the environment in general.

The preparation procedure consider selection of appropriate aerial images according to desired epochs, then follow orthorectification procedure as a condition for further primary processing of the images through photogrammetric 3D and 2D data processing. Then follow data collecting in accordance with the adopted logical structure of the data in compliance with the basic cartographic and topological rules, as well as the symbology of the mapped elements. From the collected data, the mapping and analysis of surface elements is performed. This approach should, with scientific certainty, serve to better understand and track the spatial and temporal patterns of change.

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REGIONAL DISPARITY ANALYSIS OF GREEN ECONOMY FACTORS: THE CASE OF SERBIA

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Abstract

At the end of the 20th century, the sustainable development concept and rational consumption of resources became particularly important in all spheres of the global economy. As the answer to growing environmental challenges, a green economy concept was introduced. Serbia, as a developing European country with serious environmental issues, also started with the green economy concept development. This paper aims to point out regional differences in development and implementation efficiency of the green economy in Serbia (efficiency degree of individual districts), i.e. to determine regional differences when it comes to external factors influencing the development and application of green economy. For expressing regional differences, a composite index was calculated using the DEA methodology. The composite index building is based on key environmental and economic factors that are grouped into certain categories (pollution, energy consumption, production costs).

Keywords: Green economy, Data Envelopment Analysis, Regional disparity, Serbia

Introduction

Globalization, ongoing industrial revolution 4.0, as well as climate changes, are the attributes of modern economies. Dynamic and volatile business environment, the convergence of different industries, and also a higher degree of ecologic sensitivity have all contributed to the changes of the companies' positions in the context of new business models. The said tendencies, as well as a proactive market approach in the form of change management, have enticed the development of a green paradigm for companies, and this has further conditioned the implementation of the green economy concept. In this respect, energy efficiency, recycling, and the use of renewable energy resources become imperatives of doing business, and this additionally emphasizes the importance of the environment for companies and economies.

The green economy concept exists as such for several decades and it was made to achieve the highest economic and scientific benefits with decreasing environmental risks (pollution costs, energy consumption, input of production costs) (Adams 2008). This started to be especially important after the financial crisis in 2008 when it was clear that future economic and social development will be tightly connected to solving financial problems but as well as coping with growing environmental and resources challenges. In this context green development is also used as a synonym for green growth, which aims to decrease the use of non-renewable resources. Furthermore, both green economy and green growth are served the ultimate goal of sustainable economic development.

This concept was first time proposed in 1989 and it was developed continuously since then (Pearce et all. 1989). Even then it is noticeable that effective implementation of the green economy standards and principles demands both technology innovations (e.g. green manufacturing industry) and government industrial policies (e.g. Green New Deal strategy). To achieve this, national economies which decide to implement the green economy concept start to change the economic structure and to work on its new regional and global competition (Feng at al. 2017, Grillitsch at al 2019).

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In such a way, the green economy started to be an important global topic ever since the first sustainable and environmental organizations started to act. The biggest global environmental problems such as overuse of resources, global warming, and environmental devastation incited the development and implementation of the green economy concept. Big and strong economies such as the USA or EU have already implemented this concept in their ongoing manufacturing industry structure, having already certain results. On the other hand, big arising economies such as China, much later recognized this issue as one of the main pillars in its national economic strategies, and they put this issue as the key one in their economic strategies the next 20 to 30 years (Zheng 2018, Colglazier 2015). Everybody agrees that the green development concept is the condition for achieving long-term sustainability – economic growth with minimum environmental impact.

Expected, developing countries lag behind the leading world economies in implementing green development concept. Serbia is no exception. Throughout the last three decades, Serbia has gone through a very difficult and complicated political and economic period (Manić et all. 221). Being a part of one big socialist country such as Yugoslavia, Serbia has experienced a modified variant of the central-planned economy (Ratkaj et all. 2021), after the Yugoslav state break out, Serbia entered the transition process. During the last decade of the last century, this process was seriously interrupted with the economic and political sanction of the UN against the Federal Republic of Yugoslavia (which Serbia was part of) and NATO bombing in 1999. After 2000 and political changes, the transition process accelerated. With occasional slowdowns during the last two decades, Serbia had certain economic growth and development. The acceleration of the economic growth however inevitably led to resources consumption growth and certain ecological challenges. Having in mind the high unbalanced regional development, Serbia is also facing an unbalanced resource consumption level as well as pollution emissions. Still having no seriously tailored environmental development strategy, the national economy has been torn between economic growth acceleration demands on one side and growing environmental protection on the other. The green development concept could be the key solution for such a situation, but it is obvious that there are huge differences in green economy indicators among different regions and areas.

In such context, this paper aims to point out regional differences in the green development efficiency comparing different areas in Serbia (efficiency level of individual districts/areas) with the static component emphasized (regional differences when it comes to external factors influencing the development and application of green economy). Instead of using a great number of different individual indicators measuring districts' performance, it was more appropriate to use one composite indicator for depicting this complex issue. For that reason, a composite index was created. However, a significant limitation in its creation presented the availability of suitable data, primarily on a district level (some factors affecting the development of the green economy, which could be considered important, are not included in the model because they were not available at a required level). Despite such imperfection, authors still think this methodology reveals an important aspect of the development of the external environment – differences in local factors that could be influenced by the local government in cooperation with the national government to tackle local specificities and needs.

Literature Review

The history of the world economy has undoubtedly confirmed that economic progress and growth meant a constant increase in resource and energy consumption. This led not only to the problem of resource deficit but as well to the huge environmental problem which appears to be global (global warming, climate change, ozone layer depletion, acid rains,…). It could seem paradoxical at the first glance – the more civilization develops, the more it faces the serious ecological challenges which in the end could endanger the very human being existence. This was a good enough reason for world science to try to analyse the root of the problem, the factors that influence over it, and to model and optimize some solutions for future global development.

Green development and evaluation efficiency are one of the most interesting topics among the scientific research public in recent years (Brito et al. 2019, Yang et al. 2015, Yingyu et al. 2020, Blengini et al. 2012), encompassing different topics such as green production and innovation efficiency (Mu et al. 2017, Zhang et al. 2018), green technology efficiency (Luo & Liang 2016), and green water utilization (Yao et al. 2018) within different sectors. The efficiency of green transportation development is an especially interesting topic because it concerns every aspect of production and life (Lin & Yang 2009, Musolino et al. 2019, Wang et al. 2019). Analysing the existing researches about green development efficiency, it is noticeable that besides the efficiency evaluation, the selection of the green devel-

opment indicators is another important aspect of this process. There is a huge range of such indicators that are used to build a comprehensive multi-indicator system (Human Development Index, Total Environment Load Index, ecological footprint, even green GDP) (Wang et al. 2018, Brown & Ulgiati 2002, Siche et al. 2008, Pan et al. 2019, Boyd 2007). Through the construction input-output indicator system, one could select a quite good group of indicators, which is a much better approach than choose only one or two indicators. To integrate several indicators which belongs to different groups such as production factors, energy input, pollution emissions and economic output, a comprehensive index system could be established using different methods such as cross/benefit model, the data envelopment analysis, total factor productivity (Cheng et al. 2019, Yingyu et al. 2020, Tao et al. 2016). It is clear that industrial structure, economic development, human capital, technology development, overall investment and environmental regulation strongly affect the efficiency of the green economy, and at the same time, there is a certain difference when comparing it on the lower level (regional, or even urban).

Methodology

DEA methodology – general theoretical framework

To determine regional differences when it comes to external factors influencing the development and application of green economy (a sort of efficiency aspect), the composite index has been calculated. This index is based on key environmental and economic factors that are grouped into certain categories (pollution, energy consumption, production costs) and it is calculated by using the method of Data envelopment analysis (DEA).

This technique has been widely used to assess performance in the different fields (social, demographic, economic, ecological, technological, etc.) (Mitrović 2015, Mitrović 2020) and has been revealed as "a useful tool in policy analysis and public communication" (Nardo et al. 2005, Vidoli et al. 2015).

Data envelopment analysis is a sort of methodology which constructs an 'efficiency frontier' based on each district's individual data using mathematical linear programming and avoids subjectivity in the choice of weights. It determines the best practice by measuring the relative position of each of the districts in terms of the value of the set of observed indicators. Such presentation of existing district's development in different fields and recommendations for possible improvement is clearer to the general public and non-scientific audience because the indicators built using this approach are easily understandable for the general public, as they can be normalized to one composite index (OECD 2008).

To determine the weights for each district and each individual indicator, the "Benefit of the Doubt" approach is used (Charnes et al. 1978). The calculation of the composite index is an iterative process containing several steps. After defining the selection of individual indicators, as well as the year representative for the analysis, normalization of their values has been performed. The reason for this lies in the fact that higher values of some indicators imply better, while higher values of other indicators imply the worse performance of an observed country. Normalization is conducted in the interval from 0 to 1. In the next step, the weights necessary in the final calculation of the composite index are set for each sub-index. The DEA methodology is specific in that the weights of individual indicators are determined endogenously, that is, they are different for each economy. The obtained weight value is such that there is no other combination of weights that would bring the analysed economies in a better position.

The basic Data envelopment analysis model assumed that sub-indexes and final CI (composite index) for each district j (j=0,1,...,m) are calculated as the weighted sum of n indicators where the weights are endogenously determined to maximize the value of the composite index for each district (Zhou et al. 2006, Zhou et al. 2007, Cherchye et al. 2007). Optimal weights should be determined by solving the next linear programming problem:

$$CI_j = \max \sum_{i=0}^{n} y_{ij} w_{ij} \tag{1}$$

where

$$\sum_{i=0}^{n} y_{ij} w_{ij} \leq 1 \tag{2}$$

and

$$w_{ij} \geq 0 \tag{3}$$

for any i=0,1,...,n, any j=0,1,...,m, and any k=0,1,...,m.

After the calculation of weights for each sub-index using the classical "Benefit of the Doubt" approach, the DEA Cross-Efficiency model is used to rank the countries (Doyle & Green 1994).

Composite index at the district level

Having in mind the complexity of the comprehensive input-output green development indicator system, DEA methodology is used to find the best set of certain factors (indicators) that indicate the green development efficiency level. For each sub-index which later is involved in composite index calculation, a certain number of indicators are introduced (Table 1).

Moravički, Pomoravski, Rasina, Raška, Šumadija, Bor, Braničevo, Zaječar, Jablanica, Niš, Pirot, Podunavski, Pčinja, Toplica. The raw data for the analysis were taken from the Statistical Office of the Republic of Serbia indicators database (SORS 2020, SORS 2021) and the Serbian Environmental Protection Agency (SEPA).

The normalized indicator values are shown in Table 2. Higher values for the most individual indicators except

Table 1. Statistical indicators forming the composite index and sub-indexes

Main index	Sub-index	Indicator used
Composite Index	Pollution Generation Index (PGI)	SOx/SO_2 (kg/year)
		CO2 (kg/year)
		Wastewater discharge (m^3/year)
	Energy Use Index (LII)	Water consumption (m^3/year)
		Number of vehicles
	Production Possibility Index (PPI)	Investment in fixed assets
		The employment rate (%)

Source: Authors.

The normalized values for the 7 indicators are calculated for 25 counties in Serbia: Belgrade, West Bačka, South Banat, South Bačka, North Banat, North Bačka, Middle Banat, Srem, Zlatibor, Kolubara, Mačva, the investment and employment rate are less favourable (SO_x and CO_2 emissions, wastewater discharges, water consumption and the number of vehicles). All this is taken care of during the normalization.

Table 2. Normalized Values of Individual Indicators

County name	SO_x/SO_2 (t)	CO_2 (t)	Wastewater discharge (m^3/year)	Water consumption (m^3/year)	Number of vehicles	Investment in fixed assets	The employment rate (%)
Belgrade	0.000	0.106	0.000	0.000	0.000	1.000	1.000
West Backa	0.984	0.808	0.845	0.807	0.847	0.126	0.288
South Banat	0.848	0.991	0.423	0.334	0.666	0.971	0.372
South Backa	0.900	0.106	0.000	0.522	0.000	1.000	0.757
North Banat	0.999	0.921	0.878	0.784	0.898	0.098	0.347
North Backa	1.000	0.998	0.846	0.793	0.800	0.312	0.559
Middle Banat	0.994	0.976	0.786	0.683	0.842	0.148	0.469
Srem	0.964	0.654	0.542	0.613	0.592	1.000	0.579
Zlatibor	0.991	0.938	0.569	0.589	0.677	0.309	0.409
Kolubara	0.997	0.965	0.848	0.813	0.830	0.355	0.587
Macva	0.993	0.994	0.711	0.874	0.627	0.488	0.366
Moravica	0.000	0.106	0.698	0.586	0.763	0.148	0.614
Pomoravlje	0.000	0.649	0.725	0.681	0.762	0.004	0.143
Rasina	0.935	0.940	0.716	0.716	0.749	0.229	0.296
Raska	0.998	0.944	0.545	0.627	0.634	0.357	0.005
Sumadija	0.901	0.930	0.587	0.641	0.607	0.524	0.492
Bor	0.927	0.964	0.912	0.784	0.918	0.712	0.260
Branicevo	0.000	0.000	0.871	0.908	0.790	0.306	0.190
Zajecar	0.999	0.972	0.923	0.804	0.957	0.054	0.074
Jablanica	0.991	0.993	0.814	0.867	0.826	0.356	0.178
Nis	0.997	0.985	0.399	0.597	0.543	0.120	0.476
Pirot	1.000	1.000	0.928	0.628	1.000	0.041	0.357

County name	SO_x/SO_2 (t)	CO_2 (t)	Wastewater discharge (m^3/year)	Water consumption (m^3/year)	Number of vehicles	Investment in fixed assets	The employment rate (%)
Podunavlje	0.995	0.947	0.797	0.764	0.838	0.022	0.314
Pcinja	0.976	0.993	0.707	0.248	0.829	0.355	0.000
Toplica	0.984	0.952	1.000	1.000	0.993	0.000	0.301

Source: SORS 2020; SEPA 2020; Authors' calculation.

The resulting values of composite index and sub-indexes range between zero (the worst possible performance) and 1 (the best possible performance – benchmark) (Table 3).

Table 3: The composite index and sub-indexes – calculated values

District	Sub-indexes			Composite Index
	Pollution Generation Index (PGI)	Energy Use Index (LII)	Production Possibility Index (PPI)	
Belgrade	0.032	0.000	1.000	0.344
West Backa	0.906	0.803	0.223	0.644
South Banat	0.815	0.532	0.612	0.653
South Backa	0.494	0.172	0.854	0.507
North Banat	0.955	0.828	0.247	0.677
North Backa	0.973	0.769	0.460	0.734
Middle Banat	0.952	0.759	0.341	0.684
Srem	0.794	0.577	0.747	0.706
Zlatibor	0.899	0.623	0.369	0.630
Kolubara	0.962	0.794	0.494	0.750
Macva	0.944	0.685	0.415	0.681
Moravica	0.160	0.677	0.428	0.422
Pomoravlje	0.331	0.707	0.087	0.375
Rasina	0.898	0.711	0.269	0.626
Raska	0.900	0.608	0.146	0.552
Sumadija	0.854	0.596	0.505	0.651
Bor	0.937	0.840	0.441	0.739
Branicevo	0.160	0.800	0.236	0.399
Zajecar	0.979	0.872	0.066	0.639
Jablanica	0.961	0.809	0.249	0.673
Nis	0.885	0.541	0.334	0.587
Pirot	0.988	0.841	0.230	0.687
Podunavlje	0.946	0.783	0.197	0.642
Pcinja	0.933	0.607	0.142	0.561
Toplica	0.979	0.959	0.181	0.706

Source: Author's calculations

Results and discussion

When comparing the obtained results within the territory of Serbia considering green development efficiency using DEA method, at first glance, it is obvious that the Belgrade area stands out: it has the lowest composite index (CI) which indicate that there is huge space for improving the green development in general. At the same time, some of the least developed areas, such as the Toplica area (South Serbia) or Bor area (East Serbia), shows the highest values of this index. What would be the logical explanation?

Composite index (CI) in this case has been created to show the efficiency level of the green develop-

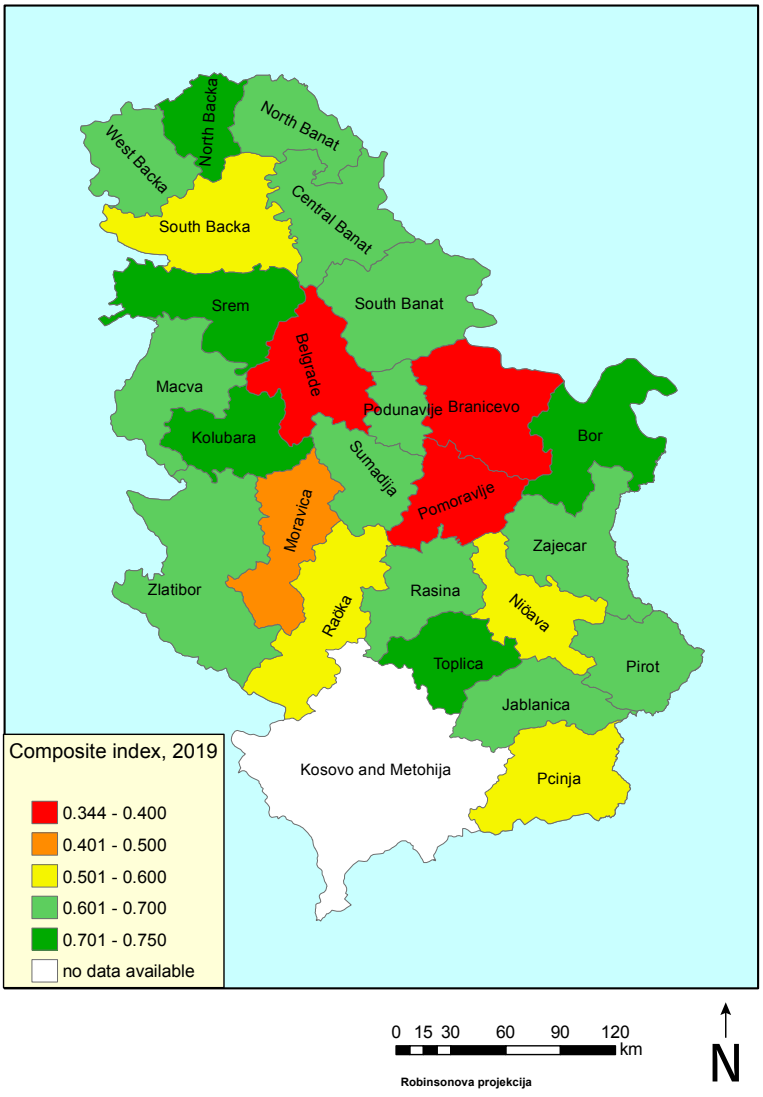

Figure 1. Composite index (CI) of green development efficiency in Serbia, 2019
Source: authors' calculations

ment between different areas within Serbian territory, acquiring several indicators of green economy development. The given levels of the green economy efficiency are the results of different indicators' influence over each area (whether the areas have the technology to decrease pollution emission or not, which is the level of technology investment, as well as the efficiency of certain technology implementation in each area).

Belgrade area shows the greatest improvement potentials having the lowest values of CI (Fig. 1).

If we crossroads this results with certain indicators group such as Production Possibility Index (PPI) or Pollution Generation Index (PGI), it could be concluded that the existing economic development in Belgrade area has incorporated little or no green development concept so far although being with the highest level of investment flow. It was expected that the Belgrade area with such economic structure and demographic pressure has the highest energy consumption, too, but unfortunately, the relatively rapid economic development of Belgrade was not followed by introducing the green development concept or circular economy development. Because of that, high scores of PGI and EUI put this area at the absolute first place by pollution emission and consequently at the first place by the lowest level of green development efficiency.

It is noticeable that two more areas in Serbia, Braničevo and Pomoravlje area, have very low performance of CI (0.399 and 0.375) with a slightly better value in the Moravica area (0.422). All these could indicate that the group of pollution emission indicators contribute the most to the CI (all three areas have very high pollution emissions, namely PGI). At the same time, the energy usage is not so low, but in some cases such as Pomoravlje are, the PPI values are extremely low.

On the other hand, having areas such as Toplica, Bor or West Backa with a high score of CI, could mislead to a wrong conclusion: these areas did not perform so much better in green development efficiency

comparing to the Belgrade area, but they are the least developed areas in the republic, with lowest PPI as the result of low economic development level in general.

Some areas with middle values of CI, such as the Pcinja and Raska areas, show that economic indicators are also quite important in green economy efficiency. These areas have very high values of PPI and EUI, but this was not enough to keep the CI values high when the economic performance is so low (the values of PPI for both areas are below 0.200). This also confirms the thesis that the DEA analysis is much better in regional disparity analysis of the green development than the usage of any singled out indicator or the group of indicators.

DEA analysis in this case clearly shows that the improvement potential in green development efficiency is the largest within the most economically developed areas such as Belgrade, South Backa and Nis. At the same time, other areas with relatively high CI are those areas where production activity does not big enough to produce high values of PPI or EUI – they have a chance to incorporate the green concept within future economic development. Reasonable industrial development and economic progress could have positive effects on green development only if this concept would be incorporated in the early phase of the planning process. Only then it would be expected that those areas with the highest PPI would be the first to face the CI growth, too. However, those areas such as the Belgrade area, where the economy is at the highest level of development in the country, would face the problem to carry out the transition towards a green economy with minimum costs. Some sort of consensus must be reached between the key stakeholders because once developed, the economic structure is very expensive to change. Far cheaper than economic structure transformation is the green development concept incorporating within those areas with the lower economic performance. But there is another problem – how to incorporate and implement such policy, especially in the areas or countries with a lower level of development and economic performance in general?

Conclusion

For almost a half of the century, there are serious researches and scientific debate about the necessity to take care more about the environmental aspect of global economic development. More than ever before, the ecology and green economy became one of the key pillars of globalization. Global environmental problems such as global warming and climate change started to leave their consequences on the regional and national level (problems with extreme weather, droughts, agriculture production, and lack of drinking water). The ecology aspect of sustainable development arose as almost equal to the economic pillar in this concept. Green economy and green development started to be an integral part of development strategy in both developed and developing countries.

The lessons in the past taken from the developed countries development taught us that economic development must not be put alone at the leading position of overall development of one country, neglecting the ecological benefits. Today, it is clear that industrial development is an integral part of overall development but only if it is integrated with the green economy concept. This is a certain way to stable sustainable development. However, none is spared of the unbalance regional development problem.

As much as the economy is primarily in regional development, this is a good starting point to create a regional development strategy incorporating the green development concept. It is not so emphasized in small countries as it is in vast ones but it is one of the instruments that could be very helpful in reconsideration of balanced regional development strategy. Because of that, the regional analysis must take into account environmental aspects and all the drivers that produce different environmental problems at the regional level.

Serbia is the middle developed economy with huge regional disparities and very low green economy efficiency. The ecology started to be one of the key problems of the overall development in the country and one of the pillars of every future development strategy, too. To show the potentials for green economy development within the national territory, the regional analysis was conducted using the DEA analysis. It was shown that the most developed areas in Serbia have the biggest green development efficiency potential and that at the same time the least economically developed areas have very little or no such potentials. These areas show very high values of composite green development index, but only because they have little or no economic performance which could decrease pollution emission indicators. So, Serbia is the country with the double environmental challenge - on one side it must take steps towards industrial structure transformation and on the other, it must strongly develop the industry sector in the areas where it lacks. Not all areas in the country need to follow the same development path, but the national development strategy

must give some framework inside of which different sectors will develop in desirable form and dynamics. It is clear that in Serbia certain technological improvements in the production process must be taken. The upgrading of the existing industrial structure must be followed by the effective promotion of green regional development. Emission standards must be strictly controlled and the efforts must arise from the source of the pollution itself. Also, energy and resources consumption must be carefully overviewed with the maximum environmental protection within the urban areas where the most population is concentrated.

Uneven regional development in Serbia with Belgrade region and area as one big development pole, indicate that cities and urban areas are the economic drivers of the country as a whole but that they are consequently also the main hubs of the green development concept implementation, too. The cities will be probably the drivers of the green deal national strategy acting as a sort of gravity nest for every region within the national territory. They are already the industrial centres, administrative and political centres as well as the centres of scientific research and technological development.

Acknowledgements

The authors acknowledge the support from the Ministry of Education, Science and Technological Development of the Republic of Serbia.

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REGIONAL GEOECOLOGICAL ASPECTS OF TRANSFORMATION OF THE HYDROSPHERE OF TRANSBOUNDARY RIVER BASINS OF EUROPE

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Abstract

Analysis of the main regional geoecological aspects of the transformation of the hydrosphere of the transboundary catchment river basins of Europe – the Danube (Black Sea) and the Vuoksa (Baltic Sea); characteristics of the state of the transboundary groundwaters of the Middle Danube (Serbia) and Vuoksa (Russia); and analysis of the spectrum of pollutants of the hydrosphere of the regions.

Keywords: transboundary transport, river basin, bottom sediments, groundwater.

Introduction.

The volumes of available freshwater resources in the world are quite mosaic and range from macro to micro levels of their content. Every year the possibilities of using drinking water become more and more limited and largely depend on the geoecological state of the aquatic environment in transboundary river basins. At present, 151 countries with a total population of 2.8 billion people are located on the territory of 286 transboundary river basins of our planet. Transboundary river basins unite countries, predetermining their common future, support the socio-economic development and well-being of mankind, and serve as a habitat for a significant part of the world's biological diversity.

The purpose of the study is to evaluate the regional features of the geoecological state and the provision of the growing needs of the population for high-quality drinking water in the transboundary river basins of South-Eastern (Danube) and Northern (Vuoksa) Europe, which are drainage basins of the Black and Baltic Seas.

The objectives of the study are to identify similarities and to determine the signs of differences between the objects of study to obtain comprehensive information that can provide optimal conditions for reducing the geoecological risks of territories in the context of global trends in climate change and growing anthropogenic load on the aquatic environment [15, 16].

The theoretical significance of the work is a comprehensive assessment of the main geoecological aspects of the transformation of transboundary river basins in different regions.

The practical focus of the work is to optimize the processes of forecasting and assessing geoecological risks to reduce the stress of the hydrosphere of transboundary river basins under the conditions of an increasing anthropogenic load.

For many states located in the area of responsibility of the United Nations Economic Commission for Europe (UNECE), transboundary waters play a key role. More than 40% of the European area of the UNECE region is occupied by basins of transboundary waters, which are inhabited by more than 50% of the European population of the region.

As a methodological basis for the implementation of this work, the methodology for assessing transboundary aquifers proposed by UNEP for groundwaters was used, and for the rivers Danube and Vuoksa - the methodology for assessing transboundary river basins and the methodology for assessing transboundary lake basins.

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Materials and methods of research

As a methodological basis for the implementation of this work, we used the methodologies for assessing transboundary river basins [27], assessing transboundary aquifers [28], assessing transboundary lake basins proposed by UNEP and the United Nations Environment Program, developed in 2011. The materials for the analysis and generalization were the results of various relevant regional geoecological studies and monitoring of the Danube River basins, within its middle part on the territory of the Republic of Serbia (Black Sea drainage basin) and Vuoksa, within the Russian Federation (Baltic Sea drainage basin), obtained by state services, research centers, etc.

Danube river basin

The Danube River originates in southwestern Germany, flows through 10 countries, and flows into the Black Sea in Romania. Its total length is 2857 km. The area of the Danube River Basin (DRB) equal to 817,000 km2 (10% of the territory of continental Europe) is divided by 19 states (Fig. 1). The river is fed by melting of alpine snows, liquid precipitation in summer, groundwater in autumn and winter, as well as its numerous tributaries [16, 24].

The total dip of the Danube River channel from the convergence of the Breg and Brigach is 678 m with an average slope of 25 cm/km. The water discharge at the mouth of the Izmail Chatal is 6500 m3/sec (about 205 km^3/year). The population of the DRB territory is 80% provided with drinking water at the expense of groundwater, concentrated in the zone of influence of the river system. For Austria, Germany, Slovenia, Croatia and Hungary, this figure reaches 90-95%, which can cause tension.

Based to the structure of geological and physical-geographical features, the DRB is divided into: Upper Danube - from the sources to Gönyu, Middle Danube - from Gönyu to the exit from the Iron Gates; Lower Danube - from the Iron Gates to the mouth.

The Middle Danube (1791-931 km) on the Great Middle Danube Lowland has the character of a flat river, except for the sections of the Visegrad and Iron Gates. On the plains, the river valley is wide (5-20 km) with floodplain terraces, labyrinths of branches, a sandy bottom, a channel with gentle banks. In the mountainous area, the valley narrows (0.6-2.5 km), the banks are high, rocky in places; the bottom is rocky; the minimum channel width of 210 m is noted in the canyon Kazan (Iron Gates). The speed is determined by the slope of the channel: on the Gönyu - Belgrade section - 3.6-4.8 km/h, on the Belgrade - the Iron Gate section - 0.4-3.0 km/h, the Iron Gate lock - Turnu Severin - 6.5-9.0 km/h.

Figure 1. The Danube River basin and the location of the Iron Gate reservoir [21]

The Middle Danube basin, on the territory of Serbia, is characterized by a continental climate with dry summers (4.5-5 months), a July temperature of 20-23 °C (up to 39 °C), which, in combination with low humidity and insignificant rainfall, creates conditions for occurrence of droughts. All watercourses of the Danube River Basin, as well as Romanian river basins flowing into the Black Sea, form the so-called Danube River Basin Region (DRBR) with a total area of 807,827 km^2 and a population of about 80.5 million people.

The total volume of discharges from the settlements of the DRBR is 1,511 kt/year in terms of COD (chemical oxygen demand) and 737 kt/year in terms of BOD (biological oxygen demand).

In the period from 1988 to 2005. the Black Sea with the Danube waters annually received about 35,000 t of phosphorus (P) and 40,000 t of inorganic nitrogen (N). Modeling has shown that the locks of the hydraulic and shipping complex Iron Gates reduce the influx of phosphorus into the Black Sea, transported by the Danube waters from the countries located upstream, as the phosphorus-containing sediments are deposited in reservoirs.

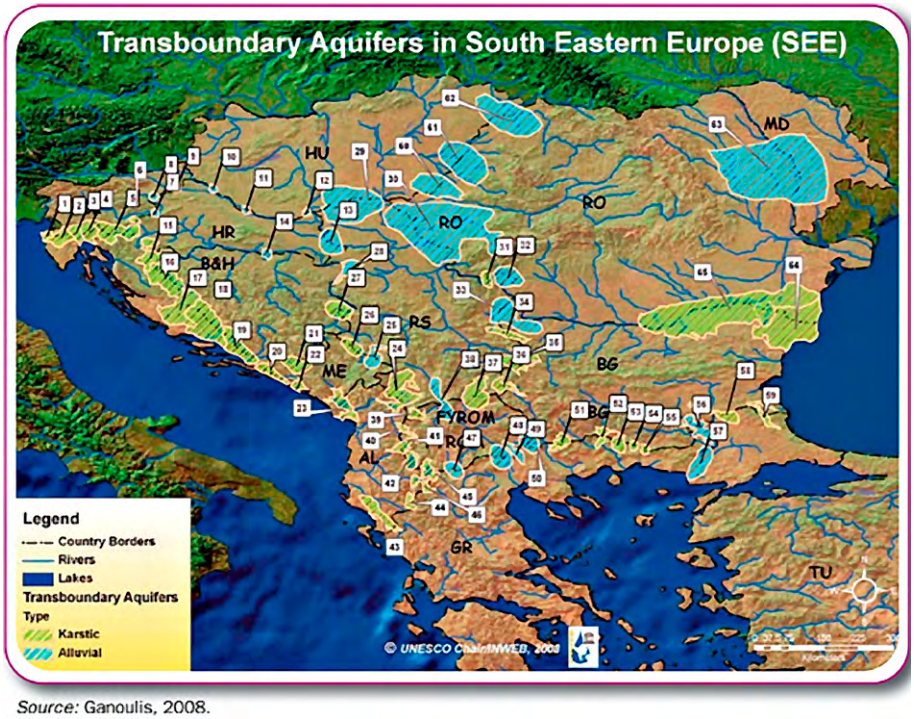
In 2004, there was an increase in the recorded volumes of load in the DRB of arsenic, cadmium, chromium, copper, mercury, nickel, lead, and zinc; the volumes of direct discharges of the last two reached 138 t/year and 171 t/year, respectively.

The leading factors of hydromorphological impact on the territory of the DRB are: 1) violation of the integrity of the river and habitats; 2) disruption of links between adjacent wetlands/floodplains; 3) hydrological changes. Flood protection (45%), hydropower generation (45%) and water supply systems (10%) are key contributors to the disruption of the river and its habitat.

According to the results of the general hydromorphological analysis, which includes five classes and three categories (channel; banks; floodplains), 39% of the Danube basin - from Kelheim (Germany) to the Black Sea was assigned to the second class, 30% of the total length of the river to class 3,28% - to 4, and 3% to fifth grade. The criteria for the assessments used are as follows: class 1 - the channel has an almost natural character, class 2 - the channel is slightly changed, class 3 - the channel is moderately changed, class 4 - the channel is significantly changed, class 5 - the channel is completely changed [16].

An example of cooperation between countries in the field of quality preservation and management of the use of transboundary basins are transboundary aquifers, which were displayed in the Atlas of Transboundary Objects, compiled according to the International Hydrological Program by the UNESCO Division of Water Sciences in 2009 (Fig. 2).

The most active load in this region was received by the territory of the Iron Gate, geologically located in the zone of the end of the Carpathians and the beginning of the Balkans mountains. One of the largest hydroelectric dams in Europe is located on the territory of the Iron Gate. The area of the reservoir for Iron Gate - I is about 330 km², the total volume is 3.5 km³; average depth - 25 m, maximum - 70 m. The reservoir for Iron Gate - II, located downstream has a smaller area (79 km²), volume - 0.8 km³, average (10 m) and



Source: Ganoulis, 2008.

Figure 2. Transboundary aquifers in South-Eastern Europe (SEE) [17]

Additional information about the legend: Croatia-Serbia (West Serbia) – 13; Albania-Serbia (Beli Drim) – 24; Montenegro-Serbia (Metohija) – 25; (Lim) – 26; Serbia-Bosnia and Herzegovina (Tara massif) – 27; (Macva-Semberija) – 28; Serbia-Hungary (Backa) – 29; Serbia-Romania (Banat) – 30, (Miroc and Golubac) – 31; (Dacian basin) – 32; Serbia-Bulgaria (Timok Alluvium/Bregovo Novo) – 33, (Stara Planina/Salasha Montana) - 34; (Nishava and Tran Karst) – 35; (Zemen) – 36; Serbia-North Macedonia (North Macedonia-SW Serbia) – 37; (North Macedonia-Central Serbia) – 38; (Tetovo-Gostivar) – 39.

maximum (25 m) depth, in comparison with the reservoir Iron Gate - I.

In general, in the spectrum of transboundary aquifers of South-Eastern Europe, in the Danube River basin, on the territory of Serbia, there are 17 different transboundary aquifers, of which 9 are karst and 8 are alluvial types [17]. The geological structure of the territory, topography and features of catchments determine the formation, location, and quality of waters of productive horizons (Table 1).

In general, groundwater resources are used only by one third of the available potential. In the structure of water use, household use is 45%, industrial, municipal, and agricultural consumption is 25%; losses are 20%. At the same time, Serbia uses both surface and groundwater for water supply, however, the quality of surface water is not as desired and as a drinking water supply is mainly used groundwater of alluvial and karst places.

A strong example of the geoecological transformation of wetlands into agricultural landscapes in the Danube basin is the Belgrade metropolitan area – Pančevo Rit (swamp), where in the period 1932-1935. a system of reclamation canals and rivers was built.

Table 1. Transboundary underground aquifers of the Middle Danube (Serbia) [16]

Area, km²	Connections with surface water systems, the direction of the watercourse	Use of underground water
South-western underground aquifer of the Baka/Danube		
Serbia – 441 Croatia - n/a	Eopleistocene alluvial medium-and coarse-grained sand and gravel, 20-45 m thick; medium connections; watercourse from Serbia	50-75% of resources for drinking water supply, <25% - for irrigation, industry, and cattle breeding
Underground aquifer or interfluve of the Baka/Danube-Tissa		
Serbia - 5648 Hungary - 4065	It is part of the North Pannonian basin; Miocene and Eopleistocene alluvium; medium and strong connections; the main direction of the underground watercourse is from Hungary to Serbia	80% of total water consumption in Serbia and >80% of total water consumption in Hungary. For drinking water supply >75%; for irrigation, industry and cattle breeding <25%
The underground aquifer of the Northern and Southern Banat or the Northern and Middle Banat		
Serbia - 2560 Romania- 11393	Tertiary and Pleistocene sands and gravel up to 2000 m thick overlain by Quaternary lake-alluvial deposits of the Pannonian basin; weak connections; direction from Romania	Distribution of water by users: 50% - drinking, 30% - industry, 20% - irrigation
The underground aquifer of the Srem-West Srem/Sava		
Serbia - 627 Croatia - n/a	Pliocene and Eopleistocene sands, gravel sands and gravel; medium and strong bonds; silts and clays direction from Serbia	50-75% of drinking water, industry and animal husbandry; about 70% of the total water supply
The underground aquifer of the Lim		
Serbia - 700 (karst aquifers) Montenegro- n/a	Triassic karst limestones and dolomites are overlain by a diabase-siliceous layer, a fractured aquifer in peridotite and alluvium; middle links	60% of water is used for household needs, 12% for agriculture, 12% for industry, 10% for energy and 6% for other needs, 40% on underground water
The underground aquifer of the Tara Massif		
Serbia - 211; Bosnia and Herzegovina - >100	Type 3; Triassic and Jurassic karst limestones, strong connections with surface water systems, watercourse from Serbia	80% of the water is used for the needs of drinking water supply, 10% for the needs of agriculture; also for the maintenance of fish farming
The underground aquifer of the Machva-Semberia		
Serbia - 967 Bosnia and Herzegovina - 250	Quaternary alluvium is sandy gravel, sands with clay lenses (35-100 m); there is no watercourse. Thermomineral horizon: limestones >1009 m; strong connections	40-60% in Serbia and 100% in Bosnia and Herzegovina. 50-75% drinking water, <25% irrigation, industry, animal husbandry
The underground aquifer of the Stara Planina - Salasha Montana		
Serbia – 100-200 (400) Bulgaria - 100-200 (400)	Type 2; Triassic and Cretaceous karst limestones with Quaternary alluvial deposits; medium connections; direction of the watercourse from Bulgaria to Serbia	They make up 50% of all water used in the Serbian part; 25-50% for drinking water supply, <25% for irrigation, industry, thermal springs, and animal husbandry

Source: Second assessment of transboundary rivers, lakes and groundwaters. ECE [16].

Swampy and often flooded lands have become fertile, and the settlements are permanent [14].

The experience of successful application of geoecological engineering is applicable for constructive and balanced implementation in wetland flooded areas suitable for transformation. The monitoring of water resources in the Serbian part of the reservoirs is carried out in accordance with the Water Framework Directive [15] by the Iron Gate Administration, and includes 9 separate subprograms that control the following parameters: (I) river discharge and retaining level; (II) groundwater level and the functioning of drainage systems; (III) regime and formation of deposits; (IV) ice regime; (V) measures to preserve agricultural land; (VI) forests and wetlands; (VII) flood control structures; (VIII) quality of water resources and sediments; and (IX) bank stability and landslide management.

Serbian experts carried out a targeted study of the presence of heavy metals in sediment samples taken in 2009 from the bottom of a reservoir approximately 50 km upstream of the Iron Gate - I dam (the area of maximum sediment accumulation). The assessment of changes according to the data of the Hydrometeorological Service of Serbia on the level and flow of the Danube River and its tributaries of the Velika (Great) Morava, Sava, and Tisa, associated with the construction of hydrological power plants Djerdap / Iron Gate showed that damming affected the dynamics of the Danube River at up to 220 km upstream [21].

According to the monitoring data of the Joint Inspection of the Danube River, conducted by Romania in 2007, metals as pollutants were contained in the bottom sediments of the reservoirs Iron Gate - I and Iron Gate - II in comparable increased concentrations (ppm): aluminum (13871.54 and 51.440.61); arsenic (141.24 and 66.61); cadmium (1.92 and 1.9); chromium (80.3 and 127.16); copper (111.04 and 111.04); iron (33184.05 and n/a); lead (1382.63 and 885.82); manganese (891.77 and n / a); mercury (0.12 and 0.3); nickel (125 and 127.68); zinc (310.35 and 385.23) [15].

Monitoring of heavy metal pollutants in bottom sediments of the Iron Gate - I reservoir in 2009 confirmed the accumulation of iron, manganese, zinc, copper, chromium, nickel, lead, cadmium, arsenic, mercury. It is noted that the concentrations of all metals according to the quality criteria of sedimentary deposits adopted by the International Commission for the Protection of the Danube River are comparable to the target values of the quality level, but almost always exceed the baseline level.

The most toxic pollutants of the Middle Danube hydrosphere are: from heavy metals - cadmium, lead, and mercury; from organic compounds DDT - insecticide (trichloromethyl (p-chlorophenyl) methane), lindane - pesticide (gamma-hexachlorocyclohexane) and atrazine - herbicides from the class of chlorides which is classified as potentially risky for the region, and the mountainous nature of Eastern Serbia determines the localization and functioning of zones of surface water sources, which are priority for environmental protection and preservation of the stability of the territory [25].

According to CRED EM-DAT, 2015, the main geoecological risks of the DRB on the territory of Serbia for the period 1990-2014. were associated with floods (55.6%), extreme temperatures (droughts) (38.9%), and earthquakes (5.6%).

The Vuoksin river basin.

The second transboundary water body of our research is the Vuoksa River, the basin of which is divided between Finland and the Russian Federation.

Compared to the Danube, Vuoksa is not such a well-known and large-scale object, however, the geoecological aspects of the transformation of its hydrosphere are very peculiar and are of significant interest both in theoretical and practical terms.

The basins of the Danube and Vuoksa rivers differ in many physical and geographical parameters, geological structure and development of the territory, hydrological features, scale, dynamics, and intensity of anthropogenic pressure on environmental components, and socio-economic significance.

The length of the Vuoksa River from its source to its mouth is 156 km, of which 143 km fall on the territory of the Russian Federation (Leningrad Oblast) (Fig. 3).

The area of the Vuoksa River catchment area is 68,700 km^2. Water consumption is 684 m^3/sec. The height difference from the source to the mouth is 72 m, while the main difference of 60 m falls on the first 26 km of the riverbed (Table 2).

The volume of water intake in the basin of the River Vuoksa in 2007, according to the Finnish side, amounted to 331 million m^3, the entire volume of water was used in industrial production.

In the Russian Federation, water withdrawal amounted to 90.89 million m^3, and the structure of water use was much wider (%): industry - 84.3; agriculture - 0.2; household needs - 4.6; energy - 4.9; other - 2.2. (Based on information provided by Finland and the Russian Federation and the First Assessment).

The source of the Vuoksa River (Baltic drainage basin) is Lake Saimaa, which is the fourth largest in Eu-

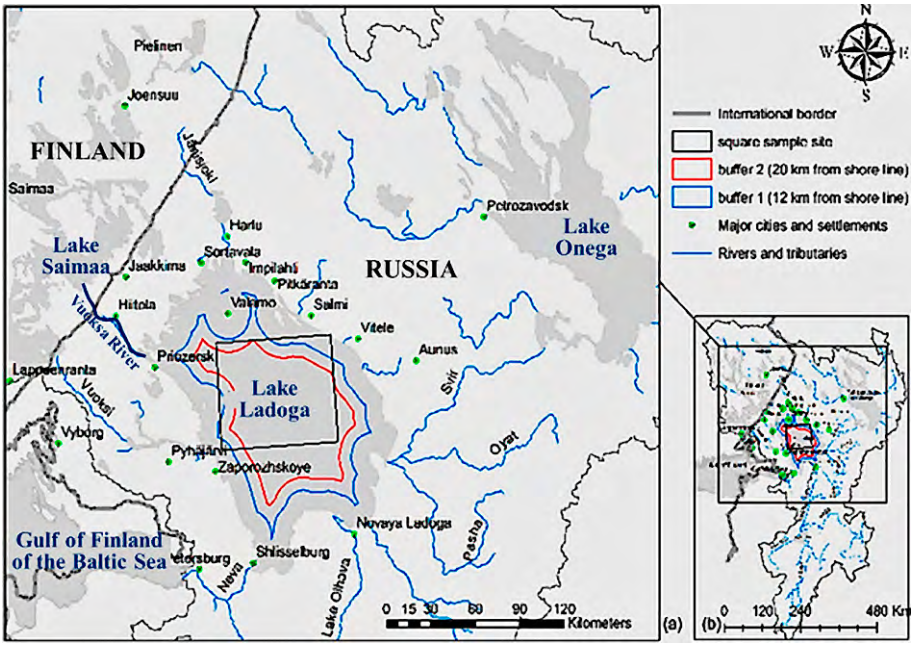


Figure 3. The layout of transboundary water bodies along the line Lake Saimaa (Finland) - the Vuoksa River (Finland-Russia) - Lake Ladoga (Russia) [18]. The following sampling sites are displayed on Lake Ladoga (buffer 1, buffer 2, square)

Table 2. The transboundary basin of the Vuoksa River and its source - Lake Saimaa [15]

Country	Area in the country (km²)	Country share (%)
Lake Saimaa		
Finland	51,896.85	85
Russian Federation	9,158.5	15
Total:	61,055.35	100
Vuoksa river		
Finland	52,696	77
Russian Federation	15,805	23
Total:	68,501	100

Source: Finnish Institute of the Environment (SYKE), 2006.

rope and the largest in Finland. It is 76 m above sea level, has a 15,000 km coastline and 14,000 islands. The maximum depth of Lake Saimaa is 85 m, the average is about 8 m [23]. The water system of the lake consists of several sub-basins of different limnological character, interconnected by relatively narrow straits, forming a structure resembling a labyrinth.

The transboundary basin of Lake Saimaa is divided 85% to 15% between Finland and the Russian Federation (RF). The lake is effectively used for recreational purposes; the only population of the Saimaa ringed seal is preserved here, which is under the threat of extinction [16].

In Finland, agricultural activity is severely limited, with agricultural land occupying less than 6% of the Finnish river basin area. However, at the same time, agricultural and forestry enterprises are the main sources of organic pollution for the Vuoksa river basin. The nutrient load from agricultural enterprises in the Finnish part of the basin is estimated at 21 t/yr. of phosphorus and 52 t/yr. of nitrogen [15]. In coastal areas, for the needs of hydropower, watercourse regulation is carried out.

The water quality of the southern part of Lake Saimaa is influenced by the pulp and paper industry, the modernization of the water treatment facilities ensures an adequate level of water quality. Wastewater from the Finnish cities of Imatra and Joutseno is discharged into the river after treatment. The nutrient load is estimated at about 10.8 t/year of phosphorus and 212.2 t/year of nitrogen.

The population in the area where the water system of Lake Saimaa is located is 564,000 people, the density is 11 people/km². In accordance with the terms of the Water Framework Directive, the ecological state of Lake Saimaa is assessed as "excellent" [23].

The Vuoksa River, the largest river in the Karelian Isthmus, is a transboundary watercourse, since it originates from the Finnish Lake Saimaa and flows into Lake Ladoga from the west on the territory of the Russian Federation. The length of the river is 153 km; catchment area - 68,700 km² of which 6,690 km² (10%) falls on the Russian Federation. The riverbed is a complex system of lakes and channels. Twelve rivers with a length greater than 10 km and more than 500 small streams flow into the Vuoksa River. The total length of all watercourses is about 2.2 thousand km, although the length of each of them does not exceed 20 km. The largest tributaries are small rivers: Begunovka, Volchya and Vyun [1].

Vuoksa flows into Lake Ladoga in two branches: northern and southern. Until the middle of the 19th century, the river flowed only along the northern arm, and now the southern arm is the main one. The river flow is regulated by numerous lakes (up to 3.5 thousand) and four reservoirs of hydroelectric power plants. The river flow is regulated on the Finnish territory of the Tainionkoski power plant (62 MW) and Imatra (178 MW) with the regulation volume of Lake Saimaa – 6,700 million m³. On the Russian side, the river Vuoksa is also regulated by the hydro-recirculating power plants in the city of Svetogorsk with a capacity of 94 MW, a reservoir volume of 28.75 million m³, and in the village of Lesogorsk with a capacity of 94 MW, with a reservoir volume of 35.4 million m³ [16].

The Vuoksa River brings to Lake Ladoga an average of 18.8 km³ of water per year, which is 28.3% of the total inflow. In 2009, the quality of 46% of the water in the Vuoksi River was rated as "good" and 43% as "excellent" [15].

The chemical composition of groundwater in the Karelian hydrographic region, to which the Vuoksa River basin belongs, is diverse in mineralization and is represented by both ultra-fresh (less than 100 mg/l) and brackish (more than 1000 mg/l) waters of carbonate, sulfate and chloride types. In general, the mineralization of groundwater in the Vuoksa river basin is low and varies from 0.03 to 1.0 g/dm³. Waters with a higher mineralization are characteristic of the Gdov and Kotlinsky regions of the Leningrad artesian basin and are developed locally.

With an increase in mineralization, the ion-salt composition of groundwater changes from hydrocarbonate-calcium-magnesium to hydrocarbonate-chloride-sodium. Healing waters with mineralization up to 1 g/l contain biologically active components - radon and iron. Groundwater with a radon content of more than 185 Bq /l is common in the northern Ladoga, Prionezhie, and central Karelia. Underground ferruginous waters with an iron concentration of more than 190 mg/l are widely spread in the territory of the Vuoksa river basin.

The most promising for water supply are aquifers confined to sandy varieties of the Quaternary cover with a thickness of more than 10 m. On their resource base, it is possible to build a water intake with a capacity of 200-300 m³/day.

Permeable zones of tectonic rupture dislocations in the basement are presented as potential sources of groundwater with a water intake capacity of up to 1,500-2,000 m³/day. Sandy deposits of the Gdovskiy and Kotlinskiy regions of the Vendian are also promising sources of groundwater, with a potential flow rate of up to 10,000 m³/day.

The underground waters of the northern part of the Karelian hydrographic region are characterized by mineralization less than 0.1 mg/l, and in the southern - from 0.1 to 0.3 mg/l; pH values in groundwater are determined in the range from less than 6.0 to 6.4.

According to radiological data, groundwater is often characterized by increased total alpha activity (0.28 ± 0.14 Bq/kg). The total beta activity does not exceed the permissible value [14].

The main aquifers in natural conditions of the Karelian Isthmus (Vuoksa river basin) are the Quaternary and Vendian.

The waters of the Quaternary aquifer of the Leningrad artesian basin with a salinity of 0.05-0.9 g/dm³ are used for drinking and technical purposes. Hydrocarbonate calcium-magnesium, hydrocarbonate-chloride, and hydrocarbonate-sulphate waters of various cationic composition. Natural components, the content of which exceeds the standards, are iron, manganese, barium, oxidizability, permanganate turbidity, color.

The waters of the Vendian aquifer are used as drinking, technical and mineral waters; mineralization in a wide range of values 0.05-137 g/dm³. According to the composition of the water, they are bicarbonate calcium-sodium, magnesium-calcium, and sodium, chloride-hydrocarbonate and hydrocarbonate-chloride mixed by cations, chloride sodium. Natural components, the content of which exceeds the standards are iron, barium, fluorine, bromine, silicon dioxide, sodium, magnesium, sodium, manganese, boron, α-activity, β-activity, turbidity [5].

After 2005, the mill's production of pulp and paper products increased significantly and, along with it, the load on the Vuoksa river basin increased. In the city of Svetogorsk on Russian territory, municipal wastewater is treated at a biological treatment plant at a pulp and paper mill. In coastal areas, for the needs of hydropower, the regulation of the watercourse is carried out [7].

According to the reported data, the situation is generally stable and even improving. On the Russian side

in 2009, the Vuoksi River, according to the Russian classification system, the water condition in the upper reaches of the river was assessed as "conditionally clean", downstream in the southern and northern branches - "slightly polluted", and near the mouth of the northern branch - "polluted" ... In the water of the Vuoksa River, the content of controlled metals in the sections before and after the Lesogorskiy settlement increased sharply in terms of manganese, respectively, from 7.2 μg/l to 17.9 μg/l; for copper - from 2.4 μg/l to 4.5 μg/l [4].

According to the results of hydrochemical monitoring of the state of water quality in the Vuoksa River in 2020, the following indicators were established in the settlements of the river basin. In the village of Lesogorsk with a population of 3,097 people and the production of timber industry, Lesogorskaya hydroelectric power station, a plant for the production of household chemicals. The oxygen regime is satisfactory. Multiple excess of standards for total iron (10.0), copper (2.8) and manganese (7.5).

In the city of Priozersk with a population of 17,685 people and enterprises Priozersk woodworking plant, "Lesplitinvest" (production of lumber), the oxygen regime is satisfactory. Multiple excesses of the standards were noted for total iron (9.0), copper (2.6) and manganese (7.3).

In the city of Kamennogorsk with a population of 6,151 people and production facilities, a gray granite mining plant, a factory for the production of sanitary and hygienic papers, the oxygen regime is normal. The standards for copper (4.1 MPC) and manganese (1.1 MPC) have been exceeded. The results of determining the content of heavy metals in the soils of Kamennogorsk, given in the table, revealed a wide range in the concentration of pollutants (Table 3).

Increased multiples of pollutants (ppm) in watercourses in the northern Ladoga area (including the Vuoksa river basin): cadmium (up to 1.6), arsenic (up to 2), antimony (up to 13), lead (up to 290), zinc (up to 110), copper (up to 160), cesium - 133Cs (up to 9), strontium (up to 370) is explained by the regional geochemical features of the ancient Archean-Proterozoic crystalline rocks of the Baltic Shield.

In bottom sediments of rivers draining complexes of sedimentary rocks of the East European Platform, the spectrum of heavy metals is presented (ppm): cadmium (up to 0.6), arsenic (up to 3), antimony (up to 1), nickel (up to 102), zinc (to 10).

Lead, chromium, vanadium, and cadmium are designated as priority pollutants for monitoring water bodies in the region, including transboundary basins. The accumulation and fixation of metals is facilitated by the humus substance and hardly soluble phases of sediments [9].

In the bottom sediments of the Vuoksa River and others, spheroidal particles have been established, the composition of which is determined by: iron, aluminum, and silicon.

The analysis of geoecological aspects of the state and characteristics and dynamics of the transformation of the hydrosphere, including both surface and groundwater, was carried out based on the results of complex long-term studies of objects of two different geological structures, physical and geographical conditions, different levels of urbanization in the territories of the transboundary river basins of Europe - widely known The Middle Danube (drainage basin of the Black Sea) and the lesser known Vuoksa (drainage basin of the Baltic Sea).

The results of the territorial analysis clearly demonstrated the decisive role in the transformation of the hydrosphere of the regions, the geological structure, composition, dynamics and interrelation of surface and ground waters, the scale, duration, and intensity of various types of anthropogenic impact. Successful solution of complex problems of rational development of water resources of transboundary river basins of various scales and geographic location is possible with effective implementation of comprehensive measures within the framework of the provisions of the Convention on the protection and use of transboundary watercourses and international lakes [4].

Among the rivers feeding Lake Ladoga, the level of 137Cs of Chernobyl origin in the River Vuoksa is about 3 times higher than in the waters of the Volkhov and Svir rivers. For the period 1988-2015 21.3 TBq of 137Cs was supplied to Lake Ladoga with the waters of Vuoksa [19].

Table 3. Average values of the content of heavy metals (mg/kg) in the soils of Kamennogorsk. Vyborg district according to the data of 2015 and 2018 [1, 2]

As	Cd	Cu	Hg	Ni	Pb	Zn	Co	Cr	Mn	V
Background area										
6.06	0.015	4.83	<0.05	4.77	1.32	22.30	3.56	7.16	96.6	9.80
Impact area										
<0.20	0.72	3.59	<0.050	5.17	4.4	15.8	1.61	9.1	48.5	N/A

Source: Committee on Natural Resources of the Leningrad Region, 2017-2018.

Lake Ladoga is the largest lake in Europe with a surface area of 17,765 km², an average depth of 48,3 m and a maximum depth of 230 m (Fig. 3). The length of the coastline is 1,570 km, the volume of water is 858 km³, the water retention time is 12 years. The lake has a total catchment area of 282,200 km², of which 20% is located on the territory of Finland. The annual temporal and spatial distribution of water temperature in Lake Ladoga mainly determines the thermal bar, which is formed in spring and early summer. This column of water formed between the cold (deep central) and warmer (coastal) waters of the lake provides intensive mixing by descending streams of water of high (temperature – 4°C) density [3].

Using satellite observations of the Copernicus Marine Environment Monitoring Service (CMEMS) in the period 1997-2019, the trophic state of Lake Ladoga, which is generally mesotrophic, was studied. Some eutrophic sections of the lake were also identified, the origin of which is explained by the intensive discharge of polluted wastewater from industrial, urban and agricultural sources that began in the 1960s.

Finland strives to ensure that the implementation of the measures provided for in the Water Framework Directive is carried out in the basins shared with the Russian Federation, including on the Vuokse River. A readiness plan has been developed for the elimination of possible oil spills on Lake Saimaa along the waterway through the Saimaa Canal, which connects the Russian-Finnish waterways for the purpose of cooperation between the rescue services of Finland and the Russian Federation [13].

The Regulations for the discharge of wastewater into Lake Saimaa and the Vuoksi River (agreement of 1989), developed by the joint Russian-Finnish Commission on the Use of Border Waters, allows for flexible and rapid change in the volume of discharge. Control over its implementation is carried out by a Commission, to which the Parties report on the implementation, discuss the consequences and, in some cases, agree on compensation. In the Finnish part of the basin, the increase in the volume of water uses for recreational needs, as well as the increase in the number of country houses, creates a load on water resources. According to some scenarios, the average temperature in the territory of Vuoksa is predicted to increase by 3-4°C, annual precipitation-by 10-25%. The most significant changes are predicted in the winter period. Therefore, it is expected that winter floods will be more severe in the Vuoksa basin. Cases of extreme surface runoff will also be observed more often. The time of surface runoff will also change: the maximum water level in Lake Saimaa will reach in March and April, instead of June and July as at present. Water consumption is likely to increase by 3-27%.

Results

The analysis, structuring and systematization of geoecological information characterizing the state and features of the transformation of the hydrosphere of the transboundary river basins of South-Eastern (Danube) and Northern (Vuoksa) Europe are carried out. Significant differences in the geological structure of the placement area, regional physical, geographical, and climatic characteristics were revealed. Differences were established in the main hydrological and hydrogeological parameters, types and structures of transboundary aquifers, mineralization levels and the spectrum of trace elements in groundwater, waters and bottom sediments of surface watercourses, the relationship of surface and underground waters [8].

Estimates of both the possible use and qualitative limitations of water for the purpose of drinking supply of the population are given. The priority factors of transformation of the considered transboundary rivers, lakes, and underground aquifers are identified.

Conclusion

Currently, there are more than 100,000 surface reservoirs on the European territory, 80% of which are rivers, 15% are lakes and 5% are coastal and transitional waters. At the same time, the requirements for the quality of water under constantly increasing man-made pressure, especially intended for drinking consumption, are constantly increasing, for which the environmental quality standards set limits for 33 new and 8 previously regulated chemical pollutants, which causes serious concern.

Modern society uses water in various spheres: industrial and agricultural production, commercial fishing, energy production, transport, and tourism, to ensure and maintain its economic growth and prosperity. The problem of water protection and water resources management is becoming more and more urgent. More than 20% of surface waters are at serious risk of pollution, more than 60% of European cities intensively exploit groundwater, about 50% of the con-

tinent's wetlands are threatened with extinction. Scientists warn of an increased risk of both droughts and floods in the coming decades.

Water is the basis of natural ecosystems and climate regulation, but the dynamics of its migration and accumulation depend both on climate changes and on the constantly growing and expanding anthropogenic impact. The range of geoecological factors of transformation of transboundary river basins in Europe is growing, creating a real risk of environmental stress for the hydrosphere.

For groundwater used mainly as drinking water, a good qualitative and quantitative chemical status is required, for which complex, including geological data should be used to determine and monitor the presence of reservoirs in underground aquifers, and water legislation should limit water intake to the level of its annual replenishment.

The methodologies for the assessment of transboundary river basins, transboundary aquifers, and the assessment of transboundary lake basins proposed by UNEP and the United Nations Environment Programs are designed to ensure a progressive and effective environmental policy to ensure the sustainable development of society.

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USAGE OF GEOGRAPHICAL INFORMATION SYSTEM IN BIOMONITORING OF AIR QUALITY

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Abstract

Oftentimes, the disruption of air quality is a consequence of human activity. Due to frequent transgression of polluting matters concentration, continuous monitoring of air quality condition becomes necessary. In our explorations in several urban and natural ecosystems, one of the most acceptable methods of bioindication has been used – the method of using lichens as best biological indicators of air quality and environment on the basis of which the index of atmospheric purity (IAP) is calculated. By applying the GIS, the spatial distribution of different levels of air pollution/purity i.e. the zones of different degree of air pollution/purity on the basis of IAP value is depicted in a simple and precise manner. Pursuant to the aforementioned explorations conducted, the GIS analysis is successfully applied, thus reaching the improvement of application of measures for managing the air quality.

Keywords: Air pollution; Lichens; Bioindicators; Mapping; Spatial distribution.

INTRODUCTION

The development of Geographic Information Systems (GIS) has enabled a number of new approaches and solutions for efficient spatial management. GIS technology has a successfully application in various studies of ecology. Some of the aims of that widely GIS usage are: detection, identification, describing and monitoring of the changes in the aquatic, as like as in the terrestrial environment, presenting that on the modern and reliable way. GIS is a very useful tool in spatial distribution of air pollution assessment in environment. Many authors highlighted the importance of GIS uses in ecological studies The potential of GIS is reflected in the fact that it provides opportunities for collecting and linking spatial data within a single geographical region. GIS, in addition to all the possibilities it provides, can also be used to monitor emissions of gases, smog, dust and other harmful substances in the air and their impact on plant, animal and human life. By monitoring these relationships, GIS becomes a tool that can be used to prevent further pollution.

The authors point to the importance of the application of GIS in environmental studies (Hunsaker et al., 2001; Scott et al., 2002; Eyre et al., 2003; Armitage et al., 2000; Townsend and Walsh, 2001). In addition to scientific research, GIS can also be used for resource management, asset management, development planning, spatial planning, cartography and infrastructure planning. Wu and Smeins (2000) employed GIS for predicting the occurrence of eight rare plant species in southern Texas, USA. They developed regional, landscape and site scale models based on a rangeof sources literature information, field visits and existing maps. Gurnell et al. (2002) developed a GIS-based habitat suitability map for *Sciurus vulgaris* (red squirrel) in an area of 2800ha of Thetford forest, East England. The study aim was to assess the effects of forest management on the species population.

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The most important role of GIS application is in environmental impact assessment. The aim of this paper is to point out all the benefits of the application of GIS in the assessment of the impact on air quality.

Air quality shows very high temporal and spatial variations (Gerdol et al., 2014). Reduction of air quality is one of the global problems of today that leaves catastrophic consequences for human health. Therefore, there is a need for timely detection of pollution levels as well as identification of pollutants. One of the preconditions for improving air quality is regular monitoring and control by establishing a monitoring system.

The main goal of the monitoring system is to collect data of quantitative and qualitative nature on the presence and distribution of pollutants, monitoring emissions and immissions of pollution sources and their effects, transport of pollutants, and the special role of this system is to monitor the effect of pollution on living beings (Wolterbeek, 2002). . Biological monitoring methods are based on the registration and monitoring of reactions and changes that occur under the influence of pollutants at some level of the biological organization of living beings (Paoli et al., 2015). It is these different levels that are seen as specific targets for the action of pollutants. It is generally known and accepted that lichens are the best indicator organisms due to their morphological characteristics.

Briggs (2005) points out three general approaches to air pollution mapping: simple location methods, interpolation analysis, and dispersion modeling. Simple location methods include analyzes such as pollutant spot marking, buffer analysis, and distance analysis. Interpolation analysis for the purposes of modeling air pollution uses statistical or other methods to model the surface of pollution based on measurements at monitoring sites. Many such tools are available in GIS. They include traditional methods such as triangulation (for making contour maps), moving window methods (e.g. inverse-distance weighting) and geostatistical methods such as kriging. Amongst these, kriging has perhaps attracted the most attention in relation to air pollution (Liu & Rossini, 1996; Cressie, 2000; Järup, 2000). Dynamic model of the dispersion process taking into account all the main factors influencing the final pollution concentration. It is an approach which has been most widely used in relation to point sources (Briggs et. al., 1997). Data interpolation for the locations from which the samples were collected was performed by the kriging method, using ArcGis 10.6 software.

GIS techniques have been applied by various researchers primarily to analyze the spatial and temporal distribution of pollutants (Maantay, 2007; Sohrabinia and Khorshiddoust, 2007; van Westen, 2004; Jensen et al., 2001). Whitworth et al. (2011) and Kim et al. (2014) have carried out ordinary Kriging spatial interpolation with monitored air quality data.

Spatial interpolation techniques have not been used for mapping of air quality in any city in Serbia before this.

METHODOLOGY

Investigations of air quality biomonitoring often use the numerical method for calculation of index of atmospheric purity. On the basis of this we found the data that can be applied and processed with the help of GIS. According to Loppi et al., (1997); Kricke and Loppi, (2002), IAP (енг. **I**ndex of **A**tmospheric **P**urity – IAP) values are calculated on this way:

$$IAP = \sum f$$

where f is the coefficient which represents the frequency and coverage of each species within the study area.

The index of atmospheric purity was calculated for each of the sampling points in sampling area. A scale was used to estimate the degree of air pollution and determine the indication zone (Conti and Cecchetti, 2001). Higher index values indicate better air quality, while lower values indicate that the air quality is low (Tab. 1).

The interpolation method of universal kriging with a linear variogram (Davis, 1986) was applied to construct maps showing the formed zones of air quality indication based on IAP values. For graphical display of the distribution of points with different IAP values, percentile maps were used where different colors show different IAP values.

Table 1. The scale of air quality assessment on the basis of the degree of pollution and the IAP value (Conti and Cecchetti, 2001)

Pollution degrees	Extremely high	Very high	High	Moderately	Poor	Very poor
Color						
IAP	0	12.5	25.0	37.5	50.0	
Lichen indiction zones	*„Lichens desert"*		*„Struggle" zone*		*„Normal zone"*	

RESULTS AND DISCUSSION

Conducted research and investigation of air quality give the knowledge that have the essential importance (Ristić et al., 2019). The results of biomonitoring studies showed that adequately application of GIS is necessary. In our previous papers GIS is employed as a tool that is successfully applied in the studies of indication of spatial distribution of air pollution in Serbia using lichens (Ristić et al., 2019). One of the examples is shown in Figure 1. In addition, in several as yet unpublished papers, there are data on the application of GIS in air quality biomonitoring studies in spa habitats that are still in the processing and research phase. Since these works are pioneering in this aspect of perceiving the environment, there is a need for even more intensive research.

Samecka-Cymerman et al. (2009) applied GIS in biomonitoring studies. This analysis has been recently used in a moss biomonitoring survey (Deljanin et al. 2015).

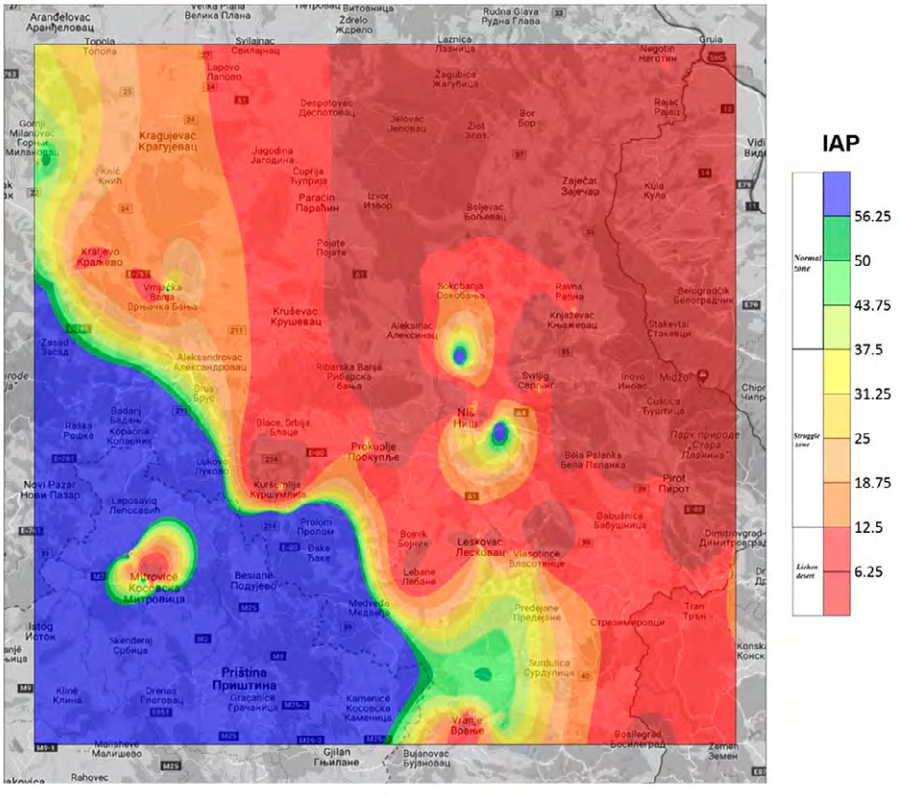

Figure 1. Spatial distribution of different zones of air pollution (Ristić et al., 2019)

Similar investigation showed the application of GIS and mapping the air quality in San José, Costa Rica (Neurohr Bustamante et al., 2013), as like as in Germany in Reutlingen area (Ulshöfer and Rosner, 2001). Sikdar (2001) applied GIS for air pollution profiling for Delhi city, from observed short term (hourly) air pollution data and demonstrated its usefulness in transport development and traffic management planning.

CONCLUSION

Based on several studies, we can conclude that GIS can be very successfully applied in biomonitoring studies to monitor air quality. The advantage of GIS application in this area is reflected in the monitoring of spatial distribution of pollution. The proposal for future research relates to finding new methods for a more detailed analysis of the distribution of concentrations of individual pollutants. Considering that this is the first research in Serbia that introduces GIS in biomonitoring studies, it is proposed that such research be continued and intensified.

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ROOFTOP AND VERTICAL GREENERY - THE IMPROVEMENT CONCEPT OF COMMUNITY HYGIENE CONDITIONS IN THE CITIES OF SERBIA

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Abstract

In conditions of overpopulated urban centers, one of the main issues is to ensure new green spaces. Vertical and rooftop greenery in urban centers is often the only possibility to increase the green areas, as well as the factor of creating better living conditions, which is the subject of this paper analysis. The greening concept of vertical surfaces and rooftops has also been proved as the factor for creating better community hygiene conditions (landscaping of neglected buildings' rooftops and solving communal problems, as well as landscaping of slopes, repairing of bridge structures, retaining walls, concrete riverbanks and canals). In addition, it has been the significant environmental protection factor (increase of green areas, decrease of climate extremes and mitigation of city "heat island", energy efficiency of buildings, increase of biodiversity, etc.). This research includes the analysis of relevant literature, scientific papers, monographs and planning documents, as well as the specific examples of various cities around the world. The aim of this paper is to determine the possibilities for implementation of the rooftop and vertical greenery concept, as the improvement factor of community hygiene conditions in the cities of Serbia.

Keywords: rooftop and vertical greenery, community hygiene, environmental protection, landscaping

Methodology

Since the subject of the research are rooftop and vertical greenery, the methodology of scientific-research work includes the analysis of the planning documentation of the City of Belgrade, which directly treats this area. In that manner, it has been concluded how much this area is represented in the planning documentation of the largest city in Serbia, which should be the leader in this area. The results obtained from this research paper are the starting point for a case study for the City of Belgrade, which would be used as a model for other cities in Serbia, but also the starting point for an initiative to change certain laws. The paper also uses the method of classification and synthesis, as well as the geographical-ecological method.

Significance and role of rooftop and vertical greenery in creating better community hygiene conditions in urban areas

The importance and role of rooftop and vertical greenery in creating better community hygiene conditions in urban areas is significant. Due to the growing problem of lack of greenery in central city parts (as a result are the worst housing and living conditions), many cities in the world are opting for the so-called rooftop greenery - green roofs (Milanović M, Samardžić I, Milinčić M, Momčilović P, 2011).

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The advantages of green seedlings on building roofs are multiple: reduction of the impact of the "city heat island", aesthetics, heating-isolation-ventilation and material recycling, atmospheric water governance, reduction of air pollution, new gardens and green seedlings, energy efficiency, longer roof life, etc. (Samardzic I, 2017). The modern age and way of life have led to specific health problems of city residents such as stress, depression, tension. Rooftop and vertical greenery can have a positive impact on the mental state of residents. Green seedlings on residential buildings have a different visual effect compared to old buildings, which are often in gloomy colors.

People live in conditions of a certain microclimate that affects human health and life, and the microclimate can be changed by planning and implementing sanitary-technical measures (Kocijančić R. et al, 2009). Rooftop greenery has an active role in retaining a certain amount of atmospheric sediment, while a roof with a substrate of 12 cm reduces noise by 40 dB, and with a layer of substrate of 20 cm by 45-50 dB (Afforestation Strategy of the Belgrade Area, 2011). Greenery absorbs rainwater, but also reduces the load on a sewer system during precipitation. Green roofs last two times longer than ordinary roofs, while a single storey house with a green roof of 10 cm of substrate and a grass cover, consumes 25% less electricity to cool rooms in summer months (Afforestation Strategy of the Belgrade Area, 2011). Some green seedlings can also be indicators of pollution. Bioindicators of air pollution are plant organisms that are sensitive to unfavorable environmental effects, most often lichens and some wooden forms (Maričić T, 2007). The health role is also reflected in the fact that green seedlings are air ionizers and have a role of phytoncides. They also increase the humidity of the air and represent places for birds to settle.

The design of such roofs is extremely important for construction to be appropriate and safe. Green roofs reduce the costs of maintaining roofs, although the initial investment is higher, but also increases the market value of apartments. Factors that must be taken into account are wind strength, temperature fluctuations, insolation. The roof construction must be waterproof, long-lasting and protected from damage, as well as appropriate for the depth of a plant root system. So, the question of the profession is how to build a suitable facility and maintain it (construction and maintenance automation), but also how to equip it and with which seedlings, taking into account the quality and type of seedlings and aesthetic fit into the ambient unit. It is necessary to avoid environmental problems related to invasive species, habitat of certain species, drought-resistant plants (botany, landscape architecture, environmental protection).

Rooftop greenery is specific for urban areas where there is no free space for the formation of parks or any green seedlings. Such roofs are used as rest areas for residents, if they are larger, they are also used as classic parks. Most often, these are green areas of closed type only for the residents of these residential buildings. There are many examples in Singapore, Monte Carlo, but also in cities that are trying to increase the area under greenery in the function of fighting air pollution, such as Milan.

In addition to rooftop greenery, there are examples in the world where outdoor spaces are also used for

Figure 1. Hotel Royal-Singapore (photo: Banjanin N, 2018)

Figure 2. CapitaLand Malls-Singapore (photo: Banjanin N, 2018)

gardening. The *Wabe23* buildings complex in Vienna offers to its tenants the opportunity to supply fruit and vegetables from their own sources, i.e., the concept of sharing outdoor space for urban gardening. Each of the five residential buildings offers the possibility of gardening on elevated or normal plant beds located around the building or on a roof of a building. There is a possibility of growing herbs on the building loggias, as well as a possibility of fruit trees planting. This complex is the largest of its kind in Europe. Similar projects of "self-sustaining settlements" have been established in Sweden.

Vertical greenery represents an aesthetic landscaping of vertical surfaces (facades, retaining walls) and contributes to energy efficiency, more rational use of air conditioning systems in the summer months, air purification and dust absorption, but also represents a space for plant species (Samardzic I, 2017). It reduces climate extremes, accelerates aeration of settlements, reduces insolation, protects from strong winds

Figure 3. Building Bosco Verticale in Milan, Italy (stories.rbge.org.uk)

Figure 4. Vertical greenery of a residential building in Sirmione, Italy (photo: Samardžić I, 2016)

Figure 5. Rooftop greenery of residential buildings in Monte Carlo, Monaco (photo: Samardžić I, 2016)

and noise, regulates humidity, protects from high and low temperatures (it can lower air temperature by 3-4 ˚C), purifies the air by removing dust, binding harmful gases (Savićević M. et al., 1997).

Vertical greenery also dampens vibrations, and like rooftop greenery contributes to the reduction of "city heat island", air ionization, retains atmospheric precipitation, and is used as the air pollution bioindicator. It also affects the real estate market value. Recycled materials can be used for the construction of vertical greenery. Vertical greenery also contributes to the lifespan of the facades.

Vertical greenery in urban areas implies green facades, green walls and gardens. Green facades are extremely useful in forming the isolation of buildings, which contributes to energy efficiency. "The role of protecting the walls of buildings from overheating is very important, whose temperature due to direct sunlight, can be significantly higher than the air temperature by 12.2 ˚C" (Savićević M. et al., 1997). It is necessary to provide water supply to green gardens as well as soil maintenance.

Maintenance of the vertical greenery system is largely automated, especially when it comes to adding substrates or irrigation. The maintenance service is necessary for arranging the greenery and replacing the soil where needed. For such jobs, housing communities hire professional companies whose activity is the maintenance of such seedlings, while there is a possibility that the housing community performs these jobs only by hiring its own tenants.

Green facades are similar to rooftop greenery and are important places for preservation of the biodiversity, because they represent a shelter or habitat for a large number of insects and birds. It is necessary to perform expert analysis to conclude which plant species are suitable for vertical landscaping (creepers, vines, shrubs, ornamental grasses), while a larger number of species can be found in small gardens (even low trees with shallow roots).

Cassette vertical gardens belong to the green walls, but they are more technologically demanding. Such gardens are interconnected and thus provide food and water better. Each pot can be replaced individually, if necessary, which is a great advantage of such gardens. A special advantage is a large number of species that can be used.

There are many examples of vertical gardens in the world, where one of the largest vertical gardens is the

Figure 6. Building Santalaia in Bogota, Colombia (inhabitat.com)

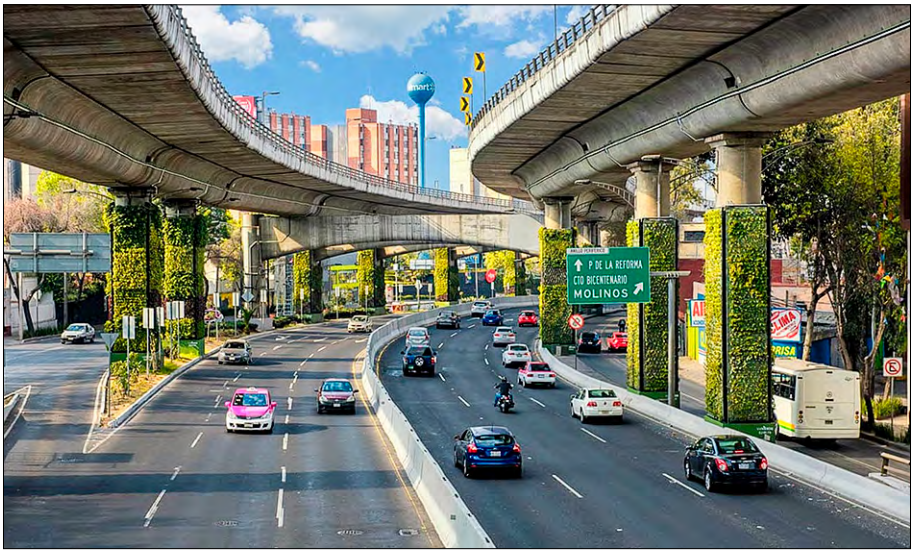

Figure 7. Vertical greenery of bridge structures in Mexico City, Mexico (en.reset.org)

building *Santalaia* ("Green heart of Bogota") in Bogota, Colombia, built in 2015 with over 3100 m² covered with 115,000 plants.

Other vertical areas in cities are also considered as vertical greenery. Lundholm T.J. et al. (2011) state that the term *walls* generally refers to old rocks (old walls that are an opportunity for the settlement of a large number of species). "Walls as ecosystems and as habitat can have multiple species, which are suitable for school teaching of several generations and usually have botanical value" (Francis A.R., Chadwick A.M., 2013). Many sources of literature and studies speak in favor of which species inhabit such areas and to what extent. Therefore, Jim C.Y. & Chen W.Y. (2010) state that they have found 134 plant species on "built" walls in Hong Kong. Hoggart S.P.G. et al. (2012) list 90 plant species and 37 invertebrate species that inhabit flood protection walls on the River Thames through the center of London.

In Serbia, such vertical surfaces are most often neglected. Particularly endangered are the vertical sections that are under vegetation and often represent places of waste disposal (landfills) and unarranged green areas (Samardžić I, 2017). Areas that can be enriched with green forms are bridge constructions pillars in the zones of uneven roads (Samardžić I, 2017). The pillars of uneven roads and overpasses in Mexico City (Fig. 7) have been planted with seedlings on recycled plastic panels, which have been attached to the bridge structures. Also, the forms of greenery were carefully selected because of resistance, while the entire system has been built with an automated watering method.

Research work results

The possibilities for the development of the rooftop and vertical greenery concept as a factor in improving the community hygiene conditions in the cities of Serbia are enormous and havea great potential, but also limitations. This concept has health, social and economic effects, it improves air quality and housing conditions. Limitations exist in the complete absence of realization of such a concept and failure to recognize its significance, but also in the legal basis that requires amendments (Law on Planning and Construction, Law on Energy Efficiency and others) and adoption of completely new bylaws.

Planning is necessary for every newly built settlement and city, and it should be on a long-term basis (Kocijančić R. et al., 2009). Obstacles to the introduction of rooftop and vertical greenery system may be the size of the investments in old buildings or the impossibility of realizing such a reconstruction. A novelty would be the introduction of the obligation that all newly built facilities in commercial zones must be partially covered with plants (Samardžić I, 2017).

This especially refers to the facilities of shopping centers, hotels and hostels, but to a possible extent also when designing superstructure facilities. Problems exist in the realization of green areas. Since the needs for green areas are rarely based on economic reasons, the demands for increasing the areas under greenery in cities generally do not have the support of politicians (Maričić T, 2007).

In France, the law stipulates, that new facilities built in commercial zones must be partially covered with plants or solar panels. This is important from the aspect of energy efficiency, because rooftop greenery help in reducing the amount of energy needed to

heat buildings during the winter and cool them during the summer. They also retain the rain and are home to birds. This is especially popular in Australia, Germany and Canada (in Toronto in 2009, a bylaw was adopted which determines that all new residential and industrial buildings must have green roofs) (Samardžić I, 2017).

Belgrade should also be in the center of attention for the development of the vertical and rooftop greenery concept, because the air pollution is at an extremely high level, especially in winter when there is no Košava wind. Increasing the area under greenery would contribute to the absorption of pollution. Another problem that occurs in Belgrade is so-called "Belgrade Heat Island". According to Andjelković G, (2005), "the so-called "Belgrade Heat Island" has a big impact on climate elements, which is a consequence of the construction of the territory, heating of facilities, traffic, industry, etc."

The Belgrade City Development Strategy, strategic goals, priorities and measures of sustainable development until 2021, defines the implementation of projects related to increasing green areas through its action plan, but also related to energy efficiency (Belgrade City Development Strategy, 2017). Also, the current Master Plan of Belgrade envisages an increase in the area under greenery (Master Plan of Belgrade 2021, 2016), while the Afforestation Strategy of the Belgrade Area defines vertical greenery and the importance of rooftop greenery (Afforestation Strategy of the Belgrade Area, 2011). Green Regulation of Belgrade and General Regulation Plan of Belgrade Green Areas - Draft plan, define green areas, type and purpose, as well as reservation of areas for green purposes (Green Regulation of Belgrade, 2002; General Regulation Plan of Belgrade Green Areas - Draft plan, 2016).

On the example of Belgrade, it is clear that the lack of green areas and the need to improve such a situation has been recognized as the problem. However, following a similar model, other local self-governments in Serbia can define problems and deficiencies, but also the goals and projections of the green area systems development.

In cities throughout Serbia, a large number of residential buildings are about half or in the second half of the projected lifespan, and due to age and lack of investment, urgent repair of roofs and facades is necessary. Where possible, the renovation of roofs and facades could include the introduction of the concept of rooftop and vertical greenery. It depends on the statics of buildings, load-bearing capacity of building and financial investment possibilities. This would be especially important for places that have registered high levels of air pollution and lack of green areas (Belgrade, Užice, Bor, Smederevo). Rooftop and vertical greenery can be realized by adequate planning of future facilities and adaptation of existing ones, and implement them in the function of urban centers development.

Terminologically speaking, *Smart City* is directly related to the environmental protection and investment in green areas. Research shows a link between planning, investment and green spaces (Hajduk S, 2016). Also, the term *Sustainable Urban Park Management* can be found in international articles, and according to Hermy M. et al. (2010) it is the reason for the development of parks since as far back as 1900, as well as the need to protect ecosystems in this way. In the conditions of densely populated urban areas in many cities, the only possibility of forming *urban parks* is on the roofs of residential and other buildings.

The concept of rooftop and vertical greenery has ecological, social, but also economic justification. If there are problems of economic justification in the development of green areas in urban environments, there is a clear financial calculation regarding savings through isolation and consumption of heat and electrical energy (energy efficiency) for rooftop and vertical greenery - e.g., to calculate the slowdown of precipitation runoff, calculate savings by recycling materials and costs of maintaining roofs and facades. On the other hand, the health effects (reduction of air pollution, noise, vibration), as well as the prevention of stress and depression are immeasurable. Researches in the world have shown that such spaces have also influenced the increase of biodiversity in urban areas.

Acknowledgements

This paper contains the research results of project No. 176008 funded and supported by the Ministry of Science and Technological Development of the Republic of Serbia.

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GEOGRAPHICAL FACTORS OF THE ACCELERATED GROWTH OF THE POPULATION OF THE BELGRADE MUNICIPALITY OF ZVEZDARA

Jelena Hajdinjak[A]

Abstract

The Belgrade municipality of Zvezdara is one of the few in Serbia that is accompanied by an accelerated growth of the number of its inhabitants. Population growth and immigration of people from other locations are stated as the most important reasons. A decrease in the number of inhabitants has been noticed in Serbia, while at the same time there is a constant increase in the number of its inhabitants in the municipality of Zvezdara. The paper presents the results of research regarding the influence of nature and man on this phenomenon. Due to the set goal of the research, the paper examines the basic physical and social geographical factors that have influenced the growth trend. The quality of life of the inhabitants of the municipality of Zvezdara is the result of a mixture of physical and social influences caused by their cooperation. The anthropogenic environment unites many influences of man and his activity on the natural environment. The world, as well as the local environment, is changing both globally and locally. The goal of the research is to determine the geographical factors that have influenced this increase the most, along with economic conditions, migration and population policy. In that way, the structural characteristics of the population of the municipality and the growth trend, as well as the comparison with other municipalities have been determined. The main goal of the research was to work on the basis of the results of the survey questionnaire, that is, the experience and attitudes of the respondents. The results of the research should show whether the geographical position of the municipality, infrastructure and roads, favourable ecological situation, proximity of cultural, educational and health institutions or green and grassy areas of Zvezdara are of the greatest importance for permanent settlement of its inhabitants among the geographical factors of the municipality.

Keywords: geographical factors, population, Zvezdara, anthropogenic environment, natural environment

Introduction

The territory of the municipality occupies about 31 km² (3,165 ha) or 1% of the territory of the city of Belgrade. Zvezdara is one of the central city municipalities, with the highest point near the Astronomical Observatory, which is surrounded by city greenery, and extends southeast of the downtown.

The municipality has a favorable geographical position in the northeast of the city, near a big river, a huge forest area and a favorable wind rose. The prevailing climate is temperate-continental. The main watercourses consist of two streams, Mokri Lug creek and Mirijevo creek. Zvezdara forest is a significant part of the city's ecosystem. The highest point in the municipality is at the site of the observatory (248.6 m above sea level). Zvezdara parks and green areas cover a total of 1,170,255 m².

Zvezdara forest is an important part of the city's ecosystem, and at the same time serves as an attractive picnic area for rest, sports and recreation. Afforestation of this terrain was done, among other things,

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to protect Belgrade from wind and included an area of 145 hectares. Today, most of the park-forest consists of pure or mixed tree species, such as acacia, black poplar, Canadian poplar, white ash, sycamore maple, European ash, English oak, Austrian pine and Scots pine, as well as forest and ornamental plants. Due to the ambient, symbolic and ecological significance for the city, a proposal was made for its protection. Vegetation, which grows in the urban conditions of the municipality, is of artificial origin and its average age is around 60 years.

The population of Zvezdara is 168,118, and the average population density is 5,423 inhabitants / km^2. Of the total area, 1,793 ha is agricultural land, 4.1% of the municipal territory (131 ha) is forest land, and the rest is urban construction land. There are 105 agricultural farms. Zvezdara has 14 primary schools, 9 secondary schools, 3 dormitories and 25 kindergartens. On the other hand, the residents of Zvezdara can be supplied at 5 green markets, the largest of which are Đeram pijaca and Cvetkova pijaca.

The municipality of Zvezdara is divided into 4 cadastral municipalities: Zvezdara, Veliki Mokri Lug, Mali Mokri Lug and Mirijevo. The entire municipality is divided into 17 local communities - not all of which are part of the urban zone, but some are rural municipalities where the main branch of the economy is agriculture.

Population change

In the municipality of Zvezdara, the number of inhabitants increased from 2002 to 2011 by more than 19,000 people, making it one of the few in Serbia with an increase in the number of inhabitants, as a consequence of population growth and immigration of people from abroad. There are 39,000 employees in a little over three thousand companies (Stanković, 2018).

According to the 2011 census, Zvezdara had 151,808 inhabitants, of which 70,614 were men and 81,194 were women, or 9% of the population of Belgrade, while in mid-2016 the municipality had about 156,872 inhabitants. According to the census, the change in the number was as follows:

Table 1. The change in the number of inhabitants of the Belgrade municipality of Zvezdara

Censuses	The number of inhabitants
1971	112.938
1981	127.753
1991	140.483
2002	132.621
2011	151.808

Source: The data of SORS Belgrade

In 2014, there were 1,855 newborns at Zvezdara (of which 917 were male and 938 female), and 1,748 people died (891 male and 857 female), making it a positive population growth. In 2012, there were 6086 immigrants and 4283 emigrants in this municipality, and this trend continued in the following years (2013 - 5866 immigrants and 4586 emigrants, and in 2014 - 6244 immigrants and 4441 emigrants). During 2017, the estimated number of inhabitants of the municipality of Zvezdara was 163,542, which indicates that the trend of population growth has continued, as well as that of all 17 Belgrade municipalities, Zvezdara has the highest population growth.

Table 2. The change in the number of inhabitants of 17 Belgrade municipalities

Belgrade municipalities	Census 1971	Census 2011	2019*
Barajevo	16552	27110	26798
Voždovac	134206	158213	169495
Vračar	84291	56333	57856
Grocka	35275	83907	86908
Zvezdara	112938	151808	168118
Zemun	111877	168170	175550
Lazarevac	45675	58622	56595
Mladenovac	47134	53096	51613
Novi Beograd	92200	214506	213040
Obrenovac	53260	72524	72085
Palilula	126380	173521	184488
Rakovica	50798	108641	107827
Savski venac	63531	39122	35359
Sopot	21166	20367	19788
Stari grad	83742	48450	44613
Surčin	28081	43819	46815
Čukarica	102254	181231	177108

** the estimated number of inhabitants*

Source: The data of SORS Belgrade

Theoretical framework of research

During the development of society, a city develops if the geographical conditions for its development are favorable, otherwise, it stagnates or disappears. The micro-location of a settlement or part of a settlement is a very important factor in the comfort of life, work and rest of the users of that area. General geographical circumstances, such as the unity of natural and social factors, are crucial for the emergence and development of a city (Lješević, 2002).

The city of Belgrade is territorially and administratively divided into ten city and seven suburban municipalities, which form a kind of whole with numerous contrasts (Stanković, 2018). The main goal of this paper is to assess the socio-geographical and physical-geographical impacts of importance on the occurrence of rapid population growth in Zvezdara.

Change is irreversible and events that happened over a period of time cannot be reversed (Hawley, 1969). Urbanization, population and expansion of urban areas, as well as the rapid changes that accompany them, represent a specific process of modern civilization. Due to the goal of the research thus set, the paper analyzes the main factors of the geographical environment - anthropogenic activities of people, lifestyle and physical and geographical characteristics of the terrain. In addition to the technological and biological revolution, there are many other human influences on the world, both globally and locally.

Natural factors refer primarily to the natural location, the soil determines the possibility and economy of construction, climatic and microclimatic factors of living comfortably, and environmental resources, which provide economic and communal development of the city (Lješević, 2002).

Relief affects the construction and operation of infrastructure facilities (roads, utility infrastructure facilities, sanitary facilities). Morphographic characteristics of the terrain, such as altitude or terrain fragmentation, affect various urban functions (Lješević, 2002). The hilly land of Belgrade can also be seen through the hills of Zvezdara. These are the hill of Zvezdara, mostly occupied by Zvezdara forest, Zeleno brdo north of Mali Mokri Lug, Stojčino brdo in Mirijevo, the hill of Bajdina in the southeast of Zvezdara or Mokroluško brdo. Such a hilly terrain of the municipality made it inaccessible to build large factory plants, demanding city roads or big sports centers. The relief of this municipality is more favorable for the traffic network, residential zones, infrastructure or cultural, school, health and tourist facilities.

The consequences of air pollution are two to three times greater on human health than previously thought. Studies have shown that air pollution increases the number of heart attacks, strokes, lung cancer, and children who live near highways have a higher risk of developing asthma (Besermenji, 2007). About 4.1% of the territory of the municipality (131 ha) is forest land, and in addition to forests, urban areas also include many green areas, grasslands, plantations or groups of trees. These plants have a beneficial effect on the environment, since they reduce the number of harmful substances in the air, and thus purify the air. The most significant step in landscaping this area was made after 1945, when young people, young mountaineers and citizens planted tens of thousands of seedlings of poplar, maple and acacia on the hill of Zvezdara, and in these actions, an area of 145 hectares was afforested. Košava is the most common wind in Belgrade. Many authors state that košava is a strong and squally wind that blows for several days, most often in the colder part of the year. Due to its strength, this wind also affects the ventilation and purification of the air, especially when it is more polluted during the autumn or winter period, when fog or smog can be noted in Belgrade. Squally winter wind, and a favorable wind rose, a municipality that is elevated in relation to the surrounding central settlements making the winds blow stronger and faster and the air move faster - lowering the concentration of aerosols in the air. It was not accessible to build large factory plants on such a hilly terrain of the municipality, and in that way the share of pollutants from these sources was reduced. The air quality of the municipality indicates its constant intertwining with anthropogenic emissions in the air, as well as with human activities and physical and geographical characteristics of the terrain.

Changes started to happen after the liberation, especially after the mid-19th century, and they were felt first in the immediate vicinity, and later in the wider area. These influences of the city are most noticeable in the development of those agricultural branches whose products are most needed by the city population such as: vegetables, fruits, flowers and milk (Lutovac, 1961). Of the total area of the municipality (3,165 ha), 1,793 ha is agricultural land - more than 50%, and the number of agricultural populations of the municipality has been noted. There are 105 agricultural farms.

In his desire for a better life, man has developed many technological procedures that have turned out to do more harm than good. But they are also scientific results. That is why today, more than before, it is necessary to make a balance for all human activities,

especially when it comes to our relation with the environment (Anđelković, 2010). The factors that conditioned the emergence and development of the city are generally stable, and this is especially true of physical and geographical factors. Some of the factors, such as anthropogenic factors, are more prone to change.

Until a few years ago, there was not a single hotel or faculty in this municipality. Today, Zvezdara is proud to have a complex of scientific facilities, high technology and electronics, known as Mihailo Pupin. Near the Sixth Belgrade Gymnasium is Zvezdara Theater, founded in 1984. There are also the Clinical Hospital Center Zvezdara and the City Institute for Lung Disease and TB. In the past, a lot of well-known industrial facilities operated here, producing ready-made clothing, footwear, textiles, knitwear, parachutes, precision mechanical devices, electronics and electrical materials (Stanković, 2018). The advantage of Zvezdara is the newly built residential buildings, the abundance of parking spaces, parks, green areas, schools, kindergartens - the municipality has 14 primary schools, 9 secondary schools, 3 dormitories and 25 kindergartens. What many scientists cite as a reason for it is the favorable geographical position, favorable ecological and microclimatic characteristics, infrastructure and roads.

Cities, primarily Belgrade and Smederevo, are gaining a leading position and important economic, strategic and cultural functions (Radovanović, 1991). The quality of life of the inhabitants of the municipality can be achieved by the complementarity of natural and anthropogenic factors of the geographical environment.

Research methodology

The methodology made it possible to compare the results in different categories of the population, as well as to record the results of related or similar phenomena. The coverage of a multitude of individual results or experiences due to the influence of natural and anthropogenic origin provided data on the ones that influenced immigration or staying in the municipality. Data on the population of a municipality in Serbia can be obtained from domestic statistical sources. The methods and material used required the creation of an appropriate questionnaire. The methodological procedures on the basis of which the research was conducted are based on the direct collection of data using a survey, but also on the data of the SORS census in Belgrade, i.e., primary and secondary data.

The target group consisted of the inhabitants of the municipality, while especially for the sake of objectivity and representativeness, a certain number of inhabitants who are natives, as well as new inhabitants, were taken into account. The survey was conducted in all four cadastral municipalities: Zvezdara, Veliki Mokri Lug, Mali Mokri Lug and Mirijevo. Field research was conducted from early March to early May 2021, and involved both sexes, different marital status and all age groups of the adult population, as well as different levels of education and diverse employment. There were no blank or partially completed surveys, which contributed to a successful and timely research. The survey included 500 respondents.

According to the subject of research, the hypotheses formed were as follows:

1. The geographical position in the northeast of the city is favorable, with downtown and a large river nearby, making it a significant factor for permanent settlement
2. The abundance of agricultural, green and grass areas has been of great importance for the permanent settlement of the municipality
3. Favorable ecological and microclimatic characteristics are a significant factor in the comfort of life and have a positive impact on decision-making
4. Traffic connections, communal and housing infrastructure met my and my family's expectations
5. The proximity of cultural, health and educational institutions is favorable and has a positive impact on settlement (social infrastructure)

The aim was to determine and rank the significance of all geographical factors listed for the respondents, as well as the satisfaction with the offered geographical factors. The broader goal of the research is to scientifically determine and prove the extent to which geographical factors affect population growth and municipal development, while the narrower goal of the research should show the degree of satisfaction and ranking of geographical factors among themselves.

The first part of the survey contained basic data on respondents - gender, age, education, employment, marital status, as well as whether they are natives or new immigrants. The second part aimed to determine the order of geographical factors that most affect the lives of residents of this municipality (factors of attractiveness). The aim of the third part was to determine and rank the degree of satisfaction with the offered factors on a scale from 1 - I do not agree, to 5 - I completely agree. Different attractiveness factors have

different meanings for certain groups of the population (age, education, gender...).

For the needs of the paper, we included natural geographical factors (geographical position of the municipality, large agricultural, green and grass areas of Zvezdara, favorable ecological and microclimatic characteristics), as well as anthropogenic geographical factors (traffic, communal and housing infrastructure, cultural, health and educational institutions - social infrastructure).

Results and discussion

In order to have a clearer view of the research topic, the presentation of the research results began with an analysis of the socio-demographic characteristics of the inhabitants of the municipality. The questions asked were clearly defined an unambiguous, in line with the research topic. Respondents were informed about the purpose and goal of the research, as well as the confidentiality of the procedure. The questions were formulated in several thematic units:

- The first group consisted of questions about the socio-demographic characteristics of the respondents (gender, age, marital status, level of education, occupation, as well as whether the respondent is a native or new immigrant).
- The second group of questions referred to the ranking and order of all natural and anthropogenic geographical factors listed for the respondents.
- The third group referred to satisfaction with the offered geographical factors, while the respondents were able to provide their experience (e.g., degree of satisfaction with environmental conditions, social infrastructure, and all other factors).

More than half of the respondents were men, 58.1%, while the rest were women, which was 41.9%. Most were middle-aged residents of the municipality (aged 31-64), 52.1% of them, followed by older citizens (65 or over), most of whom were natives - 31.8%, and then the young population (aged 18-30) - 16.1%. People under 18 did not participate in the research, so the dominant age group consisted of middle-aged respondents.

Responses on marital status showed that the number of surveyed residents who were married (41.3%) was approximately the same as the number of those who were single (37.3%). The percentage of divorced people was 15.2%, while widows were the least represented - 6.2%. Most of the respondents are natives of the municipality 72.1%, and the rest were its new residents - 27.9%.

When it comes to the level of education, most respondents had secondary education - 44%, followed by higher education (college, university, master's degree, doctorate) - 35.5%, and the least had only primary school - 20.5%.

The analysis of the questionnaires revealed that the participants in the survey had 19 different profiles (occupations). Most respondents were employed - 81.7%, followed by those unemployed - 11.1%, as well as those who retired - 7.2%.

Table 3. Research on the order and ranking of geographical factors that were most important for immigration or permanent residence in the municipality

Items (examined claims)	Arithmetic mean
Favorable geographical position of the municipality (proximity to downtown, highway and large river)	4,06
Favorable transport connections, communal and housing infrastructure	3,75
Proximity of cultural, educational and health institutions (social infrastructure)	3,29
Favorable environmental and microclimatic characteristics of the municipality	2,98
Large agricultural, green and grass areas of Zvezdara	2,76

Source: author's research

Research on the order and ranking of geographical factors that were most important for immigration or permanent residence in the municipality showed that the inhabitants of this municipality were most attracted and interested in "Favorable geographical position of the municipality (proximity to downtown, highway and large river)" – 4.06, "Favorable transport connections, communal and housing infrastructure" – 3.75, "Proximity of cultural, educational and health institutions (social infrastructure)" – 3.29, as the first three factors of attractiveness, followed by "Favorable environmental and microclimatic characteristics of the municipality" – 2.98 and "Large agricultural, green and grass areas of Zvezdara" – 2.76.

The results of the survey on the degree of satisfaction with individual geographical factors show that respondents are more satisfied with physical geographical than anthropogenic geographical factors. The respondents gave the highest mean value of the answer to the hypothesis "Favorable ecological and microclimatic characteristics are a significant factor in the comfort of life and have a positive impact on decision-making" - with an average score of 4.35. The next one was "The abundance of agricultural, green and

grass areas has been of great importance for permanent settlement" – 4.30, as well as "The geographical position in the northeast of the city is favorable, with downtown and a large river nearby, making it a significant factor for permanent settlement" – 4.22. People gave lower scores to anthropogenic geographical factors: "Traffic connections, communal and housing infrastructure met expectations for the settlement of the municipality" – 3.73, and "The proximity of cultural, health and educational institutions is favorable and has a positive effect on settlement (social infrastructure)" – 3.34. Such results need to be argued and explained.

Table 4. The results of the survey on the degree of satisfaction with individual geographical factors

Items (examined claims)	Arithmetic mean
Favorable ecological and microclimatic characteristics are a significant factor in the comfort of life and have a positive impact on decision-making	4,35
The abundance of agricultural, green and grass areas has been of great importance for permanent settlement	4,30
The geographical position in the northeast of the city is favorable, with downtown and a large river nearby, making it a significant factor for permanent settlement	4,22
Traffic connections, communal and housing infrastructure met expectations for the settlement of the municipality	3,73
The proximity of cultural, health and educational institutions is favorable and has a positive effect on settlement (social infrastructure)	3,34

Source: author's research

The factors that conditioned the emergence and development of the city are generally stable, and this is especially true of physical geographical factors. Some of the factors, such as anthropogenic factors, are more prone to change. The two anthropogenic factors offered were ranked high as attractiveness factors, but according to the degree of satisfaction, they received lower scores. Due to more frequent changes, anthropogenic factors cannot reach the stability and limitless of physical geographical factors. If the physical factors do change, changes are not fast or sudden. As a factor of satisfaction, physical geographical factors therefore ranked high.

However, as attractiveness factors, anthropogenic factors took second and third place, right after the geographical position of the municipality. They ranked high as attractive factors, since residents, when choosing a place to live, are interested in a sense of community, sense of belonging, culture of life, respecting house rules and regulations, quality of the neighborhood, proximity to important institutions (shops, educational facilities, health facilities ...), and thus anthropogenic objects are inevitable geographical factors in the settlement of urban municipalities.

In the third part of the survey, respondents had the opportunity to share their experience, or explain the reasons for their satisfaction or dissatisfaction with the factors offered. Considering the degree of satisfaction, the respondents gave the highest score to the factor - "Favorable ecological and microclimatic characteristics are a significant factor in the comfort of life and have a positive impact on decision-making", whose arithmetic mean was 4.35 and there were no significant experiences or remarks.

A slightly lower score was given to the geographical factor: "The abundance of agricultural, green and grass areas has been of great importance for permanent settlement" - 4.30, with mostly positive experiences ("Young people settle because of greenery or parks", "There are enough green parks and running trails for family life and retirees", "There are enough parks and greenery and agricultural land", "A lot of parks", "Fertile agricultural land").

The factor of geographical attractiveness "The geographical position in the northeast of the city is favorable, with downtown and a large river nearby, making it a significant factor for permanent settlement" was rated 4.22 and ranked third in terms of the degree of satisfaction of the respondents. The remarks and experiences were also very positive ("The geographical position is good", "The geographical position is perfect, the highway is nearby", "We would not change the geographical position", "Downtown is nearby").

Lower score was given to the anthropogenic geographical factor: "Traffic connections, communal and housing infrastructure met the expectations for the settlement of the municipality" - 3.73. Respondents shared their experiences ("Streets are jammed, especially sidewalks", "We need boulevards", "Passable roads and boulevard", "We need better traffic connections", "We would like cleaner urban areas", "We need more containers and cleaner streets").

The last place took the anthropogenic factor: "The proximity of cultural, health and educational institutions is favorable and has a positive impact on settlement (social infrastructure)" – with 3.34. Respondents also shared their experiences and suggestions ("It would be better to have more cultural and sports institutions", "We need a pool", "We need cultural institutions", "Health institutions are not fully realized, there are not enough doctors", "Educational institutions are not fully realized, we need more schools and kindergartens").

Conclusion

This paper examines geographical factors, i.e., their influence on population growth, while the data of SORS Belgrade shows that the population of this municipality is constantly growing. The order of geographical factors from the survey shows that the priorities and reasons why people constantly immigrate and stay in Zvezdara are the following - people are most attracted by the geographical position of the municipality, then are attracted by and need traffic connections, communal and housing infrastructure, then cultural, educational and health institutions (social infrastructure), favorable environmental and microclimatic characteristics, while large agricultural, green and grass areas of Zvezdara took the last place. They are also attracted to the objects of the natural and social environment.

Residents chose Zvezdara (cadastral municipalities of Zvezdara, Mirijevo, Mali Mokri Lug and Veliki Mokri Lug), because of the various contents they need and which represent the intertwining of physical and anthropogenic environmental factors. Possible shortcomings mentioned in the part of the survey on the degree of satisfaction of geographical factors (lack of cultural institutions, lack of swimming pools, need for cleaner streets and sidewalks, more schools and kindergartens) can and should be realized because the population is constantly increasing, and a gradual improvement of this situation has been noticed (there is a new pool, several new kindergartens, a new grammar school).

The area of the Belgrade municipality of Zvezdara, thanks to its perfect geographical position in the northeast of the city, near a big river, huge forest area and favorable wind rose, traffic network, residential areas, schools, health and cultural institutions, has all the conditions for living and immigration of new residents, with certain shortcomings that could be improved. The paper includes residents of different genders, ages, occupations, education and marital status, as well as the native and new population of the municipality, which shows that the Belgrade municipality provides opportunities for diverse profiles of people.

In the future, as a proposal for a new research, one could determine the importance and influence of natural and anthropogenic factors for the settlement of the entire city of Belgrade, as factors of population growth in the capital. By studying and accepting the respondents' views, it is easier to see the basic causes of permanent settlement and population growth in the capital. The experience of respondents can be used to recognize all geographical factors and their impact on people's lives, and to develop plans for the future.

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DIFFERENTIATION OF MORTALITY OF THE REPUBLIC OF SRPSKA POPULATION IN LINE WITH THE CAUSE OF DEATH

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Abstract

Mortality differentiation in line with the cause of death is a consequence of different biological, medical, social-economic, and demographic factors among which most pertinent ones are general health condition, individual behaviour, level of education, economic development and the organization of health care system. Distribution of the deceased in line with the cause of death in the Republic of Srpska indicates a great presence of noncommunicable diseases. According to 2018 data, diseases of circulatory system and neoplasm comprise 67% of deaths within total mortality. Spatial differentiation of the major causes of death in the Republic of Srpska points out that there are pronounced disparities among specific municipalities, regions and geographical units. The aim of the research is to use quantitative-qualitative indicators in order to establish a mortality pattern in line with the cause of death. The mortality analyses at the local level may serve as a starting point for designing policies in accordance with local, regional and national mortality levels.

Keywords: Mortality, the Republic of Srpska, cause of death.

INTRODUCTION

Mortality trends in the Republic of Srpska are based on a biological mortality model, characterized by an increase in mortality in the elderly, a decrease in infantile mortality and an increase in life expectancy.

The crude mortality rate in the Srpska tends to increase steadily. In the period 1996–2018. In 2005, the total number of deaths in Srpska increased by 35% (from 10,931 to 14,763 deaths). In addition to increasing the overall mortality rate, the mortality pattern indicates an increase in mortality in the oldest age contingents of the population. This is best illustrated by the fact that in 2000, the proportion of deaths over 70 years was 52.5%, while in 2018 the mortality rate of persons over 70 accounted for 70% of the total mortality of the Serb population.

The increased mortality rate in the three oldest cohorts (75-79, 80-84, 85+) points to a biological mortality model closely linked to the epidemiological transition and demographic aging of the population (Marinković & Majić, 2018), which is particularly pronounced in border and underdeveloped municipalities along the entity demarcation line (Marinković & Majić, 2012).

Non-communicable diseases are a leading cause of death in the Republic of Srpska, and this disease is a major cause of death worldwide (Licher et al, 2019). Most chronic diseases are caused by preventable risk factors (Divajeva et al, 2014). The World Health Organization defines a chronic disease as conditions that develop slowly and progress relentlessly (Kumar et al, 2019). The new phase of the epidemiological transition is not only based on technological advances that involve the use of vaccines or antibiotics but emphasizes responsibility and behavior especially in the area of nutrition and monitoring risk factors (Meslé & Vallin, 2012).

Reducing the mortality of the elderly is a chance to increase life expectancy. In this regard, greater control over cardiovascular disease and suppression of

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risk factors related to individual behavior would be of paramount importance (Radivojević, 2002).

The survey is based on an analysis of vital demographic statistics of the Republic of Srpska in the period 1996 - 2018. Also, a direct standardized mortality rate based on the 2013 standard European population was used as an indicator. The methods used in this study are analytical, demographic, descriptive-epidemiological, mathematical-statistical, comparative, causal, and illustrative-graphical methods.

RESULTS AND DISCUSSION

The World Health Organization (WHO) has been published by the International Classification of Diseases (ICD-10). This is a classification that is widely used in our country and the world. Its basic features are universality around the world and facilitating the interpretation of diagnostic examinations for both the patient and the healthcare professional (Marinković & Majić, 2018).

Leading causes of death in the Republic of Srpska in 2018

In the Republic of Srpska, there is a European mortality model in which chronic non-communicable diseases have a dominant role in overall mortality. Half of the deaths were related to circulatory system diseases. According to data for 2018, 6989 people have died from this disease or 47.3%. The death rate per 100,000 population is 608.8 while the standardized death rate according to the 2013 European standard population was 725.0 / 100,000. Compared to the European Union (EU-28) countries, the death rate from this disease in Srpska is extremely high.[2]

Neoplasm mortality is the second cause of mortality in Srpska. According to data for 2018, 2938 people died from this disease, accounting for 19.9% of the total mortality rate in Republika Srpska. The death rate per 100,000 population is 255.9, while the standardized death rate for the 2013 European standard population was 249.8 / 100,000.

The third cause of death in 2018 was symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified. The total number of deaths from this disease was 1650 or 11.2% of deaths. The death rate per 100,000 population is 143.7, while the standardized death rate per year was 161.4 deaths per 100,000 population in the average European population.

Endocrine, nutritional and metabolic diseases in the overall mortality rate in 2018 accounted for 5.7% (ASMR = 77.5), respiratory diseases with 4.2% (ASMR = 61.8), injuries, poisoning and consequences of external factors with 3.3% (ASMR = 41.6), as well as diseases of the digestive system 3.3% (ASMR = 43.1)

Fewer percentages include diseases of the genitourinary system (1.5%), infectious and parasitic diseases (1.2%), diseases of the nervous system and sense organs (1.1%) and other causes of death.

Mortality by the cause of death indicates a marked differentiation between sex, especially in mortality from diseases of the circulatory system and neoplasms. Specifically, of the total deaths of women in

Table 1. Mortality rate and standardized mortality rate of the Republika Srpska population by the leading causes of death in 2018 (per 100,000 inhabitants)

Cause of death	2018	
	m_x	ASMR
Diseases of the circulatory system	608.8	725.0
Neoplasms	255.9	249.8
Symptoms, signs and abnormal clinical and laboratory findings, not else	143.7	161.4
Endocrine, nutritional and metabolic diseases	73.5	77.5
Diseases of the respiratory system	54.5	61.8
Injuries, poisoning and consequences of external causes	42.0	41.6
Diseases of the digestive system	41.9	43.1
Diseases of the genitourinary system	19.2	21.3
Diseases of the nervous system and sense organs	14.7	15.2
Infectious and parasitic diseases	16.0	16.3
Other diseases	15.7	16.5

[2] According to Eurostat data for 2016, CVD mortality accounted for 35.7% of the European Union's mortality.

2018, circulatory system diseases are responsible for 53.4% of deaths. On the other hand, the mortality rate for diseases of the circulatory system in men is much lower, accounting for 41.4% of total male mortality in 2018. Other heart diseases (I26-I51), cerebrovascular disease (I60-I69), and ischemic heart disease (I20-I25) accounted for over 90% of all cardiovascular mortality in 2018.

The mortality of women from cardiovascular and cerebrovascular diseases is significantly higher in the oldest age groups, which is related to the pattern of life expectancy. According to data from the Institute of Public Health of Republika Srpska in 2017, as much as 83% of cardiovascular mortality in women was related to people over 75, while this percentage was lower for men (61%).

Numerous factors are affecting the higher mortality of the female population from heart disease. Lifestyle changes have significantly influenced today's mortality trends. Stressful work, poor nutrition, physical inactivity, elevated blood pressure, cholesterol, and blood sugar are the characteristics of 21st-century women. There is also a growing increase in the incidence and prevalence of smoking in women.

Gender differentiation of neoplasm mortality indicates marked gender differences. Unlike a cardiovascular disease, neoplasms have a higher incidence of male mortality than women. Of the total deaths of men in 2018, 23.2% are neoplasms. On the other hand, women's participation is lower, so these diseases are responsible for 16.5% of deaths in the female population.

The most common causes of neoplasm death in men are Malignant neoplasms of trachea, bronchus and lungs, and malignant colorectal cancer and prostate cancer. The highest mortality from neoplasms in the female population is due to mortality from malignant breast tumors. In the last two decades, there has been a trend of increasing the mortality rate of tracheal and lung cancers in women. The reason is the increase in the incidence and prevalence of smokers in women.

Violent deaths can affect all age categories and are the result of cultural and historical circumstances, social order and the health system (Marinković, 2010). They arise as a result of external (exogenous) factors. In medical and statistical nomenclature, mortality caused by violence is divided into four categories (accident, suicide, murder and other causes of death) (Marinković & Majić, 2018).

According to data for 2018, the total number of deaths by violent death is 482, accounting for 3.3% of the death rate of the Srpska population. Compared to 1996, the number of violent deaths decreased by 20%

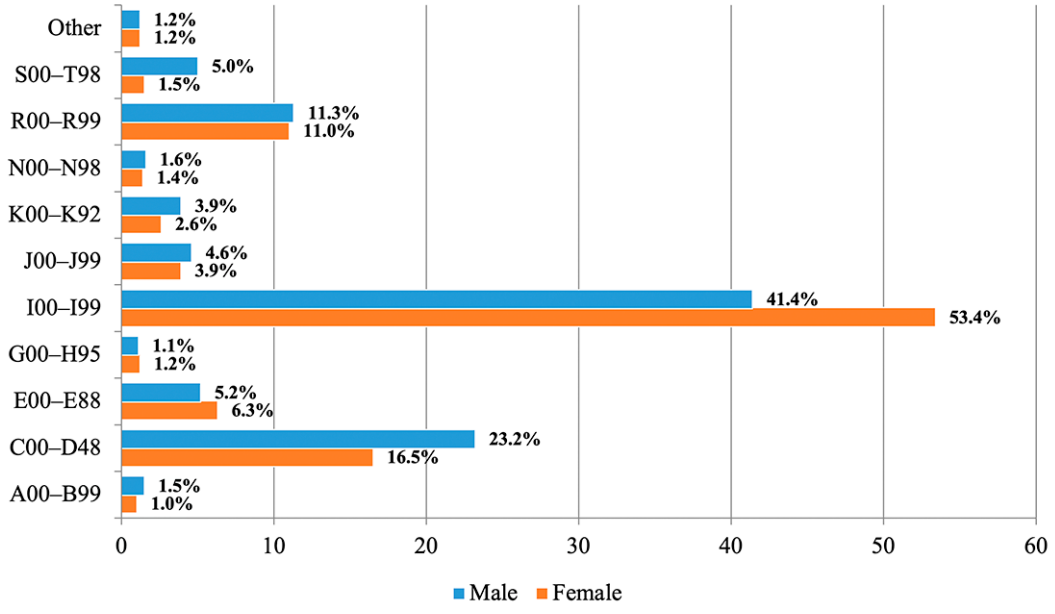

Figure 1. Distribution of the leading causes of death by gender in Republika Srpska in 2018

Changes in causes of death in the Republic of Srpska from 1996 to 2018

In the analyzed period (1998 - 2018) the mortality from circulatory system diseases has the characteristics of stagnation and slight growth. In the period over the last five years, there is a decrease in mortality from this disease, primarily due to the reduction of mortality in the age cohort (65-79) in both sexes. The differentiation of mortality by age from this disease indicates mortality reductions in all age contingents except in the 80-84 and 85+ cohorts, where a large increase in mortality rates has been reported. The absolute maximum of deaths from circulatory system dis-

Table 2. Mortality by the leading cause of death in the Republic of Srpska, 1998–2018[2].

Cause of death	A00-B99	C00-D48	E00-E88	G00-H95	I00-I99	J00-J99	K00-K92	N00-N98	R00-R99	S00-T98	Other
1996	89	1403	174	73	5341	394	257	113	1872	1005	210
1998	106	1888	268	89	6659	430	302	176	1786	622	143
2000	94	2126	238	60	7217	267	326	214	1994	701	133
2002	99	2129	198	56	6989	295	341	197	1975	577	124
2004	124	2330	160	91	7340	345	347	205	1462	552	126
2006	111	2551	790	184	6463	520	379	266	1200	615	153
2008	118	2733	764	145	6965	449	366	268	945	584	164
2010	109	2700	691	152	7211	450	398	255	877	511	163
2012	135	2937	561	207	7624	424	393	236	612	538	129
2014	136	3154	912	186	6777	524	429	150	1445	532	164
2016	187	2948	691	171	6920	510	450	218	1198	491	186
2018	184	2938	844	169	6989	626	481	220	1650	482	180

Source: Republika Srpska Institute of Statistics. Demographic statistics. 4, 10, 11, 15, 20, 2019.

[2] *LEGEND: Infectious and parasitic diseases **(A00–B99)**; Neoplasms **(C00–D48)**; Endocrine, nutritional and metabolic diseases **(E00-E88)**; Diseases of the nervous system and sense organs **(G00-H95)**; Diseases of the circulatory system **(I00-I99)**; Diseases of the respiratory system **(J00-J99)**; Diseases of the digestive system **(K00-K92)**; Diseases of the genitourinary system **(N00-N98)**; Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified **(R00-R99)**; Injuries, poisoning and consequences of external causes **(S00-T98)**. Other: Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism **(D50-D89)**; Mental and behavioural disorders **(F00-F99)**; Diseases of the skin and subcutaneous tissue **(L00–L98)**; Diseases of the musculo-skeletal system and connective tissue **(M00–M99)**; Pregnancy, childbirth and the puerperium **(O00-O99)**; Certain conditions originating in perinatal period **(P00-P96)**; Congenital malformations, deformations and chromosomal abnormalities **(Q00–Q99)**.*

ease was in 2012 (7,624 inhabitants), which was then 55% of all deaths in the Republic of Srpska.

In the structure of deaths from circulatory diseases, Other heart diseases make up the largest of all fatalities in Republika Srpska (almost 30% of fatalities). Mortality from these diseases is on the rise, especially in the female population, so that the mortality rate of women from this disease is 20% - 30% higher than for men. The increase in mortality from Other heart disease indicates a process of demographic aging of the population since this disease most strikes the oldest contingents of the population. Mortality from cerebrovascular disease, ie. stroke, has a regressive line of motion in both sexes, especially in the last five years. This is, first of all, a result of reduced mortality in the mature population (up to 65 years). The distribution of deaths by sex of this disease indicates an increased prevalence of women by an average of 10 to 20%.

For several decades in the developed Western European countries, the trend of decreasing mortality from ischemic heart disease has been registered. ie heart attack (Marinković & Majić, 2012). In the period from 2006 to 2018, there is a reduction in mortality from this disease in the Republic of Srpska. Men (about 10% larger than women) have a greater share in the structure of deaths.

The main determinants of reducing cardiovascular mortality are the result of a combination of several factors, such as changes in diet, the growth of systematic prevention and screening, as well as the spread of new treatments and the advancement of cardiac surgery (Grigoriev, 2012).

The SEE region is characterized by a high prevalence of cancer mortality rates (Znaor et al, 2013). In the Republic of Srpska, neoplasm mortality recorded the highest absolute growth in the period 1998 - 2018. In two decades, the number of deaths from this disease has doubled. The proportion of deaths by gender is higher at men (on average by 40%). In the last decade, there has been a trend of decreasing mortality in the middle-aged male population (45-54 years). In the same period, the contingents of the elderly recorded a continuous increase in the number of deaths.

Given that many European countries have significantly reduced mortality from the disease over the same period, priorities in the coming decades should focus on prevention, early detection of the disease, and the elimination of negative risk factors.

Although the movement of neoplasm mortality has an upward trend, the proportion of deaths up to 55 years of age has declined significantly in the last decade.

The reasons for the reduction of neoplasm mortality in the population up to 55 years is a decrease in mortality from gastric and lung cancer at this age, as well as a shift in the age of breast cancer mortality in women. Early detection, prevention, and control of this malignant disease are of great importance, as this type of cancer greatly affects the mortality of the female fertile population.

According to the WHO, 13% of all neoplasm mortality is due to breast cancer. Although the number of patients is increasing, breast cancer mortality in Europe is declining, primarily due to the early detection and awareness of women about this malignant disease. Lung and tracheal cancer rank first in the female population. Although the mortality from this type of cancer has increased slightly in Srpska, more and more women are expected to die in the future due to increasing tobacco consumption (Marinković & Majić, 2012).

Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified, have approximately the same level of fatalities in the analyzed period.

Significant increases in mortality have been reported in endocrine, nutritional and metabolic diseases. Women are more prevalent in the distribution of deaths from this disease, but the incidence and prevalence of the disease are also expressed in the male sex. The most common disease of this cause of mortality in diabetes mellitus.

Mortality caused by diseases of the respiratory and digestive tract has a significant growth rate in both sexes. In the structure of deaths, there is a higher proportion of males than females.

Cumulative analysis of violent mortality in 1998-2018. indicates the highest incidence of accidents (49.9%) and suicides (42.9%), followed by homicides (5.1%) and other causes (2.1%). In gender distribution, there is a significantly higher proportion of men than women. In the total number of accidents, men account for 79.0%, suicides 73.7% and homicides 70.6%.

Mortality in the accident category is mostly related to the mortality caused by road accidents. In the coming decades, traffic deaths are projected to increase, especially in developing countries. Suicide-related mortality is characteristic of Western developed countries and occurs as a result of stress, mental disorders, family problems, and the economic situation, or factors that affect the "modern man" (Marinković, Majić, 2012).

CONCLUSION

The main characteristic of the natural increase of the population of the Republic of Srpska in the last ten years is the increase in the mortality rate. Increasing mortality rates are closely related to the biological determinants of mortality, given the process of demographic aging and entry of the baby boom generation into the contingent of the oldest population.

The results of the study showed a high prevalence of chronic non-communicable diseases, representing ¾ of the total mortality of the Republika Srpska population. About half of the fatalities belong to circulatory system diseases, while 20% of the reported fatalities are due to neoplasm disease. Precisely, this disease has the highest incidence and highest mortality rate in the analyzed period.

The reduction in growth in the overall mortality rate is primarily dependent on the reduction of mortality from circulatory system diseases and neoplasms, especially in the 50-70 age contingent.

Leading causes of mortality are avoidable diseases that are highly dependent on risk factors.

Particular attention should be paid to raising the awareness of the population about the risk factors that can be achieved through various media campaigns. Prevention, screening and early detection of the disease are the most important link in combating morbidity and mortality from malignant and cardiovascular diseases. In this context, most attention should be paid to the early detection of lung cancer in both sexes, breast cancer in women and prostate cancer in men. Reducing deaths from leading causes of death can be achieved by combating metabolic risk factors (high blood pressure, high cholesterol, high blood sugar, and overweight and obesity) and risk factors that include reducing alcohol and tobacco consumption, increasing physical activity and changing eating patterns.

In the next decade, mortality rates can be expected to increase, especially in the older population contingents. In this context, the focus should be on combating risk factors, which can affect increasing life expectancy, especially for men.

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SPATIAL DISTRIBUTION OF THE POPULATION OF THE REPUBLIC OF SRPSKA - FACTORS AND INDICATORS

Draško Marinković[A], Aleksandar Majić[A]

Abstract

The important characteristic of the population distribution across the Republic of Srpska is the noticeable demographic disparity of eastern and western parts. Interregional differentiation of the population shows that the population is significantly larger in the eastern part. Based on the present demographic characteristics, the Republic of Srpska can be divided into three areas: 1) the city of Banja Luka 2) the areas with negative demographic processes, 3) the areas with extremely negative demographic processes. The city of Banja Luka has massive internal migration and positive tendencies of natural migration in the last two decades. On the other side, a large number of municipalities and cities in the Republic of Srpska have negative demographic characteristics, while extremely negative demographic characteristics are typical of almost every municipality settled along the entity border. These areas are characterized by lower demographic capacity, low population density, low fertility rate, amplified death rate, continual negative population growth rate, mechanical movement of population, violated human sex ratio and age ratio and population aging.

Keywords: population, the Republic of Srpska, spatial distribution

INTRODUCTION

The spatial concentration of the population is an important segment of the organization of geographical space, as it shows the relations and connections of elements of demographic systems in space and relations with the elements of other spatial systems (Santic, 2013).

The territorial distribution and spatial distribution of the population of the Republika Srpska are determined by interrelated physical-geographical, socio-economic and historical-political factors, and especially by demographic factors. In physical-geographical terms, relief appears as the primary determinant of population distribution. The lowland and hilly areas, as well as the valley and basin systems, influenced a significant concentration of population and settlements. The impact of urban centers and traffic connectivity have led to pronounced polarization in population distribution. Population concentration zones represent the axes of development and the largest regional centers of The Republic of Srpska, such as cities: Banja Luka, Bijeljina, Prijedor and Doboj. The expressed concentration of the population is along the transit corridors, main and regional roads of greater hierarchical importance.

The chopped settlement network and negative demographic trends, expressed through the depopulation process, have caused most municipalities in The Republic of Srpska to fall into the category of extremely small and dwarfed ones. Seven municipalities with the smallest population share (below 2,000 inhabitants) represent the remnants of municipalities from the former SFR Yugoslavia. By the Dayton Peace Agreement, smaller parts of these administrative units were annexed to The Republic of Srpska, while settlements of higher hierarchical rank, including the municipal center, remained in the Federation of BiH.

According to the results of the 2013 census, 13 municipalities (29%) in Srpska have less than 5,000 inhabitants, with extremely low demographic capacity. The average demographic size of the local govern-

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ment unit is 18,577 inhabitants, which is well below the average of the surrounding countries (Marinković, Majić, 2018).

In terms of population distribution and population density, The Republic of Srpska is a highly heterogeneous area, with pronounced regional and intra-regional differences. This unbalanced spatial distribution of the population has negative effects on the overall socio-economic and demographic development. The most alarming situation is in dwarf and mountain settlements, as well as in areas along the entity demarcation line. The negative demographic picture is further complicated by the negative migration rate so that the overall depopulation is large-scale. The basic problem of the population of The Republic of Srpska is the phenomenon of low fertility, which is a consequence of many negative factors, so the implementation of population policy measures should be imperative and fundamental principles to the society and survival of the population.

MATERIAL AND METHODS

The analysis of the spatial distribution of the population of The Republic of Srpska is based on data from the 2013 Census, vital statistics, and internal migration balance. The demographic method and system-structural data analysis were used for the research.

The following indicators were taken to analyze the spatial distribution of the population of Republika Srpska: total population, census change in population between 1991 - 2013, average population density, natural increase from 1996 to 2018, internal migration from 2007 to 2018. years and age structure of population in cities and municipalities according to the 2013 census.

RESULTS AND DISCUSSION

The entire territory of Republika Srpska is characterized by its spatial and demographic heterogeneity, which is manifested by the pronounced dispersion of the population. Almost 2/3 of the population of Republika Srpska is concentrated in the western part, between the Brcko District and the Municipality of Novi Grad (63% of the population lives on the territory west of the Brcko District). If we annex the region of Semberija to the western part of Srpska, we conclude that almost 80% of the population is concentrated in the northern part of the Republic of Srpska.

According to the 2013 census, the largest number of settlements in Republika Srpska belongs to the category of dwarf settlements (< 100 inhabitants) and small settlements. Out of the total number of settlements (2,756), 229, or 8.3%, do not have any residents. In 45% of dwarf settlements are home to only 3% of the population, and if we settlements without inhabitants add dwarfed settlements, we can see that in Srpska every other settlement is larger than 100 inhabitants (54% settlements). The typical process of spatial demographic polarization indicates that in 78 settlements (2.8% of settlements) with more than 2,000 inhabitants, 51% of the population of Republika Srpska lives (Marinković, Majić, 2018).

The spatial differentiation of settlements indicates a higher representation of settlements without inhabitants in the eastern part of the Republic of Srpska. Depopulation processes in these settlements began in the early 1970s, with the pace of demographic decline significantly accelerating over the last two decades. The factors of settlement extinguishing vary considerably in space and time. Most of these settlements are mountainous and belong to a divided type (between the Republic of Srpska and the Federation of Bosnia and Herzegovina) with poor infrastructur-

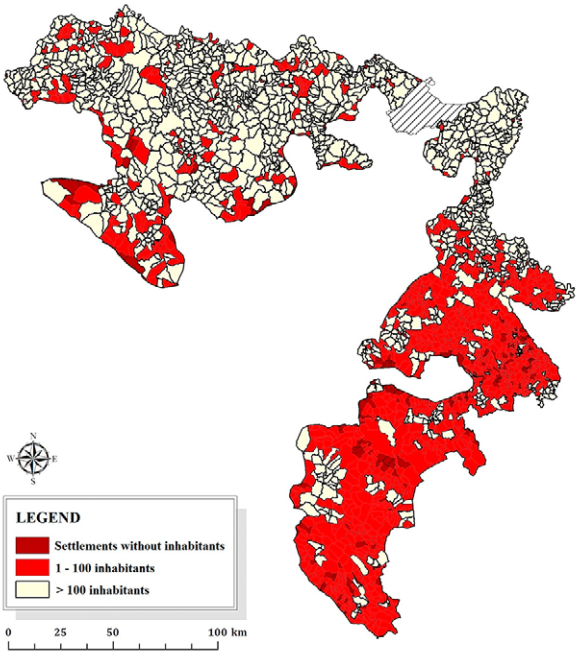

Figure 1. Spatial distribution of the population by settlements in the Republic of Srpska according to the 2013 census [click on figure to enlarge]

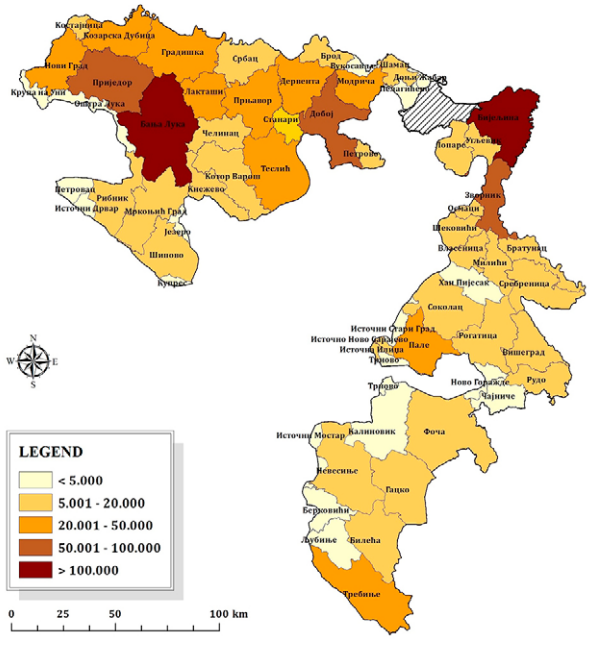

Figure 2. Population in cities and municipalities of the Republic of Srpska according to the 2013 census
[click on figure to enlarge]

al connectivity. The area of eastern Srpska, especially parts of East Herzegovina, lower and middle Podrinje, is characterized by a small and shredded network of settlements. This is evidenced by the fact that in the eastern part of Republika Srpska there are 1,735, or 63% of all settlements of Republika Srpska. In approximately the same territory, there are 1,021 settlements (37%) in the western part. The average inhabited area of the eastern part of Srpska is about 7 km², while in the west it is 12 km². The demographic capacity of settlements in the eastern part is much smaller than the settlements in the western part of Republika Srpska. The average size of a populated area west of the Brčko District is 720 inhabitants, while in the east it is much smaller and amounts to 251 inhabitants (Marinković, Majić, 2018).

The zone of pronounced concentration of population includes a small territorial coverage, which is best illustrated by the fact that in seven cities half (50.4%) of the total population of Republika Srpska is concentrated. The two largest cities according to the 2013 census are Banja Luka with 180,053 inhabitants and Bijeljina with 103,874 inhabitants, while other cities have a significantly smaller population: Prijedor (80,916), Doboj (68,514), East Sarajevo (59,916), Zvornik (54,407) and Gradiška (49.196). Banja Luka is the largest city with a share of 15.4% in the total population of the Republic of Srpska.

Demographic concentration zones are generally relatively small areas, with a high degree of urbanization and population density. They have relatively favorable demographic structures and, as a rule, represent immigration-active areas. Also, the dispersed character of population concentration is observed, with a pronounced dominance of small municipalities. The four municipalities (East Drvar, East Mostar, Kupres, and Petrovac) have less than 300 inhabitants. The largest number of municipalities (21) has between 1,000 and 10,000 thousand inhabitants.

In the census period (1991-2013), only one city and five municipalities registered population increases. The largest absolute increase was recorded in the City of Bijeljina (7,078 inhabitants), followed by the municipalities that are part of the City of East Sarajevo: East Novo Sarajevo (6,360 inhabitants), East Ilidža (6,286 inhabitants) and Pale (5,932 inhabitants). In the inter-census period, the municipality of Laktaši increased its population by 4,300 inhabitants, while the population of East Drvar increased by only five inhabitants.

Except for small, statistically insignificant municipalities, such as Kupres and East Mostar, the largest relative decrease in population occurred in the municipalities of the eastern part of the Republic of Srpska. Out of the total number of settlements (2,756), even 2,489 registered negative inter-census changes. Over 90% of the territory of the Republic of Srpska is affected by the process of total depopulation. Negative demographic processes are even more pronounced in smaller populated areas. So e.g. 97% of dwarf settlements (< 100 inhabitants) decreased their population relative to the 1991 census (Marinković, Majić, 2018).

Although the Republic of Srpska is sparsely populated with 47.5 inhabitants/km², there are very marked differences and disparities in population density within the area. This is especially pronounced between the northern and southern parts of Srpska, as well as between urban centers and rural areas. At the level of local communities, the East Ilidža municipality is the most populated area of Republika Srpska with 493.2 inhabitants/km², while the Municipality of East Novo Sarajevo has an average density of 274.3 inhabitants/km². Three other cities (Banja Luka 145.3 inhabitants/km², Zvornik 145.3 inhabitants/km², and Bijeljina 141.5 inhabitants/km²) have an average population density more than 100 inhabitants per square kilometer. (Marinković, Majic, 2018).

An extremely rare population concentration is in municipalities along the entity demarcation line to the Federation of BiH. These are extremely small municipalities (Petrovac, East Drvar, Kupres, Jezero and East Mostar), with an average population density of fewer than 10 inhabitants/km². Most of these municipalities are highly underdeveloped, and in addition to demographics problems, there are many socio-economic and functional problems. Poorly developed network of settlements, poor infrastructural equip-

ment, low degree of urbanization, depopulation of villages, the problem of unemployment and poverty are just some of the characteristics of these border areas.

Since 2002, there has been a negative rate of natural increase in Republika Srpska, and since 2011 the number of live births has dropped below 10,000. The highest value of natural increase was in 1997 (2,002), while in 2015 the lowest absolute value was registered (-5.702). The crude birth rate in 2018 was 8.3 ‰, while the crude death rate was at 12.9 ‰, so the natural increase rate was a negative (-4.6 ‰) (Population Statistics for 2018).

Analysis of natural increase in towns and municipalities of the Republic of Srpska in the period 1996-2018. indicates an intensive increase in the number of cities and municipalities with a negative natural increase: from 31 (1996) to 62 (2018).

It should be emphasized that in the period 1996-2018. no town and municipality in Republika Srpska had a constant positive trend of natural growth. As many as 16 cities and municipalities, which makes up a quarter of the area of Republika Srpska, did not have a positive natural increase value in the same period. These are Višegrad, East Ilidža, East Drvar, East Mostar, Kalinovik, Kozarska Dubica, Kostajnica, Krupa na Uni, Novi Grad, Petrovo, Prijedor, Ribnik, Rudo, Srebrenica, Han Pijesak and Šamac.

Out of the total number of local self-government units in the Republic of Srpska in 2018, only the cities of Banja Luka (with +12) and the Municipality of East Novo Sarajevo (with +3) had a positive natural increase, while the most negative values registered in the cities of Prijedor (-475), Bijeljina (- 455) and Doboj (-380). Based on negative natural increase from 1996 to 2018. in spatially larger municipalities such as Novi Grad, Kozarska Dubica, Šamac and Višegrad had a decrease of over 10% of the total population, while a population decrease of more than 20% is registered in spatially small municipalities along the line of demarcation between the entities.

In the period 1996-2018. the largest demographic losses due to the cumulative negative natural increase were registered in the City of Prijedor (-7,602 inhabitants). Extremely large demographic losses are recorded in the larger cities and municipalities: Bijeljina (-4,558), Gradiška (-3,638), Kozarska Dubica (-3,601), Doboj (-3,550) and Novi Grad (-3,038 inhabitants).

An important factor of the current and future demographic development of this area is the negative migration balance, which can be based only on estimates because for the analysis of external migration of the population in our country there are no appropriate statistics (eg migration records or population registers).

According to the Statistical Office of the Republika Srpska for 2018, only 4 cities and 11 municipalities

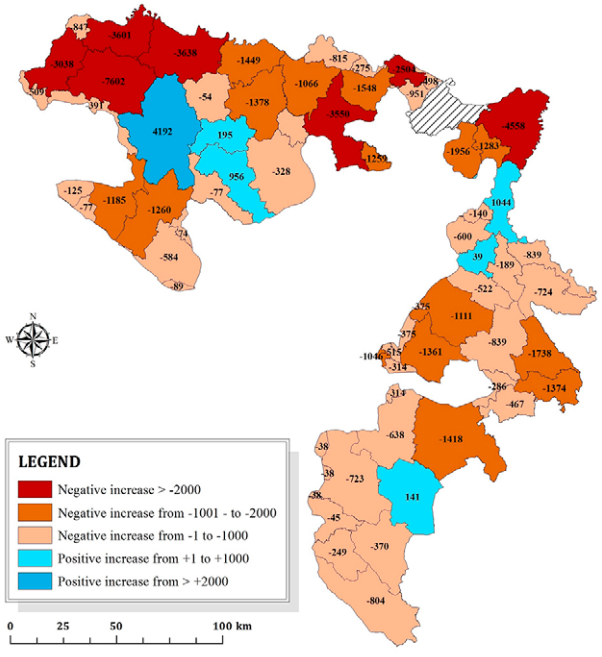

Figure 3. Cumulative natural increase in cities and municipalities of the Republic of Srpska in the period 1996-2018 [click on figure to enlarge]

have a positive migration balance. The largest positive values of the internal migration balance are the cities of Banja Luka (+740), Bijeljina (+371) and East Sarajevo (+224) and the municipalities of Stanari (+409), East Novo Sarajevo (+230) and Laktaši (+170). The cities of Doboj (-356) and the municipalities of Teslić (-104), Kneževo (-99), Lopare (-95) and Mrkonjic Grad

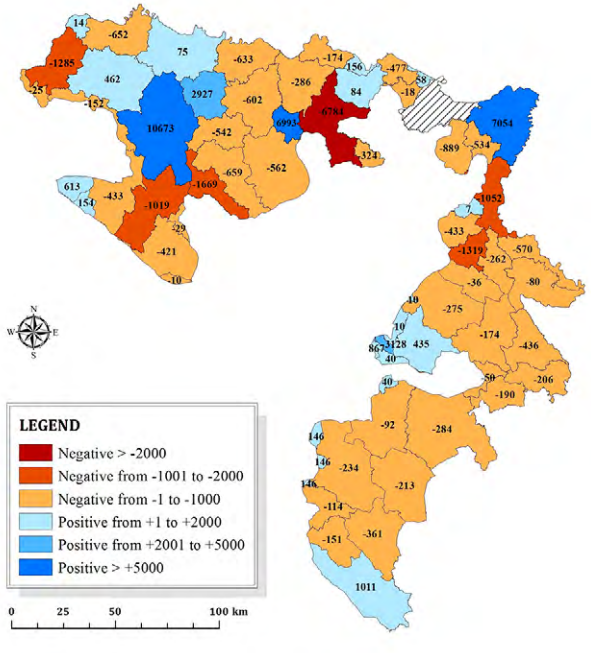

Figure 4. Cumulative balance of internal migration in cities and municipalities of Republika Srpska 2007-2018 [click on figure to enlarge]

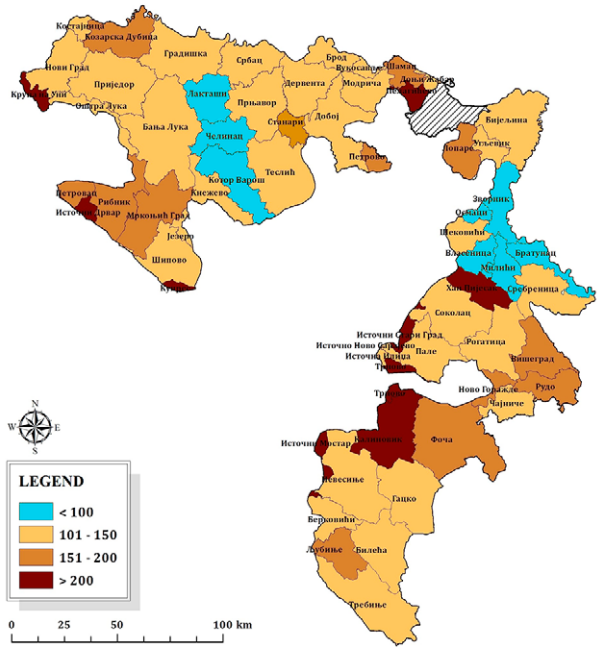

Figure 5. Index of demographic aging in cities and municipalities of the Republic of Srpska according to the 2013 census [click on figure to enlarge]

(-91) have a particularly negative balance of internal migration (Migration and asylum statistics for 2018).

Based on the cumulative balance of internal migration in Republika Srpska from 2007 to 2018. It can be stated that the cities with the highest value are Banja Luka (+10,673) and Bijeljina (+7,054). Other regional centers such as the cities of East Sarajevo, Prijedor and Trebinje also have a positive balance. Due to the separation of the newly formed Stanari municipality, Doboj has a negative internal migration balance.

Negative demographic processes over the past two decades have influenced the disruption of the age-sex structures, which are most manifested through the process of demographic aging that is present in all cities and municipalities of Republika Srpska.

According to the results of the 2013 census, in only eight local communities (Bratunac, Vlasenica, Zvornik, Kotor Varoš, Laktaši, Milići, Osmaci, and Čelinac), the proportion of young people (0-14) is higher than the old population (65+). The extremely unfavorable age structure characterizes almost all newly formed municipalities along the entity demarcation line. The municipalities of Krupa na Uni, East Drvar, Kupres, Pelagicevo, Han Pijesak, East Stari Grad, Trnovo, Kalinovik, and East Mostar are on the verge of demographic extinction, with an index of demographic aging above 200.

This transition of aging indicates the strong effect of mechanical outflow of the population, whose greatest dynamics were in the mid-1990s. The spatial dimension of demographic aging at the level of towns and municipalities in Srpska indicates a marked differentiation. Newly formed municipalities (along the entity demarcation line) have the highest average age of the population (Kupres 54.5 years and East Drvar 50.2 years). The municipalities of Kalinovik, East Stari Grad, Pelagicevo, Petrovac, Krupa na Uni, East Mostar, Trnovo, Han Pijesak, Petrovo, and Ribnik have a very old population, where the average age for both sexes exceeds 45 years.

The smallest number of household members is characteristic of municipalities with a very old population, where the majority of households consist of elderly, mostly single households. These are the municipalities of East Drvar with an average of 1.61 members, Kupres (2.29), Pelagicevo (2.43), Trnovo (2.48), Han Pijesak (2.48), Petrovo (2.49) and Kalinovik (with 2.50 members).

The pronounced intra-regional migration processes between rural and urban settlements result in a constant decrease of the rural population, resulting in negative structural changes. Disorders in the age structure and the growing aging process in most rural settlements will continue to hurt population reproduction in the future. Therefore, the perspective of the demographic development of Republika Srpska will largely depend on the process of population redistribution and population increase in municipal centers (Marinković, 2010).

It is obvious that there will be an increasing number of inhabitants in cities and regional centers, while in rural areas there will be an increasing number of inhabitants. Massive emigrations from villages to cities will cause smaller towns to die off, so they will only become points on geographical maps. Some villages are already literally halved in terms of population, as a result of the intense decline in natural increase, rural exodus and urban concentration of the population.

CONCLUSION

Equal distribution of the population is one of the most important factors for the functional sustainability of space and the prosperity of society as a whole. The area of the Republic of Srpska is characterized by negative demographic trends resulting from the socio-economic situation, historical factors, and geopolitical developments during the last decade of the 20th century. These determinants indicate the overall decrease and uneven concentration of the Republic of Srpska population.

Spatial differentiation indicates a higher concentration of uninhabited places in the eastern part of Republika Srpska. Depopulation processes in these areas began in the early 1970s, with the pace of demographic decline significantly accelerating over the past two decades. The factors of settlement extinguishing vary considerably in space and time. Larger areas occupy depopulation zones, mostly mountainous areas of the eastern part of Republika Srpska, and areas of Eastern Herzegovina and the Upper Sana-Pliva region. Negative demographic tendencies are expressed in these areas, manifested by negative natural increase, disturbance of age-sex structures, pronounced emigration, and low population density.

Based on the quantitative evaluation of the indicators of spatial distribution of the population of the Republic of Srpska, the City of Banja Luka stands out, in which more than 15% of the population is concentrated, which in the last eight years has continuously had a positive natural increase and a positive balance of internal migration. The cities of Bijeljina, Prijedor, Doboj, East Sarajevo, Zvornik, Gradiška and Trebinje and the municipalities of Laktaši, East Ilidža, and East Novo Sarajevo are affected by negative demographic processes. Extremely negative demographic processes are evident in all other municipalities, especially the newly formed municipalities along the Entity line of demarcation, such as East Drvar, East Mostar, Lake, Kupres, and Petrovac, are particularly vulnerable.

Population distribution is a fundamental indicator and a starting point for developing strategies and plans for the functional sustainability of a territory. Although it coincides with contemporary demographic characteristics, the analysis of the spatial distribution of the population of the Republic of Srpska leaves many open questions. In unstable geopolitical conditions, the emptying of these spaces should also be seen as a matter of national importance.

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MORTALITY BY SEX IN MONTENEGRO

Đoko Raičević[A]

Abstract

Continuous increase of life expectancy in female population during the 20th century compared to male population became one of the central topics in human mortality research. Male mortality rates are higher compared to female. Since the middle of the 18th century, when the first life tables by sex were constructed, it has been known that women live longer than men. The paper presents an analysis of human mortality by sex in Montenegro during the second half of the 20th and the beginning of the 21st century. For the purpose of analysis, data from vital statistics was used, as well as the number of population (total and by structures). Since the middle of the 20th century until the first decade of the 21st century, few features have characterized mortality development in Montenegro: the decline in mortality by age, higher mortality of male population compared to female population, continuous population growth, and changes in age structure that took the direction of intensifying demographic ageing. At the beginning of the 21st century, Montenegro exhibited the most important features of the contemporary mortality model by sex and age, but still has significant opportunities for reaching the levels recorded by countries that have achieved the best results in reducing mortality.

Keywords: human mortality, mortality by sex, Montenegro

Introduction

Mortality, as one of the natural components of the population changes, plays an important role in shaping the age structure, thus having great importance in demographic development. Mortality represents a multifaceted phenomenon, both in terms of the nature of the factors that drive it and the effects it produces. At the same time, it stands as a biological, social, economic, cultural, and demographic phenomenon. The differentiation of mortality at the level of population groups, national communities, regions or, in general, wider contingents of the population, enables a more complete understanding of the results of all social differentiations of mortality (Radović, 1979).

Countries with a long tradition of mortality statistics provide the most important sources of data, necessary to show the mortality trends both of the male and female population (Marinković, 2018). European countries have the most reliable vital statistics. In almost all populations, where there is data on vital events, male mortality rates are higher compared to female. In Germany, life expectancy at live birth has changed from a constant female advantage of three years before the World War I, to the current level of over six years. In most industrialised countries, the disparity in mortality by sex started to increase after the World War I, especially in the United States, England, and Wales (Luy, 2003). Between 1950 and 1995, the European pattern of life expectancy underwent significant transformations. In 1950, the north-western part of Europe had a significantly higher life expectancy compared to the Mediterranean and eastern regions, where living standard was generally lower (Meslé & Vallin, 2002).

In Montenegro, changes in mortality recorded during the second half of the 20th century indicate differences in mortality by age, both in terms of their level and the direction of change. The most intensive reduction in mortality was achieved in age cohorts that are characterised by low or very low mortality. In contrast, mortality of the older middle-aged and elderly population is significantly higher compared to the mortality of younger cohorts (Penev, 2008). At the beginning of the 21st century, there was an increase in

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the mortality rate, which came as a consequence of the aging population (Ljajević et al. 2008). Population mortality represents a basic indicator of the health status. It serves as a basis for monitoring epidemiological processes, which are in turn used to plan the public health system of the population (Arsenović, 2014). The aim of this paper is to present and analyse the mortality of the population of Montenegro by sex, in the period 1961-2019. At the beginning of the analysed period, in 1961, population of Montenegro amounted to 473,409, while there are 620,739 people living in Montenegro today.

Data and methodology

In the research of Montenegrin mortality by sex, demographic and statistical methods were used. The analysis utilises the transverse method, which means that mortality is analysed over a shorter period of time for all age cohorts. The main source of data in the research is the vital demographic statistics of the Statistical Office of Montenegro (MONSTAT) for the period 1961-2019. Vital statistics implies the use of absolute numbers with general and specific (calculated per 1,000 inhabitants) mortality rates.

Certain data was taken from the online databes of the European Statistical Office (Eurostat). The paper presents graphical annexes that have been processed in the statistical program Microsoft Excel.

Background

Before entering the phase of mortality transition, it is assumed that differences in mortality with respect to the world population did not exist. In the pre-transition period, there were certain differences in the mortality of certain population groups within countries, which are related to social stratification within certain societies. Differences in the level of mortality in individual countries begin when the cumulative social and economic conditions reflect on the living conditions of the population, which ultimately influences the mortality of the population.

In some Western European countries, this process began during the 18th century, with an indication of low life expectancy in certain population groups (35-40 years). The decline in mortality in the countries of southern and eastern Europe occurred much later. A significant decline in mortality in Italy began only at the end of the 19th century (average life expectancy was 35 years), that is, it was at the level that Sweden had at the end of the 18th century, and in this region life expectancy of 44 years was reached as late as 1926 (Radović, 1979). The dynamics of mortality as well as mortality rate of the population are directly conditioned by the intensity of the aging process (Penev, 2003),

The twentieth century is characterised by an extension of life expectancy. In developed countries, life expectancy exceeds 80 years (Bongaarts, 2014), driven primarily by better health care, which is ultimately implied the difference in mortality between the sexes. When it comes to developed countries (data for 2011), the difference in life expectancy at live birth by sex ranges from 3.7 years in the Netherlands to 11.8 years in Russia (Marinković, 2016). In the countries of the European Union, life expectancy at live birth reached 80.9 years for both sexes in 2017, 78.3 years for men and 83.5 years for women. Women live longer than men in all EU countries, on average 6 years, despite the fact that the difference has decreased by about one year since 2000, because in most countries, the life expectancy of men has been increasing faster than that of women.

Results and discussion

During the first half of the 20th century, the movement of the total population of Montenegro was conditioned by the wars that took place throughout this region, primarily the Balkan wars, as well as the World War I and World War II. After the end of the World War II, the mortality rate in Montenegro was 12,000, while in the early 1950s, the number of deaths was reduced to 4,000 per year, and in 1951 the overall mortality rate was 10.9 ‰ (Penev, 2008).

The overall mortality rate in Montenegro has been declining continuously throughout the post-war period. Although high, averaging at 2%, the rate of annual decline in Montenegro is significantly lower than the decline in mortality recorded in Bosnia between 1950 and 1976 which stood at 3.1% and Macedonia 2.8%. The overall mortality rate in 1961 was 7‰. However, in the period between 1961 and 1962, the overall mortality rate in Montenegro recorded an

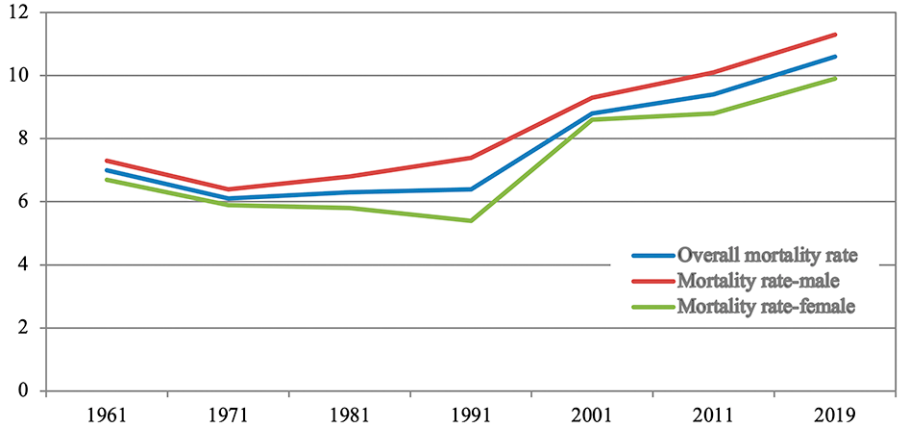


Chart 1. Overall mortality rates (‰)in Montenegro, 1961-2019
(Source: prepared on the basis of MONSTAT data)

increase of 11.4%, and from that year it began to decline with very small variations of increase in some calendar years, reaching the lowest value of 5.8 ‰ in 1974. During this period, the overall mortality rate decreased by 17.1% compared to 1961. In terms of mortality by sex, higher mortality was recorded in male population compared to female population (Chart 1), which ranges in this interval from the highest difference recorded in 1961 when the male mortality rate was 7.3 ‰ and the female mortality rate was 6.7 ‰. In the following years, the mortality rate by sex became less pronounced, reaching its nadir in 1970, when mortality by sex reached approximate values (men 6.8 ‰, women 6.6 ‰). The changes in mortality that have occurred over the past three decades have led to a continuous increase in life expectancy. In that period, there was a significant extension of life expectancy which occurred in the period 1961-1962 and 1971-1972, when the average life expectancy was extended by 6.1 for men, and 7.7 years for women (Penev, 2008).

At the beginning of the 1990s, the overall mortality rate in Montenegro reached 6.1 ‰, and in 1997 it was 8 ‰, while amounting to 9.1 ‰ in 2002. During this period, the overall mortality of the population increased by about 32%. The upward trend of overall mortality is similar for both sexes, while recording higher rates for men compared to women. In 1992, the general rate for men was 8.1 ‰, and for women 6.4 ‰. At the beginning of the 21st century, the overall mortality rate in Montenegro recorded an upward trend, reaching 9.3 ‰ in 2003, and maintaining that level with only minor variations over the years until 2015 when the general rate exceeds 10 ‰. Taking into account the analysed period from 1961 to 2020, the overall mortality rate increased by over 50% compared to 1961.

In the second decade of the 21st century, the mortality rate of the population of Montenegro amounting to 10.6 ‰ in 2019 indicates a trend of harmonization of mortality with the European average of 10.4 ‰. The reason for such tendencies of mortality of the population of Montenegro, i.e. the dynamics of mortality is the population ageing, which has resulted in a continuous increase in the share of elderly people in the

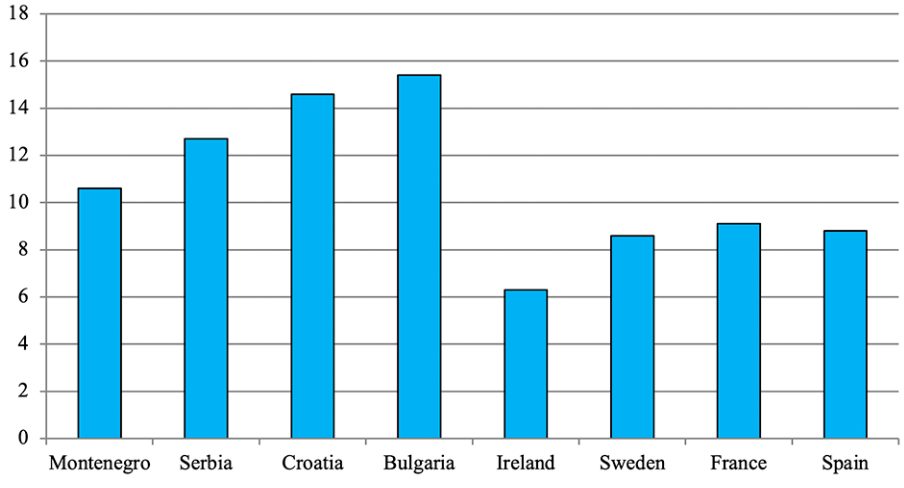


Chart 2. Overall mortality rate (‰) in selected European countries in 2019
(Source: based on Eurostat database)

total population and a growing mortality rate. However, (Chart 2), compared to Bulgaria (15.4 ‰), Croatia (12.7 ‰) and Serbia (14.6 ‰), Montenegro exhibits significantly lower mortality. Improving living conditions, and especially health care during the first half of the 20th century, led to a reduction in the specific mortality rates of the Montenegrin population. The distribution of mortality rates for both sexes has gone through significant changes over a very short period of time. Changes in mortality that have been recorded during the second half of the 20th century evidently indicate to differences in mortality by age with respect both to the level and intensity. In the first decades of the 21st century, all age groups recorded lower specific mortality rates. The largest decrease was recorded in children and young people, more moderate in middle-aged people, while it is significantly lower for age cohorts over 60 years. For the period 1961-2019, the largest reduction in mortality was observed in infants.

During the 1960s, infant mortality in Montenegro crossed the line marking high mortality and entered the group of countries with medium-high mortality (Radović, 1979), only to move to the group of countries characterized by low mortality during the last years of the 21st century. In this period, the number of deaths decreased from the initial 798 deaths in 1961 to 17 deaths in 2019. In percentage terms, mortality rate decreased by about 96%. Compared to European countries, the overall infant mortality rate of 1.7 ‰ recorded in 2018 was equal to the mortality rate of Slovenia and Iceland, while only Estonia had a lower mortality rate of 1.6 ‰. According to the value of this indicator (2018), Montenegro recorded lower infant mortality rate than the surrounding countries (Albania 8.9 ‰, Northern Macedonia 5.7 ‰, Serbia 4.9 ‰, Croatia 4.2 ‰).

There are certain specificities in infant mortality in Montenegro, which refer to the sex structure of mortality. The earliest data, even in the period between the wars (between the two world wars), indicate higher the rates in female children compared to those in male children.

Higher mortality of female children recorded in that period probably came as a result of lower care that was given to female children compared to male children. Such a trend in mortality changed sporadically after the 1960s, with the differences in mortality by sex intertwining in certain calendar years. Higher mortality rates of male infants have been continuously recorded since 1985 (Chart 3), with very small variations in individual years.

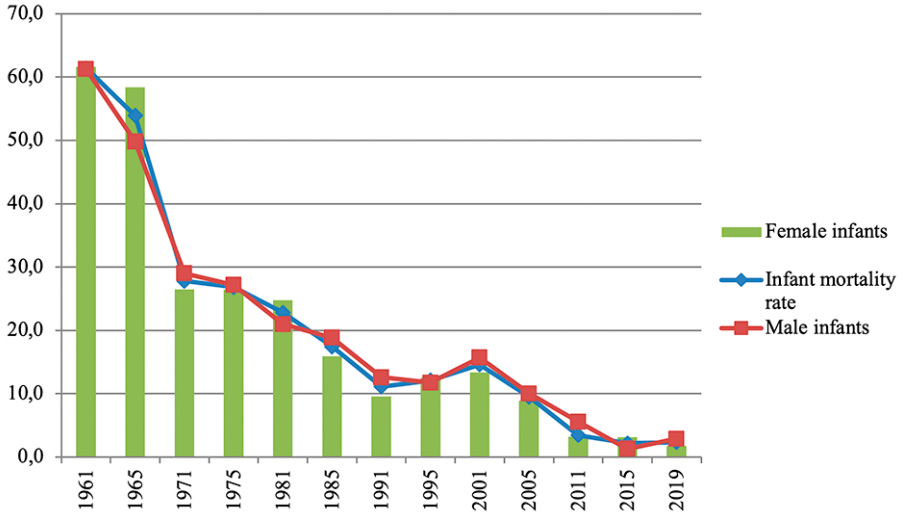
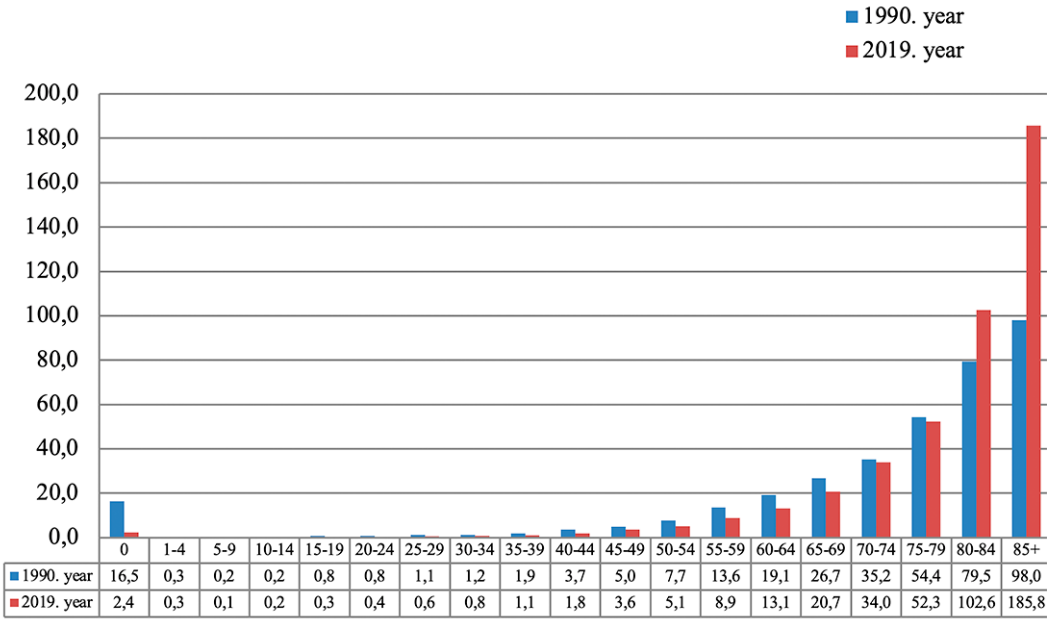


Chart 3. Infant mortality rates in Montenegro (in ‰), 1961-2019
(Source: prepared on the basis of MONSTAT data)

In addition to the abovementioned reduction in infant mortality, there was a significant reduction in child mortality in the age groups 1-4 and 5-9. At the beginning of the 21st century, Montenegro was among the leading countries in terms of the value of that indicator (around 2 ‰). During the first decades of the 21st century, the value of deaths in these groups did not exceed 0.6‰.

Differences in mortality between males and females, for all ages over 5 stand as an evidence of higher mortality of the male population, which is also a phenomenon characteristic of other populations. The reduction in mortality rates among the younger middle-aged population was more moderate, especially among the male contingent of the population, but the number of deaths, especially among women, was very small. Speaking about the difference in mortality by sex among the younger middle-aged population



	0	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
1990. year	16,5	0,3	0,2	0,2	0,8	0,8	1,1	1,2	1,9	3,7	5,0	7,7	13,6	19,1	26,7	35,2	54,4	79,5	98,0
2019. year	2,4	0,3	0,1	0,2	0,3	0,4	0,6	0,8	1,1	1,8	3,6	5,1	8,9	13,1	20,7	34,0	52,3	102,6	185,8

Chart 4. Specific mortality rate by age in Montenegro, in 1990 and 2019 (in ‰)
(Source: rates calculated on the basis of MONSTAT data)

in 1961, it is negligibly small and amounts to 0.3 ‰, only to become more pronounced in the next ten-year period, amounting to 5.7 ‰ in 1971. Such continuity of mortality continued until the end of the 20th century, and since 2001 the difference in mortality between the sexes recorded a slight downward trend in the younger middle-aged population, when the difference reached the level 3.1 ‰. In 2019, the mortality rate (Chart 4) of the younger middle-aged male population was 4.2 ‰, while the female part of the population stood at 1.5 ‰.

According to Penev (2008), in the middle of the 20th century, the mortality rate of the younger middle-aged male population was, depending on age, approximately 2 to 5 times higher, and that of women 2 to over 10 times higher. It is characteristic of both sexes that the intensity of the decrease in the value of the mortality rate decreased with age. The difference in mortality by age increased to the detriment of men, especially with older middle-aged and older cohorts of the population.

The share of the population aged 65 and over has been increasing in all European countries. The population ageing in Montenegro appeared as a consequence of fertility declining and increase of life expectancy in the previous period. This is confirmed by the already mentioned statement that there has been an increase in the share of elderly people in the total

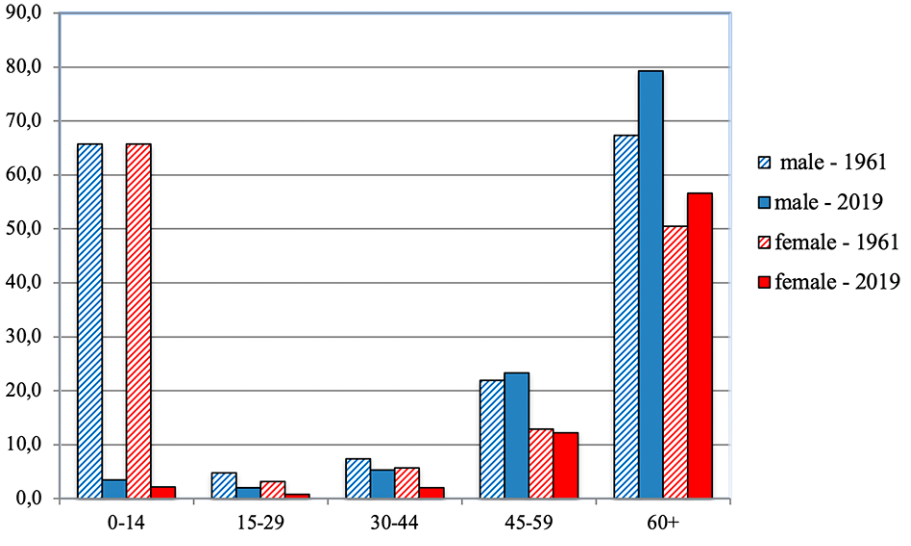


Chart 5. Specific mortality rates (in ‰) by sex, in 1961 and 2109
(Source: rates calculated on the basis of MONSTAT data)

population as well as by the growing mortality rate at that age group.

The difference in mortality by sex is particularly evident in these cohorts. Mortality of the population aged 65+ in 2019 increased by 15.1% compared to 1961 (Chart 5) for men, while for women this rate increased slightly lower and amounted to 10.9%. The oldest contingent of the population (population aged 85 and above) has the highest mortality rates. However, the analysed mortality in certain years in the oldest part of the population indicates that the mortality rates by sex had an approximate value, and that in some years the rates of women were even higher than men. This can be seen in 2001, when the rate of women was higher by 11.4% in relation to men and in 2014, when the rates in women were higher by about 6% in relation to the male part of the population in that age group.

Conclusion

With the improvement of health conditions, there has been a significant drop in mortality in all age groups, but the reduction of mortality in percentage terms was much more evident in infants and children. The greatest reduction was achieved in children in their third year of life. After the age of 45, the downward trend of mortality becomes less pronounced, while in age cohorts over 75, the percentage decline is significantly weakened.

As a result of uneven intensity of changes in life expectancy by sex, and in some periods the opposite direction, the differences in the values of this mortality indicator for male and female populations had been recording decrease or increase. Compared to other European countries, especially the former socialist countries, Montenegro currently belongs to a group of countries with the least pronounced difference in life expectancy by sex. However, it is still not possible to draw a definite conclusion as to whether Montenegro, as it is the case with many other countries, especially those that have made the largest progress in extending the life expectancy of the population, exhibits a new long-term trend of reducing differences in mortality by sex, or whether it represents only a short episode.

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SEASONALITY AND CHARACTERISTICS OF MARRIAGES IN SREMSKA MITROVICA

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Abstract

Marriage is a socially acceptable institution in which biological and socio-cultural components interact. One of the most important features of marriage is seasonality because different factors affect the time of entering into marriage, which is the primary subject of this research, analyzed on the example of the settlement Sremska Mitrovica. In agrarian societies, natural conditions were mostly between key factors that influenced the date of entering into marriage. Religion was often the deciding factor of seasonal marriage because of the limitation of dates in which it was allowed, because of religious holidays and periods that were preceded by religious holidays. The goal of this research is to highlight and notice specific trends, marital norms and patterns, the seasonality of marriage as well as to connect those changes with historical, political, economical, cultural and social contexts. Data were obtained from marriage registers (1900-2011) in Sremska Mitrovica. The characteristics of marriage in Sremska Mitrovica in the period from 1900 to 2011 were changing under the influence of historical and demographic heritage as well as the factors mentioned which also affected the seasonality of marriage in this period. In the observed period of 112 years, the highest percentage of marriages are made during autumn, in November.

Keywords: Sremska Mitrovica, marriages seasonality, nuptiality

Introduction

The study of marriage as a sociological category is a relatively new field. Major social upheavals, such as World War I, the great economic crisis of the 1930s, the World War II, numerous civil conflicts, have imposed an interest in the study of this social phenomenon. Certainly, these events have not caused the start of marriage researches, but only accelerate the process leading to a lot of scientific debate, the theory of models, and even the referendum questions on marriage or divorce. Special interest has always been shown by almost all religions, claiming to be the sole regulators of marital relations, and it can be said that the influence of religion and the church may have persisted most precisely in this sphere of social relations (Solarević, 2016).

Sremska Mitrovica is located in Srem area, on the left bank of the Sava River (Ђурчић, 2002). The city has a huge cultural and historical heritage, which are built primarily by the Romans in Sirmium, one of four Roman capitals, and set other nations who during antiquity, the Middle Ages and the new settled in this region (Лемајић, 2008). Great influence on the settlement had a period under the Habsburg or Austro-Hungarian Empire, which has shaped many of the population structures and patterns in different segments of life (Prica et al, 1969).

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Theoretical background

Marriage as a social institution, within which biological reproduction is the largest proportion, is an important topic considering the factors of low fertility of the population. Historically, one of the first functions of marriage has been to control sexuality, that is, the institution of marriage has imposed itself as a socially acceptable framework for the procreation and extension of the human species. At the same time, marriage has played an important role as a means of social integration. In agrarian societies, marriage and family are constituted and basic economic units, and thus the economic function of marriage was expressed. Marriage occupied an important place in all religious and ideological systems, as it was thought that by establishing control over marriage, control over society as a whole was established. Therefore, in each historical epoch, control of marriage was exercised by the church or the state, that is, the most powerful social force (Vuletic, 2008; Solarevic, Djercan, 2016).

Research on the seasonality of marriages, when it comes to Vojvodina, conducted in Kovačica, Bačinci, Lalic, Kać, Padina and Sajkaska region (Imro, 2013; Petras, 2019; Demiter, 2014; Petric, 2015; Zegarac, 2006; Arsenovic et al. 2015).

Methodology

The primary data were obtained from marriage registers in Sremska Mitrovica and the secondary data were collected through desk research, based on available literature. The methodological approach is based on the general scientific method in which are applied: the analytical and synthetic, inductive-deductive, comparative, generalization method, as well as the historical, statistical, mathematical, descriptive, demographic method. The research aims to define and show specific marriage trends, norms and patterns, seasonality of marriages, and link these changes to the historical, political, economic, cultural and social context.

The analysis primarily uses the demographic method. This method deals with the demographic measures and indicators, the probability using the account in the demographic analysis, making demographic tables, demographic projection models, analysis of demographic structure, by measuring and presenting the population development in time. For the seasonality is used specific index, called Henry's seasonality index (Hinde, 2014; Solarević, 2016).

Henry's seasonality index is calculated using the following formula:

$$H_m = \left(\frac{\sum N_{m,t}}{\sum_1^{12} N_{m,t}} \right) \cdot 1200$$

(Arsenovic et al. 2015).

Data were analyzed on a monthly and annual basis, relating to the total number of marriages.

Results and discussion

Marriage is, in the broadest sense, understood as a relationship between two people of different gender with the purpose of living together and creating a family. Also, marriage appears as spouses need to create a family and is affected socially and economically. On the other hand, weddings in certain parts of the year are influenced by various factors. Agricultural work in rural areas was among the most important factor that influenced the wedding date in the past. Moreover, religious practice has been the crucial factor in seasonal marriage due to limitations imposed by the marriage religious holidays and the period which preceded the religious holidays (Arsenovic et al., 2015).

In the period 1900-2011, 8,731 marriages were concluded in Sremska Mitrovica, which means about 79 marriages annually.

Distribution of marriages by month

In order to calculate changes in the number of marriages per month and to determine whether some seasonal factors affect the number of marriages in individual months, the period from 1900 to 2011 is divided into eleven periods: ten periods of ten years and a period of eleven years (2001-2011). Based on Figure 1, it can be concluded that the greatest value of Henry's seasonality index was recorded in the period from 1900 to 1910, in November and stood at 254.96. It is interesting that the lowest value was recorded in the same period, next month, in December, and amounted to 7.37. Throughout the eleven periods, one can see a change in the value of Henry's seasonality index by month.

In the first four observed periods, from 1900 to 1940, the highest values of Henry's seasonality in-

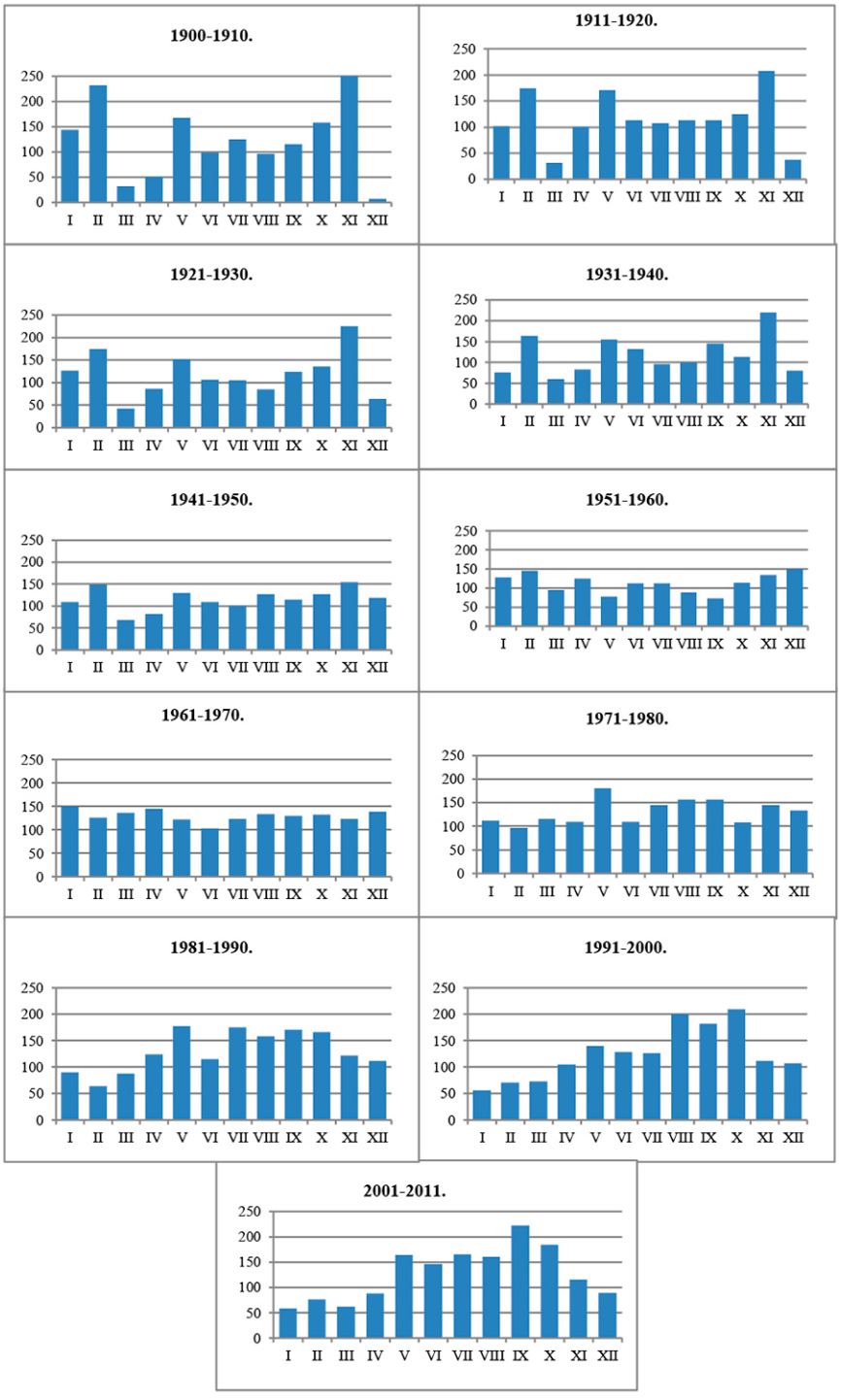

Figure 1. Henry seasonality index from 1900 to 2011
Source: Marriage Registers in Sremska Mitrovica from 1900 to 2011

dex were recorded in the following months: February, May and November. The lowest values were noticed in March and December. The values of Henry's seasonality index were consistent throughout almost every month between 1961 and 1970. May is the month to the end of the period (to 2011) that had high levels of Henry's index of seasonality. However, February and November were losing their high values together, from 1981 to the end of the period (2011).

The reasons for this distribution of marriages by months are certainly socio-economic. At the beginning of the observed period, most marriages were concluded during the winter months. Residents of Sremska Mitrovica were mainly engaged in agriculture in the first half of the 20th century. In modern times, in the last observed period from 2001 to 2011, couples often get into marriage in the period of the year when they can get days off or vacation, or when

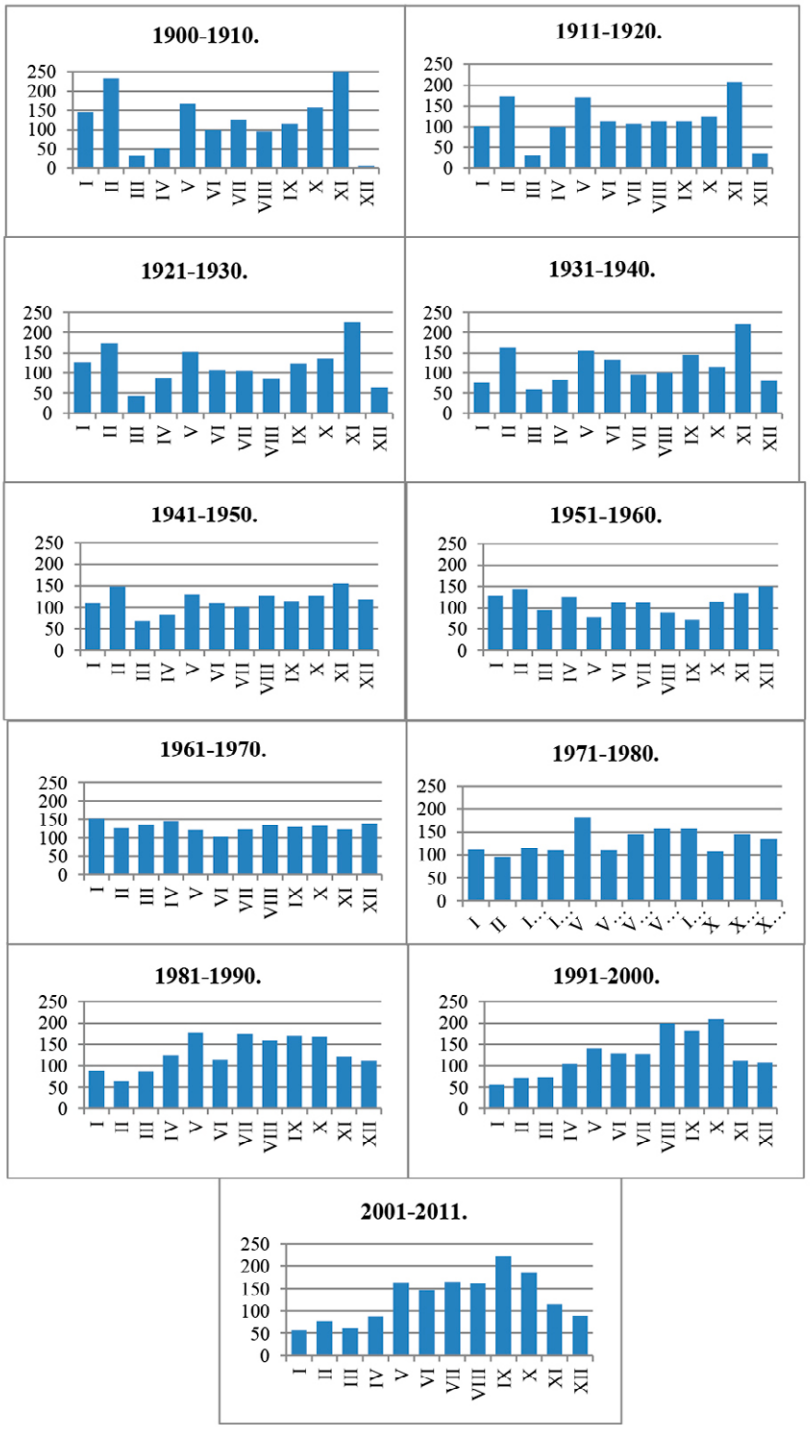

Figure 2. The percentage value of marriages by months in Sremska Mitrovica in the period from 1900 to 2011
Source: Marriage Registers in Sremska Mitrovica from 1900 to 2011

there is a vacant appointment with the registrar. The population is not engaged in occupations that are dependent on work in the field.

If we compare the value of Henry's index of seasonality with the values in some other countries, we can see that this characteristic of nuptiality is most influenced by the socio-economic structure of the population of the given region. So Henry's index of seasonality in the Province of Teramo (Abruzzo Region, Italy) in the 18th century recorded the highest value in February, May and June, while in the 19th century, most marriages in February, June and November. The reasons for this are the distribution of marriages religious nature, as well as the economic features of the settlement in the aforementioned region (agriculture) (Coppa et al., 2001).

In the 16th, 17th and 18th centuries in England shows that the value of Henry's seasonality index

also had the highest values in October and November, when they were at the beginning of the period followed by January and June, which were replaced at the end of May and December (Cressy, 2013). In southern Sweden in the 19th century, about 20% of marriages annually concluded in November and December (Dribe and Van de Putte, 2011).

Figure 2 shows the percentage values of marriages by months in the eleven mentioned periods. In the first three periods (1900-1910; 1911-1920; 1921-1930), the highest share of marriages in Sremska Mitrovica was concluded in November. The month with the lowest share of marriages during the entire observed period from 1900 to 2011 is December. One of the reasons is the fact that the large share of the population in Sremska Mitrovica is of the Orthodox religion. There are four major fasts during the year. The most important are the Great fasting (Easter) and Christmas fasting. The Christmas fast begins on November 28 and ends on January 6. During this period it is not possible to conclude a church marriage.

The distribution of marriages according to the seasons

In the early 20th century population in Sremska Mitrovica had different attitudes towards religion, compared to today. Many people strictly adhere to religious norms. According to some religious norms and principles, such as fast, it is expected that the significant share of marriages depends on that. Furthermore, mentioned norms are related to a specific period of the year (season).

When we look at all the periods respectively (Figure 3), it can be said that the biggest share of marriages was concluded in the autumn. At the beginning of the observed period from 1900 to 1950, autumn represents the season with the most marriages. Starting from 1951 to 1971, autumn loses its primacy. In the period from 1951 to 1960, winter marriages were dominant, while in the next period (1961-1970), the spring and winter marriages had an equal share. In the period from 1971 to 1980, the share of marriages was equalized in the three seasons, spring, autumn and winter. After 1991, the share of marriages in the autumn have increased.

According to Sanna and Danubio (2008) in Sardinia in the 19th century, most marriages were concluded in the autumn. A similar trend existed in Sremska Mitrovica, in the 20th century.

The share of marriages in the summer was low in two periods, from 1961 to 1970 and from 1971 to 1980. The last two periods are closely matched. For future

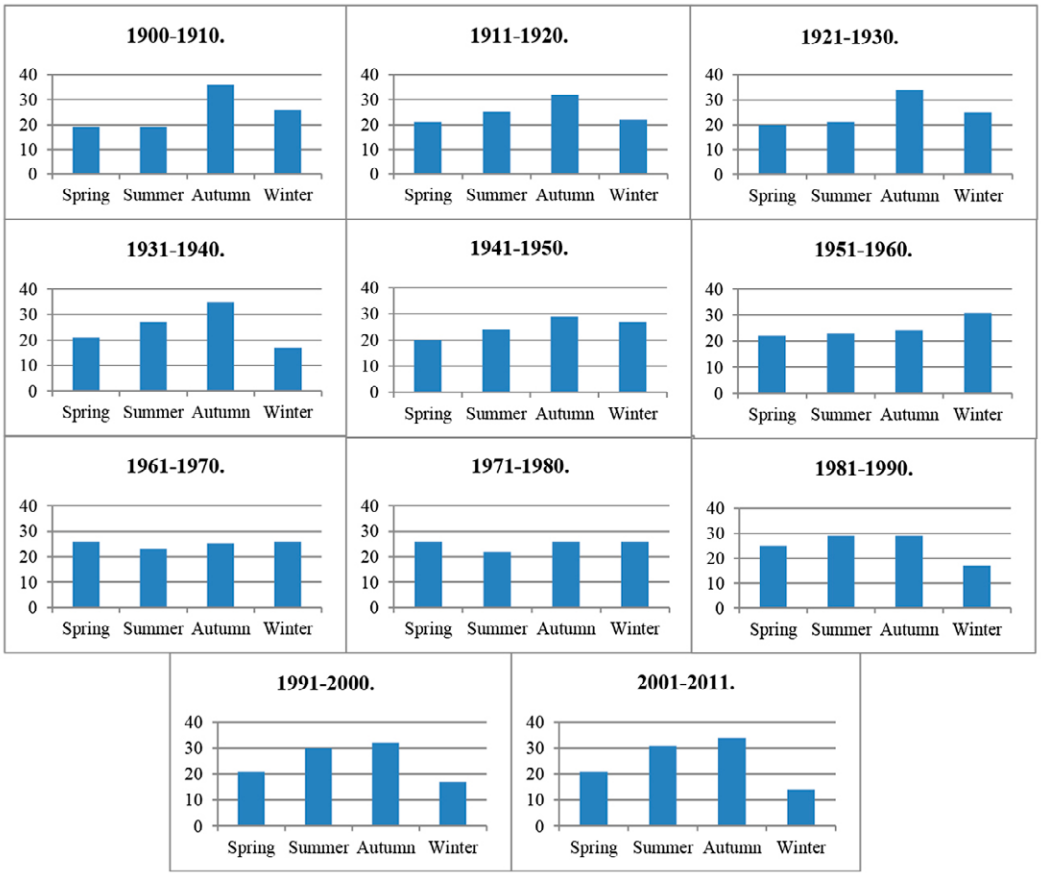

Figure 3. The distribution of marriages according to the seasons in the period from 1900 to 2011
Source: Marriage Registers in Sremska Mitrovica from 1900 to 2011

spouses it is important to make a picturesque and nice marriage ceremony and memories, so most of them want to be photographed in nature, in monasteries, and this requires good weather and holidays mainly.

Analyzing and comparing the results of the seasonality of marriages according to the seasons for many other settlements in Vojvodina (Kovačica, Bačinci, Lalić, Kać, Padina) to the results of Sremska Mitrovica, it can be concluded that the results of the seasonality of marriages differ. In the mentioned settlements of Vojvodina, most marriages were concluded during the summer.

Conclusion

In past, it used to be the rule that only one who is married can start a family because only this kind of family was acceptable, but today is a completely different situation. Today, many couples start families without getting married. Tradition and customs are losing importance, in terms of the modern way of life and thinking. Probably, this would be one of the reasons for future trends of marriage numbers and patterns in Sremska Mitrovica. The basic hypothesis of the research was confirmed and it means that the characteristics of marriage in Sremska Mitrovica in the period from 1900 to 2011 were changing under the influence of historical and demographic heritage, primarily social and economic factors, as well as cultural, religious and ethnic influences. According to the data from the marriage registers in Sremska Mitrovica in the period from 1900 to 2011, it can be concluded that in 112 years there have been only a few months in which even one marriage was not concluded. This points to the assumption that despite all the circumstances it faced (the wars, poverty, unstable political situation in the country), the population of Sremska Mitrovica is still traditionally oriented, but with an increasingly clear indication of modern marriage, trends proved that the most important pillar of society in Sremska Mitrovica is precisely the family.

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CROSS-BORDER EDUCATIONAL MIGRATION FUELLED BY HUNGARY'S KIN-STATE POLITICS IN THE SERBIAN-HUNGARIAN BORDER ZONE

Patrik Tátrai[A], Ágnes Erőss[A], Monika M Váradi[B]

Abstract

Educational migration is considered to be one of the most significant types in the migration from Serbia to Hungary. During the last thirty years, many Hungarian families in Vojvodina have come to the decision that after finishing primary school in Serbia, their children should pursue their secondary and tertiary studies in Hungary. Szeged is one of the main destinations of this type of migration, while at the same time it is also home to the most populous Vojvodinian community and serves as a scene for diverse, intensive cross-border activities. Based on narrative and structured interviews – conducted with Vojvodinian students living and studying in Szeged and also with heads of educational institutions – our main interest was to reveal how the direction and dynamics of cross-border migration and individual (or family) migratory decisions are challenged on the one hand by Hungary's kin-state policy regarding Hungarians outside Hungary and by the educational regulations of the Hungarian government and its institutions.

Keywords: Cross-border educational migration, kin-state politics, migration decisions, transnationalism, Hungarian minority in Vojvodina

Introduction: Cross-border transnational migration and ethnicity

Educational migration is considered to be one of the most significant types in the migration from Serbia to Hungary. During the last thirty years, many Hungarian families in Vojvodina have come to the decision that after finishing primary school in Serbia, their children should pursue their secondary and tertiary studies in Hungary. Szeged is one of the main destinations of this type of migration, while at the same time it is also home to the most populous Vojvodinian community and serves as a scene for diverse, intensive cross-border activities.

The present study is an empirical analysis of the features of educational migration across the Serbian-Hungarian border in the context of an international research project.[1] Based on narrative and structured interviews – conducted with Vojvodinian students attending secondary or tertiary education in Szeged and also with heads of secondary-education institutions between 2010 and 2012 – our main interest was to reveal how the direction and dynamics of cross-border migration and individual (or family) migratory decisions are challenged on the one hand by Hungary's kin-state policy and by the educational regulations of the Hungarian government and its institutions.

Cross-border educational migration is a form of transnational migration, which, in its broadest sense, can be seen as migration across political and national borders (Jordan & Düvell 2003). "We define

[1] Entitled *Integrating (trans)national migrants in transition states*, the project has been headed by Doris Wastl-Walter and funded by the SCOPES program of the Swiss National Science Foundation (www.transmig.unibe.ch).

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'transnationalism' as the processes by which immigrants forge and sustain multi-stranded social relations that link together their societies of origin and settlement. We call these processes transnationalism to emphasize that many immigrants today build social fields that cross geographic, cultural, and political borders. Immigrants who develop and maintain multiple relationships – familial, economic, social, organizational, religious, and political – that span borders we call 'transmigrants'. As essential element of transnationalism is the multiplicity of involvements that transmigrants' sustain in both home and host societies." (Basch et al. 1994: 7). Transnationalism is neither a permanent state nor a constant event, but rather a process; the intensity and frequency of transnational relations can vary, just as the ways in which transmigrants may be linked to their country of origin vary. However, being transnational does not necessarily mean possessing a transnational identity or a sense of transnationality (Levitt & Glick Schiller 2004). We furthermore use the concepts 'transnational society' and 'transnational social space' (Faist 2016) because they challenge preconceptions about closed nation-states. Feischmidt and Zakariás (2010: 159) define transnational societies as "societies that exist and function regardless of geographical factors." What one sees is not a single, one-way migration between locations, but multiple to-and-fro movements, and migrants typically remain open to further movement in the future. In our case, Vojvodinian students who study at secondary schools or universities in Hungary are transmigrants who simultaneously live in two countries and whose relations link them to two countries, albeit in different ways and with different intensities. The individual perspectives on and the outcomes of transnational educational migration can also be considered open: it can lead to the migrant permanently settling in Hungary, permanently or temporarily moving back home to Vojvodina, or even moving on to a third country (Szentannai 2001). The specific form of transnational educational migration we examine is that in which migrants who are members of the transborder Hungarian minority move to a country which many of them consider their mother country, and although they are separated from the country by the national borders and the Schengen Agreement, there is no cultural or language barrier. It is because of this characteristic that some authors categorize migration from the surrounding countries to Hungary as something in between internal migration and international migration, establishing a category of its own in which, when examining the migratory process, the common historical roots, ethnic identity, cultural similarities and common language must be considered (Gödri 2005: 79).

The theory of transnational migration is connected to the concept of the deterritorialized nation, a concept which is important for two reasons. In general, it means that transmigrants, through their activities, can belong to two or more nations at the same time without being physically present in a given state, that is to say, without living within the borders of the given state. In the specific Hungarian context, it must be emphasised that the decisions and discourses concerning Hungary's kin-state politics all aim at creating a common deterritorialized nation, to which all Hungarians belong, regardless of where they might live. This is the new form of transnational policy Michael Stewart writes about, and this is what he means by describing transborder Hungarians as 'developing transnational minorities' (Stewart 2003). In the last few years, the deterritorialized Hungarian nation existed only in a symbolic and cultural sense; however, the amendment of the Hungarian Citizenship Law resulted in a simplified naturalisation procedure coming into force in January 2011. This made it possible for people living in the former territory of the Kingdom of Hungary to acquire Hungarian citizenship without residing in Hungary. Anybody is eligible for preferential (re)naturalisation who or whose ancestors held Hungarian citizenship once, and who proves his/her knowledge of the Hungarian language. This law served both symbolic goals like the re-emerging nation-building project ("national reunification", Pogonyi 2015), and pragmatic goals such as to expand the governing Fidesz's voter base with new non-resident citizenship.

Dilemmas in immigration and kin-state politics

One of the features of migration to Hungary is that two-thirds of the people coming to and settling in the country is from the Hungarian communities of the surrounding states (Tóth 2003). It is because of this feature that Hungarian immigration policy, which is often considered merely an ad hoc solution by its critics, is closely intertwined with the equally immature kin-state politics (see e.g.: Çağlar & Gereöffy 2008; Feischmidt & Zakariás 2010; Waterbury 2010). Ever since the regime change of 1989, the basic principle of Hungary's kin-state politics has been to help Hungarians outside the borders thrive in their native

country;[2] in other words, the goal has been to maintain a Hungarian presence throughout the Carpathian basin. However, this priority is in opposition to political, economic and social interests. For example, it is also very important to maintain good relationships with the neighbouring countries, which are extremely sensitive to Hungarian political discourses and decisions concerning the Hungarian minorities that live within their borders. One of the most important facts in connection with migration is that, due to the aging and decline of Hungary's population, the country needs a new labour force (Blaskó & Fazekas 2016), and the simplest way of increasing the size of the active population while causing as few conflicts as possible and costing society the least amount is to have Hungarians living outside Hungary migrate to the country. At the same time, ethnic kins are considered to be an asset as well if remaining in their homeland, because Hungary's kin-state politics can rely on them to fulfil Hungary's regional economic and geopolitical goals (Tátrai et al. 2017).

This calls attention to the (long-standing) conflict of interest of Hungary's kin-state politics: whether to help transborder Hungarian communities to stay in their homeland or enhance their migration to Hungary to satisfy the country's demographic and labour needs. Since the political transformations in 1989, all political forces in Hungary have explicitly supported the first goal; however, some of the measures implemented implicitly served the second aim. The amendment of the Hungarian Citizenship Law reflects such controversies: however, it does not support directly ethnic kin's migration to Hungary but still facilitates it. Nevertheless, kin-state politics lacking a clear, coherent, one-way road, they serve both aforementioned directions instead. As Çağlar and Gereöffy (2008: 333) noted "it is the controversies in Hungarian diaspora politics which impeded the development and the implementation of a comprehensive migration policy in Hungary." Contemporary kin-state politics are not without such controversies although they clearly communicate welfare in the homeland as a final goal together with collective rights and autonomy, which reflects that nowadays the balance between migratory and diaspora (ethnic) politics shifted towards the first one, primarily as a consequence of the extension of the Hungarian citizenship.

Not only the 'focus' but the targets and instruments of kin-state politics are controversial as well, because the policy simultaneously seeks to support the creation of a deterritorialized (culturally and politically) unified Hungarian nation and to secure collective minority rights for transborder minority communities and help them achieve autonomy. Complete (economic, cultural, political, and territorial) autonomy in the neighbouring countries does not appear to be an achievable alternative today for many reasons, such as the assimilation policies of neighbouring nation-states and the dwindling and internal political division of minority communities. With regard to Vojvodina in Serbia, the site of our research, where the percentage of the largest (Hungarian) ethnic minority is 13% of the total population according to the last census held in 2011, the province is politically and administratively but not economically autonomous. The second goal of Hungary's kin-state politics, the virtual "reunification" of the Hungarian nation, can be quickly and easily achieved with the institution of dual citizenship,[3] which was introduced in 2010.

Naturally, professional and political views about Hungary's kin-state politics vary in Hungary. During the debate about dual citizenship it was none other than a Vojvodinian constitutional lawyer who, representing one of the strongest critical standpoints, pointed out the inconsistencies among the policy targets and instruments mentioned above: "…there is an irresolvable conceptual contradiction in that Hungarian communities outside Hungary would like to acquire the status of partner nation, to achieve a degree of autonomy that would require the modification of the nation-state model, and at the same time, to demand Hungarian citizenship on the grounds of ethnically belonging to the nation-state." (Korhecz 2010: 167). As in Hungary, priority is given to discourses about kin-state politics and there is no opportunity to start a political or public debate about the political, demographic and economic reasons for and consequences of substantial ethnic migration to Hungary from neighbouring countries or about a desirable immigration policy (Feischmidt & Zakariás 2010: 156). Nor is there any ongoing dialogue about whether the instruments and decisions of kin-state politics are able to influence the readiness of Hungarian communities beyond the border of Hungary to migrate, and if they are, then to what degree and in what direction?

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[2] This principle can be found in the 1989 constitution as well as in the 2011 basic law (Article D): "Motivated by the ideal of a unified Hungarian nation, Hungary shall bear a sense of responsibility for the destiny of Hungarians living outside her its borders, shall promote their survival and development, and will continue to support their efforts to preserve their Hungarian culture and foster their cooperation with each other and with Hungary."

[3] In practice this means preferential (re-)naturalization of Hungarians outside Hungary, which, since 1 January 2011, can be requested without a place of residence in Hungary.

Cross-border educational migration influenced by kin-state politics

For our research, the most important element of kin-state politics is the support it gives to Hungarian students studying in Hungary but coming from outside the country (for further details, see Erdei 2005; Epare 2008; Molnár 2008; Takács et al. 2013). A feature of the system that was introduced in the early 1990s is that communities outside Hungary can form scholarship boards and, taking the needs of the specific community into consideration, each board can decide which student may study what subject at Hungarian higher education institutions and receive a scholarship from the Hungarian state. Part of the support system is a network of student hostels, named Márton Áron Special College Network, that cater for students' needs (see Márkus 2014). The so-called specialist student hostels first welcomed students in Budapest, and then, after the turn of the century, in every important university centre throughout the country. The practices and philosophy at the Márton Áron Special College Network are aimed at providing education to Hungarian intellectuals living outside Hungary, reinforcing their identities and helping them return home. The special college establishes a social space in which mainly Hungarian transborder students live together and are linked in their free time as well by the numerous services provided.

From the beginning, the stated goal of the scholarship system was to reinforce the ranks of Hungarian transborder intellectuals, but it quickly became obvious that most of the students studying in Hungary do not wish to return to their native country. That is why at the turn of the century during a reform to the scholarship system, regulations were implemented according to which students taking part in the program were obliged by contract to return to their home country once their studies were over. However, this reform failed to reduce the levels of migration, just as the continuous cuts to the state scholarship budget and the support provided for the establishment of Hungarian higher education institutions outside Hungary (mainly in Romania and Slovakia) have failed. A significant proportion of students studying in Hungary, estimated as about 50 to 70% (Gödri 2005: 88; Szügyi & Takács 2011: 296), never return to their native country.[4] The head of the Márton Áron Student Hostel in Szeged points out: it has never happened that a student who did not return to his/her country had to repay the scholarship because the state does not monitor whether the conditions of the contract have been fulfilled. This means that the political instruments, which were supposed to provide education for transborder Hungarian intellectuals, have been successful only to a limited extent in achieving their original goals of keeping intellectuals in their native country. Furthermore, they did not have any significant influence on the migratory decisions of young people, except for encouraging educational migratory decisions by providing scholarships.

The parents of young Vojvodinian Hungarians undertaking educational migration possess above average qualifications (Erdei 2005). According to surveys, the parents of Vojvodinian university students studying in Hungary have a much higher educational level, than the parents of those who go to a Serbian university.[5] There is also a remarkable difference in the qualifications acquired prior to entering tertiary education: while two-thirds of the students studying in Hungary were educated in a secondary grammar school, the rate is reversed in the case of university students in Serbia, in which two-thirds have a vocational education, meaning they attended a secondary-education institution of lower prestige. These results give rise to the hypothesis that can only be confirmed through personal experience and not by systematic research, namely, that "members of the Hungarian elite in Vojvodina educate their children in Hungary" (IDKM 2010). Thus, it could be said that the elite of the Vojvodinian minority is characterized by a transmigrant lifestyle. The research mentioned above also points out that the level of migratory intentions is constantly high; the rate of potential migrants among students in Serbia is 70%, whereas among students studying in Hungary, it is 90% (IDKM 2010).

With these figures in mind, it is no surprise that studies on the educational opportunities and migratory readiness of young people are, especially when conducted by researchers of Vojvodinian origins, partly inspired by advancing ethnic and minority policy concerns. They are concerned that the continual migration especially of highly qualified intellectuals might endanger the survival of Hungarian minority communities in Vojvodina (e.g.: Mirnics 2001; Gábrity 2002, 2007; Fercsik 2008; IDKM 2010; Takács

[4] This figure does not only reflect students who receive a scholarship, because, compared to the total number of students who come to study in Hungary, their number is dropping (Szentannai 2001); most students paid tuition for their university education during the 2000s and since the introduction of preferential (re)naturalization, most of the transborder Hungarians participate in Hungarian education system for free as Hungarian citizens.

[5] Off the fathers of students studying in Hungary, 22.6% have a university degree or diploma, whereas the same rate for fathers of students studying at Serbian universities is only 7.7% (IDKM 2010).

et al. 2013; Takács & Gábrity 2014; Palusek & Trombitás 2017; Kincses & Nagy 2019).[6] From a Vojvodinian point of view, one of the main reasons for educational migration could be that there is no local, independent Hungarian higher education and that, especially at university level, the existing network of institutions offers neither sufficiently diverse departments, nor satisfactory opportunities for students to study in their native language.[7]

Educational transnational migration at the Hungarian-Serbian border

In the 1990s, when the country's borders were opened, a high number of young transborder Hungarians appeared in the Hungarian public and higher-education systems. Romania and Slovakia provide the highest number of migrants, closely followed by the former Yugoslavia. For over a decade, the number of Serbian[8] students studying in Hungary was mainly influenced by the fluctuation of the Yugoslav Wars, and their number in Hungarian institutions of secondary and tertiary education sharply increased at the time of the NATO bombings. In general, it can be said, that while the demand for tertiary education has remained constant during the 2000s, the number of students attending secondary education has been steadily dropping in this period (Table 1). One of the main reasons behind this is the process of democratization in Serbia: some aspects of Vojvodinian autonomy, including education, have been restored and secondary schools have been established for talented children where the language of education is Hungarian.[9] Beyond the institutional reasons, the general demographic characteristics of Vojvodian Hungarians, namely the low birth rate and emigration, resulted in population ageing, have also contributed to this situation throughout the period under review (see e.g. Milanović 2006; Živković et al. 2008; Badis 2012).

However, after 2010, when preferential (re)naturalization came into effect, both the number of pupils in public education and students in higher education has grown. The widely acquired non-residential Hungarian citizenship made Hungarian education tuition free for passport holders and facilitated the intensity of connections between the two sides of the border (Kincses & Nagy 2019). While number of pupils with Serbian (or with dual) citizenship has only increased by 30 percent, number of students in higher education doubled between 2008 and 2018 (Table 1).

Most of the Serbian students studying in Hungary are concentrated in the region we examined, in the city of Szeged in Csongrád County (Figure 1). According to a 2005 analysis conducted by the Hungarian Ministry of Education, 61% of the students from Serbia and Montenegro in Hungarian public education studied at primary and secondary schools in Csongrád County, 13% studied in Budapest and 11% at institutions in Bács-Kiskun County, as it is closer to Vojvodina, making transportation easier (Kováts & Medjesi 2005). According to a 2010 study, 62% of Serbian college and university students in Hungary are educated in Szeged, and 1 in every 4 is a student at an institution in Budapest (Danka 2010). The research by Kincses and Nagy (2019) confirmed, that spatial patterns have not changed significantly in the last years: in the 2017/2018 school year, 58% of the Serbian citizens studying in Hungary attends higher education institutions in Szeged.

There are two reasons for this phenomenon: first, the educational services provided by the city are of high quality. Second, most of the students with Serbian citizenship reside in North Vojvodina, where majority of ethnic Hungarians live (Figure 2).[10] Since Szeged is the closest city to the border, only few kilometres far from Hungarian settlements in North Vojvodina, educational migration influenced by geographical proximity. In this case, one can interpret such cross-border mobility as connection between city and its attraction zone – which otherwise extends beyond the border.

[6] In the years after 2000, 20–25% of Vojvodina's Hungarian college and university students were involved in higher-education migration to Hungary. The number increased to 30–35% by the beginning of the 2010s (Szügyi & Takács 2011).

[7] At some colleges in Subotica and at some faculties at the University of Novi Sad, in fact, there is partial or complete education in Hungarian. Also, in sister departments at Hungarian institutions, it is possible to acquire a degree in horticulture and information technology. A comprehensive overview of secondary and tertiary education services in Vojvodina would be too extensive for the present study, so for more details on the topic, see Gábrity 2002 and Takács & Gábrity 2014.

[8] In our study, the adjective 'Serbian' refers to migrants arriving from (ex-)Yugoslavia, Serbia and Montenegro and the Republic of Serbia. Official statistics do not include students' ethnicity and place of residence, yet 80-90% of the educational migrants coming from the successor states of Yugoslavia speak Hungarian as their native language, are of Hungarian descent, and live in Vojvodina.

[9] Hungary's accession to the EU also contributed to the changes in educational migration. Due to legal harmonization within the EU, the same laws apply to students who are Serbian citizens as to citizens of other third (non-EU) countries. Thus, after the 2007 amendment of the public education law, children may only receive free compulsory education if their parents can certify that they have income and housing in Hungary. Earlier, by law, the Hungarian state funded their education as well.

[10] The study by Kincses and Nagy (2019: 225) proved that correlation between the attraction zone of University of Szeged in Vojvodina and the territorial distribution of ethnic Hungarians in Vojvodina is quite strong (0.851).

Table 1. The number of Serbian citizens in kindergarten and primary, secondary and tertiary education in Hungary

School year	Kindergarten	Primary school	Vocational school	Secondary general school	College/ University
1995/1996	..	376	92	572	596
1996/1997	..	339	92	540	..
1997/1998	..	308	89	488	..
1998/1999	..	295	73	499	281
1999/2000	..	395	84	676	843
2001/2002	55	306	49	634	822
2002/2003	65	307	80	556	796
2003/2004	30	282	73	511	663
2004/2005	29	222	72	509	714
2005/2006	33	232	71	465	755
2006/2007	35	194	101	485	765
2007/2008	35	170	81	421	871
2008/2009	38	139	47	380	868
2009/2010	39	211	71	401	1009
2010/2011	38	174	60	353	1136
2011/2012	52	220	40	359	1244
2012/2013	52	200	32	427	1465
2013/2014	49	198	26	417	1543
2014/2015	57	208	30	483	1321
2015/2016	76	197	25	486	1670
2016/2017	61	204	46	524	1632
2017/2018	73	202	59	543	1761
2018/2019	36	111	22	319	1767

Source: Statistical Yearbook of Public Education 2018/2019, Budapest, 2020: 38

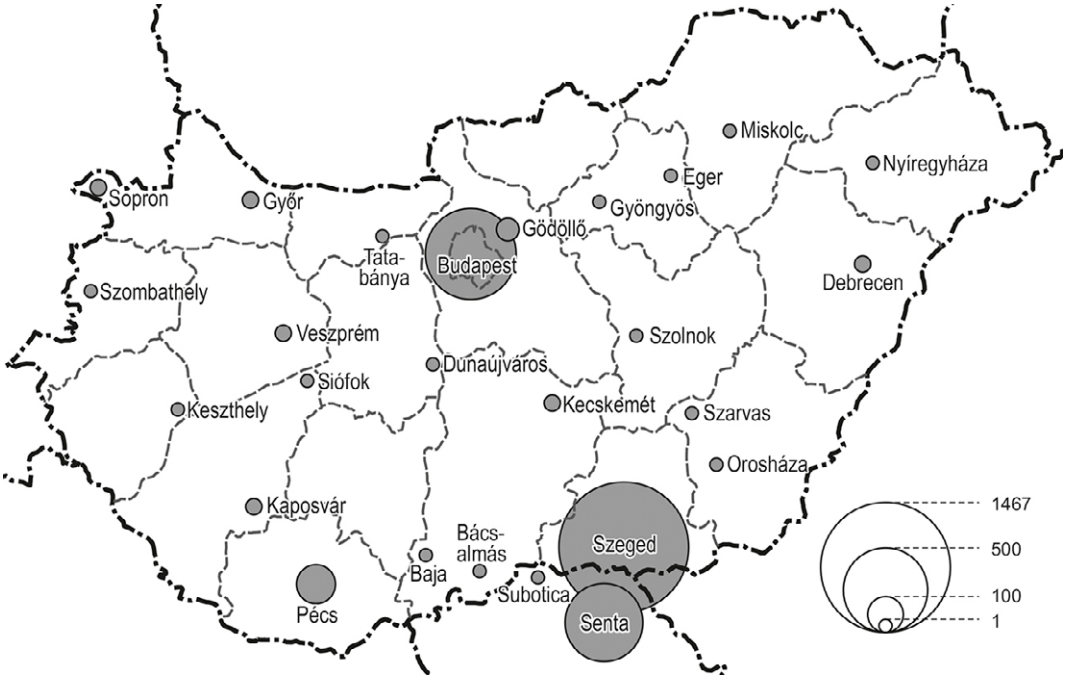

Figure 1. Serbian citizens applying in the Hungarian higher education, according to the place of education, 2005–2010
Source: Takács et al. 2013: 8.

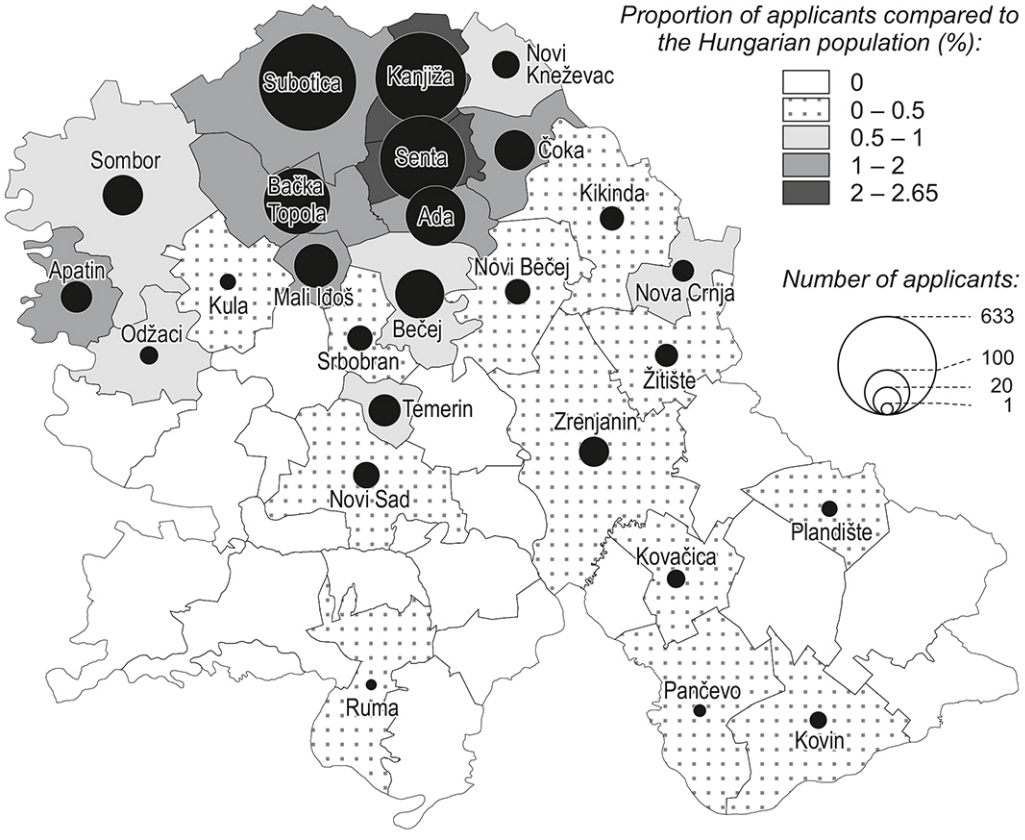

Figure 2. People from Vojvodina applying for studies in Hungarian higher education, according to their place of residence, 2005–2010

Source: Takács et al. 2013: 10.

Migration in secondary education

During the 1990s, cross-border educational migration became closely intertwined with the migration of families fleeing the country due to the crisis brought about by the Yugoslav Wars, military drafts, growing poverty and untenable standards of living. The migrants arriving in Szeged at the time lived in uncertainty and fear and, for a long time, they clung to the hope that the war would soon end and they could return home. On both sides of the border, myriads of families and children, often separated from each other, lived under circumstances they thought of as transitory. In 1993 still, a study found that many were living under temporary, migratory circumstances. It also found that Vojvodinian children studying in Szeged were talented, achieved good results, had favourable family backgrounds and that many of their parents, some of whom were well-to-do businessmen with developing business interests in Hungary, were highly qualified (Imre 1993: 22).

When we enquired about cross-border educational migration at institutions of public education in Szeged, we found that during the last two decades the presence of Vojvodinian students became fairly common and these students did not stand out in any way from other students. However, as in the 1990s, children and their families still often lived under temporary, transitional, and migratory circumstances. Most children with parents in Vojvodina live in student hostels or flats, but some parents buy a flat for their children in Szeged as preparation for the child's or the entire family's permanent relocation to Hungary. Many of the Vojvodinian students' parents have a sustainable livelihood in Hungary, so even if they do live in Vojvodina, they still have ties to both countries and seek to plant roots in Hungary, if for no other reason than to secure the future of their children.

When, in 2007, the legislative changes came into force, the local government of Szeged issued a regulation which made it possible for heads of educational institutions to exempt Vojvodinian students from paying tuition or to reduce it by taking the students' social circumstances or academic achievements into consideration. What also points to the special status of transborder Hungarian students is that the regulation only affected them and not students from other third countries, like the children of Chinese fami-

lies living in Szeged and of compulsory school age. In the last decade, the opportunity to apply for Hungarian citizenship led to an increase in the number of Vojvodinian Hungarians in secondary schools in Szeged, because, as Hungarian citizens, they have the same rights as their Hungarian peers, including the right to free public education. But even though hardly any students have to pay a full tuition fee, for many families, educating their children in Hungary still means a great financial burden.

In the cross-border market of educational services, secondary schools in Szeged mean competition for Hungarian–speaking secondary schools in Vojvodina. The institutions on the Hungarian side of the border enjoy an advantage for many reasons. As a regional educational centre, Szeged can offer a broader range of educational services than Vojvodinian secondary schools. It further adds to their advantage that pupils who wish to go to a Hungarian college or university believe that a baccalaureate from a Hungarian secondary school will make it easier for them to enter tertiary education. All this means that the decision to go to a secondary school in Hungary fits into a long-term, migration and mobility strategy for both an individual and the family. The influence of Szeged's secondary schools mainly extends to settlements close to the border. Vojvodinian children sometimes live closer to Szeged than many of their peers from Hungarian villages, and they regularly go home to their parents and friends beyond the border for the weekend.

Special features of transnational educational migration

According to interviews with young Hungarians from Vojvodina, the main driving forces behind education migration to Hungary are the following: the most important of the factors pushing for migration was the complete lack of or limited access to education in the native language, while conversely the most important factor pulling toward migration proved to be Szeged's wide range and high quality of educational services. Language skills also play a major role in migratory decisions (Gábrity 2007; Kincses & Nagy 2019). For example, children from homogeneous Hungarian communities, encounter a particularly serious problem in that they lack command of the Serbian language. Serbian is only taught as it was their mother tongue and often our interviewees proved to be sceptical about the quality of language teaching. The inadequate knowledge of the state language in itself may be sufficient to fuel the educational migration process to Hungary.

However, apart from the basic desire for education in one's native language, migratory decisions are also partially determined by prospects of a better livelihood, and these needs grow stronger during the years of education. A case in point is that higher education in Serbia is not even attractive for those who grew up in a mixed ethnic environment and have good command of the state language. Hungary offers a higher standard of living and greater employment opportunity than Serbia. It should also be recalled that since accession to the EU in 2004, Hungarian diplomas are recognized throughout the entire EU labour market, while Serbia is still waiting for accession.

Though the ethnicity of young Hungarians from Vojvodina serves as a cultural and social capital for their migration to Hungary, this process is determined by economic factors as well as by ethnic factors (Gödri 2004). Migrants' accounts often reveal that ethnic and economic motives are linked and that together, they influence the migratory decision. During the interviews, ethnic dimensions appeared primarily in a positive context: interviewees expressed a natural, sometimes unconscious, connection to Hungary and an appreciation that the language and culture are the same. Very rarely did young people and students mention the drawbacks of belonging to a transborder minority, and even when they did, it mainly concerned the limited access to career opportunities (a problem related to the lack of language skills).[11]

By conducting interviews with Vojvodinian students who previously studied or are currently studying in Hungary, we gained a number of insights: that transnational migration may best be described as a process (Levitt & Glick Schiller 2004); that permanent resettlement takes place gradually (Salt 2001); and that a migrant often tries to gain a foothold in both countries to see where the chances of an adequate livelihood are better. We also realized that transmigrant moving back and forth across the border is not characterized by a spirit of entrepreneurship or particular open-mindedness. Many young people consider that their future is open and that their current residence and circumstances are not permanent, so a final decision as to where to live is commonly drawn out. However, while livelihood and career prospects have a great impact on the final

[11] In the survey conducted with Hungarian university students from Vojvodina, the researchers were also curious about the motivation behind the readiness to migrate. Of the students interviewed, 82.8% responded that they would leave the country where they were born in hopes of making a better living somewhere else, whereas only 6.6% said they would leave due to their disadvantageous minority status (IDKM 2010).

(re-)settlement decision, social relations, such as marriage and family planning, also have a decisive influence on the outcome of the migratory process.

The importance of social networks in the migratory process can be seen in many ways in individual lives (Tilly 1991; Massey et al. 1993; Gödri 2004). Without a family's active support, a child would not be able to decide to pursue further studies. However, an environment that accepts and supports migration needs to be wider than just the family: teachers must inform students about the possibility of transborder education; parents and students visiting home need to hand on information to each other about schools; and then these pieces of information can promote and confirm individual and family migratory decisions. When making such decisions, migrants rely heavily not only on a supportive environment at home but also on siblings, relatives, friends and peers who have already resettled. These relationships help to mitigate the risks and losses of migration and provide models as well. Thus social networks at home and in the target area of migration become a source of strength. They contribute to making migration a legitimate, individual and collective life strategy spanning across generations, and so they themselves become factors that sustain and fuel migration.[12]

Conclusions

The three-decade-old transnational educational migration at the Hungarian-Serbian border is a process determined by both ethnic and economic factors, and concerns primarily minority communities with Hungarian language and identity on the Serbian side of the border. For this reason, Hungary's kin-state politics, and its related educational policy attempt to influence the nature and extent of this form of migration. Though our field research was carried out several years ago, it showed, what our current data analysis and other recent researches have also confirmed, that this policy, with its associated instruments, is unable to fulfil its most important purpose, which is to safeguard the existence of an intellectual elite in Hungarian minority communities and to help them sustain a livelihood in their native country.

However, what proved to prevail were the push and pull factors and transmigrant networks, which not only amplify educational migration but make it a supported, legitimate individual and family strategy as well. This form of transnational migration is characterised by migrants being linked to two worlds simultaneously, though the connection differs according to individual circumstances and its intensity changes over time. Although the outcome of such transnational migration is considered to be open, our research indicates that, in the majority of the cases, it is the first step towards permanently leaving behind the native country. Thus strategies and decisions concerning a child's education are at the same time long-term migratory decisions and strategies.

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[12] The importance of social networks is indicated, for example by the fact that in 2010, 35.6% of Vojvodinian Hungarians studying at Hungarian universities had family members studying abroad, while the same figure for Hungarians studying in Serbia is only 9.4% (IDKM 2010).

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NEW CHALENGES FOR SERBIAN FERTILITY POLICY

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Abstract

Despite the fact that various forms of support policies for families with children have been implemented since the Second World War, Serbia has been facing below replacement fertility for more than 65 years. These policies have been implemented with a predominantly social dimension, without demographically defined goals. Only since 2002, direct pronatalist policy has been implemented in the entire territory of the Republic, and this paper will attempt to make a rough assessment of the impact of such policy on the birth aggregate during the Covid-19 crisis in order to make recommendations for the improvement of existing family and fertility policies. Before that, the possible impact of the Covid-19 pandemic on the birth aggregate during 2021 in Serbia will be calculated based on two different methodologies. This assessment should provide evidence about the efficacy of Serbian family and fertility policy.

Keywords: below replacement fertility, Covid-19 crisis, Serbia, family and fertility policy, birth decline, fertility loss.

Introduction

Besides the long-lasting bellow-replacement fertility in Serbia, the outbreak of Covid-19 pandemic resulted in emergence of so-called Covid Crisis (CC). This CC influenced the wide specter of everyday life, from employment, financial wellbeing, uncertainty and health concerns, to work and family reconciliation, dating, marrying, and family planning. Similar demographic consequences of the progressively widespread epidemics on conception and fertility have been recorded during prior incidents. In general, epidemics manifest a common pattern as far as their impact on population, which is remarkably similar to natural disasters, i.e., a steep decline in birth rates followed by gradual increases and then followed by a baby boom. Past evidence on fertility responses to external shocks, including economic recessions and the outbreaks of infectious diseases, show that people often put their childbearing plans on hold in uncertain times (Sobotka et al, 2021). More than two-thirds of the world population have experienced lockdown measures, lasting from weeks to months, and thereby affecting family and social lives, as well as imposing a substantial burden on mental health, which can influence fertility, conception, gestation, and birth (Ullah et al, 2020). Psychological stress and unemployment rates have exponentially risen. Different researches around the globe hinted the baby bust in highly, and the baby boom in less developed countries. For example, in highly developed countries (here we include Serbia) the fertility rate is greatly influenced by higher women educational levels, and high employment rates. During CC the inaccessibility to childcare outsourcing services, combined with financial uncertainty, could further reduce the fertility rates. Opposite, in less developed economies prolonged lockdown resulted in a large number of women or men not having access to various forms of contraception. The lack of access to birth control services is likely to result in millions of unintended pregnancies, unsafe abortions, and maternal deaths (Desrosiers et al, 2020). Due to the lockdown, individuals were in their houses with their partners and because of job losses or interrupted work-related activities, the increased time spent

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at home further escalated the possibility of a baby boom in rural areas during this pandemic (Ullah et al, 2020).

On the contrary, totally different system of reproductive decision making in highly developed economies will result in not planning to conceive during the CC. Historically, economic crises have never been the preferred period for a couple to decide to have a baby. The millions of jobs lost in that circumstances, even when a couple is not directly affected, create a climate of great uncertainty, which depresses family projects (Matysiak et al. 2018). Sex lives as well as planning for parenthood have been on the hold by a number of reasons like worries about future economic difficulties, fear of getting infected, complications during pregnancy and shortage of healthcare workers. Additionally, the physical distancing required by the Covid-19 containment strategy imposed also restrictions to (physical) intergenerational support and affected more strongly fertility plans in those countries, such as Italy and Spain, where grandparental childcare is more intensive, and also due to a lower availability of childcare services in these countries (Luppi et al, 2020). Overall, the lockdown imposed the constraints to opportunities of one's life choices. Different studies about fertility plans reported that more than one quarter of couples in Italy changed their fertility plans (Micelli et al, 2020), and even 40% of USA couples (Lindberg et al, 2020). Overall, during epidemics, the birth rates decline immediately after 9 months and recover or further surpass pre-epidemic levels within a year and thereafter. Recent epidemics such as Spanish influenza, SARS, Zika virus, and Ebola, suggest that fertility rates decline during the emergence of these extraordinary events.

Incorporating lessons from the previous pandemics, it would be reasonable to postulate that the CC may significantly affect future birth rates with long-term effects. The Serbia will not be an exception. Results of one study (Luppi et al, 2020) show that fertility plans have been negatively revised in all five observed countries, and that negative revisions of fertility plans are declining with age. This study found that in Italy, Spain, Germany, UK, and France, the half of the fertility planners postponed conception, one quarter completely abandoned the decision, and one quarter was still planning to get a baby during the CC (Luppi et al, 2020). Other authors expect that after an initial reduction, it is likely that birth rates will rise again due to the mortality replacement and hoarding effects (Ullah et al, 2020). Previous studies of epidemics suggest a range from 0.25 to 2 births being added per each death toll in the course of 1 to 5 years after an epidemic. The reduction of 1 birth in 1918 during Spanish flu, was followed by an increase of 1.5 conception 1 year later and resulted in a baby boom. Yet, it is hard to presume that CC death tool will turn out to be significant fertility driver. Such claim stems from the fact that the most of SARS-CoV2 deceased are the elderly, and that the children are mostly spared from serious illness, and particularly from dying. Conclusion about reproductive decisioning based on the experience of the society in the early phase of demographic transition is at least careless and superficial.

Aim of the paper

This paper will attempt to make a rough assessment of the impact of pronatalist policy on the birth aggregate in order to make recommendations for the revision of existing birth incentive measures. Actually, there are two precise goals of the paper. First, to make an CC impact assessment on birth total in Serbia, and, second, to provide tool for indirect detecting of the potential rise or fall of the birth rate. To do so, several assumptions are needed. First, potential direct and indirect influence of death tool (number of infections) on birth total won't surpass the 'Bertillon birth effect'(BBE). If so, then we have fertility decrease of the scale that indicates population policy and state policy failure in supporting families with children. Second, every result better than expected influence of pandemic on birth total (nor BBE, neither author's predictions), may be considered as a positive fertility trend even if fertility is declining. And the third, overall socioeconomical environment in the country, altogether with birth incentive measures, may be considered as effective if the positive fertility trend will be recorded, and vice versa. Depending on results, some new fertility policy measures would be suggested.

Methodology

The main idea of this paper is to compare the regular expected number of births with number of births expected regarding death spike during Covid-19 pandemic, and also, with the number of births expected regarding number of affected population. Regular expected number of live births is calculated on monthly basis, as an extrapolation of a linear trend during past 10 years. Besides the fact that not all of the territory

of the Republic of Serbia was equally hit by the pandemic waves, births as the demographic variable are observed in total for the whole country to avoid the random variations on smaller territorial units. Time period of the direct analysis comprises all months from the epidemic outbreak in Serbia to the February 2022 as the latest month for which it is possible to estimate the number of births with the chosen methodology. On the other hand, wider time period of analysis is related to period from the year 2011 onwards. Working with monthly data pertains to the seasonality of births which display a seasonal cycle during the year. This seasonality is not neglected, and our estimate took into account a seasonal pattern of births in Serbia. When the regular birth estimate is obtained, then the Bertillon Birth Effect[1] is calculated using following formula:

$$\Delta N = \frac{n}{12} \cdot eM$$

Where ΔN is monthly change in the number of live births, n is annual crude birth rate, and eM is monthly excess mortality. Further, the only newer study (to my knowledge) testing the BBE was conducted on six case-studies ranging from 1860 to 2011. They confirmed their starting claim that the births happening 9 months after the crisis (epidemic outbreak, earthquake, financial shock, etc.) show much stronger negative relationship with the number of persons directly affected by crisis than with the excess mortality itself (Richmond and Roehner, 2018). In that case, they suggested following formula:

$$\Delta N = n \cdot Pa$$

Where Pa is the monthly number of persons directly affected by the crisis. In our case Pa would be interpreted as a total number of persons infected by SARSCoV2 during the certain month. Beside BBE model, we will use the relative monthly change in excess mortality[2] to predict the future fertility. The fact that reduction in fertility occurs 8 months[3] after the death spike is allowing us to try to predict the future fertility fluctuations on the basis of already manifested relation between the fertility and the excess mortality. Birth relation is set as:

$$N_{r,m+8} = \left| \left(\frac{R_{c,m} - 1}{3.92} \right) - 1 \right|$$

Where $N_{r,m+8}$ is the multiplier of the regularly expected number of live births during certain month, $R_{c,m}$ is percentage of mortality change 8 months earlier, and **3,92** is the average observed ratio between the mortality change during the first seven months of the pandemic and the birth change eight months later. These three time-series of the birth estimate will be compared in the purpose of detecting eventual influence of family policies.

Data and Results

Regarding the number of live births by month (Table 1), we calculated linear trends to estimate expected number of live births in the absence of any extraordinary or emergency circumstances (also by month). We will call that number of births *the regular estimate*, i.e. the number of births that should occur in the absence of CC. Having in mind that CC in Serbia started with the emergence of the first infection on march the 5th, and that pregnancy and time to pregnancy (TTP) last approximately between 9 and 10 months, then we can be sure that only live births from December 2020 onwards, are the object of influence of CC. Births that have occurred in the period from march 2020 to November 2020, surely weren't under the influence of CC[4]. Thus we come to the time period from december 2020 to ferbruary 2022 as the period of possible CC influence estimation on the number of the live births.

In December, the only observed month in the 2020, the number of live births was 5010, only 161 less than the regular prediction, but for 151 births less than BBE estimation. So we came to the conclusion that the number of births during 2020 was for 1171 small-

[1] In the wake of the influenza pandemic of 1889–1890 Jacques Bertillon, a pioneer of medical statistics, noticed that after the massive death spike there was a dip in birth numbers around 9 months later which was significantly larger than that which could be explained by the population change as a result of excess deaths. In addition, it can be noticed that this dip was followed by a birth rebound a few months later. Since that time the phenomenon was not revisited in spite of the fact that in the meanwhile there have been several new cases of massive death spikes (Richmond and Roehner, 2018).

[2] Relative change: $R_{c,m} = \frac{M,m,t}{M,m,t-1}$, for example $R_{c,m} = \frac{M,dec,2020}{M,dec,2019}$

[3] Presuming that excess deaths in one month are the result of the Covid-19 infections in the month prior, we can say that the birth collapse will occur eight months later.

[4] Only under the influence of direct mortality of women that were already pregnant, which is insignificant.

Table 1. Number of live births by month, Serbia 2011-2020.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
2011	5720	4880	4974	4729	5226	5439	6218	6187	6061	5733	5335	5096	65598
2012	5496	5050	5173	4997	5352	5360	6177	6371	6051	6242	5638	5350	67257
2013	5521	4807	5068	4646	5000	5330	6225	6151	6052	6142	5278	5334	65554
2014	5584	4692	5053	5079	5172	5795	6235	5871	5922	6093	5312	5653	66461
2015	5748	4931	5162	5204	5067	5409	6172	5657	5991	6008	5103	5205	65657
2016	5360	4832	5143	4908	4879	5019	6062	6276	6101	5964	5410	4780	64734
2017	5301	4840	5263	4816	5311	5347	5877	5878	5641	5806	5519	5295	64894
2018	5497	4792	5032	4618	5151	5271	6142	5818	5502	5720	5246	5186	63975
2019	5631	4785	5034	4997	5112	5231	6090	5784	5670	5647	5166	5252	64399
2020*	5912	4611	4882	4850	4574	5710	5820	5417	5865	5148	4946	5010	62746

Source: Demographic Yearbook of the Republic of Serbia, Preliminary data on live births and deaths in 2020, and author's calculations.

* Notice that number of births in the 2020 year differs from the currently only available preliminary data. As we have the final data for the previous years, we adjusted the preliminary data in the same way they were adjusted in the previous years, and we used following ratios between preliminary and final data on live births.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ratio	1,15	0,99	1,04	1,04	0,94	1,09	0,99	1,01	1,03	0,94	1,02	0,98

er than predicted linear decrease, from which to CC only the 161 births can be attributed. In other words, during the 2020, the CC is responsible for less than 14% of additional fertility decrease.

As our primal interest is on fertility prediction during the year of 2021, in Table 2 we will present monthly data on recorded live births, regular estimate, BBE, and author's prediction.

Table 2. Estimated number of live births during 2021 – regular prediction (RP), Bertillon Birth Effect (BBE), recorded live births (RLB), author's prediction (AP).

2021	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
RP	5621	4688	5033	4878	4866	5375	5909	5539	5622	5436	5094	5157	63218
BBE	5544	4667	5001	4774	4813	5354	5770	4267	4148	4899	4475	3813	57527
RLB/AP	5221	4384	5551	4762	4454	5600	5366	4171	5334	5383	4509	4456	59192

Source: Prelininary data on live births and deaths in 2021, and author's calculations

Discussion

The change in live birth monthly pattern in Serbia during CC so far is showing the remarkable lining with the assumptions of the BBE, author's predictions and other countries experiences that have faced pandemic waves in the similar ways as Serbia did (Figure 1).

Countries as Croatia, Hungary, Slovenia, and Bulgaria showed similar pattern of epidemic waves and related short-term fertility fluctuations (Sobotka et al, 2021). For example, Hungary, which have similar epidemic experience, but also similar generous population policy measures, recorded fertility decline of -1.4% during the first part of year 2021, remarkably similar as Serbia did (-1.9%) (Figure 2).

Across 17 countries with lower fluctuations in births, the number of births fell on average by 6.5% in December 2020 and 8.9% in January 2021 when compared with the same month of the previous year. Related declines in Serbia were 3.1% and 7.1% respectively. Spain sustained the sharpest drop in the number of births among the analyzed countries, with the number of births plummeting by 20% in December 2020 and January 2021 (Sobotka et al, 2021). Wilde et al. (2020) projected that births would start dropping in November 2020 and this fall would accelerate until February 2021, with about 15% fewer births expected compared to October 2020 (-12.4% in Serbia). The CC is likely to have a variety of short, medium, and long-term consequences for society that may vary across nations in accordance with governmental responses and other health and social policies. Having in mind that available fertility data reflect only to the first half of the 2021 year, and that related death spikes presented only 7.3% ex-

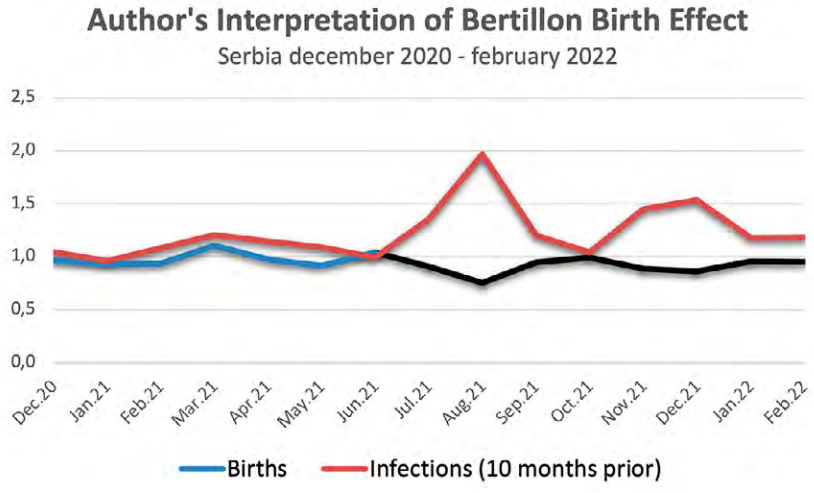


Figure 1. Recorded and estimated quantity and direction of ratio of births to infections

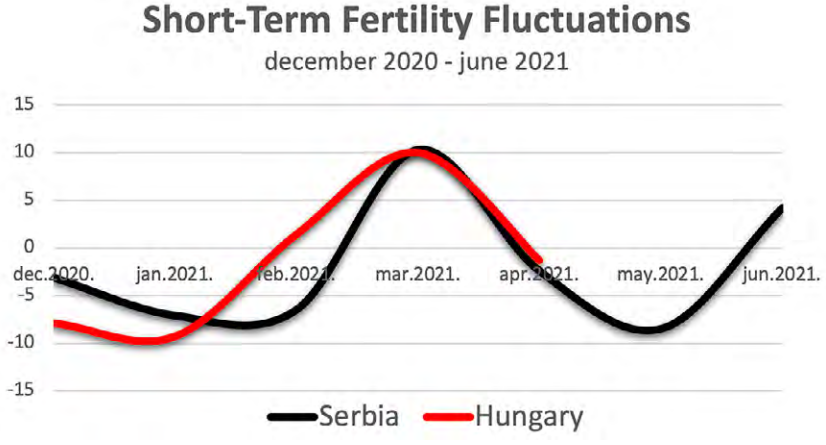


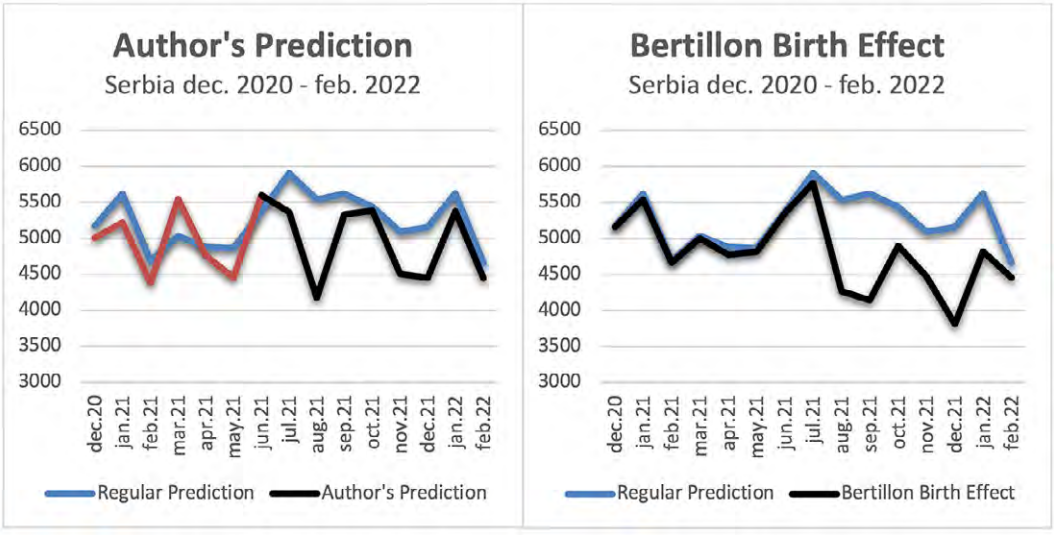
Figure 2. Ratio of recorded to expected monthly number of live births

cess mortality, it is obvious that baby-bust is yet about to happen during the following months. Excess mortality in Serbia started to rise seriously from October 2020, and during following 6 months amounted 36% on average. This five-fold increase of excess mortality surely will have tremendous negative effect on number of live births during the second half of this calendar year. In other words, so far, from January to June, number of births fell only by 1.6%, but we may expect that fertility decline during second half of this year will reach about 10.8% according to the author's methodology, and even 16.4% according to BBE methodology. Whatever turn-out to be closest to reality, we may expect that total number of the live births during 2021 in Serbia will be from 6.4% to 9.0% lower than expected.

The difference between these two methodologies stems from their assumptions. First, BBE methodology presumes that the effect on number of live births is negative all the time during the existence of the excess mortality (with time lag of 9-10 months), which the previous fertility experience of developed countries during CC has denied. And second, author's presumption that epidemic waves produce similar short-term fluctuations of fertility. In other words, excess mortality and number of exposed persons (number of newly confirmed infections) produce the opposite effect on number of births with a time lag of 9-10 months. For example, when number of newly confirmed infections is falling, and epidemic is slowing, then people "unlock" their fertility plans, and we have birth recovery 9-10 months later, and vice versa, when number of infections is rising then people put their fertility plans on hold, and we have the fertility shrinkage 9-10 months later.

Finally, as a result of different presumptions of these two methodologies, we have different dynamics of expected fertility decline, and different estimation of amount of fertility loss due to CC (Figure 3a and 3b). According to BBE methodology we will face the lack of 5.7 thousand of newborn until the end of the year, and according to newly presented methodology, we could face smaller lack of babies amounting close to 4 thousand babies less than expected.

Various studies on European and USA populations have confirmed an immediate and sudden decline in



Figures 3a and 3b. Estimation of CC related fertility decline

fertility due to CC, with the 9-10 months lag (Sobotka et al, 2021; Luppi et al, 2020; Berger et al, 2021; Wilde et al, 2021). This fertility decline is driven by many potential channels - marriages were postponed, younger people and couples living apart had fewer opportunities to meet, families struggled to accommodate to home schooling, channels of childcare were often interrupted for long-time period, family planning strategies were changed, unemployment was on the rise, feel of uncertainty was overwhelming, etc. In the end, the expectations about the income have dominant influence on reproductive decisions. The more individuals expect their income in the future to be insecure due to the current economic crisis, the greater might be the probability that their fertility plans will change (Luppi et al, 2020).

Here we come to the role of the state social and family support system. In countries with smaller labor market shocks, and diverse and generous social and family support measures, fertility decline was less sharp. Tragically, the countries with traditionally unbalanced labor markets, weak work and family reconciliation, strong role of grandparental childcare, and already poor fertility rates, experienced greatest fertility decline (Luppi et al, 2020; Berger, 2021). In order to estimate future fertility shock, some researchers analyzed Google Search Trends (Wilde et al, 2021; Berger, 2021), and they found that long-term effect on fertility shouldn't be large. Wilde et al (2021) based their claim of 15% fertility decline on the predictions of employment decrease, but the direct, fertility related, search haven't showed much of the decline. On the other hand, findings of Berger et al (2021) show that shock on searches about pregnancy test, abortion, and family planning was temporary and vanished 2-3 months after the outbreak, suggesting that significant changes in overall fertility intentions are not very likely. However, searches about union formation, relationships and weddings show steep decline with no sign of full recovery so far. To the extent that trends in union formation parlay into subsequent trends in fertility, this may suggest declines in near-term first-birth fertility. Having in mind the fall of first-time marriages in Serbia during 2020 for 35%, and traditionally high share of shotgun[5] marriages, we may expect substantial fall in the number of the live births during the year of 2021. Additionally, delaying of the first marriage and first birth will have severe consequences on frequency of conception problems in Serbia (Vasić, 2021).

Conclusion

The pandemic will cast a long shadow on birth trends in Europe throughout the whole year 2021 and probably beyond (Sobotka et al, 2021). Economic and labour market uncertainty are likely to continue exerting negative pressure on fertility plans, even if the waves of infection eventually subside. Current economic performance of Serbia doesn't provide much to make the rapid, V-shaped baby boom likely in the near future. Disadvantaged position of young adults, high gender inequalities, and dysfunctional labor market, as in the rest of the Southern, Eastern and South-Eastern Europe, in the absence of the carefully rethinked fertility policy measures, even with high financial assets, will surely yield the long-lasting fertility depression for Ser-

[5] Marriages where the bride is already pregnant in the time of the wedding.

bia. Our results suggest that the number of live-births is likely to decrease for 6.4% - 9.0%, or 4000 to 5700 live births less than expected. It will be a matter of the pro-family environment if the fertility decrease will be less profound. Opposite, if the fertility decline will be larger than suggested, than is very likely that Serbian fertility policy is totally missing the point.

Some of the recommendations regarding fertility and family policies are related to the significance of supporting the earlier parenthood through the several channels. First, recognizing the need for earlier parenting through the specific goals of Birth Incentive Strategy, Strategy of the Public Health, and National Program for the Promotion and Preservation of Reproductive Health. And, second, to incorporate marriage support as a significant part of family policies. The fact that reproductive process sovereignty of the marriage is shrinking is true, but many aspects of social, health, safety, and overall wellbeing characteristics of the formal marriage are the reasons why it should be supported as a predominant reproductive unit based on, and responsible for, the reproduction itself.

CC put tremendous challenge for family and fertility policy through the further birth and marriage postponement, acceleration of fertility decline, and the urge for introducing the principles of *specificity, flexibility*, and *timeliness* as main bedrocks for Serbian fertility policy.

Acknowledgement

The paper was written as the part of the research program of the Faculty of geography – University of Belgrade for 2021, supported by the Ministry of education, science and technological development of the Republic of Serbia.

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CHANGES IN THE ETHNIC COMPOSITION SETTLEMENTS OF KOSOVO AND METOHIJA FROM 1961 TO 2019

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Abstract

Kosovo and Metohija, the South Autonomous Province of the Republic of Serbia, the center of the Balkan Peninsula, is a unique geographical area in Europe, during which the most complex demographic processes, caused by: political conflicts, the NATO bombing of 1999, took place and took place during the 20th century and the first decades of the 21st century: killing, ethnic cleansing, persecution and segregation of the population. After 1999, 323,000 people were displaced from Kosovo and Metohija, most of them Serbs, followed by Montenegrins, Roma, Ashkali, Croats. Today in Kosovo and Metohija, in the so-called Serbian enclaves live about 130,000 Serbs in 38,000 households. Demographic surveys indicate and confirm that in the early 1960s and during the 1970s a major change was made in the ethnic composition of the settlements in Kosovo and Metohija. Analyzes of the Census in Kosovo and Metohija from 1961 to 2011 indicate that, from the aspect of ethnicity settlements inhabited where Serbs, Montenegrins, Albanians, Muslims, Turks, Roma, Ashkali, Croats, Turks lived together. Previously, heterogeneous settlements became ethnically homogeneous with a dominant Albanian population. The emergence of changes in the ethnic composition of settlements in Kosovo and Metohija over the last six decades indicates the emergence of spatially demographic polarization, which is not known to this day in the world.

Keywords: population, settlements, Kosovo and Metohija

Introduction

Demographic and ethnic processes in Kosovo and Metohija during the second half of the 20th century concentrate, homogenize and polarize those manifestations and characteristics of development population typical of the Balkan countries of conflicting ethnic communities.

Thus, the process of demographic transition among Serbs in Kosovo and Metohija has ended in the late 1960s and early1970s, while the Albanian population, by rapidly reducing mortality and maintaning high brth and fertility rates only then did it enter the frst phase of the demographic transition marked by the highest biological reproduction and the lowest mortality in Europe.

Through the cooperation of demographic and the political goals of the Albanian secessionist movement comes to a systematic pressure on the emigration of Serbs and other ethnic communities from all settlements of Kosovo and Metohija. Thus, the forced homogenization (Albanianization) of Kosovo and Metohija has reached the absolute highest level in recent times in the entire previous ethnic and demographic history of this province.

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Ethnic changes in settlements in Kosovo and Metohija from 1961 to 1991

The population of Kosovo and Metohija has been growing steadily in the second half of the 20th century. Not all ethnic communities have participated equally in increasing Kosovo's population. While the Albanian population had all the characteristics of a population boom, the Serb and other non-Albanian populations were in regression (Radovanović, 2004).

Table 1. Number of settlements where lived Serbs and Albanians during Censuses 1961-1991.

Census	1961.	1971.	1981.	1991.
Number of settlements in which Serbs lived	1.089	883	841	790
Number of settlements with an absolute majority of Serbs	393	325	302	270
Number of settlements in which Albanians lived	1.100	1.246	1.243	1.300
Number of settlements with an absolute majority of Albanians	992	1.063	1.082	1.100

Source: Statistical Office of the Republic of Serbia

The results of the 1961 census show that Serbs lived in 1.089 settlements in Kosovo and Metohija, where they were the absolute majority in 393 settlements (27% of the total number of settlements), and in 148 settlements only they lived, which is more than 10% of the total number of settlemets. Albanians had an absolute majority in 992 settlements, while in 59 settlements these two peoples did not an absolute majority, or some third nation had it (Gorans, Croats, Muslims).

The 1971 census records that Serb lived in 883 settlements, which means that they did abandoned or became extinct in 206 settlements in the 1961-1971 inter-census period years. They had an absolute majority in 325 settlements, which means that they lost it in 68 settlements in this one period. Albanians lived in 1.246 settlements, while the absolute majority was 1.063 settlements (71 settlements more than 1961).

During the 1981 census, 16 settlements appeared that did not exist during the 1961 and 1971 censuses, in which some hamlets were declared villages such as Kijevac, Klečak, Ledenik, Štuoc and Zagrađe (Kosovska Mitrovica), Košutica (Leposavić) and Lipovica (Lipljan), in which only Serbs lived. In 1981, Serbs lived in 841 settlements, which means that they left 42 settlements. They had an absolute majority in 302 settlements, and compared to the 1971 census they reduced the majority to 23 settlements. They are Albanians lived in 1.243 settlements (three less than in 1971), and were the absolute majority in 1.082 settlements (19 more than in 1971).

It should be emphasized that the 1991 census boycotted the entire Albanian, part of the Roma and part of the Muslim population. Thus, we are forced to estimate the number of settlements in which Serbs and Albanians lived and in whom they were the absolute majority. That is how the Sers were in 1991. year lived in 790 settlements, which is 51 settlements less than in 1981, while the number settlements with an absolute Serb majority amounted to 270 or 32 settlements less than in 1981. years. The number of settlements inhabited by Albanians was 1.300, which is settlements 57 more than n 1981, while the number of settlemets with an absolute majority of Albanians was 1.100, which is 18 more than in 1981.

Ethnic changes in the settlements of Kosovo and Metohija after 1999

After the end of the aggression against the Federal Republic of Yugoslavia in June 1999, organized terror of the Albanian population over the Serb and other non-Albanian population resulted in forced migration movements of Serbs, Montenegrins, Roma, Ashkali, Egyptians into central Serbia and Montenegro, which completely disrupted ethnic structure of the Province. Today, twenty years after the end of the aggression and the entry of international forces into the territory of Kosovo and Metohija, there is still speculation about the total number of population as well as the ethnic structure of the population. The information obtained from the 2011 census may be considered irrelevant (Milosavljević & Punišić, 2011). Their irrelevance is reflected, first and foremost, in the quantitative values that determine the ethnic composition of the population, especially the Serb community, which boycotted the census in all four municipalities in the north of the province, while Serb turnout in the areas south of the Ibar River was below 50%. During the census, the Serb population was exposed to threats, pressures and blackmail (Medojević & Milosavljević, 2019).

Based on the results of the census, the most numerous ethnic communities in Kosovo and Metohija were

Table 2. Ethnical structure of population (by municipalities) of the Autonomous Province Kosovo and Metohija by Census 2011

Municipality	Albanians	Serbs	Others	Total
Dečani	39.402	3	614	40.019
Đakovica	87.672	17	6.867	94.556
Glogovac	58.445	2	84	58.531
Gnjilane	87.814	624	1.740	90.178
Dragaš	20.287	7	13.703	33.997
Istok	36.154	195	2.940	39.289
Kačanik	33.362	1	46	33.409
Klina	37.216	98	1.182	38.496
Kosovo Polje	30.275	321	4.231	34.827
Kosovska Kamenica	34.186	1.554	345	36.085
Kosovska Mitrovica (southern part)	69.497	14	2.398	71.909
Kosovska Mitrovica (northern part)	-	-	-	-
Leposavić	-	-	-	-
Lipljan	54.467	513	2.625	57.605
Novo Brdo	3.524	3.122	83	6.729
Obilić	19.854	276	1.419	21.549
Orahovac	55.166	134	908	56.208
Peć	87.975	332	8.143	96.450
Podujevo	87.523	12	964	88.499
Priština	194.452	430	4.015	198.897
Prizren	145.718	237	31.826	177.781
Srbica	50.685	50	123	50.858
Štimlje	26.447	49	828	27.324
Štrpce	3.757	3.148	44	6.949
Suva Reka	59.076	2	644	59.722
Uroševac	104.152	32	4.426	108.610
Vitina	46.669	113	205	46.987
Vučitrn	68.840	384	646	69.870
Zubin Potok	-	-	-	-
Zvečan	-	-	-	-
Mališevo	54.501	-	112	54.613
Junik	6.069	-	15	6.084
Mamuša	327	-	5.180	5.507
Đeneral Janković	9.357	-	46	9.403
Gračanica	2.474	7.209	992	10.675
Ranilug	164	3.692	10	3.866
Parteš	-	1.785	2	1.787
Klokot	1.362	1.177	17	2.556

Source: Statistical Office of Kosovo

Albanians with 1.616.869 inhabitants, which participate with 92,9% of total population of Kosovo and Metohija. The majority of the population was Albanian in all municipalities, except eight municipalities (four in northern Kosovo and Metohija: Leposavić, Zubin Potok, Zvečan and northern Kosovska Mitrovica and four newly formed municipalities: Mamuša, Gračanica, Ranilug and Parteš). An equal number of Albanians and Serbs were in the municipalities of Novo Brdo, Štrpce and Klokot (Milosavljević & Medojević, 2020).

The number of Serbs in this census was only 25.532 with participation of 1,5% in the total population. However, the Serbian population in the area of Koso-

vo and Metohija is much larger and therefore its participation in the total population is larger. The estimated number of Serbs in the four municipalities in the north of the Province is 60.000, while in the interior of Kosovo and Metohija there are more than 50 ethnically purely Serb or mixed settlements in which Serbs are represented in significant numbers (Medojević & Milosavljević, 2015).

About 40.000 Serbs live in central Kosovo. Thus, the Serbian settlements in the municipality of Vučitrn: Gojbulja, Prilužje and Grace. The Serb enclaves in Priština municipality are: Gračanica, Laplje selo, Čaglavica, Badovac, Preoce and Sušica. In the municipality of Obilić, it is Plemetina, and in the municipality of Kosovo Polje: Batuse, Ugljare, Bresje and Kuzmin. The Serb enclaves in Lipljan municipality are: Dobrotin, Livađe, Donja Gušterica, Gornja Gušterica, Suvi Do, Staro Gracko and Novo naselje. Prekovce is a Serbian enclave in Novo Brdo municipality. About 2.100 Serbs live in the Metohija settlements (the Goraždevac enclaves near Peć and Velika Hoča near Orahovac). In the municipality of Istok these are: Osojane, Crkolez, Dobruša, Banja, Ljubovo and Žac. Banja and Suvo Grlo are enclaves in Srbica municipality, and Vidanje in Klina municipality. Kosovo's pomoravlje is home to 35.000 Serbs. Thus, in the municipality of Gnjilane, the Serb population lives in the villages of: Šilovo, Pasjane, Parteš, Koretište, Donja Budriga, Stanišor, Kusce, Straža, Kmetovce and Poneš, and in Kosovska Kamenica in the villages of Ranilug, Ropotovo and Donje Korminjane. In the municipality of Vitina in the villages: Klokot, Vrbovac, Trpeza, Požaranje, Novo selo, Žitinje and Binač. In the far south of the AP Kosovo and Metohija, about 12.000 Serbs live in the Šara-mountain enclaves. They are located in the municipality of Štrpce in the following villages: Berevce, Brezovica, Viča, Vrbeštica, Gotovuša, Donja Bitinja, Drajkovce, Jažince, Sevce and Sušiće (Milosavljević, 2013). Demographic data indicate that there are currently approximately 149.100 Serbs in the entire area of Kosovo and Metohija, accounting for about 8,5% of the total population.

Conclusion

The analysis of changes in the total population movement of the AP Kosovo and Metohija, during the second half of the 20th century, indicate a constant increase of the population. At the same time, with the increase of population, there are changes in the ethnic structure. The Albanian population is constantly increasing, while the Serb population is declining. How much the number of settlements in which Serbs lived or in which they seemed absolute decreased most by so much the number of settlements in which they lived or worked increased mostly Albanians. Since June 1999, due to organized Albanian terror against Serbs and other non-Albanian populations, an exodus of about 320,000 people has occurred. The Serb population was expelled from all urban areas while a smaller number was held in rural areas, making up the so-called Serb enclaves. Population in 183 settlements, four municipalities in the north Kosovo and Metohija today is about 60.000, while in about 50 Serbian enclaves, concentrated in Metohija, central Kosovo, the Šara Mountain and Kosovo Pomoravlje, about 149.000 Serbs still live.

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GIS ANALYSIS OF BEACH AREAS

Evgeniy Sergeevich Boyko[A], Tatiana Alexandrovna Volkova[A]

Abstract

The modern development of technologies of remote sensing data processing has greatly simplified the production of high-precision spatial data. Because of the work on grants of the Russian Foundation for basic research № 18-05-00333, 19-45-230004 in 2018-2019, several Digital maps was made of areas of the shores of the Black and Azov seas. Distal Dolgaya spit is a specially protected natural area, a natural monument of regional importance «Dolgaya Spit». That spit Dolgaya today is the basis for the development of local tourist and recreational complex of the city Dolzhanskaya. The beach of the Arkhipo-Osipovka city and wild beach camping Nazarova Dacha, Black Sea were investigated to compare the nature of the development of the territory and testing methods of coastal strip mapping. The territories were classified according to the type of use and anthropogenic impact. The areas of the selected zones and the assessment of the state of nature of the study area were determined.

Keywords: South of Russia, Black Sea, Sea of Azov, coastline, remote sensing, GIS analysis

Introduction

The shores of the Black and Azov seas are subject to active human economic, tourism and recreation activity. There is a development of tourist and recreational load on the seashores, as well as the construction and development of ports that form a completely different approach to the use of these territories. Assessment and control of environmental management is possible using geo-information analysis methods and modern methods of obtaining spatial information. Modern technologies for aerial photography and remote sensing data processing make it much easier to obtain high-precision spatial data. As a result of work on grants of the Russian Foundation for basic research № 16-45-230321, 18-05-00333, in 2018, several surveys of sections of the shores of the Black and Azov seas were performed.

This article discusses the use of geo-information methods in three coastal areas (Figure 1).

They are Dolgaya Spit, accumulative education, the Azov Sea, the beach of the city of Arkhipo-Osipovka and wild beach camping Nazarova Dacha, Black Sea.

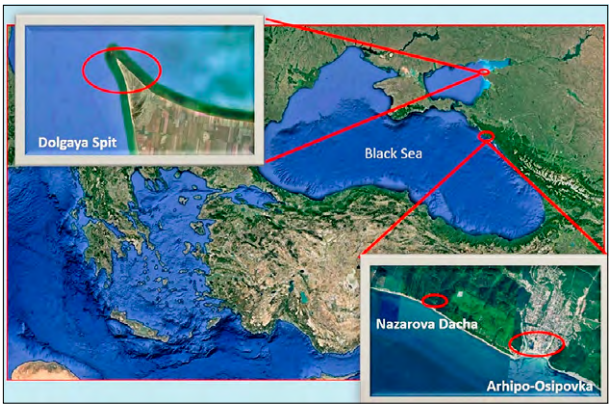

Figure 1. Research areas

Methods

Based on the obtained aerial survey data, performed in 2018 and 2019, high-precision models of the terrain and terrain of the studied territories were built. The number of images for the Dolgaya Spit was 126. The shooting was carried out in manual mode due to strong winds. The overlap between images allowed for further processing.

In addition to shooting the Dolgaya spit, this study examines data obtained in 2019 with photo fixation

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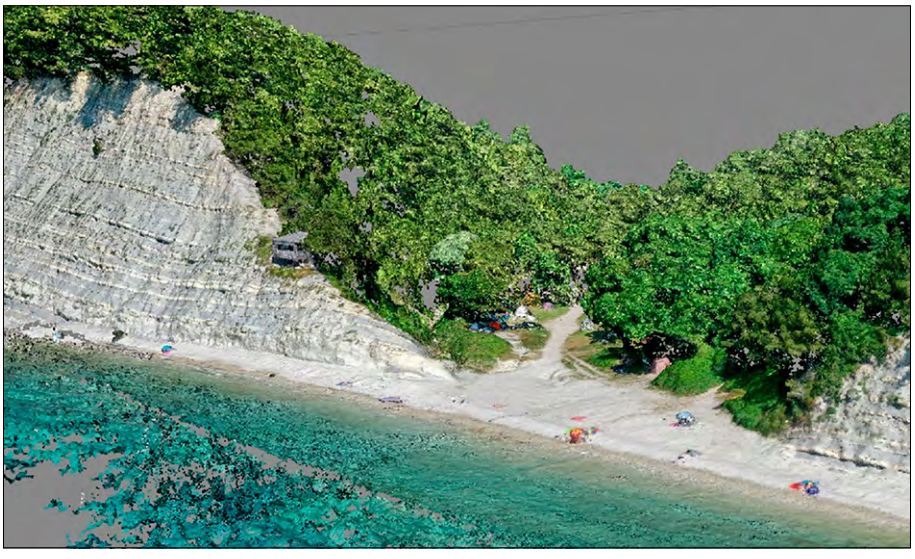

Figure 2. Three-dimensional points model of the beach camping Nazarova Dacha

of the area of the city beach of Arkhipo-Osipovka (86 images with a resolution of 2.5 cm) and the beach of the camping Nazarova Dacha (66 images with a resolution of 2-3 cm), located 5 km from the city of Arkhipo-Osipovka. The city beach was photographed from a height of 150 m along routes with a longitudinal overlap of 75% of the images and an overlap between routes of at least 55%. The area of interest was limited to 200 meters of coastal strip. A special feature of the geodetic survey of Nazarova Dacha beach was the use of a combination of Nadir and perspective photography to obtain a model of a coastal rock more than 60 m high with a steep slope of 55-75 degrees.

Agisoft PhotoScan used for image processing, which allows us to create three-dimensional models of objects based on two or more digital images automatically. The image processing process is fully automatic and does not require pre-calibration of cameras or manual image marking.

During the data processing process, three projects were created, for each of which dense point clouds were built (Figure 2). These photogrammetric point clouds are similar to laser reflection point clouds, and their processing methods are identical. Based on them, a digital elevation models and a digital terrain models were built. Then were built textured models and orthophotos.

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Using the QGIS geo-information package, maps of the study areas were compiled using the data obtained, highlighting the same type of economic use zones and determining their area. For the section of the city beach of Arkhipo-Osipovka, vacationers on the beach and in the water were digitized. An attempt was made to assess the capacity of the equipped beach and adjacent territories and analyze the recreational load at the time of surveying.

Results

The result of the research and geo-information modeling was the creation of three-dimensional models and thematic maps of three areas of the Black and Azov seas beaches.

Based on aerial surveys, three-dimensional point models with the following characteristics were obtained. For the Dolgaya Spit area (Figure 3), the number of tie points is 81,111. Then, based on the calculated camera positions and the photos used, a dense point cloud was constructed. The total number of obtained points in dense clouds is 54 912 407. The city beach of the city of Arkhipo-Osipovka, the number of tie points is 107 411, the number of dense cloud points is 71 076 142. For the Nazarova Dacha beach camping, the number of tie points is 110 233, and the dense cloud received 8 523 072 points.

Table 1. Distribution of areas of different types of terrain in the study areas

Type of terrain	Dolgaya Spit, Area, %	Urban beach city Arkhipo-Osipovka, Area, %	Beach camping Nazarova Dacha, Area, %
Beach	16.1	11.7	12.3
Equipped beach	9.0	6.8	-
Fortified beach	0.5	3.0	-
Buildings	41.7	27.2	1.2
Roads	5.0	4.1	2.3
Parking	11.9	-	8.7
Vegetation and Parks	12.8	25.3	59.9
Aquapark	-	12.9	-
Promenade	-	9.0	-
Camping	3.1		15.6
Total	100	100	100

After recognition and vectorization, detailed maps of the study areas were compiled.

The obtained models were decoded, various types of terrain were identified depending on their use and natural features, and their area was determined (Table 1).

The map of the city beach of Arkhipo-Osipovka with tourists (Figure 3) was obtained as a result of processing survey data, decoding and vectoring a three-dimensional model. Based on the results of spatial analysis of the models of the studied territories, it was possible to establish the nature of economic use of the territories, compare the areas occupied for recreation and tourism, and estimate the capacity and congestion of the beach area in three different places.

For the city beach of the city of Arkhipo-Osipovka, the number of people on the open beach, the number of places on sun beds under canopies and umbrellas, and the number of people in the water were calculated. Decoding was performed on a model with a spatial resolution of 3 cm. on such a model, both direct signs of decoding-color, shape, texture, and indirect signs, such as the shadow and relative position of objects, are clearly distinguishable. The potential capacity of the beach, which is 700 meters long, was about

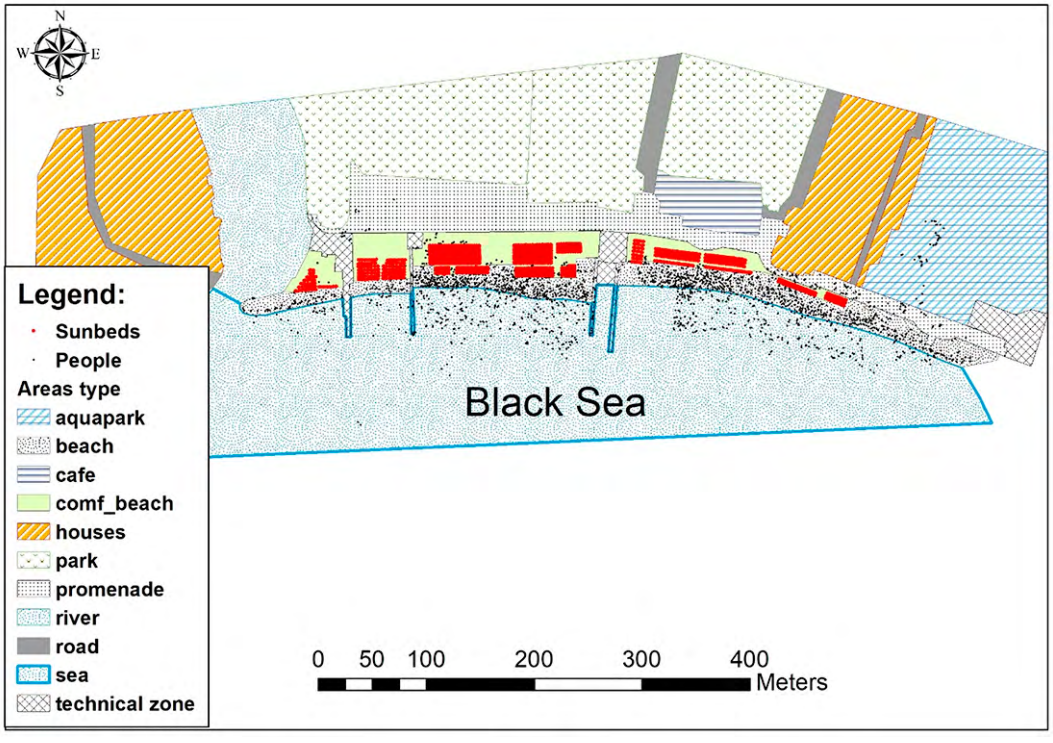

Figure 3. The city beach map of Arkhipo-Osipovka

5,000 people, equipped with sun loungers under canopies and umbrellas for 2210 seats.

In fact, at the time of the shooting, 2,021 people were present on the open beach, 689 of them were in the water. Using indirect signs, you can calculate the number of people who used sun beds under canopies and umbrellas. Their number does not exceed 600 people. So, on the date of the shooting, June 8, the occupancy rate of the beach was about 2621 people or 52.5%, which is the average at the beginning of the season.

Conclusions

Ultra-high resolution data allows you to determine not only the natural features of the beach, but also the number of tourists at the time of shooting, the equipment of the beach infrastructure and amenities, compare the load of different beaches and identify areas for optimizing the management of the coast. Three-dimensional models based on UAV data allow us to assess the visual and aesthetic potential of the studied territory, as well as anthropogenic objects located on it. Three-dimensional mapping and modeling is an important research tool, especially for beach areas located at the intersection of multidirectional surfaces. An additional advantage of using three-dimensional models in the analysis of beach areas is the possibility of predictive modeling of the development and development of emergencies, which is important for ensuring the safety and convenience of tourists.

Given the high dynamics of development of the Long spit, the area allocated for protected areas is very small today. Construction, Parking (actually natural), strengthening of the Azov sea beach (very inefficient) negate the protective function of specially protected natural areas. Thus, it is possible to observe negative consequences caused by natural and anthropogenic processes: on the one hand, the natural morphodynamics of the spit, on the other-the spontaneous development of tourist and recreational activities on the borders of specially protected natural territories lead to the gradual loss of the natural monument.

The territory of the city beach of Arkhipo-Osipovka is 100% urbanized and is in a stable state. The distribution of recreational facilities in the 200-meter coastal strip is shown in Table 1. Further development of the territory may be associated with improving the quality of services provided and the development of the service sector.

The territory of the beach camping Nazarova dacha is in the initial process of development due to its geographical features and has a certain recreational potential. In our opinion, it is important to control the processes of development and compliance with environmental and sanitary norms and rules in this territory.

The use of GIS technologies in the study of beach tourist and recreational complexes allows you to accurately analyze the processes characteristic of these natural and economic complexes and reflect the consequences of these processes.

Acknowledgement

The work was supported by the Russian Foundation for basic research (Grant no. 16-45-230321, 18-05-00333)

USE OF GIS TO DETERMINE MODELS OF EROSION PROCESSES IN RIVER BASINS

Branko Ristanović[A], Đurđa Miljković[A], Marija Cimbaljević[A], Miloš Ostojić[A], Aleksandar Popović[B], Boban Radulović[C], Dragana Milošević[D]

Abstract

Inadequate management of water resources may generate various potential geohazard risks. In order to resolve potential risks, significant anthropogenic capacities need to be engaged, such as: human, material and financial. Fluvial erosion and soil erosion control are among the major problems that occur within an integrated water management system. These natural processes can be accelerated due to certain human activities: agricultural production, civil engineering and mining. Is there a comprehensive approach that would identify the problems at the early stages and minimize the necessary actions? The application of the geographic information system within the modified Gavrilović model represents a step further towards systematic monitoring and regulation of watercourses in different parts of the basin. This case study provides an example of the early detection of hydrological problems that can occur in a river stream and a proposal for the solutions that would impose as the logical causality based key. The Likodra river basin is a representative example of the application of GIS for the early detection and prevention of current water problems.

Keywords: GIS, Gavrilović method, erosion processes, Likodra, West Serbia

Introduction

The territory of the Republic of Serbia has serious issues regarding the immense destruction of rocks and accelerated soil erosion. Several million hectares of land are endangered, large areas of productive soil have been destroyed, and many settlements, infrastructure and heritage have been jeopardized. 11,500 waters courses with the torrential regime have been registered in Serbia by the end of 2018. Torrential floods occur as the most frequent phenomenon within the geohazard risk group (river floods, droughts, landslides and rockfalls, large forest fires, etc.). Erosion processes, as an important factor in torrential flood formation, occur in 75% of the territory of Serbia, with an average annual production of erosion material of 30,000,000 m^3. A total of 8,000,000 m^3 of eroded material is transported to the river and stream beds (the main cause of large quantities of mud and stone in flooded settlements during 2014 floods). In the period 1950-2018, the floods in Serbia claimed 80 lives and caused material damage of several billion euros. The frequency of torrential floods, their intensity and distribution remain a permanent threat that may impose significant consequences on ecological, economic and social spheres. The destructive aftermath of the devastating torrential floods in Serbia in May 2014 could have been considerably lowered if flood protection works and preventive measures had been applied for the past twenty years.

Numerous erosive models have been developed, most of them based on a combination of a short-term measuring and a mathematic formula, for rapid and simple quantification of erosive processes in the riv-

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er basins. Those models, so-called empirical models, are based on either correlation of the bound variables from the set of the measured ones or on the estimate of the independent variables by means of regression analysis (Staut, 2004, 10).

The methods for the analysis of erosion intensity in the river basins were developed in the late 1940s and 1950s. The first empirical models of soil erosion were suggested by Cook (1936), Zingg (1940) and Smith (1941). Polyakov (1953) proposed the analytical expression with two parameters (mean annual turbidity of water and the river basin slope inclination), through which he determined the coefficient of erosion development. Those parameters should be measured on a regular basis on the terrain and for that reason, this method is not used extensively. Herheulidze (1947) suggested four categories that served to describe the degree of erosion in torrential stream basins. The data on the slope inclination and geological parameters of deposited materials are required for this categorization. Also in 1947, Browning suggested a relative erosion factor as the measure of soil loss due to water erosion. Silvestrov (1955) brought forward the analytical equation for the determination of the "erosion coefficient" (E). The parameters which refer to land utilization and relief are needed for this equation. Moreover, there was a renowned American erosion model USLE (Universal Soil Loss Equation) developed by Wischmeier and Smith (1965) on which modern empirical models were based (for example, the revised USLE).

The most widespread model in the West Balkan is the Gavrilović equation (1962, 1970, 1972) and its modifications (Lazarević, 1968; 1985; Pintar et al., 1986, Ristanović, 2018) which are similar to the USLE model (Mikoš et al. 2006, 205). The advantage of this model (Gavrilović, 1994, 327) is the fact that it was not only intended for calculation of soil erosion of arable land (the USLE method was developed for that purpose) but it was also developed for hydrological regulation of the water courses and calculation of soil erosion, regardless the utilization of the land. Based on previous theoretical works, Gavrilović (1962, 156, 1970, 93, 1972, 112) developed a method for the analytical determination of erosion coefficient and erosion quantification and the average annual amount of deposit. Gavrilović (1976) prepared detailed tables for the determination of parameters by means of extensive fieldwork research on the river Morava, as well as, by experimental work in the laboratory.

The Gavrilović empirical and semi-quantitative method for erosion and sediment yield explicitly combined erosion and components that impact the sediment accumulation. This model was first developed for application in torrential basins of south and southeast Yugoslavia but successfully applied in other countries, i.e. Switzerland and Italy (Bazzoffi, 1985 and Beier Portner, 1998). The Gavrilović model was applied on two Mediterranean basins in Slovenia and Croatia (Globevnik et al, 2003). The model was also used for estimating gross erosion in a large river basin in Greece (7,000 km^2) (Emmanouloudis et al, 2003.). The predicted annual degradation of the basin was relatively high compared to the results of the study applied on some of the sub-basins. Globevnik et al (2003) and Emmanouloudis (2003) demonstrated the Gavrilović model application by using spatially distributed input data on geology, soil and use of soil in GIS environment.

The Gavrilović method was widely used in Slovenia and Croatia for the last 30 years. At first, it was used for predicting the erosive processes, regulating torrential streams and performing other activities in order to control fluvial erosion (Gavrilović, 1988; Globevnik et al., 2003, 225). Ristanović (2018) modified the Gavrilović model by introducing GIS into its quantitative calculations and implementation. The modified method was again applied in Serbia, in the basin of the river Likorda (Western Serbia).

Research methods

The quantitative parameters of the Likodra river basin were calculated based on a digitized topographic map (a 1:25,000 scale) and the completed digital elevation model, combined with field observations. ARC GIS software was used for the processing of morphometric indicators. The modified empirical Gavrilović model of parameter tables (Gavrilovic et al., 1983, Ristanovic, 2018) was used for calculating the strength of the erosion process. The relief genesis of the Likodra river basin was determined and hydrological problems therein were identified based on the synthesis of existing domestic and foreign literature, fieldwork research and morphometric analysis of the digital elevation model. Due to the uniformity of the GIS model, the obtained results will enable monitoring of the basin and the watercourse characteristics and compare them with previous conditions.

Geographical position and characteristics of the basin

Micro-region Rađevina is in the west part of the Republic of Serbia. Rađevina is a small area which many researchers classify within a larger area – Jadar to which the basin of the river with the same name corresponds.

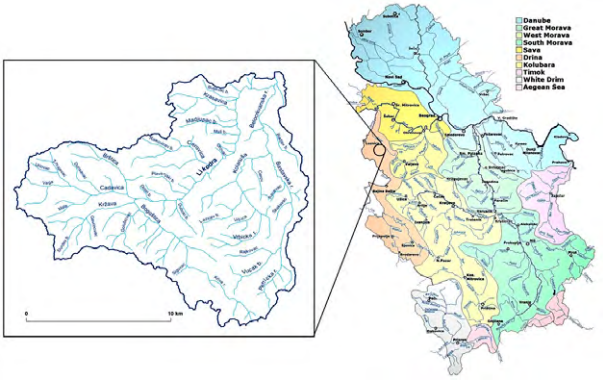

Figure 1. Geographical location Likodra basin in Serbia
[click on figure to enlarge]

The river Likodra is the biggest left tributary of the river Jadar. It is formed in Krupanj as a confluence of two channels formed by the Bogoštica with the Kržava and the Čađavica with the Brštica. On the south and south-west side, the mountains Jagodnja and Sokol with their peaks Mačkov kamen (elevation 923 m) and mountain Rožanj (elevation 971 m) divide the river Likodra basin from the river Drina basin. The east part of the basin has common borders with the Pecka river basin. The length of the river Likodra, from its forming point in Krupanj to its mouth where it empties into the Jadar river is 17 km and it is the longest tributary of the river Jadar. The Likodra river is the largest river in Rađevina with the surface of its basin of 212.5 km².

The Likodra river basin is morphologically formed by tectonic and geotectonic processes, respectively. The confluence of the rivers which form the Likodra river is in Krupanj and from there on there is the broader part of this river valley (the length of 6.5 km) up to its turning point, the meander after which it flows into the 3 km long canyon. At the canyon exit point, the Likodra river runs through the wide valley up to its mouth where it empties into the Jadar river. The features of the Likodra river course contribute to the composite character of its valley.

Geographical monitoring and quantitative indicators (hydro-climate) demonstrate that fluvial erosive processes in the Likodra river basin are highly intensive. Their amount is increased by high water levels and torrents that emerge after stronger precipitation. Torrents occur frequently on the territory of Rađevina. The indirect basin of the Likodra river comprises 30 torrential streams. The area of the catchment is 196.90 km², which represents 57.6% of the total area of the municipality, i.e. the part of the municipality exposed to torrential streams and natural hazards caused by them (torrential floods, landslides, slumps, rock falls).

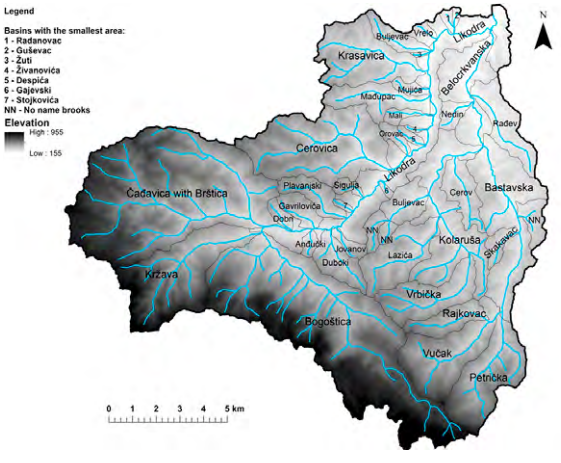

Figure 2. Relief of the Likodra river basin
[click on figure to enlarge]

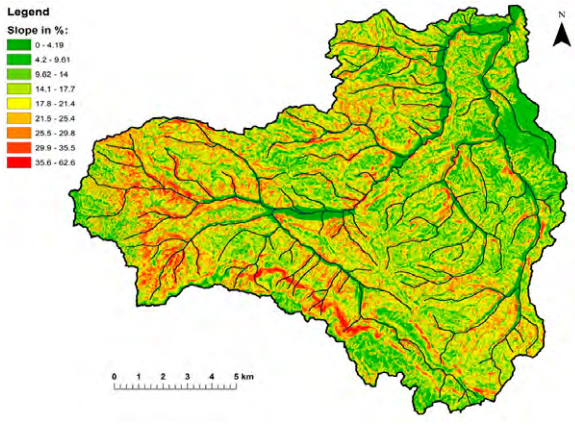

Figure 3. Slopes in the Likodra river basin
[click on figure to enlarge]

Results and discussion

Morphometric characteristics of the basin and the watercourse of the Likodra river were calculated using a software package ArcGIS 10.1. Calculations were made based on digitized topographic maps of Krupanj (a 1: 25,000 scale) and a digital elevation model (DEM).

Watercourses in the Likodra river basin have two basic hydrologic characteristics which have a significant impact on fluvial erosion processes and the formation of erosive and accumulative fluvial shapes. The first one is the torrential prone attribute and the second one frequent occurrence of sudden and relatively short torrential floods, with their specific feature of high concentration of solid material which is transported by water. Those characteristics have notably contributed to the evolution of the river beds and valleys.

The Gavrilović analytical method for examining the fluvial process which occurs in the river Likodra basin refers to the quantitative determination of parameters according to which we classify individual river basins into certain erosion types.

In the Likodra river basin, there are erosive processes from the I to IV category, i.e. from very weak to strong. In the lowland part of the Likodra river basin, there is a separate category - alluvium, where incoming deposits (accumulation) are higher than outgoing deposits (erosion). Perceiving the granulation metric composition of deposits in the beds of the river Likodra and its tributaries, it may be concluded that surface type of erosion is predominant in the whole basin.

There are small torrential streams, gullies and landslide basins that dominate in the Likodra river basin. Then follow, in a slightly smaller percentage, torrential streams and ravines. There are no torrential rivulet class tributaries in the catchment area of the Likodra river. However, three main rivers that form

Table 1. Hydrographic classes and erosion strength categories of torrents in the Likodra river basin (in %)

River basin	Hydrographic classes						Σ	Intensity erosion categories				
	A	B	C	D	E	F		I	II	III	IV	V
Likodra	4	-	4	9	9	5	31	2	8	20	1	-
Belocrkvanska river	1	1	5	8	3	2	20	-	4	6	10	-
Total	5	1	9	17	12	7	51	2	12	26	11	-
%	9.80	1.96	17.64	33.33	23.53	13.72	100	3.92	23.52	50.98	21.56	0.00

Source: Authors

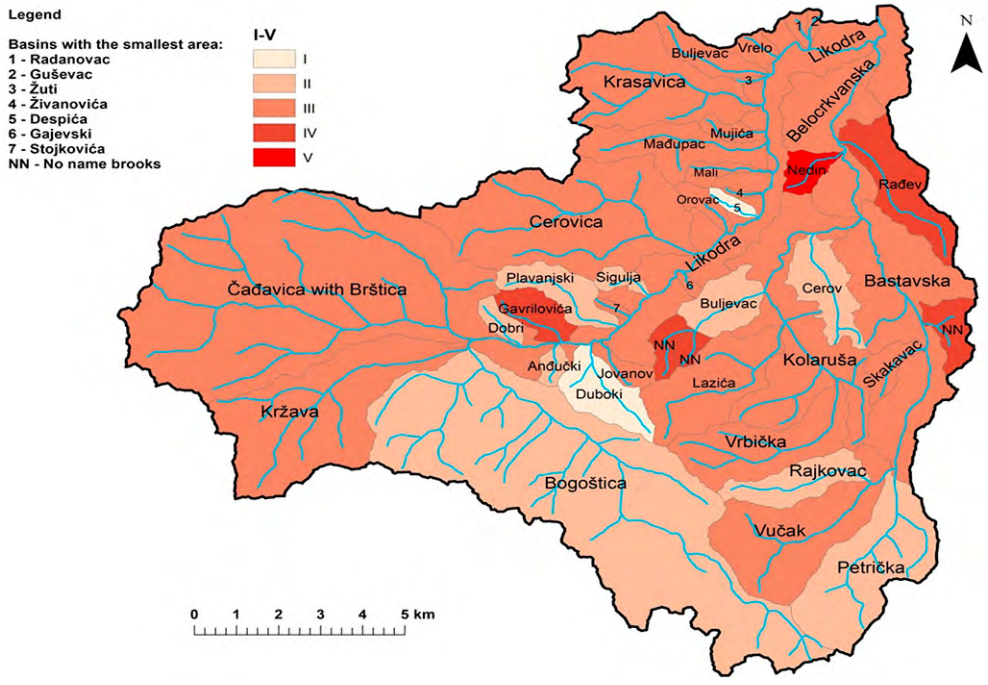

Figure 4. Intensity erosion categories in Likodra river basin

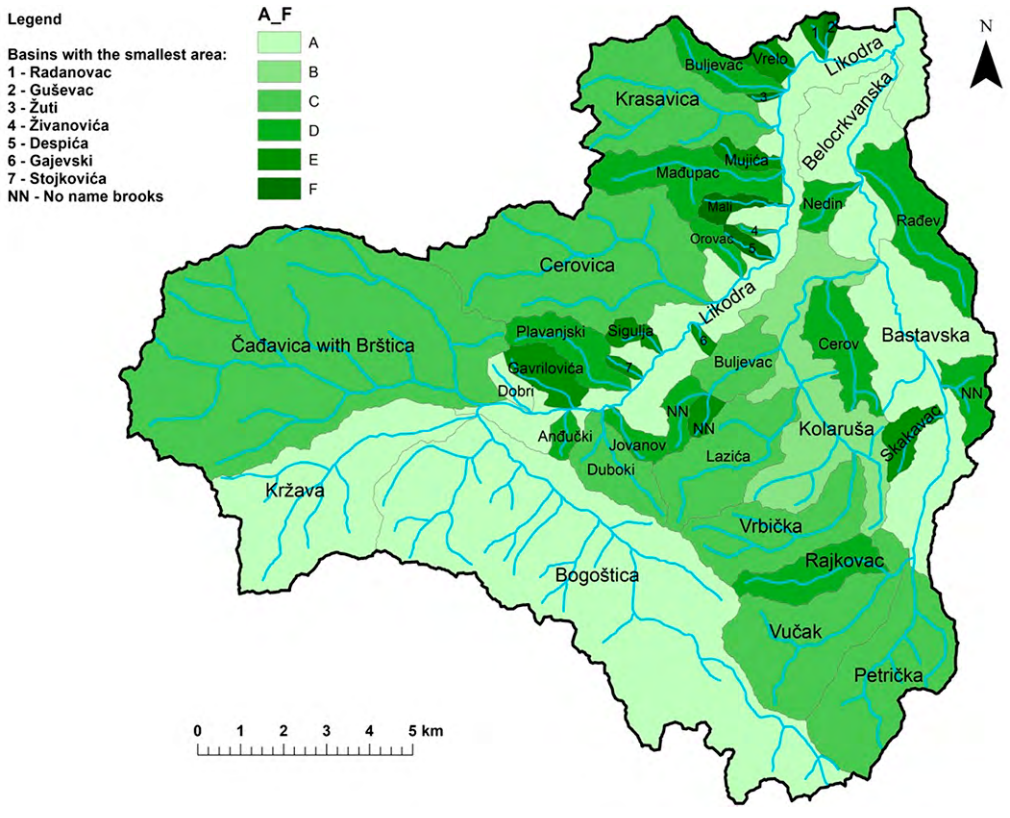

Figure 5. Hydrographic classes in the Likodra river basin

the Likodra river are classified into the group of torrential river classes. The parameters from table 2 classify the Likodra river into a group of torrential rivers.

Due to the high falls and short lengths of the water courses in the river Likodra basin, most of them give rise to badland topography and torrential streams class (33.33%), whereas the slightly smaller percentage is assigned to the class of slump basins which comprise almost a quarter of all water courses in the Likodra river basin (23.52%). Those brooks destroy significant quantities of productive land and activate many concealed landslides by their erosive activity. A significant amount of erosive activity in the Likodra river basin is made by torrential streams which belong to hydrographic class C (17.64%). All of the three mentioned classes belong to the highland basins in which the vertical component of fluvial erosion is expressed, i.e. downcutting. The other hydrographic classes are mostly connected with lower elevations, valley and depression parts of the Likodra rivers basin, with the dominating amount of horizontal erosion which results in widening of the river bed and the river valley.

The changes in social-economic relations which occurred after the Second World War also produced certain alternations in agricultural activities in many regions of Europe. Furthermore, those changes triggered a series of consequences: reduction of forest size, increase in agricultural land size, increase in erosive processes intensity in the river basins, and increase in the output of deposits in the basins and alluvial plains. As a result, there were changes in the river dynamics and river morphology (Liébault et al, 2005), (Keesstra, 2009), (Piégay et al, 2004). Numerous studies investigated the effects of deforestation and intensified erosion of agricultural land (Sing, 1999), reduction of nutriments of the land, hill-side stability (Lenhart et al., 2003) (Vanacker et al., 2003) and land characteristics (Varela et al., 2001).

All studies mentioned above perceived a qualitative connection between the changes in land utilization and changes in river morphology. However, quantitative evaluations of changes in the water balance and deposit yield occasionally remain unavailable. As a result, most of the case studies do not offer sufficient information for the identification of the limiting values in land use that initiate the changes in river morphology. Finally, the application of various models of the spatial distribution of erosion and increase in deposit yield successfully leads to the adequate simulation of the impact of changes in land utilization on deposit intensity. The application of various models provides parameters that quantify the change in the basin dynamics. Some modelling of erosion intensity was conducted earlier (Martinez-Casasnovas and Sánchez-Bosch, 2000) and (Erskine et al., 2002), however, most of the models did not offer detailed entrance parameters, or the entrance parameters were not available for the whole basin as it was the case with the Gavrilovic model.

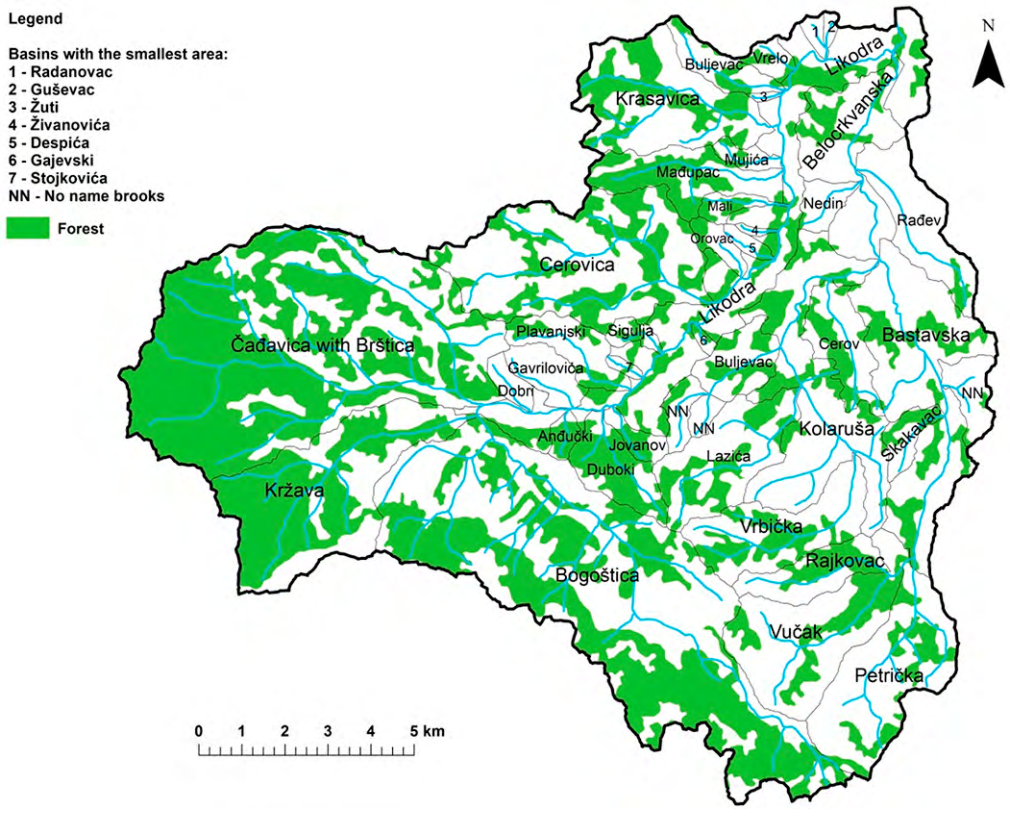

Figure 6. Forest areas in Likodra basin

The greatest part of the Likodra river basin was used as arable land. The total surface of arable land comprises 89.40 km2 or 42.07%, with the largest portion at the lower and middle parts of the basin. The arable land at the source of the river has a higher inclination, which enables washing away and carrying soil particles which accelerates the intensity of erosive processes. The forests cover one-third of the basin, i.e. 71.80 km² or 33.78%. The most represented vegetation is beech forest (on colder mountain slopes), whereas the warmer slopes are oak forest habitats. From the economic point of view, the forests are of low quality, but with good composition and with a protective role in possible land erosion. The arable land and forests cover ¾ of the total basin area, whereas the distribution of other classes is the following: meadows and pastures - 31.85 km² (14.98%); orchards - 17.50 km² (8.25%) and vineyards 0.41 km² (0.19%). The rest of the basin area is bare mountainous terrain - 1.54 km² (0.73%).

The measures for the regulation of the largest torrential stream beds (the Čađavica and the Likodra) were implemented in 1957. The works were intensified again in 1967. At that time the embankments were built on the banks of the rivers Čađavica, Bogoštica and Likodra, along their courses through Krupanj. In the lower course of the river Likodra deposit accumulation is higher than its transportation. Therefore, the regulation works (deepening the river bed and building the river bed cascades) started in 1999. Unfortunately, high water levels which occurred in 2002, 2005 and 2009 contributed to diminishing all the previous efforts and led to regressive erosion in water courses of the rivers Čađavica and Bogoštica. The following measures aimed at protection from erosive processes were taken: digging up and regulating the river bed (the river Bogoštica), construction of the embankment and two cascades 0.5 m high (the river Čađavica), construction of 2 meters high embankment, positioned about 25 meters from the river bed (the river Likodra). Unfortunately, the protection works on the rivers of the Likodra basin were conducted unsystematically and without consulting quantitative models. Moreover, the maintenance measures for the constructed objects regarding protection from torrential streams and floods were not applied. In addition, all the inadequate and inaccurate actions contributed to increasing the effects of devastating torrential floods in May 2014.

Conclusion

The first systematic register of erosive processes and torrential streams in the area of Rađevina was completed by the expert team from the waterpower engineering company from Loznica in the period 1957-1964. It was extensive field work conducted at that time; however, it was impossible to obtain complete data referring to erosive processes. Thus, it was concluded that certain rivers have torrential tributaries with developed erosive processes (the Likodra, the Cernica). Finally, the intensity degree of erosive processes, in the entire Likodra river basin was determined using the empirical Gavrilović method with tables of parameters in 2014.

The application of the Gavrilovic model has the following objectives:

1. to provide data for the verification erosion model;
2. to assess the damage caused by erosion;
3. to raise the population's awareness of the possible risks caused by erosion processes;
4. to improve the management process of river basin sediments.

According to the applied model, the analysis of the water courses in the river Likodra basin has been conducted. The implementation of integrated management for the whole basin area has been proposed as the most economic solution. It is necessary to apply erosion protection and prevention procedures and regulate the river beds of the torrential streams. Application of these procedures would eliminate current and future damage from erosion and the waters of torrential streams could be used in agriculture, tourism and recreation without negative impact.

After the application of the Gavrilović model, which proved itself as the best in the Balkan Peninsula, the authors proposed the following measures to prevent harmful effects in the river Likodra basin:

1. To regulate the riverbed of torrential streams that threaten the settlements and industrial facilities;
2. To plant forests on the terrains affected by I and II erosion process categories (excessive and strong erosion processes);
3. To introduce advanced agro-technical measures in the areas with III and IV erosion process categories, and to exceptionally permit crops in the areas with above 25° inclination with the obligatory introduction of contour bunding practice in agriculture;
4. To take advantage of all the benefits of cross-sections in torrential stream beds for intensive construction of small water reservoirs to prevent the flooding and the economic exploitation of water from torrential streams for local irrigation, development of tourism, fishery and other economic purposes;
5. To combat the deep erosion processes in torrential stream beds (landslides, landslips, rockfall and ravines) by building a series of appropriate modern dams: partition structure and leachate drainage system.

Implementation of these proposals would prevent greater damage from torrential floods and erosion of sediment. The consequence of reducing the negative impacts leads to lowering geohazard risks for the local population and creating greater opportunities for more intensive farming which is the leading economic activity of the inhabitants in the river Likodra basin.

All of the above also implies the concept of integrated management of torrential basins that would include design and construction of technical (dams, steps, regulations, micro-accumulations, retentions, embankments), biotechnical (sanitation of ravines, protection of the inclined areas) and biological objects (forestation of bare areas, melioration of degraded forests, meadows and pastures, planting orchards on terraces), as well as the application of administrative measures (organisational rules, utilisation and protection of land in endangered basins). In addition, the maintenance of the present systems for torrential floods and erosion protection and prevention (cleaning the river beds from deposits, vegetation and garbage; revitalisation of damaged objects) were not conducted which significantly reduced its efficiency (Ristanović et al., 2016). It is evident that the application of preventive and protective measures demands the introduction of Geographic Information System into the sphere of water management.

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DIVERSITY OF CULTURAL AND NATURAL LANDSCAPE AS A DIVER OF REGIONAL DEVELOPMENT – AN EXAMPLE OF TIMOČKA KRAJINA

Milica Cvetanović[A]

Abstract

The most acceptable understanding of the cultural landscape for geographers is that it is a space transformed under the influence of people. If the transformation becomes extreme and unplanned, the cultural landscape can endanger the sustainability and development of the region. Therefore, it is important to take care of the unique natural landscapes in order to strike a balance. Human activities in a particular space are conditioned by its physical geographic characteristics, but the degree of transformation and, to some extent, determining the location of the cultural landscape in the area can be planned. The combining of urban and rural parts, industrially transformed and protected natural areas, make Timočka Krajina a good example of combining natural and cultural landscape. Of course, there are some drawbacks, but there are also plenty of opportunities for better development and sustainability must always be a priority in planning the development of the region.

Keywords: Timočka Krajina, cultural landscape, natural landscape, sustainable development

Introduction

Landscape as a general term has many different understandings. First of all, we should single out the natural landscape, which represents a natural environment without human influence. On the other hand, defining the term cultural landscape is a complex problem due to different understandings of the authors. While some associate it with the transformation of visible area, others consider the term to refer to cultural heritage, and some authors see it as a combination of the two definitions. In geography, the first understanding is most often accepted.

Landscape is most commonly understood as the area of the Earth's surface that stands out from its territorial environment by its coherence (Tošić, 2012 a). This means that a particular landscape differs from other landscapes in its appearance and characteristics. But above all, the landscape is a visual phenomenon that lies in front of us (Goodall, 1987). The idea of landscape is the most significant attempt to connect the visual image and the material world (Cosgrove, 2003).

The combined actions of natural and social elements, factors and processes form physiognomy of an area. In this sense, the basic expression of the synthesis action of nature and society is physiognomy, i.e the look of an area manifested through different forms of landscape (Tošić, 2012 b).

Timočka Krajina is an area of emphasized cultural landscapes, but also of preserved natural landscapes under protection regimes. It is one of the most attractive tourist regions in Serbia, and the diversity of its landscapes is one of the biggest reasons for that fact.

The task of this paper is to single out and present the natural and cultural landscape of this region, and the aim is to connect the characteristics of the mentioned landscapes with the development of Timočka Krajina.

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Defining the concept of natural and cultural landscape

Physical geographers generally consider natural landscape as a landscape distinguished basing on its natural features. In this approach, landscape is a typological and hierarchic notion which is reflected in a large number of definitions in which landscape is understood as a geocomplex or a geosystem (Myga-Piątek, 2014).

Natural landscapes can be divided into:

1. Primary natural landscape which can be found in two forms:
   - an initial stage of landscapes developed on Earth with no impact of man
   - present day stage of preservation of landscapes not changed in the least bit of human activity
2. Seminatural landscapes include vast majority of natural landscapes which have been reached, but not transformed by man through the history (especially in the last 50 years) (Myga-Piątek, 2014).

Cultural landscape is a particular area on Earth surface of distinctive physiognomy, where man lives and carries out his economic activities. This type of landscape is transformed by man as a result of civilizational development (Andreychouk, 2008). Carl Sauer (1925) considered that human influences on the landscape are a manifestation of culture. The regional individuality of the cultural landscape is the product of the interplay of nature, man, culture and society (Tošić, 2012 a).

The author Todić (2005) states the basic directions in the development of the cultural landscape:

- urban landscape
- agrarian landscape
- industrial landscape
- traffic-tourist landscape.

Basic features of Timočka Krajina

Timočka Krajina is a region in Eastern Serbia around the Timok River Valley. It is the border area of Serbia with Romania and Bulgaria. Includes two administrative districts: Bor and Zaječar, within which there are eight municipalities. Bor, Kladovo, Majdanpek and Negotin are part of the Bor Administrative District, while Zaječar District includes: Zaječar, Boljevac, Knjaževac and Sokobanja.

The following geomorphological units are distinguished in the relief of Timočka Krajina: spacious mountain plateaus, peaks and ridges of medium height (Kučaj, Miroč, Rtanj, Tupižnica, Stara planina, etc.), the imposing river valleys of the Danube, Beli, Crni and Veliki Timok and Sokobanjska Moravica. Gorges and valleys, alluvial plains and terraces of the Danube at the entrance to Dakijski (Vlach) basin between Kladovo and Timok River mouth, are changing in a composite way. The lowest point of the region is the confluence of the Timok and the Danube (28 m) and the highest peak is Dupljak (2032 m) on Stara planina (Stara mountain) (Regionalni prostorni plan Timočke Krajine).

The factors that influenced the creation of the cultural landscape in Timočka Krajina are - if we look first through history - the Danube and Timok valleys and fertile land by the rivers, and later the development of mining and industry, the process of urbanization, but also attractive natural motifs such as climate, geomorphological features, thermomineral waters that have led to the development of tourism, especially in the area of Stara Planina, Đerdap Gorge and Sokobanja. The most represented economic activities in Timočka Krajina are mining, agriculture (with a particular emphasis on viticulture), hydropower and tourism. It is also important to note that this region is located on the Pan-European Corridor (Corridor 7 or the Danube Corridor).

Regional Spatial Plan of Timočka Krajina was adopted in 2012, and Regional Development Strategy for the same region was drafted for the period 2011-2018. The local population claims that little has been done from these documents because with the change of local authorities the priorities of development at the municipal level change. However, it will probably be the same for the whole region in future documents - the development is based on energy (primarily hydroenergy), tourism and agriculture, while the development of mining must be carefully planned in order not to continue environmental degradation. Of course, it is necessary to solve the pollution problem first, primarily in Bor.

Timočka Krajina is part of the Euroregion "Danube for the 21st Century". Euroregions represent the process of cross-border connectivity in the countries of Central and Eastern Europe. They indicate co-operation and a sense of belonging, and also encourage territories at local and regional level to connect for the common good. Euroregions are formed with the aim of promoting common interests as well as the living standards of neighboring countries (Tošić, Stojanović & Miletić, 2005).

Cultural landscape in the function of development of Timočka Krajina

Looking at the directions of development ie. the division of the cultural landscape of the author Todić (2005), in accordance with the dominant visual and economic features of the space that affect the development of Timočka Krajina, this division will be slightly modified. And this means that in the cultural landscape of Timočka Krajina, the following can be distinguished:

- urban landscape
- rural-vineyard landscape
- industrial landscape
- tourism landscape

The urban landscape is most emphasized in the most populated cities of the region and the centers of the district Zaječar and Bor. While the urban landscape of Bor is physiognomically less attractive due to the mining function of the city, Zaječar has no major negative effects of urban space transformation. Bor used to attract new residents, like other mining towns, that came for employment. Today, this city is environmentally endangered. On the other hand, Zaječar is the largest city and cultural center of Eastern Serbia. Its development is mainly based on tourism, and according to that the transformation of space is done, in both urban and rural parts. Although it has less inhabitants and therefore is less urban-transformed, Negotin is visually similar to Zaječar. Donji Milanovac (part of municipality of Majdanpek) and Kladovo are small towns on the banks of the Danube and based on that fact, their development and transformation have been made. In these towns docks for ships have been built that are also border crossings for international river traffic. Interestingly, traces of the oldest known urban settlement in Europe - an archeological site Lepenski Vir - can be seen not far from Donji Milanovac. It is a settlement on the banks of the Danube from the Mesolithic and Neolithic period.

Archaeologist Dragoslav Srejović, from 1965 until 1970, discovered on the Danube terrace the artistic monuments of an archaic and until then unknown culture. Since then, research in Lepenski Vir has been lengthy, numerous and multidisciplinary. Anthropological remains were studied, data were obtained on the use of raw materials and their processing, construction activities, settlement organization and funeral rituals were investigated. The stratigraphy of the settlement followed the chronology of the artistic monuments of Lepenski Vir (Škokljev & Škokljev, 1998).

The rural space of Timočka Krajina is very specific, first of all in ethnographic sense, since it is an area where Serbian and Vlach cultures intermingled.

The basic agricultural potential of the Timočka Krajina is primarily based on fruits production (mostly grape), located mainly in the Danube and Timok area, between the municipalities

Kladovo and Negotin and around the municipality of Knjaževac. This production has a long tradition in Timočka Krajina and it was recognized outside this region (Regionalni prostorni plan Timočke Krajine). The municipality of Knjaževac is quite known for its vineyards in the wine map of Serbia. On the territory of the municipality of Negotin there are well known wine settlements, and among them probably the most famous one in Serbia - Rajačke pimnice. These are visually similar and specific settlements with wine cellars made of stone and wood. These buildings were built at the end of the 19th and 20th centuries. There used to be many more, but today only a few settlements remain, among which the most famous are those in the villages of Rajac, Rogljevo and Štubik. There are also vineyards in the municipalities of Bor, Zaječar, Kladovo and Boljevac. The development of viticulture is directly connected to the tourist movements through wine tourism. Many facilities have been adapted for the needs of tourists.

Due to the climate, the environment of Timočka Krajina (especially at the foot of the mountains) has great potential for organic food production. This production is one of the main activities in the eco-villages, most of which are located in the Timočka Krajina. These are communes, which are increasingly being inhabited by foreigners, whose aim is to live in a healthy environment. The first eco-village in this region called Planinica came to life in 1999, but unfortunately it did not last long because families were forced to return to cities due to the abolition of the village school. Today, this village is called Gaj Oskoruša, and although it had great potential to become a larger eco-settlement, only a few inhabitants live in it today (Cvetanović & Vićentijević, 2017; Planinica.info).

At the foot of Mountain Rtanj, within the boundaries of the Sokobanja municipality, is the eco village Vrmdža, to which more than thirty families have settled. This village, which also has a small lake, has become a good example of the economic empowerment and rural development of Serbian villages as well as their revitalization (Slavković, 2016). The village residents are mostly younger, highly educated people who came primarily to seek peace and distance from the often hectic and tiring urban areas. This is the only settlement in Serbia that fully meets all the principles of eco-village construction and functioning, for now (Cvetanović & Vićentijević, 2017)

In the area between Zaječar and Boljevac is the village Osnić. At an altitude of 400 m, an ecological village project called Markov potok was designed. Some of the principles and goals of this settlement are: maximum energy independence of the settlement, use of materials that will not harm nature (therefore construction involves only natural materials),

organic food production, educational workshops, old craft courses, workshops for children, etc. (Zelene novine, 2015).

The tourist landscape is spread throughout the region and in almost every municipality. Favorable climate, mountain relief, mineral waters, Đerdap gorge and the river Danube with archeological sites from the Mesolithic period on its banks are an excellent base for attracting tourists.

However, the area of Timočka Krajina has not been exploited for tourism, but tourism has developed moderately and, most importantly, sustainably over the decades. Precisely because of that, this region is one of the most important tourist destinations in Serbia. The following ecologically oriented types of tourism have already been developed in this region: mountain tourism, spa tourism, nautical tourism, ecotourism, wine tourism, adventure tourism, archeological and cultural tourism. Although it is visited by a significant number of tourists, everything is still within the allowed limits and no major negative effects are visible. Stara planina (Stara mountian) is the most attractive mountain in eastern Serbia. It is protected as a Nature Park, so activities on it are limited to certain types of tourism. Stara planina is most often visited by adventure-oriented nature lovers, and its numerous waterfalls attract the most attention. The largest number of waterfalls is located in the area of the mountain outside Timočka Krajina, but within this region you can also find some, and the most famous is the Suvodol waterfall not far from the monastery of the same name in the municipality of Zaječar.

In recent years, Rtanj and Tupižnica have been very attractive for daily recreational excursions. Šiljak (1565 m), the highest peak of the mountain Rtanj is recognizable due to its natural phenomenon - it is a karst relief that is characterized by the shape of a coupe. That is why various mysteries are attched to this mountain, which influences the creation of excellent tourist marketing.

The Đerdap gorge is recognizable by the composite valley of the Danube and the national park that was declared in 1974.

About 6.4% of the territory of Timočka Krajina or about 455 km² (parts of the municipalities of Majdanpek and Kladovo), is marked as an area of special natural and cultural values where protection zones of I and II category have been determined, as well as a protection zone intended for tourism, sports and recreational activities (Prostorni plan područja posebne namene „Đerdap")

Đerdap I (Iron Gate I) hydroelectric power station which started producing energy in 1972, was built on the edge of the national park. With the construction of Đerdap I, the accumulation Đerdap Lake was formed, the largest artificial lake in Serbia (253 km²). The Đerdap II hydroelectric power station was built in 1984 on the Danube in the municipality of Negotin. Both hydropower stations are under the control of both Serbia and Romania. Although tourist movements are frequent in the area of the Đerdap gorge and there is a tourist infrastructure, the ecosystem of the area is not disturbed. The number of accommodation facilities is not large because most of visitors come on day trips with cruisers. Once the open space of Lepenski vir has been relocated within the museum of the same name. The Archaeological Museum of Đerdap is located in Kladovo.

Spa tourism of Timočka Krajina is developed in Sokobanja and Gamzigrad spa. Sokobanja, an urban settlement with a long-lasting tourist and health function is one of the most attractive tourist spots in the region and receives the largest number of tourists in Timočka Krajina. Within the central city park in Sokobanja there is a Roman bath (also called the Turkish bath) which is part of the Special Hospital and is known for its wellness and spa recreation. The rural area of the municipality includes the mountains Ozren and Devica. Ozren has a significant healing function, so there are hospitals for the treatment of lung and eye diseases. Gamzigrad spa near Zaječar has more of a health than a tourist function. On the territory of the municipality of Sokobanja, there is an Outstanding Natural Landscape Lepterija-Sokograd. This protected area includes one of the most recognizable waterfalls in Serbia - Ripaljka, 17.5 m high. At the foot of the mountain Crni Vrh, on the territory of the municipality of Bor, there is an artificial lake which is an attractive tourist spot.

The industrial landscape is visible through the development of mining in the municipalities of Bor, Majdanpek, Zaječar and to a lesser extent in the municipalities of Sokobanja and Boljevac. The uranium mine in the municipality of Knjaževac used to be active, but it was closed after a couple of years. The most productive mines are Bor and Majdanpek, where copper is mined and in smaller quantities gold and silver. Mining and tourism lead the economy of this area. However, the negative impacts of mining development in terms of environmental degradation are increasingly pronounced, primarily through air quality and water purity. Sources of pollution of watercourses near the mining basin in Bor are active and inactive min-

ing works (on the surface and underground), flotation tailings, landfills from mines, wastewater generated during copper processing and public utility wastewater (Obradović, Bugarin & Marinković, 2012).

Part of the Mining and Smelting Combine "Bor", to which the mine in Majdanpek also belongs, today is mostly owned by a foreign company, and that was accompanied by bringing in a larger number of workers from that country. Although average earnings have increased, the fact is that the privatization of the mining basin has brought more negative effects, primarily in terms of the environment. This means that the development of the municipality of Bor is definitely not sustainable. In the future, there may be much worse effects, such as an increased occurrence of malignant and respiratory diseases, but also the emigration of the population.

Natural landscape in the function of development of Timočka Krajina

Given the vastness of the region, there are areas in in Timočka Krajina, which the original natural landscape is preserved due to difficult access. Some of them were discovered by man, the local people usually knows about those locations, but they have not transformed them. It is quite possible that there are still undiscovered areas such as waterfalls or caves, primarily on mountain terrains. There are preserved natural landscapes on the mountains Rtanj, Devica, Deli Jovan, Miroč, Kučaj, Tupižnica and their slopes, as well as in the Đerdap gorge. These are locations to which most of the well-known recreational and tourist trails do not lead. Like cultural landscapes, the natural landscapes of Timočka Krajina are diverse - from river valleys to high mountainous areas. The Danube River mostly flows through the gorge, some of its tributaries are located in more tame areas, while mountain landscapes are distinguished by rocky, spacious grassy landscapes, forest with hydrographic motifs such as smaller rivers, springs, waterfalls. Taking into account the sensitivity and protection of space, natural landscapes in certain parts of the region should not be used for the purpose of mass tourism development. But these landscapes still have a part in its development, primarily through the visits of mountaineers, adventurers and other recreationists. On their way to the preserved natural landscapes, they use accommodation services both in urban areas and in smaller rural facilities intended for rural tourism. Of course, the money they leave when buying supplies necessary for the continuation of tourist and recreational tours should also be included. Also, some of them do not dare to go exploring mountainous areas on their own, so they use the services of local guides or local mountaineers.

Conslusion

Tourism is currently, along with hydropower, the biggest chance for the sustainable development of Timočka Krajina. Of course, this does not imply mass and extensive transformation of space in the form of construction of tourist infrastructure and superstructure, but the development of environmentally friendly forms of tourism in areas where it is allowed, is desirable. Sustainability of space should always be kept in mind as a priority, and not towards a quick financial gain that would endanger the space. Timočka Krajina, as well as other parts of Serbia, was affected by the process of migration from villages to cities, leaving a lot of unused agricultural land that can be used for planting vines or other fruits and vegetables. It is interesting that this region is the only area in Serbia known for its ecological villages with a permanently populated population. The cultural landscape of these settlements, built in the form of communes, does not disturb the environment, and leads to numerous positive effects, which is why they should be promoted in order to return the population to rural areas. This would relieve cities whose cultural landscapes are further damaged by increasingly intensive urbanization.

However, today it can be said that the space in some parts of the region has been used more than it should and that if further development of the region is not planned long-run and sustainably, the negative effects will be more visible. Given that this is a border area, the development of tourism should be directed towards motivating residents of neighboring countries to visit the nearby region, which visually and culturally represents one of the most specific areas of Serbia.

Finally, it is important to emphasize the industrial and mining transformation of the region, primarily in Bor. Extraction and processing of raw materials are necessary processes that are the carriers of the economy of this region, but there are many negative effects that can at least be mitigated if not completely eliminated. The process of land reclamation is necessary, although it cannot completely restore the former

quality of the land, but it can at least visually affect the cultural landscape. On the other hand, more attention should be paid to the quality of air and water, which affects the health of the population. The advantage of the proximity of Romania and Bulgaria for now is mainly reflected in the Danube corridor and the production of electricity through joint hydropower system used by Serbia and Romania. The affiliation of Timočka Krajina to the Euroregion "Danube for the 21st Century" is also of great importance. International cooperation and exchange of development experiences with other countries are always desirable.

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CONTEMPORARY SOCIO-GEOGRAPHICAL PROCESSES IN THE RURAL AREAS OF THE BANJA LUKA REGION

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Abstract

The Banja Luka region is a complex regional system in the north-western part of the Republic of Srpska. In the administrative-territorial terms, it consists of systems of different organizations: cities and municipalities. Banja Luka, Prijedor and Gradiška have the status of a city, while other systems of the administrative-territorial organization have the status of a municipality. After the 1990s, the central settlements of this region, today cities, become zones of dynamic concentration of population and all development functions, and municipalities, most of them, of depressed and stagnant development. Pronounced destructive socio-economic processes are particularly emphasised in the mountainous areas of the region. More recently, they have been accompanied by increasingly pronounced destruction processes in all spheres of development and spatial organization of most municipalities in the region. Key issues concern the demographic development and weakening of rural functions.

Keywords: Banja Luka region, demographic and regional development, socio-geographical development

INTRODUCTION

The Banja Luka region is conditionally differentiated regional system in the north-western part of the Republic of Srpska, which, in administrative and territorial sense, combines three urban areas of Banja Luka, Prijedor and Gradiška and 18 municipalities.

Regional system includes area of 8954.3 km² in which, according to the census from the year 2013, there are 527 840 inhabitants, or 45% of the population of the Republic of Srpska.

According to nodal-functional regionalization of the Republic of Srpska, territoriality of the Banja Luka region is determined by the functions and gravity range of the main development centre of the region – Banja Luka (Gnjato, 1997, pp.7).

In the period of accelerated socio-economic development, strong migration (emigration) of the population from the rural areas of the region is directed towards the central settlements, today the cities of: Banja Luka, Prijedor and Gradiška. The decades-long emigration of the population causes changes in the biological structure of the population and the loss of basic economic functions of rural areas.

With the emigration of the population during the war and post-war period (1992-1995), the rural areas of the region are characterized by marked depopulation, exodus characteristics, with destructive changes in the biological structure.

Contemporary socio-economic processes are the result of complex, political and overall social processes, which in the form of transition have marked the development of the region and the Republic of Srpska as a whole.

In the inter-census period (1991-2013), the region is characterized by population decrease, negative natural increase, unfavourable age structure and pronounced destruction processes in the spheres of development and spatial organization of peripheral rural areas. (Table 1).

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Table 1. Inter-census population change (1991-2013) and changes in natural population movement (2000-2013) in cities and municipalities of the Banja Luka region

Banja Luka Region	Population number		Difference	Natural increase		Difference	Share of population +65 %	
	1991	2013		2000	2016		1991	2013
Total-regions	691673	527840	-163833				9.8	16.9
Banja Luka	195692	180053	-15639	315	131	-184	9.1	15.1
Gradiška	59974	49196	-10778	-81	-310	-391	12.0	18.1
Prijedor	112543	80916	-31627	-247	-394	-641	8.4	17.4
Koz. Dubica	31606	20681	-10925	-35	-221	-256	11.2	20.1
Kostajnica	6231	5645	-586	-23	-37	-60	9.6	16.7
Novi Grad	41665	25240	-16425	-30	-165	-195	9.2	18.0
Krupa na Uni	3336	1560	-1776	-7	-19	-26	14.2	26.0
Oštra Luka	8340	2705	-5635	34	-21	-55	11.7	20.8
Srbac	21840	16933	-4907	-23	-75	-98	13.6	19.9
Laktaši	29832	34210	4378	64	-62	-126	11.7	15.2
Prnjavor	47055	34357	-12698	167	-171	-338	10.5	19.7
Čelinac	18713	15117	-3596	42	-28	-70	8.5	14.6
Kotor Varoš	36853	18361	-18492	151	-44	-195	6.7	13.0
Kneževo	15285	9368	-5917	61	-45	-106	8.2	17.2
Mrkonjić Grad	27395	15926	-11469	-13	-87	-100	11.6	21.1
Jezero	6230	1039	-5191	3	1	-2	8.2	15.3
Šipovo	15579	9969	-5610	4	-60	-64	10.8	18.7
Kupres	1451	293	-1158	1	-1	-2	16.9	46.4
Ribnik	10828	5851	-4977	-34	-62	-96	12.7	23.3
Petrovac	1225	354	-871	-8	-2	-10	16.1	27.4
Istočni Drvar	61	66	5	-1	0	-1	36.0	15.1

Source: Census of Population, Households, Flats and Agricultural Holdings 1991, Institute of Statistics, Socialist Republic of Bosnia and Herzegovina, Sarajevo, 1991; Census of Population, Households and Flats in the Republic of Srpska 2013, Institute of Statistics of the Repubilc of Srpska, Banja Luka, 2018; (Marinković, Majić, 2018, pp. 316 and 324)

Particularly pronounced socio-economic processes of destruction are in small and peripheral municipalities: Kostajnica, Petrovac, Ribnik, Istočni Drvar, Jezero, Kneževo, Krupa na Uni, Kupres and Oštra Luka. Other municipalities in the region are characterized by depressed and stagnant development.

DEMOGRAPHIC INDICATORS OF RURAL DEVELOPMENT

In the Population Census for the year 1991, out of the total number of 691673 inhabitants of the region, 53.2% of the population lived in urban areas, and in the year 2013, out of the total of 527840 inhabitants, 58.7% of the population lived in urban areas, which indicates the polarization and demographic discharge of rural areas. The inter-census change in population (1991-2013) indicates a population decrease in the region (Table 1). Population of the region decreased by 23.6%, in urban areas decreased by 15.7% and in rural areas by 32.7%.

The urban areas of the region today are dynamic zones of population concentration. Banja Luka has the largest population, with 34.1% of the region's population, followed by Prijedor (15.3%) and Gradiška (9.3%).Emphasised destructive processes are in the peripheral municipalities: Kostajnica, Petrovac, Ribnik, Istočni Drvar, Jezero, Kneževo, Krupa na Uni, Kupres and Oštra Luka, with less than 1% of population of the region (Table 2).

Population emigrations, general development of certain areas of the region, and socio-economic circumstances in the post-war period are some of the main causes of the relative decrease in population density in the region.

Compared to 1991, the population density in the region decreased from 77.2 inhabitants/km² to 58.9 inhabitants/km². Population density in urban areas has decreased in Banja Luka from 157.9 inhabitants/km² to 145 inhabitants/km², in Prijedor from 134.9 inhab-

Table 2. Banja Luka Region - Municipalities according to size and population, year 2013 and inter-census household change (1991-2013)

Banja Luka region	Surface		Population			Households		
	km²	region %	2013	region %	Inhabitants/km² 2013.	1991	2013	Difference
Total-regions	8954.3	100	527840	100	58.9	193047	185942	-7105
Banja Luka	1238.89	13.84	180053	34.11	145.3	58674	65010	6336
Gradiška	761.65	8.51	49196	9.32	64.5	17288	16939	-349
Prijedor	834.07	9.31	80916	15.33	97.0	31393	27961	-3432
Koz. Dubica	499.35	5.58	20681	3.92	41.4	9502	7492	-2010
Kostajnica	85.86	0.96	5645	1.07	65.7	1617	1896	279
Novi Grad	469.67	5.24	25240	4.78	53.7	8995	8792	-203
Krupa na Uni	93.18	1.05	1560	0.30	16.7	880	543	-337
Oštra Luka	206.64	2.31	2705	0.51	13.0	2244	971	-1273
Srbac	452.64	5.05	16933	3.21	37.4	6323	6157	-166
Laktaši	388.34	4.34	34210	6.48	95.8	8531	11293	2762
Prnjavor	629.99	7.03	34357	6.51	54.5	12905	12166	-739
Čelinac	361.80	4.04	15117	2.86	41.8	4846	5009	163
Kotor Varoš	557.34	6.22	18361	3.48	32.9	8554	5863	-2691
Kneževo	325.99	3.64	9368	1.77	28.7	3504	3168	-336
Mrkonjić Grad	669.73	7.48	15926	3.02	23.7	7854	6104	-1750
Jezero	63.17	0.71	1039	0.2	16.4	1622	365	-1257
Šipovo	550.20	6.14	9969	1.89	18.1	4347	3665	-682
Kupres	44.62	0.50	293	0.06	6.5	367	128	-239
Ribnik	499.92	5.58	5851	1.11	11.7	3194	2252	-942
Petrovac	146.10	1.63	354	0.07	2.4	378	130	-248
Istočni Drvar	75.24	0.84	66	0.01	0.8	29	38	9

Source: Census of Population, Households, Flats and Agricultural Holdings 1991, Institute of Statistics, Socialist Republic of Bosnia and Herzegovina, Sarajevo, 1991; Census of Population, Households and Flats in the Republic of Srpska 2013, Institute of Statistics of the Repubilc of Srpska, Banja Luka, 2018;

itants/km² to 97.0 inhabitants/km² and in Gradiška from 78.7 inhabitants/km² to 64 inhabitants/km².

In 2013, in the peripheral rural areas, the region was characterized by low population density (0.8-18 inhabitants/km²), in municipalities: Šipovo, Jezero, Krupa na Uni, Oštra Luka, Ribnik, Petrovac and Istočni Drvar.

With low population density (20-45 inhabitants/km2), but in a slightly more favourable situation are municipalities: Kozarska Dubica, Srbac, Čelinac, Kotor Varoš, Kneževo and Mrkonjić Grad. Other municipalities have a medium population density, from 50 to 100 inhabitants/km2).

Inter-census household change (1991-2013) indicates a decrease in the number of households in the region by 7105 or 3.6%. (Table 2) Households are decreasing in both urban and rural areas. The number of households in urban areas decreased by 4710 or 66.2% and in rural areas by 2395 or 33.7%.

At the regional level, the largest decrease in the number of households in urban areas has Prijedor (10.9%) and Gradiska (2.0%), and in rural areas, municipalities: Jezero (77.4%), Oštra Luka (56.7%), Kupres (65.0%), Petrovac (65.6%), Krupa na Uni (38.2%) and others.

The emigration of the population, in certain areas of the region, is accompanied by destructive changes in the biological structure. In 2013, the region's population showed an aging tendency, compared to 1991. In the region, the young population is decreasing in favour of the old population. The share of the young population in the total population of the region decreased by 7.5%, and the share of the population older than 65 years increased by 7.1%. (Table 3).

In the region, there is more population older than 65 years (16.9%), compared to the young population (14.0%), which will adversely affect its future development.

At the regional level, particular unfavourable age structure have peripheral municipalities, with a share of 20-40% of the population older than 65 years of age (Kozarska Dubica, Oštra Luka, Krupa na Uni, Mrkonjić Grad, Ribnik Petrovac and Kupres).

In the period 2007-2016, the region has a positive migration balance. Due to the positive migration balance,

Table 3. Population age structure of Banja Luka region in the censuses of the years 1991 and 2013

Banja Luka region	1991			2013		
	0-14	15-64	65+	0-14	15-64	65+
Total-regions	148817	474908	67948	73906	364400	89534
Banja Luka	41241	136709	17742	26394	126235	27242
Gradiška	12551	40223	7200	6556	33716	8924
Prijedor	24691	78301	9551	10184	56621	14111
Koz. Dubica	6262	21792	3552	2450	14071	4160
Kostajnica	1329	4302	600	670	4031	944
Novi Grad	8995	28832	3838	3114	17572	4554
Krupa na Uni	536	2326	474	179	974	407
Oštra Luka	1670	5692	978	400	1741	564
Srbac	4501	14366	2973	2382	11177	3374
Laktaši	6346	19994	3492	5363	23624	5223
Prnjavor	9467	32611	4977	4954	22628	6775
Čelinac	4459	12661	1593	2265	10630	2222
Kotor Varoš	10008	24362	2483	2993	12966	2402
Kneževo	3564	10463	1258	1352	6399	1617
Mrkonjić Grad	5691	18522	3182	2225	10329	3372
Jezero	1611	4106	513	137	742	160
Šipovo	3618	10264	1697	1415	6683	1871
Kupres	201	1004	246	27	130	136
Ribnik	1898	7551	1379	793	3689	1369
Petrovac	175	852	198	52	205	97
Istočni Drvar	3	36	22	1	55	10

Source: Census of Population, Households, Flats and Agricultural Holdings 1991, (Statistical bulletin 257), Population - by populated places, FBiH, FBiH Institute of Statistics in Sarajevo, 1998; (Marinković, Majić, 2018, pp. 324-325)

the population of the region increased for 6,223 persons. Positive migration balance is recorded in the cities Banja Luka (9325), Prijedor (237) and Gradiška (78). The highest number of immigrants is from rural areas of the Republic of Srpska, about (66.6%), followed by FBiH (28.4%) and Brčko District (0.9%) (Table 4). Other municipalities have negative migration balance, which confirms their poor attractiveness and functional underdevelopment.

The population is still leaving rural areas, moving towards more functionally developed centres. Rural areas are increasingly losing their function with socio-economic changes, and suburbanization processes are intensifying in urban areas.

Table 4. Internal migrations of the Banja Luka region in the period from 2007 to 2016.

Cities	Moved to RS				Moved from RS				Migration balance
	Total	From FBiH	From Brčko	From RS	Total	To FBiH	To Brčko	To RS	
Total-regions	45127	12828	440	30061	38904	9397	329	28971	6223
Banja Luka	20344	4619	283	13634	11019	3143	120	7756	9325
Gradiška	2629	715	29	1885	2551	482	30	1829	78
Prijedor	4830	2687	30	2113	4593	1884	29	2680	237
Koz. Dubica	906	300	5	611	1478	327	6	1145	-572
Kostajnica	379	85	1	293	347	59	0	288	32
Novi Grad	1311	679	9	623	2408	807	18	1583	-1097
Krupa na Uni	190	49	0	141	210	24	0	186	-20
Oštra Luka	773	476	0	297	842	152	2	688	-69
Srbac	837	79	13	745	1211	51	10	1150	-347
Laktaši	5218	380	9	4829	2599	179	17	2403	2619

Cities	Moved to RS				Moved from RS				Migration balance
	Total	From FBiH	From Brčko	From RS	Total	To FBiH	To Brčko	To RS	
Prnjavor	1666	410	16	1240	2099	329	17	1753	-433
Čelinac	871	74	4	793	1392	68	3	1321	-521
Kotor Varoš	921	352	9	560	1531	507	19	1005	-610
Kneževo	399	112	1	286	1788	115	2	1671	-1389
Mrkonjić Grad	809	199	9	601	1680	273	14	1393	-871
Jezero	263	80	4	179	295	117	22	156	-32
Šipovo	477	223	15	239	853	207	18	628	-376
Kupres	80	33	0	47	87	17	0	73	-7
Ribnik	607	184	3	420	997	126	2	869	-390
Petrovac	1049	867	0	182	521	397	0	124	528
Istočni Drvar	568	225	0	343	403	133	0	270	165

Source: (Marinković, Majić, 2018,pp 320-321)
http://rzs.rs.ba/static/uploads/bilteni/gradovi_i_opstine_republike_srpske/2018/Gradovi_I_Opstine_Republike_Srpske_2018_WEB.pdf
http://rzs.rs.ba/static/uploads/bilteni/popis/migracije/Rezultati_Popisa_2013_Migracije_WEB.pdf

Emphasized emigrations in rural areas of the region cause changes in the biological structure, which are relatively reflected in other elements of the natural movement of the population. In the post-war period (2000-2016), all cities and municipalities, except for Banja Luka, recorded a negative natural increase (Table 1). The positive migration balance in urban and individual municipal centres did not significantly affect the overall population movement in the region and its population decrease.

Table 5. Number of schools and classes and distribution of pupils enrolled in the Banja Luka region, in the school year 2003/04, 2011/12 and 2017/18

Banja Luka region	Number of schools			Number of classes			Number of students			
	03/04	11/12	17/18	03/04	11/12	17/18	03/04	11/12	17/18	Difference
Total-regions	351	321	300	2.781	2.482	2.323	57340	46659	42041	-15299
Banja Luka	61	55	52	798	732	739	17716	15625	15733	-1983
Gradiška	35	29	27	263	214	199	5490	4278	3692	-1798
Prijedor	51	51	50	385	342	315	8074	6041	5302	-2772
Koz. Dubica	11	11	10	108	85	76	2260	1654	1288	-972
Kostajnica	3	2	2	26	19	20	515	358	306	-209
Novi Grad	27	24	22	148	131	124	2835	2107	1743	-1092
Krupa na Uni	4	5	5	13	13	11	132	120	93	-39
Oštra Luka	8	8	7	33	35	29	419	337	232	-187
Srbac	21	19	18	111	100	97	1969	1526	1356	-613
Laktaši	10	9	9	144	148	154	3831	3495	3394	-437
Prnjavor	33	31	30	201	194	180	4103	3486	2854	-1249
Čelinac	18	16	15	102	90	75	2082	1491	1232	-850
Kotor Varoš	15	12	10	122	109	80	2331	1943	1499	-832
Kneževo	16	16	12	85	65	48	1467	979	680	-787
Mrkonjić Grad	18	14	14	116	89	79	2020	1526	1232	-788
Jezero	1	1	1	9	9	9	153	114	95	-58
Šipovo	6	6	6	66	55	43	1215	968	808	-407
Kupres	1	1	1	1	2	1	14	13	9	-5
Ribnik	11	10	8	44	43	35	642	528	404	-238
Petrovac	1	1	1	6	7	9	72	70	89	17

Source: Statistics of education - primary education, (Bulletin, number 4 and 13) and Statistics of education - primary education 2017/2018, Institute of Statistics of the Repubilc of Srpska, Banja Luka; (Marinković, Majić, 2018, pp. 328)

The specificities of the rural development of the region are further determined by the specific demographic processes observed in the educational structure. In the period from 2003 to 2018, the decrease in the number of pupils in schools is confirmed by the unfavourable demographic trends and indicates numerous problems in the spatial and functional organization.

The number of pupils in schools in the region decreased by 15299 or (26.6%), of which in schools in urban areas decreased by 6544 or (42.8%), and in rural 8755 or (57.2%) (Table 5).

The largest decreases in the number of pupils in urban areas are in Prijedor (18.1%), Banja Luka (12.9%) and Gradiška (11.7%), while in rural areas in Prnjavor (8.1%), in Srbac (7.9%) and Novi Grad (7.1%).

In the period between 2003 and 2018, at the regional level, 458 branch schools and 51 schools were closed. In the urban areas of the region, 193 branch schools and 6 schools were closed, and in rural areas 265 branch schools and 45 schools were closed.

SOCIO-ECONOMIC INDICATORS OF RURAL DEVELOPMENT

In 2013, 453934 working-age population were registered in the region, which represents 85.9% of the total population of the region. Out of that number, 215717 or 47.6% is economically active population and 238217 or 52.4% is economically inactive population. Working age population in the urban areas of the region is 238939 or 52.6% and in rural areas 214995 or 47.4% (Table 6).

Population activities observed in cities and municipalities indicate a medium conditionally satisfactory category of activities, with share of 30-50% of active population compared to the total population.

The most active population in the region (215717) is concentrated in urban areas 132980 or 61.6%, while in rural areas that number is 82737 or 38.4% (Table 6).

In the process of industrialization, rural areas of the region remained isolated, with underdeveloped infrastructure, especially utility infrastructure, which affected the destruction of the total area.

Table 6. Working-age population of Banja Luka region - according to activity status, 2013

Banja Luka region	Working-age population	Work force			Economically inactive		
		Total	Employed	Unemployed	Total	Pupils +15	Pensioners
Total-regions	453934	215717	164746	50971	238217	73342	100573
Banja Luka	153659	79792	61470	18322	73867	15003	35491
Gradiška	42640	20542	16068	4474	22098	3093	9176
Prijedor	70732	32646	23657	8989	38086	5263	16763
Koz. Dubica	18231	7199	5340	1859	11032	1166	4525
Kostajnica	4975	2391	1999	392	2584	360	1142
Novi Grad	22126	9251	6436	2815	12875	1451	5182
Krupa na Uni	1381	869	857	12	512	61	138
Oštra Luka	2305	632	512	120	1673	181	479
Srbac	14551	6253	4117	2136	8298	985	2942
Laktaši	28847	14194	10989	3205	14653	2178	5187
Prnjavor	29403	12328	10135	2193	17075	2289	5585
Čelinac	12852	5984	4484	1500	6868	1191	2564
Kotor Varoš	15368	6928	5577	1351	8440	1491	2748
Kneževo	8016	4144	3544	600	3872	661	1380
Mrkonjić Grad	13701	5927	4498	1429	7774	1001	3521
Jezero	902	312	236	76	590	60	184
Šipovo	8554	3781	2635	1146	4773	612	2046
Kupres	266	171	155	16	95	6	47
Ribnik	5058	2177	1859	318	2881	272	1354
Petrovac	302	153	136	17	149	16	106
Istočni Drvar	65	43	42	1	22	2	13

Source: Cities and municipalities of the Republic of Srpska, 2018, Institute of Statistics of the Repubilc of Srpska, Banja Luka, 2018, pp. 102-106.

The spatial distribution of the economic potentials of the region, in the post-war period, significantly influenced the reconstruction and development of the region. Rural areas, with their development potentials, of which the importance of natural resources is particularly emphasized, especially agricultural land, forest ecosystems, infrastructure and the like, have different development opportunities.

The largest number of employed population is concentrated in the urban areas of the region. In 2013, out of a total of 164746 employed people in the region, 101,195 or 61.4% are in urban areas and 63551 or 38.6% are in rural areas (Table 6).

Number of unemployed persons at the regional level is 50971, which makes 23.6% of the economically active population. Out of that number, 31785 or 62.3% of unemployed persons are in cities and 9186 or 37.6% of unemployed persons are in other municipalities.

The ratio of the employed population, as well as the share of the unemployed in the region, show a lack of jobs, marked differences in regional frameworks, lower activity in municipalities of Kostajnica 1.1%, Šipovo 1.7%, Kneževo 1.9%, Ribnik 1% and and relatively low employment rate in rural areas (Jezero 0.1%, Krupa na Uni 0.5%, Oštra Luka 0.3%).

The region is characterized by pronounced territorial and population disproportion of urban and rural areas and pronounced differences in socio-economic characteristics.

Changes in the structure of the active population of the region per sectors of activity indicate orientation and level of socio-economic development (Table 7).

The urban areas of the region have a developed activity structure and a greater share of tertiary activities, e.g. Banja Luka 76.0%, Prijedor 59.2%, compared to rural areas with greater number of employees in the primary sector, e.g. in the municipalities of Krupa na Uni (84.5%), Kneževo (52.4%), Kupres (84.5%), Petrovac (56.6%) and poor development of social activities.

Table 7. Structure of employed people per activity sectors in the Banja Luka region, 2013

Banja Luka region	Share of active population in working-age population (%)	Share of pensioners in the total population (%)	Unemployment rate (%)	Sector of activity		
				I	II	III
Total-regions	36.2	19.0	23.6			
Banja Luka	40.0	19.7	22.9	2.8	21.4	76.0
Gradiška	37.6	18.6	21.7	30.6	24.7	44.8
Prijedor	33.4	20.7	27.5	12.2	28.7	59.2
Koz. Dubica	29.2	21.8	25.8	16.5	35.7	47.8
Kostajnica	40.1	20.2	16.3	19.9	32.7	47.5
Novi Grad	29.0	20.5	30.4	20.7	26.6	52.7
Krupa na Uni	62.0	8.8	1.3	84.5	6.1	9.5
Oštra Luka	22.2	17.7	18.9	27.1	18.9	43.9
Srbac	28.2	17.3	34.1	24.5	29.4	46.1
Laktaši	38.0	15.1	22.5	15.8	31.0	53.2
Prnjavor	34.4	16.2	17.8	22.7	34.4	42.9
Čelinac	34.8	16.9	25.1	15.4	37.6	47.0
Kotor Varoš	36.2	14.9	19.5	10.6	50.6	38.8
Kneževo	44.2	14.7	14.5	52.4	17.8	29.8
Mrkonjić Grad	32.8	22.1	24.1	18.5	33.4	48.1
Jezero	26.1	17.7	24.4	18.2	32.2	49.6
Šipovo	30.8	20.5	30.3	21.5	39.0	39.5
Kupres	58.2	16.0	9.4	84.5	5.8	9.7
Ribnik	36.7	23.1	14.6	42.5	20.1	37.3
Petrovac	45.0	29.9	11.1	56.6	13.2	30.1
Istočni Drvar	64.6	19.6	2.3	64.3	11.9	23.8

Source: (Marinković, Majić, 2018, pp. 330-331)

CONCLUSION

Development of the rural areas of the Banja Luka region is accompanied by various socio-economic problems. Disturbances in demographic and socio-economic structures are recorded at the regional level. The region is characterized by population decrease, negative natural increase, unfavourable age structure, lack of jobs, lower activity in rural areas and relatively low employment rate. Development disproportions between developed urban and underdeveloped rural areas are emphasized in the region.

The need for more detailed analysis of the situation and development opportunities of rural areas of the region is pointed out in order to regulate and direct rural and regional development.

The concept of integrated rural development is considered as a model of development, which could conditionally ensure the sustainability of rural areas and reduce intra-regional differences.

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THE TREATMENT OF NATURAL HAZARDS IN MUNICIPAL SPATIAL PLANS IN THE REPUBLIC OF SRPSKA

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Abstract

Spatial planning plays a vital role in disaster risk reduction. This role is primarily concerned with mitigating risks related to the population, assets, and the environment. The disaster risk reduction measures can be effectively implemented at the local level, and municipal spatial plans represent a proper framework for these activities. From its inception until now, the Republic of Srpska has had several laws related to spatial planning. Unlike the previous ones, the current law that treats spatial planning introduces new concepts to disaster risk management, such as natural risk zone and endangered zone. This paper analyzes the municipal spatial plans developed after 2013 when the new Law on Spatial Planning and Construction was adopted. A total of 15 spatial plans (textual and graphic parts) were analyzed. The analysis aims to determine how natural hazards are treated in these plans. Besides that, measures related to disaster risk reduction defined in spatial plans were also analyzed.

Keywords: natural hazards, municipal spatial plan, risk reduction, Republic of Srpska.

Introduction

In recent decades, natural disasters are progressively threatening human lives, socio-economic activities, and infrastructure. Natural disasters such as river floods, earthquakes, landslides, and extreme weather conditions show that they may severely threaten local and regional development. As Greiving states, such hazardous events may be exacerbated by interaction with other hazards or by occurring in territories with a high socio-economic vulnerability (Greiving et al., 2006). These combined hazardous events often happen suddenly in a short period of time without any warning signs. Besides mentioned events, slow-onset disaster gives an early warning so that local/regional communities can see how the hazards develop and prepare an appropriate response. Disruption in economic activities and human casualties can be attributed chiefly to climate change (Anderson & Bausch, 2006; Banholzer et al., 2014; Benevolenza & DeRigne, 2018) and due to rapid urbanization (Sanderson, 2000; Lindell and Prater, 2003; Lall & Deichmann, 2009). Efforts for minimizing hazardous events should consider the frequency, intensity, and predictability of hazards. United Nations defined disaster risk reduction as the concept and practice of reducing disaster risk through systematic efforts to analyze and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and environment, and improved preparedness for adverse events (UN/ISDR, 2009).

The Hyogo Framework for Action (HFA, 2005) and several researchers (Burby et al., 1999; Smith, 2004; Dandoulaki et al., 2005; Greiving & Fleischbauer, 2006) advocates land management as an effective instrument for disaster risk reduction. The Hyogo Framework for Action also suggested that risk assess-

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ment should be incorporated into spatial and urban planning, especially in disaster-prone areas.

The increasing exposure of society to natural hazards needs to be seriously taken into account in any development proposal to avoid human and financial losses in the future (Sutanta et al., 2013). Therefore, spatial planning may minimize future vulnerabilities, although spatial planning probably does not play a decisive role in all phases of the disaster management cycle.

Integration of disaster risk reduction into spatial planning and development programs at all administrative levels is desirable. Mitchell states that mainstreaming at the national context can be realized when all related government agencies at all levels become concerned and involved in the development of the disaster risk reduction framework at the same time (Mitchell, 2003). Besides the aforementioned, Incheon Declaration promotes the integration of disaster risk reduction and spatial planning at the local level (Incheon, 2009). The local community is the one who has to respond to the disaster, so the main challenge is to implement effective policies and tools for disaster risk reduction.

Spatial planning and hazard mitigation

Various definitions of spatial planning exist. For example, the Compendium of European Spatial Planning defines spatial planning as methods used mainly by the public sector to influence the future distribution of activities in space (European Commission, 1997). The Compendium states that spatial planning is undertaken to create a more rational territorial organization of land uses and the linkages between them to balance demands for development with the need to protect the environment and achieve social and economic development objectives. It embraces measures to coordinate the spatial impacts of other sectoral policies to achieve a more even distribution of economic development between regions than would otherwise be created by market forces and to regulate the conversion of land and property uses. Fleischhauer adds that spatial planning influences the future distribution and pattern of activities in terms of their locations (Fleischhauer, 2008).

Spatial planning has a development and a regulatory function. As a development mechanism, the government has to elaborate upon development tools for providing services and infrastructure, establishing directions for urban development, preserving national resources, and enabling incentives for investment. As a regulatory mechanism, national/regional or local governments have to approve a given activity (Stead & Nadin, 2008).

Spatial planning has numerous aims, and some of them are referred to as the promotion of territorial cohesion through a more balanced social and economic development of regions and improved competitiveness. Also, spatial planning encourages development generated by urban functions and improves the relationship between the town and the countryside (Stead & Nadin, 2008; UN/HABITAT, 2015). Aims also encompass promoting more balanced accessibility and developing access to information and knowledge. Besides that, spatial planning has to reduce environmental damage and enhance/protect natural resources. Enhanced cultural heritage as a factor for the development and encouraging sustainable tourism certainly represent important spatial planning aims. In recent years, developing energy resources while maintaining safety is stressed as an essential spatial planning aim. The last but not less critical aim is the limitation of natural disasters' impact.

As mentioned before, spatial planning has its role in disaster risk reduction. Sutanta et al. (2010) identified four possible roles of spatial planning in disaster risk reduction:

- Prohibiting future development in certain areas. In the highly prone area, especially with a history of disaster occurrences, development should be banned. Areas required for emergency response and retention need to be kept free.
- Classifying different land-use settings for disaster-prone areas. Every disaster has its own acceptable risk on various land use classes. The steep slope, which is highly susceptible to landslide, should not be us for the residential or commercial area but may still be suitable for plantation.
- Regulating land use or zoning plans with legally binding status. In an area vulnerable to earthquakes, regulation on building density is essential to reduce the impact of building collapse.
- Hazard modification. Spatial planning can play a role in promoting soft engineering methods to reduce the risk of flooding. Retarding basins required to contain floodwater should be kept free of development to maintain its function.

It is important to emphasize that spatial planning must consider all spatially relevant natural hazards and cannot reduce its focus to only one or two hazards (Greiving et al., 2006). Every hazard has a spatial dimension. But the occurrence of spatially relevant hazards is limited to a particular disaster area, which

is regularly or irregularly prone to hazards (e.g., river flooding, landslides, storm surges). Spatially non-relevant hazards occur more or less anywhere (Fleischhauer, 2008). Table 1 represents that not all natural hazards lead to spatially relevant risks. Hazards like river floods, storm surges, landslides have the highest spatial relevance. Other hazards, such as forest fires, have a medium spatial relevance because they might occur in only certain areas (forests and semi-forest areas). However, such sites are large in number and often broadly spread over the territory. Thus they are ubiquitous to a certain extent (Fleischhauer, 2008).

Table 1. Spatial relevance of certain natural hazards (adapted from Fleischhauer, 2006).

Risks / hazards	Spatial relevance: ++ = high + = low 0 = none
River floods	++
Storm surges	++
Avalanches	++
Landslides	++
Earthquakes	+
Droughts	+
Forest fires	+
Extreme temperatures (heat waves, cold waves)	+
Long-term consequences of human-induced climate change	+
Epidemics	0
Meteorite impacts	0
Self-reinforcing global warming (runaway greenhouse effect)	0

Spatial Planning System in Republic of Srpska

In terms of administrative and territorial division, Bosnia and Herzegovina is divided into two entities: the Republic of Srpska and the Federation of B&H. In addition, the arbitration territory of Brčko has been declared a separate district. In Bosnia & Herzegovina, spatial planning does not exist as a state competence, but exclusive rights for planning lie with the respective entities, as well as with Brčko District (Marjanović, 2017). The modern system of spatial planning, which provides conditions for the utilization, protection, and management of the Republic of Srpska territory, results from the efforts of planning experts and academia and political structures that have recognized spatial planning as an activity of national importance. The cornerstone for spatial planning, and especially the implementation of spatial plans, lies in the legislative framework of the Republic of Srpska. Besides that, the entity institutional system and subjects in spatial planning at the entity and local level play an essential role in every aspect of planning (Živak, 2021). The whole system of spatial planning is based on the Constitution of the Republic of Srpska, the principal law in planning and bylaws. Special laws regulate the relationship of the spatial planning system to other areas. Institutions responsible for the spatial planning in the Republika Srpska, and thus for its efficiency, are the Government of the Republic (Ministry of Spatial Planning, Civil Engineering, and Ecology) and representative bodies of local government. The central (entity) government has a dominant role in determining development and planning policy and defining the legal framework.

When it comes to the hierarchy of planning documentation, Law on spatial planning prescribed two main categories of plans: strategic and executive (regulatory) plans (LSPC, 2013). Strategic planning documentation refers to spatial and urban (master) plans. These plans are long-term planning documents that define the primary goals and principles of territorial development. They are usually made for 20 year planning period. Unlike strategic, executive (regulatory) plans are technical-regulatory documents of physical planning that define the conditions for designing and constructing various facilities. These plans are usually made for a period of up to 10 years.

If we consider the previous legal framework related to spatial planning, laws from 1996, 2002, and 2010 just partially paid attention to natural hazards and their mitigation. The weakness of the solutions associated with the natural hazards is reflected in the fact that the multisectoral approach was neglected. Also,

Table 2. Planning instruments at different governance levels in Bosnia and Herzegovina (adapted from ESPON, 2016)

Planning level	Planning instrument	Type
Entity	Spatial plan for the Republic of Srpska	Strategic
	Spatial plan for an area with special purpose	Strategic
	Zoning plan for an area with special purpose	Executive
	Parceling plan for major infrastructure facilities	Executive
Local	Spatial plan of self-local government unit	Strategic
	Zoning plan for an area with special purpose on local level	Executive
	Urban plan	Strategic
	Zoning plan	Executive
	Regulatory plan	Executive
	Urban planning projects	Executive
	Parceling plan	Executive

previous laws did not define the segments of spatial plans that have the task of identifying and assessing natural hazards. This led to the solutions that only declaratively addressed the problems that may arise from natural hazards. Unlike the previous ones, the current law from 2013 introduces new concepts related to disaster risk management.

All subjects involved in making spatial plans are obliged to consider the public interest, general and specific goals of spatial development, and ownership status of the land, including interests of private investors. Also, subjects involved in planning have to ensure coordination of sectoral policies, including adopting necessary measures for mitigating natural and other hazards to protect the population and assets. The law specifically emphasizes the need to make seismic, hazard and flooding area maps and maps for other risks. It is essential to point out that the law on spatial planning introduced an article that refers to the impact of climate changes on planning territory for the first time.

Incorporating natural hazards mitigation measures in spatial plans is enabled through defining natural risk zones. By definition, natural risk zones are determined according to the area's natural characteristics (atmospheric, hydrological, seismological, and flame phenomena). Due to their location, severity, and frequency, they can seriously affect society (LSPC, 2013). Natural risk zones can be defined in all planning documents, and they can vary in spatial scale.

Certain areas affected by natural (and other) hazards can be declared as danger zones. Planning of the danger areas is of great importance both for the entity level and the local level. Danger zones can also be declared special-purpose areas, so an adequate spatial plan can be made primarily to solve emergent issues.

The municipal (local) spatial plan plays a vital role when it comes to tracing local development. Law on spatial planning states that municipal spatial plan takes over and elaborates in more detail the planning commitments from the Spatial Plan of the Republic of Srpska or commitments from other plans of a higher order (LSPC, 2013). Further, the municipal spatial plan has to determine the basis of land use in urban and rural areas and the settlement network and their connections. Besides that, zones of the state, regional, and local infrastructure facilities are defined in municipal spatial plans, including public services of importance for the local community. When it comes to the protection stage, the municipal spatial plan creates a framework for protecting local natural resources and cultural heritage. In natural hazard mitigation, Law on spatial planning stressed the importance of integrating earthquake protection measures into municipal spatial plans. In addition, these plans have to have prescribed measures for protection against natural disasters, including measures for recovery of endangered zones (flood, earthquake, landslide susceptible zones).

Dealing with Natural hazards in Municipal Spatial Plans

As stated before, the local government is the one who has to respond to a disaster at first instance. In the prevention stage, local government can influence natural hazard mitigation by adopting and implementing strategic and executive planning documents that fully respect disaster risk reduction. The integration of disaster risk reduction into spatial planning has to include elements such as policy, organization, data, and platform (Sutanta et al., 2010). Hazard mitigation can go in line with economic development, environmen-

tal quality, community development, housing, and infrastructure programming (Burby et al., 2000). The same authors state that local government might use various techniques in guiding the location, intensity, type, quality, design, and timing of spatial development. Many of the listed development management tools can be applied to natural hazard mitigation (Burby et al., 2000).

These tools are referred to as building codes, development regulations, structural measures, public facilities policies, land and property acquisition, taxation and fiscal policies, and information dissemination. Building codes are critical instruments for improving the resilience of the built environment to natural hazards (Burby & May, 1998). They include traditional building codes, flood-proofing requirements, seismic design standards, and retrofit requirements for existing buildings.

Development regulations are the traditional site development tools of contemporary planning. They prescribe the location, type, and intensity of new development (Burpy, 2000). These can include flood zone regulations, landslide areas, erosion areas, and zoning overlay zones for sensitive lands, such as wetlands and hillsides.

Structural measures for hazard mitigation are used to reduce the risk associated with physical development that has to be located close to hazards. Structures situated in hazard-prone zones need to be designed to withstand anticipated hazard impacts or retrofitted to meet standards relating to the hazard threat (Glavovic, 2010).

Public facilities policies affect public or semi-public facilities. These policies include long-term capital improvement programs, location of educational facilities, and location of public utilities to minimize disruption from hazards. Burby states that one apparent policy is to avoid placing public facilities in hazardous locations. In addition, facilities should not be sited where they would facilitate growth into hazardous areas (Burby, 2000).

Land and property acquisition is used to purchase hazardous properties with public funds and convert them to less dangerous uses. This can include acquisition of undeveloped land, acquisition of development rights, transfer of development rights to safer locations, relocation of buildings or services, and acquisition of damaged buildings (Burby, 2000).

Taxation and fiscal policies are used to more equitably shift public costs to owners of the hazardous property. These policies can include impact taxes for hazardous area development, tax incentives for reducing land-use intensities in dangerous areas, and risk-based taxes to support emergency management services.

Information dissemination seeks to influence the choices of residents and public officials when it comes to activities in hazard-prone zones. Burby states that information programs include public information, education of construction professionals, hazard disclosure requirements in real estate transactions, and construction of signs that warn people of high hazard areas (Burby, 2000).

Above mentioned tools allow planers to use several approaches to mitigate hazards. Some of the tools emphasize long-term strategies, while others react to current development proposals. Some try to reduce development in hazardous areas, while others accept such development but focus on site and buildings design to reduce vulnerability. Some redirect public investment, but most seek to regulate or influence private development. Some are regulatory, and others are voluntary.

From 2013, when the new law on spatial planning in the Republic of Srpska was adopted, to the present time, 15 spatial plans were adopted or are close to adoption. These plans are subject to analysis because they should be more "hazard sensitive", especially if we consider specific solutions from the law. The analysis refers to hazard mitigation measures that are incorporated in spatial plans. Earthquakes, landslides, floods, forest fires, and extreme weather conditions are identified as the most common natural hazards in the Republic of Srpska.

The general impression is that natural hazard mitigation measures are not sufficiently represented in municipal spatial plans. Usually, these measures are set as general measures without a specific view on local characteristics. It should be noted that there are some cases where chapters on hazard reduction measures are identical in several municipal spatial plans, even though these local communities have different natural conditions. In just six municipal spatial plans, location-oriented mitigation measures can be found. These measures are usually referred to as structural flood protection measures such as riverbed regulation and embankment construction. It is evident that thematic maps on natural hazards and risks are missing in all analyzed plans. In several planning documents, natural risk zones are mentioned but not identified on maps.

Earthquake-related measures mainly relate to non-structural measures, such as building codes and choosing a location in line with seismic risk. For landslides related measures, both structural and non-structural measures are present. Building restriction in landslide-prone zones, deforestation prevention, agricultural practice with an emphasis on soil erosion, establishing of landslides cadastre are often listed in the group of non-structural measures. In the group of structural measures, the construction of ob-

Table 3. Hazard mitigation measures in local/municipal spatial plans in the Republic of Srpska

Natural hazard / Local community	Earthquakes	Landslides	Floods	Extreme weather conditions	Forest fires
Banja Luka	NS	NS	S, NS	NS	-
Bijeljina	NS	S, NS	LS, LNS	-	-
Brod	-	NS	S, NS	NS	S, NS
Vukosavlje	NS	NS	LS	-	S, NS
Gacko	NS	LS	LS	-	S, NS
Derventa	NS	S	LS	-	-
Doboj	NS	S, NS	S, NS	NS	S, NS
Laktaši	-	NS	NS	-	S
Mrkonjić Grad	NS	NS	-	NS	-
Ribnik	NS	S, NS	S, NS	NS	S, NS
Stanari	NS	S, NS	LS, NS	NS	S, NS
Teslić	NS	NS	LS	-	S, NS
Han Pijesak	NS	NS	-	NS	S, NS
Čelinac	NS	NS	LS, NS	NS	-
Šamac	NS	NS	S, NS	-	S, NS

S = structural measures, NS = non-strucutral measures, LS = location oriented structural measures, LNS = location oriented non-structural measures.

jects whose primary purpose is the drainage of excess water is dominant. The most elaborate measures are structural and non-structural measures related to flood hazards. There are many of the listed measures in analyzed plans, and usually, they take into account local characteristics. One interesting detail is reflected in the spatial plan of the municipality of Šamac, where it is stated that flood protection should be in line with the EU floods directive (Directive 2007/60/EC), even though the Republic of Srpska and Bosnia and Herzegovina are not part of the European Union. Extreme weather conditions like drought, hail, storm winds, excessive rainfall, high and low temperatures are unfairly neglected in all analyzed spatial plans. Objectively, these hazards are present and frequent in the whole territory of the Republic of Srpska, and damages from them can be grave, especially for local communities. The incorporation of structural and non-structural fire protection measures in municipal spatial plans is on a satisfactory level. Well-developed sectoral planning certainly influenced this. One set of measures worth mentioning is related to protection against infectious disease. Only three municipal spatial plans prescribe these measures, but just in a general manner. It can be seen that taxation and fiscal policies, as mitigation measures, are almost not mentioned in any municipal spatial plan. More precisely, information dissemination and education of decision-makers and the general population are largely neglected and found in just four municipal spatial plans.

Conclusion

Detailed natural hazard analysis and risk assessment are not the responsibility of spatial planning. Instead, the result of such activities should be considered while the planning process is underway. This imposes the need for close coordination between sectoral planning and spatial planning authorities and political and administrative authorities. Currently, subjects in charge of disaster risk reduction and spatial planning in the Republic of Srpska are working uncoordinated, but that has to be changed.

Apart from the legislative framework, where the role of spatial planning is well defined, planning practice in the Republic of Srpska reveals certain shortcomings concerning natural hazards mitigation. It is evident that disaster risk reduction is not well recognized and incorporated into the local level spatial planning. Municipal spatial plans only mention hazard mitigation measures without detailed explanation. Besides that, spatial determination of hazard-prone zones in thematic maps is missing.

Although there are many drawbacks when it comes to natural hazards treatments in municipal spatial plans, some improvements can be seen. For instance, some hazards such as floods are treated more systematically in recent municipal spatial plans. Additional efforts need to be made, especially in develop-

ing methodology for "hazards sensitive" spatial plans. In line with that, the education of planning experts in the field of disaster management is desirable. Spatial planning with a focus on hazard mitigation can be an essential factor for making disaster-resilient local communities.

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DEVELOPMENT OF THE URBAN SYSTEMS IN SERBIA- TOWARDS NEW SPATIAL PLAN OF THE REPUBLIC OF SERBIA

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Abstract

In the light of making a new Spatial plan of the Republic of Serbia 2021-2035 (SPRS), the paper is elaborating on the current state and prospects of spatial development of the urban systems in Serbia. With reference to previous SPRS and implementation programs, the importance of the urban systems in the interregional and intraregional integration of Serbia and its environment is critically considered. In the SPRS from 1996., the roles between the specific centers in the organization of the territory of Serbia were not clearly divided, nor was there a clear division between the spatial plans` jurisdictions of the local communities, regions or state. The SPRS from 2010, among other things, advocated the principle of subsidiarity, which supports the functional organization of space and is based on concentration of the functions in certain centers. How the new plan perceived the position and role of urban systems, for the purpose of rational territorial organization of the Republic of Serbia and what changes enacted to establish a coherent space in the Republic of Serbia, are some of the questions this paper tried to answer.

Keywords: urban systems, integrations, sustainability, decentralization, coherence

Introduction

Today's situation in the Republic of Serbia (RS) regarding the spatial distribution of settlements is characterized by conditional **unevenness**. Favorable geographical position of settlements, their number (4.542 settlements, excluding Kosovo and Metohija), demographic or human potential, and the impression that they are distributed relatively well throughout the territory of RS, could mislead and without further research indicate that it is a territory that has very good and properly located urban system (Figure 1). This is relatively true until a detailed analysis of its structure according to different socio-economic criteria is performed. Significant regional disparities can be observed between Vojvodina and the geographically central part of Serbia. The Autonomous Province of **Vojvodina**, with a relatively rationally located and urbanized network of urban and other settlements, dominates the Serbian geospace. The highest degree of homogeneity of smaller subunits within the Vojvodina area is the result of the inherited urban matrix from the earlier period, but also the morphology of the terrain, which conditioned a clear and favorable distance between settlements and the possibility of their good connection. In the (geographically) **central part of Serbia**, settlements are more irregularly distributed, so different morphological and territorial units are distinguished, starting from those in which there are larger centers by demographic capacity, more densely distributed, to those territorial units in which there are almost none but where there are less urban, isolated parts that differ from the rest of Serbia. In other words, more densely distributed settlements are mostly positioned on the development axes, between which there is, conditionally, a lot of space that is in the "pure" sphere and where there are no demographically stronger poles. Namely, if the

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mentioned centers, spreading on the West Moravian route (Užice-Čacak-Kraljevo-KruŠevac), the Great Moravian route (Smederevo-Požarevac-Jagodina-Ćuprija-Paraćin) and the South Moravian development route (Niš-Leskovac-Vranje) are excluded, larger urban settlements in terms of functional capacity are only Kragujevac, in Šumadija part of the central Serbia and Valjevo in Kolubara part, and between them, except Gornji Milanovac, there is almost no major urban center. Furthermore, in the rest of the Serbia, in the eastern part of central Serbia (Timočka Krajina), larger centers as Bor and Zaječar can be noticed, and in the western part - Novi Pazar. Between the concentration zones of the population, functions, etc. (development axes), in the remaining part of Serbia, the distribution of smaller settlements, mostly rural, is irregular and concentrated in the form of sporadic enclaves in a demographically, economically and functionally insufficiently integrated area.

The distribution of settlements on the territory of RS coincides with the population concentration. The urban network of Serbia is characterized by a very pronounced development gap between the central (Belgrade) and other urban settlements (Table 1). The dominant position of Belgrade in relation to the national urban system is indicated by the index of urban primacy whose value is 4.86 (the ratio of the number of inhabitants of Belgrade and Novi Sad). The phenomenon of the dominant city in the urban hierarchy (far larger demographic size in relation to the second in a row - Novi Sad) and the lack of evenly distributed urban settlements of medium demographic size (from 200,000 to 500,000 inhabitants) is primarily the result of untimely directing of urbanization and inherited development policy from previous periods, according to which Belgrade was economically and functionally developed as the capital of the Socialist Federal Republic of Yugoslavia (SFRY).

Table 1. The ratio of demographic size of Belgrade and the most numerous urban settlements in relation to the total population of Serbia in 2011

	1971	1981	1991	2002	2011
G1/total population	0,14	0,16	0,20	0,21	0,23
G1/G2	5,84	5,88	5,94	5,27	4,86
G1/ G2+G3+G4+G5	1,78	1,83	1,90	1,80	1,80

Source: Census 2002., 2011, Statistical Office of the Republic of Serbia.

Some expert opinions emphasize the views of the Serbian territory overurbanization, in the first place the overurbanization of the dominant developmental pole - Belgrade, however, detailed research and knowledge of socio-historical processes of this area indicate that Serbia is still insufficiently urbanized state (Tošić, D., Nevenić, M., 2010), and that Belgrade was, like some other centers (e.g., Budapest, Vienna) developing primarily for the needs of former SFRY. Due to unfavorable political and economic conditions during the nineties of the 20th century, it remained the capital of a much smaller territory compared to previous period (while it was part of the SFRY), but with inherited problems of overcrowding, traffic and infrastructural neglect, etc. Also, starting from the point of view that urbanization is a historical-geographical, i.e., socio-historical legality that showed different tendencies depending on the space and conditions in which she took place (somewhere it went faster due to a better economic basis), it can be said that in the urban system of Serbia polarization processes prevail, with accompanying effects. With planned urbanization, initiated by industrialization, city centers attracted the population in proportion to their functional capacity, which led to polarization of the Serbian space (Jeftić, M., 2013). The processes of polarization are justified and logical, having in mind the fact that Serbia was a centralized state with a planned economy and a capital city who, as the most functionally developed in the country, attracted the largest number of inhabitants and thus created a large disproportion in the national urban system. The

Figure 1. Network of settlements in the Republic of Serbia
Source: Spatial Plan of the Republic of Serbia, 2010.

pressure on Belgrade alleviated the process of suburbanization in the internal spatial and functional structure of the metropolitan, i.e., the City of Belgrade, but also the development of other local and regional centers that attracted the population of the narrower and wider area. There was no decentralization of urbanization at the level of Serbia, which reflected in the slowing down of stronger functional and economic development of other urban centers on the territory of the Republic. The current trend within the national urban system is conditioned by the change of the socio-political system, i.e., liberalization in the economy and by transition from a centralized economy to almost liberal capitalism. In the EU member states, liberal capitalism is defined by the laws that govern them, while in Serbia these processes take place more spontaneously than planned (Nevenić, M., 2009).

The problems of urban development and the development of the Serbian urban system are ambiguous and multidimensional. They appear in the domain of unfinished harmonization of domestic legislation with the European one (as well as its actual application), horizontal and vertical inconsistencies of the institutions and planning documents, "mixing" of competencies, insufficiently clear responsibilities in space, etc. One of the biggest problems is certainly **depopulation**, which is reflected through two prisms - a general decrease in population, but also through the disruption of the socio-economic stability of population structures in terms of labor quality, population aging, emigration, etc. Of particular concern is the emigration trend of the highest quality labor force to stronger functional capacity centers, i.e., abroad. Nikitović, V. points to recent estimates of the demographic situation in Serbia, based on which it is observed that "every year on average about 50,000 people go abroad for at least a year, and that about 35,000, mostly old and retired people, return to their homeland" (Nikitović, V., 2020). Depopulation is accompanied by a reduced impact of urban centers on their surrounding area, where the centers` functions are less and less integrating their immediate surroundings.

From functional urban areas to urban systems- brief review

Spatial Plan of the Republic of Serbia, 1996

With the abolition of inter-municipal regional communities, on the basis of similar separation criteria, the territory of RS was divided, by the Law on Territorial Organization of RS in 1992., into 29 administrative districts and the territory of the City of Belgrade[1]. This is also the period of SFRY disintegration, war conflict, introduction of international sanctions against Federal Republic of Yugoslavia. It comes to economic, financial, social and collapse in all other social spheres. Several attempts to rebuild the state are blocked and fail in the conditions of international isolation of the country, loss of previous markets and the introduction of the so-called war economy. However, in the state system planning, there is an initiative to develop the territory of the RS in a planned way, i.e., a consensus is established on the thesis that without spatial planning there is no rational organization. For the purpose of this goal in 1996. year, the first Spatial Plan of the Republic of Serbia was finally formed, which, for the first time in the theory and practice of planning, introduces the term functional areas. Until the drafting of the Spatial Plan of RS in 1996. year, planning documentation on the impacts of the centers on their surroundings, i.e., functional urban regions, did not exist, but was a territorial division of the state in administrative and governance terms, into certain units that played the role of functional regions (counties- srezovi and inter-municipal communities). The basic hypotheses of the division into functional areas were as follows (OG RS 13/1996):

1. Governing rationalization and more efficient work performance in the field of everyday needs of citizens[2]
2. Organization of public services more harmonized with the needs, possibilities and interests of local communities.
3. More efficient coordination of activities and programs of local communities[3]

[1] Administrative districts (okruzi) were later renamed into districts (oblasti) and today RS (according to the amendments to the Law on Regional Development - Official Gazette of RS No. 30/10 and 89/2015), is administratively-territorially divided into provinces, regions, administrative areas, City of Belgrade, cities and municipalities. The territorial organization of RS consists of five regions (Belgrade region, Vojvodina region, Šumadija region, western Serbia region, Southern and Eastern Serbia region and Kosovo and Metohija region). They include the City of Belgrade as a special territorial unit determined by the Constitution and by Law, and 30 administrative districts, 24 cities, 30 city municipalities, 150 municipalities, 6,158 settlements and 193 urban settlements.

[2] This hypothesis was the basis of functionalism, i.e., the functional organization of the territory of RS. Thus, the needs of the citizens were the basis for the regionalization of the territory of RS, which caused the incompatibility of the functional division (true in smaller segments) with the territorial administrative division into administrative districts.

[3] The principle of subsidiarity was not sufficiently satisfied with this hypothesis. The rule of European subsidiarity, as a basic rule of the EU, is based on respect for local initiatives through institutionalized forms of action. It implies the participation of the public and the

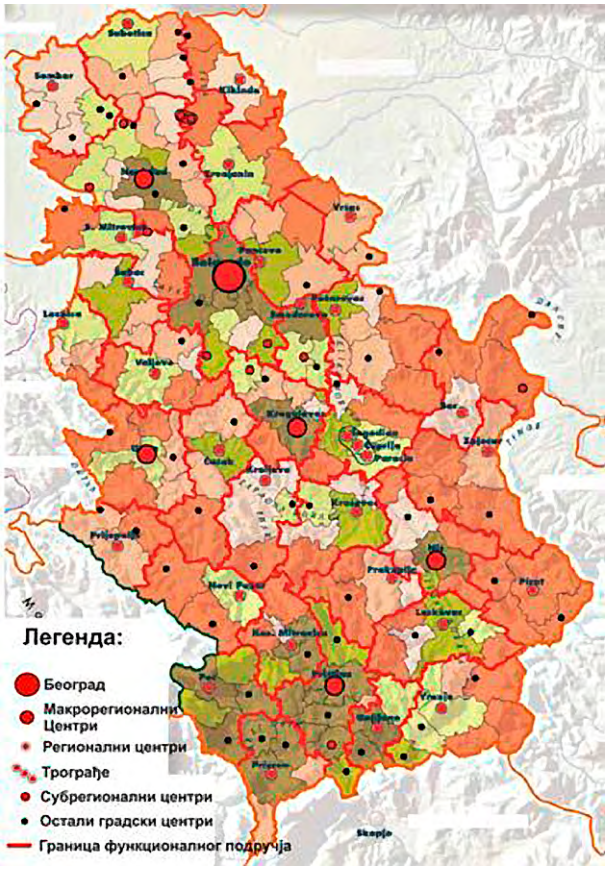

Figure 2. Functional areas in Serbia
Source: Spatial Plan of The Republic of Serbia, 1996

Based on these hypotheses, 34 functional areas of RS were singled out, organized according to the principles of dominant centers (Figure 2). Thus, at the top of the hierarchical pyramid was the state center (Belgrade). Lower rank had macro functional areas, in whose core areas were macroregional centers (Novi Sad, Niš, Priština, Kragujevac and Užice), then functional areas of lower rank, within whom were influential spheres of smaller or larger urban centers (regional, subregional centers, developed urban centers, rural community centers, etc.).

Spatial Plan of the Republic of Serbia, 2010-2020

The concept of functional areas in the Spatial Plan of RS from 2010, following the example of European Spatial Planning, i.e., ESPON methodology, was replaced by the FUA model[4]. The hierarchy of centers from the first Spatial Plan of RS (1996), despite all the changes, conditionally speaking, was retained in the second national Spatial Plan from 2010 (Figure 3). The central city has been given an even greater opportunity to be the main development conceptor of the processes that will take place in the future. The basic planning goal is directed towards the determination, organization and networking of FUAs as a basis for balanced regional development of the RS. Accordingly, a hierarchy of Serbian centers is given, based on which they are categorized into 6 levels[5] (*OG RS 88/2010*):

- 1 center in the category of European MEGA 3 - Belgrade
- 2 centers of international importance - Novi Sad and Niš
- 21 centers of national importance - Čačak, Kragujevac, Kraljevo, Kruševac, Kikinda, Leskovac, Loznica, Novi Pazar, Jagodina, Pančevo, Požarevac, Šabac, Smederevo, Sombor, Sremska Mitrovica, Subotica, Užice, Vranje, Valjevo, Zaječar and Zrenjanin.
- 2 centers of regional importance - Pirot and Vršac.

In accordance with the main (but also specific objectives), the Spatial Plan concept (2010 year) started from the following principles of FUAs spatial development, which refer to: polycentricity, sustainability, cooperation, decentralization of functions and activities, subsidiarity, competitiveness and coherence. Special emphasis is placed on the principle of subsidiarity, which is not sufficiently elaborated in the previous plan and which supports the functional organization of space and is based on the concentration of functions in certain centers. The roles between certain centers in the organization of the Serbian space were not clearly divided in the previous plan, nor was existing a clear distribution between the competencies of the spatial plans of local communities, regions or the state.

By comparing the role and importance of functional areas in the old and national Spatial Plan (from 2010), it is possible to conclude that the FUAs in the 1996 plan were treated as functional areas by whom was Serbia completely "covered". The methodology of FUAs delimitation in the old plan was different in relation to the Plan from 2010 year. Also, in the Spatial Plan from 1996., functional areas did not have a prefix urban, which is logical bearing in mind that Serbia

non-governmental sector in the system of producing and adopting strategic documents.

[4] The data used in the research were generated at the municipal level, i.e., the impacts of the first and second order of neighboring municipalities of the analyzed city and vice versa (city as an administrative territory) were considered, without using the level of settlements within the municipality, which would of course give a more precise picture of the spatial disposition of the same influences. As a result, marginal relations have been abstracted in the plan and determined are, in relation to the observed regularities of some parts of Serbia, the limit values that delimitate the scope of FUAs influence. As the boundary of each FUA is dynamic and subject to change in a short time, their graphical representation is presented exclusively as a model and not as a precise image indicating any administrative division (*OG RS 88/2010*).

[5] In Kosovo and Metohija, due to the lack of relevant data, the situation remains defined in the same way as in 2009 year.

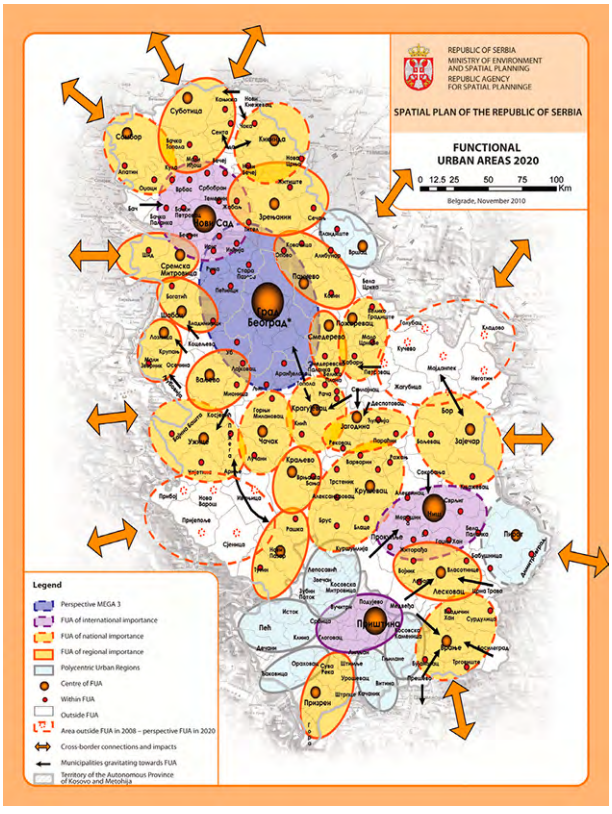

Figure 3. Functional Urban Areas in Serbia.
Source: Spatial Plan of The Republic of Serbia. 2010-2014-2020. Abridged version, 2010, Republic Agency of Spatial Planning, Belgrade
[click on figure to enlarge]

was not sufficiently urbanized at the time first spatial plan was made (according to the 1991 Census, Serbia had about 50% of the urban population), nor were existed functionally developed urban relations to which one city center would have a wider territorial entirety that completely gravitates to it. The situation has changed to date.

Spatial Plan of the Republic of Serbia, 2020-2035- urban systems in Serbia

Recent SPRS 2021-2035 is currently in the draft stage (has passed procedure of the public insight). Similar to previous spatial plans of RS, this plan through planning regions[6] organizes the space of Serbia at the level of urban areas which in perspective should have the role of more even and rational regional development instruments (Figure 4). The specific urban system development objectives are focused on the following: (2) An urban center with a functionally dependent surrounding area, i.e. urban area as a basic structural unit of spatial organization; (2) Establishing a hierarchy of urban systems and centers based on subsidiarity by decentralizing the centers` functions; (3) Polycentric development of agglomerations as an instrument of controlled concentration; (4) Transformation of smaller urban centers in rural areas into progressive and prosperous centers of rural areas; (4) Sizing the functions of urban centers according to the total number of space and services users, which includes the number of permanent residents and other permanent and occasional users.

The prefix functional (urban areas) has been replaced, in the new plan, by the notion urban areas. In terms of terminology and practice, there are not much essential differences between urban areas and functional urban areas because both terms are recognized as a *"territory of variable coverage and different morphological and physiognomic manifestation, which besides urban center is consisted of surrounding settlements and rural areas, connected with the center by daily commuting of labor force and other population movements conditioned by functional dependence of the center"*[7]. Serbian society is seen in the plan as urbo-centric (about 60% of the urban population lives in the cities that have a dominant position in the Serbian geospace). Compared to the previous SPRS, the new plan especially separates urban settlements from rural ones and makes their more detailed and precise classification, so urban areas are divided into 5 categories and rural to.

In general, based on the territorial distribution of settlements, their demographic capacity and other criteria, the urban system of Serbia consists of (Jeftić, M., 2013; SPRS 2021-2035, Draft):

1. **Belgrade agglomeration**, i.e., Belgrade urban area, which is in the which is in the metropolis category of the European rank and has an impact on the entire Serbian territory. It is polycentric, but with a pronounced centralization of the core settlement (Belgrade) and with internal differentiation into

[6] Even more attention was paid to the planning regions of Serbia compared to the previous period, because the elaboration of the planned spatial development of the RS will be carried out through a new generation of regional spatial plans, i.e., through the revision of all spatial plans of special purpose areas adopted before 2010. year, in order to perceive the degree of planning solutions` implementation and to test the concept of spatial development in the special purpose areas.

[7] *Depending on the demographic size, traffic accessibility and functional capacity, urban areas are hierarchically organized. Depending on the number of functionally connected urban centers, urban areas can be* ***polycentric****, and morphologically they are recognized as a* ***metropolitan area*** *(complex and dynamic system of urban settlements of multilayered hierarchy and high degree of functional and spatial relations),* ***urban agglomerations*** *(morphologically and functionally connected urban centers of significant functional capacity),* ***urban areas with different zones of influence*** *and* ***urban centers of rural areas*** *(SPRS 2021-2035, Draft).*

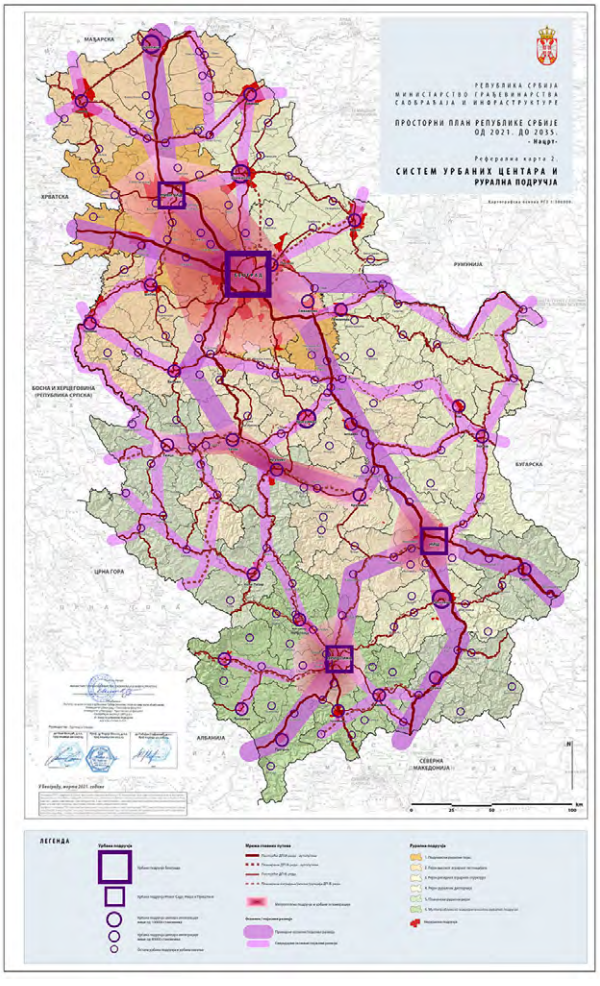

Figure 4. System of urban centers and rural areas in Serbia

Source: SPRS 2020-2035, Draft. https://www.mgsi.gov.rs/sites/default/files/PPRS%20Nacrt.pdf

[click on figure to enlarge]

subcenters and suburbies of different characters and hierarchical ranks[8].

2. **Novi Sad urban area and Niš urban area** (former macro-regional centers - Novi Sad and Niš). Novi Sad is a polycentric urban agglomeration that spatially and functionally integrates the entire territory of Vojvodina. In a broader sense, Novi Sad urban area is a part of the larger bipolar Belgrade-Novi Sad FUA. Niš urban area also forms the wide zone of influences which, compared to the previous period, is weaker due to the decreasing number of inhabitants in the municipalities out of which is Niš (functional) urban area consisted of.
3. **Larger agglomerations networked by development axes** actually represent the backbone of primary development axes on the territory of RS (Danube-Posavina, Moravia-Great Moravia, South Moravia, West Moravia, etc.).
4. **Centers of former FUAs**, which are most often the centers of districts-areas[9]. SPRS 2021- 2035 in this category recognizes urban areas that are outside the primary development axes such as Kragujevac, Valjevo, Bor, Novi Pazar and others.
5. **Municipal centers that have the status of urban settlements**. They number from 5,000-15,000 inhabitants and in the conditions of economic recession they face the problem of insufficient contingent of employed population which could prospectively support these municipalities and be the carrier of their spatial and economic development[10].
6. **Central settlements that have a certain centrality but do not have the status of an urban settlement.** These are municipal centers of rural character with a small impact zone, which functionally meet the needs of the local population and exist in almost all parts of Serbia, and are especially typical for underdeveloped parts of Serbia (eastern, western, southeastern Serbia).
7. The existing classification of the centers, among other things, allows a qualitative organization of functional connections and relations within the RS, and at the same time provides multiple possibilities for different types of cooperation between

[8] Belgrade FUA is a multifunctional system within which exists one system with two subsystems of the first and second rank. The first rank has the core of the City of Belgrade in the administrative sense, i.e., the city settlement of Belgrade with a zone of intensive, weaker and weakest influences. The area of the Belgrade settlement intensive influences includes the periurban ring settlements of the City. The weaker influence zone consists of the parts of Stara Pazova municipality, the City of Pančevo and the municipalities of Pećinci, Opovo and Smederevska Palanka, while the weakest influence zone of the Belgrade settlement is built on the previous ones, including the parts of Kovin, Kovačica, Ruma municipalities and Cities of Valjevo, Šabac, Smederevo and others. In the **second rank** are three subcenters (Mladenovac, Lazarevac, Obrenovac) of similar demographic size, which form a secondary subsystem, also polycentric one. **The centers of lower rank** within the secondary subsystem are Grocka, Sopot, Barajevo and according to the recent development tendencies and to the analysis of the last Census from 2011 - Surčin and Borča. Subcentres Mladenovac, Lazarevac, Obrenovac, Surčin, Grocka, Sopot and Borča are places of work for employees in the municipalities of the same name, i.e., places of residence for employees in the settlement of Belgrade.

[9] Districts in Serbia exist in the administrative-territorial sense but they do not have governing levers and essential mechanisms for development controlling and directing. The Spatial Plan of the RS from 2010 planned the functional competencies of urban centers, i.e., an attempt was made to determine their rough limits of influence.

[10] In relation to the previous scientific and professional standpoints that dealt with the delimitation criteria for urban settlements, as well as regarding to the views of official statistics, the previous minimum number of inhabitants, as a criterion relevant for a settlement to be considered autarchic (which can meet its needs) was 5,000inh. According to the last Census from 2011., the limit minimum was raised to 10,000 inh., and even 12,000 inh. in some cases.

Serbia and neighboring countries and regions (OG RS 88/2010). **Cross-border cooperation** of centers in Serbia with the wider environment is most intensive in the north and east of Vojvodina - with Hungary and Romania[11], while cooperation with Bulgaria in eastern and southeastern Serbia is insufficient, as well as with Macedonia in the south. There are certain types of cooperation and joint actions with Bosnia and Herzegovina through a series of parallel ties on the line Bosnia and Herzegovina-Republika Srpska-Serbia. In summary, sufficiently strong centers of cross-border cooperation currently do not exist in the territory of RS, but it is possible to assume that they will gradually take shape in the future, depending on the political and economic situation in the region. In that sense, some centers such as Sombor, Vršac, Kikinda, Loznica, Pirot and others are seen as the carriers of cross-border cooperation in the future.

General urban context as an instrument of rational functional organization of space

In general, the development of the Serbian urban system is based on the **"general urban concept"**. It requires that comprehension of traditional hierarchy model of urban centers transforms into the general urban concept according to which urban areas and centers he attracts are qualitatively equal in providing conditions necessary for quality life, and are complementary in the supply of jobs and services for residents as well as for daily and other migrants. This means that the elements of urban life quality (basic set of services and quality infrastructure) and security, are felt in almost every settlement of the urban system, regardless of its distance from the center and demographic size. Preconditions are in the development of efficient interurban transport and decentralization of functions, public social infrastructure and institutions, which will encourage daily and general mobility of the population. This especially refers to the urban areas of Belgrade, Novi Sad, Niš, Kragujevac, Priština, as well as to the West Moravian agglomeration (SPRS 2021-2035, Draft). What does that exactly mean?

Each city has a "territorial horizon" of its influence (sphere of influence) which usually overlaps with the territorial horizons of neighboring cities. The overlap is facilitated by two seemingly opposite processes, rivalry and cooperation. In this way, opened are the possibilities of accomplishing the interests of various economic and social actors to use, in different ways, certain territorial values from the zone of overlapping spheres of several cities` influences. In this direction, the planning of the deployment of social and economic functions is considered, as well as during commuting planning that takes place in direction: first ranking central city - central cities of a lower rank of centrality, a central city - its territorial-functional horizon, and – or between central city - zones of overlapping with other urban centers. The main urban centers indirectly induce the development and have an impact to organizing the territories which are not in their direct spheres of influence, but are parts of a general "urban context" (SPRS 2021-2035, Draft).

The novelty of SPRS 2021-2035, in the segment related to the development of urban systems are the planning guidelines defined individually for each category of the Serbian urban areas. Although given in general, these strategic guidelines provide wide opportunities for regional spatial plans and special purpose area plans to more precisely define planning measures at lower levels and thus provide proposals for solving local development problems. Planning measures are categorized for the following 5 types of urban areas in the territory of RS (modified SPRS 2021-2035, Draft):

1. **Belgrade and Novi Sad bipolar FUA** is recognized as the dominant Serbian development engine, in which the concentration of functions, population, users of space and economy will continue in the future. The metropolitan area will also become the dominant tourist destination in Serbia. There will also be a manifestation of the suburbanization effects as a consequence of the life quality deterioration (environmental quality) in the central, most densely populated parts of the metropolitan area. It is a development opportunity for the smaller local centers, especially in the Srem and Banat part of metropolitan area.
2. **Priština and Niš urban areas**, as well as the urban areas of cities in the West Morava valley (Užice, Čacak, Kraljevo and Kruševac) need a better infrastructure, as well as expanding the range of services. Emphasis is placed on the economy that needs highly educated and quality workforce, with the scientific research development and technical-technological capacities. At the same time, these are preconditions for stopping the emigration trends towards the metropolitan area.
3. For the **Kragujevac, Subotica, Zrenjanin and Leskovac urban areas**, it is imperative to continue economic growth and development, especially in the domain of high-tech industries, and then the development of services and institutions of region-

[11] The area of Vojvodina Autonomous Province has been a part of the DKMT Euroregion (Danube-Krish-Mures-Tisza) since the mid-1990s, while numerous border municipalities have cooperated through bilateral projects together with regions / municipalities in neighboring countries.

al character, in order to stop emigration to the metropolitan area and abroad.

4. For **Sombor, Vršac, Kikinda, Valjevo, Šabac, Loznica, Novi Pazar, Jagodina, Bor, Zaječar, Vranje, Pirot, Prizren, Uroševac, Peć, Đakovica, Gnjilane and Kosovska Mitrovica urban areas**, the priority is to improve their functional capacity, especially in domain of economy, public services and institutions. They also have a great chance as networking centers of 219 small centers in the rural areas that surround them.
5. **Urban centers of rural areas** must adapt to the seasonal oscillations to the number of space users, and focus on products and services offered by resource-rich rural environment, tourist potential and predominantly high-quality environment. The available EU funds make these areas to be considered as the leading priorities of the state's spatial development. It is realistic to expect that by 2035, the functions, economic development and new integrative roles of certain smaller urban centers will be strengthened, especially those in the metropolitan area and in agglomerations.

Conclusion

The role of FUAs is important for balancing the distribution of population and functions in space. Defining the central settlement scope of influences within the FUA individually will not by itself contribute to reducing development imbalances between different parts of Serbia. For that, it is necessary to have clear mechanisms for the planning / strategic concepts` implementation at the state level, which emphasize the demographic development of local and regional centers as a priority development goal. Only after that will be created the preconditions for demographic growth and the transformation of current local centers into real local development centers in the future. The planned organization of public social infrastructure, completion of infrastructure corridors, modernization of the local transport network and other previously mentioned measures would affect the distribution of functions that would consequently affect the population relocating (staying in the place of residence or daily migration of employees). It is imperative to plan the intra-regional differentiation of urban areas depending on the nature of their manifestation in space. *Monocentric (functional) urban areas* require planned strategies based on concentrated centralization of population and functions. *Polycentric (functional) urban areas* with several stronger poles require strategies that would be based on decentralized concentration of population and functions and constituent poles networking into a homogeneous entirety.

Whether the new SPRS 2021-2035 will be, conditionally speaking, implemented through urban areas, time will tell. The Belgrade agglomeration certainly remains the backbone of the Danube-Sava development belt of Serbia - part of the pan-European development corridor of exceptional traffic importance and development opportunities. The position of the four largest agglomerations in Serbia (Belgrade-Novi Sad, West Moravia, Niš and Priština), their demographic capacity and connection with traffic corridors should provide a fundamental basis for forming a solid network of urban areas which, together with larger centers, have better economic and demographic capacity and in cooperation with urban centers of rural and border areas can contribute to better functional integration of Serbian territorial units. The potential is better infrastructural connectivity and equipment, with the completion of the traffic corridors and accompanying facilities constructing, as well as the started process of reindustrialization. Some urban settlements have a valuable cultural heritage and cultural diversity, including the heritage of modern architecture and urbanism of the twentieth century (especially in the Vojvodina part of Serbia). Parts of planned urban settlements have a high level of traffic and communal infrastructure and good coverage of public service facilities. (SPRS 2021-2035, Draft).

However, due to neglecting the development of rural-urban connections, disparities in the quality of life and accessibility between urban and rural settlements are growing. This is reflected in the long-term depopulation of rural areas and the unplanned expansion of urban settlements. The quality of life in peripheral and peri-urban zones is lower in relation to central urban cores, but it is higher in relation to rural settlements, which contributes to the continuation of the negative tendencies in regional, urban and rural development. There are differences in the cities and urban settlements between parts of the urban area in terms of life quality, primarily equipment and availability of infrastructure and public services and utilities. The reasons for the emergence of these differences are primarily in the mass illegal building of the settlements` new parts, in peripheral urban zones, but also in the existing substandard neighborhoods that can be found in some central parts of urban settlements. The lack of basic urban infrastructure further worsens the living conditions and health of the inhabitants,

and pollutes the environment of the substandard settlements, but also the wider urban environment. In illegally built parts of the settlements, the luxurious residential buildings can be find, but also multi-family residential buildings. The harmonization of urban development policy with the construction land policies and communal economy is insufficient. Spontaneous and unplanned construction, in the previous decades, among other things, led to the incompatibility of the traffic network and other purposes in space. Cities, but also other urban settlements, are facing congestion (caused by exhaust gases), insufficient flow capacity and lack of space for stationary traffic.

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THE NATURAL AND CULTURAL HERITAGE OF THE THE REPUBLIC OF SRPSKA – INSTITUTIONAL JURISDICTION, LEGAL FRAMEWORK, PLANNING AND STRATEGIC PERSPECTIVES

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Abstract

Preservation of cultural and natural heritage is an obligation of global proportions because there is a clear consciousness that the world is a unique habitat for all life. The basis of the work on heritage preservation is the recording, valorisation and proposing of a solution for declaring it as protected. The state of Bosnia and Herzegovina consists of two entities (The Republic of Srpska and Federation of Bosnia and Herzegovina) and Brcko District which is conditioned as a specific mode of governance with many competencies divided. A complex way of managing the interweaving institutional competencies at different levels of government, and the application of laws and regulations prescribed by state or entity government, becomes relevant when it comes to heritage. The paper gives an overview of institutional jurisdiction, legal framework, and treatment of natural and cultural heritage in the current spatial planning documentation of the The Republic of Srpska. Basic protection measures and activities are proposed to be implemented to preserve natural and cultural heritage.

Keywords: The Republic of Srpska, natural and cultural heritage, institutional jurisdiction, legal framework, planning and strategic perspectives

Introduction

In the modern world, one of the most current concepts is the concept of sustainable development, defined by the United Nations [UN] Brundtland Report (World Commission on Environment and Development [WCED], 1987) as well as Agenda 21 adopted at the UN World Summit in Rio de Janeiro (United Nations [UN], 1992). The essence of the concept is that the population rationally uses resources, that is, natural and cultural heritage, but in a way that it will stay preserved for future generations. A large number of countries in the world have created serious mechanisms (institutions and laws) that are the bridge between the idea itself and the realization of the concept.

By the Dayton Peace Agreement from 1995, Bosnia and Herzegovina were administratively divided into two entities (The Republic of Srpska and Federation of Bosnia and Herzegovina) and Brčko District. Such a state division also led to a specific way of governing the state in which many competencies are shared between the entities and the District. The very structure and division of competencies are completely asymmetrical in the two entities, including the Brčko District. Unlike the The Republic of Srpska (which has no cantons), the Federation of Bosnia and Herzegovina has general competencies related to the protection of the natural and cultural heritage within the cantonal ministries, while the Brčko Dis-

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trict Government is directly responsible for these issues. Responsibilities are further shared between entities and/or cantons and municipalities.

Given the global trends (put about 15% of the territory under protection) and the devastating fact that the The Republic of Srpska has only about 1.3% of the protected natural area (Panić & Nagradić, 2019, pp. 42), it is evident that it is facing a great challenge. The first steps in mastering it should be establishing a clear policy of protection and allocating the responsibilities of all responsible entities with a clearly defined hierarchy from central to local government.

Methodology

This research is based on a quantitative analysis of the natural and cultural heritage of the The Republic of Srpska since its formation until today. A complex system of institutional jurisdiction is analysed. In addition to the fact that different institutions deal with natural and cultural heritage, jurisdiction over particular segments of cultural heritage is further institutionally divided. However, the greatest problem is the division of competencies, as well as their inconsistency at different levels of government. In addition to the overview of institutions, the main problems caused by this system of institutional jurisdiction are presented.

The legislative analysis indicates that complications related to institutions have been transposed to the legal framework as well. Laws and by-laws concerning natural and cultural heritage are adopted at the entity level. The elements of the The Republic of Srpska's heritage have been comparative analyzed, classified according to the law categories. Elements that are under international protection were singled out.

The planning and strategic perspectives of the heritage elements were analysed through the spatial plans of the The Republic of Srpska, highlighting planning activities that were not implemented in the planning period. Priority activities necessary for the protection and promotion of natural and cultural assets have been proposed. The involvement of the The Republic of Srpska/Bosnia and Herzegovina in world initiatives and projects initiated to link areas and goods of common interest for the realization of the principles of global space protection was also analysed.

The overall insight into the natural and cultural heritage of the The Republic of Srpska, as well as the identification of the deficiencies of a complex system of competencies, legislators and spatial planning perspectives, enables us to act in the direction of adequate treatment of heritage protection following the principles of sustainable development.

Institutional jurisdiction

According to the Constitution of Bosnia and Herzegovina for the period after 1995, the issue of protection of natural heritage is within the competence of the state through the activities of the Environmental Coordination Committee, which was established in 1998. The Committee was composed of eight members, four from each entity, and several non-voting representatives of international organizations (Office of the High Representative [OHR], United States Agency for International Development [USAID], World Bank [WB] and European Commission [EC]). It was established to harmonize environmental laws, regulations, standards and action programs, cooperating with neighbouring countries and international organizations, signing international environmental treaties, controlling their implementation and participating in international processes.

With the establishment of the Inter-Entity Environmental Protection Body (Official Gazette of The Republic of Srpska, Vol. 116/06, 123/12), the Environmental Coordination Committee ceased to exist. The Inter-Entity Environmental Protection Body has eight members, four of whom are appointed by the Government of the Federation of Bosnia and Herzegovina, and four by the Government of The Republic of Srpska. The body is responsible for all environmental issues requiring concerted access by the entities, as well as for issues related to preparation and implementation of international agreements and programs in the field of environment, and participation in cooperation with international organizations and other countries. In the The Republic of Srpska, the competence in the field of nature protection belongs to the Ministry of Physical Planning, Construction and Ecology, but also to other institutions, the most important of which are the The Republic Institute for the Protection of Cultural, Historical and Natural Heritage, Environmental Protection and Energy Efficiency Fund of the The Republic of Srpska, Hydrometeorological Institute of the The Republic of Srpska...

Unlike natural heritage, cultural heritage is divided into three segments: immovable, movable and in-

tangible heritage. Institutional competence is following this division, which further complicates the management and conservation of this segment of heritage. The Commission to Preserve National Monuments of Bosnia and Herzegovina was established in 2002 by The General Framework Agreement: Annex 8 – Agreement on the Commission to Preserve National Monuments (Office of the High Representative [OHR], 1995) and the Decision on the Commission to Preserve National Monuments (Official Gazette of Bosnia and Herzegovina, Vol. 1/02, 10/02). A five-member of the Commission (3 domestic and 2 foreign) is appointed by the Presidency of Bosnia and Herzegovina for a term of five years. Highly qualified persons, corroborated by scholarly work and other activities, including involvement in the preservation and protection of cultural, historical, religious and other material civilizational heritage, shall be eligible for appointment as members of the Commission. Foreign members are proposed by the Director of the United Nations Educational, Scientific and Cultural Organization [UNESCO]. The Commission is responsible for establishing the Provisional List of National Monuments, as well as for making decisions on the designation of movable and immovable property as national monuments. The responsibility for implementing the decisions of the Commission lies with the entity governments and ministries responsible for spatial planning and culture, as well as institutions for the protection of cultural monuments. For the The Republic of Srpska, it is the Ministry of Education and Culture and the The Republic Institute for the Protection of Cultural, Historical and Natural Heritage.

Protection of the movable cultural heritage of the The Republic of Srpska is encompassed through the work of protection institutions (archives, museums, libraries and cinemas) founded by the The Republic of Srpska or by local government units. The jurisdiction over the protection of intangible cultural heritage is divided into two levels. In 2009, the Council of Ministers of Bosnia and Herzegovina adopted the Decision on Establishing the State Commission of Bosnia and Herzegovina for UNESCO (Official Gazette of Bosnia and Herzegovina, Vol. 77/09), of 19 members, at the request of the Ministry of Civil Affairs of Bosnia and Herzegovina. Members of the Commission are proposed, for 4 years, by the State and Entity Ministries responsible for UNESCO matters. The Commission established the Preliminary List of Intangible Cultural Heritage of Bosnia and Herzegovina. The Preliminary Lists are established by the entity ministries in charge. For the The Republic of Srpska, these are the Ministry of Education and Culture and the Museum of the The Republic of Srpska, in which the Department for Intangible Cultural Heritage is established.

In the The Republic of Srpska, competencies for the protection of natural and cultural heritage apart from ministries, institutions and organizations operating at the entity level have been transferred to the local community level. Within cities and municipalities, there are departments such as the Department of Spatial Development, Department for Spatial Planning and Housing and Communal Affairs, Department of Economy, Department for Social Activities, Department of Culture, Tourism and Social Policy... The names of departments and competencies are not uniform across local government units, so that different department at the municipal level deal with the issues of protection of natural and cultural heritage.

Legal framework

Following the Dayton Peace Agreement, all legal legislation from the former Socialist The Republic of Bosnia and Herzegovina has been retained and has been in use until new laws are enacted. Until the 1990s, protected areas in Bosnia and Herzegovina were categorized under the Law on Protection and Utilization of Cultural-Historical and Natural Heritage of Bosnia and Herzegovina (Official Gazette of the Socialist The Republic of Bosnia and Herzegovina, Vol. 20/85). The The Republic of Srpska has passed the Law on the Environmental Protection (Official Gazette of The Republic of Srpska, Vol. 53/02, 109/05, 41/08, 29/10), in 2002, which was amended several times and replaced in 2012 by the new law (Official Gazette of The Republic of Srpska, Vol. 71/12, 79/15), also amended. The Law on Nature Protection was adopted in 2002 (Official Gazette of The Republic of Srpska, Vol. 50/02, 34/08, 59/08), amended twice and replaced by a new law in 2014 (Official Gazette of The Republic of Srpska, Vol. 20/14). Law on National Parks was adopted in 2010 (Official Gazette of The Republic of Srpska, Vol. 75/10). Laws are based on European Union [EU] legislation and the on approach taken by EU members to manage protected natural resources. In this way, the The Republic of Srpska wanted to create the preconditions for the effective protection of nature and protected natural values.

Protected areas in the The Republic of Srpska (Table 1) are categorized according to the 2014 Law on Nature Protection as follows:

1. strict nature reserve – Category Ia;
2. special nature reserve (wilderness area) – Category Ib;
3. national park – Category II;

4. natural monument – Category III;
5. protected habitat (habitat/species management area) – Category IV;
6. protected landscapes – Category V:
   - protected natural landscapes,
   - protected cultural landscapes,
   - nature park;
7. protected area with sustainable use of natural resources – Category VI:
   - forest park,
   - designed nature objects (monument of park architecture).

For the functioning of the system of protection of natural values, it was necessary to adopt the appropriate legal and by-laws as soon as possible. The management of national parks is regulated by the adoption of laws for all three designated national parks, and the management of other protected areas is regulated by a series of decisions on their designation. In addition to the aforementioned acts, at the level of the The Republic of Srpska, a set of rules has been adopted, which have been amended over the years: Rulebook on establishment and management of information systems for nature protection and monitoring system (Official Gazette of The Republic of Srpska, Vol. 85/05), Rulebook on official uniform, identification card and use of issued weapons to supervision service in national parks (Official Gazette of The Republic of Srpska, Vol. 83/11), Rulebook on order in national parks (Official Gazette of The Republic of Srpska, Vol. 83/11), Rulebook on protected natural estates register (Official Gazette of The Republic of Srpska, Vol. 55/15), Rulebook on contents, determination and enforcement of measures of protected areas management (Official Gazette of The Republic of Srpska, Vol. 83/15), Rulebook on layout of label of environmental protection, procedure and requirements for its use (Official Ga-

Table 1. Protected areas in the The Republic of Srpska

Name	Category IUCN	Area (ha)	Municipality/Town
Strict nature reserve „Prašuma Janj“	Ia	295.00	Šipovo
Strict nature reserve „Prašuma Lom“	Ia	297.82	Petrovac, Istočni Drvar
National park „Sutjeska“	II	16052.34	Foča, Gacko, Kalinovik
National park „Kozara“	II	3907.54	Prijedor, Gradiška, Kozarska Dubica
National park „Drina“	II	6315.32	Srebrenica
Natural monument „Pećina Ljubačevo“	III	45.45	Banja Luka
Natural monument „Pećina Orlovača“	III	27.01	Pale
Natural monument „Žuta bukva“	III	0.50	Kotor Varoš
Natural monument „Pećina Rastuša“	III	11.39	Teslić
Natural monument „Jama Ledana“	III	28.26	Ribnik
Natural monument „Vaganska pećina“	III	12.00	Šipovo
Natural monument „Pećina Đatlo“	III	43.42	Bileća, Gacko
Natural monument „Pavlova pećina“	III	13.40	Trebinje
Natural monument „Girska pećina“	III	25.37	Sokolac
Natural monument „Pećina pod lipom“	III	6.10	Sokolac
Natural monument „Pećina Ledenjača“	III	7.40	Foča
Natural monument „Velika pećina“	III	820.92	Bileća
Natural monument „Pećina Kuk“	III	-	Kalinovik
Natural monument „Lijevčanski knez“	III	0.34	Gradiška
Protected habitat „Gromiželj“	IV	831.30	Bijeljina
Protected habitat „Tišina“	IV	196.49	Šamac
Nature park „Cicelj“	V	330.76	Čajniče
Nature park „Una“	V	2772.60	Krupa na Uni, Novi Grad, Kostajnica, Kozarska Dubica
Monument of park architecture „Univerzitetski grad“	VI	27.38	Banja Luka
Forest park „Slatina“	VI	35.73	Laktaši
Forest park „Jelića brdo“	VI	2.96	Laktaši

Source: The Republic Institute for the Protection of Cultural, Historical and Natural Heritage

zette of The Republic of Srpska, Vol. 50/16), Rulebook to prescribe the manner of marking the protected area (Official Gazette of The Republic of Srpska, Vol. 3/18), Rulebook to extensively prescribe the conditions that the protected area manager must meet (Official Gazette of The Republic of Srpska, Vol. 65/19)... The adoption of a set of laws created a quality basis for the formation of a stable protection system and defined clear frameworks in which it is necessary to take concrete measures and actions.

The strict nature reserve "Prašuma Janj" near Šipovo is the first and only natural asset from the territory of the The Republic of Srpska/Bosnia and Herzegovina included in the UNESCO World Heritage List. This is a serial nomination "Ancient and Primeval Beech Forests of the Carpathians and Other Regions of Europe" from 2007 (UNESCO, 2021), which in 2021 was expanded with 15 new protected areas, which includes the Janj rainforest of 295 hectares, of which 58 hectares have been set aside in which forest exploitation and any human activity is prohibited. The rainforest consists of beech, fir, maple, elm, ash and spruce trees. The transnational nomination "Ancient and Primeval Beech Forests of the Carpathians and Other Regions of Europe", with 94 parts across 18 countries, currently represents the largest serial property of the World Heritage. It covers areas in Albania, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, France, Germany, Italy, Croatia, the Czech The Republic, Northern Macedonia, Poland, Romania, Slovakia, Slovenia, Spain, Switzerland and Ukraine, which certainly requires cross-border cooperation and reflects close the relationship of the beech forest with European culture.

In addition to natural areas, protected areas of the The Republic of Srpska also include immovable cultural properties which, according to the Law on Cultural Property (Official Gazette of The Republic of Srpska, Vol. 11/95, 103/08), is categorized as follows:

- cultural monuments,
- spatial cultural and historical units,
- archaeological finds,
- famous places.

It is impossible to provide a precise list of protected immovable cultural property in the The Republic of Srpska. The list, with over 700 cultural assets, should consist of the following lists: property from the Register of the Social The Republic of Bosnia and Herzegovina until 1992, property proclaimed by the decisions of the National Assembly and the Government of The Republic of Srpska, Provisional List of National Monuments of Bosnia and Herzegovina, List of proclaimed national monuments of Bosnia and Herzegovina, a list from the Spatial Plan of the The Republic of Srpska, lists from the spatial planning documentation of municipalities and cities in the The Republic of Srpska and a list of goods under prior protection.

International protection of cultural property in the The Republic of Srpska is minimal and consists of two elements inscribed on the World Heritage List: "Mehmed Paša Sokolović Bridge in Višegrad" (UNESCO, 2007) inscribed in 2007 and "Stećci Medieval Tombstone Graveyards" (UNESCO, 2016) inscribed as the common cultural property of Bosnia and Herzegovina (there are 10 localities in the territory of The Republic of Srpska (Table 2) out of 22 recorded throughout the country), Croatia (2 localities), Montenegro (3 localities) and Serbia (3 localities) in 2016.

Table 2. Locality of Stećci Medieval Tombstone Graveyards in the The Republic of Srpska

Name	Number of Graveyards	Municipality/ Town
Kalufi	462	Nevesinje
Borak	213	Rogatica
Gvozno	87	Kalinovik
Grebenice-Bunčići	291	Bileća
Luburića polje	44	Sokolac
Potkuk	243	Berkovići
Mramorje	127	Pale
Bečani	138	Šekovići
Crkvina	207	Foča
Čengića bara	52	Kalinovik

Source: State Commission of Bosnia and Herzegovina for UNESCO

The protection of the movable cultural property of the The Republic of Srpska is governed by several applicable laws and regulations, the most important of which are: the Law on Museum Activity (Official Gazette of The Republic of Srpska, Vol. 89/08, 57/12, 18/17), the Law on Archival Activity (Official Gazette of The Republic of Srpska, Vol. 119/08) and the Law on Library and Information Services (Official Gazette of The Republic of Srpska, Vol. 44/16). The list of movable cultural property of The Republic of Srpska also does not exist, and it would consist of objects which are inherited by the institutions of protection, classified in the registers of cultural property.

The protection of the intangible cultural heritage is regulated by the Law on Museum Activity. The amendments to this law from 2008 were aimed at including the concept of intangible cultural heritage in the existing legal documentation, which provided the legal basis for its recording and protection. The Preliminary List of the Intangible Cultural Heritage of The Republic of Srpska currently contains 22 elements (Table 3), of which two elements are listed on the UNESCO Representative List of the Intangible Cultural Heritage of Human-

Table 3. Elements of the Intangible Cultural Heritage of The Republic of Srpska

Name
• Zmijanje embroidery
• Picking of iva grass on Ozren mountain
• Lipizzan horse-breeding traditions
• Nevesinje Olympic Games, traditional games
• Mowing the grass in place Balkana (municipality Mrkonjić Grad)
• Osaćanski jezik, the language of traditional builders of area Osat
• Slava, a celebration of family saint patron's day
• Masla, a celebration of village saint patron's day in villages Popovići, Kulaši and Ćuća (municipality Prnjavor)
• Lile torch ignition, the custom of the Serbian people on the eve of St. Peter's Day
• Vidovdan Olympics in place Kulaši (municipality Prnjavor)
• Gusto kolo, traditional folk dance on Kozara Mountain and Potkozarje region
• Gusle (a simple string instrument), Singing to the accompaniment of the Gusle and Oral tradition – epic folk poetry
• Banjalučki ćevap, grilled meat sticks in flatbread from Banja Luka
• Paljenje žežnice, traditional charcoal production in eastern Herzegovina
• Blacksmith's craft in Mrkonjić Grad
• Teslić embroidery
• Oj djevojko (ojkača), traditional song
• Serbian Cyrillic alphabet
• Sarajevsko-romanijski priglavak, short woolen socks from Sarajevo-Romanija region
• Lace from Banja Luka
• Derventa fair
• Sir iz mijeha, the process of making cheese from goat or sheepskin

Source: State Commission of Bosnia and Herzegovina for UNESCO

ity: "Zmijanje embroidery" (UNESCO, 2014), inscribed in 2014 and "Picking of iva grass on Ozren mountain" (UNESCO, 2018), inscribed in 2018. In 2022, the entry of the element "Nevesinje Olympic Games, traditional games" in the UNESCO Register of Good Safeguarding Practices is expected (UNESCO, 2021a).

Planning and strategic perspective

The spatial planning system in Bosnia and Herzegovina until 1992 was a mixture of the planning systems, where the dominant system of planning was based on an integrated approach. In the planning system of Bosnia and Herzegovina the elements of planning with the dominant tradition of urban planning, and planning system based on a determination of land use can be identified. This kind of planning system is still evident in The Republic of Srpska. (Bijelić & Đorđević, 2017, pp. 238)

The first spatial plan for the territory of The Republic of Srpska was adopted as "The Spatial Plan of The Republic of Srpska 1996-2001 – Phased Plan for the period 1996-2001" (Institute for Urbanism of The Republic of Srpska, 1996). The plan provided a quality basis for the future development of The Republic of Srpska, with clearly set goals for the protection of natural heritage. Although the plan was prepared for the planning period up to 2001, "The Spatial Plan of The Republic of Srpska until 2015" (Institute for Urbanism of The Republic of Srpska, 2008) wasn't adopted until 2008. One of the goals of this plan related to the protection of natural resources was the formation of the Biosphere Reserve "Drina". The biosphere reserve would cover parts of the territory of The Republic of Srpska/Bosnia and Herzegovina and Serbia. The protected area on the side of The Republic of Srpska/Bosnia and Herzegovina included in this reserve would be the National Park "Drina" in the Srebrenica area and would constitute a narrower area. Parts of the municipalities of Višegrad and Rogatica would be included in the buffer zone. Although the goal is clearly defined and certain measures and instruments of protection have been passed to the first implementa-

tion activities, almost twenty years have passed, so the same goal has been repeated with the current spatial plan "Amendments to the Spatial Plan of The Republic of Srpska until 2025" (Public institution New Urban Institute of The Republic of Srpska, 2015). So far, based on the Study for the designation of protected area – National Park "Drina" (Official Gazette of The Republic of Srpska, Vol. 20/14) and the Law on the National Park "Drina" (Official Gazette of The Republic of Srpska, Vol. 63/17), the proclamation of the National Park "Drina" has been made. The recommendation, following the legislation of The Republic of Srpska, is to draw up a "Drina". To date, two spatial plans for the special purpose have been drawn up – for National Park "Kozara" and National Park "Sutjeska". The Spatial Plan of the Special Purpose National Park "Kozara" was adopted in 2014. The Draft od Spatial Plan of the Special Purpose National Park "Sutjeska" was withdrawn at the initiative of the proposer (the Government of The Republic of Srpska) due to the need for additional consultations regarding the construction of mini-hydropower plants in the area of the national park (Stupar & Milanovic, 2017, pp.114).

The current spatial plan continues to protect those territorial units that had the status of protected even before the planning document was adopted. It is planned to increase the total area under protection through the designation of new protected areas on the proposal of The Republic Institute for Protection of Cultural, Historical and Natural Heritage. By the end of the planning period, in addition to the 3 national parks already mentioned, the following should be placed under the protection regime:

- 4 more national parks (7 in total),
- 5 protected natural landscapes,
- 4 natural monuments,
- 38 habitat management areas,
- 17 protected landscapes,
- 41 nature parks,
- 18 forest parks. (Public institution New Urban Institute of The Republic of Srpska, 2015, pp. 104–109)

Cultural heritage is a specific topic in spatial planning, which could be addressed as a separate component of sustainable development, given its great importance and dependence on the natural environment in which it originates and exists, as well as the economic circumstances in which it is created. The protection, organization and use of cultural heritage are based on three sets of principles:

- principles of sustainable development (rational use and protection of landscape),
- principles of integrative conservation (harmonization of conservation requirements and spatial planning goals),
- the principles of integrated planning (protection of heritage in an appropriate environment through the placement of heritage in line with other interests in the planning process). (Dželebdžić, 2012, pp. 178)

To achieve action following these principles, the current spatial plan envisages several planning solutions:

- reform of legislation in line with contemporary world trends and social changes,
- graphic representation of the cultural property,
- promotion and presentation of cultural heritage,
- introduction of a cultural landscape into the legislative framework,
- integration of potential cultural trails into the tourist offers of the Republika Srpska. (Public institution New Urban Institute of The Republic of Srpska, 2015, pp. 159)

Analyzing the master planning documents, it is clear that the planning solutions have a low level of realization. Factors of the unsatisfactory level of implementation of planning solutions, when it comes to protection, can be sought in an inadequate network of institutions, inconsistent legal acts and regulations and low level of education and developed awareness of the role and importance of preserving natural and cultural properties of the elements of the identity-bearers of the society. Therefore, priority activities for the protection and promotion of natural and cultural properties would be:

- designation of a reference institution in the field of protection for the total or individual protection of natural or cultural property,
- preparation of complete documentation for each property, criteria for their categorization and establishment of a register of protected natural and cultural properties, as well as monitoring,
- development of planning documents that will treat individual protected areas,
- interregional, cross-border and international cooperation.

It is important to note that at the beginning of 2012, the project "Dinaric Arc Parks" was initiated by the World Fund for Nature Conservation [WWF], which start an initiative to link the protected areas of Albania, Bosnia and Herzegovina, Montenegro, Croatia, Kosovo, Macedonia, Slovenia and Serbia. An initiative was made aiming create a regional alliance of protected areas in the territory of the Dinaric Arc countries. In that sense, The Republic of Srpska is part of the system of protection of the Dinaric mountains and the linking of protected parks in cooperation with the Federation of

Bosnia and Herzegovina and The Republic of Montenegro. Also, The Republic of Srpska is a significant and transboundary protected area of the Biosphere Reserve "Tara". Biosphere Reserve "Tara" is planned to include the area of the National park "Sutjeska" with planned expansion, the planned National park "Tara Canyon and Ljubišnja" in The Republic of Srpska, and National park "Durmitor" and Nature Park "Piva" in Montenegro. In 2010, a Feasibility Study on the establishment of a transboundary protected area "Durmitor-Tara-Sutjeska Canyon" was made.

Concerning cultural heritage, a significant initiative launched in 2019 by Slovenia and Austria is to include "Lipizzan horse-breeding traditions" on the UNESCO list of World Intangible Cultural Heritage. In 2020, a joint nomination is planned by eight countries (Austria, Bosnia and Herzegovina, Croatia, Italy, Hungary, Romania, Slovakia and Slovenia). The nomination must focus on the common traditions that characterize all the states in this project, while also reflecting their diversity. The coordination of activities is led by the Ministry of Culture of The Republic of Slovenia, and the joint nomination is an expression of the spirit of European cooperation. This element is expected to be inscribed in the UNESCO representative list in 2022 (UNESCO, 2021b).

Conclusion

Whether it is economic prosperity or simply differences in mentality, there is a noticeable difference in heritage treatment in the so-called developed western countries and those trying to become. In this second group of countries, where are Bosnia and Herzegovina/The Republic of Srpska located, there are usually several legal documents dealing with heritage. Their implementation capitulates in the face of daily existential problems. (Živanović & Đorđević, 2005, pp. 53–54). The evident significant natural, cultural and historical diversity of The Republic of Srpska requires planned action in the field of protection and sustainable development. In the area of the protection of natural values, the long-term goal is to leave at least 15-20% of the total area of The Republic of Srpska under legal and real protection. Natural values should be kept in perception as well as preserved and protected, together with cultural and historical properties, which would achieve the principle of global space protection. Regarding this, the initiative undertaken by UNESCO to gather experience from the World Heritage Sites is of fundamental importance as it provides the necessary data and guidance for the development of regulatory planning frameworks. Planning practice in The Republic of Srpska lacks an appropriate methodological framework as well as elaborated methods and techniques that respond to the requirements. The research should be directed towards evaluating localities and areas that may be of interest for protection. In presenting cultural heritage, despite individual good examples from domestic practice, the concept of cultural heritage as an economic value that can generate income has not yet been developed. There is a belief that cultural heritage is a burden on the budget community so that this sector has been minimally transformed and is still sufficiently adapted to the new economic situation. The unresolved issue of ownership of cultural property and outdated laws in this area are major obstacles to its proper maintenance and presentation. In addition to updating laws, it is necessary to draft by-laws for the regional protection of natural, cultural and historical suppliers, designate reference institutions, reconfigure the terrain and inventory the heritage.

Development of spatial plans for special-purpose areas, as well as spatial plans of municipalities in whose territories the protected areas are located, would greatly contribute to their conservation, protection and improvement. It is also necessary to improve information systems in the field of protection of natural, cultural and historical heritage and to establish monitoring systems, as well as to educate the owners and users of protected areas to achieve the principle of sustainability. The protection of natural values and cultural and historical heritage in The Republic of Srpska requires cooperation at all levels of government, cooperation between competent institutions and the involvement of appropriate professions (geographers, spatial planners, ethnologists, biologists...), which would exclude past practice – the exclusive right of the individual. Adequate treatment of protection in line with sustainable development requires cooperation with neighbouring countries and global action.

Acknowledgements

The paper is the result of a research project "Multidisciplinary Dialogue with Cultural Heritage" (19/6-020/961-145/18), realized by the Faculty of Natural Sciences and Mathematics, University of Banja Luka. Coordinator is Irena Medar-Tanjga, PhD. The project is funded by the Ministry of Science and Technology Development, Higher Education and the Information Society in the Government of The Republic of Srpska.

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ANALYSIS OF IRREGULAR MIGRATION FLOWS IN CROATIA AFTER THE CLOSURE OF THE BALKAN ROUTE

Mislav Stjepan Čagalj[A]

Abstract

At the peak of European migrant crisis in 2015 Croatia was faced with the large influx of immigrants. The main migratory path into Europe was The Balkan Route which runs through Croatia. Although European Union officially declared the Balkan route closed in the March of 2016 immigrants continued to arrive via the Balkan Route. In this paper author investigates irregular migration in Croatia after the proclaimed closure of the Balkan Route. Analysis of statistical data on immigration in Croatia since 2016 has shown continuous increase in the number of attempted illegal border crossings which points to a stronger migration flows but it is also a reflection of a stricter border control. Outbreak of the coronavirus pandemic in 2020 has caused border restrictions however migration still rose compared to 2019. Also, research has shown that the Balkan route has shifted away from Hungary to Bosnia and Herzegovina which changed the immigrant's entry point in Croatia.

Keywords: Croatia, Irregular migration, The Balkan Route, border control, Coronavirus pandemic

Introduction

International migration has long been a subject of research and analysis in several disciplines of the social sciences including geography. Prompted by recent European migrant crisis geographers are increasingly studying various aspects of human migration and mobility (Ehrkamp, 2017). Croatia is situated in the Balkans, which has for centuries been a frontier region where migration between Europe, Asia and Africa has taken place (Cocco, 2017). In 2015 Europe was faced with the large influx of immigrants who mainly arrived to European Union via so-called Balkan Route. European Union officially declared the Balkan Route closed in 2016, albeit migrants continued to arrive (Hameršak et al., 2017). This paper investigates irregular migration to Croatia after the declared closure of the Balkan route in the March 2016. The author identifies the hot spots where migrants enter into Croatia, transit routes and exit points from Croatian territory. Also, this paper outlines the development of Croatia's bordering policy and migration management. Finally, this paper studies the influence of COVID-19 pandemic on irregular migrant flows.

Theoretical and Methodological Framework

Since irregular migration is clandestine, it makes it difficult to research it. Migration routes are continuously changing and ever evolving. They are highly responsive to alterations in conditions in countries of origin, transit, and destination. This research article is based on primary and secondary sources: reports, press releases, documents published by governments and by international and non-governmental organizations. Academic literature was also taken into consideration. Migration is a controversial topic which

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has sparked bitter conversation over the past few years with many contrasting views depending on the attitude towards migration. In order to alleviate any bias, a variety of documents were analysed. Also, research is based on analysis of statistical data on migration. The statistical measurement of international migration is challenging (Bonifazi and Mamolo, 2004). Evidence always lags behind the current realities on the ground due to the nature of data collection. Also, concepts, definitions and data collection systems are different across countries and times (Bonifazi and Mamolo, 2004). Moreover, numerical data on immigration is generally carefully selected before being circulated. Some phenomena are almost never recorded by public statistics and are consequently absent from official figures on immigration and also from public debate (Michalon et al., 2019: 16). This is the case of data on "exits" from the territory. The focus on migratory "flows", or on interceptions on the border, which also mask these exits, conveys a skewed image of immigration by shifting the focus away from net migration and exclusively onto the number of entries (Michalon et al., 2019: 16). There is no data about victims of migration policies. Because official data is so flawed, in this paper into consideration was taken unofficial data collected by non-governmental organizations. Out of all the data regarding immigration three key indicators were analysed including detections of illegal border-crossings, criminal acts of unlawful entries and pushback. The European migrant crisis was widely regarded by the public as a humanitarian and as a security challenge, in which the securitization of European borders seems to be more important than facilitating access to territory and to forms of protection for people in need (Župarić-Ilijić and Valenta, 2018). The concept of securitization is used in this paper to refer to tightening of either internal and external border control. Securitization may involve both the narrowing of opportunities for legal entry or stay, and the stricter deterrence and prevention of unauthorized entry and stay in ta country. Finally, a explanation regarding the language: the term migrants is used to refer to all people on the move who have or have not initiated or completed the legal process of claiming asylum. This group includes people fleeing war-torn countries such as Syria, as well as those who are seeking jobs and better lives, labelled by governments as 'economic migrants' (Lazarova, 2017).

The Balkan Route

Migrations have been a fundamental element in the history of the Balkans (Heršak and Mesić, 1990). For centuries the region of Balkan has served as a place of origin for migration into Europe as well as transit route to Europe for migrants coming from other regions of the world. At the beginning of 21th century majority of immigrants arrived to European Union overseas from across the Mediterranean Sea. In 2014 increased forced migration to Europe from other continents begun. Since there are very few, if any, legal pathway to claim transit to the EU migrants are forced to illegally cross the border (Van Houtum and Bueno Lacy, 2019). From January to April 2015, approximately 1600 migrants died on the route from Libya to Lampedusa, making it the deadliest migratory route in the world (Selcik, 2015). In response to that the EU launched a military operation known as Operation Sophia that had the scope of intercepting boats used by human traffickers in the Mediterranean. Scholars agree that the aftereffect of the Operation Sophia was the deviation of the route of the migrants from the Central Mediterranean Routes to the Balkan Route (EDMONDA, 2018). Owing to significant policy change in the Mediterranean Sea, the Balkan Route became the main migratory pathway into Europe. The label 'Balkan Route' indicates a single, unified path, but comprises multiple converging and diverging routes across this space (Bird et al., 2018). Furthermore, they are fluid, and highly responsive to EU border 'closures'. Migrants traveling through the Balkans often take a combination of routes. The main route (see Figure 1) taken by the largest share of migrants goes via Turkey and Greece onwards through

Figure 1. The Balkan Route 2015-2017
Source: BVMN 2019
[click on figure to enlarge]

North Macedonia and Serbia to Hungary and then further into European Union.

The Balkan Corridor

In the period 2014-2016, the Balkan Route was a preferred by migrants over alternative routes. There are no precise data on the number, but it is estimated that around 1.5 million of migrants, mostly from the MENA region, arrived in Western Europe via the Balkan Route (Weber, 2016). Faced with the large influx of people countries along the Balkan Route formed a humanitarian corridor in order to regain control over the movements by channelling them (Hameršak et al., 2020). Initially, Croatia was not faced with a large influx of immigrants. Meanwhile, after the fortification of the Hungarian border in the second part of 2015, more and more people tried to cross into Croatia by hiding in or under trains or walking through the forest in the border area. Back then, the majority of migrants arrived in Croatia from Serbia, particularly via the border town of Šid. In 2015 countries along the Balkan Route began to undergo process of (re)borderization (BVMN, 2020). In the course of the summer of 2015 Hungary built a 175 km long border along the border with Serbia, the first country along Balkan Route to do so. Alongside key border crossings on the Balkan Route fences were built. Also, asylum procedure was sped up. and border control was increased (BVMN, 2020).

Closure of the Balkan Route

The corridor through the Balkans was operative in different and ever-changing modalities until March 2016. On the 18th of March 2016, the Europe Union (EU) and Turkey signed a bi-lateral agreement which agreed that all refugees who reached Greece through unauthorized means would be returned to Turkey (Hameršak et al., 2020).

The Figure 2 shows that the closure of the Balkan Route reduced migrant flows to the EU, however without halting them completely. The implementation of tighter border control measures resulted in number of migrants accumulating at certain border locations along the route as they were unable to easily continue their journey. Consequently, even tough the overall size of the transiting flow of migrants was significantly reduced, the pressure on some border sections persisted, sustained by the accumulated migrants . Owing to enhanced border control migration routes diversified (Hameršak et al., 2020).. Especially from the end of 2017 migrants are trying to bypass existing security measures along the main route via Serbia, so instead they use Bosnia and Herzegovina-Croatia sub-route. The single corridor proliferated into more branches with the trend of channelling migrants towards Bosnia and Herzegovina, which brought additional challenges to an already vulnerable and institutionally weak state (Hameršak et al., 2020).

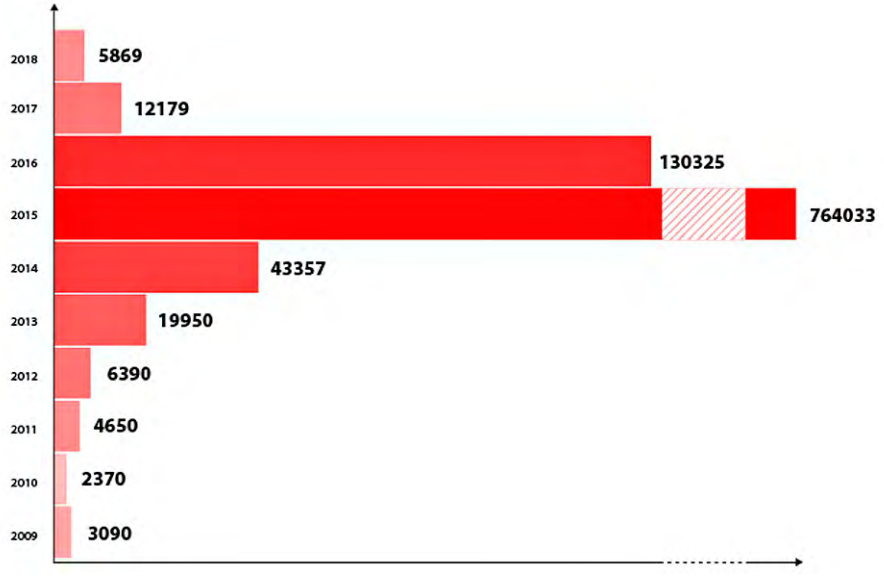

Figure 2. Illegal border crossings on the Balkan Route in numbers, 2009-2018
Note: The break in column for 2015 is for presentation purpose, but it should be noted that the actual figure is 7 times larger than for example in 2014
Source: Frontex, 2021

As Hungarian migration politics became more restrictive, migrants increasingly opted to take a route through Croatia during the spring of 2017 (BVMN, 2021). Majority of migrants tried to cross from Serbia into Croatia particularly via border town of Šid. Croatian police responded with tighter border control and soon it became harder for migrants to cross into Croatia. Consequently, the route via Hungary once again became as common as the one via Croatia. As a result migrants move northern in vicinity of towns of Sombor and Subotica. From there they go to Hungary or to Croatia.

Borderization of Croatia – Europe's gatekeeper

The European migrant crisis has led to an intensification of the security practices of the EU policy. Since then the primary objective of the EU strategy for coping with migrants is to reduce irregular crossing and keep the migrants outside of EU by tightening border security and externalizing migration processes. EU-Turkey agreement is just a manifestation of the practice of outsourcing EU borders. Under EU guidance countries along the Balkan Route are thickening the border, while trying to manage asylum and irregular migration in a more securitized and militarized manner. The European Border and Coast guard Agency (Frontex) plays an important role in implementing EU border policies. Its budgets have soared in this period, growing from 6.2 million in 2005 to 544 million in 2021 (Kuschminder, 2021). Croatia has been an EU member state since 2013 and its main foreign policy objective is accession to the Schengen Area, representing full integration into the EU. The EU institutions have emphasized that control of external borders as an essential requirement for the preservation of the Schengen agreement. So in order to gain entry to Schengen are Croatia has to prove that is able to defend its border, an outer EU frontier against large number of migrants (Lasić, 2020). As a consequence Croatia started implementing EU-centric migration policies. It is noteworthy that the Schengen Area accession negotiations were only launched after the country started to systematically turn back migrants at the border. Owing to the weird shape of its territory Croatia has one of the EU's longest external frontiers. Total length of the land border with non-member countries amounts to 1,377km, so it is no surprise that Croatia has a difficulties monitoring such a long border. Since entering EU Croatia used EU funds for managing migration. Croatia has benefited from €163.13 million of EU support from 2015 to 2021 (European Commission, 2021). The EU support to Croatia to better manage migration and borders come from two EU funds, including the €41.10 million from the Asylum, Migration and Integration Fund and €122.03 million from the Internal Security Fund (European Commission, 2021). Interestingly, the majority of resources have been directed at the acquisition of hi-tech equipment for sophisticated border control. For example, in 2020 Croatia announced the use of EU funds to upgrade stationary and mobile devices at the border with Serbia and with Bosnia and Herzegovina, as well as its aerial surveillance means (FRA, 2020). Also, the large sum of money covered the operational costs, including the salaries of police officials that have been repeatedly accused of pushback and abuse of migrants (Guardian, 2020). On the other hand, little of EU's assistance has been used to protect the right of migrants.

Bosnia and Herzegovina – "Bottleneck" on the Balkan Route

Throughout European migrant crisis very few migrants attempted to reach Europe via Bosnia and Herzegovina. Yet, from the end of 2017, with the tighter control at Croatian and Hungarian border, the route through Bosnia and Herzegovina (see figure 3) emerged and soon became the main route of access to Europe (Kemp et al., 2021). Bosnia and Herzegovina border is porous because its border police is understaffed and lacks the techniques needed to monitor the border. According to the director of the border police of BiH the country only has 340 border policemen while it needs 1300 to effectively patrol the bor-

Figure 3. The Balkan Route from 2018 to present
Source: BVMN 2019
[click on figure to enlarge]

der (Ajnadžić, 2021). As a consequence, the migrants relatively easily reach BiH across the borders with Montenegro and Serbia. The border between Serbia and Bosnia and Herzegovina is 363 kilometres long, 261 kilometres of which is delineated by the Drina river. This border area is densely populated and partially hidden by lush vegetation so the terrain provides many opportunities for illegal crossing (Kemp et al., 2021). After crossing the Drina river, migrants arrive to Republic of Srpska, one of two Bosnia and Herzegovina feuding entities. Due to political division Bosnia and Herzegovina is lacking common policy regarding migrants. Majority Serbian part Republic of Srpska is reluctant to accept migrants but willing to provide a corridor for them. Although migratory routes passes through Republika Srpska no migration reception centres are located in this entity.

After crossing Drina river groups of migrants usually move towards Tuzla, first major town in Federation of BiH, another entity. The majority of migrants reach Una-Sana canton in the north-western part of BiH as the most favourable place for reaching the Schengen area in Slovenia quickly. According to UNHCR, the number of migrants entering BiH increased dramatically in 2018 when 24,000 migrants entered the country (Reliefwebint, 2021). Due to increased police presence alongside the border with Croatia migrants got stuck in Bosnia and Herzegovina. As a consequence, Una-Sana canton, especially major towns Bihać and Velika Kladuša, became overburdened by migrants which led to a humanitarian crisis in and around refugee camps. Majority of the border crossing happens in Una Sana canton even tough Bosnia-Croatian border is more than 900 km long. It is unclear wherefor migrants head for Bihać rather than cross the border at other points, for example further south. The explanation for migrants converging on Bihać seems to be similar to why migrants stuck to certain well-trodden routes through the Balkans in 2015: namely, word of mouth from acquaintances and others who had managed to migrate before them (Kemp et al., 2021). Between the second half of 2018 and early 2020, the Borići, Sedra, Miral, Bira and Lipa camps were set up and managed up by IOM and financed by the EU (Reliefwebint, 2021). Also, the tent city in the village of Vučjak was founded, even tough it was never officially recognized by the European Union but closed after seven months. Even after the camp Vučjak was closed in 2019 majority of the residents of the camp refused to be rehoused further away from the Croatian border (Grulovic, 2019). Furthermore, offers of voluntary return to countries of origin have been refused. Since 2018 migrants are increasingly using the route over Albania and Montenegro to reach BiH and then finally Croatia (Kemp et al., 2021). This route enters Bosnia and Herzegovina across rugged mountains that extend along most of the border with Republika Srpska and Montenegro. The terrain is difficult for border management. The number of entries into BiH continued to rise in 2019 with 29,000 reported arrivals. In 2020 16,150 irregular arrivals were reported (Reliefwebint, 2021). In addition, it is assumed that there are a large number of undocumented migrants.

Traversing from Bosnia and Herzegovina to Croatia

Migrants stay in border areas, from 2 weeks to 3 months, waiting for the opportunity to cross the border or by on foot or pay smugglers to take them by vehicle to Croatia or Slovenia. Croatia border with Bosnia and Herzegovina is hilly and heavily forested. Smuggling routes historically used to transport fuel, cigarettes and livestock are today popular paths used by migrants to cross the borders into Croatia (Kemp et al., 2021). Migratory routes are continuously changing and evolving in order to evade police. Most of the migrants use GPS navigation on smartphones in airplane mode, which prevents them being traced. Unlike 2015, nowadays migrants tend to avoid urban areas and instead they move through the countryside and sleep in abandoned buildings. Although the distance between Slovenia and Bosnia and Herzegovina is only around 70 km, the walk through Croatia usually takes 10 days or more (BVMN, 2020). Yet these long and dangerous journey can result in forced return to Croatia. Migrant transit is circular, involving moving forward and backward. Over the years the Balkan route transformed into "Balkan circuit" (Hameršak et al., 2020). When attempting to cross the border migrants often use tactics called "the game". Several people from a group of perhaps 20, rush the border first, knowing that there is likely they will get caught. This manoeuvre diverts the attention of the police, letting the others cross the border. However, it is becoming increasingly difficult to "win a game". Since the middle of 2020, migrants are increasingly trying to traverse into Croatia around Odžak, Derventa, Gradiška and Brod (Kemp et al., 2021).

Pushback

Following the securitization of borders in the Balkan region use of pushbacks as an illegal tool of border management became widespread. Occurring without formal procedures of safeguards, pushback is an expulsion of an individual or a group of people to another country (BVMN, 2019). Numerous NGOs, among others Are You Syrious NGO, the Centar za Mirovne Studije (CMS) in Zagreb and the Border Violence Monitoring network, claim that Croatian police is systematically pushing migrants into Serbia and Bosnia

Figure 4. Transit routes and pushback zones in Croatia
Source: BVMN 2021
[click on figure to enlarge]

and Herzegovina without allowing them to lodge an asylum claim, a basic right enshrined in international law. Reports of the pushback (some of them include medical documentation) of migrants from Croatian territory has been extensively documented since the closure of the Balkan Route in 2016. Since then, NGO BVMN alone has collected 624 pushback testimonies from Croatia detailing the treatment of 6,621 people (BVMN, 2021). Push-back usually occur in a handful of rural, secluded border areas (see figure 4) in order to minimize the risk of witnesses. In Serbia, people reported being pushed back mainly by the Tovarnik (see figure 4) train station and in forests nearby Batrovci, close to Šid. In Bosnia and Herzegovina, people described violence and push-backs on off roads and forests close to the border areas surrounding Velika Kladuša, Šturlić and Bihać (see figure 4). These push-back points are most often close to streams or downward sloping hills, which serve as a natural tool of assistance for the police officers carrying out these actions (BVMN, 2021).

Despite multiple reports accusing Croatia of violating the rights of migrants, the Croatian Ministry of Interior is denying the use of abusive border policies.

Dangers along the Balkan Route

As the Balkan Route becomes increasingly securitized by state authorities, migrants embark on travelling obscure and dangerous routes throughout thick forests and rapid rivers to avoid return to BiH if caught (BVMN). Alongside the Balkan Route many borders are marked by rivers, especially along the Croatian border with Bosnia and Herzegovina and Slovenia. When attempting to traverse the river, migrants are straying away from bridges since they are located in high-density areas. Over the past couple of years, several migrants drowned in rivers. Also, there several other threat's to migrants life. Along the Croatian border with Bosnia and Herzegovina there are thousands of unexploded mines which remained from the 1990s Balkan war. In 2021 a migrant died when he stepped on the anti-personnel device (Pušić, 2020). The absence of a centralized database and, therefore, accurate statistics, about migrant deaths in Balkan countries makes it all the more difficult to push for accountability from the authorities (Papachristou, 2021).

Exits from the Croatia territory

After entering Croatia migrant hope to reach Slovenia, a member of the Schengen area. From Slovenia, the Balkan Route continues towards the towns of Trieste and Gorizia in Italy (see figure 4) or to Austria. Since the peak of the European migrant crisis in 2015, the Slovenian government has erected barbed wire fence along the border with Croatia in order to curb migrant inflow. The fence direct irregular migrants to location where apprehension can be carried out more easily. Until 2021 the total length of fence is 178 km which is slightly less than a third of the Slovenian border with Croatia that is about 667 km long (Safner et al., 2021). However, the fence had little impact on migration flow since very few migrant reach Slovenia (Trkanjec, 2021). In addition to border fence, Slovenian army is assisting police in border surveillance which is just manifesting of borderization of Slovenia. In 2021 Slovenian government introduced joint patrols with officers from other EU members on its border. According to several reports, there is a system of coordinated chain-pushbacks designed to send people back from Europe to Bosnia and Herzegovina, a non-European Union country. Italy sends people to Slovenia, Slovenia to Croatia and finally Croatia to Bosnia and Herzegovina (Gostoli, 2020). Because the Croatian-Bosnian border is an external EU-border, Croatia and Bosnia and Herzegovina do not have readmission agreements similar to those between Italy and Slovenia (Gostoli, 2020). As such, pushbacks happen informally.

Irregular migration to Croatia after the closure of the Balkan Route

According to the official statistics of the Ministry of the Interior of the Republic of Croatia, continuous increase in the number of illegal border crossing was recorded after the closure of the Balkan Route in 2016. In 2017 4.808 (see figure 5) persons were caught during unlawful entry into Croatia. The number continued to rise in following years, with 8.207 reported ir-

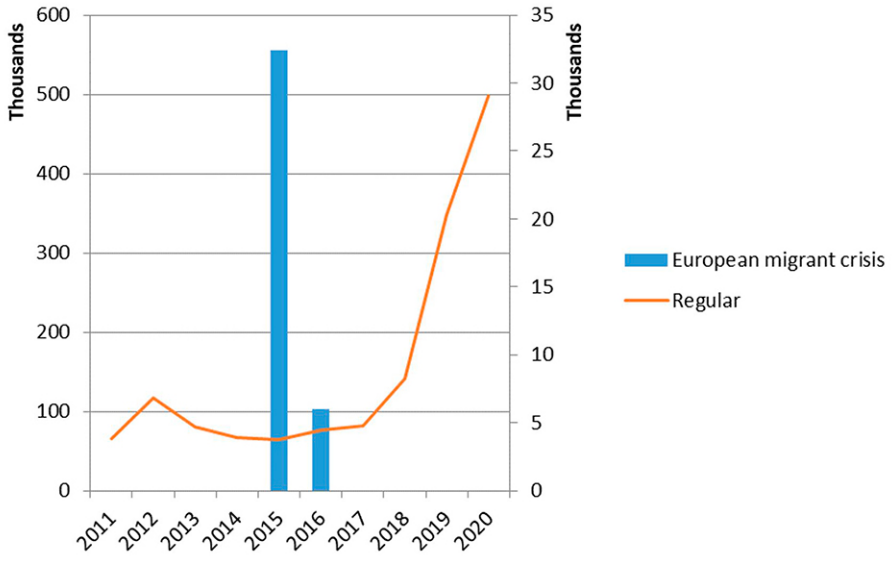

Figure 5. Illegal Border-Crossings 2011 to 2020

Note: During the peak of European migrant crisis in second part of 2015 Croatian police allowed migrants to travel to Western Europe. That is reflected in low number of illegal border crossings.

Source: European Migration Network, 2021

regular rivals in 2018 and 20.278 in 2019 respectively (European Migration Network, 2021). The data points to a stronger migration flows, but it is also a reflection of a tighter border control.

A single person can be caught trying illegally to cross border multiple times. The largest number of people is apprehended in the depth of the territory, but the number of people apprehended on the state border and accepted form police of other states is also big. Although data above is official, there are inconsistencies in it. Take a look at year 2018. In 2018, 8,207 people crossed the Croatian border irregularly. Amongst those 8,207,1,438 were returned to third countries, 1,068 applied for asylum and 536 were detained. So, there is no data about remaining 5,165 and their status. Some NGOs assumed that these people were illegally refused entry in Croatia (Centar za Mirovne studije, 2019). However, there are no official statistics on expulsions of migrants from Croatia. The criminalization of migration is also reflected through the intensified phenomenon of human trafficking and smuggling of migrants. In 2016, a total of 156 criminal offences was recorded under Article 326 of the Criminal Code "Illegally entering, moving and staying in the Republic of Croatia, another Member State of the European Union or a signatory to the Schengen Agreement (Roksandić et al., 2021). In 2017, the number of criminal acts rose to 365, 619 in 2018, and 946 in 2019. On the other hand Croatian police is accusing the migrants of asylum abuse. According to statistics from Ministry of Interior, over last four years 73,2% of applications for international protection were discontinued due to the applicant's disappearance (Veljković, 2021). Migrants apply for asylum just so they can legally stay in Croatia while they attempt to reach Western Europe. Moreover, most asylum seekers, who arrive in Croatia from refugee camps in Greece and Italy under an EU relocation program, leave. Of 250 resettled persons whom Croatia accepted as part of the EU solidarity mechanism, only 67 or 26.4 percent have stayed in Croatia (Veljković, 2021). Also migrants often present themselves as juveniles and therefore are placed in an open type shelter, which facilitates attempts to leave the area and go to destination EU countries. The data above is indicating that Croatia is still perceived as a transit country for migrants on their way to other countries in Western Europe.

Irregular migration to Croatia during COVID-19 pandemics

The first quarter of 2020 kicked off with high migratory pressure at Croatia's border with non-member EU countries, however this pressure soon subsided owing to COVID-19 countermeasures. In response to the outbreak of the coronavirus pandemic EU member states, including Croatia, adopted restrictive measures at the border which has affected human mobility. Also, migrants in the Balkans were confined to a large extent to migrant camps which largely restricted their mobility. As a result, during the March and April of 2020 (see figure 6), the number of illegal border crossings slightly declined. As the border restriction were eased off during the summer in the second half of the year clandestine entry detections multiplied compared to 2019. It is noteworthy that during the winter number of the border crossings is slightly lower due to

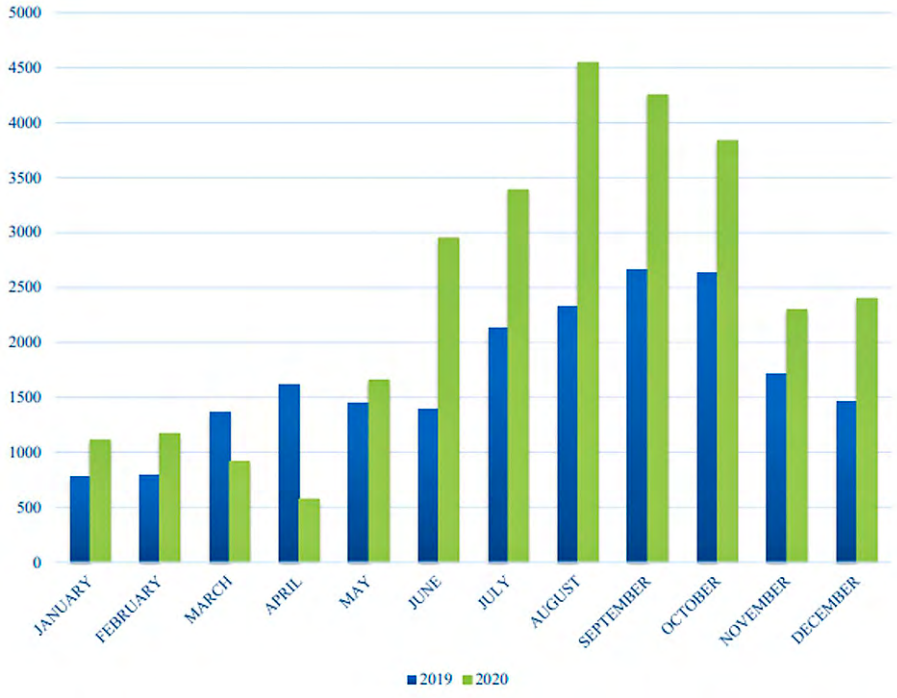

Figure 6. Illegal Border Crossings in 2019 and 2020 per month
Source: European Migration Network, 2021

harsh weather conditions. Especially families mainly decide to sit out winter in Bosnia and Herzegovina, while young male are eager to cross the border.

On overall in 2020 the Croatian police recorded 698 criminal acts of unlawful entry which is 35.5% less than in 2019 when there were 946 cases of unlawful entry (Roksandić et al., 2021). Foreign offenders, who make up a significant proportion of all perpetrators, have in a large number of cases previously used legal possibilities of inter-state traffic which was significantly limited in 2020 (European Migration Network, 2021). Additionally, the decrease in the number of reported criminal offences is due to the dismantling of smuggling chains. It can be concluded that the restriction measures implemented by the Croatian government introduced as a result of the COVID-19 pandemic resulted in lowering of the activities of organized criminal groups. On the other hand, individual migrants were even more motivated to cross the border because the more travel restriction are imposed the more migrants feel they have no choice but to continue moving. Migrants feared being sent to jungle camps. So in the 2020 the Croatian police recorded 29,094 illegal border crossing, a 43.4% fold rise from 2019 when there were 20,278 illegal border crossing (European Migration Network, 2021). Also, it could be due to the introduction of lockdown in Croatia in the period from March to May and from November to December, when a numerous police officers were in the field (Roksandić et al., 2021). Also, due to the earthquakes that hit Croatia, a large number of police officers were present in the area where the largest number of illegal crossings was previously recorded (Roksandić et al., 2021).

Recent development on the Balkan Route

The most recent noteworthy shift on the Balkan Route is emerging of the route through Romania. Since the Croatian and Hungarian borders are heavily policed, a portion of migrants seek other weak spots alongside the EU external border. Some of them reroute them from Bosnia and Herzegovina into Serbia and try to travel through Romania and Hungary. It is much cheaper to cross the porous Romanian border, so migrants who have run out of money chose this option. Romanian police claim there were more than 45,000 attempts to "illegally cross the border" in 2020, four times more than in 2019 (France 24, 2021). Timisoara the largest town near the border with Serbia is overwhelmed by the influx of migrants. However, this route is longer and no less risky. Eventually, migrants will inevitably have to cross into Hungary, which is the first country in Europe's passport-free Schengen area.

Conclusion

Formal closure of the Balkan Route may have reduced the overall number of migrants reaching Western Europe, but it has not halted migrant flows. Due to enhanced border control alongside the Balkan Route, at some border location larger groups of migrants accumulated because they were unable to continue their journey. As a result, the pressure on some border sections persisted. Moreover, owing to tighter border control migration routes diversified. The single corridor proliferated into more branches with the trend of channelling migrants towards Bosnia and Herzegovina. Under the EU guidance and sponsorship Croatia heavily secured its border with Bosnia and Herzegovina in order to prevent migrants reaching the EU. Consequently, the majority of migrants remain stranded in neighbouring Bosnia and Herzegovina. Several NGOs accused Croatian police of violent border practices, including use of pushback as an illegal tool of border management. Analysis of official data on irregular migration to Croatia has shown rapid growth of illegal border crossing into Croatia since the closure of the Balkan Route which points to higher migratory flow, but it is also a manifestation of tighter border monitoring. In the same period number of criminal acts of unlawful entry has risen dramatically, which is a reflection of criminalization of migration. Faced with very few or not any legal ways to claim asylum, migrants are forced to cross the border illegally. Furthermore, they embark on travelling dangerous routes in order to evade police, which can lead to death. Restrictive measures at the border implemented in 2020 by the Croatian government in order to halt the spread of the coronavirus resulted in lowering of the activities of organized criminal groups. On the other hand, individuals were even more motivated to cross the border to evade being stranded at migration reception centres. Most recently in 2021, due to securitized Croatian border, migrants are more and more using route over Romania.

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COLLABORATIVE ROLE OF SCHOOL MENTOR AND METHODICS MENTOR DURING THE SCHOOL PRACTICE OF GEOGRAPHY STUDENTS AND TEACHER TRAINEES

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Abstract

Mentoring during school practice involves cooperative and collaborative engagement of the school mentor and the faculty mentor in preparing geography students and teacher trainees for independent teaching. The aim of this work is to point out the importance of a systematic approach to preparing students and teacher trainees for work in primary, gymnasium and secondary vocational education. Gradual involvement in the teaching process enables students and teacher trainees to acquire basic teaching competences through several related activities within the methodical group of subjects at the faculty and during school practice. This work highlights the role of mentors in advising students and teacher trainees to develop their own teaching style. Key words: observation, discussion, cooperativeness, competencies, outcomes.

Keyword: school mentor, geography, students, teachers

Introduction

Students' school practice is an extended part of the teaching process that takes place in elementary, secondary vocational schools and in gimnasiums. The main task is the practical training of students for teaching work by building and developing their teaching competences. This process is planned and done in cooperation with faculties and schools in order to create a database of competent, young teachers who, after graduation, will be engaged in teaching and procedures for gaining a teacher licence.

School practice is realized through several activities: hospitating, holding classes, holding exam classes, evaluating classes, observation, and discussion. Each of these activities is consisted of a series of steps that ensure a high level of practice success and reduce the risk of unplanned negative events during the process. The possibilities of applying the outcomes and Buhberger 4C models in teaching geography during geography students' school practice and preparation for taking the exam within the programme for the Geography Teacher License Exam are also analyzed in this paper (Buhberger, 2015). The students and teacher-probationers' training process during school practice is realized through cooperation of methodological mentors, school mentors, faculty teaching assistants in methodical subjects and students.

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Tasks and cooperative work of school practice participants

The school practice programme is implemented in accordance with the school practice rules and contracts between faculties and educational institutions. The plan of realization of school practice is made by collaborative work of methodology teachers at the faculty and geography teachers at schools. School mentors are organized within the municipal or district assets or a subsidiary of the geographical society. Faculty Mentors they are usually unable to attend all of the students' classes because of the workload - teaching at faculty, preparing students for hospitating and class holding, research work, consultations and work within multiple committees. The school practice team consists of students, a school mentor, teaching assistant and methodologist mentor at the faculty. Affiliated team members can also be school psychologist and pedagogue. The schools and faculties' mentors cooperation and collaboration is a prerequisite for success of the school practice team's work. Cooperation is achieved through direct meetings or indirect agreements.

The school mentor has a very important role in the professional training of students for teaching. The school mentor is given a group of students then he/she presents a plan of teaching realization, makes recommendations in accordance with the characteristics of the class, monitors the classes in stages, evaluates the classes, participates in the observation and discussion of the class, makes the record and delivers it to a methodologist mentor. A school mentor can be a licensed geography teacher and a teacher who has completed training within the project of "School Practice Rooms". The tasks of the school mentor are to:

- present geography programme, projected outcomes and standards to students;
- warn students of any possible disciplinary problems in the class (present the experience of treating students in a given situation);
- enable the students to hold more classes;
- draw students' attention to gifted students and instruct them to work with those students (setting problem tasks and experiments);
- inform students about which students are in the IEP (Individual Education Plan) programme, to introduce the contents of those plans and to make recommendations;
- provide informal introduction to students (socializing and participating in extracurriculars activities);
- points to the contemporaries' conflicts solving
- initiates joint building of an atmosphere of mutual trust and good intentions;
- introduce their obligations and reminds them of those obligations from time to time;
- builds an atmosphere of mutual trust;
- produce certainty and predictability.

Students and teacher-probationers are subjects of the school practice process whose task is to meet the school mentor and students activities during the hospitation. During hospitation students note significant segments that should enable them to make a plan for the realization of their own lessons. The number of hospitation classes should not be less than 10 if the student monitors and observes the activities of one class. In order to get better teaching skills students have to meet as many students as they can.

Students realize a school practice programme according to determined plan of visits and holding both regular and exam classes. Students cooperate with mentors during school practice, get introduced with pedagogical documentation, subject and school curriculum, achievement evaluation rules, prepare for teaching (analyze programme, standards, goals and outcomes, prepare for the class), hold classes, and engage in discussion after the classes.

The teacher of methodical subjects is a mentor to all students at the faculty who realize school practice program. The task of the methodologist mentor is to produce as many methodical situations as possible during lectures, consultations and discussions of held classes. This should allow students to be prepared while holding their own classes to cope with certain events and respond to those events on time and in a correct way. The methodologist mentor initiates, develops, and follows discussions about the held classes, enables students to build their own work style, to make the preparation and scenario of the class by themselves. Methodologist should provide a theoretical basis for the use of teaching competencies and to present the very importance of proper choice of methods and forms of work. Methodologist mentor is expected to introduce possible teaching models to the students and to instruct them to the proper use of vertical, diagonal and horizontal correlations. The mentor introduces the cross-curricular competencies that are universal for all subjects and provides directives - how to use them functionally in teaching geography. It is important for geography teachers to master cross-curricular competences because geography teachers often take civil education classes where these abilities are more lighted. The methodologist mentor creates the entire process of school practice, provides the conditions for realization of the programme, makes criteria and elements for evaluation of exam classes, considers reports from the school mentor and teaching assistants, takes the reports into account

when forming the final grades for the methodical subject, directs the process and provides instructions.

The teaching assistant for methodical subjects plays a significant role in the realization of the concept of students' school practice. The assistant implements a teaching evaluation plan, monitors student presentations and makes his/her record which is the subject of analysis during the exam. In addition to regular activities at the faculty, the tasks of teaching assistants for teaching methodical subjects are students' work monitoring during school practice and submitting their own evaluation reports.

One of the most challenging tasks of a school practice team is to train students to manage the learning strategy throughout the teaching process (Brofi, 2015). Student has to master teaching competencies during training that involve giving clear instructions of what the student is expected to do and why it is important. By applying collaborative teaching and methodical frames, the teacher motivates the students to solve the tasks in class. The student has to be able to build an atmosphere for work so that pupils gradually and spontaneously, collaboratively or independently come to a realization and solution. The student's role is to encourage individuals patiently using his/her existing geographical knowledge and experience which leads to the achievement of learning outcomes and to the benefits students have from them.

Class observation

The methodical credibility and qualitative outcome of a student's class can be determined on observation basis. Observation can be performed according to established criteria by which one or two activities and typical situations that reflect the student's teaching style are observed. Students should be involved in the process of observations while holding regular classes. It is necessary to specify what the object of observation will be before the observation starts. It is not possible to observe all activities and phenomena and events during the class. It is therefore necessary to abstract relevant observation parameters. The observation plan can be unstandardized and standardized. Unstandardized plans may contain most of the standardized elements and elements specific to particular circumstances and context. Standardized observation plan contains measurement elements prescribed at the national level. There are standard procedures and value propositions scales that allow you to determine how many times situations are repeated and what their functions and purpose are. Recording a dialogue is not an easy process because it takes place under circumstances when the dialogue can be redirected to another student. Therefore, it is necessary to make an adequate form for monitoring dialogues and to use abbreviations and symbols.

Prior to the observation class, the students whose class is going to be observed, is supposed to hold several classes where mentors and other students will make informal observations to make the plan for formal observation based on an analysis of those notes.

Buhberger (2015) considers the involvement of students in observing lessons as an integral part of school practice to improve their teaching competences. He also emphasizes that the observational plan determines the goals of the observation, the possibilities during the observation, the application of the model 4C (cooperativity, continuity, competencies and context) and insists on setting general goals observations. These are: respecting the rules of conversation, developing students' opinions, focusing on topic, as well as creating conditions for all students to participate in the conversation as adopted protocol.

Observation is the basis for competent discussion about the class and analysis of it. The subjects of observation can be following student's activities:

- whether the student has defined goals and whether the goals are in accordance with the projected outcomes;
- the success of linking previously acquired knowledge to the contents that will be processed as well highlighting the difference in processing of similar lessons and teaching areas;
- students involvement (how many students participate actively, the frequency of individual activities, what the relation of teachers with students who give correct or incorrect answers is)
- dialogue with the student (wheather the questions point to geographical thinking, if the questions are clear, if they in acoordance with the programme, if they reflect the substance of the topic, if they are appropriate for their age, if they are structured according to the levels of complexity and domains of the mind engagements (knowledge of facts, knowledge of geographical terms, reasoning, analyzing, integrating));
- style, length of presentation, associative digression during class;
- continuity of thoughts during presentation;
- whether activation and motivation procedures are being applied to the students;
- building and using multidisciplinary links;
- comparing and citing examples;
- use of factual material;

- verification of knowledge acquisition during processing (manner and length of duration);
- use of teaching aids and instruments;
- whether the student updates the topic being processed and to what extent;
- whether he/she pays sufficient attention to the obscurities that arise when learning a new content;
- recapitulation of lessons and message;
- homework (type of tasks, whether they are sorted according to complexity levels, if the student makes them by his/her own and if they are in accordance with the outcomes)

Monitoring one student's activity determines the significance of that activity, the monitoring process, whether and to what extent certain goals are achieved, whether there is continuity and whether the activity is useful concerning methodically – geographical aspect.

The mentioned activities are being monitored by the phases of the lesson, from the introducing part through the amplification phase which is intended to elaboration and which can be divided into several subphases depending on the topic, up to the final part of the class (Dragović, 2017). The final part of the class is intended to recapitulate and feedback. Feedback from the final phase of the class enables the student to register weaknesses and to respond to them so the next class could be more successful. This extended phase can be marked as a post-teaching phase of thinking about the held lesson.

The process of students' training begins by holding regular classes when students are given the opportunity to register all deficiencies on time and to eliminate shortcomings and improve their skills and competences based on previous classes experiences. The conversation with candidates about held regular classes is led by a school mentor. The goals of these conversations are to register and eliminate perceived deficiencies and to prepare for discussion and analysis after the held examinations classes. This reduces the factor of sudden eventual hypersensitivity to criticism and the student knows what to expect in exam classes in advance. If the self-criticism of the class is authentic, it influences positively on the development of teaching virtues and competences. Being aware of his/her failures and defects the student reduces or completely eliminates any possible errors that accompany his/her teaching work.

After exam classes being held, an universal analysis and discussion of each held class is implemented. Students, a school mentor, and teaching assistants for methodical subjects participate in the class analysis. It is advisable that school pedagogue, psychologist and students from the candidate generation attend these meetings.

Written observations and evaluation of the held class are complemented by the school mentor with observations during the interview and analysis of the class. The school mentor shapes all the observations into a detailed report on held class and gives it on to the methodologist mentor.

Buhberger (2015) believes that in addition to general elements, the observational plan should include notes on a student conversation, who helds the class, with the students then audio or video records, conversations protocol with the duration of individual episodes and the order by which students were addressed.

The purpose of the observation is about meaningful verbal learning of geography, construction of cognitive connections and interactions of already consolidated geographic knowledge with contents being currently processed (Ausubel, 2003; Dragović, 2012).

The discussion

Discussion and analysis of the held class is a common stage in the school practice under which all activities registered during observation are considered. The primary task of mentor is to provide the positive conditions and climate to talk about the class. As it is a delicate phase certain preparations and agreements of the school practice team members' views with the candidate who held the class are necessary. Isolated and individual discussions about the held class cannot be of much use, but rather harmful to the development of teaching competences. The conversation should be led by mentors who have developed methodological and didactic competences and abilities for metacommunication and reasoning.

The conversation should be stimulating in order to give the student an opportunity to clarify certain procedures registered during the evaluation and observation of the class. That doesn't mean that if major oversights are registered, mentors should diminish their significance or relativize in some way. On the contrary, all failures must be analyzed in a multiplane manner and consider damages arising from these failures. It is important to choose the correct procedure for reporting certain failures. The most effective method is to ask the student questions regarding his or her findings. For example, a student declares that students were passive during class. The mentor should use this statement to ask questions such as: what do you think why the students were passive and what did you do to motivate stu-

dents to participate in discussions, how many students were active during class, why did not all students participate in the discussion, what would happen if you applied another form of work, do students correctly use the wall map and questions like that. The finding that the discipline was at a low level should be followed by the question, why do you think the discipline in the class was not good. The questions asked this way open a number of other questions and concerns which remove the illusions of an ideal class, open the field for objective self-criticism attitudes and put him/her in a position to independently improve his teaching competences. The mentoring approach of direct criticism and excessive objections without giving the candidate the opportunity to explain his / her actions and activities during the class does not contribute to the development of teaching qualities and produces candidate's dissatisfaction. The conversation about the class should not be the attack – defense based, or to end with a brief statement, the class is great, I have nothing to add. If the class was not successful and the candidate did not meet the basic methodical assumptions, the mentor gives the observations and tells his opinion to the student, with a clear explanation and without emotional connotation.

Focus on achieving outcomes

Students who are in training programme for future teachers begin their training for achieving outcomes that lead to the achievement of educational standards for geography. Outcomes define the purpose of studying the specific content. Training students to write and achieve outcomes begins at the faculty where theoretical knowledge of properly and precisely defined outcomes is obtained (Dragović et al., 2014). Due to disagreement about the differences between goals and outcomes some theorists believe that goals should be abandoned and that careful attention should be given to outcomes (Moon, 2002). These two categories are not in conflict and, if properly defined, they are mutually compatible.

The goals reflect the teachers' expectations concerning class, and through standards outcomes are met. The key difference between goals and outcomes is that the goals relate to teachers' intentions, whereas the outcomes indicate what the students will be able to do with the acquired knowledge, competences and skills at the end of the period. The outcomes determine what the student knows, can, applies and what he is capable for at the end of the school year, cycle or end of the educational process, while standards are measurable tools for achieving projected outcomes (Kennedy, 2007). As defining outcomes requires certain experiences and to a certain level of developed competence, students are not able to define them independently. Students who do school practice do not hold classes throughout the school year so this raises the question of the purpose of introducing the activities which refer to achieving outcomes. It is necessary for the methodist mentor and the school mentor to involve the students in the procedure and activities that lead to the achievement of outcomes. By continuous holding more lessons in one class, a student can make a significant impact on students while achieving certain outcomes.

The level of success in achieving outcomes depends on many factors. Achieving outcomes depends on the question to what extent they are achievable, whether they are appropriate to the educational capacities of the students with whom the student works and whether the students are able to apply them. The prepare domain on achieving outcomes include competent interpretation of cognitive levels, classification of content according to these levels and the application of an altered Blum taxonomy (Bloom, 1981). If the student chooses to apply the group form of work then the tasks that the groups are given should be linked by the logic and order of geographic study and accomplishment of projected outcomes. The evaluation of tasks performed by inhomogeneous groups is significantly more difficult than the evaluation of tasks performed by homogeneous groups. In a non-homogeneous group can not reliably determine the individual students' contribution without profound monitoring, while in homogeneous groups, individual evaluation of students' work is easier because of similar educational potentials of students.

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COMPARATIVE ANALYSIS OF PRIMARY SCHOOL CURRICULA IN THE REPUBLIC OF SERBIA AND THE REPUBLIC OF SLOVENIA

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Abstract

The analysis of the curriculum in the primary schools in Serbia and Slovenia has the aim to indicate the current functioning of a school system, as well as to determine the similarities and differences in the primary schools curriculum. It was important to establish teachers' satisfaction with the curriculum, whether they consider it as good, efficient and adapted to the contemporary needs of the pupils. Teachers' views on this topic are of significant importance for this paper, so the survey was used as an instrument. Research was conducted by individual interviews of teachers of different subjects in Serbia and Slovenia. Teachers were supposed to express their opinions on the curricula. The survey revealed whether the curricula are in line with the needs of the 21st century, modernization, globalization and enhancement of young people's intellectual potential. The aim of the research was to determine whether there are statistically significant differences in the teachers' answers and to correlate those differences to the general education situation of the two countries.

Keywords: primary education, primary school curriculum, teachers' opinions, Serbia, Slovenia

Introduction

The concept "*curriculum*" has been related to pedagogy since the baroque period and means "*the flow of education*". This concept, in its educational meaning, has been used in Anglo-Saxon countries up to now (Đere, 1985). In most European countries, the concept was accepted again in 1960s and is still used (Donald, 1987; Carton, Tawil, 1997; Romelić, Ivanović Bibić, 2015).

The concepts "teaching plan and program" and "curriculum" are not synonyms. The significant difference between traditional teaching plans and programs and development of the curriculum, which came as a reaction to them, should be looked for in the fact that goals of teaching and learning in the curriculum are specified in a way that they list pupils' verifiable and perceptive reactions. European educationalists define the term curriculum as "the first draft of the learning and teaching process in which statements on content, goals, learning conditions, teaching methods and evaluation processes are collected in one place" (Mehisto, 1993; Ivanović, 1997; Maksimović, 1997; Mijanović, 1997; Ratković, 1997; Noel, 1997; Romelić, Ivanović Bibić, 2015). At the beginning, a closed curriculum was an alternative to traditional plans and programs. The essence of this concept is reflected in all pre-planned elements of learning. An open curriculum means including as many teachers as possible in the curriculum development. It involves the formation of development groups consisting of teachers and scholars, who have a task to formulate teaching programs and to enable spontaneity in the realization of the teaching content in the teaching process (Herera,

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Mandić, 1989; Wadi, 1997; Ostini, 1998; Komlenović, 2004, Tot, 2010). This way, according to the Recommendation of the International Conference on Education in 1984, rigid planning and defining can be avoided, as it is the case in a closed curriculum.

In the Republic of Serbia primary education is compulsory, lasts eight years and is carried out in two educational cycles. In the first cycle, pupils are taught by class teachers. Exceptionally, subject-based courses in foreign languages, elective and optional subjects may be organized for pupils in the first cycle in accordance with the law. In the second cycle, pupils are taught by different subject teachers (Lešćešen et al, 2013).

In the Republic of Slovenia primary education lasts for nine years and is carried out in three educational cycles; pupils enrol in primary school at the age of six. The implementation of the new nine-year long primary school has started gradually since 1999/2000 (only in well prepared schools) and since 2003/2004 all schools have conducted the nine-year program.

The focus of primary education today is on the comprehensive development of personality and society through an education system that is being refined and innovated every day in most countries (Lukić et al., 2019; Stojšić et al., 2019; Đukičin Vučković et al., 2019). A case study of Serbia and Slovenia was considered since these two countries have similar goals in education, but very different conditions and predispositions for their realization. A great number of differences in primary education poses a challenge and an opportunity to consider which of the two curricula is better, provides more lasting and functional knowledge and more comprehensively prepares and equips pupils for life and work in the 21st century.

Theoretical background

The Education Development Strategy in Serbia is an instrument which has the task to ensure the achievement of defined mission and goals of the education system from the beginning of the implementation of the strategy, with appropriate adjustments of the strategy to the new circumstances of education development in the Republic of Serbia (http://www.mpn.gov.rs/wp-content/uploads/2015/08/STRATEGIJA-OBRAZOVANJA.pdf).

Some of the goals and tasks of the education program are:

- development of intellectual capacities and knowledge of children and pupils necessary to understand nature, society, themselves and the world they live in, in accordance with their developmental needs, opportunities and interests;
- encouragement and development of the physical and health abilities of children and pupils;
- training for work, further education and independent learning in accordance with the principles of constant development and lifelong learning;
- developing awareness of national affiliation, nurturing Serbian tradition and culture, as well as the traditions and cultures of national minorities;
- enabling involvement in European and international integration processes;
- developing awareness of the importance of protecting and conserving nature and the environment;
- developing curiosity and openness to the cultures of traditional churches and religious communities, as well as ethnic and religious tolerance among children and pupils, enhancing trust among children and pupils and preventing behaviours that violate the right to diversity;
- respect children's rights, human and civil rights and fundamental freedoms and develop the capacity to live in a democratic society (http://www.mpn.gov.rs/wp-content/uploads/2018/04/Правилник-о-наставном-плану-за-први-други-трећи-и-четврти-разред-основног.pdf).

The systematic renewal of education in the Republic of Slovenia took place during the 1990s. The Higher Education Act was enacted in 1993 as the legislative basis for the modernization of higher education. The comprehensive White Paper on education in the Republic of Slovenia was published in 1995, on the basis of which a package of laws on pre-university education was adopted in 1996. The period between 1996 and 1999 was characterized by the implementation of new legislations and broad curricular reform (Ministry of Education and Sport, 1995). Compulsory primary education in Slovenia lasts nine years.

Some of the education goals and tasks in Slovenia (Basic School Act) are:

- enabling high quality general education for the entire population;
- promotion of coherent physical, cognitive, emotional, moral, spiritual and social development of an individual, taking into consideration developmental principles;
- enabling pupil's personal development according to his/her capabilities and interests, including the development of his/her positive self-image;
- gaining the ability for further education and career with an emphasis on competency for lifelong learning;

- education and training for sustainable development and active participation in a democratic society, which includes deeper knowledge and responsible attitude towards ourselves, health, other people, our own and other cultures, the natural and social environment of future generations;
- developing awareness of nationality and national identity, knowledge of the history of Slovenes, their cultural and natural heritage and promotion of civic responsibility;
- training for the common cultural and civilizational values which derive from European traditions;
- training for respect and cooperation, for accepting differences and mutual tolerance, respecting human rights and fundamental freedoms;
- developing literacy and understanding of the text, natural sciences, mathematics, information, social sciences and art;
- developing the ability to communicate in foreign languages;
- achieving internationally comparable standards of knowledge;
- developing entrepreneurship as a personal attitude in pupils' effective action, innovation and creativity (http://www.mizs.gov.si/si/delovna_podrocja/direktorat_za_predsolsko_vzgojo_in_osnovno_solstvo/osnovno_solstvo/#c17845).

In Serbia, the first semester starts on the first working day in September and the second semester starts in mid-February. For the eighth grade pupils, the second semester finishes on the last week of May and for the pupils from the first to seventh grade it finishes in mid-June, while the school year lasts until 31st August (http://www.mpn.gov.rs/wp-content/uploads/2018/07/Pravilnik-%C5%A0K-za-osnovne-%C5%A1kole.pdf). The school year in Slovenia starts on the first working day in September, it ends in mid-June for pupils of the ninth grade, while for others it lasts until the last day of August (http://www.mizs.gov.si/). School year is divided in two semesters, both in Slovenia and Serbia.

Weekly class load for pupils in Slovenia and Serbia differs regarding the grade, as pupils get older weekly number of classes is higher. In the first cycle, pupils in the Republic of Slovenia weekly have more classes than pupils in Serbia, while in the higher grades the situation is the other way around (http://www.mpn.gov.rs/; http://www.mizs.gov.si/).

Apart from the differences in the duration of primary education in Serbia (8 years) and Slovenia (9 years), there are also certain differences in the teaching plan in these two Republics:

- In the first grade of primary school, children in Slovenia have six compulsory subjects, while in Serbia they have seven; subjects are similar and while in Slovenia there is a subject Learning the Environment, in Serbia it is World around Us; another difference is that in Serbia children learn a foreign language from the first grade while in Slovenia that is not the case. Weekly number of classes in Serbia is 19 and in Slovenia 20.
- In the second grade of primary school in Slovenia children have seven subjects, just as in Serbia; other subjects are the same as in the first grade in both Republics and in Slovenia children start learning a foreign language from the second grade. Weekly number of classes in Serbia is 20 and Slovenia 23.
- In the third grade of primary school in Slovenia, children take the same subjects as in the previous year and weekly number of classes is increased by one (from 23 to 24); in Serbia, the subject World around Us is replaced by a new subject - Science and Social Studies, the weekly number of classes is the same as in the second grade (20);
- In the fourth grade of primary school, children in Slovenia no longer have the subject Learning the Environment, but they take two new subjects – Society and Science, and Technology, while in Serbia all subjects are the same as in the third grade. Weekly number of compulsory classes in Slovenia is 23.5 and in Serbia 20;
- In the fifth grade of primary school in Slovenia, pupils get one new subject called Home Economics and other subjects are the same as in the fourth grade. In Serbia, the fifth grade marks the beginning of the second cycle of primary school and pupils get new subjects such as Geography, History, Biology and Technical and ICT Education and they no longer have Science and Social Studies. Weekly number of classes in Slovenia is 25.5 and in Serbia 23;
- In the sixth grade of primary school in Slovenia, pupils no longer have the subject Society, they get new subjects such as Geography and History and they also do not have Science and Technology anymore, but Science and Technical Education and Technology. In Serbia, pupils get a new subject – Physics. Weekly number of classes in Slovenia is the same as in the fifth grade (25.5) and in Serbia it is 24;
- In the seventh grade of primary school in Slovenia, pupils no longer have subject Home Economics, as it is now called Patriotic and Civic Culture and Ethics and other subjects are the same as in the previous year. Pupils in Serbia take another new subject – Chemistry. Weekly number of classes in Slovenia is 25.5 and in Serbia 26.
- In the eighth grade of primary school in Slovenia, pupils get new subjects – Physics, Chemistry and Biology, instead of one called Science. In Ser-

bia, subjects are the same as in the seventh grade. Weekly number of classes in Slovenia is 25.5 and in Serbia 26 (http://www.mpn.gov.rs; http://www.mizs.gov.si/);

- In the ninth grade of primary school in Slovenia, pupils no longer have subjects Patriotic and Civic Culture and Ethics and Technical Education and Technology and weekly number of classes is 25.5 (http://www.mizs.gov.si/).

Similarities and differences in the elective subjects in the two Republics are reflected in the following: Pupils in Slovenia learn a foreign language from the second grade, but they can also learn it from the first grade, if it is an elective course, and they take the second foreign language as an elective course from the seventh or fourth grade. In Serbia, one foreign language is taught from the first grade and another elective foreign language from the fifth grade. (Cvjetićanin et al., 2011; Leščešen et al., 2013; Milanković et al., 2015). In Serbia, elective courses are present throughout the whole primary education, and this is not the case in Slovenia (the second and third grades are without elective courses, as well as the seventh, eighth and ninth grades where there is only a second foreign language), (http://www.mpn.gov.rs/wp-content/uploads/2018/04/Правилник-о-наставном-плану-за-први-други-трећи-и-четврти-разред-основног.pdf; http://www.mizs.gov.si/fileadmin/mizs.gov.si/pageuploads/podrocje/os/Izbirni_predmeti_pojasnila.pdf).

Geography in elementary schools in Serbia and Slovenia

Geography lessons in primary schools in Serbia are structured in the framework of thematic sections that cover the topics of general geography, regional geography and national geography.

Innovation in the school geography program, unlike programs used in the 1990s, is reflected in the fact that annual teaching program is divided into teaching topics and thematic characteristics without the structured number of classes. A teacher has a freedom to organize classes according to the teaching sections specifics. The program does not suggest the types of lessons and does not define the time for other teaching activities (lecture, revision, assessment, practice).

Table 1. Geography curriculum in primary school in Serbia

Grade	Geographical contents	Annual number of classes
V	Earth as a whole	36
VI	Social geography, geographic map, geography of Europe	72
VII	Regional view of Europe and non-European continents	72
VIII	National geography - Serbia	68
Total		248

Source: http://www.mpn.gov.rs/wp-content/uploads/2018/04/Правилник-о-наставном-плану-за-други-циклус-основног.pdf

Geography lessons in primary schools in Slovenia are structured in the framework of thematic sections that cover the topics of general geography, regional geography and national geography. The teaching subject has a clearly defined educational goal for each grade and each thematic section of the program is defined by educational goals and activities. Terms and names that a pupil needs to master within a specific teaching topic are listed.

The aim of Geography teaching in the Republic of Serbia and the Republic of Slovenia is to create conditions for all pupils to develop motivation for learning

Table 2. Geography curriculum in primary schools in Slovenia

Grade	Geography contents	Annual number of classes
6	Earth as a whole	35
7	Geographical characteristics of Europe and Asia	70
8	Geographical characteristics of America, Africa, Australia and polar areas	52
9	Slovenia - our homeland	64
Total		221

Source: Ministry of Education and Sport, 2011

and interest in the subject contents, as well as to get to know and understand the geographical objects, phenomena, processes and laws in space, their cause-and-effect relationships and develop geographical literacy and geographical thinking (Ivkov, 2002; Komlenović, 2004, Višnić et al., 2017).

Methodology

For the purpose of the study aimed at comparative analysis of curricula in the two countries, a survey was conducted to compare teachers' views on this issue. The survey has proven to be a successful tool in some previous research in the field of education (Lukić et al., 2019; Višnić et al., 2017; Đukičin Vučković et al., 2019)

A close-ended survey consisting of 3 parts and 14 questions in total was used for collecting data. The research was conducted by personal interviewing and each respondent received a questionnaire. The first part (questions 1-3) collects demographic data. Likert scale - a five-point scale by which teachers were supposed to express how much they agree or disagree with a particular statement (1-strongly disagree, 2-disagree, 3-undecided, 4-agree, 5-strongly agree) was used for the second part (questions 4-11). The average values for each claim imply to a certain extent a positive or negative attitude towards the particular statement (Likert, 1932). For the third part of the research (questions 12-14), survey contained questions to which respondents had to give yes/no answers, i.e., questions for which they had to circle only one of several given answers.

The content of the survey is original and has not been modelled on any of the previous curricula surveys. The survey was designed to respond to and follow education trends in Serbia and Slovenia.

The research was conducted in the school year 2018/2019. The sample was random. After the survey was completed, there were 30 correctly completed surveys in the Republic of Serbia and 30 in the Republic of Slovenia. Respondents were of different gender, work experience, place of school, and subjects taught. All respondents are employed in primary schools. The respondents voluntarily participated in the survey.

One of the tasks of the paper was to determine whether there were differences in teachers' views on the education system in the two countries and on the curricula of primary schools. It was assumed that the teachers from the researched areas had different experiences in working in primary schools, and thus different attitudes on the subject.

The data obtained were analysed in the SPSS statistical program, which is widely used in similar studies. A T-test for independent samples was used to compare the average values of the results and to determine the statistical significance of their differences. Independent samples t-test was applied to compare the arithmetic means of two groups of respondents: men and women. One-factor analysis of variance, ANOVA, was used to examine whether there was a statistically significant difference between respondents with different length of work experience (Langdon, Vesper, 2000).

Results and discussion

After completing and reviewing the surveys, the final number of correctly filled surveys was 60. The data processed have a normal distribution and do not deviate from the usual one.

Among respondents (Figure 1) there were most of those with between 6 and 15 years of service (38%) and then over 26 years (28%). There were slightly fewer respondents with 16 to 25 years of service (22%) and the least were those with less than 5 years of service (12%). Based on the country in which the respondents work, the result was as follows: a total of 50% of the respondents work in Serbian primary schools, as well as 50% in Slovenian primary schools. According to gender, majority of the respondents are female teachers 72%, and 28% are male respondents.

Class teachers and teachers of 17 different subjects in primary schools in Serbia and Slovenia participated in the research. Majority were class teachers (18), then geography and maths teachers (6), teachers of Slovenian and English languages (Figure 2). Class teachers are quite present in the sample, as many of them work in

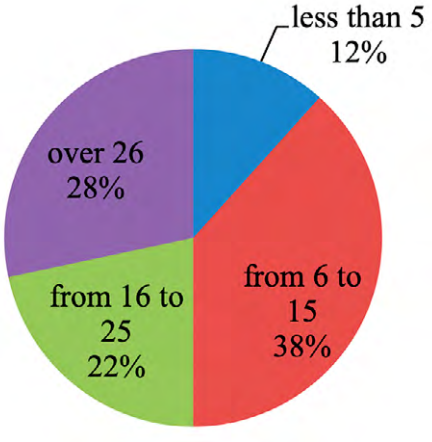

Figure 1. Respondents' years of service

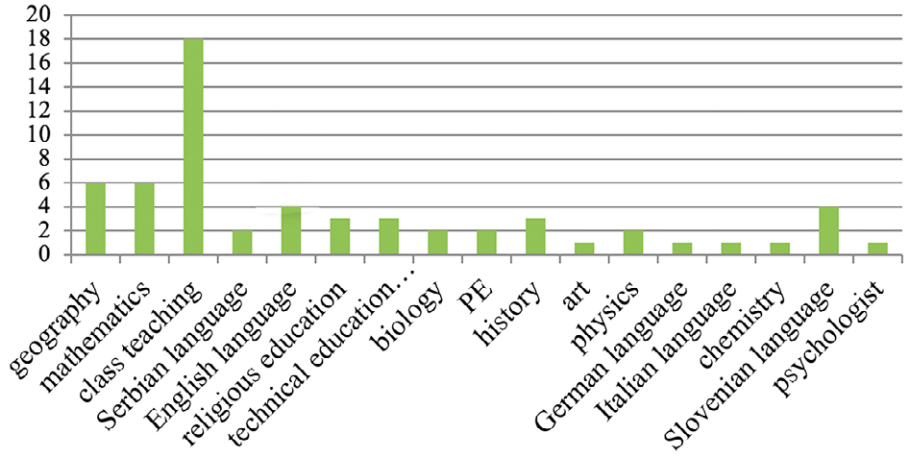

Figure 2. Respondents from Serbia and Slovenia according to the subject they teach

primary schools (Lukić et al., 2019; Đukičin Vučković et al., 2019), as well as maths teachers and teachers of Serbian and Slovenian languages. Other teachers are present to a smaller extent and among them are the teachers of geography, chemistry, physics, technical education, teachers of religious education, art, physical education, history, biology and other foreign languages. One psychologist was also interviewed.

Table 3 shows average values of the respondents' answers from the second part of the survey. In most cases respondents expressed their agreement with the statements or their answers meant that they did not have an opinion on a specific statement. If we look at the respondents, the assertion that is rated the highest by teachers in Serbia is: *Education is the most important and complex factor of modern society.* The average response value is 4.70. In Slovenia, respondents mostly agree with the statement: *The task of modern education encourages the development of creative skills and the raising of intellectual potential of young people*, with the average response value of 4.50. The statement with which the respondents in Serbia expressed the least agreement is: *Open curricula are a step towards greater autonomy of the school, but also a step towards greater innovation and creativity of the teachers,* and the average response value is 4.20. In Slovenia, the respondents expressed the least agreement with the statement: *Democratization of education is necessary in the 21st century.* The average response value is 3.37.

Major disagreement between the average response rates of primary school teachers from Serbia and Slovenia (4.37 versus 3.57) is expressed for the statement *Democratization of education is necessary in the 21st century.*

Table 3. Average response values of the respondents from Serbia and Slovenia

Statement	Country	Average value
Education is the most important and complex factor of modern society	Serbia	4.70
	Slovenia	4.23
Democratization of education is necessary in the 21st century	Serbia	4.37
	Slovenia	3.57
The modernization of education develops a child's scientific attitudes, creativity, critical thinking, objectivity and accuracy	Serbia	4.57
	Slovenia	4.43
The task of modern education encourages the development of creative skills and the raising of intellectual potential of young people	Serbia	4.60
	Slovenia	4.50
Globalization processes affect national education systems and their development	Serbia	4.27
	Slovenia	4.13
Primary education must provide more than just teaching fundamental reading, writing and numeracy	Serbia	4.53
	Slovenia	4.37
School autonomy is one of the factors that can play an important role in improving the quality of education and upbringing	Serbia	4.43
	Slovenia	4.10
Open curricula are a step towards greater school autonomy, but also a step towards greater innovation and creativity in teaching	Serbia	4.20
	Slovenia	4.17

Table 4. T-test results for the male and female respondents in Serbia and Slovenia

Statement/question	Country	F	p
Education is the most important and complex factor of modern society	Serbia	6.356	0.018
	Slovenia	0.959	0.336
School autonomy is one of the factors that can play an important role in improving the quality of education and upbringing	Serbia	9.755	0.004
	Slovenia	2.671	0.113

Table 4 shows the results of the t-test for statements/questions where statistically significant differences were observed between male and female respondents in Serbia and Slovenia.

Statistically significant difference between the answers of male and female respondents in Serbia and Slovenia (level of significance $p<0.05$) is seen in two of eight tested statements/questions only with the respondents from Serbia, while with the respondents from Slovenia there were no statistically significant differences. The biggest difference is seen in the question: *School autonomy is one of the factors that can play an important role in improving the quality of education and upbringing.* Such values clearly indicate that the hypothesis that there are statistically significant differences in the attitudes of teachers of different genders has not been confirmed.

Analysis of Variance (ANOVA) showed that there are no statistically significant differences in the answers of the respondents with different length of employment (Lukić et al., 2019; Đukičin Vučković et al., 2019). Eight statements / questions were tested and only for one of them a statistically significant difference between the respondents from Serbia was found. It is a claim that *School autonomy is one of the factors that can play an important role in improving the quality of education and upbringing.*

Therefore, this hypothesis has not been confirmed. High level of agreement with the given statements/questions shows that teachers with different years of service have similar views on education.

The third part of the survey consisted of questions for which respondents had to choose one of the given answers. For the question, *The following strategic decision is the most important in education?* (Figure 3) the majority of respondents from Serbia and Slovenia agreed that quality is the primary development goal at every education level. In the second place in both groups of respondents is that the quality of a teacher is the key factor of the high-quality education.

Only few respondents think that accreditation, evaluation and quality checks are the most important. One respondent from Serbia said that the plan and program modernization is the best strategic decision and not learning the facts by heart. It can be concluded that, regarding the education strategy, teachers from Serbia and Slovenia have similar views.

Table 5. ANOVA results for the respondents from Serbia and Slovenia based on their years of service

Statement	Country	F	p
School autonomy is one of the factors that can play an important role in improving the quality of education and upbringing	Serbia	4.937	0.008
	Slovenia	1.501	0.238

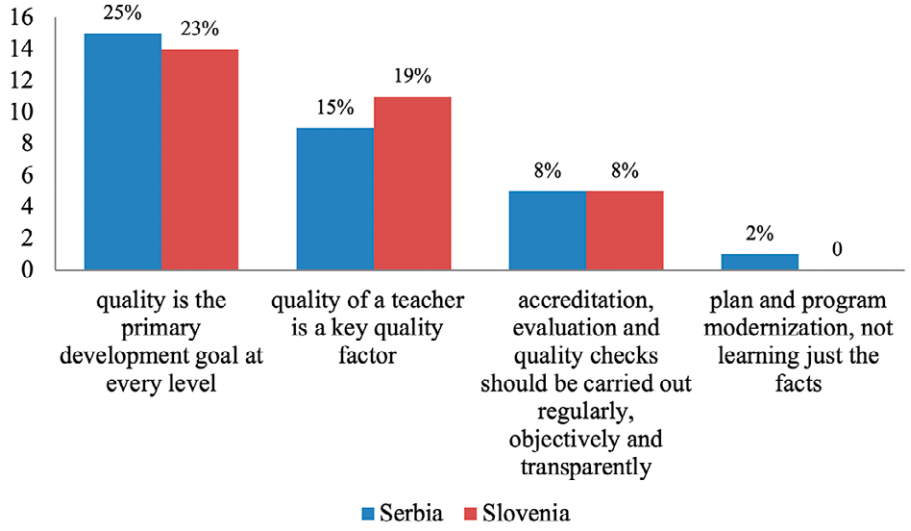

Figure 3. Respondents' answers to the question: The following strategic decision is the most important in education

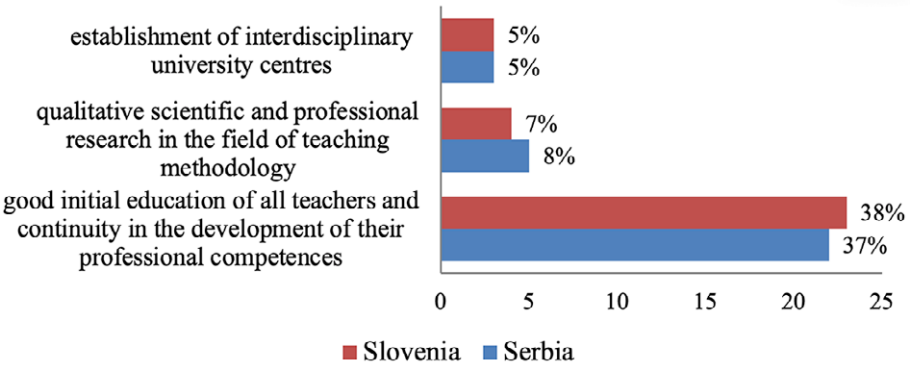

Figure 4. Respondents' answers to the question: Teachers' development and education strategy will be best followed through

For the question *Teachers' development and education strategy will be best followed through* (Figure 4), most of the respondents agreed that good initial education of all teachers and continuity in the development of their professional competences is the best strategic element in the development and education of the teachers. A smaller number of the respondents thinks that it is due to high quality scientific and professional research in the field of teaching methodology and only a few of them think that the best element is the establishment of interdisciplinary university centres. This question also shows a great deal of agreement in the attitudes of the teachers from Serbia and Slovenia.

Figure 5 shows a clear difference in the attitudes of teachers from Serbia and Slovenia. Most of the teachers from Serbia (66%) who participated in the research think that education system in Serbia is not at a satisfactory level. Contrary to that, even 76% of the teachers from Slovenia is satisfied with the education in their country and think that it is at the appropriate level.

Although most of the questions/statements in the survey showed agreement in the attitudes of the teachers from Serbia and Slovenia, the last question can be a clear indicator that there is a difference in the curricula of the two countries. The view that most Slovenian teachers think that their education system is at a satisfactory level, contrary to the attitude of Serbian teachers, suggests that reforms should be introduced in the curriculum in Serbia (Đukičin Vučković et al., 2019).

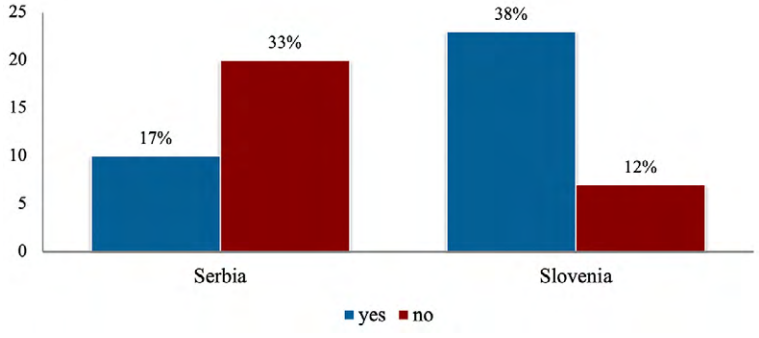

Figure 5. Respondents' answers to the question: Do you think the education system in your country is at the satisfactory level?

Conclusion

Changes in education are necessary for: social, economic, political, cultural and other aspects of the organization of society. Innovation in all segments of education is necessary, from primary to higher education. Through different subjects or fields in primary school, pupils acquire knowledge; develop skills, value orientation and attitudes necessary for life and work in modern conditions.

Standardization of program requirements and contents, which is done on the principle of modern didactic taxonomy, contributes to the successful realization of well-selected teaching contents and more lasting and higher quality knowledge of the pupils. Opportunity to take elective courses in primary school, along with the obligatory ones, contributed to the improve-

ment of the quality of education systems in Serbia and Slovenia in several ways.

A very important link in the complete education chain is certainly the teacher who must be able to follow education trends regarding the methods and quality, but who will strengthen his/her competences through continuous professional development. Teacher education reform must be based on prestigious academic degrees.

Research results show that the hypothesis that there are statistically significant differences in the answers of respondents working in primary education has not been confirmed. On the other hand, the high level of agreement with the claims offered suggests that teachers from Serbia and Slovenia with different length of service have similar views on education.

Global social movements have again shifted political attention to the education sector worldwide, bearing in mind the interconnectedness of a strong and high-quality education system and the rapid changes of the modern world. Countries with high-quality teaching staff and more numerous and flexible education opportunities, can rely on creative solutions and innovation-based growth. The National curriculum of the Republic of Slovenia and the geographic curriculum as one of its segments, with its qualitative characteristics, may serve Serbia for tracing the curricular pathway.

Acknowledgment

This research was supported by the Erasmus+ strategic partnership project no. 2019-1-CZ01-KA203-061379, and by Project 142-451-2350/2021-01 of the Provincial Secretariat for Science and Technological Development, ECAP Vojvodina (Serbia).

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NATURE SCHOOLS IN THE REPUBLIC OF SERBIA

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Abstract

The first open-air schools date back to the Middle Ages. Today, teaching in nature represents a form of educational work that covers compulsory subjects, elective programs, project-based learning, and extracurricular activities in the curriculum for the first cycle of primary education. This kind of work is carried out in climate-friendly places for health-recreational and educational reasons. To determine how much class teachers in the Republic of Serbia do this type of work, a questionnaire was developed and distributed to over 100 elementary schools. The research results show that teaching in nature is mostly carried out in the fourth grade, most often in the mountains, in the month of May, lasting for 7-8 days. The suggested hypotheses predict statistically significant differences between the attitudes of teachers of different gender, years of work experience, school location, and regarding whether teachers conduct classes in nature at all, in different grades.

Keywords: nature schools, Serbia, primary education, teaching in nature, teachers' attitudes

INTRODUCTION

In the teaching process, there is an increasing emphasis on the independence of pupils, their ability to use different sources of knowledge, the integration of knowledge from different fields, the practical application of knowledge in solving problems in everyday life and creating conditions for the most diverse and creative participation of pupils in the teaching process. As one of the key goals of the educational process is to enable students to learn on their own, the preference is given to those forms and methods of work that contribute to a more active attitude of the pupils towards the teaching content, establishing a closer link between the knowledge acquired in the classrooms and real-life problems and situations. Hence pupils are given opportunities to get to know and learn about their natural and social environments in different settings. The best way to get pupils acquainted with the nature that surrounds them, and the society that can directly or indirectly affect the environment, is to organize classes or schools in nature.

There is not enough information nor a more thorough and comprehensive research into the question when exactly natures schools started to be organized. We have found information about that in a diverse, but not rich literature which, after considering other pedagogical problems, also addresses this one.

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DEVELOPMENT OF NATURE SCHOOLS

First nature schools can be found in ancient history. The pedagogical ideas of the humanists acknowledged the demand for approaching nature, for following nature in everything including education. During the fourteenth and fifteenth centuries, special merit for the theoretical and first practical realization of the idea of a nature school belonged to the Italian humanist educator Vittorino da Feltre (1378-1446), who, at the invitation of the Duke of Montana, Francesco Gonzaga, organized a school located in a castle, out of town, on the shore of the lake, called the "Home of Joy", in which he educated his children.

With the development of capitalist relations during the eighteenth and nineteenth centuries, the government recognized the importance of education for the advancement of society, so it took care and control of primary schools, and the school became separated from nature temporarily, but for quite a long period of time. Urban life slowed down and made it difficult for people to adapt to these conditions, compared to the earlier environment in which they lived, and the consequences of this were particularly felt in the environmental problems of cities and the health problems of urban residents.

In the late nineteenth and early twentieth centuries, to overcome the weaknesses that were present in the system of education and organization of educational work in the schools of Central and Western Europe, a whole series of reform movements appeared, within which the idea of an open-air school and classrooms in the field appeared, intended primarily for the sick and the children of more tender health. These schools should, under favorable climatic conditions and appropriate specific organization of educational work, strengthen health and improve psychophysical development (Nikolić, 1994; Mladenović, Milić, 2018). Working in classrooms in the field has proven to be a good solution, especially for children with tuberculosis who have subsequently fulfilled their school obligations in the fresh air.

At the initiative of doctors and educators, the first forest school was opened in 1904 in the Berlin suburb of Charlottenburg, for normally endowed children who inherited poor health or were weak and lagging in their social development, or poorly progressed due to anaemia and poor nutrition in schools. This school was in a pine forest (Adžić, 1924). Several pupils were permanently in school, while a considerable part of them, together with their teachers, came to school daily by organized transport. The curriculum that was implemented was kept to a minimum because the primary goal of the school was to strengthen health, which is why a considerable amount of time was allocated for play, rest and recreation. Knowledge was gained through direct work and experience in nature, in classrooms in the field, separately for the gifted and children with disabilities. This place has been jointly selected by educators and physicians. Later nature schools were intended not only for children who were ill but also for the healthy ones (Nikolić, 1994). The idea of classrooms in the field was realized at that time in Italy, France, and Hungary (Mladenović, Milić, 2018).

Nature became a great workshop and classroom and presented a better opportunity for pupils to gain new knowledge than they could in an indoor classroom (Banđur, Veinović, 2008). The pedagogical values of the newly constructed nature schools were extremely significant and their number increased year by year (Nikolić, 1992). Even today, a nature school is a modern form of educational activity (Stanojlović, 2000).

At the initiative of the teacher and school principal Sreten M. Adžić, in 1908, the first classrooms in the field were opened in the experimental garden of the famous school for teacher education in Jagodina. Although they were opened only a few years after the opening of the first school in Germany, there was a difference in goals. In the teacher education school in Jagodina, they were intended for healthy pupils only, to prevent the bad influence of the built-up classrooms, while the German and English ones had a therapeutic aim, that is, to treat already vulnerable children (Nikolić, 1994). Such schools had a positive impact on the overall psychophysical development of children. In the classrooms in the field, regular theoretical and practical classes were conducted in almost all subjects, with specially constructed, non-built-up green space, throughout most of the year when external conditions allowed it (Petrović, 2018; according to Djordjević, Lazarević, and Nedeljković, 1998). The construction of field classrooms represented a modern step forward in education in Serbia in that time (Mladenović, Milić, 2018,86). According to S. Adžić, no country in Europe had a classroom in the field so arranged. Knowledge was gained through direct experience and practical work. All schools of this type justified their existence, that is, they had a positive effect on the overall psychophysical development of children (Nikolić, 1994).

In the post-war period, along with the reconstruction of the war-torn country, intensive work was done to expand the school network. However, their purpose then significantly differed from the tasks of the

nature school today. Considering the results that were expected in terms of education, upbringing and the health of children and youth in nature schools, all material investments and subjective efforts made to develop it are pedagogically and socially justified.

In the Republic of Serbia, there is a long tradition of organizing classes through programs of a nature school. Some of the areas where the nature school is organized are Divčibare, Letenka, Testera, Kopaonik, Tara, Fruška Gora, Belo Blato, Petnica and others.

THE CONCEPT OF NATURE SCHOOLS AND TERMINOLOGY EXPLANATION

Before defining the term *nature school* itself, it should be noted that there were different approaches in the explanation of this term. In the past, this type of activity came under different titles: *schools in the free nature, forest school, country farming homes, school homes in the country, school in the open air, educational homes in the nature, air school, sun school* etc.

Nowadays, a few terms have emerged that have their genesis and substantially express the essence of this activity, such as: *summer school, recreational teaching, nature school, teaching in nature, outdoor learning, school field trips, outdoor classrooms* etc. In Russia, such schools are called лесная школа - a forest school, while in Britain *open-air schools - a school in the free nature.*

There are very clear common features of this differently named forms of upbringing in the immediate nature:

- They were in the countryside outside populated areas,
- They had a purely healthy and educational character.

In our country, the most widespread term was *recreational teaching*, which means planned, permanent, systematic organization and creative acquisition of knowledge through learning, play and fun, based on a variety of sources of knowledge and student-centred activities in the free natural environment under the professional guidance of teachers and other educational staff. Dr Ljubica Prodanović (2005) under *recreational teaching* implies a special form of teaching that takes place outside the school premises, usually in nature.

The most complete definition of the term *nature school*, which is the most adequate and comprehensive, was given by B. Stanojlović and S. Simić (1984): this term means a special form of full-day organization of educational activities of a boarding school, which is realized outside the place of residence in the natural environment, with extended pedagogical activity through leisure activities. Educational work relates to the psychophysical recreation in nature, and the realization of educational contents, determined by the curriculum, adapts to the specific conditions of the natural and local environment, addresses those contents to which these conditions are the most appropriate and in which they can be most successfully achieved. All educational work is carried out under the professional guidance of teaching and extracurricular staff.

Such a definition of the concept of a *nature school* incorporates all of the above concepts and fills them in with content. *Nature school*, compared to other forms of work, has broad and significant tasks with a high pedagogical level of organization of life and work, rich and functional structure. This term was the most appropriate and comprehensive because it included all the contents covered by the actual activities of the nature school.

The Rulebook on the Organization and Realization of Teaching in Nature and Field Trips (Official Gazette of the Republic of Serbia, No. 30/2019) defines this form of work as *teaching in nature*. According to this rule, *teaching in nature* is a form of educational work through which compulsory subjects, elective programs, project teaching and extracurricular activities from the curriculum of teaching and learning for the first cycle of primary education are carried out in a climatically suitable place for health, recreational and educational reasons. The Rulebook precisely defines the goal, tasks, contents, curriculum in nature and more.

The class teacher takes care of the organization and realization of the regular classes and envisaged activities, as well as the safety of the pupils during the process. The teacher should respect the individual characteristics of the pupils, the differences in their needs and abilities and encourage cooperation and teamwork, independence, and personal responsibility. With the replacement of regular classes, there are many teaching and extracurricular activities that should be carried out in the natural environment - independent student activities, sports and recreational and cultural activities, games and entertainment, passive and active rest. Teaching in nature can take up seven to ten days. The director of the institution (the principal) (Official Gazette of the Republic of Serbia, No. 30/2019) is responsible for the legal matters regarding teaching in nature.

How important and effective the natural environment is for the acquisition of teaching content, which is primarily applicable in real, everyday life, can be

seen in the results of research by numerous authors. Golubović-Ilić (2014) states that by direct contact of pupils with sources and objects of knowledge that are in authentic environment, greater dynamics and intensity of the teaching process are achieved. Turtle et al. (2015) pointed out that in *forest schools* for example, through play, children can gain an understanding and appreciation of the natural environment and at the same time, improve physical, social and emotional well-being.

Through primary education, it is very important to encourage and strengthen the predisposition of schools and children to go outside, to ensure that young people leave school with a greater understanding of the environment and a positive attitude towards it (Heras, Medir & Salazar, 2019). Outdoor classrooms, which are increasingly used in educational establishments, fulfil two key functions. The first function is related to fomenting environmental empathy, connectedness to nature, and attitudes and respect for nature; and the second function is to help children and adolescents with adjustment problems to achieve greater motivation and school integration while promoting pro-environmental behaviours (Musitu-Ferrer, D., Esteban-Ibáñez, M., León-Moreno, C., & F. García, 2019; Yaman, Abdullah, Rozali, &Salim, 2018).

METHODOLOGY OF RESEARCH

The aim of the research was to involve as many teachers as possible from different regions in Serbia, both urban and rural, to determine their opinion on realization of *nature schools* in the Republic of Serbia. The purpose of the research is to show if teachers agree on key questions regarding the organisation and realisation of *teaching in nature* and how much their views about that kind of teaching are similar or different.

It was assumed that the teachers of different gender and place of employment gained different experiences related to *nature schools* and have, therefore, developed different attitudes towards this kind of schools. The starting hypothesis was that teachers agree with the importance of realisation of *nature schools* and that it is necessary to carefully plan and organise this kind of teaching. The hypothesis included in the research stated that there are statistically significant differences in the attitudes of the respondents.

Data collection

In this study, the field survey method was used. The design of the questionnaire was based on the original study. The research was conducted during the school years 2017/2018 and 2018/2019. The sample was random. After the survey was completed, there were 130 correctly completed questionnaires. The respondents were of different gender and work experience, were not employed in the same schools nor lived in the same place and were class teachers. The research was conducted on the territory of the whole Republic of Serbia in both urban and rural environments. The participants voluntarily agreed to participate in the study.

Research instruments

A three-part questionnaire was used in data collection. The research was conducted through personal survey and every respondent was given the questionnaire. The first part collected mostly demographical data. In addition to gender and years of work experience, respondents were asked to write which school they work at and where they are located. In the second part of the survey, respondents were asked to declare whether they were organizing a *nature school* for pupils from the first to fourth grades of primary school. If yes, the place and accommodation facility of the *nature school* should be given, how many days it takes and the month when it is organized.

The third part (15 items) was a 5-item Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree) that measured attitudes toward this kind of teaching. The content of the questionnaire is original; it is not based on any available research of this type.

Data analysis

The obtained data are analysed using statistical program SPSS, version 23. The most common statistical analyses that have been applied in this research include: an initial descriptive statistical analysis followed by the t-test analysis for independent samples and the one-way analysis of variance, ANOVA. To determine how significant the difference is among individual groups, the post-hoc Scheffe test was used as one of the most rigorous and most commonly applied tests. The t-test of independent samples was applied to compare the arithmetic means of two groups of respondents: male and female, teachers working at primary and secondary schools, teachers working at the city and village schools. The application of the one-way analysis of variance, ANOVA, was used to investigate if there is a statistically significant relationship between dependent variables (items related to the attitudes of the respondents) and independent variables (social characteristics of the respondents).

RESULTS

The respondents were mainly teachers with 16 to 25 (36.9%), and over 26 years of work experience (33.8%) (Table 1). There were fewer respondents with 6 to 15 years of work experience (20.8%) and the fewest respondents included those with less than 5 years of work experience (8.5%). All respondents work in primary schools (100.0%). Based on the work environment, the results were as follows: 76.2% of them work in city schools, while 23.8% work in rural schools. Based on gender, most of the respondents were women (89.2%). This was expected as there are, generally, more female teachers than male. Only 10.8% of men participated in the research.

Table 1. Respondents by gender, location (urban and rural) and years of work experience

Gender	Frequency	Percentage (%)
Male	14	10.8
Female	116	89.2
Total	130	100.0
By location	**Frequency**	**Percentage (%)**
Urban	99	76.2
Rural	31	23.8
Total	130	100.0
By years of work experience	**Frequency**	**Percentage (%)**
less than 5 years	11	8.5
6-15 years	27	20.8
16-25 years	48	36.9
more than 26 years	44	33.8
Total	130	100.0

Research results show that most class teachers do not organize a *nature school* in the first grade (60.8%). Those who take the pupils, usually choose Divčibare for this type of educational work (19.6%). Sokobanja was in the second place with 11.8%. Other places include: Gučevo, Bukulja, Tara and others. Most teachers did not answer the question regarding the accommodation facilities, so we will not mention them in this research. Regarding the duration of the nature school, the results show that the pupils mostly stayed for 8 days (37.2%), in May (39.2%).

In the second grade of primary school, the percentage of teachers organizing the nature school is significantly higher than the previous one - 53.8%. Nature schools are mostly located in the mountains (Divčibare and Tara - 14.3% each, Zlatibor - 11.4% and others). In the second grade, pupils most often spend 8 days in the nature school (27.1%) or 7 (10.0%), again in May (39.1%). April is the second with a share of 21.7%. The percentage of pupils going to the nature school is very similar in the third grade - 53.1%. The largest number of schools chooses Tara (18.8%) and Sokobanja (17.4%). Other destinations include Divčibare, Zlatibor and Kopaonik. They most often stay for 8 days (36.2%), also in May (36.2%).

In the fourth grade, nature schools are organized more often. From the total number of respondents, as many as 64.6% organize this type of teaching. The most popular destinations are the mountains Tara (20.2%) and Kopaonik (11.9%). The nature school usually lasts 7 days (33.3%) in May (34.5%).

Table 2 shows us the mean values of teachers' responses to the statements from the third part of the survey. Before analysing the results by gender and other variables, it should be emphasized that the statement that there should be a permanent professional staff in nature schools that will oversee extracurricular activities is rated highest 4.30. A nature school requires a very good organization by the teachers. Unless more professional people are involved in this type of teaching, it is very difficult for one teacher to implement all the requirements that influence the school's success in nature. The lowest assessed is the statement that there is little learning in nature schools and that nature schools realize only the entertainment and recreation program at the expense of the implementation of compulsory teaching activities. This clearly indicates that teachers consider that they devote a large part of their time in a nature school to teaching activities appropriate to the circumstances.

The results of the research by gender are interesting. A much higher proportion of female respondents must be considered here, but certainly the data are comparable. Female class teachers are dissatisfied with the facilities used for the realization of a nature school, but unlike male class teachers, they believe that in Serbia there is a large selection of locations for the construction of school facilities in nature. Lack of appropriate professional literature is seen by female teachers as a bigger problem both in the organization and in the realization of the nature school. Both male and female teachers had a uniform opinion about the statement that class teachers were not sufficiently trained, but it can certainly be concluded that they themselves are not sure whether they are fully prepared to perform this type of fieldwork (the average grade of this statement is 2.5). With most statements, the answers by teachers of both genders are uniform, so that, apart from the above, there is no greater difference in attitudes regarding the organization and realization of a nature school.

Table 2. Mean values of the respondents' answers by gender and by the settlement where the home school is located

Statement	Gender	Mean values	Place of employment	Mean values
Nature school should have a purely fun and recreational character.	M	2.71	Urban school	2.84
	F	2.80	Rural school	2.65
Nature school is exclusively an educational institution.	M	3.14	Urban school	2.93
	F	2.96	Rural school	3.13
The success of working in a nature school depends to a large extent on normative-legal solutions.	M	3.07	Urban school	3.00
	F	3.05	Rural school	3.23
There are major problems with the organization of the nature school.	M	3.36	Urban school	3.16
	F	3.18	Rural school	3.32
The facilities used to realize the nature school are mostly intended for tourism and do not meet some other standards.	M	3.64	Urban school	3.19
	F	3.08	Rural school	3.00
Improvisation is always present when preparing for the stay and upbringing and educational work of children in a nature school.	M	3.21	Urban school	3.27
	F	3.32	Rural school	3.42
There is a large selection of locations for building facilities for nature schools in Serbia.	M	3.86	Urban school	4.12
	F	4.17	Rural school	4.19
There should be a permanent professional staff in the nature school who will oversee extracurricular activities.	M	4.14	Urban school	4.24
	F	4.28	Rural school	4.32
The organization of work in a nature school requires the extra effort of the teacher.	M	4.36	Urban school	4.26
	F	4.20	Rural school	4.06
The material and technical conditions for the work of the nature school are appropriate.	M	3.57	Urban school	3.29
	F	3.20	Rural school	3.06
The curriculum of a nature school must deviate significantly from the curriculum in a regular school.	M	2.71	Urban school	2.74
	F	2.77	Rural school	2.84
Class teachers are not sufficiently trained for extensive and complex work related to nature schools.	M	2.57	Urban school	2.42
	F	2.53	Rural school	2.87
A major problem in the organization and implementation of the nature school is the lack of adequate literature.	M	3.29	Urban school	2.72
	F	2.65	Rural school	2.71
There is little learning in a nature school. To the detriment of the implementation of compulsory teaching activities, it only implements a program of entertainment and recreation.	M	2.79	Urban school	2.18
	F	2.11	Rural school	2.19
The nature school significantly burden the pupils' family budget.	M	3.29	Urban school	3.44
	F	3.50	Rural school	3.58

If we look at the results in relation to the place of the home school – urban/rural, same attitudes can be observed for most of the statements. However, it must be pointed out that teachers working in rural areas agreed more with the statement that there are major problems regarding the organization of a nature school. This clearly indicates that the requirements of organizing a nature school, starting with the school itself, agencies, and other actors, are far more accessible to teachers working in urban settings.

Table 3 shows the mean values of the respondents' answers depending on whether they are organizing a nature school. The answers are shown by grade.

Teachers who do not realize the nature school were more adamant according to most statements. Namely, they are more in agreement with the statement that the success of a nature school depends to a large extent on normative-legal solutions. This may be one of the reasons why they do not carry out such teaching, because the experience would show that this kind of teaching requires the flexibility of teachers and all other actors at every stage of achieving the goals and objectives of nature schools. In support of this is the attitude of teachers who do not take pupils to nature schools that there are major problems in organizing them. Those who realize it, however, do not consider that there are major problems with the organization. Teachers who do not conduct nature schools have stronger views about the following:

- Children's accommodation facilities are mostly intended for tourism and do not meet other standards,

Table 3. Mean values of the respondents' answers, depending on whether they take pupils to a nature school, by grade.

Statement		1st grade	2nd grade	3rd grade	4th grade
Nature school should have a purely fun and recreational character.	Yes	2.86	2.79	2.71	2.76
	No	2.75	2.80	2.88	2.85
Nature school is exclusively an educational institution.	Yes	3.13	3.04	2.98	2.98
	No	2.87	2.90	2.97	2.98
The success of working in a nature school depends to a large extent on normative-legal solutions.	Yes	3.02	2.97	2.94	3.06
	No	3.08	3.15	3.18	3.04
There are major problems with the organization of the nature school.	Yes	2.55	2.81	2.87	2.90
	No	3.62	3.65	3.57	3.74
The facilities used to realize the nature school are mostly intended for tourism and do not meet some other standards.	Yes	2.72	3.00	2.90	2.96
	No	3.41	3.31	3.43	3.48
Improvisation is always present when preparing for the stay and upbringing and educational work of children in a nature school.	Yes	3.29	3.21	3.19	3.21
	No	3.32	3.42	3.44	3.48
There is a large selection of locations for building facilities for nature schools in Serbia.	Yes	4.06	4.09	4.06	4.15
	No	4.19	4.20	4.23	4.11
There should be a permanent professional staff in the nature school that will oversee extracurricular activities.	Yes	4.20	4.10	4.19	4.24
	No	4.30	4.45	4.34	4.30
The organization of work in a nature school requires the extra effort of the teacher.	Yes	4.16	4.10	4.16	4.27
	No	4.25	4.35	4.28	4.10
The material and technical conditions for the work of the nature school are appropriate.	Yes	3.61	3.40	3.45	3.33
	No	3.00	3.05	3.00	3.06
The curriculum of a nature school must deviate significantly from the curriculum in a regular school.	Yes	2.67	2.59	2.59	2.62
	No	2.82	2.97	2.95	3.02
Class teachers are not sufficiently trained for extensive and complex work related to nature schools.	Yes	2.16	2.27	2.19	2.34
	No	2.77	2.83	2.92	2.87
A major problem in the organization and implementation of the nature school is the lack of adequate literature.	Yes	2.47	2.57	2.56	2.63
	No	2.87	2.88	2.88	2.87
There is little learning in nature school. To the expense of the implementation of compulsory teaching activities, it only implements a program of entertainment and recreation.	Yes	1.94	2.00	2.01	2.01
	No	2.34	2.40	2.38	2.50
The nature school significantly burden the pupils' family budget.	Yes	3.23	3.31	3.26	3.30
	No	3.63	3.67	3.72	3.80

- Improvisation is always present,
- There should be permanent staff in schools,
- Organization requires greater effort of teachers,
- Material and technical conditions are not fully adequate,
- Program content must deviate significantly from the regular curriculum,
- Teachers are not trained adequately,
- There is a lack of adequate literature,
- Nature schools burden the pupils' family budget.

The t-test of independent samples was applied to compare the arithmetic means of two population groups. In this paper, only the results showing statistical relevance at the level of significance $p<0.05$ are presented.

A statistically significant difference between the respondents' answers by gender and by place of employment was not observed in any of the given statements (at the significance level $p<0.05$). This clearly indicates that the hypotheses made about the differences between teachers' responses by gender and different places of work (urban and rural) are not confirmed.

However, if we compare the responses between teachers who have experience in taking pupils to nature schools and those who do not practice this kind of teaching, there are some differences.

The answer for the first grade shows a statistically significant difference only in the statement that the nature school is exclusively an educational institution (Table 4). Teachers who do not conduct teaching in nature have a much more flexible attitude to this statement, while

teachers who have experience believe that it must largely satisfy this criterion. In the 2nd grade, a statistically significant difference (at the significance level p<0.05) occurs in two statements. One of them is that there should be permanent staff in nature schools. It has already been noted that this statement is highly rated. Teachers who do not conduct this type of teaching rated it with 4.50, considering that they cannot be the only ones who will participate in the realization of certain contents of nature schools. The second statement is about learning at a nature school. Teachers do not think that there is little to learn in nature, but there is certainly a noticeable difference between their responses because those who organize nature school have expressed a much greater degree of disagreement with the statement.

Out of fifteen statements, only one with a statistically significant difference was observed in the 3rd grade (Table 4). Teachers who do not have experience in taking pupils to a nature school find that program content must diverge from the curriculum in regular teaching. Teachers with experience seem to be quite good at conducting the intended teaching content in nature schools and have expressed greater disagreement with the statement.

The use of one-factor analysis of variance, ANOVA, was used to examine statistically significant differences between dependent variables (items related to respondents' attitudes) and independent variables (respondents' social characteristics). Table 5 presents the results of the ANOVA analysis based on different lengths of class teachers' working experience.

Despite some disagreements, the hypothesis that there is a statistically significant difference in the responses of teachers with and without experience in taking pupils to nature school has not been confirmed.

The analysis of variance ANOVA shows that there is no statistically significant difference among respondents with different length of work experience. Fifteen statements were tested and only three statistically significant differences were established. Therefore, this hypothesis has not been confirmed. The high level of agreement with the statements suggests that teachers with different lengths of work experience have approximately the same views on the organization and delivery of teaching in nature. Table 5 presents the results showing the statistical relevance at the level of significance $p < 0.05$.

Teachers with more work experience (over 16 years) expressed greater disagreement with the statement that they were not sufficiently trained for nature schools, that there was no adequate literature, as well as there was little learning in nature school.

Table 4. The results of the t-test for participants who organize or do not organize nature schools, by grades*

Statement	Nature school	*F*	*p*
1st grade			
Nature school is exclusively an educational institution.	Yes	7.401	.007*
	No		
2nd grade			
There should be a permanent professional staff in the nature school that will oversee extracurricular activities.	Yes	6.885	.010*
	No		
There is little learning in nature school. To the expense of the implementation of compulsory teaching activities, it only implements a program of entertainment and recreation.	Yes	6.696	.011*
	No		
3rd grade			
The curriculum of a nature school must deviate significantly from the curriculum in a regular school.	Yes	4.806	.030*
	No		

** Table 4 does not show the results for the 4th grade, because there is no statistical relevance at the level of significance $p < 0.05$.*
*** $p < 0.05$.*

Table 5. The results of the analysis of variance, ANOVA, for the respondents with different length of work experience

Item	*F*	*p*
Classroom teachers are not sufficiently trained for extensive and complex work related to nature schools.	4.507	.005*
A major problem in the organization and implementation of the nature school is the lack of adequate literature.	3.638	.015*
There is little learning in nature school. To the expense of the implementation of compulsory teaching activities, it only implements a program of entertainment and recreation.	3.285	.023*

*Note. *$p < 0.05$.*

DISCUSSION

Teaching content that is closely related to the natural and social environment is still not sufficiently organized in dedicated facilities and moved from the traditional classroom, which still occupies a central place in the processing of content that is in the function of getting to know the world around us. There is a clear need for a greater functional integration of the teaching content, its presentation and acquisition in some other facilities in the natural environment. A considerable number of teaching contents from the 1st to the 4th grade of primary school can be processed in an acceptable and high-quality way even outside the classroom, although this type of teaching requires much more preparation and engagement of teachers. Some teachers may not be able to use other teaching facilities at some point in time, but their unwillingness and inertia to organize the teaching more actively and move it to other teaching facilities is also present.

There were 130 correctly completed surveys. In fact, there were far more respondents, but a lot of answers were not included in this analysis because it was observed that they identified teaching in nature with, for example, one-day excursions. The work was primarily based on nature schools lasting minimum seven days, in facilities that are partially or fully adapted for this type of work for pupils from the 1st to the 4th grade of primary school.

The analysis shows that teaching in nature is not sufficiently implemented in all grades in the first cycle of primary education. In the first grade, less than 40.0% of teachers take pupils to nature school, in the second grade, this share increases to 53.8%, in the third it is 53.1% and in the fourth it is the highest - as much as 64.6%.

In the Republic of Serbia, teaching in nature is most often carried out in the following facilities: Mitrovac on Tara, Stanišinci on Goč, Bukulja in Arandjelovac, Rudnik on mountain Rudnik, "Stevan Filipović" on Divčibare and others. All these facilities belong to the Centre for Children's Summer Resorts of Belgrade and are used for teaching in nature, as well as for camps that are organized during summer and winter holidays. In addition to thematically equipped classrooms, entertainment rooms, sports fields, swimming pools, ski slopes, all facilities also have infirmary and twenty-four-hour health care. Educational excursions, hikes, evening programs are organized in all these resorts (http://www.cdlbgd.rs/nastava-u-prirodi.html).

CONCLUSION

Whatever it has been called, teaching in nature, outdoor school, nature school, outdoor classrooms, the goal has always been the same. The goal has been modified over time to accommodate the needs of the society, the education system, and, above all, the needs of children. They were founded primarily to improve the health of children, but today their importance is immeasurable and far beyond the original foundations. In addition to health, nature teaching has great pedagogical and social importance.

The paper presents the current position of this type of teaching in the Republic of Serbia. The data clearly indicate that it is not sufficiently implemented for some reason and that greater attention must be paid to this issue.

The hypotheses that there were statistically significant differences between respondents of different gender, place of employment, and length of work experience were not confirmed. Some differences are noticeable between the attitudes of teachers who realize or do not realize the nature school. The problem of organizing a nature school, in addition to extensive preparation of the school, teachers, pupils and their parents, is the very procedure for choosing the location where it will take place.

This way, very clear attitudes of the class teachers were formed regarding the organization and realization of this type of work, as well as defining the problems that teachers face when planning nature school.

One of the following research articles will refer to the attitudes of the subject teachers on the organization of teaching in nature on the territory of the Republic of Serbia. Also, the views of teachers on terminological understandings of the nature school will be examined, how much the contents of different school subjects are conducted outside the classroom, and what are the objects that are most suitable for teaching outside the classroom. Implementation of the subject in the curricula of the teacher education faculties that would cover the issues of teaching in nature and students' excursions would greatly contribute to the further development of such educational systems.

In the era of mobile phones, computers and various electronic games, staying in the open air, fresh air and movement is of utmost importance to pupils.

Acknowledgement

This research was supported by the Erasmus+ strategic partnership project no. 2019-1-CZ01-KA203-061379, and by Project 142-451-2350/2021-01 of the Provincial Secretariat for Science and Technological Development, ECAP Vojvodina (Serbia).

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PLAY IN EDUCATION - YES OR NO?

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Abstract

The phenomenon of play, its influence, function and importance in a child's development have been the subject of much research. On account of its many benefits, play has its place and role in the educational process. It is a powerful educational tool because through it students simultaneously express and develop their feelings, learn to follow the rules, develop a collaborative and competitive spirit. Play is used in teaching as an educational and learning technique, on top of being a motivational tool. This paper aims at establishing the position of play in the teaching process and the attitudes of students and teachers towards it. Research hypotheses and sub-hypotheses have been put forward regarding whether the use of play facilitates the achievement of better results and increases motivation, but also whether teachers are willing to use this method or not, and to what extent they apply it. Are there differences at the regional level, as well as in terms of the ratio of rural and urban areas in the Republic of Serbia? Based on a survey of 950 teachers from the territory of the Republic of Serbia, these answers will be sought.

Keywords: teaching, geography, play in education, Serbia

INTRODUCTION

Play has always been the central and most important activity in a child's life. The most famous pedagogues and psychologists have written about the phenomenon of play, its influence, function, and importance in children's development. They all agree that play is a powerful tool for encouraging a well-rounded personality development, because it enables the cognitive, emotional, social, and physical development of a child, preparing them for the world of adults. The basic children's activity until puberty is play. Play can be defined as a free action that we accept as fictional and separate from everyday life, an activity without any material interest and benefit, which takes place in a purposely limited time and space, in the order provided by the given rules (Kajoa, 1979).

Play is an authentic activity that has its own sources of motivation, where the process is more important than the outcome of the action, the means dominate the goal, and there is an absence of immediate pragmatic effects. Play also relieves tension, resolves conflict, and also regulates physical, cognitive, and socio-emotional development.

From the beginning of its development, the school was an imposed and forced activity, and strict teachers did not accept play because it undermined the strict discipline they sought to create. As a result, the school was not adapted to children, their interests and abilities. These schools were characterized by traditional teaching where internal motivation through play as a form allowing children to show their best qualities was not present. The closed traditional system made it impossible to realize high-quality and innovative ideas of individual pedagogues throughout Europe until the middle of the 20th century.

Interest in the use of play in teaching appeared in the second half of the twentieth century mainly as a

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result of psychological research into the phenomenon of play. Since the 1960s, play has begun to be applied in the teaching process. Its integration into the teaching process was slow and difficult. One of the reasons for this situation is the lack of appropriate educational games and manuals that would provide guidelines on how to organize the teaching process through play.

Didactic games are children's games, which, in addition to having all the general properties of games, also incorporate activities (perceptual, logical, speaking) which are specially adapted and built into their rules to improve the general and especially intellectual development of children (Kamenov, 2006).

The game method is important because by involving students in a game, the students' intelligence, knowledge, perseverance, and desire to win are expressed, because a game always simulates a certain conflict situation or competition situation. Through a game, its participants present themselves. They reveal their willingness to sacrifice in order to achieve their goals.

Some authors highlight that the rules set in the game are crucial for the development of opinions, speaking skills and children's actions. Didactic rules (which must be clear and precise) should be distinguished from organizational rules that define the structure of the game. Didactic games and teaching aids needed for their realization are most often designed by teachers. Teachers must make sure that the game is in accordance with the age of students and that it fits into the appropriate teaching unit. Since it is created by the teacher, there is a possibility that they will not adapt the game to the children's needs, and that some students will not accept it. Children's games differ from didactic games in spontaneity, although didactic games can also turn into spontaneous play. Rules in didactic games have the function of regulating their content, course, and behavior of participants. They allow or prevent certain actions, give guidelines for achieving the goal (solving the task), thus bringing tension and uncertainty into the game.

The main problem in Serbia is that there are not enough educational seminars and appropriate manuals, and the collections of games for teaching purposes in every school subject. Our educational system has fully accepted and systematically developed games only in music and physical education.

OVERVIEW OF PREVIOUS RESEARCH

At the end of the last century, education reforms were implemented in many countries of the world. In some countries, reforms were radical and modernizing, in others they were structural and systemic. Education reform consists of a set of organized actions and measures aimed at innovating and modernizing certain segments or the entire education system, i.e., adapting education to socio-economic and technological innovations. The changes were also reflected at the level of education, where there was modernization, an introduction of new methods and forms of work (Miljković, 2019).

Numerous researchers have been involved in research related to play in the classroom. The previously mentioned Caillois (Kajoa, 1979) noticed that play is:

1. Free, i.e., the player cannot be forced into it, because in that way the game will lose its purpose;
2. Determined, i.e., limited in time and space. The time and place are determined in advance;
3. Uncertain, because its outcomes cannot be predicted;
4. Unproductive, because it does not create any material wealth;
5. Prescribed, because it is subject to provisions that repeal ordinary laws and introduce new ones that last only until the game is over;
6. Fictional, because it can be completely unrealistic in relation to real life.

On the other hand, Matijević (1994) points out that play is a simultaneous behavior when divergence (organization of behavior in a new and unusual way), incompleteness (does not include achieving a specific goal, compact and short-term behavior) and inadequacy (behavior inconsistent with the given situation).

Huizinga (1970) again believes that play, i.e., a competition through play is older than culture itself. Matijević and Topolovčan (2017) state that by playing, we acquire important competencies for life - from speaking and walking to various social and work-related skills, and that playing is a global didactic strategy for achieving learning goals. Đurić (2009) states that play is important in life because it is one of the first ways of learning, which enables acquiring new knowledge through personal experience, play is the main interest of a small child, so role-playing or simulation applied in teaching can have positive connotations. Through play, man develops as a whole being. The game satisfies a person's need for fun, relaxation, stress relief, learning and spending time with friends. Through play, young children develop their motor skills.

Through play, a person develops their self-confidence, feels accepted, develops empathy and tolerance, is motivated for further activity and adopts certain behaviors. According to Pachner (2014), sociability is an important aspect of play, a child meets new friends through play and develops its social skills. Bognar

(1986) states that learning through play is as effective as learning through worksheets.

In their research related to play in history teaching, Zirawaga et al. (2017) point out that games can be used as a support tool to complement traditional teaching methods to improve students' learning experiences during teaching.

Based on numerous studies, it can be noticed that researchers display a positive attitude towards the implementation of play in teaching.

PLAY IN TEACHING

Teaching has been defined in different ways. In fact, it is not easy to define at the moment because it has been undergoing faster and bigger changes, so none of its definitions can remain completely accurate.

Due to its numerous advantages, play has its place and role in the educational process at school. Depending on the type and purpose of play, students develop different abilities in the game, such as observation, maintaining attention, understanding spatial relationships, cause-and-effect relationships, as well as the ability to learn independently - finding, analyzing, applying and communicating information. Play also affects the proper growth and development, the development of motor abilities and skills, and it also develops elementary organizational skills. It also encourages the development of creativity and aesthetic perception in students. Play is a powerful educational tool, because through it the students simultaneously express and develop their feelings, learn to respect the rules, develop a collaborative and competitive spirit. It is also a means of affirmation and expression of students' personalities. Through play, students strengthen self-confidence, self-realization, learn to express their arguments and opinions.

In addition to the rules, in playing games, there is also a task that the student must solve faster and more accurately than the opposing team. The teacher gives guidelines such as: observe, connect, notice, find, try, think, relying on Bloom's taxonomy.

In a didactic game, there are also points, results and the announcement of the winner. Achieved points usually serve as feedback to the teacher, how much the students have mastered certain teaching units. What makes a didactic game special is: testing the knowledge and acquired experience, acquiring new knowledge, developing abilities, competing with others, but also with oneself. In each didactic game, it is possible to distinguish its goal and the tasks to achieve the goal, the means and rules that regulate the course of the game and the result.

A game is used in teaching, above all, as a method or educational technique by which students can learn, but also as a motivational tool for learning. An educational game is always aimed at achieving some pre-set goals, learning and educational tasks. In relation to age, the most common games in school are role-playing games, drama games, music games, mathematical and logical games, various types of elementary, computer and traditional games, then those that help developing speaking skills, liberate movement, but also other games that develop concentration, memory, perseverance, imagination (quizzes, association games, crosswords, puzzles, jigsaws, sudoku, chess, etc.).

The use of games in teaching implies the use of various materials and teaching aids (from the simplest to the most modern). In recent times, the application of elements of multimedia teaching (use of computers, video projectors, the Internet, TV) is especially important because it facilitates and improves the educational work of participants and makes it more successful, dynamic and interesting (Trifunović, 2007).

The application of games in teaching is possible at all levels of education and in all types of schools, equally successful in working with high school students, as well as with students at younger school age. Also, their use in teaching does not exclude other forms and methods of work and activities. On the contrary, the game can be applied in the realization of the content of all subjects through individual work, work in pairs, small or large groups, through extracurricular activities.

Depending on what we want to achieve with the game and how it is designed, it can take place throughout the class or at certain stages. For example, in the introductory part of the class as a motivational tool or as an activity to divide students into groups, or in the final part of the class as an activity that will provide feedback or revision of what we have learned. Sometimes even the simplest five-minute game can give good results.

In teaching, the game should not take place just for the sake of it, but should have its purpose, i.e., to contribute to the achievement of a pre-set goal. A classroom game achieves its purpose only when it is well-designed. It is important that the game has a precisely defined goal (what we want to achieve with it), then that the rules are clearly defined and known in advance to all participants, that it has a beginning and end, that it requires some intellectual effort from the students, poses a problem to be solved.

Success in the use of games in teaching, to a large extent, depends on the teacher. Their role in preparing

and leading the games is very important and not at all simple. They should facilitate that learning through play takes place imperceptibly and spontaneously. In this way, teachers' organizational skills come to the fore. They should choose a game suitable for students, set clear rules and create an atmosphere in which everyone feels like responsible and equal participants, because that further encourages their self-confidence and sense of commitment. During the game, with praise and encouragement, teachers strengthen students' interest in achieving the best possible results.

In order to achieve the set goals and tasks of the game-based class, it is very important to make the right choice of the game and to realize it in an appropriate way. The choice of the game implies determining its place and role in the realization of the learning and teaching plan of a certain school subject and considering at what moment the game itself can help in the learning process. In the game, the content should be selected, organized and directed so as to encourage students to certain types of activities that support their development and learning. It should always imply a certain level of requirements and efforts, which are necessary for the development of certain functions in students, but again to preserve what makes it a game - being interesting and playful. The choice of the game also depends on the age of the students and the composition of the class, spatial and technical conditions.

If necessary, the teacher can design a new game or can expand and enrich the already used one with new requirements, taking into account the students' prior knowledge, goals, tasks and contents.

The game, no matter how long it lasts, should always be brought to an end and time should be left for discussion, exchange of opinions and expressions of views, as well as suggestions regarding planning and designing new games (www.kreativnaskola.rs).

GAMES IN TEACHING GEOGRAPHY

It is known that the geography curricula with specific teaching content have a prominent place in general education and in the formation of a complex view of the world. Improving and modernizing curricula, their rationalization and improvement does not only mean changing the curriculum with new program requirements, but also implies the necessary correlation and interconnection and harmonization with other curricula.

Systemic reform of education in our country has posed very delicate and complex questions to geographers regarding:

1. Education strategy;
2. Organization of geography teaching in primary and secondary education;
3. Implementation of experiences of other countries in teaching geography in Serbia;
4. Structure of geography education;
5. Professional teacher development (Komlenović, 2003).

Geography is a science that keeps pace with the times and what ensures the quality of teaching is certainly keeping up with modern science and technology. Modern organization of teaching in primary and secondary schools is inconceivable without innovation. By innovation we mean changes and advances in all forms of teaching. Good organization, interesting facts, and new tendencies in the development of this science can contribute to raising the quality of teaching to a higher level, and thus to the acquisition of students' knowledge to be complete and rational. Getting familiar with innovations should help students develop a dialectical way of thinking when explaining objects, phenomena and processes in nature and society, and should also enable students to notice causal relationships. The application of new methods should provide maximum activity of students in terms of their research and independent work (Ivkov, Ivanović, Pašić, 2009).

A creative teacher can turn the teaching of geography into a game-based class which aims to develop responsibility towards oneself and others. Play is used in geography teaching as a method or educational technique by which students can learn, but also as a motivational tool for learning. Education games are always directed towards achieving some pre-set goals and tasks of educational work. Regarding students' age, role plays, drama games, logic games, enigmatic, computer games could be played in geography classes that develop imagination, concentration, and perseverance. Teachers are expected to design games in which they will use the map and thus develop the ability of orientation, understanding of spatial relations, cause-and-effect relationships. The game must be exciting, witty and it should encourage teamwork.

The teaching of geography in all its various aspects enables the application of game-based methods. It does not matter whether it is the simplest competition games in the form of knowledge quizzes about geographical concepts and locations, or the latest computer games. In all these games, there is and continues to be an interest in the practical side and significance of geography, and the adoption of a certain way of thinking (Trifunović, 2007).

Play in geography teaching should have its function, i.e., to contribute to the achievement of a preset goal. Success in the application of games in teaching, to a large extent, depends on the teachers. Their role in preparing and leading the games is very important and not at all simple. They should enable learning through play to take place imperceptibly and spontaneously. In this way, teachers' organizational skills come to the fore. They should choose a game suitable for students, set clear rules and create an atmosphere in which everyone feels like responsible and equal participants, because that further encourages their self-confidence and sense of commitment. During the game, with praise and encouragement, the teacher strengthens the students' interest in achieving the best possible results. If necessary, the teacher can design a new game or can expand and enrich the already used one with new requirements, considering the students' prior knowledge, goals, tasks and contents.

Geography teaching should be based on maximum activation of students. In teaching, play can be effective under the guidance of a good and professional teacher. Play has an indirect impact on the educational process. It has been noticed in pedagogical research that these indirect procedures are more efficient, but because they require a more creativity and pedagogical knowledge, many teachers avoid it. It is important to know in which stages of the class games would be most effective, as well as which games are intended for which age.

During the game, an interest develops into the geographical way of thinking, its practical side and significance, and there is an acceptance of a certain way of thinking, i.e., the formation of positive habits in students.

Through the game, you can easily connect several different subjects: Serbian and geography, geography and biology, geography and history, geography and the local environment.

Integrative teaching is one of the innovative models which interconnects teaching contents from several school subjects. This model of teaching provides greater dynamism and interdisciplinary approach to a particular issue and if applied moderately during the school year brings quality progress in the teaching process (Radojičić Lukić, 2011). So, this is a way to create a problem to be solved using the teaching material and to help students to see the whole. When planning integrative teaching, it is important that the teachers who will be preparing the activity, thoroughly study the curricula of different subjects to find common content or a common problem that will be the topic of the integrative lesson.

For the purposes of teaching geography, different games that students know from everyday life can be used: connecting pairs, circular walks around continents / countries / regions, gap fill, guessing game, different enigmatic games (find the odd one out, continue the list, fill in the gaps, word matching), universal games (hangman, jigsaw puzzles, rebus puzzles, crossword puzzles, associations, word puzzles, geography fun quiz).

Today's students have been computer literate since the earliest period of their lives and are very good at computers. The introduction of computer games in the classroom is one of the means of reaching out to new generations, because in this way students will certainly meet their social needs (Prensky, 2006; Janko, 2011).

Computer games represent a fundamentally new way of teaching. Computer games make it possible to gain a general idea of similar situations or objects, thus developing generalization and classification skills as the most important thinking skills. Hence, training is one of the most important functions of computer games. Logical thinking develops, because the student understands that the objects on the screen are only representation of the corresponding real objects. Children's memory and attention improve. Motivation to play gradually turns into motivation to learn when an interest in the content of the task emerges. Particularly interesting are computer games in the field of geography, where the student can learn new concepts, revise the material or reinforce knowledge through play (Ivkov Dzigurski at al, 2021).

QUESTIONNAIRE SURVEY

The questionnaire survey was conducted over a period of three years on a sample of 945 teachers working in primary and secondary schools in the territory of the Republic of Serbia. The questionnaire form was filled out by teachers of all subjects.

The survey questionnaire contained 16 questions / statements. The first part referred to the socio-demographic characteristics of the respondents, where they entered how many years of work experience they had, whether they worked in primary or secondary schools, in a village or a city, and their gender. Then they wrote down which subject they taught at school, and then, in the second part, they expressed their views on the use of games in teaching.

After complete data processing and correlation of individual parameters, a much clearer picture will be obtained about the similarities and differences in teachers' attitudes depending on gender, place of work and type of school, but in general we can draw a few basic results.

Socio-demographic characteristics of the respondents are given in Table 1.

Out of the total number of respondents, the largest part were teachers of foreign language (14.9%), Serbian language (12.1%), geography (11.6%) and mathematics (11.1%).

If the respondents' attitudes according to gender are compared, in 9 out of 10 statements, the female respondents express a higher degree of agreement about certain statements. The female teachers mostly agree that classroom games should be planned and controlled in detail (4.47), as well as that they are well-accepted as an element in the classroom by the students (4.25). Male teachers are also confident about these claims, but there is a slightly lower degree of agreement among them when compared to the female respondents.

Regardless of the place and type of school they work in, the teachers mostly agree with the claims that students accepted the games nicely, that the games contributed to innovation, but that they should definitely be planned and controlled in detail. It is interesting to mention that teachers who are employed in high schools are more critical about the claim that using games in high school context is inadequate (2.99). The general impression is that the teachers employed in primary schools use games more, which shows a higher degree of agreement with the proposed statements. Therefore, considering all the findings, it is evident that using games as a factor of activation in teaching, in both primary and secondary schools, regardless of the environment in which the school is located, should be implemented more in the teaching process.

Considering the differences in the years of work experience, there are some discrepancies in the teachers' attitudes. Namely, younger teachers, especially beginners, express a greater degree of agreement in most of the claims that speak of the importance, benefits, and effectiveness of the application of the game in the teaching process. Teachers with more than 26 years of work experience, as well as those with 16 to 25 years of work experience, believe that this way of working requires greater efforts and greater preparation of teachers, whereas the younger ones are more willing to implement games in their work.

In future research, it would be interesting to determine the attitudes of primary school class teachers, because in general they have greater opportunities for the application of games in teaching.

CONCLUSION

Given that children from the age of seven spend most of their time in school, it is understandable that this is an environment that should contribute to the acquisition of the most wide-ranging and high-quality knowledge, not only provided by the curriculum but also somewhat wider. We are witnessing daily progress in all areas of our lives and thus in the teaching process. Geography teaching has come a long way from a descriptive stage to a scientific (explicative) one in which it is no longer important where something is and for how long it is there, but to give reasons for it, i.e., discovering cause-and-effect relationships has become the most important aspect.

In order to change this situation, at one point, the idea of using play in teaching emerged. Why play? The answer is clear. From the earliest period of their lives, children encounter toys and games, which are present almost every day throughout their childhood, and even later (e.g., board games, video games, etc.). If children were asked whether they would prefer to learn or play, most of them would almost certainly say they would prefer to play. Through different types of play, children acquire motor skills, develop mind and logic, creativity, and imagination. If we take these facts into account, then why not incorporate play in the teaching process itself?

It is true that games have been used in teaching for the last couple of years, but still not to the extent they should be. Of course, this should not be overused either, because each teaching unit requires a special type of organization. The implementation of games must not be forced at all costs and too often, and it is the teacher who, as the "creator" of the teaching process, determines competently when the right time would be to implement it. In addition, it is of great importance to adequately combine different types of teaching forms.

Finally, it can be concluded that applying innovative teaching aids, methods and forms contributes to the improvement of the teaching process, so it is desirable to use this type of innovative practice from time to time.

ACKNOWLEDGEMENT

This research was supported by the Erasmus+ strategic partnership project no. 2019-1-CZ01-KA203-061379, and by Project 142-451-2350/2021-01 of the Provincial Secretariat for Science and Technological Development, ECAP Vojvodina (Serbia).

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ANALYSIS OF THE CURRICULUM OF ELEMENTARY SCHOOL IN THE REPUBLIC OF SERBIA

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Abstract

The Law of school curriculum defines the curriculum for students from the first to the eighth grade of primary school. School curriculum is one of the most important school documents, which regulates the overview of the scope and structure of teaching for a longer period, according to the age of the students. The curriculum of each subject clearly defines the goals and tasks, hence the structured teaching contents and provides basic didactic-methodical instructions for its realization. This paper is focusing on the research where the target groups were the teachers of geography in primary schools. The aim was to determine the attitudes of the teachers about the school curriculum in Serbia, the possibilities of implementing innovations in the teaching, as well as activating students. Furthermore, one of the aims was to pay attention to the student workload, and the curriculum coherence by subjects.

Keywords: elementary education, elementary schools' curriculum, teacher, school, student

INTRODUCTION

The term curriculum is relatively new in many countries in Europe and the rest of the World. Most educational reforms done in the last decade of the 20th century, the term curriculum is used with the idea that it represents an influential condition for the success of the reforms, namely the innovations introduced by the reform. It is considered that the transition to the curriculum is the best path for the educational system to be opened and adjusted to the requirements of the modern time, whilst leaving an option of constant improvement and development of the educational system. The term curriculum is usually connected with the baroque pedagogy and represents the "course of education". The significant difference between the educational plans and traditional programs of progress should be sought in the fact that the curriculums have the goals of teaching and learning that are specified and include the verified noticeable reactions of the students. The teaching content is deductively drawn from the opulent systematical experience of the civilization in certain scientific, humanistic and artistic disciplines. Teaching programs is one of the most used school documents which regulate the overview of the scope and structure of the teaching for a longer period, according to the age of the students. They include: lists of all the courses thought in the specific type of school according to the grades or years of study, the order of teaching of those courses according to the grades, the weekly number of classes of specific courses, overall weekly load of students of one grade, the number of predicted classes of each class for a year, the overall number of classes predicted for a year for each grade. In the teaching plan, each course has clearly defined basic goals and tasks, and therefore logically structured teaching content and basic didactic-methodical instructions for their realization (Simeunovic, Spasojevic, 2009).

Primary education in Serbia lasts for eight years and is done in two cycles. The cycles are divided in accordance with the developmental and age char-

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acteristics of the students. Each cycle lasts for four years. *First cycle*: classroom teaching- from 1st until 4th grade. In this cycle, one teacher is responsible for the teaching of all courses except for the language courses and some optional courses. *Second cycle*: subject teaching- from 5th until 8th grade. During this cycle, each course is thought by a different teacher, specialized in a specific area, whilst one teacher, the headteacher, is responsible for leading the class (Komlenovic, 2004).

RESEARCH METHODOLOGY

A field research method was used for this paper. A three-part survey comprising 21 statements/questions were used to obtain data. The research was conducted through the Internet, and each respondent was given a questionnaire. The first part (3 questions) collected demographic data. The second part (12 questions) contained statements/questions about the courses the respondents teach, then the questions related to their role of a head-teacher and whether their school uses an electronic class register. The second part of the survey used a Likert scale- a scale of attitudes that consists of five statements. It was given to respondents with the aim to express the level of their agreement or disagreement with each statement, using the five-level scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree) (Likert, 1932).

The third part (5 questions) included the questions of the organization of the teaching plan and program and their effect on the teaching process. The content of the survey was developed for this research and is not modeled by any existing survey on the topic of *Analysis of the curriculum of the elementary school in the Republic of Serbia*. After the completion of the field survey, there was a total number of 116 properly filled-in surveys. It was as summed that teachers of different gender, places of employment (elementary and high school), and places of work (urban/rural areas) have different experiences in managing the school administration, and thus have different attitudes toward the issue. The respondents' participation was a volunteer.

The aim of the research was to include as many geography teachers, from urban and rural areas, in order to determine the attitudes and experiences of teachers related to the teaching plan and program currently used. It is assumed that the teachers of different gender and area of employment, have different experiences related to the teaching plan and program, and therefore different opinions about it. The hypothesis used for the research assumes that there are statistically relevant differences in the opinions regarding the usage of the teaching plans and programs, of the respondents of different gender and area of employment. It is also assumed that teachers from different areas of employment and working experience use different methods of teaching. The teachers with more work experience are assumed to have more knowledge of the organization of the teaching plans and programs. One of the assumptions is that the teaching plans and programs are allowing the inclusion of the special needs' students in the teaching process. Due to this, one of the hypotheses assumes that there are statistically important differences in the opinions of the teachers with the different working experiences regarding the usage of different methods of teaching the certain parts of the curriculum.

The obtained data were analyzed in the statistical program SPSS, which was used in similar researches (Alghazo & Gaad, 2004; Altınkök, 2017; Sharma, Moore, & Sonawane, 2009; Višnić, Ivanović Bibić, Đukičin Vučković, Ivkov-Džigurski, & Konečnik Kotnik, 2017). The most common statistical analyses used in this research are initial descriptive statistical analysis, t-test analysis for independent samples and one-way analysis of variance (ANOVA). To determine if there is a statistically significant difference between individual groups, post-hoc Scheffe test was used as one of the strictest and most used tests. T-test of independent samples was applied in order to compare the arithmetic mean of two respondent groups: male and female, teachers working in elementary and high school, teachers working in urban and rural areas. One-way analysis of variance (ANOVA) was used to determine whether there is a statistically significant difference between dependent variables (statements related to respondents' attitudes) and independent variables (respondents' social characteristics).

Among the responders, the largest group included those with the working experience between 6 and 15 years (43.1%), then those from 16 to 25 years (25.0%). There was a slightly smaller number of responders with up to 5 years of working experience (21.6%). The smallest group represents those with over 26 years (10.3%). All the responders are employed in primary schools. Based on the area of employment, the results are totally 57.8% or 67 of the responders out of 116 are employed in the urban area, whilst the 42.2% or 49 responders are employed in the rural areas.

RESULTS AND DISCUSSION

As it can be seen on the Figure 1, most of the respondents had between 6 and 15 years of work experience (43.1%), followed by those with 16 to 25 years of experience (25.0%). There were a few respondents with less than 5 years of work experience (21.6%) and the smallest number of respondents was in the group with over 25 years of work experience (10.3%). Depending on the place of work, the result was the following: a total of 57.8% of respondents work in schools in urban areas while only 42.2% work in rural areas. According to the gender structure, the vast majority are female teachers, 59.5%, as it was expected since more women are involved in this profession. Male respondents are present in 40.5%.

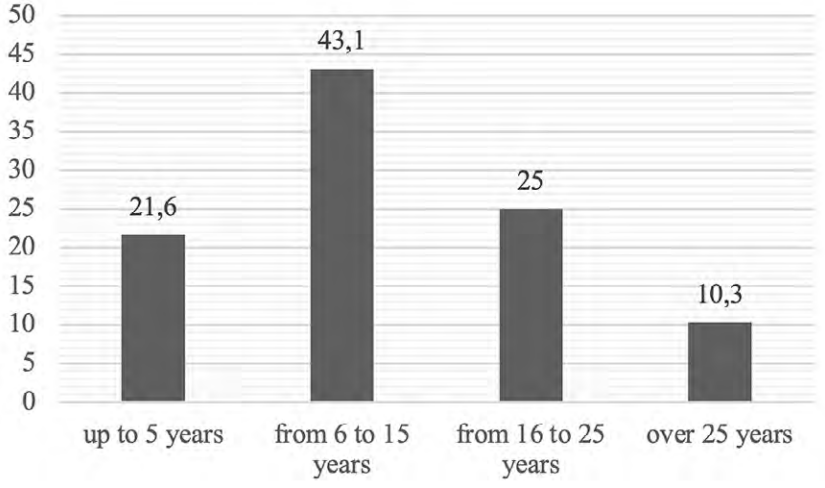

Figure 1. Structure of respondents according to their work experience (%)

The term "correlation" in the educational methodology has several interpretations. Besides the usual, the correlation is set between the orientation goals of teaching and the strategy of teaching. This term can also be linked to the meaning of the term "methodology". The correlation is interpreted as linking the content of one course with the content of the other with the goal of activation of students and innovations in teaching (Mrkalj, Z.V. 2010). The opinions of teachers regarding the correlation of courses based on the existent curriculum in primary schools are rather negative (Figure 2). Even 65% of respondents think that the content is not harmonized with the courses, and without that harmonization, we cannot speak of correlation, as one of the innovations.

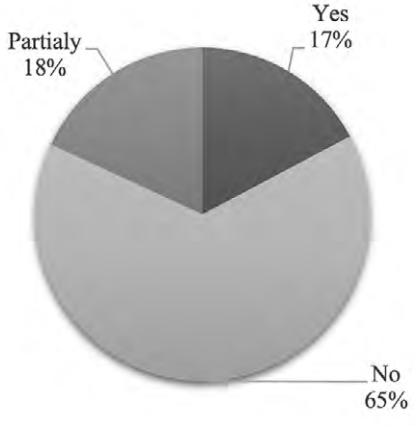

Figure 2. The opinions of teachers regarding the correlation of courses based on the existent curriculum in primary schools (%)

As it can be seen on the Figure 3, 74.14% of respondents think that the students are overwhelmed by the school duties. Those duties are directly connected to the curriculum. Therefore, the teachers have expressed their dissatisfaction with the current curriculum because of the load the students have and the impossibility of students' activity.

During the survey, the teachers have listed the most used methods. Out of the total number of respondents, 80.17% uses the frontal method, while 14.65% uses the group method. The rest of the methods as the individual work with the help of a teacher and the individual work without the help of the teacher is used by only 5.18% of respondents. The active school/teaching is basically the school that is mostly centered, directed towards the child that is treated like a complete personality not just the student. The main characteristics of this "new" school are: the existence of the whole prefixed curriculum is not necessary, there should be oriental curriculum, or one obligatory and one flexible part, the starting point is the interests of children and the learning process is

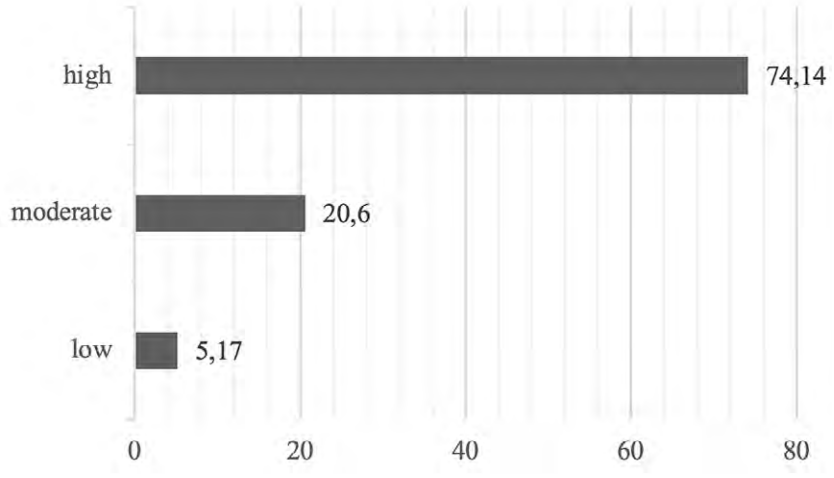

Figure 3. Teachers' answers about the topic if the students are overwhelmed by the school duties (%)

connected to those interests, every teaching is connected with the previous knowledge and the personal experience of the child, the motivation for learning is personal (inner), the predominant methods of active teaching are practical, working, manual activities, expressive activities, laboratory activities, fieldwork etc. The goal of this type of school is the growth of the personality and individuality of a child, not only the adoption of the curriculum. What should be graded is the kids' satisfaction with the activities, motivation and will to participate, and the personal growth (Ivic et al., 2001).

T-TEST RESULTS

A t-test is a statistical analysis that is used to determine whether there is a significant difference between the means of two groups. The following tables show the results of the T-test for the statements with statistically significant differences in the respondents' answers.

The results of the t-test have shown that there is a statistically significant difference between the answers of the respondents based on their gender (the level of significance $p<0.05$). Statistically, a significant difference is also noticeable with four out of twelve statements. At the answers of the respondents for the statement: *The curriculum is unadjusted with the requirements of further education*, we can notice the statistically important difference. The female responders have graded this statement higher than the male ones. The other 3 statements were graded higher by the male responders than the female ones, which means that female teachers are less in agreement with the statements regarding the curriculum. The statement that showed statistically significant differences is *The curriculum offers the possibility of involving the students with special needs in regular education*. The contemporary education implies the involvement of children with special needs, the primary education is obligatory for every child that is able to attend the school. Their education is dependable on the curriculum. Therefore, female respondents think that the curriculum does not follow the requirements of inclusive education. The curriculum for special needs students that are de-

Table 1. T-test results for the respondents of different gender

Statement	Gender	F	P
The curriculum offers the possibility of involving the students with special needs in regular education	male	10,760	0,001
	female		
The curriculum is unadjusted with the requirements of further education	male	11,464	0,001
	female		
The curriculum is appropriate for the age, individual needs of students and their previous education	male	15,486	0,000
	female		
The curriculum is constantly improved and modernized	male	7,258	0,008
	female		

veloped as the individual educational plan is adopted by the school team (parents, teachers, psychologist and/or pedagogue of the school). According to that plan, the curriculum can be adapted to the needs of students, as a whole or partially (e.g. one course or the group of similar courses that are troubling for the student). If needed, the standards of accomplishment and goals of education can also be changed based on the capacity of the student.

Statistically, a significant difference is also spotted at the statement that reads: *The curriculum is appropriate for the age, individual needs of students and their previous education and the curriculum is constantly improved and modernized*. The answers for all other statements are the same for both female and male teachers. These results show that the hypothesis that implies statistically significant differences in opinions of the teacher based on their gender is correct (Table1).

RESULTS OF THE ANALYSIS OF VARIANCE (ANOVA)

One-way analysis of variance (ANOVA) was used for determining whether there is a statistically significant difference between dependent variables (statements related to the respondents' attitudes) and independent variables (the respondents' social characteristics). The analysis of variance ANOVA shows that statistically, a significant difference is not present among the respondents of different work experiences.

Twelve statements were tested, and no statistically significant difference was established for any. Therefore, this hypothesis has not been confirmed.

The analysis of variance ANOVA shows that the statistically significant difference between the respondents based on the lengths of their experience does not exist. Twelve statements have been tested and not one has shown a statistically significant difference. Due to that, this hypothesis has not been confirmed. The high level of agreement with the statements shows that the teachers with different lengths of working have more or less similar opinions about the curriculum and agree that it is not well represented, formed and does not follow the improvement of students, nor incentives the activation of students or inclusive education.

CONCLUSION

The curriculum is mostly one of the basic school documents, which is used to regulate the volume and structure of teaching for a longer period of time, based on the age of the students. The curriculum is significant documents that include the didactical concretization of general and methodical elements of the teaching plan. The curriculum includes clearly defined general goals and tasks, logically structured teaching content and basic didactical-methodical guidance for its use for each course. Based on the survey done among the teachers of geography in primary schools, with different places of employment and years of experience, it is deemed that the reform of curriculum is needed, as well as its adaptation to the students with special needs. The teachers surveyed also believe that the activation of students should be more important. As shown in the results, with the existent curriculum, teachers mostly use the frontal teaching method, which represents the traditional method that puts the children in the second position. The modern understanding of the World's methodologists is that the children should be in the first place and that the school should be a place where they have most of their studying done. The survey also shows that the existent curriculum is not in accordance with the courses and the students are overwhelmed with the number of materials. With the unadjusted curriculum, the special needs students are disconnected from the obligatory education or in the worst case, disregarded. The load of the students by the curriculum leads to a lack of interest for certain courses and therefore leads to the lower overall grades. Involving the teachers in the process of creating the curriculum with lead to better outcomes of education. They are the ones directly passing the curriculum over to the students.

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THE POSSIBILITIES OF INTEGRATIVE TEACHING OF GEOGRAPHY AND BIOLOGY

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Abstract

Integrative teaching model is one of the innovative didactic models that connect content from two or several teaching subjects. Diverse programme contents in the fields of geography and biology in elementary schools provide an excellent opportunity for applying an integrated teaching model and an active type of learning for students. In Serbia, geography and biology are taught as independent subjects in elementary schools from fifth to eighth grade. Similar content is observed in all elementary school grades in the subjects of geography and biology. This paper presents teaching units in geography and biology that have the most opportunities for integrative teaching. In this class, geography and biology teachers used an integrative teaching model and brought similar content to students through a geographic and biological point of view.

Keywords: integrative teaching, geography, biology, elementary school

Introduction

School curricula tend to separate knowledge into isolated subjects. To develop a curriculum that effectively integrates science subjects in school, it is important to provide rich and meaningful experiences to prospective teachers, to engage them in interdisciplinary teaching practices and understanding of such connections (Frykholm & Glasson, 2005). The idea of the integrity of teaching appears fairly early. The renowned Czech pedagogue, Jan Amos Komensky, the creator of the teaching system by subject, noted precisely that teaching by subject matter leads to an excessive fragmentation of the content of the teaching. As a result of this he recommended that the teaching content should be grouped into natural and logical lessons that could be worked on and developed within the framework of certain topics. Komensky's idea did not come into practice, and integrative teaching as a model was applied much later (Vilotijević, 2006).

Although organized into separate subjects, courses or program areas there are many connections across the curriculum. Integrating across content areas, and providing ways for students to make connections, enhances student learning (Kaur, 2019). Children learn better when valid connections are laid out across the entire curriculum. Integrative teaching promotes meaningful learning especially in the initial stages of education, but integration is possible in any of the stages of learning (primary, secondary and tertiary). The Association of American Colleges & Universities (2007) describes integrative learning as being the key change in university education for the 21st century. According to Pigdon & Wooley (1992), an integrated approach allows learners to explore, gather, process, refine and present information about topics they want to investigate without the constraints imposed by traditional subject barriers. Integrated learning encourages students to see the interconnectedness and interrelationships between the curriculum areas. Rather than focusing on learning in isolated curriculum areas, an integrated program is based on skill develop-

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ment around a particular theme that is relevant to the children in the class. Godemann (2006) outlines the path that knowledge needs to change to be applicable in an integrative approach (Table 1).

Table 1. Differences between disciplinary and integrative knowledge

disciplinary knowledge	integrative knowledge
simplicity	complexity
singularity	heterogeneity and hybridism
linearity	non-linearity
unity and universality	unifying an integrative process
fragmentation	connection, collaboration and consequence
boundary formation	boundary blurring and crossing
the short-term and ephemeral	long-term
analysis and reduction	synthesis and dialogue

Source: Godemann, 2006.

Through integrative teaching children can develop a deeper understanding of content through a range of purposeful activities (Smith & Ellery, 1997). Integral to the model of integrated learning is the inquiry approach. Students are active learners who research, interpret, communicate, and process learning to both others and themselves. Inquiry approaches allow for students to construct meaning using their prior knowledge on a subject, and new knowledge gained during the learning process (Pigdon & Wooley, 1992). The essence of integrative teaching is a thematic approach that involves the integrated linking of content from different scientific disciplines or subjects within the selected topic. In that sense, the concepts involved in the subject matter are enabled to be built up in a complex way, since the contents can be looked at from different aspects. In the literature we come across integrative learning under different names: integration of teaching, concentration of teaching, correlation of teaching, joint teaching, complex system. All of these conceptual terms have their own explanations but their common goal is the elimination of the negative consequences of teaching by subject matter (Vilotijević & Mandić, 2015). Integration does not mean the elimination of subjects, but rather the establishment of a relationship that involves the existence of different subjects and intertwining the related content taken from various subjects (Spasić Stošić & Tasić Mitić, 2018). The positive effects of implementing integrative teaching in everyday school practice are the following: 1. students develop a sensitivity to problems with an ethical dimension; 2. students widen their ability to view matters horizontally; 3. students develop the ability to synthesize and integrate facts he/she has learned; 4. creative, original and unconventional thinking is developed; 5. the ability for critical thinking is developed; 6. student manage a balance between subjective and objective thinking; 7. sensitivity to bias increases; 8. students realize that the opinion of one expert is not final (Ivanitskaya et al., 2002). In this way, students are trained to effectively solve problems from different fields and gain a deeper and more systematic knowledge that can be applied to real life. Integrative teaching prepares students for the process of lifelong learning as it blurs the boundaries between traditional subjects (Lake, 1994). The positive results of implementing the integrative approach not only relate progress in the development of students, but this teaching model also has a beneficial effect on teachers as well. It provides them with a more dynamic organization of their time and a modern method of teaching, considering the fact that they are able to use numerous sources and resources in teaching (Spasić Stošić & Tasić Mitić, 2018). An integrative teaching approach is a very good solution for a number of science content subjects: biology, chemistry, physics, geography, mathematics (Johnson & Dasgupta, 2005).

Integrative teaching theme between geography and biology in the elementary school curriculum in Serbia

Numerous programs of geography and biology in elementary school provide an excellent opportunity for the implementation of integrative teaching, which would provide students with better quality teaching. Their knowledge in both subjects would not be differentiated, no "islands" of knowledge would be created.

Geography and biology begin to be taught in elementary schools in Serbia from the fifth grade. Both subjects are obligatory from the fifth to the eighth grade. The annual number of teaching hours for geography in the fifth grade is 36 classes, while the annual number of teaching hours for biology is 72 classes. In the sixth, seventh and eighth grades, the annual number of classes for both subjects is the same (72 for the sixth and seventh grades and 68 for the eighth grade). An analysis of the curricula of geography and biology revealed that there are numerous opportunities for correlation between the two subjects. Figure 1 shows topics in biology and geography at primary school. The lines that are drawn represent possible correla-

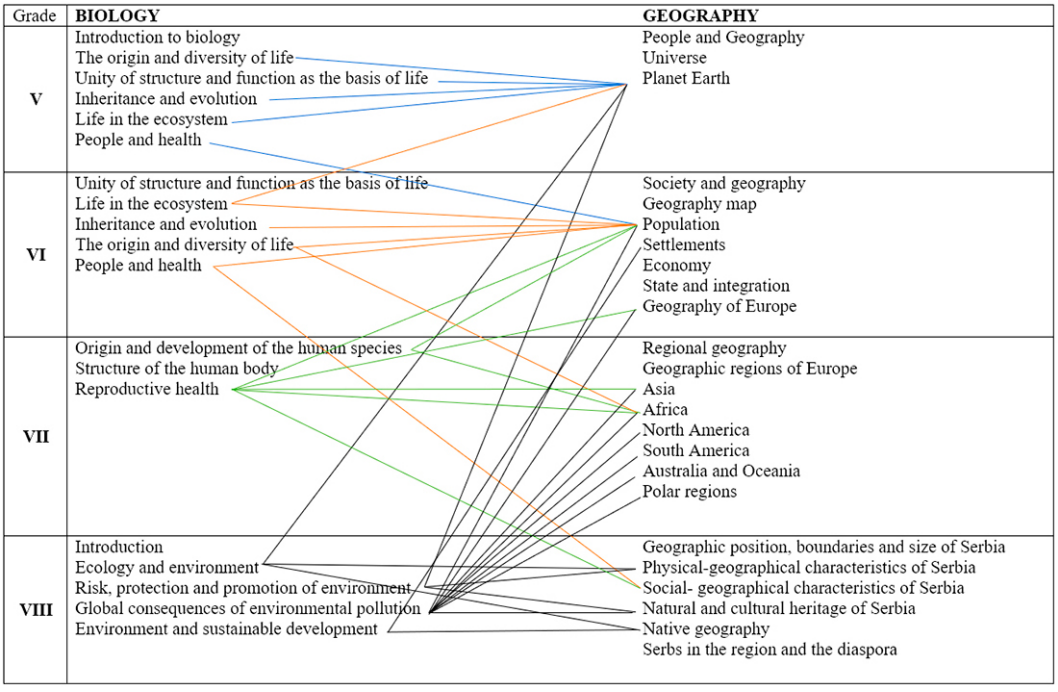

Figure 1. Possible correlations of teaching biology and geography topics from the fifth to the eighth grade of elementary school

Source: made by the author based on curricula from the 2019/2020 school year (Milanković Jovanov, 2020)

tions of teaching biology and geography topics from the fifth to the eighth grade of elementary school. The lines range from topics in biology to topics in geography. It is noted that there are horizontal correlations, related links in topics in the same grade. But there are also many diagonal correlations, where it is possible to relate biology topics to the geography topics from the previous grade or to correlate it with topics that will be learned in later grades. Horizontal correlations between subjects provide an opportunity for integrative teaching. Diagonal correlations are important for linking material between subjects. It can be observed (Figure 1) that there are many horizontal connections in the fifth grade. Almost all topics in biology can be linked to a geography topic Planet Earth. The knowledge gained in the fifth grade of geography can also be used in the later grades in biology classes, as confirmed by diagonal connections. Topics in biology in the sixth grade show the highest correlation with the topic Population in Geography. These horizontal connections are a good basis for applying integrative teaching. There is little horizontal correlation between topics in the seventh grade. Within the theme of Reproductive Health in the seventh grade, students in biology classes learn about birth rates and family planning. It is possible to relate this topic to topics about the Population of Asia and Africa in the geography class. It is a good example to explain to students how to plan a family in Asia (China and India) or how the increased birth rate affects the development and life of the population in Africa. The eighth-grade biology topics can relate well to prior knowledge gained in geography classes. Therefore, a large number of diagonal correlations can be observed, ranging from topics in biology in the eighth grade to topics from earlier geography classes (Figure 1). Biology topics such as Global Consequences and Environmental Pollution can be correlated with almost every topic in geography at the seventh grade, because the whole world has a problem with the consequences of pollution. The eighth grade provides great opportunities for integrative teaching, as students have already acquired sufficient knowledge in both subjects. Also, there are horizontal links between topics that allow the application of an integrative teaching model. In biology classes, the eighth-grade students learn about the environmental threats, types of erosion, the effects of climate change, natural and cultural assets and similar issues, while in geography classes, students are introduced to the national geography of their country. Some of the topics for integrative teaching can be Natural Resources in Serbia, Types of Erosion in Serbia, Environmental Problems and Ways to Improve the Environment etc.

The teaching materials of both subjects provide an opportunity for collaboration between biology and geography, which would greatly contribute to a better understanding of the school material by the student. The implementation of integrative teaching requires planning lessons that will encourage the acquisition of systematic knowledge, skills and abilities, gaining experience, creative activities and the formation of value attitudes.

Planning and difficulties in implementing integrative teaching

Integrative teaching model requires planning and good organization. Unlike the usual teaching plan, in this model, more than one teacher is planning, organizing and delivering teaching. The focus of such model of teaching is the topic or problem of multiple subjects. Based on the chosen topic or problem, teachers must note related and/or the same content appearing in different subjects. Integrative teaching starts with a topic or problem that needs to be comprehensively considered. Therefore, teaching is focused on the topic or problem, not the subject. When choosing a topic, teachers need to consider: the learning outcomes set out in the curriculum for each subject; what prior student knowledge is required; appreciation of individual learning styles, opportunities to work in smaller or larger groups, existence of the necessary resources for the realization of the topic, opportunities for realization of teaching outside the classroom etc. (Vilotijević, 2006). Finding the same or similar content is just the first step in planning for integrative teaching. Teachers must choose appropriate methods, means, forms, and procedures. Since teachers design and plan lessons as a problem or topic, the basic methods of working in class will be dialogue, research, and problem-solving. Therefore, the dominant forms in such a conceptualized teaching are discovery learning, problem learning, experiential learning, using examples in teaching, a research approach and the like. Regarding students' preferences, it is well-known that students are more successful in learning if the learning content is lifelong and satisfies their needs and interests (Buljubašić-Kuzmanović, 2007). When planning integrative teaching, it is necessary to start with the students' experiences and needs. Topics that are planned must relate to reality, to the student's living environment, and not just to individual aspects of a particular science or subject. Some authors recommend involving students in planning (Jacobs, 1989b). Whenever possible, it is good to involve students in planning and developing the idea of which topic will be addressed. It is not always desirable to involve students in planning, but it should be done when teachers see that it makes sense, as this increases students' motivation and interest to learn. According to Gajić (2015) the path that teachers should take when planning integrative teaching is: (1) selecting the appropriate topic; (2) presenting a range of ideas and associations regarding the topic; (3) familiarizing teachers with the content from other teaching subjects; (4) finding connections and relationships among the content of various subjects, (5) defining the goals and tasks to be accomplished; (6) defining methods of working in class (7) defining activities to be implemented; (8) planning materials and teaching aids necessary for the realization of the classes; (9) designing timeline and planning of teaching realization; (10) deciding how the set learning goals and objectives will be evaluated.

The teacher should be aware that this model of teaching carries great freedom in work, but also a great responsibility. It is necessary for the teacher to lead the discussion among the students so as to encourage the observation of the topic / problem from different perspectives. The success of the implementation of the integrative teaching model depends on the initiative, co-operation and creativity of the teacher.

Integrative teaching starts with topics and problems that are real, lifelong but also about the interests and needs of students. This means that there may be a need for a separate plan for each class and that, instead of developing a single plan for one class, the teacher should devote more time to planning more different programs.

Difficulties are most often related to the problem with the teaching staff and the lack of time (Brandt, 1991; Casey, 2009). In our education system, teachers are educated to teach a single subject, and very often do not have some broad knowledge of related subjects. This requires involving more teachers in integrative teaching. Also, teachers are not trained to teach in this way and have difficulty fitting into this type of work. If they want to collaborate with colleagues and have integrative teaching, they have a major problem organizing regular school teaching. However, this can be overcome if teachers are willing to devote time to collaborative planning towards connecting and integrating teaching content.

Application of integrative model in geography and biology classes

In the 2018/2019 school year, one class was conducted by using an integrative teaching model in the eighth grade in an elementary school in Novi Sad. This class is part of the author's research into the importance of applying an integrative model of teaching in schools in Serbia. This class was organized by one geography and one biology teacher. Teachers found a link between the geography topic *The National Parks of Serbia* and the biology topic *Protected Natural Resources.* After choosing a common theme, teachers and stu-

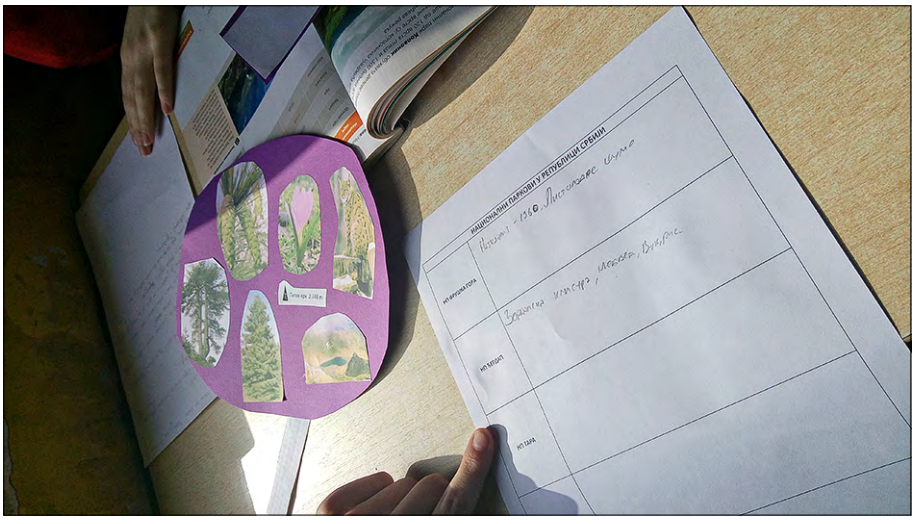

Figure 2. Some of the materials and students' checklist

dents continued with the preparation. Students were asked to read in advance textbooks related to national parks and protected areas. The teachers prepared the lesson plan and all the necessary materials to bring to the class. The materials consisted of photographs from various locations of national parks in Serbia, information on the highest peaks of mountains that are national parks, some protected plant species and photographs of protected species of animals in national parks in Serbia, etc. All materials were mixed and put on the one desk at the end of the classroom.

At the beginning of the class, the teachers divided the students into 5 groups (the number of national parks in Serbia). Both teachers presented basic information about national parks in Serbia and protected areas and gave students instructions for further work. Each group had to take, from the prepared materials, what was belonging to their national park and prepare a short text to present in front of the whole class.

Before presenting to other students, they had to paste the material onto a map of Serbia at the exact location of their national park. Other students listened and marked the basic information in the preparation checklist.

At this school class, the focus was on the students' research work and their activity, while the teachers were only the coordinators and moderators of the class. The good preparation and cooperation of the teachers greatly influenced the success of the class. This is a good example of the application of an integrative teaching model in the collaboration of geography and biology teachers. It is important that students always have a "tangible" result in classes like this, in the form of a solution to a particular problem or materials they made themselves. In this case, it is a map of Serbia with national parks that will serve them in class and be part of their joint work.

Figure 3. Map made by the students at the end of the class

Conclusion

Teaching practice in Serbia shows that the teaching process is still being implemented according to the principles of traditional teaching in which the student is a passive listener and a recipient of knowledge, and the teacher is someone who transmits knowledge, who dominates the classroom and requires the student to have reproductive knowledge and rota memorization of facts. Modern education is increasingly striving for integrative and interdisciplinary knowledge.

An important characteristic of integrative teaching model is the fact that in this methodical model the material is problematized. Students do not adopt unrelated facts but learn about a problem or a topic. This view of adopting the material also changes the roles of teachers and students in relation to traditional teaching. The "new" role of the teacher is to be a leader, moderator, associate, facilitator, initiator of new ideas and diversity of opinions and attitudes. Accordingly, the student acquires knowledge by being active, exploring, analysing, comparing, discussing, explaining, offering a large number of ideas and solutions with arguments.

The preparation and organization of integrative teaching require significantly more effort and time of the teacher than the traditional teaching. The implementation of integrative teaching involves more investment, both human and material resources. The very fact that more teachers need to plan and organize the teaching process indicates the complexity of such planning. Teachers need to be well-organized and coordinated in order to successfully complete the classes and achieve the planned goals.

Topics between geography and biology in elementary schools in Serbia provide numerous opportunities for teacher collaboration and organization of integrative teaching. The application of this teaching model provides opportunities for students to better understand the content of both subjects, to understand the connections between them and to approach the problem more creatively.

An example of this is a class organized in the eighth grade, after which students expressed a desire to have more of these classes. The students emphasized that it is easier for them to master the school material when teachers present the connections between the subjects and when they come up with a solution themselves.

Acknowledgment

This research was supported by the Erasmus+ strategic partnership project no. 2019-1-CZ01-KA203-061379, and by Project 142-451-2350/2021-01 of the Provincial Secretariat for Science and Technological Development, ECAP Vojvodina (Serbia).

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IMMANUEL KANT: THE GEOGRAPHER IN THE CIVIL TWILIGHT BETWEEN PREMODERN AND MODERN

Goran Mutabdžija[A]

Abstract

This paper analyses the contribution of Immanuel Kant to geographical thinking (Harvey,1969 and May 1970), which, as part of a broader philosophical discourse, represented a revolution point in the history of philosophy. After a cursory introduction to the basic elements of Kant's epistemology (Kant, 1970; Milisavljević, 2010 and Skirbekk & Gilje, 2017) and "Copernican revolution" (Smiljanić, 2014), it will attempt to present his contribution to the development of geographical thinking. The starting point for this is that he also taught two geography courses at the University throughout his academic career (Eze, 1997, Louden, 2007 and Elden, 2010). In the summer semester, he taught physical geography and anthropology (the forerunner of social geography) for forty years in the winter. He did not authorize his lectures, so his books on geography are a compilation of various notes published by his students subsequently. The basic questions it's trying to answer relate to why Kant taught these geographic subjects and how he defined them? In addition to the general concept of Weltkenntnis (Kant, 1974; 2006), the analysis of these cases also gives rise to three concepts that have a geographical meaning and require a broader explanation. These terms refer to space, the ethics of cosmopolitanism, and the human race.

Keywords: Kant, epistemology, geographical thinking, the notion of space, cosmopolitism, and races.

INTRODUCTION

The rapid increase in geographical knowledge of the world, following the "great discoveries" during the 15th and 16th centuries, provided the necessary basis for the gradual establishment of academic (scientific, formal, or modern) geographical science in the nineteenth century. The establishment of the scientific method contributed decisively to the development of scientific thought and, as a geographical peculiarity, represented the definition of a new scientific discipline's philosophical and conceptual basis. The establishment of the scientific method contributed decisively to the development of scientific thought and, as a geographical peculiarity, represented the definition of a new scientific discipline's philosophical and conceptual basis. Given its horological (spatial) basis, a key point was defining the term space as an absolute category, which Kant realized in his first critique (*Critique of Pure Mind*, 1781). Thus, two critical periods in the history of science began with this book. The first concerns geography and the creation of scientific assumptions for a complete break with medieval cosmology. It was completed in the first half of the nineteenth century and, according to Peet (1998), it is the year of the death of the first great geographers, von Bismarck and von Ritter (1859), which mark the formal beginning of a new phase (modern) in the scientific development of geography. The second period concerns the action of philosophy over the next fifty years. In its multimillennial history, this was a short period, but half a century between the occurrences of this book of I. Kant and the death of G. F. V. Hegel will be characterized as a very glittering period, named as the school of German idealism. This teaching is considered the pinnacle of German philosophy, so it compares with classical Greek philosophy in terms of its historical and philosophical significance. Undoubtedly, the emergence of such significant philosophers

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as Kant, Fichte, Schelling, and Hegel has left a tremendous influence on the development of geographical thinking and the creation of the preconditions for the emergence of the geography of modernism.

ELEMENTS OF KANT'S EPISTEMOLOGY AND "COPERNICAN REVOLUTION"

With the development of German idealism, the notion of space becomes one of the central issues, and philosophical thought becomes so "broad and deep" that it is impossible to present it in short lines to be "clear" to geographers (after all, this is not even a subject of geography). It is also a central issue of scientific geography. Based on the interpretation of this term alone, a whole range of philosophical and geographical directions is being developed, which do not move in succession, but partly in parallel, over the next period. Therefore, it isn't easy to understand the historical development of geographical thinking, so it's necessary to take a break here in its further study while focusing on a key figure, a philosopher who made a significant contribution to the emergence of modern geography. Kant (1724-1804) lived in the east of Prussia, formerly Konigsberg, and today Kaliningrad (Russia), on the shores of the Baltic Sea. In professional terms, Kant worked as a teacher and then a university professor teaching basic philosophical subjects (logic, ethics, ontology) and writing five capital philosophical works.[1]. Curiosity is that he also taught two geographic subjects over the 40 years of his academic career or "throughout his career at the university, Kant offered 72 courses in Anthropology and Physical Geography, more than in logic (54 times), metaphysics (49 times), moral philosophy (28), and theoretical physics 20 times" (Eze, 1997). He did not marry, he lived by strict rules, he spent his entire life in his hometown, and he was known for going out for walks at the same time every day and always walking the same paths. The scientific authorities whose works left the highest mark on his intellectual development were the leading philosophers of England (Hume, the empiricist), France (Rousseau, the Enlightenment), and Germany (Leibniz, the rationalist). However, to completely understand Kant's philosophy, it is necessary to become more familiar with his upbringing.[2] and education:

At the University, Kant listened to Martin Knucen, who was at the same time a petitioner and supporter of Wolf's philosophy. It is indisputable that the latter exerted a significant influence on the formation of Kant's opinion. However, it can be assumed that Kant's reception of Wolf's rationalism took place precisely in a sign of internal tension towards the pietistic underpinning of Kant's education. Thus, the question arises as to whether Kant's rationalist orientation was, from the beginning, problematic to a much greater extent than is usually thought. For example, Kant was particularly impressed by Crusius' critique of the Wolf's School rationalism from one - although inconsistent formulated - empiricist standpoint ... The idea of Kant as an unreserved supporter of Enlightenment rationalism, still widespread, not only to a broader audience but also with professional philosophers, it's fundamentally wrong. Kant's spiritual formation falls into a period of intense criticism of rationalism in Germany. We would be less harmful in characterizing Kant's pre-critical philosophy as "empiricist" than "rationalist." Suppose today it is problematic whether a representative of the Wolf's School can be recognized in the youngest bucket. In that case, there is no doubt that the bucket itself was understood as an "empiricist" from the 1960s onwards (Milisavljević, 2010, p. 21-23).

Newton's physics, and indirectly the teachings of Copernicus, Galileo, and Kepler, interested him in publishing the famous hypothesis of the emergence of the solar system.[3], followed by ideas of space and time[4]. After that, Kant fell into a "dogmatic snooze" that lasted 11 years. He wrote nothing but tried to answer questions about the immortality of the soul, free will, and God's existence, which were elements of Hume's philosophy. When he found the answers to all

[1] These are three criticisms: Critique of the Pure Mind (1781), Critique of the Practical Mind (1788), and Critique of the Power of Trial (1790), and the Founding of the Metaphysics of Morality (1785) and Eternal Peace (1795).

[2] Kant was educated in the pietistic spirit, referring to the Protestant movement, which emphasized the internal restoration of man as an individual.

[3] Kant and Laplace (1755), independently of one another, offered the first hypothesis about the origin of the solar system from the hot-gas mass. It slowly rotated around its axis, took on the shape of an ellipsoid, gradually cooled, thickened, and shrunk. From the center of the bow became the Sun, and from the separated rings, they became planets, and from the worlds, while in the heat-gaseous state, new calls were separated from which they became satellites. This hypothesis was popular in the XIX century. And she was quickly abandoned.

[4] On the Form and Principles of the Sensory and Thought Worlds

the questions, he wrote The Critique of Pure Mind in just a few months (680 pages).

So what was so revolutionary about Kant's philosophy that it sparked a "Copernican revolution."[5] In science and created the assumption that in just three decades, from the emergence of the Critique of Pure Mind to Hegel's Logic, a new modern era began that gave German philosophy world-historical significance? After his geography students, will that same period begin in geography? To clarify his contribution to geographical thinking, it is necessary to explain the theory of knowledge within his philosophy since he also belonged to a liberal tradition that broke with empiricists and utilitarianism. Through his transcendental philosophy, he wanted to reconcile Locke and Hume (empiricist skepticism) with Descartes and Leibniz (rationalist dogmatism). Kant called transcendental any knowledge that does not deal with objects, but "our knowledge of the subject if it should be possible a priori." According to him, transcendental philosophy is a system of concepts that "enables the exploration of the possibilities of the limits of knowledge." The basis of Kant's theory of cognition is the epistemological model and types of understanding. The starting point for constructing this theory Kant realized through a critique of skeptical empiricism, which attributed a very modest role to the mind. With the rejection of such skepticism through the argumentation of experiential forms of space, time, and cause, as inalienable elements of human knowledge, Kant found the answer in distorting the epistemological point of view. Just as Copernicus better mastered astronomical data and representations when he left the settings of the geocentric system, so Kant abandons the basic assumption that knowledge is influenced by an object on a subject and twists that relationship by claiming that "the subject is the one affecting the object." In these settings, Kant's theory of cognition rests precisely because the object (as we know it) is shaped by the way the subject perceives and thinks. This twist of epistemological preconditions is called the Copernican revolution. According to Kant, the epistemological model implies that the issue shapes all knowledge, and all impressions take on the form we attribute to him. Sensory perceptions are formed through forms of perception, space, and time. We only gain an ordered experience when the sensory impressions are translated into concepts, i.e., when reason by its categories marks the observed multitude. Kant believes that all people have the same primary "forms" in themselves, so all knowledge in all people must be shaped by the same forms. They are space and time, as forms of observation or perception, and causality consists of 4 categories and 12 statements or judgments:

- • Quantity: general, particular, and singular
- • Quality: affirmative, negative, and infinite
- • Relation: categorical, hypothetical, and disjunctive
- • Modality: possible, natural, and necessary

Skirbekk & Gilje (2017) argue that in the natural (and beyond: in empirical sciences), there are forms of observation that are necessary and generalizable because our knowledge must be distinguished by time, space, and causality, to be understandable. To be knowledge. These forms or structures are not in the object but all subjects, and they are not subjective in the sense that they are arbitrary or wrong. Still, they exist in all matters, and they are an epistemological precondition that enables the objective, i.e., actual knowledge. In the realm of cognition, Kant recognizes three types of awareness:

1. analytic (a priori) refers to the connection between terms,
2. synthetically (a posteriorly) forms sensory impressions,
3. synthetic (a priori) concerns insight into forms,

In addition to this schematized description of types of cognition, it is essential to note that the notion of

Table 1. Kant's types of knowledge and their characteristics

Types of cognition	Attitude to experience	Example
a priori	independent	"a bachelor is not married."
a posteriori	depending on	"This house is blue."
analytically	A statement where a logical predicate is a "part" of a logical entity, e.g., "Bachelor is not married."	
	A statement whose negation leads to a logical contradiction, e.g., "Bachelor is not unmarried."	
synthetic	A statement where a logical predicate is not "part" of a logical entity, e.g., "This house is blue."	
	A statement whose negation does not lead to a logical contradiction, e.g., "This house is not blue."	

Based on: Skirbekk & Gilje, 2017, p. 384.

[5] According to Sindjelic (2010), this philosophical term came from Kant's question, "How are universal synthetic statements a priori possible"? Kant agreed with the empiricists that knowledge comes from experience but argued that it is merely the content of our empirical knowledge, which forms our intellectual power.

Kant's cognition does not only divide the sensual and the intellectual but:

Also, the world is sensual and intelligent. And this naturally indicates that intellectual cognition is cognition of intelligible, just as sensual cognition is cognition of sensible. Since extra-terrestrial reality belongs to the class of understandable, we can expect Kant to say that dogmatic metaphysics, understood as a system of learned truths, is possible (Copleston, 2014: 218-219).

KANT'S INTERPRETATION OF THE TERM SPACE

Now that the essential elements of Kant's epistemology have been superficially considered, his contribution to the development of geographical thinking will be attempted. It has already been said that he taught geographical subjects, physical geography in the summer semester, and anthropology (the forerunner of social geography) for forty years in the winter. But, unfortunately, he did not authorize his lectures, so did his geography books.[6] Are a compilation of various notes published by his students, subsequently. Several papers have been written about Kant's contribution to geography, among which are the analyses of R. Hartshorne.[7], J. A. May[8], D. Livingston[9], S. Elden[10]And a comprehensive compilation of geographical works edited by S. Elden and E. Mendieta.[11]. In the beginning, the question is, why did Kant teach geography? While these were some of his best-attended courses, it does not explain enough. Louden (2007) suggests that at first there were "purely scientific" reasons, that is, to become more precise ideas about travel, and some believe that the popularity of the course among students was aimed at "civilizing them to become citizens of the world." he also thinks of the meaning of lectures in anthropology, as of spreading knowledge that emphasizes philosophical purpose, but with a goal that was not merely educational, because

Lectures in anthropology and physical geography were not primarily intended to contribute to Kant's critical transcendental philosophy ... [which] was not his only preoccupation. Instead, much of Kant's teaching activity was devoted to enlightening his students about the people and the world around them so that they could have a pragmatic and morally better life (Louden, 2007: 38).

Kant considered physical geography and anthropology to be "crossed halves of one larger entity" to be studied for pragmatic reasons related to acquisition knowledge and its relation to moral and practical life principles. Through the interpretation of Kant's geography, three crucial questions come to the fore, which have several opposing dimensions. These are questions related to understanding space, the ethics of cosmopolitanism, and humans. Kant first reflected on the area in The Space View (1768) and then in a professor's inaugural dissertation.[12] He tried to reconcile the differences between Leibniz's relativistic view of space (the result of the relationship between things) and Newton's complete view (space as a container for items).

In these experiments, Kant argues that absolute space possesses its reality, regardless of the existence of matter. At the same time, he shows an awareness of the difficulties accompanying the theory of space as an independent, objective reality. And he notes that absolute space is not an object of external observation but is a fundamental concept that enables this external observation (Copleston, 2014: 163).

According to Harvey (1969), his later explanations varied from "a total space based on Cartesian geometry and absolutely in Newton's sense, to a non-historical Euclidean conception." Such a relation to the notion of space was strongly influenced by Descartes (the world of ideas) and Newton (the material world), who regarded it as "something more than a simple equation that clarifies the relation of different visions but was already an open system." In his book Critique of the Pure Mind, he presents views explicitly focused on the pure Newtonian concept of space. In the transcendental aesthetics of space and the metaphysical examination of this concept, Kant says that under the study of space, he understands:

A clear idea of what belongs to one concept and metaphysical is an examination when the play contains what shows the term as a priori.

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[6] Immanuel Kant, Physische Geographie, edited by G. Vollmer, Mainz, 1801-05. and F. T. Rink, Konigsberg, 1802.

[7] In the capital work The Nature of Geography (1939), Hartshorne gives an overview of Kant's contribution to geography in the chapter "The Pre-Classical Period of Modern Geography."

[8] The most comprehensive study was written by J. A. May (1970): Kant's Concept of Geography and its Relation to Recent Geographical Thought.

[9] David Livingston wrote Immanuel Kant's study, Subjectivism, and Human Geography: A Preliminary Investigation, Transactions of the Institute of British Geographers (1981).

[10] His major works include Reassessing Kant's Geography (2009) and Reintroducing Kant's Geography (2011).

[11] Reading Kant's Geography (2011).

[12] The Form and Principles of the Sensible and Intelligible World.

Space is by no means a practical term that is abstracted from external experiences ...

Space is a necessary play a priori that forms the basis of all external observations ...

Space is not any discursive, or as the saying goes, a general notion of the relations of things in general, but one pure observation. Because, first, only one space can be imagined, and when we talk about many areas, we mean only parts of the same space ...

Space is represented as a single infinite size. Indeed, every term must be conceived of as a single play that contains an endless variety of possible representations (as their common designation) and thus encompasses them. Still, no term as such can be conceived of as having an infinite assortment of plays. Yet space is imagined (because all the unlimited parts of space are simultaneous). Thus, the elementary notion of space is to perceive a priori, not notion (Kant, 1970: 63-65).

Kant also transcendentally examines the notion of space, and does so through geometry, which he says:

It defines the properties of space synthetically and yet a priori. By the term transcendental, he considers "the explanation of one term as a principle by which one may see the possibility of other synthetic knowledge a priori. This goal requires: That such knowledge indeed derives from a given term; That this knowledge is possible only on the assumption of a given explanation of the term' (Ibidem, p. 66).

In conclusion, Kant states that:

Space is by no means a feature of anything in itself, or in their mutual relationship, that is. not any provision of them that would be joined to the objects themselves and would remain, even if abstracted from all the subjective conditions of observation. For neither absolute nor relative provisions can be observed before the existence of the things they belong to, i.e., a priori. Space is nothing but the form of all phenomena of external senses, i.e., subjective condition of sensuality under which external observation is only possible for us. Since the subject's receptivity, namely its ability to affix objects to it, necessarily comes before all comments of these objects. It can be understood how the form of all phenomena can be given in consciousness before all actual observations, i.e., a priori, and how it as pure a perception in which all objects must be determined may contain the principles of their relations before each experience (Ibidem, p. 67).

Kant analyzed space and time within the framework of transcendental element theory (first part), which aroused interest among contemporary geographers and translated this into the relationship between geography and history. Elden (2010) believes that Kant is "geography is the basis for history because events must necessarily be placed in a geographical context," but this does not prioritize history. Kant insisted on their coherence and complementary analysis, not separation. At the same time, in his capital work Explanation in Geography (1969), Harvey expresses doubts about Kant's conception of space. He proposes that we should view and understand space in addition to the "absolute view" of space. As "relative and relational."[13]. He also notes that Kant tries to connect the dimensions of space and time, but in a way that "certainly does not advance historical-geographical materialism," which he advocates or "geographical history," as other geographers call it. However, he sees his separation of space and time as the product of theorizing, which is constantly intertwined concerning geographical detail in historical studies.

KANT'S INTERPRETATION OF COSMOPOLITANISM AND THE HUMAN RACE

Kant's lectures in geographical subjects were seen by many as a need for broad education because physical geography and pragmatic anthropology provided the empirical basis for students for their general understanding of the world. Kant regarded this knowledge as part of world knowledge (*Weltkenntnis*), usually translated as cosmopolitan knowledge of the world or cosmopolitanism, which was to become an integral part of citizens' moral and political life. Kant explicitly claims that anthropology is a type of cosmopolitan philosophy, so this world knowledge is essential for understanding the world's image. Through physical geography, it is an "object of external senses," while anthropology makes sense as an "object of the inner senses." Although the term 'cosmopolitan' is associated with Greek philosophy, especially with the Stoics, the creation of modern or 'classical cosmopolitanism' is related to the rise of modernity in the secular European West, whose development can be described as:

Events that were predominantly linked to geographical discoveries as well as to scientific advancement. From the Renaissance to the Enlightenment, the spirit of cosmopolitanism spread throughout Europe. It was a period in which nationalism, while growing,

[13] By these terms, we need to understand the variability of the natural environment and its transformation through human labor into an anthropogenic climate. At the same time, the interconnectedness of all elements of space (living and inanimate nature) indicates their interconnectedness and cause and effect dependence.

was still not a dominant force, such as for many, cosmopolitanism and nationalism were not processes of opposite meaning. The primary inspiration for cosmopolitanism was not a critique of nationalism but a critique of the present, and in the eyes of the cosmopolitan, it was absolutism and dogmatism. Insofar as it cultivated the view of the need for global cohesion and transcendental sensibility about the centrality of the human personality and its rights, the Enlightenment could be considered cosmopolitan, even when the term was not explicitly used. Insofar as it cultivated the view of the need for global cohesion and transcendental sensibility about the centrality of the human personality and its rights, the Enlightenment could be considered cosmopolitan, even when the term was not explicitly used (Amin, 2009: 117).

According to Withers (2009), three types of cosmopolitanism can be distinguished today. Moral cosmopolitanism is a philosophical perspective that assumes that all human beings should be morally committed to the essential goals of humanity, which are above individual interests. Political cosmopolitanism is easier to define as an attempt to limit the nation-state in solving global problems, forms of governance from transnational centers, and relates to human rights issues. This is why political cosmopolitanism, more than moral, concerns the relationship between nations - states and between the state and the individual. This is also the sense by which Kant has furthered his cosmopolitan vision.

On the other hand, cultural cosmopolitanism essentially addresses the problem of recognizing differences and respecting the diversity of human cultures, but in a way that does not presuppose the values and meanings of the dominant culture alone. In the Faculty Conflict essay, Kant divides philosophical studies into two parts. The first section deals with "pure rational knowledge" that contains the metaphysics of nature and morality and pure philosophy and mathematics. The second part is about "historical knowledge," which includes history, geography, philology, and the humanities and natural sciences, based on empirical knowledge. Of these aspects, physical geography represents the physical description of the Earth as a pedestrian assumption for understanding the world. Kant's concept of geography and his positioning of the organizational structure of geography with independent areas: Physical geography forms the basis for other branches of geography as well as history (general study or nature of nature); Mathematical Geography refers to the measurement of the shape, size, and motion of the Earth, as well as its position in the solar system; Moral geography, represents the relationship between moral codes and customs, but also of regions, as elements of spatial differentiation; Political Geography, refers to the political system and political laws regarding the general characteristics of geography, as part of the reason why they are only nominally universal; Commercial Geography, focuses on geographical elements in the trade of surplus products; Theological Geography, considers the theological attitudes and principles, as well as their relation to the physical features of the landscape; influences the shape of spatial differentiation.

According to Kant, physical geography studies nature, the anthropology of man, but the latter goes beyond the former because nature exists for the benefit of human beings. This points to the double meaning of the term Weltkenntnis, which should be treated cosmologically. Kant was not the first professor in Germany to teach explicitly geographical content, but he was original and innovative. While other professors' lectures resembled travelogues, Kant attempted to systematize geographical essence (subject) through synthesized insights from various sources. His curriculum was unique, and he had to seek special permission from the Minister of Education to take a course for which he had no textbook. The ministry responded that it was better "than any textbook" and that professors could improve the authors of the textbooks. Still, that dictation should be stopped, adding: "Of this, however, we make an exception for Professor Kant and his course in physical geography, for which a suitable textbook is not yet available" (Elden, 2010: 9).

There is a similarity in the structure of his physical geography courses. It begins with an introduction that provides a general assessment of the subject and its relation to other topics. It then moves on to Earth movements and devotes the central part of the course to analyzing three segments. Through physical geography, it examines several biological processes relating to the Earth, and the second part deals with the study of nature (fauna, flora, and minerals). The final piece is the regional geography of the world, with descriptions of specific regions of Asia, Africa, Europe, and America. And from such a cursory overview of Kant's lectures in physical geography, one can see the importance of geographical knowledge for the general education of students and the desire to realize a cosmopolitan ideal. Kant says our world experience is limited by time (life span) and space (even if we have traveled a lot). So, we have to rely on others who can provide us with either narrative: temporal (history) or spatial (geography). Therefore, Kant emphasizes that geography enables the categorization of different taxonomic units on a three-level scale, from topography as descriptions of individual sites, chorography as descriptions of regions to global levels, overviews of the whole world. Regional geographic analyses of the world contributed significantly to this goal, which can

be read in two ways today. The first would be an excellent and genuinely cosmopolitan idea based on the opinions of the Enlightenment. The second dimension should be viewed in the light of the concepts of liberalism and the desire to control and provide resources from the "third world" for the needs of the emerging industry. According to Mutabdzija (2018: 107), this could only be achieved through the development of colonialism, in which Germany was lagging other European powers (Great Britain, France, Spain, and Portugal). Since Germany had already exercised cultural (dominant Protestantism) and trade control (the Hanseatic League) over the Baltic, expansion was necessary. The emphasis on the education of cosmopolitan citizens, but better than other countries, may have been only the first stage in realizing this goal, which will be attempted in the coming centuries.

Table 2. Kant's Lectures on Logic suggest that four fundamental questions can be considered as part of anthropology

Question	The answer is provided by:
What can I know?	metaphysics
What should I do?	ethics
What can I hope for?	religion
What is a human being?	anthropology

Based on: Skirbekk & Gilje, 2014.

The final element in this geographical account of Kant's philosophy is the most problematic and has caused the most controversy throughout history. These are human races, about which Kant has debate in works in various fields of his interest. Elements of this teaching are also found in his physical geography, which he views from a moral and political point of view. He included a discussion of human beings, their racial differences, and their geographical differentiation. He studied the population as part of physical geography, both because it is one of the characteristics of the Earth's surface or soil (*Erdboden*) and that humans transform the Earth's surface. Anthropology lectures provide the basis for an empirical interpretation of the population, which provides a geographical perspective on a range of social, cultural, and physical phenomena. In them, Kant devoted a small space to the question of the character of the races and exposed a little of what had previously been the subject of his texts on race. He explained the connection between the geographic courses he had taken by stating that:

Anthropology begins where physical geography ends; the different climates and environments explored in physical geography explain the existence of different types of human beings in the world, and the internal bacteria and natural predispositions studied in anthropology explain why a man could adapt to different climates and environments (Wilson, 2016: 125).

In his lectures on anthropology, Kant began to distinguish pure rational knowledge from experience through his senses. The relation to Kant's theses on racial disparities and the absence of his critical attitude toward negative historical processes will mark the past three centuries, which, philosophically, has been characterized by a constant interpretation and re-examination of his views case ethical. Rujević (2014) emphasized that Bernasconi expressed his critique of Kant's supremacy of white Europeans through three points, which relates to slavery, which Kant never explicitly condemned, then the ambivalent attitude toward colonialism (from charging him to supporting European colonialism). And, finally, problematic attitudes regarding the intersection of human races (he argued that the law of nature is to prevent over-crossing of races and that nature acts in the opposite direction, that is, encourages separation and isolation). The most striking examples of negative interpretations of humans are seen in Kant's work *Von den verschiedenen Racen der Menschen* (On different races of people), where Kant said of the Native Americans.

They have a half-extinguished life force, making them bad slaves because they lack neither the skill nor the endurance. As a cause, it merely laconically cites the effect of the cold climate "... He said of the black race that "In physiological terms, they have an unpleasant odor due to the evaporation of phosphoric acid from their skin, being powerful, fleshy and skilful in handling, but also molluscs, lazy and lazy due to being adapted to live in Africa, which, due to its warm and humid climate, is a land of plenty (like the proverbial land of Dembelius, in the context of contemporary circumstances, this is a tragic, almost cruel irony) "... and for the white race, Kant claimed:" All right, the whites dissolved in [body] juices do not precipitate and thus show the perfect blend of juices and indicate the strength of these people about others (Rujević, 2014: 183).

Kant's contribution to geography is an interdisciplinary endeavor, as it covers both segments, social and physical geography while addressing philosophical issues. Given the renewed interest in anthropology and the connections this material has to geography, Elden (2010) thinks this is the right time to analyze their historical and contemporary significance. We are therefore obliged to give our overview of the issues raised by him. According to our understanding of these texts, it is necessary to shed light on the geographical implications arising from his interpretation of the connection of the population to the soil (Erdboden), which will indirectly associate the Nazis in

the 20th century to create racial laws.[14]Based on soil and blood. This is also discreetly emphasized by Bernasconi when he claims that Kant not only defined the term race. Figuratively, Kant opened a new "space for thought," which created a new territory, from which, "while Kant may have stopped there, those who came later worked in the space he opened," i.e., the Nazis only added to Kant's ideas. A confirmation of this is found in Mein Kampf, a program text of Nazi Germany:

The Aryan tribes are subjugating - often with their tiny national numbers - foreign nations and developing, now encouraged by the living conditions of a new area (fertility, climatic conditions, etc.), and to the advantage of the existing ancillary power available in humans. Lower types, their dormant spiritual and organizing abilities. They create, often for millennia, and even centuries, cultures that initially bore the entire intrinsic features of their being, adapted to the unique characteristics of the soil already indicated above, as subordinate people. But in the end, the invaders err on their own, initially respected, the principle of maintaining the purity of their blood, beginning to mingle with the subjugated natives and ending their being; for in the event of sin in paradise, of course, the expulsion from it was still followed (Smiljanić, 2010: 207).

On Kant's political and ethical views, a clear picture was also made by Copleston (2014), who stated that Kant was prone to republicanism and had sympathy for Americans during their struggle for independence, as well as for the ideals of the French Revolution. Since his spirit was foreign to militarism and chauvinism, "he could not be a thinker whom the Nazis could use for their own ends."

CONCLUSION

The issues raised by Kant three centuries ago are extensive and geographic, and some are still relevant today. Geographers still have so many challenges in their work, although some have been answered by geography scholars such as Hartshorne or Harvey. In anthropology (social geography), questions about race and cosmopolitanism, the relationship between space and time, the interaction of geography and history are still open. Today, other important geographical issues, from human-environmental relations to migrations receiving features of the "migration of peoples" from the Afro-Asian space to Europe. It can be interpreted on a civilizational basis as relations between Islam and Christianity (Huntington) or the political-geographical matrix of "center-periphery" (Fukuyama). Amplifications can be an interaction between the post-historic (money and technology) and the historical world (labor and energy). It can be seen from the preceding that Kant built a world of philosophical concepts and opened perspectives for the emergence of a new scientific discipline. It was a time of "civil twilight" in which Kant, through decades of pedagogical work and redefining the terms of space and cosmopolitanism, clearly limited the world of cosmology and created the preconditions for the emergence of scientific geography.

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FOUCAULT'S GEOGRAPHY: A FRAMEWORK FOR GEOGRAPHY OF THE POSTMODERN AND GENEALOGY OF A WEDDING IN SARAJEVO

Goran Mutabdžija[A]

Abstract

This paper analyzes Foucault's contribution to the development of geographical thinking by emphasizing the elements of his geoepistemology, the philosophical framework for the emergence of the postmodern and the genealogical method. It is essential because of the two issues we will address in this paper. The first refers to more precise definitions of the boundaries of modernity, the end of which some geographers link to the identification of three critical principles for the construction of postmodernism, namely: style, epoch, and method (Dear, 1988); an intensified attack on historicism in modern thought (Soja, 1989); with what is very difficult to define (Cloke et al., 1991) or with the emergence of neoliberalism (Peet, 1998). The second question refers to the indications of genealogical analysis on the example of the political-geographical significance of Sarajevo during the civil war in Bosnia and Herzegovina (1992-1995). To answer these questions, we will start from the geographer's interest in Foucault's geography. Then, based on Foucault's reference works for geography and the mentioned studies, the importance of modern interpretation of space will be highlighted. Thus, the door of genealogical analysis in understanding contemporary historical-geographical political-geographical issues will be opened.

Keywords: Foucault, geoepistemology, modern, genealogy, Sarajevo.

Introduction

Michel Foucault (1926–84) was one of the founders of *French theory*[1] which left an indelible mark on the American academic community and decisively influenced modern trends in social development. Foucault was just one of those most striking thinkers and theorists of science whose works encompass a diverse and wide range of creativity.[2] Not only in the social sciences. He had a broad education.[3] After that, he built a university career worldwide (France, Brazil, Tunisia, Japan, and the USA). Since 1968, he has lived and worked in Paris (Collège de France). His most outstanding merits concern discovering material practices and power relations, which have been applied in philosophy, medicine, and history. That is why he is still widely quoted in papers from various scientific fields. The interest is reflected in the fact that he is essential for developing urban planning and theoretical issues of geography. However, he spoke directly about geography in only one interview for Herodotus magazine.[4]At the same time, the significant opuses of

[1] The title of F. Cusset's book, in which he describes the influence of contemporary French thinkers and social theorists (Foucault, Derrida, Lacan, Bachelard, Deleuze, Guattari, Latour, Lyotard, Baudrillard, Kristeva, Irigaray, Serre, Virilio), on cultural life in the United States, and thus globally, in the 1970s and 1980s.

[2] The most famous bibliographies of his works in 1954-1984 were edited by: J. Lagrange (1994) in French and M. Karskens (2019) in English.

[3] He graduated in philosophy in 1948 and a year later in psychology to defend his doctorate (1961) in social sciences.

[4] *Questions to Michel Foucault about geography*, 2012b.

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contemporary geographers speak best of Foucault's relevance and popularity in geography. The first to recognize it was: P. Claval (1981; 1998), who pointed out the importance of his work on the growing popularity of epistemology and scientific evangelism in his geography, but also emphasized how the imperatives of control are opposed to others, i.e., "when the population is to be brought under control, space must be separated." D. Gregory (1983; 1994) wrote about the significance of Foucault's work for the geography of power, knowledge, and space, while E. Soja (1984; 2013) emphasized Foucault's warning about the emergence of the space age and shaping a distinctly postmodern and critical human geography that boldly reaffirms the interpretive significance of space in the historically privileged prohibitions of contemporary critical thought. During the 1990s, C. Philo (1991) presented his geography as more open to theoretical representations of space, territoriality, and social reproduction, while R. Peet (1998) incorporated poststructuralist studies of his geography into the recognizable book *Modern geographical thought*. During the 2000s, S. Elden (2001) presented Foucault's archeology and genealogy in an excellent mapping of the present. Then, with J. Crampton (2007), he edited the complete collection of geographical works on Foucault. Meusburger, Gregory, and Suarsana edited a book on the geography of knowledge and power (2015), and recognizable encyclopedic reviews of his work were written by M. Huxley (2009) and K. Woodward et al. (2009). The specificity of this is the South Slavic languages because the literature on Foucault, in these languages, was predominantly created by sociologists and other scientists, which speaks of the interdisciplinarity of his subject of study, but also of the lack of interest among geographers.

Foucault and the boundaries of modernity in geography[5]

The question of modernity should be viewed as a social process that moved in a wide arc, within which the historical frameworks in philosophy and geography did not coincide. Pete (1998) emphasizes the historicist elements of the duration of modernity.[6]He sees the fundamental reasons for its emergence in Hegel's teaching (philosophy) and the establishment of the scientific method (geography). Hegel is relevant to modernity as a world-historical process because, after it, there is no longer a single philosophical system, more philosophical directions appear, and philosophy turns to the problems of man and his existential issues. However, of the modern social theorists, the most relevant for us is Habermas[7] (1998: 27-46), based on whose study of modernity this diagram was created, a kind of imaginative interpretation of modernity, within which two parallel currents developed.

In the following diagram, it can be seen that one current went along the "H" line (Hegel, Horkheimer, Habermas), and the other arose as a deviation, mostly of French thinkers, from Hegel's ideas and flowed from Nietzsche through Weber and Heidegger to Foucault, Derrida, and Deleuze. From a geographical point of view, the basis for this is Hegel's (2001) interpretation of space as "dead, fixed, non-dialectical and immovable," found in the *Encyclopedia of Philosophical Sciences*, part two *Philosophy of Nature*, the chapter on mechanics. From these physical properties of na-

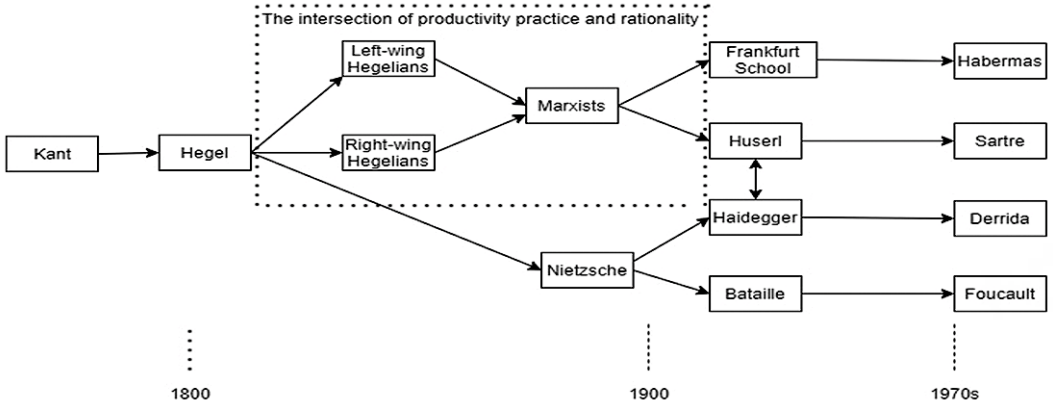

Figure 1. An overview of the main philosophical directions during modernity

[5] See G. Mutabdžija, *Boundaries of Modernity: Geographical Aspect*, 2021.

[6] In philosophy, it is the year of Hegel's death (1831), and in geography, the death of von Humboldt and von Ritter (1859), while the emergence of neoliberalism in the late 1970s marked the end of modernity.

[7] Habermas explained Hegel's notion of modernity in the eponymous (2/12) chapter of the *Philosophical Discourse of Modernity*.

ture (matter, distance, time, motion), Bond (2014: 14) recognizes that time stands in opposition to space as "wealth, fertility, life, dialectic."

This kind of dichotomy in the philosophical interpretation of modernity is best reflected in the confrontation of the views.[8] Of Foucault and Habermas, where Habermas (Eribon, 2005: 191) described Foucault's work as "postmodernism of the neoconservative" who invokes positions in modernity to "establish ruthless antisemitism." In his work, he recognizes the "spontaneous forces of imagination, subjective experience, sensibility," to which they attribute a distant and archaic basis. In a Manichean way, they oppose reason to a principle that can only be invoked, whether it is o the will to power, o the sovereignty of being. or o Dionysian poetic power. "At the same time, Foucault sought to ignore the work of Habermas, and Rabinow, and Dreifus.[9] Sought to devise a way to overcome this doctrinal conflict. For example, individualization and universalism), while postmodernism represents the restoration of unacceptable irrationalism for Habermas.Foucault briefly explained his position by referring to Kant's answer *Was ist Aufklärung*?[10]

> Smaller text, maybe. Nevertheless, it seems that he gradually entered the history of thought into a question to which modern philosophy was not able to answer, nor was it able to resolve it. And here, it has been two centuries since he repeated it, in different forms. From Hegel to Horkheimer or Habermas, through Nietzsche or Max Weber, there is almost no philosophy that, directly or indirectly, has not faced this same question: what, then, is an event called the Aufklärung, which is, to a greater or lesser extent, determined what we are today, what we think and what we do? (Rabinow, 1984: 32-50).

Foucault's interpretation of the boundaries of modernity is not based on the performance of history as a world process (Hegelian approach). Still, he determines them through the theory of power, i.e., social practices that have led to the discipline of the population. Thus, he does not make a theoretical insight into modernity "from the position of trust in civic ideals," but in the book *Supervise and Punish*, he turns to a new range of thematic occupations (poststructuralism), which in geoepistemological terms best reflects the triad "hospital-madhouse-prison." Through this metaphor, Foucault strongly articulated a new political and intellectual interest in the history of the state disciplinary system, which established a new methodological framework for defining modernity. Foucault builds this framework through two synchronous processes that lead to a "disciplinary society" and different expressions of power.[11]. One is shaped through a new spatial expression of power, while the other is characterized by the decline of the power of European monarchies. Because of this, Foucault's work can be considered doubly important, for philosophy (power theory) and geography (spatial turn), with the former determining the origin and the latter the end of modernity. Although this is not the subject of this paper, it should be said that from a geographical point of view, its interpretation of the term space is critical, which for Elden & Crampton (2013: 2) is "a vital part of the battle for control and supervision of individuals, but not as a battle for domination. but as a point of contact between the technologies of power and the technologies of the self[12]." The best example of his view of space (Foucault, 2012a) is given in the short essay *Of Other Spaces*[13]According to Frank (2009: 67), which became one of his most frequently quoted and anthological texts and "can rightly be called the founding text of the spatial turn."

The previous table was also confirmed by Ritzer (2009) in contemporary sociological theory, whose parallels are on Foucault and modernists. It has already been mentioned that geographical thinking indicates ways of thinking within different philosophical traditions. Foucault is specific because he created on the border of different epochs (modern and postmodern). He is mainly responsible for this discontinuity. However, for Soja (2013: 26-31), he was a "postmodern geographer in its entirety," from his first to his last work, who explored the "fateful intersection of time and space" and who was inspired by an emerging "postmodern perspective." historicist and postmodern critical human geography. "

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[8] One of their few meetings was on the occasion of Habermas' visit to the Collège de France (1983), about which D. Eribon (1994) writes.

[9] It was an invitation to Foucault and Habermas to participate in a seminar on modernism held at the University of Berkeley in the fall of 1984. Still, during the summer of that year, Foucault passed away.

[10] The Berlinische Monatschrift (1784) posed this question and, as particularly important, published the answers of Mendelson and then Kant, who described the Aufklärung as a process by which we abandon "minors." Under this term, he understands a particular state of our will that forces us to accept someone else's authority to use the mind and gives three examples. First, we are in a state of infancy when the book substitutes reason, our spiritual leader covers conscience, and the doctor prescribes diet.

[11] Establishment of institutions for treatment (hospital and insane asylum) and control of persons (prison).

[12] See G. Mutabdzija, Foucault's geoepistemology: space, heterotopy and archeology, 2021.

[13] Although the essay Of Other Spaces was presented in Tunisia in 1967, it became publicly available until 1986.

Table 1. Elements of grand theories of social development in modernism and Foucault

Grand Theory	Home	Development	Social History
Modernists	Seek the source (beginning) of social development. Finding the source means finding the answer.	Emphasis on coherence. How do things stick together over time?	He saw in everything: continuity, development, and progress.
Foucault	Describes and analyzes social reality in different epochs. It is not possible to find an answer, but it is essential to ask questions.	There is no coherence. What are these internal contradictions that exist at all times?	Discontinuity, turning points, and surprises. There is no uniform, consistent and one-way movement. History is moving in all directions, up, down, left, right, even forward.

Based on: Ritzer, 2009: 344.

Genealogy of geography

Foucault borrowed the term genealogy from Friedrich Nietzsche (*Genealogy of Morality*), with which he achieved a new methodological step forward, and he marked genealogy as the history of the locality. It is a kind of counterbalance to the Hegelian interpretation of world history, which begins the chapter Geographical Basis of World History with the aspiration to totalize historical consciousness as a world-historical process.

> These natural differences must, above all, be regarded as exceptional possibilities from which the spirit springs; in this way, they represent the geographical basis. But, of course, we do not care to get acquainted with the soil as an external place. Still, we care about getting acquainted with the natural type of locality, closely connected to the kind and character of the people who originated on such soil. That character is precisely how nations appear in world history and occupy a position and a place in it. - Nature should neither be overestimated nor underestimated; the mild Ionic sky has undoubtedly contributed much to the grace of Homer's poems, but it alone cannot produce Homer, nor does it always produce them; poets did not appear under Turkish rule (Hegel, 2006: 96).

In an essay entitled *Nietzsche, Genealogy, History,* Foucault demonstrates the power of what he sees as Nietzsche's genealogical method, a "multidisciplinary technique for discovering contingent historical trends that support contemporary discourse and practices of power." That is why he states that, unlike the Hegelian sun of world history, "genealogy is gray; it is petty and patiently documentary. "Foucault (2012b: 90) simply emphasizes the difference between archeology and genealogy: "In two words: perhaps it could be said that archeology would be a method inherent in the analysis of local discursive practices, and genealogy a tactic that, based on the described local discursive practices, into play introduces the liberating knowledge that results from them. And to establish the project as a whole. "Therefore, for him, the goal of genealogy is to understand the "history of the present" independently of the known historical narratives and political ideologies that represented the past. Huxley (2009: 255) sees genealogy as "a method for discovering power exercises, which are involved in setting up certain regimes of truth and valorizing subordinate knowledge." Thus Foucault's methodological turn towards genealogy is expressed in the book *Supervise and Punish* (1997), which became one of his most famous books. He defines modernity as a disciplinary society shaped by new forms of power. His interest in the genealogical history of the present inspired Foucault to the next series, a trilogy of the history of sexuality, which, despite its differences, "consistently uses Nietzsche's deconstruction of the origins of the Western soul and submissive regimes of truth, ethics, and identity."

Dreyfus and Rabinow (1982: 119) emphasize that the genealogy of knowledge consists of two different corpora: first, from other opinions and theories that have not been established or widely recognized, and, second, from local beliefs and understandings. It seeks to discover these two kinds of knowledge and their struggle to pass them on to others while not claiming to be more accurate than institutionalized knowledge. It represents only the missing part of the puzzle, and it works by isolating the main features of some current political mechanisms and then following them to their historical roots. These historical roots are available to us only thanks to these described corpora of knowledge. That is why Foucault (2012b: 90) defines genealogy as a kind of endeavor with the aim of "breaking the yoke of historical knowledge and becoming free" and becoming a cadre for "opposing and fighting against the coercion of unitary, formal and scientific theoretical discourse." That is why local knowledge contrary to the "scientific hierarchy of cognition and the internal effects of power" is essential to him.

Unlike the method of archeology, which is neither formalizing nor interpretive, genealogy is an interpretive, analytical method which, according to Pete (1998), is "opposed to traditional historical methods of research." It does not seek to recognize a fixed essence or internal laws. Still, it seeks "discontinuities, avoiding in-depth searches and recording the past to undermine the notion of a modern march of progress." As in the previous case, to better understand it, it is necessary to clarify the essential concepts that arise from discursive practices (power, knowledge, and body) and which essentially determine genealogy as a method.

The genealogist finds hidden meanings, sublime truth, and depth of consciousness, which are equally false: instead, the genealogical truth is that things have no essence. In archeology, Foucault sought a space in which we encounter objects and talk about them based on rules regulated by the system. In genealogy, this field is considered a space where social practices occur when subjects engage in a repetitive domination game. History is not the progress of universal achievement, but humanity is moving from one authority to another. Exploring the order of knowledge, as the order of the new discursive practice of the time, Foucault distances his genealogical approach to learning from the history of science:

> What distinguishes what we might call the history of science from the genealogy of knowledge is that the history of science is essentially placed on one axis, which is, in general, the axis of knowledge-truth, or, in any case, the axis that goes from the structure of knowledge to demands the truth. In contrast to the history of science, the genealogy of knowledge is placed on another axis, the axis of discourse - power or, if I may say so, the axis of discursive practice - confrontation with power (Foucault, 1998: 217-218)

In *History of Sexuality I*, Foucault argues that modern "bio-power emerged in the seventeenth century as a coherent political technology, when the stimulation of life, and the growth and care of the population, became the main challenges of the state." created modern human sciences, which were still associated with bio-power technologies. Their goal was to produce an obedient but productive body (bodies in advance) and, not as a consequence, capitalism (Dreyfus and Rabinov, 1983). Foucault's (2012b: 83-112) 1976 lectures emphasize particular aspects of genealogy interesting to geography. First, he favors autonomous, decentralized theoretical production whose correctness does not depend on the approval of established regimes of thought. Second, of subdued knowledge, he means blocks of historical knowledge disguised as functionalist and systematization theory, which usually disqualifies knowledge as inadequate, naive, below the required level of science. Third, by reviving the history of struggle and through that subdued knowledge, Foucault thinks critical discourse can reveal a new essential power. In this sense, genealogy deals with the detailed rediscovery of efforts, reconstructions that would not be possible unless the tyranny of globalizing discourse is eliminated. It is a methodological discourse that Foucault believes in and which genealogy of power he should follow.

Based on this, we can try to deconstruct the imposed political-geographical discourse on the civil war in Sarajevo.[14], which starts from the "fact" that there were Serbs in Sarajevo and Bosnia and Herzegovina in 1992-95. carried out an "ethnic cleansing" of Muslims (Dahlman & Toal, 2005: 644)[15]Which neglects the number and structure of the population (before and after the war) as a basic geographical fact. In doing so, they draw their conclusions based on indicators for two smaller inland cities (Zvornik and Jajce) and neglect the state capital, with the most significant demographic, economic and political significance. This kind of interpretation of geographical data is a typical example of a selective approach to facts, which should deconstruct and recognize all discontinuities in these statements, which means rejecting the imposed "truths" and returning to Foucault's local knowledge. The best basis for beginning the deconstruction of such approaches is to present the geographical facts about the number and national structure of the population of Sarajevo before and after the war.

As a supplement to the previous table, it should be said that 13,9% of Bosniaks live in the Republic of Srpska (according to the 2013 census), and only 2,5% of Serbs in the territory of the other entity (Federation of Bosnia and Herzegovina). Since the aim of this paper is not a detailed political-geographical analysis of the civil war in Sarajevo, nor its consequences, but a "rebellion of conquered knowledge" that leads us to discover the hidden truth, we will dwell on these indications as a guide to the complete application of genealogical analysis in modern political-geographical problems.

[14] This civil war began with the murder of a Serb wedding party in Sarajevo in 1992 and ended with an international conference in Dayton (USA) in 1995.

[15] The authors mention the term ethnic cleansing on eighteen occasions, although many facts were not known at that time (2005), not to mention impartial historical studies and judgments of relevant courts.

Table 2. Ethnic structure of the population of Sarajevo 1991-2013.

Year	Total		Serbs		Muslim/Bosniacs		Croats		Other	
	No.	%	No.	%	No.	%	No.	%	No.	%
1991	527.049	100	157.143	29,8	259.470	49,2	34.873	6,6	75.563	14,3
2013	413.593	100	13.300	3,2	346.575	83,8	17.520	4,2	36.198	8,7

Source: Agency for Statistics of Bosnia and Herzegovina, https://bhas.gov.ba

Conclusion

Foucault's geography proves to be a powerful methodological instrument that leads us to a more precise determination of the boundaries of modernity in geography, which are determined by understanding and defining the essential disciplinary subject of study - space. Foucault's departure from the Hegelian approach to interpreting space as "dead, fixed, non-dialectical, and immovable" enabled what Lefebvre would call the production of space (relational space), which Harvey and Soja would translate into the world of geography. Also, Foucault's genealogical analysis becomes challenging only today and very demanding. In the time of "fasting truth" and fluid understanding of justice, it leads us to search for that discontinuity and hidden truths.

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REAL WORLD ISSUES IN ENGLISH LANGUAGE LEARNING FOR GEOSCIENCES

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Abstract

Teaching English for Specific Purposes (ESP) at the university level has made a shift towards covering real world issues. Technology enhanced ESP brings forth interactive learning within the classroom. This paper aims to present a more learner-centred approach in language teaching and learning at the tertiary level. Such a model integrates discipline-specific needs within separate topic modules: student life, careers in geosciences, scientific research, popular science, etc. The teaching materials meet the language needs for a career in geosciences retaining teaching segments of academic language skills: reading, writing, listening, speaking, presentation skills, pronunciation and grammar which are practised around proposed topics. Students are also taught to acquire a system of knowledge for adequate communication skills, reading, receiving and sending information in the English language that is connected with their main activities in pursuing geography studies and future careers.

Keywords: ESP, interactive learning, geoscience, academic language skills

INTRODUCTION

This paper promotes a learner-centred approach in teaching English for Specific Purposes (ESP) at the university level. We propose a teaching strategy based on technology-enhanced ESP instruction for language skill enhancement, taking discipline-specific needs on the one hand, and separate topic modules (student life, careers in geosciences, scientific research, popular science, etc.) on the other, as fundamental issues to this purpose. This prompts a somewhat different definition of the traditional concept assumed in a foreign language classroom. This study aims to take a step further from various related traditional approaches and to explore the relation between general and discipline-specific language competency, which we believe to be essential to a successful outcome of a learning process for university-level students.

We are especially interested in the above-mentioned competencies and sub-competencies as they include the capacity to understand and analyse a range of different types of oral and/or written texts from different fields produced in various languages; to develop the capacity to produce different types of texts from different professional fields; to ensure that the characteristics and conventions of the major text genres and sub-genres used in professional textual production and translation/localization are adequately applied in the distinct cultures in which source and target languages are used (Milivojević, Radojičić 2015).

THEORETICAL BACKGROUND

The acquisition of all language skills is a gradual step by step process which is strongly influenced by the degree of complexity of the material, texts, textual structure and mechanics and textual genres that students are faced with. The greater complexity of the text re-

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quires a higher level of textual, translation and/or intercultural competence of the students.

English for Specific purposes is closely connected to a task or project-oriented context. Students are offered English for Specific Purposes (ESP) courses because of the necessity to fulfil tasks by using the language, such as writing a CV, letter of motivation, or email, as well as presenting and discussing various discipline-specific topics. (Bracaj, 2014, p. 42). In this view, students' needs are observed as essential for their potential success in the course and further in their studies and professional context that all decisions related to content and method are based on the learner's reason to learn the language (Hutchinson and Waters, 1992, p. 19).

Language is a dynamic system and as such, it evolves historically (in time), geographically (in space) and socially (in stratification) (Grygiel 2015, p. 77). This social aspect of language evolves within socially driven mechanisms, e.g., professional language communication. Considering the professional context, it is highly important to achieve clarity and conciseness of statements. Also, the presenting forms are different from those in everyday life. Therefore, the softs skills (life skills or employability skills) that students already possess need to be shaped, upgraded and reshaped through ESP language instruction methods.

HYBRID AND MULTIDIMENSIONAL ESP PEDAGOGY

Intending to avoid overuse or underuse of traditional practices, integration of content and soft skills in equal measure in ESP for Geosciences seems appropriate to prepare students both for the content, task and project-based learning, for interculturalism and socialisation as well as for the rules of discourse and academic style (Brinton et al., 1992). To fulfil all the aforementioned segments, an innovative ESP curriculum "is designed to simulate the demands of regular courses and to offer systematic and scaffolded language and content learning support" (Flowerdew & Peacock 2001, p. 217). Such a curriculum offers thematic units that accompany and support the core language skills with the addition of soft skills that are developed combining the core course consisting of thematic modules and underpinning courses practising other essential skills (Stoller, 1999).

Therefore, a form of a Hybrid Multidimensional Curriculum (HMC)[1] is suggested to meet the basic prerequisites for successful language learning: the real and intense language contact, the opportunity to use language in its truest sense, the use of learning motivation, and the focus on the language forms.

Three distinctive features explain the category of hybrid learning. The first one is time (when), which can be synchronous ("real-time") or asynchronous (sequential) or it can have a mixture of both. The second is space (where), which can be in person (face-to-face) or can be remote (different physical locations). The third one is interaction (how), which can be defined as the *direction of the communication* (one-way; bi-directional or multi-directional) or *type of engagement*, ranging from no-participation (learning alone without interaction with others), limited participation (interaction is limited, structured or controlled) and high participation (active and dynamic exchange). The teaching and learning processes flow from a variety of activities, such as observation, discussion, asking questions, searching for information, trials and errors, and reflection.

The suggested approach to this ESP for Geosciences HMC is proposing teaching materials referring to topics from one content area, in this particular case geosciences. The course is organized around several carefully structured thematic modules, which normally run 15 weeks or approximately 45 hours. Thematic modules (Physical Geography, Hydrology, Environmental Geography, Climatology, Demography, History of Geography, Political Geography, Archaeology, Tourism/Medical Geography, Research in Geosciences) are selected in response to students' general interests or intended academic majors. The selected thematic modules are either general or more specific but they could be further portrayed by a set of subtopics (focus is on instruction within a theme) according to specific notions, functions, situations, language skills and grammatical patterns. Thus, the thematic unit on demography, for instance, might focus on several different subtopics: the impact of population on the environment, population trends in developing countries, population migrations, etc. The selection of topics is often the result of text selection (defined broadly as the content originating from readings, videos, graphics, core subjects lectures, field trips) which is important for curricular consistency. By following the task instructions, students explore thematic content and practice language skills, as well as academic skills that emerge naturally from the content materials. The use of academic tasks rather than academic content is perceived as the facilitator for more successful curricu-

[1] The idea of Hybrid Multidimensional Curriculum emerged from the Hybrid Curriculum for EAP students suggested by Stroller, 1999

lum design (Carson, et al., 1997). Through further exploration of the topics concurrent to core subjects for Majors in Geosciences, practising integrated language skills, academic skills, students also prepare themselves for the content-learning demands of the main courses.

Such complex and wide-ranging thematic structure material is actually preparing the students for self-directed lifelong learning which is widely accepted as an important educational goal (Bolhuis, 2003). Thematic units are authentic, extracted from scientific-popular magazines, scientific journals, educational videos and podcasts adapted for language learning purposes. Although the challenge is perceived as a fundamental issue, self-directed learning engages both students and teachers, who are learning as well. Teachers need to put in additional effort to become familiar with the course content and then properly scaffold it and present it to the students. At this point, a specialist from the core discipline would be an ideal resource for various suggestions about authentic resources, pertinent to the needs and abilities of foreign language learners. Here the process of teaching is also viewed as a social practice.

Through the ESP instruction, the teachers need to prepare their students to meet the expectations both of the academia, and their own as future researchers and professionals in the field of geosciences. The role of ESP instructors is to provide them with the best, state-of-the-art pedagogically effective methods to help them achieve their academic success by using a hybrid multidimensional curriculum.

Figure 1. Sample model of a hybrid multidimensional curriculum – core course with underpinning courses (adapted from Stoller's Hybrid curriculum from EAP)

A hybrid multidimensional curriculum that combines content, task and project-based activities that also reinforce soft skills instruction, is a very effective way of helping students achieve academic success and acquire skills needed for their future job. Teaching ESP courses nowadays includes famous 4C concepts: communication, collaboration, critical thinking and creativity. Within the hybrid multidimensional curriculum students' learning becomes more meaningful, their understanding much better, since it mirrors real-life issues.

Underpinning short courses

The underpinning or supportive courses that make up the rest of the HMC are designed to reinforce the skills and strategies introduced in the core course. Such courses add multidimensional features providing curricular support. Their design and selection depend on particular student needs. What follows is a description of seven underpinning courses, designed for B1 and B2 level ESP students.

Writing Lab addresses students' writing needs through small-group tutorials. Instruction can be tailored to meet students' fluency and accuracy writing needs. In writing tutorials, students work on major writing assignments such as abstract and summary writing.

Intercultural communication focuses on speaking and listening skills development as well as cultural adaptation and understanding. These activities are usually structured around pair work and small-group discussion. An unconventional dimension can be added to intercultural communication by inviting foreign exchange students, ideally, proficient speakers of the target language, to participate in the course.

IELTS/TOEFL test preparation emphasizes test-taking strategies, English grammar, vocabulary development, reading and listening comprehension applicable to IELTS or TOEFL as well as other testing and learning situations. This broadened focus leads students beyond their possible misconceptions of what testing and learning are all about.

Video Lab is designed to expose students to varieties of spoken English and help them improve their listening activities, encourage content learning and natural language use as well as language skills development (Stoller, 1999).

Reading Lab reinforces reading skills and helps students become more strategic readers. The reading lab may combine silent reading with teacher-guided instruction, individualized reading that allows students

to work at their own pace and with texts from their own academic disciplines and out-of-class reading material for pleasure.

Real-Life Issues. The overall goal of this short course is to simulate real-life situations to prepare students to respond effectively to different situations in their future professional careers. This is a natural-growth approach, which aims to immerse students in real-life communication without any artificial preselection or arrangement of items.

Self-directed Learning & Assessment. This short course is conducted as a small-scale self-directed learning project, first assessing self-directed learning readiness and then aiming at developing skills and strategies for lifelong learning.

INSTRUCTION METHODOLOGIES IN ESP HMC

The importance of soft skills can be observed in both the university and professional contexts, which further proves the validity of the statement that their development goes along with self-directed lifelong learning principles and should be initiated at the university level. However, there is a misconception that students who enrol at university have already equipped themselves with the necessary tools to navigate through all post-secondary academic and professional challenges.

Such notion has been addressed by Chamorro–Premuzic et al. (2010, p. 221) who emphasize that "unlike academic or disciplinary knowledge, which is subject-based, content-specific and formally assessed soft skills comprise a range of competencies that are independent of, albeit often developed by, formal curricula and rarely assessed explicitly". There are presents arguments for the importance of soft skills in the context of higher education and in favour of integrating them into the curriculum of the ESP classroom since the field is relatively young but dynamically responding to the requirements of the professional job market.

ESP soft skills-oriented instruction not only develops the tools needed to achieve the main goal of the course, but also the instruments needed to measure the outcomes or results. The main aims of the soft skills instruction-oriented ESP course are the following:

a) communication skills and strategies needed at the workplace by using ESP in the geosciences field,
b) ESP in simulated situations (problem-solving, decision making, recalling real situations in the workplace),
c) next to natural reactions to real-life situations, teamwork encouragement,
d) individual motivation to learn ESP fostered by real usage of the language in a professional environment.

According to Price (2015), the methods and strategies we proclaim in this soft skills-oriented part of the curriculum include various aspects of real-life situations such as:

1. Professional environment communication issues: introducing checklists to monitor the progress of students, tracking test scores to encourage self-assessment, concentrating on defining "added value" after each class.
2. Presentations: preparation of professional PowerPoint presentations, preparing and evaluating oral speeches accompanying prepared presentations.
3. Teamwork: giving tasks encouraging cooperation and teamwork, reflecting on a cooperative model of working, clearly defining responsibility.
4. Oral communication: using specific language in a professional context, extending specific vocabulary, organizing professional conversations, negotiating and role-play
5. Listening: exercising active listening in conversations referring to the working environment, playing original interviews, news, reports specific to the chosen field, summarizing the most important issues mentioned in the audio, listening for detail, categorizing clue information.
6. Written communication: writing different genres typical for the working milieu, like emails, paragraphs, reports, etc., summarizing and synthesizing professional texts in written form, characterizing the lexical and syntactic structure of specific texts, preparing lists of specific terminology for the particular field.
7. Problem-solving: introducing problem-solving activities simulating real situations from a work environment, role-playing

In addition, there are common areas of interest between soft skills and ESP: communication skills, negotiating, presenting, public speaking, active listening, decision-making and problem-solving. Hand in hand with the application of soft skills in an ESP course, there is the need for developing specific methods and instruments to support cooperation within all three fields involved– ESP teaching, soft skills training and content-based learning.

HANDS-ON LANGUAGE TEACHING, SOFT SKILLS AND PROJECT-BASED LEARNING

Teaching ESP courses at the university level is aimed at developing the skills of professional communication, depending on the area of the student's professional expertise. It means that such teaching should be inextricably connected to the student's particular specialisation. (Milivojević, Radojičić 2015:116)

This new approach is student-centred. Students are exposed to a wide variety of language use and not just to grammar points. Most of the time the students are put into authentic communicative situations in which they are allowed to use all their language resources to deal with the situation. If the teachers are aware of students' needs, they would certainly encourage their students to take some responsibility for their own learning. Primarily, the students may start with sharing ideas, collaborating and communicating. Often, they involve multidisciplinary skills borrowed from other subjects which promotes higher-order thinking and authentic use of modern technology. In this respect, students and teachers adopt their new roles.

For a good and important start in combining all three aspects of the ESP classroom (language teaching, soft skills and project-based learning), it would be useful to establish cooperation with representatives of the professional field (for example, in-service graduates) or experts willing to share their experience. This opens new perspectives for interdisciplinary project-based language learning and provides better insight into the demands of professional life in the field of geosciences. At this point, there is a need for materials that combine subject-oriented issues and the training of soft skills. However, these require a high workload from the teachers, as well as constant updates of the subject content knowledge, which can be supported by the implementation of case-oriented teaching. Case-oriented teaching is using authentic, real-life issues based on real-life situations in the geosciences field. Implementation of real-life issues may be conducted by the development of problem-solving strategies and negotiation skills needed to convince other group members to agree on the presented option or solution. One possible method of implementation is the use of authentic cases, based on real situations, and the encouragement of the development of problem-solving strategies and the argumentation and negotiation skills necessary to convince the rest of the group to choose the presented option. An additional part of soft skills development would be delivering public speeches on current topics in the field. Similar to presentations, it requires a system of assessment and feedback.

The introduction of new topics or skills requires the learning of background information, facts, and procedures that are best conducted with the involvement of the entire group. In this case, the ESP instructor plays an active role in the teaching process to elicit student interest and to establish content relevance for target concepts and skills that will later serve as primary knowledge for subsequent real-life issues in the laboratory or workplace. In addition to carefully articulated explanations, the teacher facilitates interactions with and among students via questioning and reviewing techniques. Direct teaching techniques are also used for demonstrating how things work, including rules and procedures to set the context for skills application in the laboratory or workshop. Further, direct instructional strategies help create student interest in a topic and address the eternal student question: "why do I have to learn this?" In this case, background information should be mixed with relevant facts and applied to real-world situations.

Moreover, written short and long forms, such as abstracts, summaries or scientific popular short articles need to be introduced with the special attention paid to argumentation strategies among which discourse markers, especially hedging and boosting strategies in presenting claims to the relevant audience. These are only suggestions that need to be further analysed.

In this respect, the soft skills of students attending ESP courses can be understood as their ability to handle strategies for implementing foreign language and subject content knowledge in a professional environment, in order to successfully master their professional tasks.

CONCLUSION

Students play an important part in ESP instruction but seem to be constantly under pressure to meet the academic requirements as well as the challenges in their professional careers later on. Therefore, ESP instructors or researchers must do their part to ensure the students are provided with the state-of-the-art, most effective pedagogical methods to help them in their academic success. Using the presented HMC model, which is a contemporary curriculum that combines a content-based course with underpinning courses that reinforce skills instruction, is one of the effective ways of helping them meet the

expectations and challenges on their academic and professional journey.

To conclude, raising general awareness of HMC complexity which is observable through various elements leads to higher language competencies in ESP students and thus to their higher academic and professional productivity. Such an approach that integrates real-life issues and soft skills into teaching core language skills improves the strategies of implementation of language information leading to the desired capacity for critical thinking, professional aspirations and also culture mediating.

We believe that this highly flexible framework for the ESP course for Geosciences proposed in the paper can be useful not only for developing language skills of students in ESP courses and enhancing their language competence but also in their stronger commitment to academic content-learning needs and the development of real-life professional skills used by students as future researchers, and/or mediators in their prospective professional practice.

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IMPLEMENTATION OF GEOGRAPHY CURRICULA TO ONLINE HOME EDUCATION OF FOREIGN STUDENTS

Stefan Stajić[A]

Abstract

This article aims to show the interest and the significance of geographical curriculum as part of homeschooling in which digital technologies have made a profound impact. Views of the parents and students on this topic are of remarkable importance for this paper, so the survey was used as an instrument. The research was conducted by an online survey on geography topics that students or their parents are interested in. Based on the outcomes of the discussion, it will be considered whether or not foreign students who are enrolled in elementary school, secondary school or university need geography teachers from Serbia.

Keywords: online homeschooling, geography curricula, education, survey

Introduction

The invention of the World Wide Web in 1992 made online education increasingly accessible and allowed new pedagogical models to emerge. Because the Web is easy to use and capable of presenting multimedia, it expanded the range of disciplines that could be offered online (Harasim, 2000). One of those disciplines is geography. The Internet represents the latest in technological advancements that continue to have important effects on geography curricula and instruction. Many geographers are involved with Internet-based instruction, which some educators believe has the potential to facilitate changes in how we teach and even what we teach (Hill, Solent, 1999).

MacDonald (2008) highlighted that distance technologies have opened up new potential in higher education and other forms, and the literature is full of enthusiastic predictions. For example, networks offer scope for new ways to access and combine information using the limitless resources of the Web. Distance education students, or those separated from their peers for other reasons, no longer need to work in isolation but can join other learners in an electronically supported community. These developments offer the possibilities to develop greater self-direction in learners and to move away from teacher-directed approaches to teaching and learning.

In many ways, learning and teaching in an online environment are much like teaching and learning in any other formal educational context: learners needs are assessed, content is negotiated or prescribed, learning activities are orchestrated, and learning is assessed. The pervasive effect of the online medium, however, creates a unique environment for teaching and learning. The most compelling feature of this context is the capacity for shifting the time and place of the educational interaction. Next comes the ability to support content encapsulated in many formats, including multimedia, immersive environments, video, and text, which gives access to learning content that exploits all media attributes. Moreover, that capacity of the Net to access huge repositories of content on every conceivable subject – including content created by teacher and fellow students – creates learning and study resources, previously available only in the largest research libraries, accessible in almost every home and workplace. Finally, the capacity to support human and machine interaction in a variety of formats (i.e., text, speech, video, and so on), in both asynchro-

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nous and synchronous modalities, creates a communication-rich learning context (Anderson, 2008).

The role and place of geography education vary from country to country. One of the questions that will be discussed in this article is if the geography curricula that graduated students gained at any university in Serbia is sufficient for the online home education of foreign students. For graduated students of geography, it is not only sufficient to know complete science but also languages, in most cases English. As Wong (2009) stated, the issue of learners' preference of native English teacher and non-native English teacher has become a popular topic in the field of teaching foreign languages and other sciences. It is not uncommon to hear English students express that they prefer being taught by a native speaker, whether or not they are qualified in teaching English or some other subject as a second language or English as a foreign language, so that is one of the topics that will be discussed in this article. Because of different geography curricula all around the world, another question that needs to be asked is who is attracted to online geography learning. As Palloff and Pratt (2003) stated, online students may be non-traditional undergraduate, graduate, or continuing education students.

Criticism and geography content suitable for online home education

By this time, geography is misunderstood and mistold by the geographer and this leads to many problems. Because the science of geography is not a useless mass of knowledge, not encyclopaedic knowledge to memorize, not teaching or memorizing geographical knowledge of certain areas. In this way geography became charmless. Geography is a science of comment and synthesis. To reach its aim geography teaching must be given appropriate teaching methods. Otherwise, geography is introduced as a science that is different from real, false, useless and unnecessary science-cancel science (Sahin, 2003). One of those methods is learning geography online. For some geography educators, online learning cannot convey the essence of being a geographer. Gober (1998) cautioned that conducting online courses, even portions of a course, `threatens the essence of what it means to be a geographer, particularly the `connection with real, live places`. Di Base (2000) countered that geography educators have a moral obligation to offer distance education, especially to a non-traditional student. DiBase correctly identified the challenge for geography educators, that being whether to accept a `Faustian bargain` to sacrifice the connections to real places to reach students desiring an education uninhibited by time and distance. Over the last decade, many geography educators have accepted this bargain, yet challenges remain (Ritter, 2012).

As computers and silicon chips have become more capable and less expensive, geographic information systems (GIS), global positioning satellite (GPS) receivers, and remotely sensed images of Earth from aeroplanes and satellites have become accessible to geography students and faculty at all levels. These technologies are key research and communication tools for geographers and have significantly increased interest in geography among everyone (Bernardz, et al., 2006). One of the geography content that is suitable for online home education is GIS. GIS represents an effective tool for teaching the understanding of space and place. GIS finds application in various fields from natural science and geology to sociology and anthropology, from political sciences, economics and urban studies to archaeology and history. The use of this tool enables the introduction of research methods in geography teaching (Demirci, 2009). Another geography content suitable for online geography teaching is physical geography. Most physical geography topics can be presented to students online but some researchers do not agree with that completely. The needs of those taking the course or help for general education are not necessarily the same as a geography major. For example, fieldwork is an essential part of every geographer training, especially a physical geographer, but not necessarily for general education student of any age (Vecchis, 2014). For searching help of geography teachers students especially young ones who are enrolled in Early childhood Education or Early Elementary Education are interested in content suitable for their age and it is about maps, flags of countries in the world, which is part of Regional geography. Also, geography teachers can play with children online geography games such as Seterra (easily the best resource for memorizing countries, cities, flags etc.), exploring the world with Geoguessr etc. or singing geography songs for helping them memorizing the continents, oceans, planets etc.

The most famous websites where geography teachers can find students to teach are Chegg and Preply. Preply is a service that helps you find local and online tutors. Preply is an online marketplace for searching tutors or placing a request on finding a specialist in a foreign language or other sciences for a hobby, school curricula and even business. On the platform, you can choose not only a local teacher as a tutor but also teachers from other countries (Zhuk, 2016). Chegg is

the leading online student resource website that specializes in books, test prep, and homework help. Its products are considered to be split into two groups: Required Materials and Chegg Services. Chegg Services include Chegg Study, Chegg Tutors, Test Prep and Chegg Writing Tools (2018).

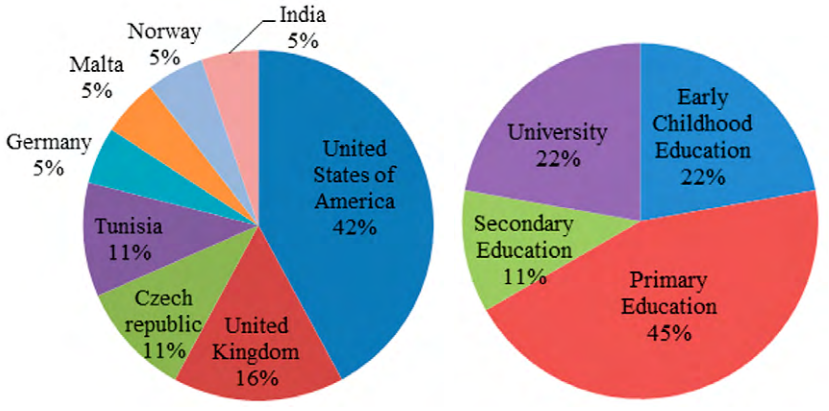
Research Methodology

The online survey of students of geography was used for this research. The survey consisted of four parts comprised of 19 statements/questions to obtain data. The first part (5 statements) collected demographic data about age, gender, country of origin, city, town or village student lives in and at what educational stage are students enrolled. The second part contained statements/questions about where did students or their parents find out about online geography lessons, what internet site did they use and what level of English do they think is sufficient for a teacher in order to be able to teach geography online. The third part of the survey used statements/questions about what branch of geography they needed help with, what topic of geography students were the most interested in, what did the students find to be the most difficult about online geography lessons, what was the easiest thing and what was their least favourite topic. Also, for the third part of the survey Likert scale-a scale of attitudes was used, consisting of five statements. It was given to the students to express the level of their agreement or disagreement with each statement, using the five-level scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree) (Likert, 1932). Students were asked how difficult do they find geography lessons, do they understand online geography lessons and how much they enjoy the lessons. The fourth part of the survey also used the Likert scale in terms of how much time students spend online and taking geography online lessons per week. After that they were asked if learning geography is the same in the class and at home on the internet, whether foreign teachers can help students, how do teachers prepare and how much of the syllabus do teachers cover. Also, statements/questions were used for the fourth part to see what students like and how geography lessons online could be improved. The content of the survey is genuine and was not designed according to the model of any previous research survey about the implementation of geography curricula to online home education of foreign students. During the processing of the survey, the software package MS Office Excel and online Goggle form were used for computing the mean and percentage values.

Results and Discussion

The research included 19 students and in the largest group, the respondents were aged 10-20, which counts 42.1% of the total. It was followed by the group aged 1-10 (36.8%) and the smallest participation had the group aged 20-30 (21.1%). According to the gender structure, the vast majority were male students (68.4%). Female students were present in 31.6%. One of the purposes of this paper was to see which countries of the world need geography teachers from Serbia. Research showed that most participants came from countries where English is a native language. The highest percentage (42.1%) of students were from The United States of America (from the following cities: Portland, Phoenix, New York, Los Angeles, San Diego and Victorville) and the United Kingdom (15.7%) stationed in London. It was followed by students from Tunisia (10.5%) and the Czech Republic (10.5%) and the smallest portion of students were from Germany (5.3%), Malta (5.3%), Norway (5.3%) and India (5.3%). The educational stage at which students are enrolled was yet another parameter that was observed in the research. Primary education had the highest proportion in the educational structure with 38.9%, followed by Early childhood education and University with 22.2% each. Students enrolled in Secondary education needed the least help from geography teachers (11.1%) (Figures 1 and 2).

Half of the students found out about online geography lessons from a friend, family member etc. Most of the students who are enrolled in Early childhood education or Primary education were helped to find and contact geography teachers by their parents or grandparents. The least number of students who are or were enrolled at University education wanted help from geography teachers because they had difficulties adopting knowledge from teachers in the classroom. As it has already been mentioned, the most famous sites where students or their parents could find a geography teacher are Preply (89.5%) and Chegg site (10.5%). When asked what level of English is sufficient to teach geography online, 57.9% of students or their parents said that the Advanced level of English is sufficient to teach geography online, following Intermediate (21.1%) and Proficient level (15.8%). Most of the stu-



Figures 1 and 2. Country of origin and educational stage of students

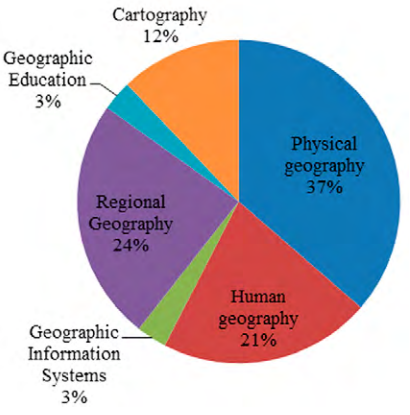


Figure 3. Graphical view of Geography branches students needed the most help

dents said that foreign teachers can help them or their children learn geography (88.9%). At the end of this part, students told that 84.2% of geography curricula was covered by online geography teachers.

Out of all branches of geography, students said that they needed help relating to Physical geography (37%), following Regional geography (24%) and Human geography (21%). The smallest percentage of students needed help relating Cartography (12%), Geographic Information Systems (3%) and Geographic Education (3%) (Figure 3). Research showed that the highest interest is in the following topics of geography: Tornadoes, Climate Change, Biogeography, Planets in the Solar System, landforms, countries of the world and demographic changes. Biogeography was the topic in which the students were the most interested (11,1%), as it was expected because of the educational structure of the students. Also, the least favourite topics for the students were pedology, migrations, tectonic plates and writing essays which is mandatory in some countries.

For many teachers as well as students, being a part of an online learning community is a new experience. Newcomers face particular difficulties: some are new to study, some are new to this method of teaching, some are tentative about embarking upon a new endeavour and some are very nervous about their capacity to succeed (Hare, 2011). Students who participated in this research agreed that having online lessons is a new experience, that you can learn in any place where you have access to the internet, and that there is a greater possibility to contact the teacher whenever students want. If something is not clear it is clarified immediately. Finally, the students can choose something that they are passionate and knowledgeable about and some of them said that geography lessons are making them nervous at the beginning but most of them enjoy and understand (94.7%) them. Also, 52.6% of students said that learning geography is the same in the class and at home on the internet. Some of the difficulties that students mentioned are weak connection, coordinating time with a teacher who lives in a different time zone, being in front of a computer, etc.

It is found that the more time people spend using the internet, the more they lose contact with their social environment. This effect is noticeable even with just 2–5 internet hours per week, and it rises substantially for those spending more than 10 hours per week (Horman, Erbring, 2002). Students who participated in this survey are spending 1-2 hours per week exploring the internet (31.5%). Most students need help with geography once or twice a week 63.2%, following students who need help 4-6 hours (21.1%) and 2-4 hours (15.8%).

Just like face-to-face courses, online and hybrid courses are not ideal for everyone (Mansour, Mupinga, Davison, 2007). A majority of students said that the online geography lessons are good for them (93.6%). They said that most of them like the enthusiasm of geography teachers from Serbia. Also, most of the students did not have any suggestions on how geography lessons could be improved, except one student who said that for better understanding and more practising, geography teachers should use some platform where they can write or draw something.

Limitations of the Study and Future Research Suggestions

As mentioned above, there are few limitations of this study. Firstly, there were only 19 participants. There are not many foreign students who need help relating to geography, especially if they are from different countries, in this case, Serbia. Secondly, this study was researched by only one geography teacher from

Serbia because there are not many graduated teachers who know that it is possible to teach geography online. Thirdly, the teacher in this study taught only for eight months. It cannot be seen what changes would be made if the teaching continued. A future survey could prove if the number of students would increase or decrease during a time. Hence, there are more graduate geography teachers needed for future research.

Conclusion

The findings of the present study are important because they reveal that graduated geography teachers from Serbia can find other sources of delivering and implementing knowledge that they gained at a university in the country. One of the limitations is teaching in a foreign language, but the more languages students know the better they can implement their knowledge of geography in online tutoring. Also, for teaching online the only necessity is a stable internet connection and regular technical qualifications of personal computers. Research showed that this way of communication between students and geography teachers is way faster and better if the students need help in a short time, especially for University students, or if they want to learn something that is not part of geography curricula in their country.

One of the weaknesses for geography teachers from Serbia is adopting foreign geography curricula which demand lots of preparations. For example in the United Kingdom and some other countries in the world popular academic qualification taken by students is the General Certificate of Secondary Education (GCSE). Topics of study include climate change, poverty, deprivation, global shifts in economic power and the challenge of sustainable resource use. Students are also encouraged to understand their role in society, by considering different viewpoints, values and attitudes (Internet 1). Also popular is International Baccalaureate Diploma Programme (IBDP) which provides an internationally accepted qualification for entry into higher education and is recognized by many universities worldwide. Teachers from Serbia have adequate knowledge but they are not completely prepared for this type of geography curricula for online lessons.

The quality of online learning is the same as that of traditional private tuition. Students get the entire teachers time and attention as well as comprehensive classes customized by student needs. Availability of online learning is for everyone regardless of age and ability. There are lots of school pupils, college students and adults who want to learn geography from foreign teachers from Serbia. Location is not an obstacle anymore, as via Preply, Chegg, Skype or any other site students can receive knowledge at any place of the world. Mobility and flexibility of online learning is a key factor for busy people. Frequent business trips, private journeys or some other student or adult activities can not affect the learning process. Also, students are free to plan Geography classes according to their schedule. In addition to the lower process for online classes, students do not need to spend their money and time on going to/from lessons around the city. No traffic jams and transport expenditures as well as no need to purchase learning materials (they are presented in an electronic form) (Internet 2). If graduated teachers from Serbia have a decent knowledge of foreign languages and want to improve their geography and at the same time Second language knowledge, being part of an online community is ideal.

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USE OF THE GENERIC CONCEPTION OF CREATING GRAPHIC ILLUSTRATION IN TEACHING CARTOGRAPHIC CONTENT IN THE SIXTH GRADE OF PRIMARY SCHOOL

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Abstract

In everyday teaching practice, graphic illustrations are often merely a visual-aesthetic 'supplement' to teaching content or, at best, a means of displaying certain quantitative size. This neglects the potential that graphics can have in understanding the complex natural and socio-economic processes. The paper deals with the generic concept of cognitive-methodical formation of graphic representations, which significantly facilitates understanding and enhances student's self-activity and creative attitude towards learning. Generic graphic illustrations was used in the teaching cartographic contents in the sixth grade of primary school. The tested pupils were divided into groups. In one group the teaching content was presented with separate textual and graphic materials and in the other with integrated materials. The degree of understanding of the content of both groups of pupils was tested with problem solving questions.

Keywords: generic graphical illustration, constructivism, cartographic content, primary school.

INTRODUCTION

The founder of the concept of graphicacy Balchin (1976) believes that the ability to express graphically and to understand graphic assets is a kind of educational imperative. Geography, that is, cartography as fields based primarily on the visual-spatial aspect of intelligence, should be its carriers. Textbooks would therefore be a key place for the development and application of graphicacy. Different illustrations and graphical representations were certainly present in the textbooks well before the concept of graphicacy emerged. It is evident that illustrations influence the effectiveness of learning by increasing the interest in the content presented in the text. Graphics certainly facilitate understanding and enhance the self-activity and creative attitude towards learning. Levin and Mayer (1993) state the main reasons why illustrative and graphic material can enhance learning outcomes, especially understanding of teaching content. These reasons are found in the very nature of graphic illustrations, or in their content, but also in their cognitive and methodical formation. The authors emphasize that through the proper use of graphic illustrations, the teaching material, among other things, becomes: "more concise, focused, more concrete, more connected and comprehensible." (1993, p. 97-100) Yet didactic reality is always different from projected possibilities.

And this reality is such that almost 85 percent of these graphic illustrations have either a purely decorative function or are just pictures of objects (Mayer, 1993). Generally speaking, almost every 7th illustration within a textbook is designed to be a useful and functional learning tool.

This especially relates to the role that illustrations play in explaining dynamic processes and phenomena that require more cognitive abilities such as spatial thinking (Trifunović, 2018).

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Based on the above data, it is quite legitimate to conclude that the basic problems that prevent the realization of the potential of graphical representations in the teaching process is the deep-rooted assumption of textbook creators that visual materials should primarily have an aesthetically appealing function and that they can only represent forms but not processes.

According to this paradigm, words are needed to adequately explain the process, whereas images are only for visual representation of some static object.

What is the real role of these two, seemingly opposed, media of knowledge transfer? Is it really necessary to strictly separate words and images when explaining the dynamic aspects of different processes?

DUAL CODING THEORY AND GENERIC CONCEPTION OF GRAPHICAL ILLUSTRATIONS

The aforementioned dilemmas in the literature take the form of different conceptions and theories that seek to explain the general way in which reality is represented. On the one hand, there is the opinion that different content is adopted in the same way, whether it is presented or "encoded" verbally or graphically. This amodal approach is mostly advocated by researchers in the field of artificial intelligence, who believe that all knowledge is actually placed in the form of propositional representations, that is, meanings that are neither visual nor linguistic in nature, but symbolic (Molitor, Ballstaedt and Mand, 1989, 9). If the learning process is carried out in such a way that all information is represented and thus placed and made accessible through the system of abstract symbols, then it is completely irrelevant in what form the teaching content will be presented. However, many empirical researches in the field of cognitive психологије (Harp & Mayer, 1997; Mayer, Heiser, & Lonn, 2001 ; Mayer & Jackson, 2005; Leopold, C., & Mayer, R. E., 2015; Xie, H., Mayer, R. E., Wang, F., & Zhou, Z., 2019) show that cognition actually occurs through two distinct and relatively separate systems of representation. According to Dual Coding Theory (DCT), textual information is adopted and represented through the verbal system, but also through pictorial information, on the basis of which we learn about non-linguistic objects and events. Both of these systems are specialized, but the learning occurs only on the basis of the interplay of these systems (Paivio, 2006).

From the perspective of graphic design of materials in textbooks, this practically means that textual information is placed and processed based on verbal coding, and that graphic content is represented through image code. What is very important in this process is that even when adopting text material, some of the information is visualized and placed in the form of image code. This duplication of encoding also occurs when adopting image content, which, apart from the visual system, is also placed in text form as verbalized copy (Molitor et alt, 7).

However, the process of dual encoding of text and image is different. While textual content double encodes only concrete information, visual content is fully embedded in both the verbal and image systems. Dual coding theory can thus explain the advantage that learning from images and text has compared to adopting purely textual content (Paivio, 1991).

Dual coding theory finds its practical importance in the generic approach to the design of graphic displays and other educational materials.

Generic theory, therefore, is aimed at devising the kind of textual and graphic-illustrative material that will, to the greatest extent, enable students to understand. The authors cite three cognitive stages, that is, the preconditions for occurrence of meaningful learning, whether it is textual or graphic material. These are *selection, organization* and *integration*.

The process of constructive cognition begins with an observation that, based on predefined guidelines (e.g. the title of a topic to be processed…), focuses on selection of relevant information presented on a illustration. This selection forms a certain *visual base* from which the process of construction (and recon-

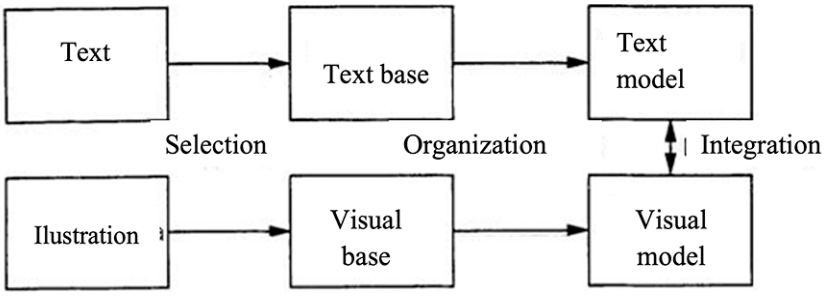

Figure 1. Cognitive stages of interpretation of integrated text-graphic material
(Source: modified according to R. E. Mayer, K. Steinhoff, G. Bower, R. Mars, 1995; p. 32)

struction) of the meaning of the material presented starts. The further course of cognitive activity is represented by phase no. 2, that is, the (re)organization of the adopted visual database that occurs due to the effect of newly arrived information when continuing to interpret the illustration. In this way, we construct a visual mental model of the material itself represented by graphic material. The final stage of construction of the meaning of the interpreted material within the generative theory of graphic illustration production is the integration of the visual and verbal mental model into one whole, which, in fact, results in an understanding of the process being explained (Mayer et all, 1995, p. 32) .

MATERIALS AND METHODS OF RESEARCH

Cartographic teaching contents, whether map projections or ways of presenting relief forms, prove to be quite challenging to understand, especially in the lower grades of primary school. Their understanding requires from the pupils mainly elements of spatial cognition in the form of mental rotation and manipulation, change of perspective, etc., that is, mastery of projective spatial thinking. (Piaget and Ihelder,1968, p. 153)

Given the abstract nature of these contents, well-designed graphical illustrations are a key element of their effective learning. By analysing the graphical displays used in explaining the process of presenting reliefs via isohypses in a textbook of geography for the sixth grade of primary school in the Republic of Srpska, we assumed that the principles of generic design could significantly contribute to their understanding. For the purpose of the research, a generic graphic representation was created in which the images and adequate conceptual explanations were combined. The process of creating isohypses is shown successively, from the relief form, through the way of forming the relief layers to their transformation into isohypses, where for each subsequent step the process of abstraction was greater. At certain stages, the images were accompanied by appropriate cartographic terminology. In this way, pupils were enabled to form both a visual and textual base related to the process of isohypse formation. Similarly, combination of words and images makes it possible to integrate textual and image representation into a comprehensive explanation. The result of this approach is the formation of a visual mental model of the process of transformation of the relief form into isohypses. Establishment of this model should allow students to manipulate the process in the opposite direction, from isohypse to relief.

In order to verify these assumptions, a worksheet has been designed (Attachment), which contains the above-mentioned generic illustration in the upper part, while specific assignments have been set up in the lower part, which have been used to check the degree of understanding of the processed cartographic content. The aim of the first assignments is to reconstruct the relief shape based on simplified and geometrically stylized isohypses. For easier and more accurate analysis, the task was scored by segments, where each correctly set isohypse got one point. In the second assignments the pupils were required to identify more complex forms of relief and to represent them through isohypses. Given that it was necessary to connect five pairs of relief shapes and corresponding isohypses, this assignment was also scored by segments. This type of worksheet was used for testing of so-called integrated group of pupils (GIG). The second group of students was given a worksheet in which the tasks were the same as in the first, but the graphical representation, taken from the textbook, was not done on the basis of the generic principle.

Testing was performed in the sixth grades (VI_1, VI_2 and VI_3) of the Primary School Ivan Goran Kovačić in Banja Luka. A total of 77 pupils were tested. The Group with text-image integrated illustration (GIG) had 39 pupils and the other 38 pupils worked on a worksheet with non-integrated illustration (GNG). The duration of the test was the same for both groups - 30 minutes including the same clear instructions provided by the test teacher.

RESULTS AND DISCUSSION

As mentioned above, the evaluation was performed by counting each of the integral segments of the assignments. The evaluation of the results was performed based on the number of correct answers to each of the set tasks. For example, in the first task, each correctly presented isohypse was considered as acceptable answer, or each correctly connected pair, as in the second task. In this way, we got the number of correct answers, that is, the number of pupils who answered correctly to one of the tasks. That served as a base for the subsequent calculation of the share of correctly solved tasks. In the study, we set up two hypotheses.

The basic hypothesis that we set out to explore : *Usage of a graphic illustration based on the principles of*

generic design could significantly contribute to the understanding of abstract cartographic content.

Successive presentation of the process of transformation of the relief form into line-expressed height zones with the integration of textual and visual explanations should enable pupils to better understand the spatial-projective processes necessary for problem solving assignments. The second hypothesis: The structure of this understanding should rest on the principle of forming a functional operational mental model on the basis of which students can successfully solve problem related to cartographic relief presentation.

Assignment 1.

The results of the research show a significant difference in the achievement of the group that was resolving the tasks based on integrated graphic-textual material (GIG) compared to the group that was guided by "plain" graphical display (GNG). In the first assignment, this difference is most visible in the category of general success or failure to solve the problem. The group with non-integrated graphic material had 55.27 percent of pupils who failed to correctly present any of the required isohypse (Figure 2).

On the other hand, within the GIG group, this percentage is slightly below 13. Over 40 percent of the pupils from the GIG group managed to solve the first task completely, which is a significantly higher percentage than the pupils who worked on the basis of textbook graphics (13.16 %) (Figure 3).

A clear difference in the level of understanding of the principle of transforming the isohypse into an appropriate relief form is also indicated by the category of pupils who correctly transferred three isohypses. One third of the pupils in the GIG group have three correct answers, compared to less than 8% of those in the group with non-integrated display. The fact that sixth of the pupils in the same group managed to solve only one isohypse also supports our hypothesis that the generic display provides an integral understanding of the explained process that later can be used in accordance with the problem situation.

Assignment 2.

The objective of the second assignment was primarily to test our second hypothesis that learning based on the generic principle of graphical display design leads to the formation of a visual mental model of the process of transformation of a relief form into isohypses. That should allow pupils to manipulate the process in the opposite direction, that is, from isohypses to relief form. Successfully solving assignment in which pupils

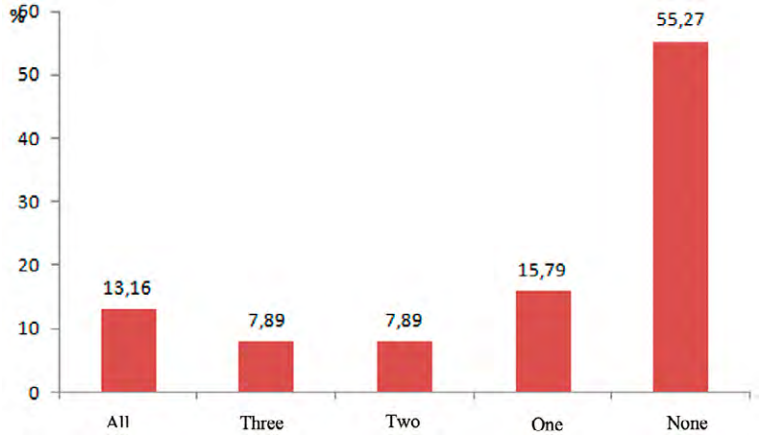

Figure 2. Percentage of correctly resolved isohypses of the GNG group in the task 1

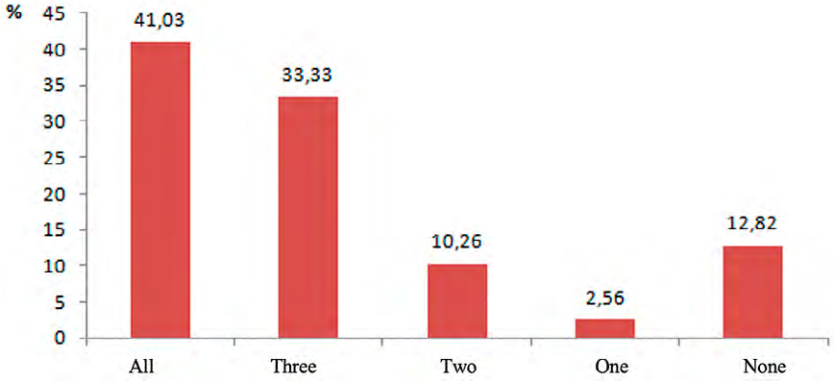

Figure 3. Percentage of correctly resolved isohypses of GIG group in the task 1

need to connect relief forms with their corresponding representations obviously requires the application of one such model of "two-sided" view of the process.

Table 1. Structure of the answers of the pupils from the GIG group to the questions in the task 2

Relief form	Number of pupils	Percentage (%)
All	21	53.85
Four	14	35.89
Three	1	2.56
Two	2	5.14
One	0	0.00
None	1	2.56
Total	39	100

The fact that more than half of the pupils in the GIG group were able to solve all five pairs is in support of this claim (figure 3). This percentage is much smaller within the group that did not work on the generic principle - 23.68 (table 2). When we add pupils who had 4 correct answers, then the difference between the GIG and the GNG group is even more pronounced (figure 4).

Establishment of the above mentioned mental model on the basis of generic display and its operability in solving cartographic problems in sixth grade pupils is evident from the data that only one pupil (or 2.5% of

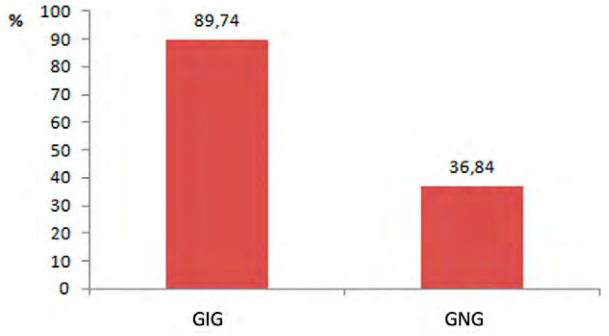

Figure 4. Share of pupils in GIG and GNG groups with 4 and 5 correct solutions in task 2

the total GIG group) was unsuccessful in solving any pair, compared to 10.5 pupils in the other group (table 2).

Table 2. Structure of the answers of the pupils from the GNG group to the questions in the task 2.

Relief form	Number of pupils	Percentage (%)
All	9	23.68
Four	5	13.16
Three	10	26.32
Two	3	7.89
One	7	18.42
None	4	10.53
Total	38	100

CONCLUSION

Graphic illustrations represent a significant part of contemporary textbooks, but the design and features of graphic attachments are inadequate given the cognitive capabilities of visual representations. The majority of graphic illustrations have only the aesthetic role or, at best, the role of mere representation of a geographical object. Very few of them are designed to facilitate the understanding of more complex processes that require a high level of abstraction from the pupil, such as cartographic contents in lower grades of elementary schools. The theory of dual coding of teaching content and the conception of generic design of graphic materials and textbooks are a good framework for correcting the deficiencies of graphic illustrations in our textbooks. The results of the research conducted within this paper undoubtedly indicate the justification for using a generic way of planning and producing graphic representations in textbooks and other educational materials at all levels of teaching. The benefits of integrating textual and visual elements in graphical representation have been manifested primarily in the form of facilitating the understanding of complex content.

On the other hand, generic display allows students to form visual mental models that can become operational in other similar problem situations.

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DIFFERENT ADOPTION OF GEOGRAPHY CONTENTS

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Abstract

Differences in the level of geography content adoption on the transition from the elementary to the high school are significant. The initial test, previous used teaching tools clearly indicate reasons for inadequate use of the map, orientation, determining the latitude, longitude etc. During the high school, teachers can face with a different attitude of students towards the contents of certain geography disciplines with an inadequate application of geography knowledge in other subjects and the inadequate correlation between teaching subjects generally. Inefficient combination of teaching methods at some schools especially the lack of methods of research, play, problem-solving methods or comparison in regional geography was observed. This may result in the inadequacy of the learned and creating low motivation for new contents. Possible solutions are a more fundamental focus on linking geography content between grades at primary school and the concrete correlation between subjects.

Keywords: teaching, school, innovation, efficient.

Methodology

1. Analysis of the results of the initial test in the first grade of Gymnasium/High school.
2. Discussion with students about used teaching tools and methodologies in Elementary school in Geography classes.
3. Analysis of the frequency of usage geographical maps and orientation on the maps, determining the latitude, longitude, and all four cardinal directions on the map and in reality.
4. Analysis of learning methods.

Method 1. Analysis of the results of the initial test in the first grade of high school

Test sample questions for two groups of students:

№	Physical geography	Social geography	Maps orientation/latitude / longitude	Facts related to the toponyms, highest, dippiest, biggest...
1.	The hydrosphere is _____, and lithosphere is____.	The indigenous Australians are _____.	Africa is located in all four hemispheres. YES or NO	Africa's highest peak is _____.
2.	The border of Europe and Asia is the mountain of _____.	Indigenous peoples of the Americas are _____	Connect countries with their capitals: Countries are Austria, Russia, Argentina, Pakistan, Ukraine, Slovenia, Slovakia, China, Bangladesh and Chad. Cities are Bejing, Moskow, Islamabad, Ljubljana, Wien, Kyev, Bratislava, Buenos Aires, Dhaka and Tokyo.	Write all the oceans: _____.

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№	Physical geography	Social geography	Maps orientation/latitude / longitude	Facts related to the toponyms, highest, dippiest, biggest…
3.	For life on Earth, the most important layer of the atmosphere is _____.	The creator of the concept of a heliocentric solar system is Polish astronomer Nikola Copernicus. YES or NO	There is a vast Plain along the Ganges River. Its name is....	Write all the continents:_____.
4.	Which are the only two points on Earth that almost do not participate in Earth's rotation?	Pre Columbian city Chichen Itza is an archaeological site located in_____.	The Equator passes through Ecuador. YES or NO	The name Asia derives from the word Asu, which meant: East. YES or NO
5.	Steppes are areas of ____ grass without trees. They are widespread in the _____ climate.	The major religious groups in the world are_____.	The Latitude is the angular distance north or south from the Equator of a point on the earth's surface. YES or NO	Europe, after Asia, is the second-largest continent. YES or NO
6.	The oldest parts of the European mainland are the Russian Plate and the Baltic Shield. YES or NO	The rate of natural increase is the difference between numbers of live births and_____.	The Geographe Bay is on south-west Australia. YES or NO	Australia is the highest continent. YES or NO
7.	Climate zone from 00 to 23027`is___.	Name the country with three capitals.	Which ocean lies between Australia and Africa?	What is the name of the longest mountain system in the world?
8.	The Earth rotation has no specific direction. YES or No	Majority of European people are: German Roman Slavic	The zero parallel line passes through the Greenwich observatory in London. YES or NO	South America's highest peak is _____.
9.	Monsoons are planetary winds. YES or NO	Japan industry is based on automotive branch? YES or NO	A number of the time zones on the Earth is _____.	The largest lake in Europe is___.
10.	Most lakes in the Alps are of tectonic origin. YES or NO	India's population is the second after USA, China or Russia? Mark the correct answer.	Map scale represents the relationship between distance on the map and the corresponding distance on the ground. YES or NO	The maximum depth of the Adriatic sea is ____ meters.

№	Physical geography	Social geography	Maps orientation/latitude /longitude	Facts related to the toponyms, highest, dippiest, biggest…
1.	80%	75%	32%	4%
2.	92%	98%	53%	98%
3.	5%	18%	18%	96%
4.	2%	3%	53%	78%
5.	60%	71%	41%	15%
6.	25%	66%	6%	43%
7.	83%	5%	59%	41%
8.	39%	38%	31%	38%
9.	48%	89%	82%	63%
10.	55%	92%	75%	12%
Total	48,9 %	55,5%	45%	48,8%

All students are the first grade of High school, vocational orientation (114 students). They were divided into 4 groups during the work, separately, for two weeks in September, depending on the week`s geography class schedule. The test consisted of 10 questions. The difference between student's results is visible on the following points

Significant number of students (49 %) were well informed about general climate characteristic. At to the same time, it is interesting; they are not familiar with the distribution of vegetation, grasses or forests regarding the climate and location. Conclusion upon the question: students missing proper correlation between ecology, biology and geography lessons from the previous year of study or another lesson in the same year of education.

When students have opportunity to choose an answer by YES or NO, I found a satisfying level (44,4 %)of correct answers for all areas of geography comparing it with other questions and with needs to add some words as an answers, where the passing level is lower. Conclusion upon the question: The correct answers to this type of questions could just be guessed.

Better results are found in the area of social than in physical geography.

Regarding maps orientation, almost 36 % of students are not familiar with Latitude or Longitude, but about 31% of them knows the Greenwich meridian, 41,6 % of students are completely aware of Equator location and measure.

Details related to the facts of countries, capitals, rivers, mountains, bays etc. are known only to 50,9 % of students.

Questions related to the history or some other contents, considered as interesting were not memorized on a proper manner on behalf of students. It is not in a line of the common opinion that students remember interesting details.

Level of acquired knowledge regarding the test answers is in general 49.55 % for all questions and all students.

Method 2. Discussion with students about used teaching tools and methodologies in Elementary school in Geography classes.

During the discussion with students about used teaching tools and methodologies in Elementary school in Geography classes, that could explain the results I learned that our students missing possibilities to analyse think critically, rather than memorize information. Geography offers children a wide level of skills and knowledge, so if children are directed and motivated to adopt geography knowledge on the proper way, they will be more successful at solving everyday problems, but will also have a completely different attitude to their skills and knowledge. They will have a much higher level of self-esteem, self-regulation, and motivation to learn new and implement learned lessons because learning for them will remain a game even after childhood during further education. Based on the above, one of the possible solutions to the challenge facing students at the beginning of high school is a more fundamental focus on linking geographic content between grades in Elementary school, to create a clear needs for students to utilize knowledge from the lower grade to the upper, resulting with adequate geographic connectivity and a secure basis for transition to high school. The following recommendation relates to a concrete correlation between Elementary school subjects, which, if practised frequently, focused and planned, that would allow the creation of a necessary and solid network of geographic knowledge among students and thus ensure more effective adoption of content in geography and other subjects in secondary school.

Method 3. Analysis of the frequency of usage geographical maps and orientation on the maps, determining the latitude, longitude, and all four cardinal directions (north, east, south, west) on the map and in the reality.

Analysis of the frequency of usage geographical maps and orientation on the maps, determining the latitude, longitude, and all four cardinal directions (north, east, south, west) on the map and in the reality depending on the concrete Geography teacher practice results on how frequently the maps were used. Students themselves bring up the problem of dissatisfaction with the use of maps. They say they are incapable of using it properly, they feel there is a great deal of resistance while approaching maps and negative experience of the way how maps were used in Elementary school. Very often I faced comments on behalf of students that they rather wish to memorize significant amount of information than to search for some locations on the map. Latitude and longitude concretisation on the map is a common problem, which implicates to other Geography lesson and other school subjects, like Mathematic and Physic. One of the solutions to solve this issue is the daily usage of maps and drawing some objects or locations in the notebook at school or home frequently. The method used at Elementary school is different and this issue is very important when students enrol the next level of education with completely different approach on Geography classes' methodology. It is very obvious when a student came from Elementary school with active learning methods. Those students are willing to cooperate, ready to learn and usually very creative. Comparing with them some students are saying that Geography teacher didn't use

map often. This is an important issue for High school teachers because we are dealing with different experience as a ground for future efforts. Do we have enough time to change student`s approach that we found it`s not proper? Do we have enough professional experience to change it in positive directions? Do we have the professional support of colleagues? If the aim of teaching geography in the Gymnasium/High school is to develop geographical logical thinking and to acquire new knowledge, skills and attitudes in the fields of physical and social geography, world geography and national geography with geographic terms, phenomena and processes necessary for understanding contemporary world reality and social development, we, as a Geography teachers, must work on common students development, moral values, tolerance, respect and other life important values.

Method 4. Analysis of learning methods.
It is evident that there are differences in the level of adoption of geographic content on the transition from the second to the third stage of the educational cycle, which indicate:

1. Different ratio of students to the subject;
2. Different attitude of students towards the contents of certain geographical disciplines;
3. The fact that most students do not manage the geographical map as expected;
4. The fact that there is an inadequate application of geographical knowledge in other subjects;
5. Inadequate correlation between teaching subjects at school in general;
6. The emergence of an inefficient combination of teaching methods of working with students in some Elementary schools, especially the lack of research methods, play and problem-solving methods, as it is mentioned in previous research paper.
7. Insufficient use of methods of comparison in regional geography was observed, which may result in the inadequacy of the learned and creating inadequate motivation for new contents. This statement is also found in other literature.

Conclusion

The methodology of teaching geography aims is to - Develop competencies for the successful preparation and teaching geography. This involves developing skills: to define precisely the purpose of the lesson itself; make an appropriate selection of geographic content to be present in accordance with the goals and outcomes defined in the curricula; to select the most appropriate teaching methods and apply different teaching methods, different organizational forms of work in the teaching process; to use text, visual and audio-visual teaching tools with modern didactic. Some of those principles are:

1. The principle of adaptation of teaching to the age of students;
2. The principle of the conscious activity of students;
3. The principle of systematic and gradual teaching;
4. The principle of obviousness;
5. Principle of connection between theory and practice;
6. Principle of rationalization and efficiency in teaching;
7. Principle of individualization of teaching work;
8. The principle of sustainability of knowledge;
9. Principle of attractiveness in teaching.

The level of geography content adoption on the transition from the elementary to the high school is significant. The initial test, previous used teaching tools clearly indicate reasons for inadequate use of the map, orientation, determining the latitude, longitude etc. During the high school, teachers can face with a different attitude of students towards the contents of certain geography disciplines with an inadequate application of geography knowledge in other subjects and the inadequate correlation between teaching subjects generally. This may result in the inadequacy of the learned and creating low motivation for new contents. Possible solutions are more fundamental focus on linking geography content between grades at primary school and the concrete correlation between subjects. Adopted basic skills, prepared to be implemented in different areas are the key not only to the High school but also in further life, higher education and the labour market. Too many young people are insufficiently prepared for the challenges of modern societies characterized by a high level of innovation. We need to continue to support them, using innovative approach, based on practical as well as theoretical knowledge. High-quality education plays an important role in this, just as proper and modern teachers re-training. I firmly believe that taking decisive action today will help reduce social exclusion in the future and build a socially cohesive society. Also, the roles of parents are an important part of a successful educational process. Continuation of the educational process at home, after classes in an effective correlation between family and school could establish the ground for implementation of lessons learned at school.

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PHYSICAL GEOGRAPHIC FEATURES OF VLASINA AS A BASIS FOR TOURISM ZONING OF THE REGION

Milica Cvetanović[A]

Abstract

The Vlasina region is recognizable for its natural features that are conducive for the development of a number of eco-friendly types of tourism. Geographical research of this region (which includes municipalities Surdulica, Crna Trava, Vlasotince and Babušnica) will determine its dominant physical geographic features. Differences in relief and climate, as well as numerous hydrographic features can influence the development of different types of tourism. By dividing the region into smaller areas, based on their attractive natural characteristics, tourism zones can be formed. Determining these zones would contribute to better planning of tourism development and the region itself. However, more hydroelectric power plants have been constructed or are currently under construction in the Vlasina river basin which could endanger the ecosystem of the region. This fact should be taken into account with particular care when planning tourism development.

Keywords: Vlasina, tourism zones, natural features, sustainable development

Introduction

The Vlasina region is located in the southeast of Serbia. It includes four municipalities: Surdulica, Crna Trava, Vlasotince and Babušnica. The name of the region comes from the Vlasina River, whose basin covers the mentioned municipalities. This area is predominantly mountainous, with lower elevations in the lower and middle reaches of the Vlasina River, the right tributary of Južna Morava. The natural features of the region are extremely suitable for the development of sustainable types of tourism, but so far this area has not been sufficiently promoted for this purpose, and its many potentials have been unused. The main tourism potential of the region is Vlasina Lake on the plateau of the same name. However, even lake tourism is not developed according to the available opportunities. The northeastern part of the region used to have developed spa tourism, but today the spa is neglected. Certainly, the development of any form of tourism must be planned in detail and sustainably so that the ecosystem of the region wouldn't be threatened. It is also important to say that some parts of the region are under protection regimes, which is why only certain activities are allowed. Some of them are under strict protection so any activities in them are prohibited, apart from certain scientific research.

Vlasina has relatively good geographical position and traffic connections. The region is bordered by Bulgaria in the east and is close to the border with North Macedonia. Several state roads pass through the region, and the A1 highway (Horgos-Belgrade-Niš-Preševo), a section of the E75 road connecting the north and south of Europe (Norway with Greece), passes not far from the region. This road is located on the route of the Pan-European Corridor 10. The Belgrade-Skopje-Thessaloniki railway runs along the route of this corridor. Also, Vlasina is relatively close to the international airport in Niš (Cvetanović, 2018; Prostorni plan područja posebne namene „Vlasina").

Although small towns Surdulica, Vlasotince and Babušnica are part of the region, Vlasina is is often referred to as a rural region, considering the large number of villages and physical geographical features of the area.

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Tourism development opportunities in rural areas are primarily defined by the natural conditions in which winter and summer tourism, adventure, spa and health tourism, ethno and eco tourism are developed. The tourism potentials of rural areas are largely unrecognized and their promotion is selective and limited (Mandić, 2019). According to that, the task of this paper is to divide the region based on its natural features and on that basis propose potential tourism zones that need to be managed sustainably in order to achieve positive results and lead to tourism development. The aim of this paper is to make a clear and applicable proposal for the sustainable development of tourism in this region.

Basic physical geographic features of Vlasina

As stated, Vlasina is predominantly a mountainous region. The most prominent geomorphological unit is the Vlasina Plateau, surrounded by the Rhodope Mountains of Čemernik (1638 m) and Ostrozub (1546 m) on the west side, Gramada (1721 m) on the north and east sides and Milevska planina (1 737 m) on the east. Vardenik (1876 m) extends south and southwest of the region, Crni Vrh (1463 m), Gramada (1721 m), and Ruj planina (1704 m) to the east, Golem Stol (1238 m) to the northeast, and Bukova Glava (1472) in the southeast. The peak Pandžin grob (1659 m) is located on the south part of the plateau and is the site of the Vlasina River source, while the north of the region extends the slopes of Kruševica (913 m) and Suva planina (1809 m). Most of the plateau is occupied by Vlasina lake with an area of 16 km², at an altitude of 1213 m. Lower altitudes of the region are located in the municipality of Vlasotince, along the middle and lower reaches of the Vlasina River.

The climate of this area is predominantly mountainous, which is not conducive to a longer swimming season on the lake (lasts only a month - from mid-July to mid-August). Nevertheless, these climatic features are suitable for the development of many other recreational types of tourism. Lower altitudes are characterized by temperate continental climate.

Vlasina Lake is a major tourim potential, but in some ways also a starting point from which tourism development can be planned in other parts of the region. This could be achieved by linking tourism potentials, that is with precisely made itineraries. The filling of the second largest artificial lake in Serbia lasted from 1949 to 1954. It is recognizable for its peat vegetation and floating peat islands.

The Vlasina River begins its route below the peak called Pandžin grob in the south of the plateau and flows out of the lake. The river has undergone a lot of changes lately as a number of mini-hydro power plants are being built or are already finished, and some new ones are planned, which puts its ecosystem and environment in danger. The mentioned hydropower plants, more specifically their purpose and negative consequences especially in mountainous areas, have been the subject of public discussions at the national level for several years now. The tributaries of the Vlasina River are also endangered, as are the rivers in the north and east of the region that belong to other basins. Also, the landscape was visually transformed in a negative way, which is certainly not attractive to tourists. On the other side, the Vrla River, which flows through the municipality of Surdulica, was used for the purpose of forming the Vlasina Hydropower System, and four hydroelectric power plants were built long ago (three are located in the Vlasina region and one of them is underground). The problem is that the new mini-hydropower plants are considered excessive and will have a minimal contribution to electricity at the state level. The region also has a number of mineral springs of pure mountain water. On the territory of the municipality of Babušnica, there is Zvonce spa, which is currently inactive.

Vlasina biogeographical features are specific and largely protected. This is where the Outstanding Natural Landscape "Vlasina" and and the Strict Nature Reserve "Zeleničje" are located. The most valuable biogeographic features are found in the Vlasina Plateau area, and it has been declared as the IBA (Important Bird Area) as well as the Ramsar area (of particular importance to wetland birds) and for Emerald Area (European Ecological Network for the Conservation of Wild Flora and Fauna and their Natural Habitats in Non-EU Countries).

Formation of tourism zones

Based on its physical geographic features, the author divided the Vlasina region into four zones. The names of the zones are given on the basis of the most promising potentials that can be developed in a given area in terms of tourism. These are: the lake ecotourism zone - in the south and central part, the countryside and winter tourism zone in the west of the region, the spa

tourism zone in the northeast and the wine tourism zone in the northwest.

Lake ecotourism zone

The most attractive area is the Vlasina Plateau with the lake of the same name. The plateau is bordered by the Čemernik, Ostrozub and Gramada mountains. The lake was formed in the area of the former peat bog.

The shore of the lake is quite rugged with several bays that used to be mouths of the rivers. There are two islands on the lake - Stratorija and Dugi del, and the biggest attraction is the floating peat islands, which represent the remnants of the peat that has risen to the surface over time.

The Vlasina Plateau is protected as a outstanding natural landscape, which means that activities at this area are restricted. Therefore, in this area it is possible to plan only certain forms of tourism of ecological character that will not endanger the natural environment.

Outstanding natural landscape Vlasina includes parts of the municipalities of Surdulica and Crna Trava. Certain tourist activities are allowed, mainly those that are environmentally oriented.

Three protection regimes of I, II and III categories were established in the mentioned area. The category I includes the islands of Stratorija and Dugi Del on the lake. The protection of the second category was proclaimed in the following places: mountain peak Vrtop - Jelički rid, Mali Čemernik, Veliki Čemernik, Stevanovski potok, Blato-Delnice-Bratanov del, Dugi del island, Vlasina lake, Vučja river gorge, Zlatna bukva (Golden beech). The regime of protection of the third category is established in the remaining parts of the Outstanding Natural Landscape Vlasina, mainly in cadastral municipalities on the shore of the lake. Almost every type of space transformation is prohibited on the areas where the regime of protection of the third degree has been established, and in order to conserve air, water, land, forests and wildlife (Uredba o zaštiti Predela izuzetnih odlika „Vlasina"; Cvetanović, 2018). The formation of the accumulation affected the climate of the plateau. Since the formation of the lake, the mean annual temperature is lower than before (Stanković & Laušević, 1997). The winters in this area are cold and the summers are fresh. During the day, the temperature can change drastically so that after a warm day the nights could be very cold. Due to its climate features, the bathing season is very short and lasts one month at most, from mid-July to mid-August. Although attractive for winter tourism development, none of the mountains surrounding the lake are tourist-activated. The only ski slope is on the south side of the plateau, but there is no tourism infrastructure in its surroundings.

Due to the sensitivity of the area, it goes without saying that mass tourism is not desirable but a moderate, sustainable eco-friendly visitor stay. It can be said that lake tourism can be developed and that would include staying on the shore of the lake and activities on it. Due to the mountain climate, the most suitable time for visits and activities on the lake is summer, and the stay can also be realized outside the main bathing season. It is desirable to use eco-friendly electric and solar powered tour boats. Within the framework of the realization of ecotourism activities, paths of health as well as places for bird watching should be marked.

In addition to hiking, tourists can get acquainted with the culture and customs of the local people, can buy their products such as food and drink, homemade teas, natural cosmetics, as well as souvenirs made in domestic crafts. If allowed, the tourists themselves can collect certain plants such as medical herbs and forest fruits (Gajić & Cvetanović, 2015).

Due to the limited tourist activities, but also the extremely high degree of depopulation in this region, the number of tourists decreases over the years, and the most frequent visitors are those who already own vacation houses in this area. Construction on the shores of the lake, and in certain parts further off lake, is prohibited, so the only way to activate the space is to renovate and promote the already existing hospitality and tourism facilities. However, these facilities are not enough to attract more tourists.

Countryside and winter tourism zone

This zone occupies the western part of the region and villages in the municipalities of Vlasotince, Crna Trava and Surdulica. Town of Surdulica can be taken as the lower boundary and Vlasotince vineyards as the upper boundary of the zone. The fresh mountain climate as well as the rich vegetation provide excellent conditions for recreational types of tourism. These are villages on the Čemernik and Ostrozub mountains.

Čemernik is located between the Vlasina Plateau and the Grdelica Gorge. It is covered by meadows, pastures and forest vegetation (Belij & Nešić, 2014). A smaller part of the mountain is under the regime of protection within the Outstanding natural landscape "Vlasina", while the bigger part of the mountain which is located in the western part of the region is suitable for the development of countryside and winter tourism. Ostrozub mountain is located northeast to Čemernik (some geographers consider that Ostrozub is actually part of this mountain). At the foot of the Ostrozub there is an area under protection. It is a Strict Nature Reserve "Zeleničje" in which economic activities are prohibited, and therefore the development of tourism. Villages on this mountain are in a very unfavorable sit-

uation due to the lack of population, and according to the latest census (2011), villages Ostrozub and Javorje had only one inhabitant each, and are considered to be extinguished. It is very possible that in the meantime, other villages have been granted the same status. Although the same problem is encountered in the eastern part of the region, the villages of Ostrozub are somewhat closer to the Vlasotince and important roads, and therefore the adaptation of these villages could be considered (except for the Zeleničje protected zone located in the source part of the Ostrozupska river). All these villages outside the protected zone are located at mountain heights, and some are below 1000 m above sea level and they are most suitable for the stay of tourists. Those who enjoy the harsher air and cooler climate and who are fond of winter stay on the mountain should be offered winter tourism at higher altitudes, primarily on the Čemernik. Also, the ethnographic significance of this region, in which Serbian, Bulgarian and Turkish customs have crossed through history, should be added. The construction of tourism infrastructure should be in accordance with the old construction of this area, but existing buildings (houses) can also be used and adapted if possible. For winter tourism development at Čemernik it is desirable to build at least one hotel and other tourism and hospitality infrastructure such as smaller accommodation facilities, ski trails, shops, souvenir shops, restaurants, tourist information centers.

Spa tourism zone

This zone could be mostly covered by the municipality of Babušnica. It is a mountainous area of exceptional natural features, which is quite neglected today, although it once had good potential to develop, thanks primarily to spa tourism. Zvonce spa, located in this zone, currently is neglected. The only hotel has been privatized and the outdoor hotel pool is currently being renovated, while the facility is still unusable. The rest of nature resources of the zone are threatened by the construction of small hydroelectric power plants. There are several waterfalls on the territory of this municipality on the smaller mountain rivers, and the most attractive are Skokovi waterfalls in the central part of the municipality of Babušnica. Visiting these waterfalls require equipment for hiking. This means that this potential tourist zone could also be oriented in terms of adventure tourism. Residents of this municipality have been fighting a difficult battle for the preservation of their rivers for several years, and until this situation is resolved, sustainable tourism in this part of the region cannot be talked about. However, if the rivers are preserved and the Zvonce spa is revived, sometime in the future, it is possible to plan a tourism zone suitable for the development of spa tourism.

Zvonce spa belongs to the group of spas that make the most of their income in the summer. These spas have very small number of accommodation capacity, the offer in them is incomplete and tourist traffic is low. Also, they are mostly rather far away from the

main tourism emitting region of Serbia (Jovicic & Hrabovski Tomic, 2009). The spa is lacking in accommodation facilities, and the closest ones are located in the territories of other municipalities outside the region. Near the spa on the river Jerma is Cediljka, the narrowest canyon in Europe. Given the peripheral location in the region and the close proximity to other attractive physical geographic motifs, cooperation between the municipality of Babušnica and neighboring municipalities is desirable. Zvonce spa should be placed as a leading tourism motive and its impact should be spread throughout the municipality, ie. make it a municipal brand. This spa is also recognizable as an air spa suitable for the most diverse groups of people, given that it is located in the lower mountain heights and therefore its climate is not as harsh as at higher altitudes. Its mineral waters are rich in calcium, magnesium, sodium and potassium. While active, it was mostly visited by those with ocular and rheumatological diseases, as well as diseases of the nervous system.

Vetrensko or Zvonce lake is another unused motif of this potential tourist zone. The lake is considered semi-natural because it was created when a nearby hill collapsed and partitied the Vetrenska river. It is a small accumulation known mainly for fishing, but certainly attractive for tourist excursions, primarily because it is located near the Zvonce spa. The lake shoreline offers a view of Asenovo kale (1033 m), a rock that rises above Zvonce spa and on which are the remains of a medieval fortress. This elevation is also a very attractive location for the lovers of adventure tourism.

Wine tourism zone

At slightly lower altitudes in the lower reach of the Vlasina River, but also on the slopes of Ostorzub and Kruševica, extends the Vlasotince vineyards, the carrier of tourism of this part of Vlasina. Although not recognizable like some other wine-growing regions of Serbia, this area has significant potential for the development of the wine tourism. All the vineyards in municipality of Vlasotince are located at altitudes above 300 m, and one of them even at altitude higher than 600 m, which is a curiosity of this region, since grape growing is most favored by the warmer climate. In these vineyards, a large number of grape varieties are grown, both native and those from other parts of the world.

Agricultural households with their own wine production are also a good starting point. Vlasotince

hosts the Wine Ball manifestation, which is one of the ways to present this tourism product. Formation of wine tours and adequate tourist presentation of grape growing and wine production is desirable (Plan razvoja turizma Opštine Vlasotince).

The connectivity and accessibility of tourist sites and localities in the Vlasotince area is very poor - there is no system of adequate roads, pedestrian and bicycle paths connecting tourism sites and recreational areas. The condition of local roads in some sections is also unsatisfactory. A special problem is the absence of organized transport within the tourism region, as well as the need to organize excursions for visitors to tourist centers in this region. (Strategija lokalnog održivog razvoja opštine Vlasotince 2012-2016 – nacrt).

Threats to the sustainable development of the region

As already noted, the current threat to the sustainable development of the region is the construction of mini hydropower plants on its rivers. The construction of these installations breaks the law on environmental protection, which in Article 17 states:

"Activities that endanger the capacity of the environment, natural balance, biodiversity, hydrographic, geomorphological, geological, cultural and landscape values or in any way impair the quality and properties of the natural property shall not be performed in a protected natural property."[1]

The wave of mass construction of mini hydro power plants, mostly of derivation type, affected all countries of Southeast Europe. In recent years, mini hydropower plants on rivers in Serbia have been promoted as one of the main ways to increase the share of energy from renewable sources, given that Serbia has plenty of water. However, when it comes to the effects of mini hydropower plants in terms of socio-economic and environmental impact, the opinions of the scientific and professional public are divided (Zvezdanović Lobanova, Lobanov & Zvezdanović, 2019).

The amount of gases emitted during the production of materials for their construction is bigger than the savings of greenhouse gases and therefore mini hydroelectric plants do not represent a clean source of energy (Đorđević 2018 in Zvezdanović Lobanova, Lobanov & Zvezdanović, 2019., pp.228). Mini-hydro power plants of derivative type already built in Serbia have led to disruption of groundwater regime, as well as to soil erosion, general degradation of biodiversity and disruption of the local population's lifestyle (due to noise or disappearance of drinking water sources). In the village of Rakita (Municipality of Babušnica), where construction works on the water intake structure are being carried out in the very center of the village, there was a strong resistance from the local people and the public to stop further construction of the started and prevent the start of planned mini hydro power plants. The state is expected to find an adequate solution to the problem of construction of mini hydro power plants so that the interest of private investors is not realized at the expense of the environment and the local population. It is necessary to review the approvals given for the construction of mini hydropower plants, since numerous regulations have been ignored while making an environmental impact assessment study. A problem is the fact that the attitude of local communities that live and depend on water as a basic resource is not considered at all when approving the construction of mini hydropower plants (Zvezdanović Lobanova, Lobanov & Zvezdanović, 2019)

Another problem that prevents the development of the region is the country's decades-long poor investment in this region in all aspects. Forcing Belgrade as the main nodus puts the rest of the country, especially its southeast, into financial trouble. After World War II, the population was largely abandoning Vlasina in search of work, and in recent decades departures have become more intense. So far, almost nothing has been done by state authorities to motivate the population to return to their home region or at least to attract new residents.

Conclusion

By its physical geographic features, Vlasina is visually one of the most attractive areas of Serbia. However, this has not yet been recognized as a chance for the development. Instead of investing in the creation of Vlasina as a significant tourism destination, the people were allowed to move out massively and the villages to be extinguished. Physical geographic features are just one segment of the potential tourism zones

[1] Environmental Law - Zakon o zaštiti životne sredine ("Službeni glasnik RS", br. 135/2004, 36/2009, 36/2009 - drugi zakon, 72/2009 - drugi zakon, 43/2011 - odluka US, 14/2016, 76/2018, 95/2018 - drugi zakon i 95/2018 - drugi zakon)

of the area, as in each one can find specific cultural motifs, especially since it is a border region. The formation of tourist zones based on the natural features of the area proposed by the author is only one of the numerous proposals for planning sustainable tourism, and thus the sustainable development of the region. Over the years, numerous authors, experts and institutions have spoken and written about the importance of using tourist potentials to bring this region to life, primarily through an ecological concept, but so far little has been done. And what has already been realized has not attracted more tourists because it was not planned and invested in long distances, so Vlasina became neglected again, and some other tourist destinations in Serbia, which have been dominant for decades, were emphasized. In these tourism places there are various omissions such as the massive often illegal construction of residential and hospitality facilities or as in the case of Vlasina - a mini hydroelectric power plants, which makes tourism in such places less sustainable and increasingly threatens space. A country with a negative financial policy and results, with a negative natural increase and a massive departure of young people, needs a more equal development of the region. Tourism should also be planned in this direction, thus giving equal chances to the development and presentation of various tourism destinations across the country. Successfully and sustainably developed tourism, besides tourists, would also attract the population, especially those who want to live in a preserved environment and engage in tourism, hospitality or agricultural production.

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TOURIST POTENTIALS OF GLEDIĆ MOUNTAINS

Zorica Vulović[A]

Abstract

Gledić Mountains are located in the central part of Serbia and south Šumadija. They are located in the north-northwest-south-southeast direction, 40 km long between Kragujevac in the north and Trstenik in the south, then in the river Rekovac in the east and Gruža in the west, an average width of 20 km. It is a hilly-mountainous area. Depending on the way the tourist destination is built, it depends on achieving the goals of tourism development. The aim of the paper is to highlight the development of tourism in the Gledić Mountains, on the base natural and anthropogenic tourist values, to form a market acceptable and specific tourist product. The paper will highlight the tourist value of Gledić Mountains, as a future tourist destination. There are a large number of villages with preserved ethnographic sites in the Gledić mountains folklore heritage, rich and preserved nature and represent areas with special natural features.

Keywords: Gledić mountains, tourist destinations, tourist value

INTRODUCTION

A tourist destination originates from the Latin word "destinatio", which means a certain space on Earth where a tourist offer develops (Milenković, 2009) and is attractive and gathers tourists (Kicošev&Stefanović, 2005) or one or more places where tourists come, and reside, as the goal of their movement (Holloway, 1989). It can be an area or a place or a mountainous area, which has many features (Davidson&Maitland, 1997) such as: a resource-based tourism product, an active private sector, the local community and its organizations, and more.

The increasing need for non-standard services and individualization of tourists is linked to emancipation, greater travel experience, active vacations, greater environmental awareness, increasing learning (Moutinho, 2005). The motive drives tourists towards meeting needs or achieving certain goals (Dibb et.al., 1995). More motive encourages tourists to activity. The incentive motives influence the tourists who will choose the destination, regarding its permanent place of residence and the characteristics of the tourist offer (Goodall&Ashworth, 1990).

Dedicated destinations are a means of attracting foreign and domestic tourists and as a solution to the problem of product isolation in an increasingly competitive tourism market (Vrtiprah, 2004).

The development of tourism in the Gledić mountains is based on the creation of mountain tourism on the mountain itself, as well as the creation of a tourist value chain of a wider area of the mountain, in the cities of which are: Kragujevac, Kraljevo, Rekovac and Trstenik.

It is necessary to create a mountain destination with an emphasis on nature, active holidays in nature, relaxation, and health.

The Gledić mountains have good potential for the development of those types of tourism that are based in particular on anthropogenic factors. They are primarily cultural, historical, religious, manifestation tourism, which can attract more tourists.

Tourism has direct effects on organizers that directly influence tourism development. When it comes to rural tourism, they are rural tourist households (Medlik, 1966), which enables the rural population to be empowered.

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The Gledić mountains represent the most beautiful mountain in Šumadija. It has a large expanse. Spacious forests, smaller forests and groves, flowering meadows and pastures alternate. It is an especially beautiful autumn with shades of different colors. Particularly interesting is the fragmentation of the relief. The main mountain range stands out, as well as the smaller, parallel and lateral peaks, with deep and narrow gorges between them. There are also remains of natural beauty: waterfalls, caves, rare flora and old tree species.

TOURIST-GEOGRAPHICAL POSITION

Gledić mountains are located at the intersection of Eastern and Western European roads, in central Serbia and southern Šumadija. They extend in the north-northwest-south-southeast direction, 40 km long, between Kragujevac in the north and Trstenik in the south, then Rekovac in the east and Gruža in the west, with an average width of 20 km. They are located between 43°37'01'' and 43°57'03'' north latitude and between 20°50' 03'' and 21°03'03'' east longitude, at an altitude of 186 to 922 m (Samar Peak). It covers an area of 829.6 km^2, on the territory of the municipalities of Kragujevac, Knić, Kraljevo, Trstenik and Rekovac. It is surrounded by the rivers: Lepenica in the north, Gruža in the west, West Morava in the south, and in the east the Levač valley and Juhor mountain.

The tourist position along the main tourist routes, West Morava and Greater Morava is favorable because it connects central Serbia with Vojvodina and southern Serbia. It also connects neighboring municipalities that represent strong tourism dispersions. It is characterized by a network of local and regional tourist destinations, conditioned by the abundance and diversity of tourist motives and facilities and their different territorial location.

The Gledić mountains have a polyvalent position, i.e. it connects neighboring municipalities, which are characterized by numerous and varied tourist motives and facilities. Polyvalence has not come to the fore in tourism propaganda, supply and development of tourism. It is important for directing the tourist movements of local and foreign tourists, since the travel and tour of the Gledić Mountains takes different directions, which gives the opportunity to get acquainted.

Contactability stands out for specific landscape units, characterized by good connectivity. Numerous directions of tourist movements that connect the mountain area are highlighted.

The transit position is exceptional because it is located in the central part of Serbia, so that numerous roads connecting neighboring municipalities pass through it.

The traffic position is advantageous because the roads over the Gladiator pass roads connecting it with the Great Morava, West Morava and South Morava valleys. These are the main roads: Kragujevac-Kraljevo, Kragujevac-Trstenik-Kruševac in the east, Kraljevo-Kruševac in the south.

NATURAL TOURIST VALUES

Natural tourist values form the basis for the development of several types of tourism and enable the satisfaction of multiple needs. The center of mass excursion tourism throughout the year. It determines the development of recreational and sport-manifestation tourism.

Relief as a tourist potential. There are 64 peaks in the Gledić Mountains, accessed by marked hiking trails or country roads. Mountain tourism in the Gledić mountains would consist of: a hunting camp (it would be located on the highest peak, on Samar (922 m), it is possible to build about 50 apartment-type houses), ozone trails (done and will present the tourist offer of Kragujevac and Kraljevo), accommodation units (that would be rural households, in the villages of Gledić, Godačica, Ravanica, Leševo, Stubal and other villages), sports zones (located in Godačica near the Primary School and containing sports fields), medical and wellness zones tourism (opening salons of various contents), settlements (there is a possibility of construction on Samar, near Vasin water mill, in Kalenić and Ljubostinja). All these activities would be implemented in several stages, so that the Gledić Mountains would become an exemplary mountain destination.

Karst relief forms. The spectator mountains are built of limestone, so that karst forms of relief are represented, namely caves: Sibnička, Mala Tamnica, Mala, Gledićka, Lomnička and Sibnička pit. It enables the development of speleological tourism.

Fluvial relief forms are the most pronounced. It consists of the river valleys of the Dulenska, Županjevačka, Kalenićka, Pčelička, Lomnička, Kruševička, Dobroselička, Sibnička, Riljačka, Ljubostinjska and Čukojevačka River. The gorges of the Ljubostinj and Čukojevačka River in the upper and

middle reaches, Jarma and the Dubička River, tributaries of the Ljubostinj River, the Ravanica River, are also interesting. To the west of the Gledić Mountains are the valleys: Drlupska, Zakutska, Vrbetska, Čestinska and Lipnička River, and to the north: the valleys of Lepenica, Grošnička River (with a gorge in the spring) and Ždraljica. All these valleys and gorges are suitable for the development of excursion and recreational tourism.

Rivers as a tourist value condition the development of swimming and fishing tourism. In Dulenska, Županjevačka, Grošničko, Kalenica, Dobroselički, Kruševički, Čestinska, Čukojevka, Ljubostinjska, Riljacka, Ždraljica, the Lepenica spring has barbel, cattle, pear and brook trout. There are catwalks, chub and river crabs in the Gledić River. In Gruža there are barbells, redheads, vertebrae, creepers (lower and middle stream), crocs, saplings, and catfish.

Waterfalls and Cascade. They are accessible and can be reached by marked hiking trails. Those are:

- there are several small waterfalls and waterfalls two to ten meters high on the Ravanička River, a tributary of the Čukojevačka River, and a waterfall seven to eight meters high at the source
- on the Kamidžor creek in Gornja Sabanta, not far from Lipar, there is a waterfall of the same name 10 m high
- on the Dubočac stream in Donja Sabanta, near Lipar there are over 30 small waterfalls, ten of which are over three meters high (including the Vineyard stream, a tributary of Dubočac)
- there are waterfalls Mali Buk 2.5 m high and Veliki Buk five meters high on the Karovski brook in Čestin, the source arm of the Čestinska river, tributaries of Gruža
- there are several stepped waterfalls about five meters high on Bajčetinski brook, the source arm of the Grošnica River, in the village of the same name
- on the Kruševička river, tributaries of the Dulenska river are the waterfalls Mali Buk (four meters) and Veliki Buk (eight meters)
- at the Raletinca Monastery there is a waterfall about three meters high
- on the Siljevačka River, in the village of the same name, a tributary of the Krušević River is a waterfall 15 m high, one of the largest in the Gledić mountains and in Šumadija
- there are several small waterfalls and waterfalls on the Mala Reka, a tributary of the Dobroselička River in Bogalinac
- on Samar, the highest peak of Gledić mountains, on its southern slopes there is a waterfall 10 m high
- there is a waterfall three meters high on the Govedarički creek upstream of the Kalenić monastery
- a waterfall on the Greek creek in the village of Gledić, 1.5 m high.

The lakes in the Gledić mountains are fringed, such as Grošničko (white fish-roach, redfish, bleak, woodpecker, chub, prussian carp), carp, catfish and perch. In Dragovac Lake there are carp goad, carp wild boar, white toast, catfish, grass garp, bandar-perch, babushka, klen, roach, cattle-beetle, chub, pike and other species. She also has shells. It was stocked in 1967.

The other lakes are: Dulensko, Godačica, Preveštansko, Oparićko, and the bars: Rogozna in Gornja Sabanta, Nedina in Donja Sabanta, Velika Kruševička in Velika Kruševica.

Sources. There are about a thousand springs in the Lookout Mountains. The source of „Speech-water", below the summit of Grad, on the left bank of the Sibenik River, in the area of the village of Sibnica, near Rekovac, is of particular interest to tourists. It has medicinal properties. It is arranged and can be reached by a rural gravel road. It is a type of intermittent source, a fly or a secret.

Medicinal waters are: Vidarica and Bar (sulfuric) spring in Grošnica, Radovanac and Bakarnjača in Donja Sabanta, salt spring in Grošnica.

Climate like tourist value. The weather is temperate continental (with heat summer, cold winter, fresh spring and warm and arid autumn), and from 800 m above sea level a sub-mountainous climate with this fresh breeze and a rather cold winter humid. The climate made the most of the tourist's moving point of destination annually.

The wildlife and the world of life are complementary tourist motifs, with many tourist attractions. Introduce them to small forest kits and grasslands (meadows and pastures). Forest complexes of mixed forests are in Kalenić Prnjavor (pronunciation of the Kalenićka River) on an area of 1,000 ha and in Erdeč-Bajkovac (Bajkovačko-Erdečka Forest) on an area of about 700 ha. In the picture of Grošnik river under forest 2,300 ha. Confier forest has in Županjavac (Big City, Strazevica), Bajkovac (Watts), Dobroselici, Ava Meadows (Male Meadows), Grošnica (Gradina), Doja Sabanta (Watchtower), Rekovac (Glavaja), Čistinu (Kamenac) pronounce Kalenićke rivers), Ravanici (valley of Ravanička river), valley of Love river.

There are oaks over 300 years old in the Glad Planning area, as well as other types of older trees.

They all attract the attention of the tourist, as her magnificent body dominates and captures her appearance.

ANTHROPOGENIC TOURIST VALUES

In addition to the natural ones, anthropogenic tourist values are also important, which make the Mountains of the mountains attractive and attractive. These are: monasteries, old churches, old cities, memorials, various objects of national architecture. Anthropogenic tourist values stimulate cultural and manifestation of tourist movements (Stanković, 1994).

Moravian-style architectural monuments are categorized as cultural property of exceptional importance to Serbia. They have an artistic and aesthetic value, such as the monasteries of Ljubostinja and Kalenić (Besermenji, 2006).

The first monuments witness the existence of life in this region and date back to the Roman period as well as to the Middle Ages. There were conditions for the construction of monasteries and fortifications.

Archeological sites. The remains of a stone tool were found at the Gradina site. In Čukojevac in Stari selo, utensils and crepes were found, which tells us that there used to be farmhouses (archeological site „Okruglica").

A settlement in Donja Sabanta dates from the Roman period, and a Roman well built in bricks, 13 meters deep, was found in Grošnica.

There are cemeteries in these areas: in Grošnica, Lipnica (above Beli spring in Polje), Čestin (in Zlatićev hill), Vitkovac (in two localities). In Donja Sabanta and in the Leševskom field there were Latin ones, and in Peceno, there was a Jewish cemetery. There are Serbian and Hungarian medieval cemeteries in Veliki Pčelice (15), Dulen, on the road between Grošnica and Erdeč during the Austrian occupation, Dragobraća, Erdeč, in Stubel on Kovaluk and in Stari selo, Čukojevac (on the right side of the Čukojevac River).

Medieval localities: Panjevac and Smrdan (medieval necropolis) in Goločel; Selište and Seleštance under Džepar on Medna, the Old Village under Mammoth Hair in Donja Sabanta; Dulen Karaula; Guards and Arnaut huts in Grošnica; the monastery of Zgodačica in Godačica; the church (now there are stone slabs without an inscription) in Kraljevačka Sibnica.

The old cities date back to the Middle Ages. They were erected on the more difficultly accessible hills of the Gledić Mountains. The cities were fortified with stone walls. The places where the old fortifications are located are called town, fort, fort. Fortified cities existed in: Županjevac (Roman and Middle Ages), Grošnica (Roman period, Middle Ages: Jerina's castle, on the hill of Gradina, Staro selo, Cemetery and Crkvina), Dulen (town „Silne Jerine", on the site called Gomile, with a circular foundation. It was built of stone from the surrounding area. The wall is one meter high), Čukojevac, Grabovac (Jerina's town), Nadrlje (Nikola Boljar's son-in-law's son-in-law Jerina), Rekovac (on Heads), Preveštu (arrows on City Hill), Dubič. In Erdeč, in the area of Zbegovište, the traces of an old fortress are known (it is assumed that it was a town built by the Serbian despot „damn Jerina" and is called „Jerina's town"). In the village of Vrbeta there is a village near Selište where the walls are dug, and below the present-day Krdzović and Djordjević houses were once village houses, and this place is called Selište. In Gruža, there was a Roman settlement that housed parts of the Seventh Roman Legion. In Leševo, on the Gradina, there were walls of a „Latin city". Near the monastery Kalenić are the remains of three ancient cities.

The church has many places. There used to be monasteries or churches. They are found in: Velika Pčelica, Dulen (Middle Ages), Kaludra, Lepojević, Nadrlje, Sibnica (Rekovačko), Prevest, Županjevec, Vinište (settlement that existed before the Turkish era), Korican, Grošnica (Middle Ages), Goločelu (remains) from the medieval period: Selište, the Old Cemetery and the Jewish Cemetery, the remains of settlements before the Turkish era), Čestin, Godačica (Prnjavor), Zakutin (there used to be a log cabin in the area of Crkvina), Vrbeti (between Vrbeta and Sibnica), Sibenik (Kraljevo), I will watch (in the place of Duvarincet), Rajinac, Bogdan, Donja Sabanta in the place called latina, Stublo the Kovaluk, Čukojevcu in the Old Village.

Churches were erected mainly in the second half of the 19th century. These are: Županjevec (erected in the middle of the 19th century), Godačica (built between 1875 and 1877), Grošnica (St. Peter and Paul, erected in the second half of the 19th century), Velika Pčelica (from 1888, the church St. Theodore Tyrone), Zakuta (erected in 1975), Upper Sabanta (Church of the Transfiguration of the Lord), Dragov, Oparić, Rekovac (St. Roman), Siljevica (St. Petka), Velika Kruševica (St. Nicholas).

The monasteries are predominantly medieval. These are: Ljubostinja (end of XIV century), Kalenić (beginning of XV), Kamenac (XV) in Čestin, Raletinac (second half of XIX century), Sarinac (end of XIV century) and Denkovac (end of XIII and beginning of XIV century) in Veliki Pčice. Monastery in Velika Kruševica with the church of St. Nicholas, which dates from the 15th century, Lipar in Donja Sabanta with the church dedicated to St. George the Great Martyr, erected in 1936 on the foundations of the old temple; Preradovac monastery between the villages of Lepojević and Oparić, St Petka Monastery in Stublo.

Memorials. There are about 80 of them. These are monuments, fountains, memorial skeletons, memorials, memorial plaques and memorial houses.

There are *pomen – plocas* in the villages: Donja Sabanta (1912-1918), Velika Pčelica (from the National Liberation Struggle and the First World War), Siljevica, Grošnica (1941-1945; from the National Liberation War) fighting), Erdeč, Vinišće, Male Pčelice, Trešnjevak, Korićani, Dragobraća, Đurisel, Stanovo, Gruža (warriors of the Drina Division), Ljubić (1912-1918, 1941-1945), Gornja Sabanta (1941- 1945, another plaque of the National Liberation War and from the First World War), Siljevici (1941-1945), Motrić (1941-1945), Petropolj (1941-1945), Adžin Meadows (at school). Dulen (at the Elementary School), Beloševac (from the National Liberation Struggle).

Monuments are located in the villages of: Medvedja (1876-1878, 1912-1918), Adžin Meadows (1912-1918), Čestin (1912-1918, near the Kamenac Monastery), Balosave (1912-1918), Ljubić (1912-1918), Lipnica (1912-1918), Vrbeta (1912-1918), Sibnica (Kraljevo) (1912-1918), Pajsijević (1912-1918, 36 unidentified heroes of Podrinjac killed in the battle of 1915 and memorial plaques from 1941-1945), Zakut (for the killed warriors of Zakut, Sibnica and Petropolje), Dobroselica (for four killed warriors in the First World War) Bogalinac, Kaludra, Lepojevic, Lomnica, Rekovac, Grošnica (eight monuments; memorial to the Kosovo refugees killed; from the First World War), Donja Sabanta (monument to Đuri Jakšić).

Monuments to fallen warriors in the wars of 1912-1918, 1941-1945. in Rekovac, Čukojevac, Dragovo, Korićani, Ravanica and Gornja Sabanta. Then, in Grošnica (four monuments shot on October 19, 1941 and shot from Metohija, as well as a priest shot from Gospic), Prevešt (killed Partisans on Lake Hair), Balosava (from 1941), Stublo (fighters of the Rasina Partisan Detachment).

Monuments – ossuary is located in Donja Sabanta, Lipar.

Monuments – houses are located in: Grošnica (water mill), Dulen (house of Vojin Pavlović), Lipnica (primary school building), Rekovac, Dragovo (Dušan Popović).

Monuments – faucets are found in: Prevešt, Nadrlje, Kaludra, Dobroselica, Kalenićka Prnjavor, Sljivica and Bogalinac from 1912-1918. years. Then, in the Great Bees, Lipnica, Gledić, Zakuta and Donja Sabanta from 1941-1945. year, Siljevici.

Monuments – honor are located in Godačica (Olge Milutinović), Gruža (Rade Šubakić), Dragobraći (Božane Prpić). Bust of Đuro Jakšić in Gornja Sabanta, bust in front of Oparić Primary School.

Old houses and watermills. There are a large number of authentic Serbian villages in the Gledić Mountains, which have not been reached by a modern way of life, and the population lives simply and modestly. Many houses are more than 100 years old (in the hamlets of Slatina and Jošovići in the village of Čestin and over 200 years old), and they still live in them.

The houses are in the style of old Šumadian architecture. There are about 180 houses made of mud and wood in this area. They are reminiscent of the old way of life in Šumadija and are an example of the preserved tradition of living in this area.

Mostly half-timbered houses and chutmars occur, less frequently are houses of the Moravian-Leftist type. *Semi – logcabin* has the most in Dragobraća, Cestin, Nadrlje, Vrbeta, Drlupa, Godačica, Milakovac, Bogalinac, Zakuta, Gornja Sabanta, Adžin Meadows, Vinisht, Gledic and Siljevica. There is *chatmars in* Milakovac, Županjevec, Dulen, Adžin Meadows, Čestin, Gledić, Siljevica.

In the villages in the Gledić mountains there are old snakes (the oldest in Dulen), old baskets, dairies (the oldest in Goločel), cattle huts or rubble (in Sljivica, Nadrlje, Gledić, Kalenićki Prljvor, Tresnjevak, Županjevec), old watermills (on Čukojevka river) in Čukojevac, Godačica and Gledić, Grošnica River in Grošnica and Tresnjevak, Dulenska River in Dulen and Velika Pčelica, Županjevacka River in Nadrlje and Županjevec; Kalenicka, Čestinska, Ljubostinjska, Ždraljica).

There are houses of the Moravian-Leftist type (from the second half of the 19th century) in the eastern part of the Gledicke Mountains.

The Dulen House is known for having a counseling session on September 16, 1941. The General Staff of the National Liberation Army and the Partisan Detachment of Serbia were there.

In the villages of the Gledić Mountains, there are preserved old houses in Donja and Gornja Sabanta, Veliki Pčelice, Adžin Meadows, Baljkovac, Tresnjevak, Grošnica, Nadrlje, Dobroselica, Županjevec and other settlements.

Protected houses: Milovan Senicic in the village of Pečenog (Seničići house).

The old school in Cestin (during the reign of Prince Milos Obrenovic at the Kamenac monastery), as well as the old school-house in Dragovo, Gornja Sabanta from 1873, where Djura Jakšić worked.

Old roads. An old road is in the village of Gornja Sabanta, on Krvačko Brdo (from the time of Prince Lazar). In Dulen, there are the remains of the old road, which led from Kruševac via Levča, all the way to Siljevica, then by hair across the Pčelickog atara to the „Evil Water" and to Osredak, and then through Dulen and Sabanta to Kragujevac. In Beloševac there are remains of an old Turkish road, which did not coincide with today's roads. The road to Kraljevo (Karano-

vac) was passing through Celestin to Čestin, where the Turks were constantly passing.

Special monuments are: Muslin's tomb (located at an altitude of 700 meters above the elevation of Iverak 777 m, between Veliki Pčelice, Dulen and Dobroselica), monuments to Prince Ilija Vukmanović and Stana Marković in Donja Sabanta. Wooden sculpture in Rekovac.

Museums. Dimović Ethno Museum, in the hamlet of Brakovska River in Veliki Pčelice, a memorial museum dedicated to the establishment of the First Battalion of the Kragujevac Partisan Detachment (in the Primary School building) in Lipnica, the National Museum in Duleni.

Mountain Lodge „Dr. Sonja Perišić" in Adžin Meadows.

Profile architecture objects. Chimney in Donja Sabanta.

ETHNOGRAPHIC TOURIST VALUES

Musical folklore, folk costumes and culinary specialties, as ethnographic and ethno-gastronomic tourist motifs in the Gledić Mountains, are interesting for both domestic and foreign tourists. They represent complementary tourism values and have a narrow contraction zone. Since the villagers are good cooks, this can affect the volume of tourism spending.

ANALYSIS OF TOURISM POTENTIAL

Analyzing the tourist potential of the Gledić Mountains, we can conclude that they are underutilized. The geographical and tourist-traffic position is favorable. The proximity of city centers and the network of roads are an advantage to take advantage of.

Natural tourist values are the basis of its tourism development. They come to the fore, the Lookout Mountains with landscapes, hydrographic objects, karst forms, richness of forests, is a promising tourist destination. Hiking trails, wells, hunting grounds have been developed. They condition the development of mountain, recreational and excursion tourism. Represents an air spa.

Anthropogenic tourist values are expressed and represented by the remains of medieval cities, monasteries and churches, which are centers of spirituality. Cultural and historical sights are complementary and condition the development of cultural and manifestation tourism.

The tourism material base is underdeveloped. In the periphery there is a hotel "Euro-Gaj" on the road Kragujevac-Kraljevo.

In order to develop tourism in the Gledić Mountains, it is necessary to market the tourism product, tourist propaganda, which would affirm values, which would lead to tourism development and significant economic results. Inter-municipal cooperation is required for tourism development, because the Gledić Mountains are located in the territory of several municipalities.

It has a wide dispersion zone, which allows a shorter stay for rest and recreation.

CONCLUSION

The Gledić Mountains have been relatively little studied. Tourism development in this area has a bright future. The villages of the Gledić Mountains preserve the traditional way of life of the population. It enables the development of rural tourism.

Based on the presented tourist values, we can conclude that the Gledić Mountains provide an opportunity for active rest, recreation and relaxation. They condition the development of multiple types of tourism. Given its values, it has all the prerequisites for affirmation in the tourism market.

Nature and culture are often a motive for coming to a tourist destination. New experiences, new experiences motivate tourists to visit the Gledić Mountains. Successful placement of a destination in the tourist market requires knowing the motives of arrival, the availability of information, whether tourists are satisfied with the visit. It is important to find out the interaction between natural and anthropogenic resources, on the one hand, and the expected tourist experience, on the other. The tourism product should be formulated as an attractive product offered to tourists seeking to get acquainted with the Gledić Mountains. An important way of interpreting the Gledić Mountains is that it can only create an experience.

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ENGINEERING-GEOLOGICAL ASPECTS OF THE DEVELOPMENT OF THE REGIONAL MODEL OF TERRITORIAL PLANNING

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Abstract

In the development of regional models of spatial planning, issues of assessing the engineering-geological conditions are important. The territory of the Krasnodar Region is characterized by a variety of natural conditions and the development of the economic complex. Exogenous (landslides, erosion, abrasion, flooding of territories) natural geological processes pose a great threat to the economy and security of the population of the region. Regulatory documents on engineering surveys for the preparation of territorial planning documents, territory planning documentation and site selection (construction route) provide for the preparation of maps of geotechnical zoning of the territory and maps of territories at risk of natural and technogenic emergencies. As a result of the study, a set of spatial data was generated on hazardous exogenous processes in the form of digital information resources. An evaluation scheme for engineering and geological zoning was created, and a characteristic was given to identify by the degree of favorable conditions.

Keywords: territorial planning, geological processes, GIS technologies, geotechnical zoning, complexity assessment

Introduction

Krasnodar Region is one of the largest and most developed regions of the South of Russia. It occupies a favorable geographical position, has a high resource and personnel potential. The situation near the Azov Sea and the Black Sea, the landscape diversity of the territory, the high density of linear objects contribute to the development of industrial production, agriculture and the recreational complex. Krasnodar Territory takes the 3rd place among the regions of Russia in terms of the number of inhabitants. As of January 1, 2019, the population amounted to 5648.2 thousand people. The total forest area is 1.8 million hectares. The largest in Europe, the Azov-Kuban artesian freshwater groundwater basin, is located on the territory of the region. Krasnodar Region is the oldest oil producing region of Russia. Production has been going since 1864. The region produces about 7% of gross agricultural output in the country. Volumes of housing commissioning for a number of years ranks second in Russia. The region has a developed infrastructure, including railways, roads, airports, sea and river ports, trunk pipelines.

The Town Planning Code of the Russian Federation (chapter 3) refers territorial planning of territories to the scope of regulation. The most urgent task of the city-planning complex of the Krasnodar Region is the creation of a territorial planning system of different levels. The modern development of the territories should ensure the safety of the population, trouble-free functioning of engineering structures, engineering protection of buildings and other capital construction facilities. Questions of assessing the complexity of engineering and geological conditions have great importance for development of regional models at territorial planning.

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Regulatory documents on engineering surveys for the preparation of territorial planning documents, territory planning documentation and site selection (construction route) provide for the preparation of maps of geotechnical zoning of the territory and maps of territories at risk of natural and technological emergencies.

As you know, the map provides the best visualization of the display of geological processes, the speed of perception of spatial information, and the convenience of analysis. The first map of engineering-geological zoning edited by M.I. Cherkasova was built in 1968 using materials of those years. In 2004, temporary creative teams collected and systematized archival and fund materials and created a map of the engineering and geological conditions of the Krasnodar Region (M 1: 200000). Currently, we must link the materials of geotechnical conditions of Krasnodar Region, which were accumulated over the past decades, with the process of territorial planning.

Our experience in the construction of Olympic facilities, the Kerch Bridge, and federal highways on our Krasnodar Region showed that the question about choosing the most optimal territory for future construction arriving already at the stage of territorial planning. Exogenous geological processes (landslides, erosion, abrasion, etc.) are a great threat to the economy Krasnodar Territory and security of the population. Different parts of our region are characterized by unique complexes of dangerous geological processes and appearances. Issues of flooding and waterlogging of soils are relevant for the steppe agricultural regions of our region., Mudflow processes are periodically activated on the tributaries of the large rivers such as Ashe, Psezuapse, Shahe, Mzymta after prolonged rain showers at the mountainous part of the southern coast. So, more and more investors are starting to enter the construction market using western experience in conducting a preliminary set of studies to select the optimal and safe construction site in various areas. Therefore, we must to conduct an early assessment of the engineering and geological conditions of the sites, both the future construction of facilities and those in operation.

Materials and research methods

The relief and climatic conditions of the territory play a key role in the development of various dangerous natural processes. By the nature of the variability of the relief, the territory of the Krasnodar Region includes five different regions of the variability of the relief.

Region I has very low relief variability and is located in the western Azov part of the Krasnodar Region. It includes the eastern part of the Taman Peninsula. There are a lot of estuaries and flooded zones here. It approximately coincides with the Priazovskaya lowland valley of delta alluvial deposits in geomorphological terms. This area is not subject to water erosion but potentially is subject to very weak wind erosion. The upper part of the section is composed of upper Quaternary sediments and is represented by sands, pebbles, sandy loams.

Region II of low values of relief variability adjoins from the east to region I and covers it from the north. It includes zones of accumulatively erosive loessial Pliocene-Quaternary plain on the substrate of Scythian clays and the Lower Quaternary delta and coastal terraces of the river Kuban. River flow is regulated in this part. It is subject to weak (in its southern part) and medium (in its northern part) wind erosion, The upper part of the section is composed of quaternary deposits of sand, pebbles, conglomerates, and sandy loams of different ages.

Region III is a region of the mean relief variability. It adjoins from region II to the east. In geomorphological terms, it includes zones of accumulatively erosive loessial Pliocene-Quaternary plain on a substrate of Scythian clays and the Lower Quaternary delta and coastal terraces of the river Kuban in its northern part. It includes the northern foothill gently sloping and intermountain synclinal terraced plains and terraces in the southern part. It is subject to weak (in its southern part) and medium and strong (in its northern part) winds. In the structure of the upper part of the section, quaternary deposits of sand, pebbles, conglomerates, and sandy loams are developed of different ages.

Region IV is a region with high relief variability covers the southern part of the territory of the Krasnodar Region. In geomorphological terms, it includes foothill gently sloping and intermountain synclinal terraced plains and terraces in its northern part, and mid-mountain erosion-tectonic relief in the area of development of Neogene anticlinal and brachianticline structures and other forms in the southern part. Water erosion has development from weak in the northern part to strong and very strong in the southern part. In general, the region is characterized by large lateral and vertical variability in the composition of base rocks and overlapping sedimentary complexes of the upper part of the section.

Region V has very high relief variability and is located in the central part of region IV. In geomorphological terms, it contains alpine glacial-erosion-tectonic relief and other geomorphological forms of the highlands. Water erosion is very strong.

Difficult physical and geographical conditions are the cause of great variety of climate in this area. We can distinguish transitions from the continental dry climate in the northeast of the region to the temperate continental in the Prikubanskaya lowland and the warm humid climate of the foothills, from the cold climate of the highlands to the subtropical on the Black Sea coast. We can distinguish 4 districts by hydro meteorological features: the first - the Black Sea coast and the southern slopes of the Northwest Caucasus. The second are the Azov coast, the foothills and northern slopes of the Northwest Caucasus, and the steppe part. Precipitation is the main climatic factor determining the magnitude of surface and underground runoff. Atmospheric condensation are distributed extremely unevenly at the territory of the Krasnodar Territory, especially in mountainous regions. In general, the amount of precipitation during the year increases in the territory from north to south and averages in most of the lowland areas 500 - 600 mm, in the foothills and in the adjacent lowland areas it increases to 700 - 800 mm, and in the mountains - up to 800 - 3000 mm. The maximum rainfall on the flat territory falls in the summer, and on the coast - in the cold part of the year. In total, 17 districts are distinguished according to the characteristics of the moisture regimen in the Krasnodar Region. Humidity factors vary from 0.25 to 0.6 or more.

These characteristic of geomorphological and climatic parameters allows us to analyze regional spatial and temporal patterns of the formation of dangerous geological processes and to evaluate and regionalize the territory, taking into account the exposure of engineering objects to their negative influence.

Assessment of territories by environmental conditions provides for both a separate assessment of the components of the environment, and a summary of various types of activities (industrial and civil construction, recreational facilities, etc.). In this regard, we propose to include maps of dangerous geological processes and an integrated map of geotechnical zoning in the regional model of territorial planning.

Geographic information systems are the most effective tool for working with databases, spatial modeling and analysis. That why they can be successfully used to create urban planning documentation. The main body of research was carried out using the method of cartographic analysis in the geographic information system ArcGIS, ArcMap application.

At the first stage, the available cartographic materials were brought to a single cartographic basis.

We received cards:

- the degree of dissection of the relief;
- distribution of specific soils (swelling and subsidence);
- the territory is affected by subsidence relief forms;
- affection of the territory by flooding;
- the impact of mudflow on the territory
- landslide damage to the territory;
- damage to the territory by landslide-talus processes;
- affected area gully erosion.

They are shown at Figure 1.

The Prevalence rate (K), which reflects the degree of affection of the territory by process is the basis for the construction of maps. The coefficients were calculated based on the total area of territories affected by

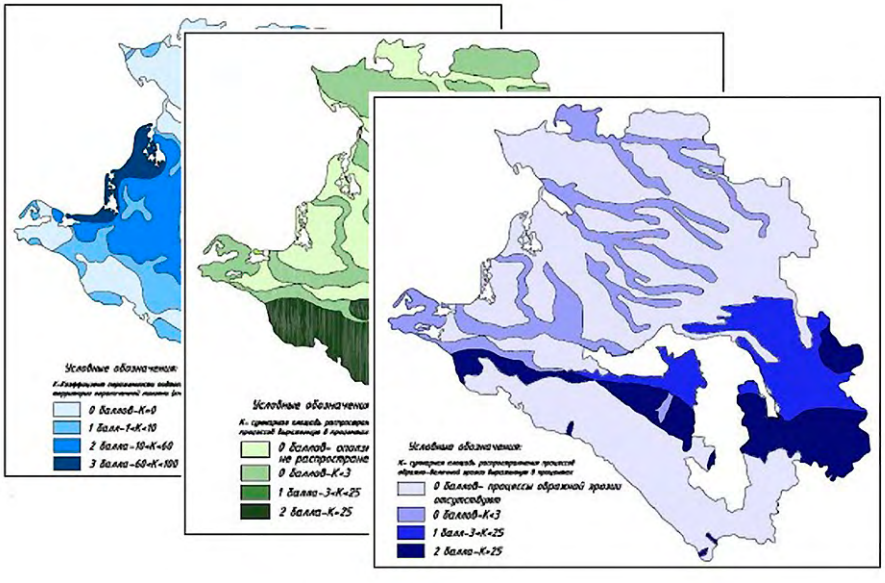

Figure 1. An example of schematic map of the defeat of the territory of the Krasnodar Region by various dangerous exogenous processes

the process, expressed in percent and based on available data.

Point rating method was used for a comparative assessment of the complexity of the engineering-geological situation. In a broad sense, point rating method is the expert determination of the most significant factors, criteria, which are assigned weights depending on their importance. Qualitative estimates for each of these criteria are expressed quantitatively, i.e. they are assigned points. The final grade is calculated as the arithmetic average of all points for the selected influence factors, rounded to the nearest integer according to the rules of mathematical rounding.

Next, we carried out overlay operations and took as a result new combined layer of characteristics of ARC / INFO coatings with new attribute data. Overlay analysis operations provide highly professional means of combining and analyzing graphic information. They include the possibility of mutual overlapping of polygonal, point and linear coatings and a number of other functions based on the spatial and topological relationships of objects.

The results of the research

The result of the work was a schematic map of the estimated engineering-geological zoning, shown in Figure 2.

The color code of the schematic map was adopted according to the "traffic light principle". Territories that are characterized by the most favorable engineering and geological conditions and have a minimum hazard score are colored green, and we highlighted the territory that has adverse conditions and maximum hazard in red.

Interpretation of the results showed that about 30% of the territory of the Krasnodar Territory is characterized by the most favorable engineering and geological conditions for construction. This is the northern and northwestern part of it. About 35% of the territory of the Krasnodar Territory is characterized by conditionally favorable engineering and geological conditions. Such areas are common in the central part of the region. Adverse conditions characterized by about 28% of the territory of the Krasnodar Territory. These are territories confined to the mountainous and lowland parts of the region. Extremely unfavorable engineering and geological conditions characterize about 7% of the territory of the Krasnodar Territory. Regions with such characteristics are confined to the mountainous territory of the region.

At the next stage of the development of the regional model, we imposed the boundaries of the cadastral division on the estimated map of engineering-geological zoning. Without the presence of administrative-territorial borders, we will need time to search and link objects to a specific territory and geotechnical conditions (Fig. 3).

This allowed us to analyze the obtained synthetic schematic map and propose solutions for urban development of the territory.

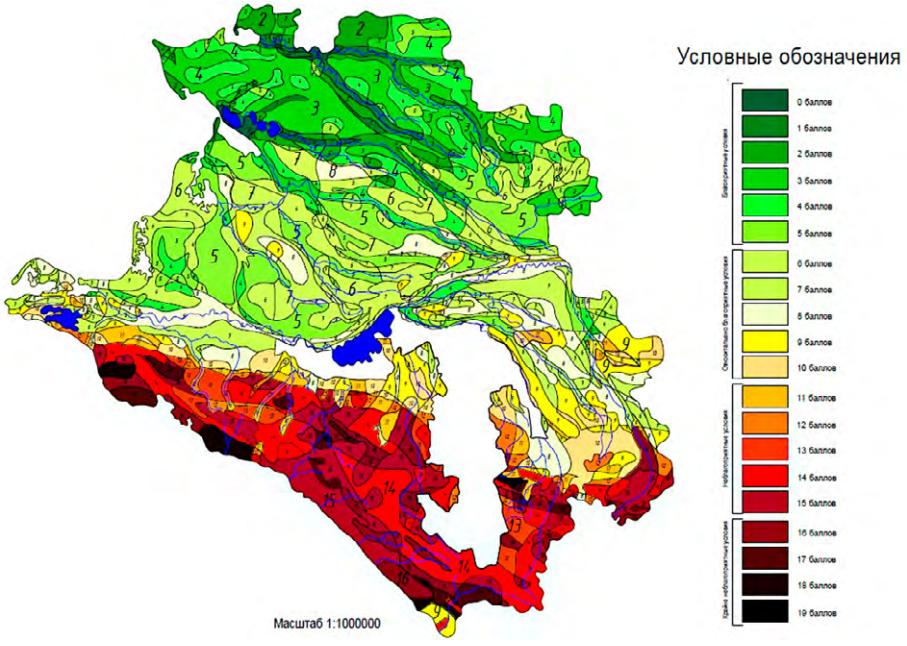

Figure 2. Schematic map of the estimated engineering-geological zoning of the territory of the Krasnodar Region

Figure 3. Schematic map of the cadastral division of the territory of the Krasnodar Region

Conclusions

Creating a schematic map of the estimated engineering and geological zoning of the territory of the Krasnodar Territory can become a framework on the basis of which we will carry out territorial planning and solve the problems of assessing the risks of dangerous geological processes and possible damage from them.

The use of GIS methods contributes to a significant increase in the accuracy and detail of mapping, which is necessary for territorial planning at the regional level. The resulting graphic materials will allow developing restrictions in the rules of land use, to consider licensing of natural resources and subsoil use, to regulate economic activity as soon as possible with minimal financial costs. The possibility of combining the digital map layers in any combination allows us to create unique business mapping documents for all consumers of this information. With regard to spatial planning, this means adopting a research-based project proposals, based on a comprehensive analysis of the data.

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GIS APPLICATION IN ANALYSIS OF NATURAL CONDITIONS FOR THE GENESIS OF TORRENTS IN TERRITORY OF LOEQ „VLASINA“

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Abstract

In this paper predisposition of the terrain for the emergence of torrents by application of Geographic Informational Systems (GIS) was made. Due to great ecological importance of this area, it is necessary to continuously monitor the state of the environment. High rainfall over a short period of time is the main cause of torrential floods, and because of the high elevation of Vlasina, the average annual rainfall exceeds 800 mm. The method used to determine the predisposition of a landscape of exceptional qualities (LOEQ) „Vlasina“ on occurrence of torrential flood is the Flash Flood Potential Index (FFPI). To identify the possibility of torrential floods occurence, natural conditions were analyzed: slope of the terrain, types of geological substrate, vegetation density and the way the land use. Using the GIS tool, a map of the susceptibility of terrain to the occurrence of torrents in the territory of LOEQ „Vlasina“ was obtained, and the classification of rivers was made based on the probability of occurrence of torrential floods on them.

Keywords: Torrents, GIS, LOEQ „Vlasina“, FFPI

Introduction

Natural or anthropogenic calamities may cause huge material damage and, unfortunately, the loss of human lives. Quantifying the extent and coverage of damage due to flooding is extremely difficult (Alcantara, 2002; Toya and Skidmore, 2007; Spalevic et al., 2017; Blöschl et al., 2019; Lovrić et al., 2019). The occurrence of natural and anthropogenic extreme phenomena all around the world makes us pay more attention to their environmental and economic impacts (Guzzetti et al., 2005; Schmidt et al., 2006; Lerner, 2007). Floods, in all their various forms, are the most frequent natural catastrophic events that occur throughout the world (Berz et al., 2001; Barredo, 2007). Among natural hazards with serious risks for people and their activities, torrential (flash) floods are the most common hazard in Serbia (Ristić and Nikić, 2007; Ristić et al., 2012) and the most significant regarding huge material damage and loss of human lives. The frequency of these events, their intensity and diffusion in the whole country make them a permanent threat with severe consequences to environmental, economic and social spheres (Ristić et al., 2012).

The most commonly used both globally and in our region, is the Flash Flood Potential Index (FFPI). This method was developed at the Colorado Basin River Forecast Centre (USA). Its main purpose is to supplement the conventional tools, such as Flash Flood Monitoring & Prediction System (FFMP). The Flash Flood Potential Index (FFPI) is determined by using GIS software tools through a statistical approach based on the principle of established correlations between the factors and the spatial distribution of drainage basins of the flash flood basin, or heuristic approach, indexing weighting factors, i.e. assigning a weight to individual factors which cause flash floods on the basis of empirical experience (Smith, 2003; Ristić et al., 2009;

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Prăvălie & Costache, 2014; Minea et al., 2016; Kostadinov et al., 2017; Novković et al., 2018).

Serbia has not been included in the most recent studies that have examined flood hazards within the territory of Europe and globally (Barredo, 2007; Mosquera-Machado and Dilley, 2009).

The Vlasina area is very interesting for testing the susceptibility to torrents due to the large floods that have occurred in this area before. The most famous one is from 1988, when the Vlasina River took bridges, destroyed homes and damaged hundreds of acres of arable land.

Material and methods

Study area

Natural property, the landscape of exceptional qualities of "Vlasina", is located in southeastern Serbia, mostly in the territory of the municipality of Surdulica, and with small parts in the territory of the municipality of Crna Trava (Момчиловић, 2019). The area of exceptional qualities of "Vlasina" covers an area of 12,815 acres. There are 12,302.4 acres or 96% in the territory of the municipality of Surdulica, and 512.6 acres or 4% in the territory of the municipality of Crna Trava (ЗЗПС, ПИО „Власина", 2014).

Vlasina Plateau is located in southeastern Serbia, not far from the Serbian-Bulgarian border. According to its surface (with coastal sides about 150 km^2) and the above sea level altitude (the lowest point of the plateau is about 1,200 m), it is one of the most extensive and highest plateaus in Serbia. It is about 30 km away from the South Moravian basin. The plateau is surrounded by high mountains and often scattered between their peaks.

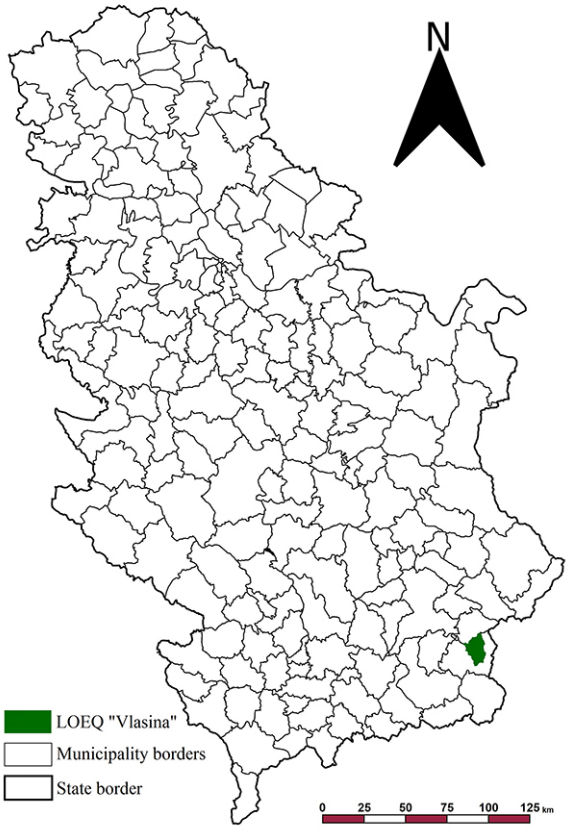

Figure 1. Study area - LOEQ „Vlasina"

On the north side of the Vlasina plateau rises the Gramada mountain (1,721 m), on the west the mountain ranges of Cemernik (1,638 m) and Vardenika (Veliki Streser 1,876 m), on the south side of the Milev mountain (1,733 m), and on the east, towards the Jerma basin, there is a relatively lower area at about 1,400 m (ЗЗПС, ПИО „Власина", 2014).

Metodology

The method used to determine susceptibility to the occurrence of torrential flood is Flash Flood Potential Index (FFPI). It was developed primarily because that torrential flood prediction, based on a survey of meteorological parameters, did not give adequate results and did not define connection between the occurrence of this disaster and certain physical-geographical characteristics of some territory. The structure and texture of the soil are characteristics that define water retention and infiltration. Slope and basin geometry determine the speed and concentration of runoff. Vegetation and structure of the canopy equalize the entering of the atmospheric water in the surface. Land use and urbanization in particular, have an important role in the infiltration of water, concentration and behavior of runoff. Together, these rather static qualities, provide information on the possibility of a torrential flood in a certain area (Smith, 2003).

Of course, they are also subject to dynamic changes. For example, seasonal changes in the vegetation of deciduous forests significantly affect the possibility of the development of mentioned process, and forest fires, in addition to changes in the vegetation, adversely affect the soil, in which, due to the burning of organic matter infiltration power is reduced. The use of this method, as an evaluation methodology of the potential of flash-floods formation, has a special importance, because they represent actual issue in the contemporary society. The pragmatic result of the proposed index is in the spatial representation of the areas with a flash-flood risk, therefore, giving possibility to prevent the negative effects (Prăvălie & Costache, 2014; Lovrić et al., 2019). Calculation of FFPI is performed according to the formula (Smith, 2003):

$$FFPI = \frac{M+S+L+V}{4}, \text{where}$$

M is slope index, S is rock type index, L is land use index, V is vegetation density index.

The slope index (M) is calculated in GIS, based on 25 m digital elevation model (DEM). At first slope is calculated, expressed in percentage, and then following formula is applied:

$$M = 10^{n/30}$$

where n is slope in %. If n is greater or equal to 30%, then M value is always 10.

Geological maps of 1: 100,000 of The Socialist Federal Republic of Yugoslavia scale were used for the analysis of rock types (S). A classification was made based on the predisposition of the geological base to the torrents.

Land use index (L) is calculated on the basis of CORINE Land Cover data (2018), where certain types of land cover were given values from 1 to 10, depending on the characteristics important for the emergence and development torrential processes.

For vegetation density index (V) was using the bare-soil index (BSI). For the purpose of obtaining the said index, the multispectral satellite images of the SENTINEL 2 satellite that belongs to the Copernicus were used. The remote detection technique has unparalleled advantages and potential in the field of regional land erosion assessment and torrents (Vrieling, 2006; Le Roux et al., 2007; Guo & Li, 2009; Mutekanga et al., 2010; El Haj El Tahir et al., 2010, Durlević et al., 2019). The bare-soil index is obtained by the following formula:

$$BSI = \frac{(B6+B4)-(B5+B2)}{(B6+B4)+(B5+B2)}+1$$

where $B6$ is the shortwave infrared spectral channel (SWIR 1), $B4$ is the red spectral channel, $B5$ is the near infrared spectral channel (NIR), and $B2$ is the blue spectral channel.

To obtain the V coefficient, the formula was also used:

$$V = 7.68 \cdot \ln(BSI) + 8$$

Results and discussion

The slope of the terrain is a very important factor in the analysis of natural conditions for the occurrence of torrents. As the degree of inclination of the terrain increases, the susceptibility to torrential floods increases.

The most common slope of the terrain is from 7.5 to 12.5°. The highest slope was recorded in the northwest and northeast part of the protected area, while the area of the lake and the terrain around the lake is characterized by flat, or slightly inclined terrain. On terrains above 10 degrees slope, combined with other natural conditions, there is a real chance of torrents. The mean slope of the terrain is 8.73°.

Of the rock types, metamorphic rocks account for the highest proportion of representation, while slight magmatic rock formations occur in the southern and western parts. Of the total protected area (127.4 km²), metamorphic rocks occupy as much as 110.36 km². Vlasina Lake covers an area of 14.12 km². Magmatic rocks cover 3.55 km² of territory and alluvial sediments cover the area of 0.11 km². Alluvial sediments occur around river watercourses. A geological substrate made up of metamorphic rocks increases the chances (combined with other geohazards) of torrents.

The map of land use shows heterogeneity in the use of space. A significant part of the surface is occupied by deciduous forests. The thicker the forest floor and the root system, the chances of torrents are less likely. Only one larger settlement was observed. Woody-

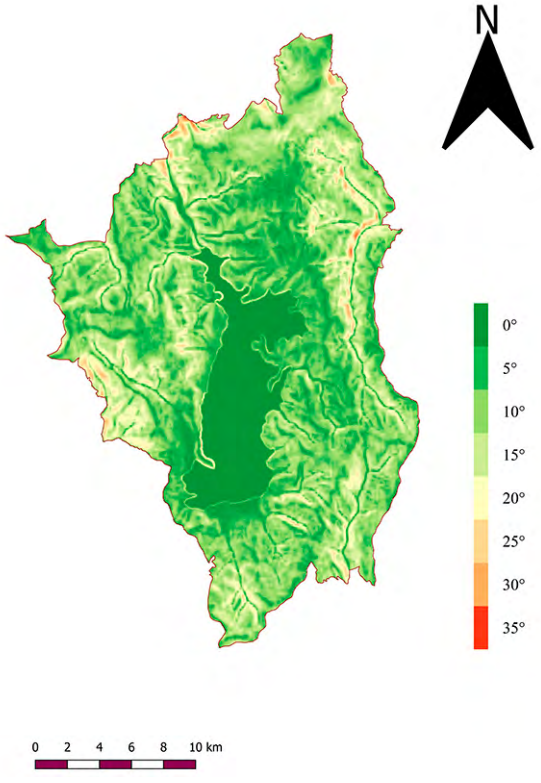

Figure 2. Terrain slope map

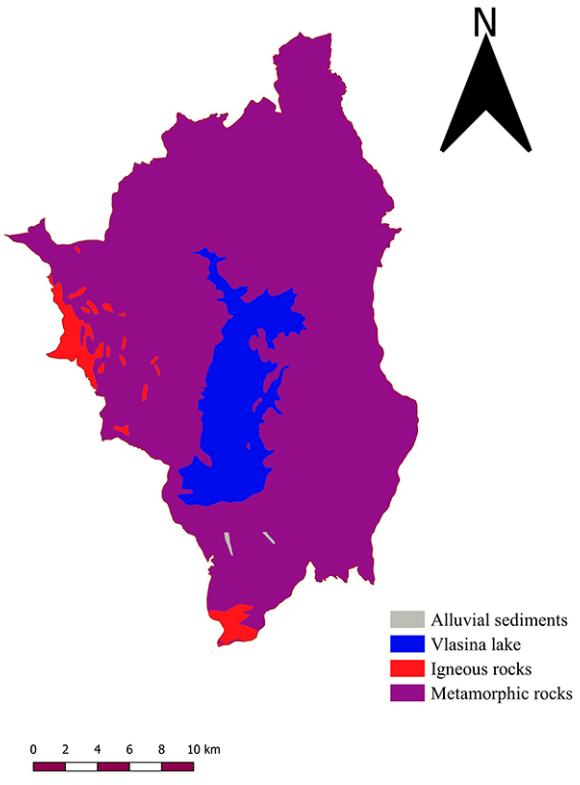

Figure 3. Geological map

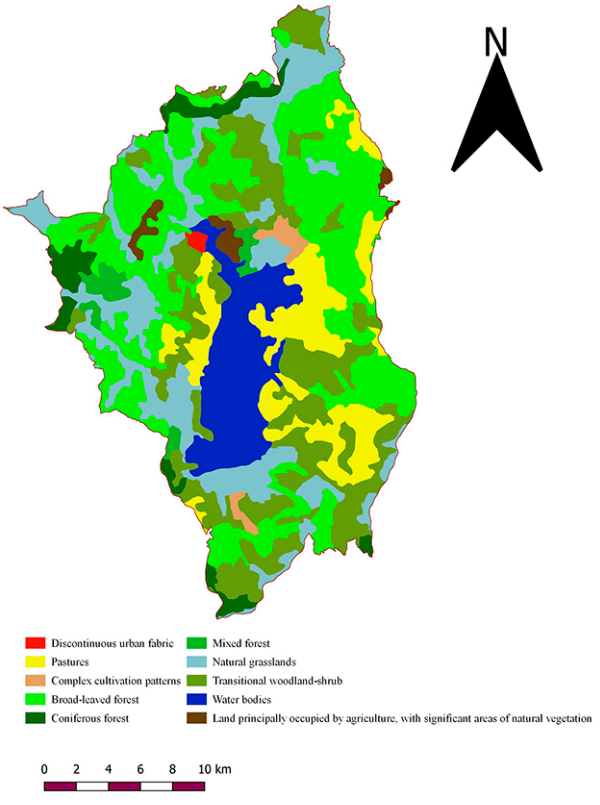

Figure 4. Map of land purpose

shrubby vegetation, as well as pastures, are also present in a larger percentage in the territory of the Protected Areas of Vlasina. The water surface is expressed in the form of Vlasina Lake.

Different levels of land without vegetation can be observed on the terrain map. Terrain dominated by forest ecosystems is represented by the lowest values due to dense vegetation. The orange depicts the

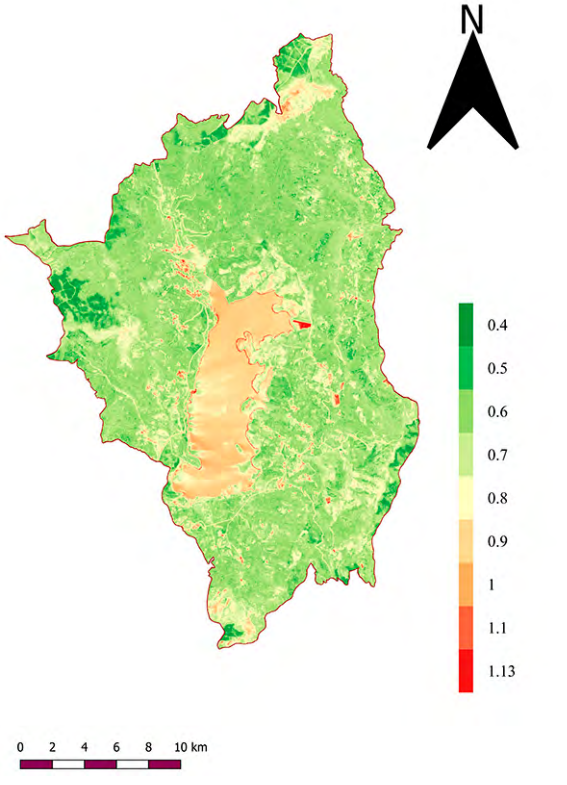

Figure 5. Map of the degree of the terrain denudation (BSI)

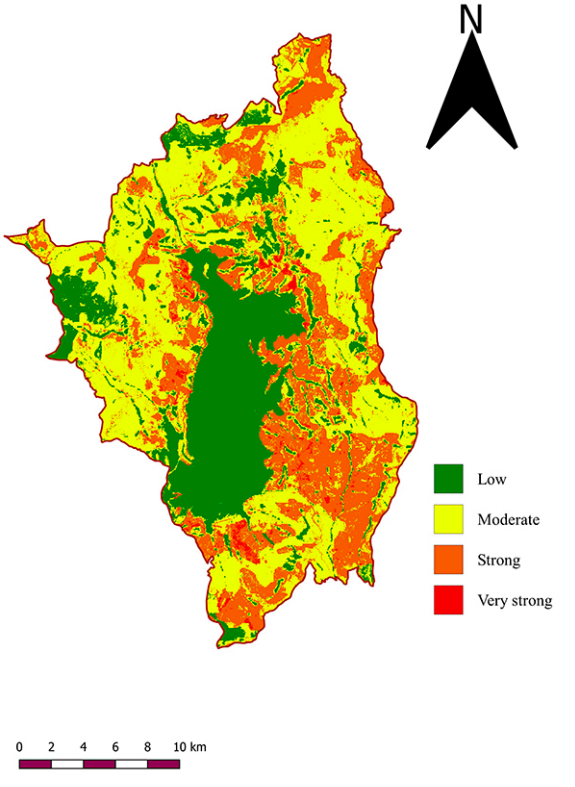

Figure 6. Torrential susceptibility model based on the Flash Flood Potential Index (FFPI) method

bare land, along with Vlasina Lake. The terrains that may be cited as areas with the highest degree of land without vegetation are the areas in the coastal zone whose relief is partially altered by exogenous processes. Also, the process of forest deforestation has a significant effect on increasing the level of land without vegetation, and thus increasing the chances of torrents.

As a final product of this model of torrent calculation, a synthesis map of terrain threatened by torrential floods is presented. The results obtained show the possibility of torrents under appropriate conditions. Whether this will really be the case, depends on a number of factors, which is why we are talking about the predisposition, that is, the susceptibility of the space for the emergence and development of this disaster (Новковић, 2016). After the classification of the Flash Flood Potential Index (FFPI) values obtained, it was found that the very high susceptibility class is represented at 1.5 km² of area and the high susceptibility class is 34.9 km² of area.

Table 1. Area of terrain threat classes by torrential floods according to the Flash Flood Potential Index method

Susceptibility to torrents	Area (km²)	Share in total area (%)
Very strong	1.5	1.2
Strong	34.9	27.3
Moderate	58.4	45.6
Low	33.1	25.9
Total	127.9	100

The obtained data show that in 28.5% of the terrain there is a strong and very strongsusceptibility to torrents, mostly to the east of Vlasina Lake. Moderate susceptibility is represented to a large extent (45.6%), while low susceptibility belongs to 33.1% of the territory.

Conclusion

Based on the processing of data in geographic information systems using the Flash Flood Potential Index method, classes of terrain threatened by torrential floods have been defined for the Protected Areas of Vlasina. Additional field research needs to be conducted in an area characterized by being strongly and very strongly susceptible to torrents. Intensification of anti-erosion works in the form of biological, biotechnical and technical works with the aim of reducing the intensity of erosion would greatly contribute to eliminating the damage caused by erosion and torrential floods.

Additional testing is required in the area of smaller tributaries of Vlasina Lake, which flow into the lake from the east side. Afforestation of the terrain and adequate management of agricultural land would lead to a decrease in the percentage of terrain under strong and very strong susceptibility to torrents. Continuous monitoring of the environmental situation in the Protected Areas of Vlasina will enable timely analysis and proper management of this protected area, especially about torrential floods.

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THE PROFESSIONAL DEVELOPMENT OF (FUTURE) GEOGRAPHY TEACHERS AND THE ROLE OF DIDACTICS OF GEOGRAPHY AS APPLIED GEOGRAPHIC SCIENCE IN THIS PROCESS

Karmen Kolnik[A], Eva Konečnik Kotnik[A]

Abstract

The article presents the results of a case study in which the professional development of geography students at the end of the 2nd Degree pedagogical study program Geography at the Faculty of Arts, University of Maribor was investigated. The students assessed the importance of the targeted competences in the program and then evaluated their own achievement. They also identified the role of Didactics of Geography in this process. Exposed are personal reflections of students. Students acknowledge the high importance of the target competences and the slightly lower level of self-achievement at the end of the study. Subject-specific didactic contents are the closest to real professional competence. Self-reflections indicate that professional development is satisfactorily stimulated during the study process, since students consider their ability to "critical evaluation of their pedagogical performance" among the highest evaluated competences.

Keywords: geography, professional development, future teachers, didactics of geography

Introduction

The professional development of teachers is a lifelong process. The teacher's understanding of his or her role and behaviour in the classroom are to a large extent shaped by very early influences: experiences in the framework of his or her family; experiences with learning / being taught at school, when the teacher was in the role of a pupil; training for the teaching profession, including acquiring geographic content and didactic training; first individual experiences with teaching; the working environment at school; continuous professional development; personal life experiences, etc. All these factors can affect an individual positively or negatively, which also influences how he or she will act as a teacher in the classroom (Knowles 2003, qtd. in Konečnik Kotnik and Javornik Krečič 2011).

Jaatinen (1994, qtd. in Niemi Kohonen, 1995) also notes that the teacher is the result of his or her "cumulative autobiography", which functions on the basis of constructs, beliefs and understandings of human beings, learning, growth and conceptions. We have observed that before deciding to enrol in a pedagogical study programme, geography students often ask themselves whether they should have been born with specific potentials and abilities to be good geography teachers at all. A potential positive answer to this question may represent a belief that significantly impedes the choice of a pedagogical study programme and professional self-realization. But it is a fact that the basic elements of a teacher's professionalism are behaviour and the way of communication, which form the so-called 'plastic competence', i.e. a competence that can be developed. If we associate the latter with a willingness to learn about geography as such and vocational learning, we have a good indicator of the learning achievements of potential pupils (Hattie 2009, Košir 2017).

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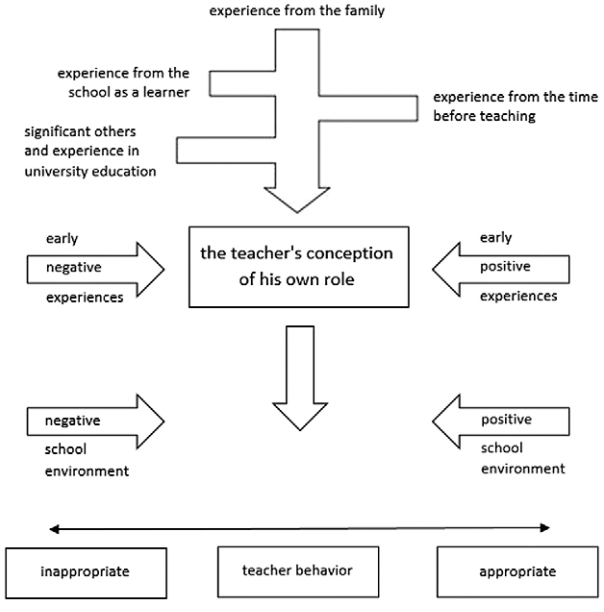


Figure 1. Impacts on teacher work in the classroom
Source: adapted from Kowles 2003 (qtd. in Konečnik Kotnik and Javornik Krečič 2011)

In the in-depth autobiographies of Slovenian geography teachers (Konečnik Kotnik, Javornik Krečič 2011), it was established that teachers indicated the following factors as major influences on the direction of their professional development: family, role-models of good geography teachers, undergraduate / graduate education, internships and the first years of professional experience. In this article, we will focus on university education as a factor in the professional development of geography teachers, thereby shedding light on some other factors.

So-called 'knowledge-in-action' is very important in the education of future teachers, therefore it is essential to gain as much practical experience as possible throughout the duration of their studies. In doing so, care must be taken to ensure that these experiences are diverse and appropriately intensified (Marentič Požarnik 2000, Tiessen 2000, Cvetek 2004, Razdevšek Pučko 2004). Almost two decades ago, we wrote in *Zelena knjiga o izobraževanju učiteljev* [*Green Book on Teacher Education*] (2001, 62) that "… professionalized models of teacher education enable the development of a wide range of professional activities, which teachers adapt to individual participants, objectives, tasks, content and situations. The development of these activities requires a wide foundation of knowledge, as well as a coordinated and coherent practice, which enables (future) teachers to become familiar with learning situations in which they can connect theory and competent reflective activity." The latter is particularly important so that future teachers can overcome the potentially obstructive beliefs they might have at the beginning of their pedagogical training, but also in wider professional practice, namely that "theory is one thing, practice is another."

Since future geography teachers need extensive and research-reflective supported knowledge in the field of geography and teaching it, as well as proven forms and methods of the practical use of knowledge, pedagogical geography study programmes in Slovenia are structured as can be seen from the comparison of the programmes of the University of Maribor and the University of Ljubljana.

Figure 2. Basic structure of the pedagogical geography study programmes at the University of Maribor and at the University of Ljubljana

Faculty of Arts, University of Maribor	Faculty of Arts, University of Ljubljana
Didactics of Geography 1 – 3 ECTS	Didactics of Geography 1 – 6 ECTS
Didactics of Geography 2 – 5 ECTS Didactics of Geography 3 – 3 ECTS	Didactics of Geography 2 – 4 ECTS
Pedagogical practicum: Geography 1 – 3 ECTS Pedagogical practicum: Geography 2 – 4 ECTS	Pedagogical Practice Geography – 6 ECTS
ICT in Geography Lessons – 3 ECTS	Organization and implementation of excursions and fieldwork – 4 ECTS
4 subjects of regional Geography (4 ECTS each)	5 subjects of regional Geography (4 ECTS each)
General subjects of the pedagogical, didactic and psychological fields	General pedagogical module
Elective pedagogical subjects and elective geographical subjects (include pedagogical fieldwork)!	Elective pedagogical and elective geographical subjects

Source: Internet 1 and Internet 2

The selected double-major pedagogical second-cycle study programmes of Geography consist of study subjects from the field of geography, aimed at learning about different spatial units and other geographical topics, of geographical didactic subjects and of general study subjects from the pedagogical, didactic and psychological fields, in which students acquire theoretical and practical knowledge in the field of education and the teaching profession. The courses in the last set are common to both study areas of the double-major study programme. The programmes include pedagogical practice in primary and secondary schools.

The basic goals of the pedagogical study programme Geography at the University of Maribor are thus the following:

- To educate future teachers who, by the time they complete the study programme, will have the knowledge, skills and competences which by international standards are considered to be fundamental in the field of educating geography teachers; thereby, these teachers will be qualified to teach geography at both the primary and the secondary school level.
- To educate future teachers who will be qualified to identify and analyze current processes and conditions in the field of education and to transfer these findings into documents and actions that are important for the development of education in both a general sense and in the context of teaching geography.
- To educate future teachers who will be able to critically evaluate the natural-geographical, social, economic and ecological conditions in the region / the geographical area with the purpose of educating for a sustainable development.

The programme also defines 15 subject-specific competences in teaching geography (Internet 1).

The purpose of the practical pedagogical training of students is to train them to systematically observe how teachers, experienced practitioners and fellow students teach, as well as to train them to plan, perform and evaluate lessons in accordance with modern pedagogical-psychological and didactic theoretical bases and good practice. Furthermore, the purpose is to develop students' awareness that they need to continuously reflect upon their own teaching practices, to adapt the planning and implementation of learning units to the needs of pupils, to collaborate with other teachers, as well as to continue their professional development and thus their professional growth. To facilitate this, we introduced a portfolio (as supporting pedagogical documentation) in the process of the pedagogical training of geography students, thus enabling students to self-reflect and have proof of their practical pedagogical achievements, as well as enabling their mentors (teachers-mentors and experts for didactics of the subject) to individually monitor and evaluate the students' progress and achievements (Kolnik et al. 2007). That is to say that learning in order to participate in a knowledge-based society has to be focused on forming skills of independent, critical thinking and deliberation, on the effective handling of sources and information, on team collaboration and lucid communication, as well as on presenting ideas. The portfolio strives for the aforementioned and at the same time represents an opportunity to see the quality of a particular student's progress and the results of his or her work also in the field of so-called tacit knowledge (skills, mental abilities, attitude to learning and the profession, etc.) (cf. Klenowski, 2002, Sentočnik 2004). By the end of the practical pedagogical training, students are expected to have developed competences related to work both in and outside of the classroom, competences related to school, as well as competences related to their own professionalism (Kolnik et al., 2007).

Research: Opinions of students, i.e. future geography teachers, about developing professionalism during their studies

The paper is going to present part of a broader study entitled "Self-evaluation of the Pedagogical Competence of Students – Future Geography Teachers", which was carried out from the academic year 2016/17 to the end of the academic year 2018/19. It encompassed all the students that in the academic years 2017/18 (14 students) and 2018/19 (8 students) were enrolled in the second year of the double-major second-cycle study programme Geography at the Faculty of Arts of the University of Maribor.

Definition of the content of the research

In the part of the research that we are going to present, we would like to specifically highlight the results related to the question what are students' personal reflections on the dilemmas and positive aspects of developing their own professionalism during their studies. We will also summarize some of the results, published in New Horizons in Subject-Specific Education (Lipovec et. Al. 2020), connected to the questions: how much importance students ascribe to particular competences identified in the study programme, which are to be acquired / developed during practical pedagogical training; whether there are any differences in the students' evaluation of the importance of the three sets of study subjects (general pedagogical-psychological-didactic set, geographical didactic set and elective courses set); whether there are differences in the assessments of the above research parameters between students of the two observed generations.

Participant sample and data collection process

The broader survey, encompassing two graduating generations of students, ran from 2017 to 2019 and in June 2018 (graduating generation of 2017/18) and July 2019 (graduating generation of 2018/19), when students completed a questionnaire and submitted their portfolio. The study encompassed all students

enrolled in the second year of the second cycle study programme Geography at the Faculty of Arts, University of Maribor in the academic year 2017/18 (14 students) and in the academic year 2018/19 (8 students). In total, 18 female students (81.8%) and 4 male students (18.2%) participated in the survey. Due to the low number of participants (although we covered 100% of all students enrolled) and the in-depth insight into the personal views of individuals, the survey has elements of a case study.

Methodological definition of the research

We approached the research with a combination of quantitative and qualitative research. We used a descriptive and causal-non-experimental method of empirical pedagogical research.

As a research instrument of the quantitative research, we developed a questionnaire for students who have completed two years of practical pedagogical education. In it, students evaluated, among other things, the competences listed in the study programme, which they should have developed during the practical pedagogical training, and their level of achieving these competences. Furthermore, the students compared the role / the importance of sets of study subjects in the study programme for developing their professionalism. Students performed the evaluation on the basis of five-level (descriptive) rating scales. First, we weighted the data from the assessment scales: we assigned numerical values to the descriptively expressed levels, ranging from a score of 1, which signified the lowest importance, to a score of 5, which signified the highest importance. The questionnaires were statistically processed in accordance with the purposes and presumptions of the survey; due to the number of participants (14 students in the first group and 8 students in the second group), we kept to the basic statistical parameters (mean rank and proportion of the answers). In addition, we used the portfolio of individual students as a research instrument of qualitative research. We reviewed the portfolios and made so-called 'condensed transcriptions' from the self-reflections. We summarized each reflection and highlighted those parts of the text that we found to be relevant to the research goals. By abstracting common features from the transcriptions, we extracted key factors that students highlight as important in their professional development during their studies, and are often repeated in written reflections. Some of the findings are illustrated and substantiated by the words of the students themselves (with quotations, whereby the names of the students have been changed); the parts we wanted to highlight are in italics.

Results and discussion

Below we will present the results of the research in three parts. In the first part, we will present some samples of students' reflections from the beginning of their pedagogical studies. In the second part, we will present quantitative evaluations of the level of achieving the study competences and the role of study subjects in developing them. In the third part, we will present samples of students' self-reflections from the conclusion of pedagogical studies, which, among other things, further illuminate the quantitative results.

Initial self-reflections

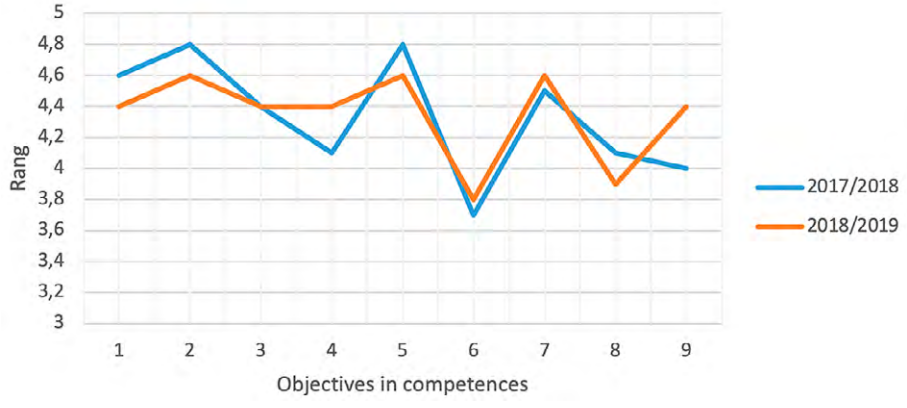
The initial reflections of students related to how they see their future profession, what they expect from teacher education and—connected to this—from themselves, show the influences of their family / life experiences and experiences from their educational path. We can also detect some limiting beliefs that can affect and even inhibit teachers' professional development.

- *"From the very beginning, I have had some fears about how I will handle more than 20 naughty heads, because I am considered to be a quiet and calm girl."* (Aneja, 2017/18)
- *"I have often witnessed poor teaching practices as a pupil, therefore I am well aware of what kind of teacher I do not want to be.* Above all, I want practical and applicative knowledge based on concrete examples. It means a lot to me if I can get any factual information that comes from the real-life experiences of teachers." (Minka, 2017/18)
- *"I value teachers who are fair, empathetic, have enough knowledge about the field they teach, and who care not just about facts (which pupils have to basically learn by heart), but who know how to present things in a way that they are appealing, closer and useful to pupils. I want to be such a teacher myself. I know that this is a skill that can be learned and I will try to do learn it."* (Nika, 2018/19)
- *"So far, through observing teachers, I have already developed ideas, but I would like to acquire skills in various motivational strategies for activating pupils, and to improve my knowledge of applications and teaching materials for better presenting the subject matter.* As far as the preparation, carrying out and evaluation of lessons, I also still do not have enough experience in how to prepare, how to adapt to specific learning environments and pupils' abilities." (Alica, 2017/18)

- *"I realize that as a teacher I will have to be a little more open about adopting new approaches to learning and new tools,* such as the use of interactive whiteboards or tablets. *I am accustomed to an approach where the teacher appears more or less in front of the class*, but already I am gradually changing my opinion." (Tona, 2018/19)
- *"Teaching trends are changing almost from year to year, and they keep pace with the times.* Especially because of the seminars in Didactics of Geography and ICT in Geography Lessons, *I noticed that teaching has changed a lot since I was a pupil."* (Tom, 2018/19)
- *"I already had some qualities [of a good teacher], but I lack content expertise… However, I am of the opinion that the certain qualities that a future teacher must possess cannot be learned at university.* What I would like to point out here is that you have to clearly and decisively step into the classroom and must not be afraid of being the centre of attention. *You also cannot acquire having a sense of children and you cannot acquire humanity; these are simply innate to you."* (Anita, 2017/18)
- "My previous work at a youth centre was dynamic and flexible, therefore it was important to be like that also and to act quickly. *Most often, only good execution was important, not theoretical knowledge. I therefore think there is something missing, that things could be done differently or easier. I wish I would have learned this during my pedagogical studies."* (Ana, 2017/18)
- *"Although I have worked extensively with children as a volunteer so far, I have no practical experience with teaching children from a different environment, children with special needs, gifted children. Mastering the subject matter will be a challenge.* Therefore, I cannot define my ability to apply appropriate approaches to diverse children. *I will have to put the most effort into improving how to organize classes and manage knowledge."* (Sandra, 2017/18)
- *"I want to become a good teacher, successful on the expert, pedagogical and personal level, who will constantly improve her knowledge in pass it on to younger generations, who will grow as a person during her pedagogical work*, since this is her life's mission, which will open up a broader view of the world to her." (Sanja, 2018/19)

Evaluation of achieving study competences and of the role of study subjects

Within the framework of pedagogical studies at the Faculty of Arts, University of Maribor, students of the double-major second-cycle pedagogical study programmes are expected to develop nine key compe-



Graph 1. Evaluation of the competences of the practical pedagogical training of geography students
Legend: Objectives and competences
1: Effectively observing and evaluating the pedagogical activities of experienced teachers and fellow students, and planning pedagogical activities based on this.
2: Identifying / defining the learning objectives and adjusting the planning and carrying out of lessons to the needs and capabilities of pupils.
3: Differentiating between pupils' level of cognitive, social and emotional development, learning style and strategies, etc.
4: Applying the principles for a quality preparation, execution and evaluation of learning units.
5: Using different methods, forms and techniques of teaching, assessing and grading knowledge.
6: Anticipating possible problems during pedagogical work in the classroom and planning how to solve them.
7: Critically evaluating one's own pedagogical performance.
8: Applying a research approach to problem solving in teaching and pedagogical activities.
9: Defining the needs for one's own further professional development.
Source: Kolnik, Konečnik Kotnik 2020, 187-188

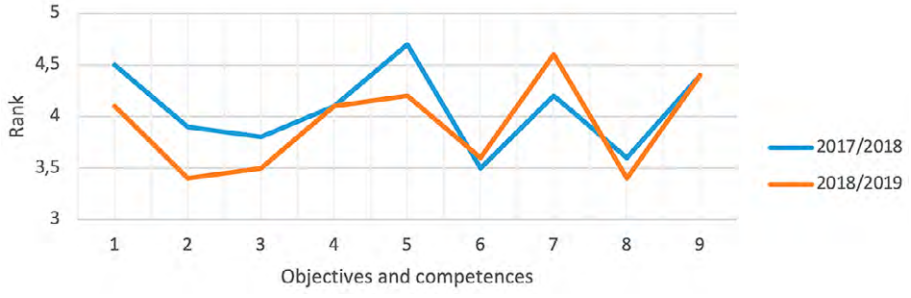
tences by the time they complete their studies. The students surveyed evaluated these on a five-point scale based on their personal assessment of how important a certain competence is for the successful work of teachers. Both surveyed generations of geography students evaluated the importance of the competences with scores ranging from 3.7 to 4.8 (2017/18 generation) and from 3.8 to 4.6 (2018/19 generation).

The competences "identifying / defining the learning objectives and adjusting the planning and carrying out of lessons to the needs and capabilities of pupils" and "using different methods, forms and techniques of teaching, assessing and grading knowledge" were given the highest score of 4.8 by the first surveyed generation. The second surveyed generation, however, rated three sets of competences as the most important (with a score of 4.6): the same two that the first group also rated the highest and "critically evaluating one's own pedagogical performance". The two groups surveyed rated the competency "anticipating possible problems during pedagogical work in the classroom and planning how to solve them" with the lowest score. The latter may be the result of the students' awareness that practicing the profession is very important for the development of this competence, but there is not enough of practice in the framework of the pedagogical study programme. (ibidem)

In the self-evaluation of the attained competences upon completion of the practical pedagogical training, the surveyed students of the 2017/18 generation assessed their success in the range between the lowest evaluated achievement (with a score of 3.5) for their competence in the field of "anticipating possible problems during pedagogical work in the classroom and planning how to solve them", and highest self-assessment (with a score of 4.7) for their competence "using different methods, forms and techniques of teaching, assessing and grading knowledge". The second group of surveyed students evaluated two sets of competences as their lowest self-achievement (with a score 3.6): "applying a research approach to problem solving in teaching and pedagogical activities" and "identifying / defining the learning objectives and adjusting the planning and carrying out of lessons to the needs and capabilities of pupils". In the self-assessment, the highest score of 4.6 was given to the competence "critically evaluating one's own pedagogical performance".

A comparison of the questions about the importance of particular competences for the successful work of teachers and about the self-assessment of the attained competences shows that in both surveyed groups the greatest differences in the assigned scores can be found in the set of competences from the field "identifying / defining the learning objectives and adjusting the planning and carrying out of lessons to the needs and capabilities of pupils". In the first surveyed group (2017/18 generation), the gap between the importance of the competence for successful work of teachers (4.8) and the achieved competence (3.9) is 0.9 points. In the second surveyed group (2018/19 generation), the gap is 1.2 (importance of the competence: 4.6; self-assessed achieved competence: 3.4). The 2017/18 generation of surveyed students evaluated the competence of "using different methods, forms and techniques of teaching, assessing and grading knowledge" with the highest score (4.8), and also self-assessed its achievement of this competence with the highest score (4.7). The difference between the two scores is minimal (0.1). The ability to "apply the principles for a quality preparation, execution and evaluation of learning units" was evaluated equally by both generations of respondents with a score of 4.1. The generation of students surveyed in 2018/19 assessed the competence of "critically evaluating one's own pedagogical performance" with 4.6 both in terms of its importance for successful work and self-assessment of its achievement. (Kolnik, Konečnik Kotnik 2020, 189-190)

The surveyed students also evaluated the importance of study subjects for achieving competences.



Graph 2. Evaluating self-competence at the end of the practical pedagogical training of geography students

Note: Objectives and competences as stated in the Legend of Graph 1.

Source: Kolnik, Konečnik Kotnik 2020, 189

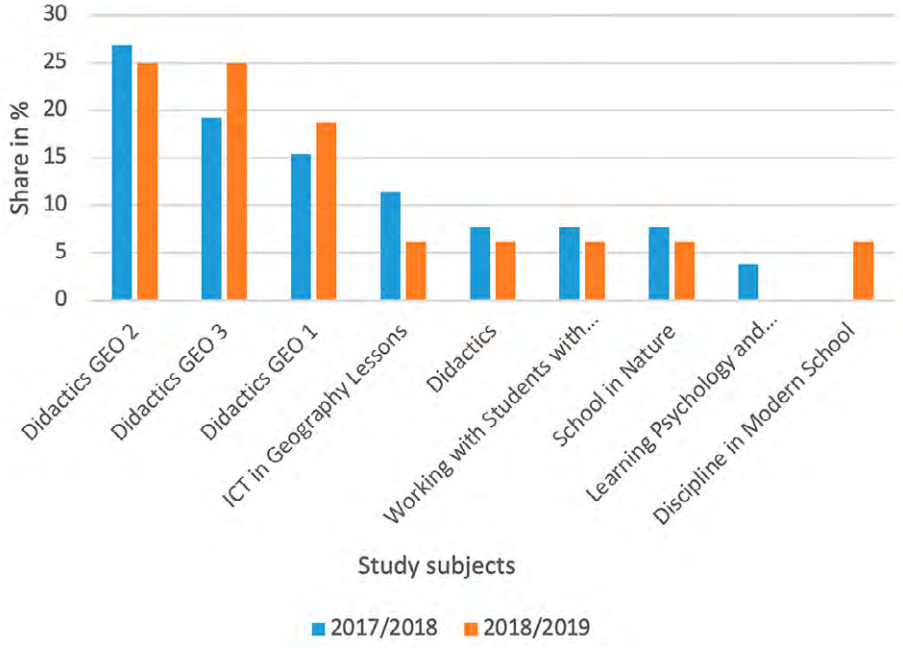
Table 1. Evaluation of the importance of sets of study subjects (lectures, seminars and tutorials) for achieving the competence objectives of geography students

Sets of study subjects	Rank 2017/18	Rank 2018/19
General pedagogical-psychological-didactic set: Pedagogy; Didactics; Learning Psychology and Adolescent Development; Working with Pupils with Disabilities	3.7	3.8
Didactics of geography set: Didactics of Geography 1, 2 and 3; ICT in Geography Lessons	4.7	4.7
Elective subjects of the general pedagogical-psychological-didactic set	3.5	3.6

Source: Kolnik, Konečnik Kotnik 2020, 190-191

The geographical-didactic set of four compulsory study subjects received the highest score (4.7) in both surveyed groups assessing the importance for achieving competence. The two surveyed groups were also very much unified in evaluating the importance of the compulsory study subjects of the general pedagogical-psychological-didactic set (with scores of 3.7 and 3.8) and five elective study subjects that were selected from a set of fifteen existing elective courses (3.5 and 3.6). (ibidem)

The respondents indicated which two study subjects from the previously indicated fields of training for the profession gave them the best insight into their future profession and the work of a geography teacher. Respondents from the 2017/18 generation made a total of 26 responses, attributing the largest share of influence to the geographical-didactic set (Didactics of Geography 1, 2 and 3; ICT in Geography Lessons) with 67.7%. With 19.2% of all responses, the respondents attributed the second highest importance to three study subjects (out of four in total) from the general pedagogical-psychological-didactic set. Also on the list of the study subjects which the surveyed students of geography considered to offer the most insight into their future profession was the elective study subject School in Nature, which was listed twice (7.7%). The second group of respondents also ranked the geographical-didactic subjects the highest with 74.9% of all answers. Of the four compulsory subjects from the pedagogical-psychological-didactic field, only two were selected (Didactics and Working with Pupils with Disabilities); combined they were attributed 12.4% of influence on the respondents' insight into the future work of geography teachers. Two elective study subjects were included in the list, i.e. Discipline and Managing the Class and School in Nature, with each of them being listed once. (Kolnik, Konečnik Kotnik 2020, 191-192)



Graph 3. Study subjects that provided the best insight into the future profession and work of a geography teacher

Source: Kolnik, Konečnik Kotnik 2020, 191

Self-reflections of geography students at the end of their pedagogical studies

Students' reflections at the end of the pedagogical study programme Geography reflect the perceptions of their increased professional competences, their perspectives on the dynamics of professional development, and at the same time students point out the possibilities of improving practical pedagogical training.

- *"It is only when you find yourself in the classroom that every bit of theory, every piece of advice, every experience related to you comes in handy.* It wasn't until I stepped in front of the class and took on the role of teacher that I realized how important every minute of the lesson is." (Nika, 2018/19)
- "Although I am still learning and will continue to learn throughout the entire period of working with pupils, I can say that I have come from point zero to the first step. That is to say that I have more hope for myself… *That I will perform my tasks as well and properly as possible and that I will also learn from my mistakes."* (Andreja, 2018/19)
- *"In the classroom and among the pupils I now feel good, confident, I have less anxiety. I also seem to connect well with them and take their opinions into account.* I have retained some strictness, since by being intransigent and exacting in certain situations I let pupils know that I care about them and their knowledge." (Alica, 2017/18)
- *"Over the course of two years of pedagogical studies, I have found out that teaching is basically the right thing for me.* When I ask myself now what it would have been like if I had chosen a non-pedagogical study programme, I shudder because of what I would have missed. *I think I have made a lot of progress,* especially in expressing myself and integrating lessons into the bigger picture. *I am proud of myself and what I have achieved. I managed to turn my biggest shortcomings into advantages and I think that was also the point of it all."* (Mare, 2017/18)
- "… As far as practice is concerned, I can say that this is by far the best and most important thing that a future teacher should experience, and there certainly should be more of it. *At the beginning, I somewhat hated the didactic subjects and all the theory, but now I understand that everything made sense, and because of that I function much better in the classroom."* (Aleks, 2017/18)
- "From the very beginning of practice, I felt that I was doing right and that there was no need for fear. *The greatest encouragement and acknowledgment at the end were the curious and happy faces of the children. With each spur, they seemed to grow and blossom, which was evident from their increasing involvement and ideas. Looking at competences, especially the goals and expectations that I wrote down at the beginning of the semester and the lectures, I definitely notice progress both on a personal and professional level."* (Aneja, 2017/18)
- "For my part, I can say that during my geography studies *I acquired mostly planning and organizational skills, by which I mean both lessons in class and other forms of work, for instance project work, field trips, field work, etc.* I know which documents are important for teachers in order to do their work in a quality and successful way, I know how to put together a lesson plan, *although I know that there is still room for improvement.* I learned about the methods of working in geography classes, acquired skills related to communicating with pupils, I know how to critically assess various teaching aids and materials. *With all the observations, I think that I have developed my criticality, which is a consequence of being aware of how I should carry out lessons, what is appropriate and what is not, etc.* All the teaching observations helped me to put together and prepare for the supervised lessons that I taught myself. *Even with those supervised lessons, I was able to critically assess / evaluate what I could have done better; where there is still room for improvement."* (Minka, 2017/18)
- *"The experiences that the geography teachers shared with me were of a lot of help. Precisely these moments were some of the most valuable to me, because after all, we learn throughout our lives,* and if nothing else, we can learn something good from every bad experience, so that we do not repeat a certain action." (Ana, 2017/18)
- "Throughout my education, I have learned a lot. *I have amended many of my weaknesses, some of which I still need to work on. I am of the opinion that we learn throughout our life, and it is no different in the teaching profession. We are always faced with new challenges, additions, innovations, and all this must be included in one way or another in the teaching itself, if we are to be successful in our profession. The most important thing I have learned is certainly an innovative / modern approach to teaching geography.* Nowadays there is a great variety of technical aids and I think it is important to include them in education, since children are very well-versed technically and at the same time progress in education itself is indispensable." (Sandra, 2017/18)
- *"At university, we were excellently prepared for teaching as far as the theoretical knowledge is concerned. However, I think that it is still the practice that perfects you. So I would have liked to have had a lot more of it. I am aware that the teachers acquire and develop their professional skills gradually. Above all, they learn from their own experiences in the classroom…* Preparation alone does not cause me any

major problems. I only get stuck occasionally when I get an unexpected response from the pupils." (Anita, 2017/18)

- "Maybe we *could have more supervised teaching in class, because thereby I would have gained more experience how to better carry out lessons or use different learning strategies and see which ones work best for me. Of course, I cannot generalize, as each class and pupil is different and one needs to adapt to the situation.* From this point of view, I would like more practice, in order to avoid major mistakes later." (Taja, 2018/19)
- *"I would like (as I believe most other students of pedagogical study programmes would) to have more practical training as part of my studies,* as I believe that this is the best basis for a career path." (Jasna, 2018/19)
- "By upgrading theoretical geographical knowledge in combination with practice and with the help of the right mentors, one gets faith in making independent decisions. *Critical self-awareness and peer-critical awareness in the right working environment enable innovation, and keep people conscious. This makes it easier for one to get rid of subconscious thought processes, such as prejudices and ideals.* (Luk, 2017/18)
- "I think that *extracurricular activities also contribute to professional growth."* (Tina, 2018/19)
- "I am satisfied and everyone from the professors to the mentors deserves praise. *If 5 years or 2 years ago someone had asked me whether I can imagine myself teaching a class, I would have said no, but now I hope to get a job as a geography teacher."* (Tom, 2018/19)

Conclusion

In the article we have presented the results, related to the research question what are students' personal reflections on the dilemmas and positive aspects of developing their own professionalism during their studies. We have also summarized some results that answer the questions: how much importance students ascribe to particular competences identified in the study programme, which are to be acquired / developed during practical pedagogical training; whether there are any differences in the students' evaluation of the importance of the three sets of study subjects (general pedagogical-psychological-didactic set, geographical didactic set and elective courses set); whether there are differences in the assessments of the above research parameters between students of the two observed generations.

Both generations of surveyed students decidedly confirm the importance of all competences in the study programme, since scores range from 3.7 to 4.8. Students ascribed the highest importance to the following competences: "identifying / defining the learning objectives and adjusting the planning and carrying out of lessons to the needs and capabilities of students", "using different methods, forms and techniques of teaching, assessing and grading knowledge" and "critically evaluating one's own pedagogical performance". With regard to achieving particular competences, the surveyed students' self-assessment is that they achieved a high degree of all the competences, with scores ranging from 3.5 to 4.7. The competences in the following areas were ranked the lowest: "anticipating possible problems during pedagogical work in the classroom and planning how to solve them", "applying a research approach to problem solving in teaching and pedagogical activities", "identifying / defining the learning objectives and adjusting the planning and carrying out of lessons to the needs and capabilities of pupils". Students expressed the opinion that the competences they developed best were "using different methods, forms and techniques of teaching, assessing and grading knowledge" and "critically evaluating one's own pedagogical performance".

Based on the research results in both generations of students, we can confirm that the pedagogical study programme Geography satisfactorily follows the professional needs as perceived by students and that in the process of the second-cycle study programme we appropriately stimulate and direct professional development. That is to say that "critically evaluating one's own pedagogical performance" is both among the highest evaluated competences in general and among the competences which students manage to achieve best. This is also indicated by the personal reflections of the students presented in connection with the fourth research question.

In the framework of the pedagogical study programme, some more attention could be devoted to working with students in order to develop a "research approach to problem solving in teaching and pedagogical activities". Furthermore, the frequently perceived need for a greater proportion of all forms of practical pedagogical training is not new, as students regularly express this in various forms of self-reflection over several generations. Although recent positive developments have been achieved with the introduction of the Bologna study programmes at the Faculty of Arts, University of Maribor, such as the introduction of diffuse and observational practice (Internet 1), we believe that

this trend will need to be further developed in the future towards increasing the scope of all forms of practical training. As a basis for increasing the volume of practical pedagogical training, systemic changes must be achieved that would more satisfactorily regulate the cooperation of faculties and schools.

At the Department of Geography at the Faculty of Arts of the University of Maribor we encourage students to self-reflect by means of various forms of study, in individual and group dynamics, and especially by the method of putting together a portfolio. The most important part of the portfolio is the student's critical thinking and assessment of his or her own work and results (Konečnik Kotnik et al. 2008; see also Razdevšek Pučko 1996, 1998; Sentočnik 1999). The results of the present study clearly show self-reflection to be an element of professional development that is firmly embedded in the personal and professional image of future geography teachers. We deem this to be a significant achievement.

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FEMALE EDUCATION LEVEL AND ITS IMPACT ON FERTILITY IN NOVI SAD

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Abstract

Fertility in the modern world is influenced by many factors, from the individual, through the influence of the environment, to perennial changes in lifestyle and also population policy in countries. The delay in starting a family significantly affects the demographic picture of birth rates. Reduced number of children per person in the fertile period, emigration of young generations from Serbia, and large losses during the war in these areas can lead to the depopulation of one state, and thus one nation. The task of the paper is to investigate and analyze the fertility of highly educated women in the area of Novi Sad, primarily the level of education, the number of children, the desired number of children, the number of children, and the factors that influenced this achievement. The results showed that the majority of respondents want a larger number of children, two, three, or four, with only six respondents having three children and two respondents having four children. Lack of housing, incomes that are not enough to provide basic needs for one child, working hours, especially for women employed in private companies, certainly affect the realization of the desired number of children.

Keywords: fertility, female education, children, Serbia

INTRODUCTION

Fertility represents the average number of children born to one woman in their reproductive age. The basic determinants of fertility include the following factors: modernization (education, urbanization) - a connection is established between quantitative fertility indicators and various aspects of modernization; cultural factors (religious and ethnic affiliation) - birth control, sterility, fetal mortality, genetic factors of parents also play a major role in fertility (Đurđev et al., 2016). The total fertility rate represents the number of children that a woman will give birth to if she lives until the end of the reproductive period. The reproductive period represents the time period from the age of 15 to the age of 49, although she will give birth at the same specific fertility rates by age as the woman in a given year. To ensure the level of simple population renewal, a woman must give birth to between 2.1 and 2.5 children, depending on mortality (Đurđev et al., 2016). We decided to represent the data we collected and analyzed to get a better insight into the relationship between the decision-making process of the number of children and different levels of education in women living in Novi Sad. We offer some possible solutions that could have an impact on women's ability, readiness, and willingness to have more children. The main reason why we opted for Novi Sad as a specific place while implementing this research is the fact that Novi Sad is a city that is recognized as a fruitful ground that offers a lot of opportunities for future academic work, due to the high quality of education that

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the University of Novi Sad provides. The city of Novi Sad has been a destination city for students and young professionals from all over Serbia, but Bosnia and Herzegovina, Montenegro, and Croatia as well. All this contributed to the creation of a multiethnic environment, which has been shown and proven as a desirable factor in the decision-making process regarding the future place of living. With this being said, a large number of young people coming to Novi Sad to study end up staying permanently upon completion of their studies is a common scenario. While writing the assignment, we came up with the questions for the survey together, Aco did the statistical analysis in SPSS, and Amra did the theoretical part.

According to Kovaček-Stanić G. (2014), population policy is a policy conducted at the state level and represents a policy aimed at the population. It can be a pro-natal policy that is represented in countries with low natural increase, and a policy aimed at limiting the birth rate that is conducted in countries with extremely high birth rates. Population policy is a policy pointed towards population aging, population mortality, and migration. We have cases of countries in certain regions facing different needs regarding population policies, and in those cases, the differential population policy is being introduced. Measures to encourage childbirth are reflected in the provision of child allowances, financial benefits for the family, maternity leave for women and men, flexible working hours, tax breaks, childcare subsidies, household subsidies, promoting equal participation of both spouses in parenthood and household chores. Measures to reduce births are the integration of family planning and safer motherhood programs into the primary health care system, providing easy and simple access to reproductive health services, promotion of men's responsibility in sexual and reproductive health, raising the lower limit for legal marriage, educating women and introducing cheap and safe contraception. Measures of population policy towards births are prescribed by the Labor Law, the Law on Financial Support to the Family, and the Law on Health Insurance. When we talk about birth control strategies, it is necessary to mention the 2008 Strategy. In Serbia, two different measures of population policy towards fertility were being implemented: parental allowance and full salary compensation to an employed mother during maternity leave for one year. The policy towards the mortality of the population in Serbia is reflected primarily through health care. Parental allowance is progressive; the highest is for the fourth child, states Kovaček-Stanić G. (2014), and it does not depend on the social status of the family, so it is a pronatal measure. If a woman gives birth to a third child, a special length of service of two years is calculated, according to the Law on Pension and Disability Insurance1 (Kovaćević-Stanić, 2014).

METHODOLOGY AND RESEARCH

The research was conducted through an online survey. The first part (7 items) was consisted of collecting demographic data. The second part (5) contained statements/questions where respondents provided their attitudes regarding the number of children they have, they think it is ideal in Serbia, and their preferences regarding the number of children. For the examination of the third part, the Likert scale was used - the scale of attitudes, which is consisted of 7 statements related to different aspects of attitudes about population policy measures that would contribute to a higher birth rate. The content of the survey is original and is not modeled on any previous research survey on the topic of Fertility of highly educated women in the area of Novi Sad. It was assumed that women of different marital statuses, work experiences, and levels of education have different opinions about the proposed population policy measures and benefits that would encourage them to have more children. The hypotheses set during the research are that there are statistically significant differences in the attitudes of respondents of different ages, marital status, work experience, and level of education according to the proposed measures and benefits. It is assumed that older women evaluated the claims differently than younger respondents. Due to such assumptions, one of the hypotheses is that there are statistically significant differences in the opinions of respondents who are in a marital union according to the stated measures, which makes the null hypothesis of this research, assumptions are that there is a statistically significant difference between employed and unemployed persons. Also, it was assumed that there is no statistical significance between women of different levels of education.

RESULTS AND DISCUSSION

Educational status:

- master's degree holders – 71 (38%)
- bachelor studies – 62 respondents (33.2%)
- Doctor of Science – 28 respondents (15%)
- high school graduates – 21 respondents (11,2%)
- specialization- 5 respondents (2,6%)

On the question about the number of live births, 24.8% of respondents do not have children, and these are the ones who stated that they had not established a marital union by the time of the survey, the other 17% are married, but do not have children yet. A total of 28.4% have one child, while those who have two children represent 23% of the total number of surveyed women in the city of Novi Sad. A total of six women stated that they have three children, which is 5.1% of the total number of respondents, and only two women (1.7%) have four children. Đurđev (2004) in his work concluded that in the most optimal scenario, women would give birth to 2.1 children by the end of the fertile period, and half of them could give birth to three children each. On an annual level, 105.000 babies should be born, and the fertile period should be longer than 10 years.

When asked, most of the respondents - 63 out of total stated that they desire to give birth to three children, while 115 expected two children, and 9 surveyed women did not want to have children at all. These results follow the optimal number of children in their opinion, 63 of them think that it is *two children per family,* and a total of 36 think that it is *three children*. A significant number of respondents believe that the optimal number of children per family is four, as stated by 12 respondents.

The reasons why the respondents did not achieve the desired number of children are reflected in the following. The largest number of respondents, 48.2% stated that it is because of the residential space, followed by answers related to the disagreement with the partner, 31.6%. Serbia, still being a developing country does not provide the necessary safety net for the future parents who plan on having larger families, besides the policy regarding longer maternity leave for women who are having their third and fourth children. Considering the fact that the costs of living in cities such as Belgrade and Novi Sad are significantly higher than in the rest of Serbia, families with average jobs and incomes often face financial struggles. Unlike Central and Western Europe, the Balkan area has the custom of not renting but buying the properties to live in and start a family. This might also contribute to the ''non-readiness'' factor in terms that couples often do not want to start the family unless they have secured living space in terms of an apartment or a house. Owning a property often comes with a financial burden of a bank loan and mortgage, which greatly affect their readiness and ability to start and expand the family. Owning a property of a certain size puts a limit on the size of the family since there are no conditions for a larger family in a small and limited living space. The respondents had the opportunity to state the other reasons why they did not achieve the desired number of children, as well. The fact that young professionals decide to settle in Novi Sad, a city that is not their hometown, in a way also might influence fertility rates. Living in a city that does not provide the safety net regarding close family members and friends willing and able to help out with the children, in terms of babysitting, weekends with grandparents, and others. These benefits of close family and friends living in the same city are extremely appreciated and acknowledged, especially in the Western Balkans area, where besides formal daycare of children in the kindergarten - grandparents and/or close friends often help out with children due to the parent's long working hours. This help represents free of charge help, where a different situation, such as hiring a nanny or additional help in the house, represents an additional financial burden on the budget.

The most common reasons given by the respondents were that both partners are young, and they do not want children yet. When discussing the age of the first marriage in Serbia, WorldAtlas (2017) says that it is 31 for men and 28.1 for women, which is 29,6 on average. This number is relatively low comparing it with Sweden's average age of 34,6, Iceland's 33,7, and Spain's 33,4. If we take into consideration that the level of education has increased in countries such as Serbia, where we have growing numbers of highly educated individuals, unlike in the past, when the majority of the population had completed secondary education, found employment, and worked on starting the family.

T-TEST RESULTS

While conducting the research, we asked our respondents about the factors that could influence their decision- making process regarding the number of children, that could be introduced on the state level.

The results of the t-test showed that there is no statistically significant difference between the answers of respondents who have different marital statuses on a specific example of married and unmarried women (at 95% confidence interval). A statistically significant difference was observed in three of the seven claims. For respondents' responses to the statements listed in Table 1, there is a statistically significant difference. Respondents who declared themselves as married in the survey rated these statements with a higher score than respondents who declared themselves as unmarried. In other claims, the answers of all respondents are similar and do not have a statistically significant difference. These results indicate that the null hypothesis that there are significant differences in the attitudes of women with different marital statuses has been confirmed, as statistical significance is observed in four of the seven claims.

Table 1. Mean values of respondents' answers and t-test results depending on different marital status (married or unmarried)

Statement	Marital status	N	Mean values	F	p
Higher amount of child allowance	married	91	3.96	6.562	0.012
	unmarried	77	4.38		
Discounts in housing loans	married	91	4.02	11.752	0.001
	unmarried	77	4.41		
Increasing the mother's pension coefficient for each child	married	91	3.78	12.103	0.001
	unmarried	77	4.14		
Economic stimulus	married	91	4.10	20.329	0.000
	unmarried	77	4.70		

By looking at Table 2, the results of the t-test among the answers of the respondents who are employed or unemployed are very interesting. These results show a statistically significant difference between the answers of the respondents (at the level of significance $p<0.05$) is observed in three out of seven statements. This is noticed among unemployed persons who rated these three statements represented in Table 2 higher than the employed respondents. The reasons for such results can be found in two facts, the first, there were 25 unemployed respondents while all the others, i.e., 94 of them at the time of the survey, were employed. Therefore, their answers are lower, and the average score is higher. Another reason for these results may be that the employed respondents were satisfied with the working hours and benefits provided to women during pregnancy and maternity leave. The hypothesis is that there is a statistically significant difference between the dependent variables, in this case, employed and unemployed. is partially confirmed because statistical significance is observed in three of the seven statements.

Table 2. Mean values of respondents' answers and t-test results on different employment status (employed or unemployed)

Statement	Employment status	N	Mean values	F	p
Benefits that are reflected in the form of faculty scholarships for more than one child at the same time	employed	139	4.14	4.527	0.035
	unemployed	48	4.60		
Partial working hours	employed	139	4.37	4.952	0.028
	unemployed	48	4.64		
Increasing the mother's pension coefficient for each child	employed	139	3.97	3.391	0.068
	unemployed	48	4.24		

RESULTS OF THE ANALYSIS OF VARIANCE (ANOVA)

The application of a one-factor analysis of variance, ANOVA, was used to examine whether there was a statistically significant difference between dependent variables (items related to respondents' attitudes) and independent variables (respondents' social characteristics). One-way ANOVA showed that there are statistically significant different levels of education, which confirms the alternative hypothesis presented in this paper that there is a statistically significant difference at the value $p<0.05$ for respondents with different levels of education. Seven claims were tested, and a statistically significant difference was established for two at the level of significance $p>0.05$. The difference can be seen in the statements about increasing the mother's pension coefficient for each child and economic stimulus (Table 3).

The analysis of ANOVA shows that there are statistically significant differences in only one response of respondents from different places of employment (state-owned company, private company, and self-employment). Seven claims were tested, and a statistically significant difference was established for one, at $p<0.05$. The difference can be seen only in the statement about *Increasing the mother's pension coefficient for each child* (Table 4). The initiation of application of this population measure in the population policy of Autonomous Province of Vojvodina and thus of Serbia would significantly increase the overall birth rate which is the goal of every nation.

Table 3. Results of analysis of variance, ANOVA, for respondents according to the level of education

Statement	F	p
Increasing the mother's pension coefficient for each child	3.031	0.019
Economic stimulus	2.724	0.033

CONCLUSION

By writing this assignment we wanted to present the findings we got from the research implemented in Novi Sad, Serbia. Novi Sad is one of the biggest economic, political and cultural points in Serbia and it represents a unique place for living. With a great circulation of people - the local population emigrating to the Western European countries, and the population from more rural areas of Serbia, but surrounding countries as well, migrating to the area of Novi Sad. As the times are changing, the requirements on the labor market are changing as well, which has brought the necessity of having a degree of higher education. Through this research, we wanted to find out how the level of education influences the preferences regarding the actual number of children, an optimal number of children, and what might influence their ability and willingness to decide on having more children. 115 respondents stated that the optimal number of children in their opinion is two, followed by 63 of them thinking that three children are optimal, and the rest 9 of them do not want to have children at all. When asked what the main obstacles are preventing them from reaching the optimal number of children, the main reasons were disagreement with their partner and the lack of opportunities regarding financial status and housing.

After completing the research, the results showed that the respondents do want a higher number of children regardless of their level of education and employment, but that they cannot achieve the given number due to several reasons such as low financial incomes into their family budget, disagreement with the partner regarding the number of children, and the biggest problem for the respondents is housing. In the respondent's response to the statement: A higher amount of child allowance; Relief in housing loans; An increase in the mother's pension coefficient for each child and an Economic incentive a statistically significant difference was shown. The adoption of the Civil Code, as well as the laws it envisages, which have been awaited since 2006 (when the commission was formed) and greater investment of funds for the indicated population policy measures, would increase mothers' incomes for each newborn child, and thus the general birth rate of the city of Novi Sad.

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Official Gazette of RS", No. 55/05, 71/05 - correction, 101/07, 65/08, 16/11, 68/12 - the US, 72 / 12, 7/14 - the US and 44/14.

EFECTS OF MILITARY GEOGRAPHY PROBLEM BASED LEARNING ON CADETS' COGNITIVE ACHIEVEMENTS

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Abstract

Problem based learning requires independent discovery of the problem solving process within the set problem situation using new previously acquired knowledge, experience and new information. The experiment established to what extent military geography problem based learning influences on the educational achievements of cadets in the field of military geographic space analysis. The research sample (N=110) consisted of two groups that studied through problem and traditional teaching. Differences in achievement after the control and final exam were proved by the ANOVA test, which showed that problem teaching has greater effects in the domain of understanding and application of knowledge, as opposed to acquiring factual knowledge where there is equality with traditional teaching. The results improved a military geography teaching practice and provide a basis for further research in area.

Keywords: Problem based learning, cognitive achievements, military geography, cadets.

Introduction

Modern organization of teaching in general, and even teaching in the military education system, is unthinkable without innovation. A quality reform of military education cannot be implemented without a comprehensive approach to the transformation of education in which social and global processes must be taken into account. The achievement of the aforementioned requirements cannot be fully achieved through the transmission mastery of programming content whose basic paradigm is knowledge reproduction. One of the solutions besides the general modernization of the didactic system could be the introduction of new teaching strategies which include problem based learning. Ivkov (2002) considers problem based learning to be the hierarchically highest and most effective form of learning or strategy with problem solving not an end in itself or a teaching method but a means of comprehensive thought activation in the function of gaining scientific knowledge. Pawson, Eric, Haigh, Muniz, Trafford & Vajoczki (2006) point out that problem based learning is a comprehensive teaching and learning strategy that involves not only mastering problem-solving but also a carefully designed curriculum, containing selected problems that foster thought-provoking activities: the acquisition of key knowledge, critical thinking, independent learning, teamwork, gaining the ability to find information resources and preparing for lifelong learning. The activities of the student in problem based learning are conceptualized in a different paradigm *the student at the center of the teaching process.* According to Jovanović and Živković (2005) during the problem-solving process the student is expected to: identify, define and refine the problem; taking the initiative to solve the problem; solution planning (finding solution principles and defining hypotheses); independent discovery of problem solving techniques and methods; independently collecting information from various sources and analyzing the facts that are needed for a solution; presenting possible solutions and discussions with the teacher and others about the findings.

Long before problem based learning and similar teachimg strategy became actual geography traditionally included some innovative components such

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as field and laboratory teaching in its curriculum. It is similar when it comes to Military Geography course. According to Day (2012) geographers can reasonably be considered pioneers of contemporary teaching strategies which in our case provides a good basis for a more active and broader application of problem based learning in military geography. " Military geography research the geographical features that influence the conduct, organization and planning of military action and the use of armed force in a particular military system" (Gigović, 2011: 8). According to Mišović (1999), the military-geographical spatial analysis is reflected in finding optimal solutions to the set spatial problems systematization and rationalization of all elements within specific geographical factors that influence the performance of combat operations. In this sense the adequate selection of geographical factors (mathematical, physical and social) necessary for the analysis of various military tasks in practice requires: a critical thinking, deeper thought processes, the ability to find and analyze information, developed geographical, logical and creative thinking. Skills for teamwork, argumentative discussion and a multidisciplinary approach to problem solving are also desirable skills because military geographic problems are not solved by an individual but by a command or headquarters that hosts numerous specialists in different fields. Such abilities and applicable knowledge cannot be acquired by mechanically memorizing the basic principles of military-geographical analysis of space and characteristics of military-geographical factors, but rather requires applicable knowledge in a professional context. This recognizes the importance of implementing problem based learning in military geography in order to master this complex method. When considering the impact of problem based learning on the study of military geography there has been no relevant research in scientific practice to date. On the application of problem-based teaching and the results it achieves in geography, research is also meager (Herceg-Mandić, Džigurski, Bibić, & Đukičin, 2016; Golightly & Muniz, 2013; Golightly & Raath, 2014; Jo & Ku, 2011; Scheyvens, Griffin, Jocoy , Liu, & Bradford, 2008; Sproken-Smith, 2005; Spronken-Smith & Kingham, 2009; Yeung, 2010; Weiss, 2017). The aforementioned research does not fully shed light on the effects of problem based learning in the whole range of knowledge and skills but in the conclusions they emphasize the need for further exploration of this problem as well as the necessity of learning geographical content through problem based learning. This attitude cause us to explore this problem empirically in the context of military geography.

Materials and methods

By applying experiments with parallel groups we wanted to determine whether and how the application of problem based learning in military geography influences the increase in cognitive achievement of cadets in the field of military geographic spatial analysis. The research sample (N=110) included cadets of the 2nd year of studies at the Military Academy. In order to be able to compare groups it was first necessary to satisfy the requirement for parallel groups to be equable. In our case the groups were equalled according to the number of cadets and based on the results achieved on the pretest of achievement in Military Topography course. The experiment has lasted for 14 weeks. The experiment in this case the application of problem based learning in military geography represented an independent variable and the observed learning effects primarily the cognitive achievement of cadets in the domain of factual knowledge (elementary level), comprehension (intermediate level) and application (advanced level), represented the dependent variable. During the experiment two groups of subjects were compared: the experimental group (n=5), in which problem based learning was entirely applied using different sources of information, and the control group (n=55), in which traditional teaching was applied. At the end of the experiment the control group had classes where problem based learning was also applied using different sources of information. The aim of introducing problem based learning into the work of the control group was to determine the extent to which the cadets of the control group were able to solve problems since they had previously acquired knowledge in the traditional way. The questions in the tests are designed to measure the cognitive achievement of cadets from military-geographical spatial analysis at the elementary, intermediate and advanced levels. Each test consisted of 21 questions (7 elementary level, 7 intermediate level and 7 advanced level). The initial test consisted of 17 open-ended questions and 4 closed-ended questions. The control test had 15 open-ended and 6 closed-ended questions. The final test had 18 open-ended and 3 closed-ended questions. The Analyst Tool as part of the Microsoft Office Excel software package was used to statistically process the results of the experiment. One-way analysis of variance (ANOVA) tested differences between experimental and control groups in terms of educational attainment levels. Comparing the results from the final knowledge test and the control knowledge test which was given to the subjects before the introduction of the experimental treatment in the control group it was de-

termined whether the introduction of problem based learning and the control group had any effects on improving their cognitive achievement. Based on the differences found between the initial and final condition in terms of the observed effects of the treatments applied and the comparisons of the groups in terms of effectiveness it was determined which type of teaching was more successful.

Results and Discussion

Based on the results obtained, we can conclude that on the pre-test cadets from the experimental and control groups showed approximately the same knowledge at all three observed cognitive levels. The relatively high overall score of the cadets in both research groups on the pre-test can be explained by the fact that the initial testing was done immediately after completing the course in Military Topography and that a larger number of subjects passed the exam in this subject. It is observed that the cadets' achievement in both research groups at the advanced cognitive level (Table 3) was significantly lower than the previous levels (Tables 1 and 2). Reasons should be sought for the fact that tested cadets rarely completed tasks during school that required the application of acquired knowledge and problem solving using different sources of information and such tasks in the test wich were difficult for most cadets. According to this we can observe that during the first year of study that the cadets did not have the opportunity to gain experience in solving tasks at a higher cognitive level. According to the authors (Suphi & Yaratan, 2016) the final year respondents of Bachelor's Degree studies where traditional teaching was mostly applied did not acquire the necessary experience that would enable them to successfully solve a wide range of problem tasks.

In terms of student achievement in the realm of fact-finding the research findings show that the difference between the experimental and control groups was not statistically significant both on the control (Table 4) and on the final knowledge test (Table 5). The results of our research can be explained by the fact

Table 1. Results of ANOVA test on pre-test of knowledge achievements questions group

Groups	Count	Sum	Average	Variance		
E	55	914	16.62	9.54		
C	55	900	16.36	11.87		
Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Between Groups	1.78	1	1.78	0.167	0.684	3.929
Within Groups	1155.71	108	10.70			
Total	1157.49	109				

Table 2. Results of ANOVA test on pre-test of comprehension achievements questions group

Groups	Count	Sum	Average	Variance		
E	55	1152	20.95	64.50		
C	55	1085	19.73	65.46		
Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Between Groups	40.81	1	40.81	0.628	0.430	3.929
Within Groups	7017.75	108	64.98			
Total	7058.55	109				

Table 3. Results of ANOVA test on pre-test of application achievements questions group

Groups	Count	Sum	Average	Variance		
E	55	448	8.15	52.53		
C	55	486	8.84	58.44		
Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Between Groups	13.13	1	13.13	0.237	0.628	3.929
Within Groups	5992.36	108	55.48			
Total	6005.49	109				

that within problem based learning, wich does not impact on memorizing facts, understand processes and phenomena as well as to draw conclusions. According to some studies (Pawson et al., 2006; Day, 2012; Carriger, 2015) the key drawback of problem based learning in acquiring a greater amount of factual knowledge characterizes concept of this type of teaching strategy. Accordingly in our study during the problem-based learning class cadets extracted and adopted only those facts that were relevant for solving specific problems while cadets from the control group during the lectures had the opportunity to come into contact with a wider range of factual knowledge through transmission.

Concerning the achievements in comprehension of the process, phenomena and theory the results of the research show that the difference between the experimental and control groups was statistically significant both on the control (Table 6) and on the final test (Table 7). The result obtained can be related to the fact that during the problem based learning the cadets gain higher cognitive level thinking processes such as: critical logical, divergent and convergent thinking. Similar findings have been made in other studies (Golightly & Raath, 2014; Jo & Ku, 2011; Zahid et al., 2016). Zahid et al. (2016) indicate that the problem-solving process fosters an analytical mindset which further leads to a deeper comprehension of phenomena, processes and theory.

Table 4. Results of ANOVA test on control test of knowledge achievements questions group

Groups	Count	Sum	Average	Variance		
E	55	562	10.22	9.80		
C	55	529	9.62	7.50		
Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Between Groups	9.9	1	9.9	1.144	0.287	3.929
Within Groups	934.36	108	8.65			
Total	944.26	109				

Table 5. Results of ANOVA test on final test of knowledge achievements questions group

Groups	Count	Sum	Average	Variance		
E	55	763	13.87	15.19		
C	55	746	13.56	9.44		
Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Between Groups	2.63	1	2.63	0.213	0.001	3.929
Within Groups	1329.64	108	12.31			
Total	1332.26	109				

Table 6. Results of ANOVA test control test of comprehension achievements questions group

Groups	Count	Sum	Average	Variance		
E	55	823	14.96	57.04		
C	55	617	11.22	44.54		
Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Between Groups	385.78	1	385.78	7.596	0.007	3.929
Within Groups	5485.31	108	50.79			
Total	5871.09	109				

Table 7. Results of ANOVA test on final test of comprehension achievements questions group

Groups	Count	Sum	Average	Variance		
E	55	1245	22.55	96.18		
C	55	935	17.00	96.85		
Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Between Groups	845.68	1	845.68	8.762	0.004	3.929
Within Groups	10423.64	108	96.52			
Total	11269.32	109				

In terms of students' achievement in the domain of knowledge application the results of the research show that the difference between the experimental and control groups was statistically significant both on the control (Table 8) and the final test (Table 9). Through experiential learning the cadets gradually developed: meaningful knowledge, self-awareness, self-confidence, higher thought processes (logical connection, critical thinking, divergent thinking inference), the ability to selflearning, as well as the ability to apply knowledge in new situations. Other studies have come to similar conclusions (Carriger, 2015; Halliwell, 2008; Khatiban & Sangestani, 2014; Yeung, 2010). As cadets were continually involved in new problem situations traditional reproduction-based learning patterns were not possible but required: research work, conceptual changes in problem solving, continuous upgrading of previously acquired knowledge, active discussion and exchange of ideas between cadets, critical looking at the arguments and looking at them more deeply as other research has indicated (Loyens et al., 2015). In the process of problem solving not only new knowledge is acquired but also the ability to apply that knowledge in new situations is formed (Terhart, 2001).

Based on the final test results the following conclusions were drawn. An ANOVA test showed that at a significance level of (p=.05) a score of $F(1, 110)=2.213$, $p=0.001$ was obtained with $F<F$crit wich indicates that there was no significant difference between the experimental and control groups. Regarding the adoption of facts, concepts and principles. In terms of comprehasion the processes, phenomena and theory at the significance level of (p=.05) the result is $F(1, 110)=8.762$, $p=0.004$ with $F>F$crit wich indicates that there is a difference between experimental and control groups. Also, the existence of a statistically significant difference between the experimental and the control group with regard to the application of acquired knowledge in concrete or simulated situations was determined at the level of statistical significance of (p=.05) where the result $F(1,110) = 13.860$, $p=0.000$ where is $F> F$crit.

Table 8. Results of ANOVA test on control test of application achievements questions group

Groups	Count	Sum	Average	Variance		
E	55	714	12.98	55.43		
C	55	445	8.09	50.57		
Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Between Groups	657.83	1	657.83	12.413	0.001	3.929
Within Groups	5723.53	108	53.00			
Total	6381.35	109				

Table 9. Results of ANOVA test on final test of application achievements questions group

Groups	Count	Sum	Average	Variance		
E	55	1146	20.84	126.81		
C	55	745	13.55	84.14		
Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Between Groups	1461.83	1	1461.83	13.860	0.000	3.929
Within Groups	11391.16	108	105.47			
Total	12852.99	109				

Conclusion

This research has pointed to the following effects of the application of problem based learning in military geography. Systematic application of problem based learning with the use of different resources contributes to the thought and practical activation of cadets in the learning process and enhances their cognitive achievements in the field of military-geographical spatial analysis. The results obtained showed the significant statistical differences between the tested samples at the highest level of cognitive achievement which relates to the application of acquired knowledge in new situations as well as to the understanding of processes, phenomena and theory in the field of military geographic spatial analysis. Although research is expected to show that problem-based teaching has a significant impact on greater congenital achievement in the do-

main of knowledge of facts, concepts and principles the results have shown that this impact is not significantly greater than the effects of traditional teaching. Activation of more cadets also depends on the established level of motivation in their introduction to the problem situation overcoming obstacles within the problem situation and consistent implementation of all steps in the problem solving process. As a key and most important step in this process is identifying and defining a problem without which it is not possible to adequately determine a problem, find and select appropriate information that would contribute to its solution. Cadet information literacy also contributes to this which cannot be acquired through individual semester courses but requires a continuous development of knowledge and skills in that context. The complexity of the problem-solving process increases the level of attention of the cadets and requires discussion between group members, confrontation of opinions, deeper understanding of the essence of the problem, argumentative explanation of the products of the work which influences the generalization and systematization of the acquired knowledge. The results indicate the broader importance of introducing problem based learning into a completely new and unknown teaching area (military geography), which has not been explored so far. The findings we have gained through this research complement the general knowledge about the application of problem based learning in didactics and methodology of military geography and form the basis for further research into the application of problem based learning in military geography. Further research should focus on identifying in which aspect of cognitive achievement (meaning, terminology, classification, theory, and principles) problem based learning has the greatest effects. Clarifying this issue would contribute to a better quality modeling of problem based learning and how to evaluate it. In this sense we believe that the results would be more accurate if the experiment were conducted over a longer period, which would indicate to what extent this affects the extent of the knowledge gained.

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CORRIDORS PLANNING FOR UAV CARGO DELIVERY USING GIS-LCP MULTICRITERIA SELECTION: A CASE STUDY OF "TARA" NATIONAL PARK, SERBIA

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Abstract

The use of an Unmanned Aerial Vehicle (UAV) for cargo delivery in the zone of protected natural areas requires optimal planning of flight corridors. Solving this problem requires determining possible flight corridors, based on the technical and safety capabilities of UAV flights and the boundaries of protected areas of the national park. This article introduces the multicriteria selection method of UAV flight corridors, using the Geographic Information Systems (GIS) Least Cost Path (LCP) analysis tool. The area of research was the National Park "Tara", the Republic of Serbia. The results of this case study have shown that the application of the GIS-LCP multicriteria method can be successfully used in the optimal and safety planning of corridors for the transport of packages by a UAV. The advantages of the presented method are its simplicity and the speed of application, while for more complex analyses it is recommended to use a larger number of weighted criteria.

Keywords: Geographical Information System, Least Cost Path, Unmanned Aerial Vehicle, Corridors, National Park.

Introduction

The mass use of Unmanned Aerial Vehicles (UAVs) for commercial purposes has followed a long development path. Their original use was limited exclusively to military purposes. The transition from the military framework to mass commercial use has enabled the technological improvement of UAVs through miniaturization, integration with systems for geospatial data collection and navigation, and low production cost (Mitka & Mouroutsos, 2017). Mass use of UAVs has intensified in various areas, such as: agriculture, construction management, transportation, management, environmental protection, public safety, emergency and disaster safety (Belov, 2016; Jackman, 2019). An intensively increasing trend in the use of UAVs is in the field of logistics and transport – for package delivery. There are several advantages over the conventional way of delivering packages. The use of UAVs to deliver packages to ships, oil platforms, and other inaccessible areas simplifies and reduces the cost of transportation (Barmpounakis et al, 2016). It enables the delivery of medicines and food in the mountainous areas when the roads are inaccessible due to the snow cover (Silvagni et al. 2017). Yakushiji et al. (2020) highlight the benefits of short-range UAV transport of some blood products in Rwanda and other countries, and its use in pandemic operations during the corona virus crisis (COVID-19) in the infected areas. However, various factors make it difficult to plan UAV flight corridors. These factors can be of natural, anthropogenic and administrative kind. Natural factors include relief, vegetation obstacles and meteorological influences. Anthropogenic factors include artificial barriers, such as: power lines, buildings, bridges, etc. Administrative factors include restrictive flight zones, such as distance from the airport, military infrastructure, authorized upper and lower flight altitudes prescribed by the state institutions (Ren & Cheng, 2020).

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The problem of this research is the planning of the flight corridor for a UAV cargo delivery within the National Park "Tara" (NP "Tara"). A corridor selection model based on the use of GIS-LCP tools and multicriteria techniques is proposed. The procedure was developed taking into account various natural, anthropogenic and administrative criteria and limitations that affect the flight of a UAV.

Methodical background

Planning a UAV flight corridor for the delivery of packages in the zone of protected areas of the national park requires mutual harmonization of environmental protection requirements with the technical limitations of a UAV. This requires multicriteria analysis (MCA) of a large amount of data for which the use of GIS technologies is suitable. GIS offers the ability to route flight paths using the Least Cost Path technique (LCP). The LCP routing technique is based on the selection of the lowest cost value of the path between the starting point and the destination. LCP with GIS-MCA integration has been successfully applied to solve the problem of route selection in different areas (Asamel & Ahmed, 2009). The basic methodological approach in this paper is the integration of GIS, Multicriteria Weighted Overlay (MWO) and Least Cost Path (LCP) modeling techniques for geospatial selection.

The proposed model includes the following phases:

- Phase 1 - Defining the problem and research space;
- Phase 2 - Identification and definition of criteria affecting a UAV flight;

This phase requires the study of geospatial characteristics of the study area and the identification of the most important geographical factors that affect the flight of a UAV. On the other hand, it is necessary to study the limiting factors related to the protection zones of the NP "Tara".

- Phase 3 - Data collection and formation of raster maps for each of the criteria;

Based on the selected spatial criteria, the entry, the acceptance and transformation of thematic data into an appropriate digital form follow. The condition for the next phase is that the thematic maps must be in raster format, with an identical reference system and cells of the same values. For the starting and ending points of the destination, vector layers of point objects are created.

When designing the Cost surface (CS), the criteria do not have the same significance of influencing the UAV flight limitation. For that reason, it is necessary for the decision maker to define priorities. For the development of CS in this paper, the often applied and simple Multicriteria Weighted overlay MWO technique was applied, which is shown in equation (1). Each raster is assigned a weight W_k whose value is defined between 0 and 1. The sum of all weights should be $W_1 + W_2 + W_3 + ... + W_n = 1$.

$$CS = \sum_{k=1}^{n} W_k R_k = W_1 R_1 + W_2 R_2 + W_3 R_3 + ... W_n R_n \quad (1)$$

The final result of this step is the *CS* layer, where the lower values of the raster cells represent the areas above which a UAV flight is suitable, while the higher values are unsuitable.

- Phase 4 - Create Cost Distance (CD) and Cost Back Link (CB);

The creation of Cost Distance (CD) and Cost Back Link (CB) layers is performed on the basis of a previously modeled CS layer and the starting point of the UAV flight, which is in vector format. The CD layer is modeled raster with the least accumulative cost distance (Ac) for each cell to the nearest source from the start point over a cost surface (2).

$$Ac = \sum_{k=1}^{n} A_k = A_1 + A_2 + A_3 + ... A_n \quad (2)$$

Using the equation (3), the method of calculating values between adjacent cells for horizontal and vertical cost distance is shown.

$$A_1 = \frac{\text{cost } 1 + \text{cost } 2}{2} \quad (3)$$

For diagonal cell movement, the method of calculating cell values is shown in equation (4).

$$A_1 = \sqrt{2}\frac{\text{cost } 1 + \text{cost } 2}{2} \quad (4)$$

The CB layer contains the values from 1 through 8. Each value defines the clockwise direction or identifies the next neighboring cell along the least accumulative cost path from the start point (source cell) to reach its least cost source to the final destination.

The value 0 is reserved for source cells or the start location. The distribution of cell values is performed on the basis of CS raster. The entire procedure is repeated for each segment between the packet distribution locations within the UAV flight corridor.

- Phase 5 - Finalization of flight routes using Cost Path (CP) technique;

Cost Path (CP) tool calculates the LCP from the source to the destination. The CP layer is modeled on the basis of previously made CD and CB layers of the starting point and the location of the desired UAV flight destination. The procedure is repeated for each specific flight segment between location points within the UAV flight corridor.

- Phase 6 - Visualization of the UAV flight corridor for package delivery and recommendations.

This final step involves merging individual flight routes into a UAV flight corridor for package delivery. The corridor is visualized with an LCP map with the necessary topography labels of settlements. Individual routes within the corridor are analyzed and appropriate recommendations are given.

Results and Discussion

The NP "Tara" covers an area of 634.461 km2, located in the western Serbia between 43° 43' and 44° 01' north latitude and 19° 14' and 19° 43' east longitude. The average altitude range is between 231 m and 1544 m. In the immediate vicinity of the NP "Tara", as a mechanism of active protection of the protected area, a wider protection zone has been established. According to the spatial plan of the National Park "Tara" (Republic Land Use Planning Agency, 2010), the protected areas of the Landscape of Exceptional Features "Zaovine" and the Nature Park "Šargan-Mokra Gora" belong to it. Within the land use of the area, 431.705 km² or 68% of the area are protected (Tucović et al., 2015). In the area of our research, we have integrated the NP "Tara", Landscape of Exceptional Features "Zaovine" and a small part of the Nature Park "Šargan-Mokra Gora". Most of the research area included I and II protection zone, while a smaller part is within protection zone III. Based on the analyzed geospatial characteristics of the study area, the following criteria were selected that affect the flight of the UAV: Slope (C1), Altitude (C2), Land Cover (C3) and Zone of protection (C4). In the next step, the data were collected (Table 1) and a database was created using ArcGIS Desktop 10.2 software.

In the next phase, the raster maps were normalized for each of the selected criteria (Table 2). The largest

Table 1. Used data for criteria map modeling

Criteria	Data and scale	Geoprocessing	Reference
Altitude Slope	Digital Terrain Model (DTM) 25m x 25m	Surface spatial modeling, Reclassify	Military Geographical Institute, 2006
Land cover	Corine Land Cover (CLC) 2018 25m x 25m	Reclassify	European Environment Agency, 2018
Zone of protection	Land Use Plan of NP "Tara" 1:50.000	Drawing polygon vector, Raster transformation, Reclassify	Republic Land Use Planning Agency, 2010
UAV take-off cargo delivery locations	Digital Topographic map 300 (DTK300) 1:300.000	Drawing point vector	Military Geographical Institute, 2003

Table 2. Criteria for modeling UAV flight corridor in the NP "Tara"

Criteria		Assigned cost value		
		1 - Low cost	2 - Moderate cost	3 - High cost
C1	Altitude (m)	<1200	1200-1300	1300<
C2	Slope (°)	0-20	20-40	40<
C3	Land cover (LC)	Natural grasslands, Pastures, Complex cultivation patterns, Land principally occupied by agriculture with significant areas of natural vegetation.	Broad-leaved forest, Mixed forest, sports and leisure facilities	Transitional woodland/ shrub Coniferous forest, Water bodies, Discontinuous urban fabric
C4	Zone of protection (ZP)	III zone of natural protection	II zone of natural protection	I zone of natural protection

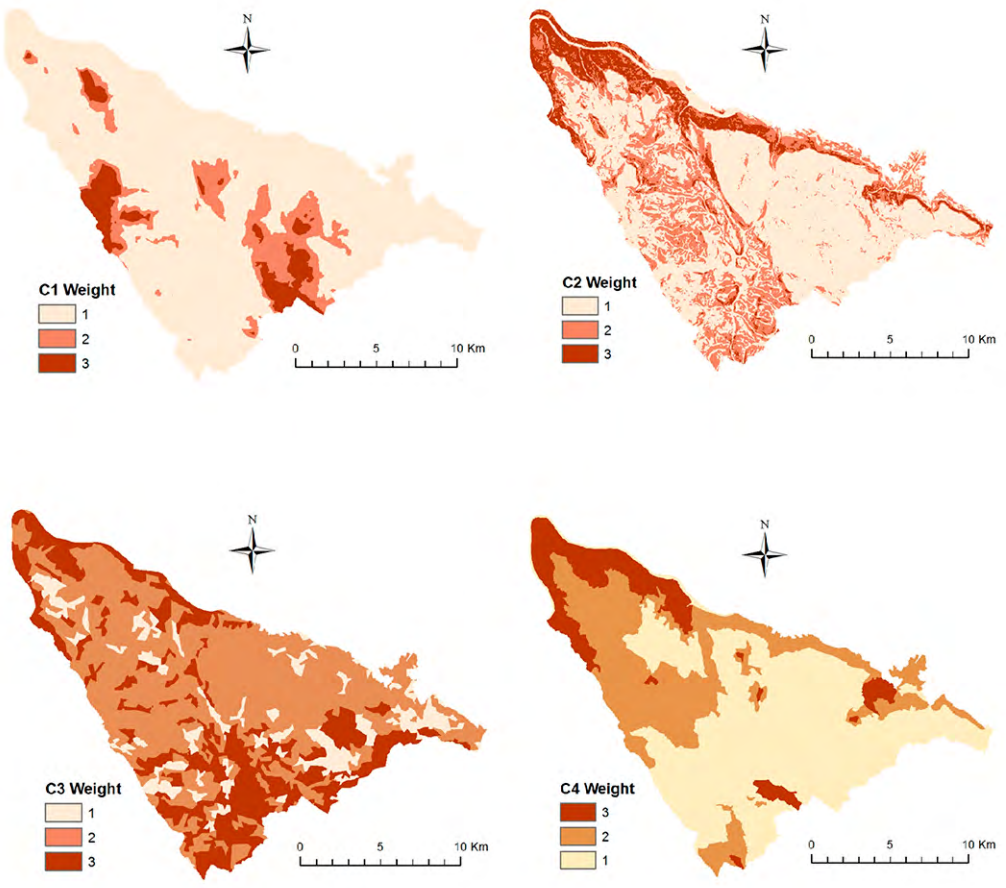

Figure 1. Criteria normalized maps

percentage of the nature park is located at about 1100 m. Frequent flights over the peaks with higher altitudes, as well as flights near steep slopes could endanger the safety of a UAV flight. Coniferous vegetation, whose average height is about 25-40 m, had the same impact. On the other hand, the restrictive protection zone I had a high cost price because planning a flight corridor through the UAV was not desirable. By applying the reclassification tool and assigning the cost price value, normalized raster maps were obtained (Fig. 1).

Based on the normalized criteria raster and using MWO, the Cost surface raster (CS) was modeled according to the following equation (5). As a result of this step, a CS layer was created, which is the initial condition for the Cost Path (CP) modeling technique.

$$SC = \text{ALTITUDE} \cdot 0.1 + \text{SLOPE} \cdot 0.1 + \\ + \text{LAND COVER} \cdot 0.2 + ZP \cdot 0.3 \quad (5)$$

In the next step, using the Cost Distance GIS tool, a raster Cost Direction (CD) and Back-link (BC) rasters were created for the following source-destination UAV flight routes: 1. Šljivovica - Mitrovac, 2. Mitrovac - Zaovine and 3. Zaovine - Šljivovica (Fig. 2.)

In the last phase, the flight routes were combined and merged into the final UAV flight corridor for a cargo delivery. The map was visualized using CS, flight corridor and point layers of significant settlement locations within the NP "Tara" (Fig. 3).

The obtained results represent the shortest and safest routes for cargo delivery using a UAV. The length of the route can be harmonized with the technical capabilities of commercial UAVs for cargo transport. The flight corridor is harmonized with the requirements of environmental protection and minimally endangers the protected zones within the NP "Tara" (Table 3).

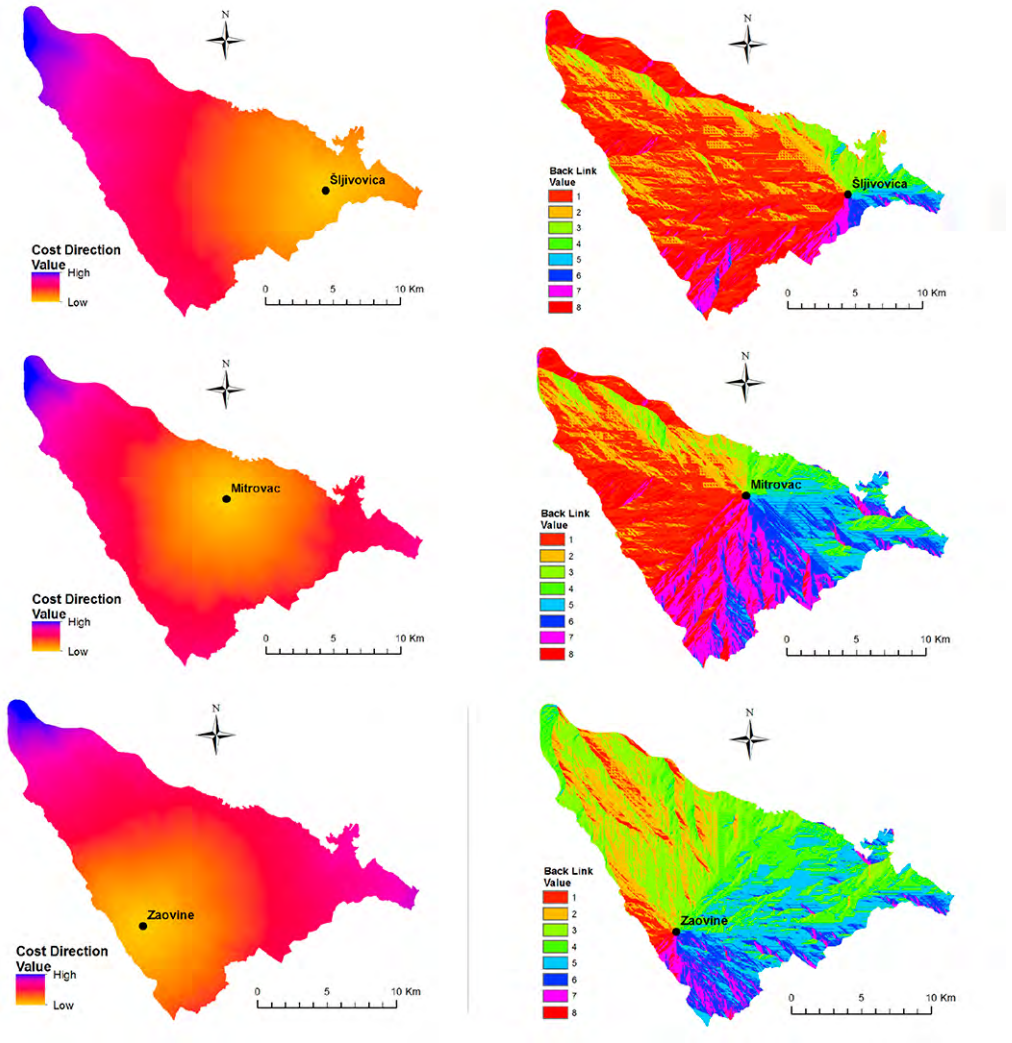

Figure 2. Cost Direction and Back Link maps

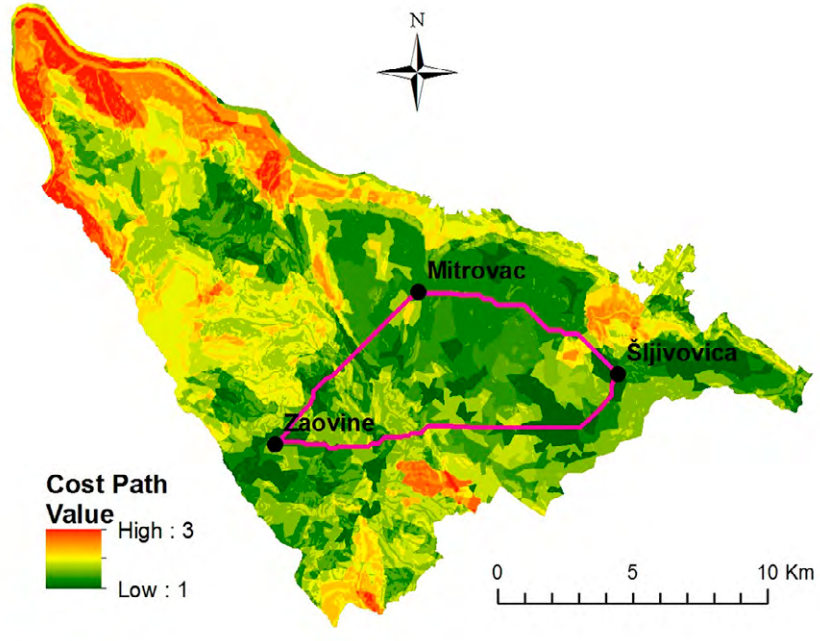

Figure 3. Final Least Cost UAV flight corridor map

Table 3. UAV flight corridor for cargo delivery impact on natural protected zone of the NP "Tara"

Corridor	Route length (m)	Zone of protection (%)		
		I	II	III
Šljivovica - Mitrovac	8636	0.0	8.1	91.9
Mitorvac - Zaovine	7909	0.0	8.8	91.2
Zaovine - Šljivovica	14.286	0.0	0.0	100
Sum (Σ)	30.830	0.0	4.5	95.5

Conclusion

The research in this paper showed the successful application of the GIS-LCP method of corridor selection for the UAV flight within the NP "Tara". The applied method is characterized by the simplicity and flexibility of application. The method can be applied in solving the problem of UAV flight planning in similar or different geospatial conditions. This requires the inclusion of other geospatial criteria in the analysis, which may affect the flight of the UAV. In this paper, the flight corridor for the UAV flight is modeled for ideal meteorological conditions, which is the main limitation in this research. In a more complex geospatial environment, urban infrastructure, transmission lines, restrictive flight zones and tall buildings must be taken into account. In the future research, increasing the number of criteria requires the application of more complex methods of multicriteria optimization for the UAV flight corridor modeling.

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COMPARATIVE ANALYSIS OF THE OUTDOOR THERMAL COMFORT IN URBAN ENVIRONMENTS - CASE STUDY OF BIJELJINA AND LOZNICA

Milica Lukić[A], Dijana Đurić[B]

Abstract

This paper presents the comparative analysis of the Outdoor Thermal Comfort (OTC) of two urban environments - Bijeljina (Republic of Srpska) and Loznica (Serbia). Universal Thermal Climate Index (UTCI), which represents the heat stress of the human organism caused by meteorological conditions, was used as a measure of thermal comfort in the study. The main goal of the research was to monitor changes in the index values, as well as the frequency of various categories of thermal stress during the hottest summer months (June, July, August), over a ten-year period (2009-2018). For the purpose of determining the UTCI index, mean daily values of meteorological data were used, which were measured at the weather stations Bijeljina (44° 75' N, 19° 20' E, 97m) and Loznica (44° 32' N, 19° 14' E, 121m). The obtained results show a gradual change in the bioclimatic conditions of these areas, which are generally less favorable during July and August, somewhat more in Bijeljina, then in Loznica.

Keywords: UTCI, outdoor thermal comfort, urban environments, Bijeljina, Loznica

Introduction

Constant urban population growth and intensive urbanization lead to increased pressure on urban areas leading to uncomfortable living conditions. The quality of urban living conditions often depends on the thermal comfort of the open urban spaces, which are used on a daily basis (Dunjić, 2019). Besides, progressive modification of city's morphological characteristics, i.e. the replacement of natural, permeable surfaces with mineral, rough materials such as concrete and asphalt, resulting in large quantities of solar radiation stored and then re-emitted in urban areas, which results in more severe bioclimatic conditions (Tsoka et al., 2017). So, it is necessary to investigate different technical solutions to mitigate the microclimatic conditions and to improve the thermal comfort of the citizens of a densely populated area (Battista et al., 2019). That is the reason why the attention towards outdoor thermal comfort is increasing in the last decade (Dunjić, 2019). Human thermal comfort is defined as a condition of mind which expresses satisfaction with the surrounding environment, according to ANSI/ASHRAE Standard 55. High temperatures and humidity provide discomfort sensations and sometimes heat stress. People react differently to environmental elements, depending on the physical and mental health and their adaptation to certain conditions. Common for everyone is that they are not immune to meteorological conditions, especially air temperature and humidity (Đurić, Topalić-Marković, 2019).

In 2011, the International Society of Biometeorology (ISB) announced a new thermal index for outdoor thermal environments called the Universal Thermal Climate Index (UTCI). The index was developed under ISB Commission 6 by COST Action 730, under the umbrella of the WMO Commission on Climatology (Park et al., 2014). The UTCI is heat budget index

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in function of both physiological and meteorological parameters, which describes the physiological heat stress that human body experiences in the attempt to maintain thermal equilibrium with the surrounding outdoor environment (Blazejczyk et al., 2013).

UTCI is a widely accepted human thermal index, whose results can be mapped as human bioclimatic maps and it is a useful tool for analyzing outdoor human thermal effects in urban landscapes (Park et al., 2014). Nowadays, UTCI application can be found in numerous scientific studies. Roshan et al. in 2018 presented a spatiotemporal analysis of bioclimatic comfort conditions for Iran using mean daily meteorological data from 1995 to 2014, analyzed through PET and UTCI. Park and others, in 2014 have investigated the microclimatic effects for human thermal sensation on human bioclimatic maps in summer 2009 using UTCI. Study locations were downtown Nanaimo, BC (Canada) and Changwon (Republic of Korea). Kolendowicz et al. (2018) have studied human-biometeorological conditions in the southern Baltic coast based on the UTCI. In study conducted by Mölders (2019), data from 456 surface meteorological sites in Alaska, eastern Russia and northwest Canada for 1979-2017, were used to model hourly Universal Thermal Comfort Indices (UTCIs) under consideration of Alaska-appropriate clothing. The results served to determine a high-resolution climatology of thermal comfort levels for Alaska at various temporal and spatial scales, as well as the frequency of thermal stress levels.

Wu et al. (2019) have used UTCI as a measure of outdoor thermal comfort in China between 1966 and 2016. Annual and seasonal UTCI were calculated using the daily dataset collected from 591 stations to developed a REOF-cluster-EOF hybrid model to optimize regionalization and assess regional-scale variations for UTCI. Bleta and others (2014) have analyzed the human bioclimatic conditions of Crete Island, by applying two human thermal indices: PET and UTCI, covering the 30-year period (1975–2004). In 2015, Pappenberger et al., have assessed the potential of using the UTCI for forecasting thermal health hazards. It is shown that probabilistic UTCI forecasts are superior in skill to deterministic forecasts and that despite global variations, the UTCI forecast is skillful for lead times up to 10 days. The paper also demonstrates the utility of probabilistic UTCI forecasts on the example of the 2010 heatwave in Russia.

In recent years, outdoor thermal comfort (OTC) in urban areas of Western Balkan countries was subject to several studies (Basarin et al., 2016; Basarin et al., 2018; Dunjić, 2019; Đurić, Topalić-Marković, 2019; Kendrovski et al., 2011; Lukić, et al., 2019; Pecelj et al., 2017; Pecelj et al., 2018; Trbić et al., 2017; Vučković et al., 2019; Zaninović, Matzarakis, 2014). In spite of the fact that in the last decade in Serbia, articles have been published containing an analysis of bioclimatic conditions, the detailed bioclimatic condition has not yet been thoroughly analyzed by means of the UTCI. The interest of researchers is growing, so in the coming period, we should expect the development of this scientific discipline in our region.

Study area

The research involved studying two synoptic stations – Bijeljina (Figure 1) and Loznica (Figure 2). The first weather station (44° 75' N, 19° 20' E, at an altitude of 97 m) is located in the territory of the city of Bijeljina, in the northeastern part of the Republic of Srpska. Geographically, it is located in the Peri-Pannonian area, more precisely in the Semberija region. According to Köppen's climate classification, Bijeljina belongs to the Cfb type – where the climate is moderate continental, with moderately cold winters and warm summers, and the average annual temperature is 11.6°C (Republic Hydrometeorological Service of Republic of Srpska, 2019).

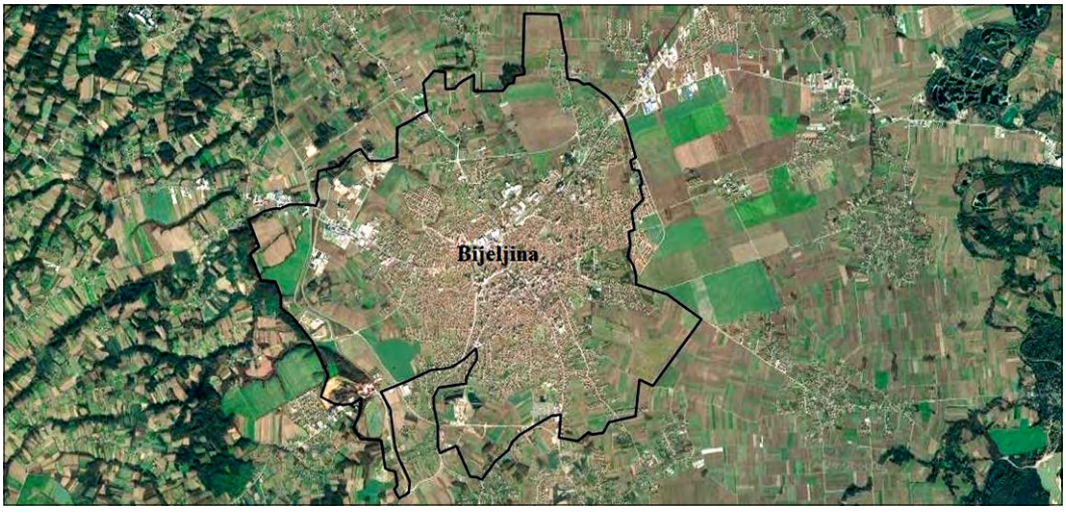


Figure 1. The urbanized area of Bijeljina (Map ratio 1: 60,000)

Figure 2. The urbanized area of Loznica (Map ratio 1: 35,000)

The second station (44° 32' N, 19° 14' E, at an altitude of 121 m) is located in the territory of the city of Loznica (Serbia). Loznica is located in the Jadar region, in the northwestern part of Serbia, and it belongs to the Peri-Pannonian and Podrinje region (Gajić, Vujadinović, 2010). City is positioned in Lozničko polje, near the Drina River. Downstream from Zvornik, the Drina Valley extends considerably and transforms into a flatland called Lozničko polje. The area is surrounded by low and medium-sized mountains which have a significant impact on the climate (Bilić, 1978). The territory of Loznica is characterised by temperate continental climate, where the average annual temperature is 11.6°C (Stojićević, 2016). According to Köppen, this climate is classified as Cfb type.

Geographical proximity, similar morphological and climatic characteristics are the main reason why these two urban areas were selected as the subject of this study. In addition, these are synoptic stations located in the territory of the two neighboring states, therefore they are considered relevant to the analysis.

Materials and methods

This study implements the methodological approach of the Universal Thermal Climate Index (UTCI) based on the human heat budget model relying on the evaluation of human energy balance. UTCI is the equivalent temperature for the environment derived from a reference environment. It is defined as the air temperature of the reference environment which produces the same strain index value in comparison with the reference individual's response to the real environment (Zare et al., 2018). As a thermal comfort indicator, the UTCI considers combined meteorological and physiological parameters describing thermal comfort through the evaluation of human energy balance.

In terms of physiological conditions, the metabolic rate (MET) has a very important role (Błażejczyk et al., 2013). As a measure of physical activity, a unit of MET was defined, which corresponds to the release of human heat of 58.2 $W.m^{-2}$ for average body surface area (1.8 m^2), i.e. it is equal to the energy rate produced per unit surface area of an average person seated at rest (ANSI/ASHRAE Standard 55). According to ISO 8996 for standard applications, the metabolic heat energy is M = 135 $W.m^{-2}$ i.e. 2.3 MET, for a person moving at a speed of 1.1$m.s^{-1}$.

The human reaction was simulated by the UTCI-Fiala multi-node model of human thermoregulation (Fiala et al., 2012), which was integrated with an adaptive clothing model. For any combination of meteorological parameters (Eq. 1), based on the conception of an equivalent temperature, the UTCI is the air temperature of the reference environment which, according to the model, produces an equivalent dynamic physiological response under a set of reference conditions (Bröde et al., 2012). In other words, this model simulates the same sweat production or skin wettedness in human body response as the actual environment condition (Błażejczyk et al., 2013; Błażejczyk et al., 2014). The UTCI can be represented in general function as bellow:

$$UTCI = f(t, f, v, t_{mrt}) \quad (1)$$

UTCI = f (air temperature, relative humidity, wind speed, mean radiant temperature)

For a given combination of air temperature, wind speed, radiation, and humidity, the UTCI is defined as the air temperature of a reference environment that would elicit in the human body the same UTCI-Fiala model's response (sweat production, shivering, skin wettedness, skin blood flow, and rectal, mean skin and face temperatures) as the actual environment (Di Napoli et al., 2018). The reference environment is described as a condition of calm air, i.e. wind speed 0.5 m/s at 10 m above the ground, no additional thermal irradiation, i.e. radiant temperature equal to air temperature, 50% relative humidity (capped at 20 hPa for air temperatures above 29°) where an average person walks at 4 km/h (1.1 $m.s^{-1}$), generating a metabolic rate equal to 135 $W.m^2$ (2.3 MET) (Błażejczyk et al. 2013; Bröde et al., 2012; Di Napoli 2018; Jendritzky et al., 2012).

Although UTCI is one of the best indices, it also has some weaknesses. One of them is a necessity of reduce wind speed to human-biometeorological reference height (1.1 m a.g.l) which is done in UTCI procedure by use of a relatively simply approach. Next problem is estimation of T_{mrt} (mean radiation temperature) which is calculated on the base of solar radiation. However, it is worth to emphasize that the solar radiation measurements are relatively rare; Tmrt is calculated in BioKlima software package (Błażejczyk, 2011) indirect with consideration of cloudiness and geographical position of measurement point (Kolendowicz et al., 2018).

As this study focuses on the summer months, five stress levels ranging from slight cold stress to very strong heat stress, are considered. Particular ranges of UTCI are categorised according to thermal stress (Table 1).

Table 1. UTCI thermal stress classification

UTCI (°C)	Stress category
UTCI > 46	Extreme heat stress
38 < UTCI < 46	Very strong heat stress
32 < UTCI < 38	Strong heat stress
26 < UTCI < 32	Moderate heat stress
9 < UTCI < 26	No thermal stress
0 < UTCI < 9	Slight cold stress
-13 < UTCI < 0	Moderate cold stress
-27 < UTCI < -13	Strong cold stress
-40 < UTCI < -27	Very strong cold stress
UTCI < -40	Extreme cold stress

Source: Błażejczyk et al., 2013; 2014.

Mean daily values of meteorological parameters: air temperature (t), relative humidity (f), wind speed (v) and cloud cover data from the two urban (Bijeljina and Loznica) weather stations were considered for the determination of specific UTCI thermal heat stress in the summer months (June, July, and August), covering the data period from 2009 to 2018. The meteorological data for Loznica was retrieved from the Meteorological Yearbook for the period from 2009 to 2018 (Republic Hydrometeorological Service of Serbia), while the data set for Bijeljina was provided by the Republic Hydrometeorological Service of Republic of Srpska. The UTCI index was calculated by applying the BioKlima 2.6 software package (available at http://www.igipz.pan.pl/Bioklima-zgik.html).

Results

Under the influence of climate change, the climate and microclimate of Serbia and its surrounding countries, especially urban areas are subject to constant change, and adverse weather conditions are becoming more frequent. Minimizing their effects, establishing sustainability and improving living conditions in urban areas is becoming a true challenge (Lukić, 2019). As a result, an increasing number of studies are emerging related to the observation of heat waves and their frequency, outdoor thermal comfort, the occurrence of extreme temperatures in the hotter part of the year and drought across the region etc. (Basarin et al., 2016; Lukić et al., 2019; Pecelj et al., 2017; Unkašević, Tošić, 2009). The findings of numerous studies exploring different aspects of the weather conditions in Serbia indicate a steady increase in the average annual air temperature and show that these changes are especially noticeable during the summer season. The findings that have been obtained in this paper are in keeping with the above studies.

Figures 4, 5, and 6 show the ratio of the total number of days for each category of thermal stress which was recorded during the investigation period, for both synoptic stations. Out of 10 categories of thermal stress defined by this methodology, 5 categories were recorded: slight cold stress, no thermal stress, moderate heat stress, strong heat stress and very strong heat stress.

The graphs clearly show that June is the most favorable month from the bioclimatic point of view during summer season. June is the only month where results of UTCI calculation showed all five mentioned categories (five in Bijeljina and four in Loznica) (Figure 4). The prevalent category of heat stress is the one defined as "moderate" (26<UTCI>32). However, its presence has varied over the years, especially in 2016

in Bijeljina, when 23 such days (of which 16 consecutive days) were recorded, while in 2018 were recorded only 8 days. The highest number of days in category of "moderate heat stress" in Loznica was also recorded in 2016 (21 days). Apart from this category of outdoor thermal comfort, days in which UTCI belongs to the category of "strong heat stress" (32<UTCA>38) on a daily level were also registered. Strong heat stress showed some differences between these two weather stations, wherein Bijeljina were recorded a higher number of days compared to Loznica, for each year during the observed period (2009-2018). Both cities have reached the highest number of days in this category in 2012, Bijeljina 17 days, of which 9 consecutive, and Loznica 13 days, of which 8 consecutive. On the territory of Serbia the year 2012 was the second hottest year since 1951, with the greatest number of tropical days recorded within the period 1951-2012 according to Republic Hydrometeorological Service of Serbia.

The isolated case of "slight cold stress" was observed in 2010, in both cities, when the mean daily temperature was 10.7°C in Bijeljina (UTCI = 1.89, June 1st) and 11.6°C in Loznica (UTCI = 8.68, June 1st). In general, in June occures lower temperatures than in July and August, and it has the highest number of days with "no thermal heat stress", meaning the highest number of pleasant days. In the city of Loznica, in this category (9<UTCI>26) at least one day was recorded every year, with minimum of 1 day in 2016, and the maximum of 9 days in 2009 and 2014. On the other hand, regarding the category "no thermal stress", Bijeljina proved to be somewhat less favorable, with a lack of such days during two years, 2012 and 2016.

As regards the thermal stress category "very strong heat stress" (38<UTCI<46) during the discussed period of 10 years in June, there are only a few cases of the UTCI exceeding its threshold value in Bijeljina: only two such days in 2010 (UTCI=38.15, June 12th) and 2013 (UTCI= 38.56, June 20th). On the same day was recorded the maximum daily temperature in June that year (respectively Tmax=36.3°C and Tmax=36.1°C), for both synoptic stations.

Compared to June, in July there was a lower representation of the category with no thermal stress, both in Bijeljina and in Loznica during a ten-year period, only 15 and 19 days respectively - which means that July is the least favorable summer month for outdoor activities (Figure 5). Moreover, the years 2012, 2014 and 2015 stands out as years when in July there was not recorded even one day when UTCI mean daily value was between 9 and 26. With its average temperature of 26.9°C, July 2012 was the hottest one ever since meteorological data started being recorded and August 2012, with its average temperature of 26.4°C, was the second hottest August in the last 120 years according to Republic Hydrometeorological Service of Serbia. Categories "moderate heat stress" and "strong heat stress", which are dominant in the city of Bijeljina in July, make this urban area slightly less favorable for living in comparison to Loznica, during the same period. Total number of days in "strong heat stress" category (32<UTCI>38) in Bijeljina was 164 (14 consecutive days in 2012) and in Loznica 110. Further, in the territory of Bijeljina 5 days in the category of "very strong heat stress" (38<UTCI>46) were recorded: in 2013 (1 day, UTCI=38.54, July 29th), 2015 (2 days, UTCI=38.35 and 38.13, July 8th and 22nd), 2016 (1 day, UTCI=38.47, July 13th) and 2017 (1 day, UTCI=38.56, July 10th).

In August (2009-2018), according to results obtained for Bijeljina synoptic station, the category of "strong heat stress" was singled out as a dominant, with 159 such days (or 51.29% of the total share). The following was the "moderate heat stress" category, with 130 such days (41.94%). Furthermore, there were 4 days with a mean daily value of UTCI that belonged to the "very strong heat stress" category (38<UTCI>46). This has occurred in 2012 with 2 days (August 5th and 6th, UTCI=39.25 and 38.43), and in 2017 with also 2 days (August 4th and 9th, UTCI=38.73 and 39.13). The highest value of UTCI on the mean daily level reached for all three months at the Bijeljina weather station, was 39.25 (August 5th, 2012).

In the territory of Loznica, during August (2009-2018), as a dominant category of thermal heat stress, the "moderate" category was singled out. Of the total number of days in August, during the 187 days on the mean daily level, the value of thermal comfort was between 26 and 32. With a 60.32% share "moderate heat stress" category was in the first place. In the second place was the "strong heat stress" category with 101 days (32.58%). The highest number of days in this category was recorded in 2018 (19 days), 2015 (18 days), and 2017 (14 days). As the most adverse 2012, 2015, 2017 and 2018 year stands out. The highest value of UTCI on the mean daily level reached for all three months at the Loznica weather station was 37.84 (August 11th, 2017). During the observed period at Loznica weather station was not recorded even one day belonging to the category of "very strong heat stress", even though the air temperatures exceed 40°C on some days. In these situations, the importance and impact of the other meteorological parameters (wind speed, relative humidity, cloud cover data, and air pressure) used for the purpose of determining the UTIC is clearly evident. This is the main advantage of UTCI over other simple heat indices.

The most significant difference between these two urban areas in terms of bioclimatic conditions is seen

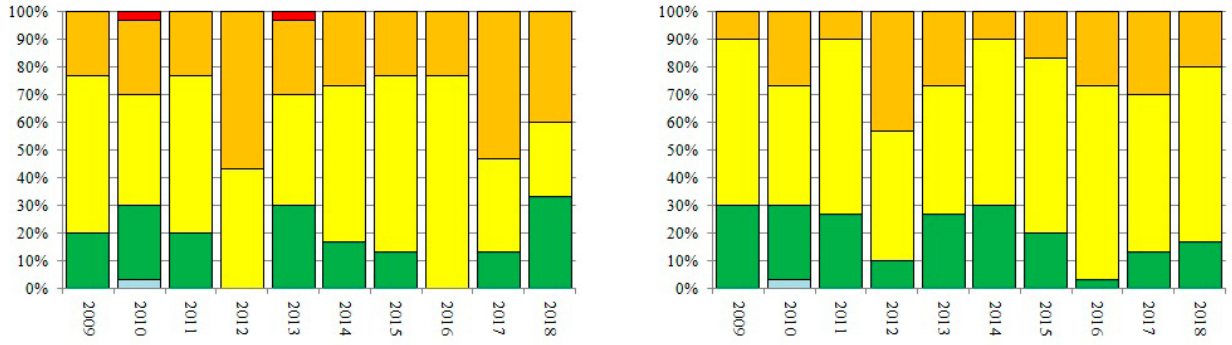


Figure 3. UTCI thermal stress categories in total, Bijeljina and Loznica, June 2009-2018

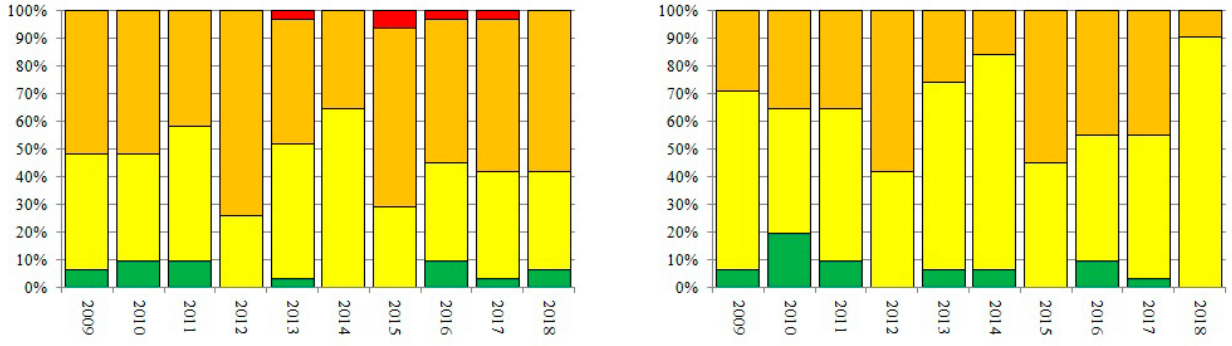
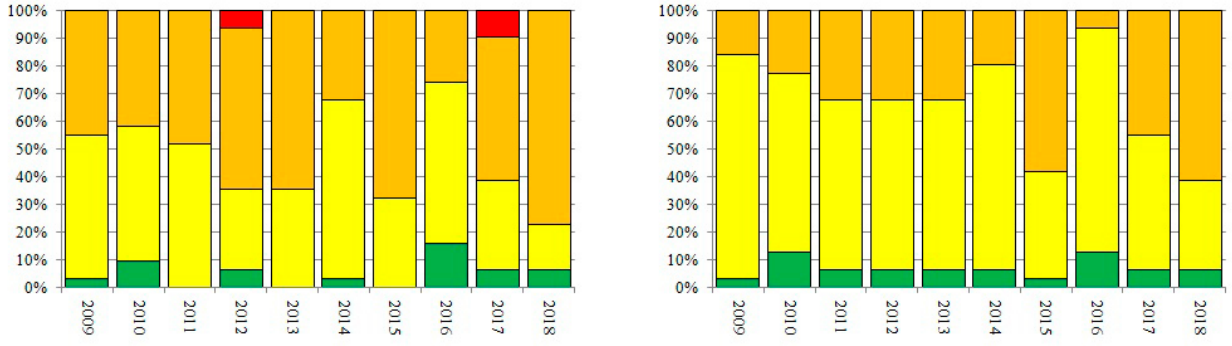


Figure 4. UTCI thermal stress categories in total, Bijeljina and Loznica, July 2009-2018



Slight cold	No thermal	Moderate	Strong	Very strong
0<UTCI<9	9<UTCI<26	26<UTCI<32	32<UTCI<38	38<UTCI<46

Figure 5. UTCI thermal stress categories in total, Bijeljina and Loznica, August 2009-2018

in the presence of days when outdoor thermal comfort exceeded the threshold of the UTCI category of "very strong heat stress" (38<UTCI>46). Based on meteorological data obtained from the Bijeljina weather station, a total number of such days were 11, while not a single one day in that category was recorded at the Loznica weather station (Figure 6). The main reason for this we can find in the high influence of the steppe climate (semi-arid climate) which comes from the wide Pannonian Plain and modifies the moderate continental climate of Semberija. On the other hand, low and medium-sized mountains that surrounds the city of Loznica have a significant impact on the climate of this area.

In order to give a more thorough insight into the changes recorded in the analyzed period, we have given Figure 7, which shows the trendline of the number of days for categories of thermal heat stress according to UTCI for the whole summer (June, July, and August). This enables the simple insight into the changes of summer discomfort over the analyzed period. Table 2 shows annual trend of increase/decrease in the number of days per year, with a particular thermal stress category for both weather stations.

Linear graphs and values in Table 2 show that the most significant changes in outdoor thermal comfort are related to the category of "strong heat stress". There was an increase in the observed heat stress cat-

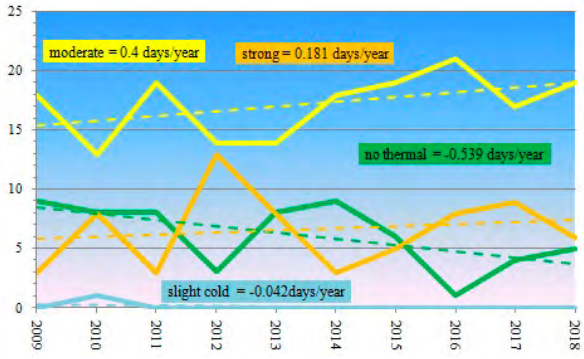
Table 2. Annual trend of increase/decrease in the number of days with a particular thermal stress category, Bijeljina and Loznica, 2009-2018

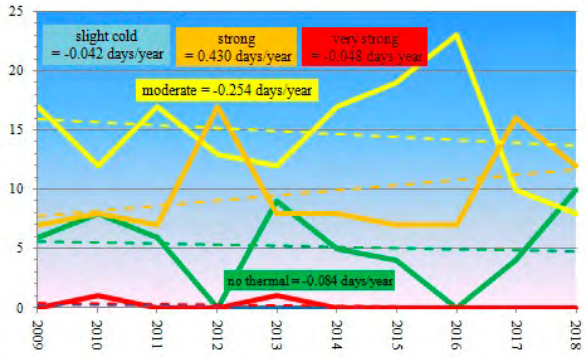
Month	Syn. Stat.	Annual trend (days/year)				
		Slight cold	No thermal	Moderate	Strong	Very strong
June	Bijeljina	-0.042	-0.084	-0.254	0.430	-0.048
	Loznica	-0.042	-0.539	0.4	0.181	/
July	Bijeljina	/	-0.090	-0.181	0.169	0.103
	Loznica	/	-0.321	0.446	-0.145	/
August	Bijeljina	/	0.133	-0.678	0.454	0.090
	Loznica	/	0.012	-0.951	0.939	/

egory, at both weather stations, with the exception of Loznica in July, when an increase of the "moderate heat stress" category was registered (0.454 days/year).

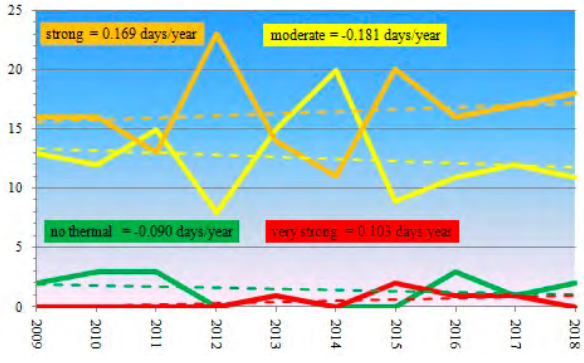
The highest growth trend for both areas was recorded in August (2009-2018), at the Loznica weather station in "strong heat stress" category, amounting to 0.939 days/year. At the same time, the highest declining trend was recorded at the same synoptic station, in "moderate heat stress" category, and it was -0.951 days/year. In Bijeljina, the category of "very strong heat stress" shows a linear increase during July and August, with a positive trend of 0.103 days/year, respectively 0.090 days/year. As for the "no thermal stress" category, the results indicate a declining trend during June and July (the highest decrease was -0.539 days/year in June, in Loznica), which confirms the fact that bioclimatic conditions change from year to year and became more severe.

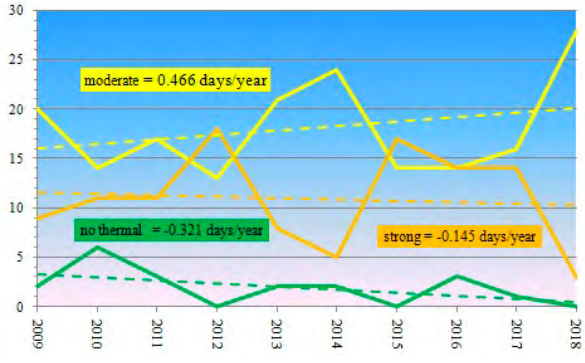
Considering the tendency of increasing daily temperatures and values of UTCI in August, it can be expected that in the coming decades a higher presence of the "very strong heat stress" category will occur, both in Bijeljina and Loznica.



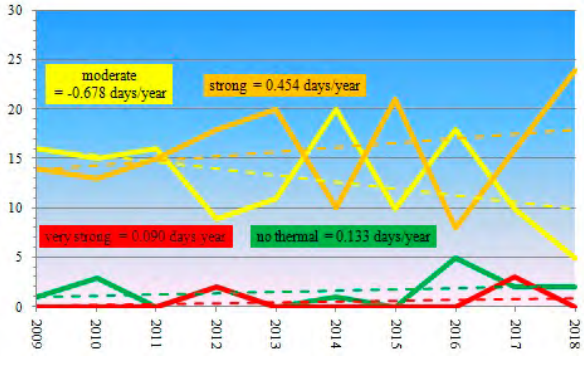


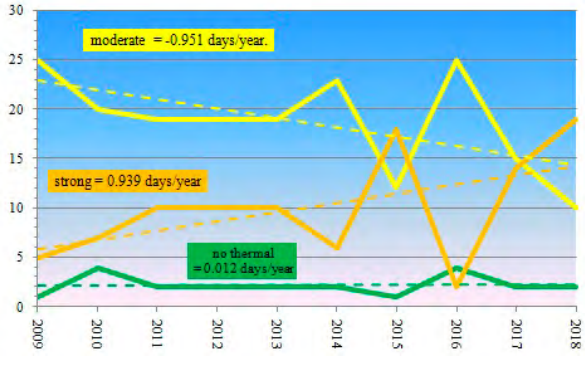
a) June (Bijeljina and Loznica)





b) July (Bijeljina and Loznica)





c) August (Bijeljina and Loznica)

Slight cold	No thermal	Moderate	Strong	Very strong
0<UTCI<9	9<UTCI<26	26<UTCI<32	32<UTCI<38	38<UTCI<46

Figure 6. Trendline - number of days for each thermal stress category of UTCI, for Bijeljina and Loznica, 2009-2018, a) June, b) July, c) August

Concluson

The aim of this paper was to determine the outdoor thermal comfort of two urban environments - Bijeljina (the Republic of Srpska) and Loznica (Serbia), during the hottest part of the year (summer months June, July, and August). The assessment of human biothermal conditions for the investigation period from 2009 to 2018 was provided by using UTCI, heat budget index which represents the heat stress of the human organism caused by meteorological conditions. The results in this study help us to better understand how the bioclimatic conditions of the local environment change, and how it affects human beings and ecosystems in urban environments.

Regardless of their geographical proximity and similar morphological, climatic and urban characteristics, these areas have some differences relating to

outdoor thermal comfort, but also a lot of similarities. Outdoor thermal comfort in both areas is generally more adverse in July and August. In the period of 10 years, 2012, 2015 and 2017 stands out as the most adverse ones. The highest UTCI mean daily value was recorded in August 2012 (UTCI=39.25), and this was recorded at the Bijeljina weather station. At the Loznica weather station the highest index value has occurred in August 2017 (UTCI=37.84). The most significant difference between these two urban areas in terms of bioclimatic conditions is seen in the number of days with a "very strong heat stress" on a daily level. There were 11 such days recorded in the territory of Bijeljina, while in Loznica were not obtained data in this category. In addition, the findings show that in the two-months period (June and July) during the 10 years, there was a considerable decline in the number of days characterized by the subjective perception of "no thermal stress" in an outdoor environment. The highest growth trend for both areas was recorded in August (2009-2018) in "strong heat stress" category.

Acknowledgements

The paper represents the results of research on the National project supported by Ministry of Education, Science and Technological Development, Republic of Serbia (No. 176008). We owe special gratitude to the Republic Hydrometeorological Service of Republic of Srpska for providing the necessary meteorological data set for this study.

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FULFILLMENT OF GENERAL COMPETENCES OF GEOGRAPHY TEACHERS IN RURAL AND URBAN SCHOOLS IN THE REPUBLIC OF SRPSKA

Rada Mandic[A], Lidija Jovicic[A]

Abstract

In the recent years, the complex problem of defining general as well as specific professional competences has become the center of interest for many educators. Competences represent the unity of knowledge, skills and abilities that are necessary for a particular job to be accomplished. We place emphasis on general competences in the work and therefore the aim of this paper is to examine the achievement of general competences of geography teachers in rural and urban schools in the Republic of Srpska. The basic hypothesis of the paper is based on the assumption that there is a statistically significant difference in the fulfillment of general competences of rural and urban schoolteachers, with particular reference to the possession of information and technical literacy and knowledge of a foreign language. The data presented in this paper were obtained on the basis of a questionnaire, whose processing and analysis were performed using the five-step Likert scale and the statistical package SPSS-20. Of the total number of geography teachers, the sample was 12% and 39 teachers respectively. The results obtained show that there is a statistically significant difference in the fulfillment of general competences of rural and urban schoolteachers in Republic of Srpska.

Keywords: competences, foreign language, information and technical literacy.

Introduction

In teaching theory and practice, there are various interpretations and definitions of competencies that imply not only skill but the unity of knowledge, skills and abilities to perform an activity (Biggz, 1994; Branković and Partalo 2011). Nowadays competences are being approached in the complex way because they contain important aspects of teaching in their structure. A competence or an ability is a combination of cognitive and metacognitive, interpersonal, intellectual and practical skills. Maksimovic (2005) states that the most common areas for defining competencies are knowledge and abilities, teaching and learning, planning and organization, knowledge of students and learning processes, monitoring, assessment and evaluation, behavior, professional values and practice, communication strategies, problem solving, the use of information technology and many others.

In addition to numerous classifications, pedagogical theory has not yet successfully developed a system of competency classification. It is of great importance to mentionTuning project (2006) and within which two broad categories of competencies were identified: general competences and area-specific competences required by each profession.

In addition to numerous factors, in the opinion of Brankovic and Popovic (2018), the competences of teachers should be crucial to the quality of education, which should be understood as an open and dynamic system related to different areas of social life. They classify teachers' competences into four broad groups that are interconnected and conditioned, that is, the development of some competences significantly influences the development of others, and together they represent a system of professional and profession-

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al competences. This system consists of pedagogical, psychological, didactic and methodical competences. Also, they believe that today's teachers face competency challenges that determine the formation of new or abandonment of existing competencies, that is, determine the course of professional development as a continuous process.

Today's teaching should be aimed at students and monitoring their progress, which is why it is important to improve their own competences of teachers (both general and professional) in order to focus on the quality of the teaching process, which will also affect the interest and motivation of students for certain subject contents. Koh (2008) believes that competencies such as experience, self-assessment, and nouns cannot be measured because they depend on personal attitude and experience, whereas Jerković and Damjanovic (2007) view competencies as the ability to learn one's own practice, experience, through reflection, evaluation, and planning .

Arsentijevic and Andevski (2016) understand competencies based on an individual's ability to use his or her own natural and personal resources to achieve a good result, namely the ability for self-reflection and self-affirmation. According to them, a competent teacher should enable the creation of a pedagogical atmosphere in which the learner is applied to their needs and abilities.

Key competences - those that are necessary for the pursuit of a professional activity and include information and communication competences, social and work competences, language competences and cultural competences. In the context of the aforementioned, language and communication competencies are often a prerequisite for acquiring others due to their multidimensional nature (Stojanovic&Misic, 2018). They are at the same time "goals to be pursued, outcomes of the process of development of other abilities and dimensions of personality, but also the basis for the development of all the abilities associated with them" (Jovanovic, 2007). Anđelković (2009) is committed to innovating teaching activities that need to be implemented into contemporary curricula in initial education that are based on these competencies. The results of the research indicate that 41.3% of people with initial education develop the most, and 13.55% of digital competences with the lowest level (Krljež, Polovina, 2019).

Research methodology

The subject of the research focuses on the general competences of geography teachers, i.e. the extent to which teachers are able to use information technology and language communication in the teaching process, how to find and present digital content to students and to refer them to independent research.

The aim of this paper is to determine the competence of teachers regarding the possession of cultural and civic competence, information and technical and linguistic literacy in their native and foreign languages, personal characteristics, problem solving and independent decision making, readiness for team work and interpersonal communication, knowledge in scientific and artistic fields and research skills.

The basic hypothesis of the paper is based on the assumption that there is a statistically significant difference in the attainment of general competences of rural and urban school teachers, with particular reference to the possession of information and technical literacy and knowledge of a foreign language.

The data presented in this paper were obtained on the basis of a questionnaire conducted throughout the Republic of Srpska, whose processing and analysis were performed using the five-step Likert scale and the statistical package SPSS-20.

The results obtained show that there is a statistically significant difference in the achievement of general competences of rural and urban school teachers.

Research results

Geography teachers, given the multidisciplinary nature of education (knowledge of the social characteristics of states: religion, language, culture), can be found in each of the competencies, which include, inter alia, communication in their native and foreign languages as well as the application of digital technology (multimedia). The importance of these competences is reflected in the most accurate and innovative presentation of social (linguistic) diversity in order to develop an awareness of cultural expression. The multidisciplinary nature of geography has not only allowed teachers to develop their own competences in terms of activity, research spirit, entrepreneurship, creativity and innovation, but also to develop them in their students in the most effective way to acquire new content. If we integrate knowledge in the field of cartography, climatology, demography, geomorphology, regional geography, we will enable students to apply technical and informa-

tion technologies in the field of knowledge upgrading. Therefore, in the following overview we will pay attention to the self-assessment of general competences of geography teachers in rural and urban schools of Republic of Srpska on the following issues:

1. I express myself orally and in writing in accordance with the rules of the Serbian language and the language in which I teach (oral and written communication in my native language).
2. I have basic and general knowledge in scientific and artistic fields and research skills.
3. I know a foreign language
4. I have information and technical literacy.
5. I am trained in teamwork and interpersonal communication.
6. I am trained in problem solving and independent decision making.
7. I respect universal human and national values (possess cultural and civic competences).
8. I possess certain personal qualities (autonomy, initiative, commitment to the call, openness to cooperation, creativity, ambition, etc.).

In this group of general teacher competencies, it is evident that rural geography teachers value competences the most:

Table 1. Fulfillment of general competences of geography teachers in rural schools

п	number, %	very good	good	sometimes	rarely	never	average grade
1	н 100%	17 (100)	0 (0)	0 0	0 0	0 0	5,00
2	н 100%	3 (17,64)	11 (64,70)	3 (17,64)	0 0	0 0	4,00
3	н 100%	3 (17,64)	5 (29,41)	9 (52,94)	0 0	0 0	3,64
4	н 100%	3 (17,64)	7 (41,17)	7 (41,17)	0 0	0 0	3,76
5	н 100%	7 (41,17)	5 (29,41)	3 (17,64)	0 0	0 0	3,76
6	н 100%	9 (52,94)	6 (35,29)	2 (11,76)	0 0	0 0	4,41
7	н 100%	17 (100)	0 0	0 0	0 0	0 0	5,00
8	н 100%	17 (100)	0 0	0 0	0 0	0 0	5,00

Source: independent data processing in SPSS program

Table 2. Achievement of general competences of geography teachers in urban schools

п	number, %	very good	good	sometimes	rarely	never	average grade
1	n 100%	20 (90,90)	2 (9,09)	0 0	0 0	0 0	4,90
2	n 100%	6 (27,27)	16 (72,72)	0 0	1 (4,54)	0 0	4,90
3	n 100%	5 (22,72)	7 (31,81)	5 (22,72)	3 (13,63)	2 (9,09)	3,45
4	n 100%	6 (27,27)	6 (27,27)	5 (22,72)	4 (18,18)	1 (4,54)	3,54
5	n 100%	14(63,63)	6 (27,27)	2 (9,09)	0 0	0 0	3,90
6	n 100%	18 (81,81)	4 (18,18)	0 0	0 0	0 0	4,81
7	n 100%	19 (86,36)	3 (13,63)	0 0	0 0	0 0	4,86
8	n 100%	21 (95,45)	1 (4,54)	0 0	0 0	0 0	4,95

Source: independent data processing in SPSS

- I express myself verbally and in writing in accordance with the rules of the Serbian language and the language in which I teach (oral and written communication in my native language) with a scale value (5).
- I respect universal human and national values (possess cultural and civic competences) with scale (5)
- I have certain personal attributes (autonomy, initiative, commitment to the call, openness to cooperation, creativity, ambition, etc.), also with a value of 5, with the lowest score being foreign language skills (3.64) and computer literacy (3.76).

Similarities are found in urban schools, which are the most valued competences, but not in their average grade.

Regarding urban schools, competencies are highly rated:

- - I express myself verbally and in writing in accordance with the rules of the Serbian language and the language in which I teach (oral and written communication in my native language) with a scale value (4.90).
- - I possess certain personal qualities (autonomy, initiative, commitment to the call, openness to cooperation, creativity, ambition, etc.), with a value of 4.95, and the lowest grade was also given to foreign language skills (3.44) and computer literacy (3. 54).

If we take a closer look at the self-assessment of general competences of teachers, we see that the first are competences related to oral and written communication, secondly the cultural and civic competences, and then the competences related to the personality itself and its characteristics (autonomy, initiative, commitment, openness, creativity, ambition etc). Competencies related to problem solving and independent decision making, as well as competencies related to team and interpersonal communication, are in fourth and fifth place. Today's teachers are becoming less information-literate and there are fewer who know one foreign language, our results show (these variables are in the last place in the rank of general competences), that is, teachers' self-assessments, who believe that they are not just trained when it comes to this knowledge.

Using the t test, at the significance level r <0.05, we examined the difference in self-assessment of general teacher competencies in rural and urban environments.

The results obtained t = -1.85877 with a value of r = 0.036447 less than 0.05 indicate that there is a statistically significant difference in the achievement of general competences of rural and urban school teachers, with special reference to possession

IT literacy and knowledge of a foreign language, thus confirming our hypothesis.

Conclusion

Based on the self-assessment of geography teachers in rural and urban schools on general competences, we conclude that teachers perform very well in competences related to oral and written expression, respect for values, possessing personal qualities such as autonomy, initiative, attendance, openness to cooperation , creativity, ambition, etc.

However, on average, they are acquired in competences related to knowledge in scientific and artistic fields, research skills, and at least in information and technical literacy and foreign language skills.

Rural schools show a greater presence of knowledge of a foreign language and computer literacy since they mainly employ younger staff and up to 10 years of work experience with a university degree, while in urban areas we must mention respondents who have over 33 years of experience and higher degrees, but with better competencies in the arts and research skills.

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TREND OF PRECIPITATION IN VOJVODINA FOR THE PERIOD OF 1978-2018

Milica Marčeta[A*], Marina Kovačević[A]

Abstract

Annual and seasonal quantities and trends of precipitation were analyzed for five stations (Novi Sad, Sombor, Sremska Mitrovica, Vrsac, Zrenjanin) located in Pannonian parts of Serbia. The data were analyzed using the Mann-Kendall test for the period from 1978 to 2018. The results showed that the precipitation trends during winter and spring had decreased, while in summer and autumn had increased. Tendencies of annual precipitation time series show rise on most analyzed stations, as a consequence of rainy years and extreme rainfall events in the last 10 years.

Keywords: precipitation, climate change, Pannonian Basin, Mann-Kendall test

INTRODUCTION

Data from meteorological stations worldwide from 1990 to 2005 show a trend of increasing precipitation in North and South America, northern Europe, Asia and Australia, and on the other hand, a negative trend in the Sahara, Mediterranean, southern Asia and western and southern Africa (Trenberth et al., 2007). Undoubtedly, the reduction of precipitation and consequently the increase of droughts in the Mediterranean area will have consequences in the field of agro-culture, ecosystems, water resources and further economics. Surveys conducted in Mediterranean countries, Spain, on the basis of annual, seasonal and monthly trend analysis of precipitation over the period 1961 to 2006, show a decrease in precipitation in February, March and June, and an increase in May, August, September and October. A similar situation is in neighboring Portugal, where a dry period has been observed in the central and western parts of the country. In Italy (Calabria) a negative trend, ie. reduction of precipitation was observed for the autumn-winter period, while a positive trend was shown in the summer half of the year for the whole region. Authors Longobardi and Villani have identified an annual decrease in precipitation over the past 50 years, but also a positive trend in the summer part of the year for the period 1918-1999. in southern Italy. In Greece in the period 1958-1997. for all stations, a significant decrease in precipitation was observed during spring, autumn (Ionian Islands and mountainous region in the west) and winter (Ionian islands, north, east and southeast of the Aegean Sea, mountainous region in the west) (Luković et al., 2013).

Possible causes of precipitation fluctuations in the territory of Serbia are discussed by several studies as well as by the topic of spatial distribution of precipitation. Tosic (2004) studied the spatial and temporal distribution of precipitation during the winter and summer half of the year at 30 stations in Serbia and Montenegro for the period 1951 to 2000, and based on the Mann Kendall test and spectral analysis, observed a negative trend of winter precipitation. The importance of atmospheric circulation for precipitation changes is indicated strong correlation of the North Atlantic Oscillation (NAO) index associated with winter precipitation. According to Stanojevic (2012), the lowest mean perennial precipitation values were determined for stations in northern Serbia, in general, a decrease in precipitation from west to east of the country is observed. The northeast, east, south and southeast show negative trend values, in contrast to the west and southwest of Serbia with positive precipitation values established (Stanojević, 2012). The

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authors, Ducić, Luković, and Stanojević (2010) analyze the relationship between seasonal and annual precipitation changes with atmospheric circulation based on Hes-Brezovsky circulation types, where it has been observed that atmospheric circulation is a significant factor in precipitation fluctuations and regional climatic differences. According to Unkašević and Radinović (2000) based on statistical analysis of monthly precipitation and daily maximums for Belgrade in the period 1888-1995. indicates that the daily precipitation maximum is associated with cold fronts followed by showers and stormy weather and cyclones above the eastern Mediterranean with centers in the southwest coast of the Black Sea. Based on the cluster analysis, Milovanovic pointed out 6 separate units where the average annual precipitation in five of the six clusters was observed, most pronounced in the west and southwest of Serbia. The reduction of precipitation is present in the Negotin region and the valley of Greater Timok. Out of the 22 meteorological station analyzed, there was an increase in 15 stations and an 8 decrease in the mean annual precipitation. During the spring months, precipitation decreases at a large number of stations (13) with a mean annual decrease, and during the summer at 18 stations, the trend of mean precipitation during the summer half of the year is significantly increasing, with the largest increase in the north of Bačka. During the mean autumn precipitation, 19 stations experienced an increase, with the highest growth recorded by stations located in the south of Backa and Srem, northwestern and western Serbia. During winter, the largest decrease in mean winter precipitation is recorded by stations located in Srem (statistically significant) and in the Negotin region (Milovanovic, 2017).

The main objective of this paper is to examine the annual, seasonal and monthly trends in precipitation in Vojvodina for the period 1978-2018. at 5 synoptic (main) stations (Novi Sad-Rimski Šančevi, Sombor, Sremska Mitrovica, Zrenjanin, Vršac).

Geographical position

With about 80% of the territory, Serbia belongs to the Balkan Peninsula, as a surveyed area of this work with an area of 88,361 km². As the 45-parallel passes through the northern part of the earth, its position belongs to the southern part of the Earth's hemisphere. It is predominantly of a mountainous character, located between the Dinaric, Sharz, Rhodope and Carpathian-Balkan entities (Romelic, 2008). The average height of Serbia is about 473 m, starting from 29 m near the Bulgarian border with Romania to 2.566 m on the Prokletije mountain in the south. As mountain massifs rise above much of the Balkan coast, this has caused major differences in the climate of the coastal and inland parts of the peninsula Climate differences are also affected by the openness of the interior of the peninsula through the Pannonian and Vlach-Pontic lowlands to central and eastern Europe. There are three main types of climate in Serbia: continental, moderately continental and modified Mediterranean climate. The northern parts of the country are characterized by a continental climate with warm summers, insufficient humidity, while winters are relatively long and cold. Autumn and spring are moderate and short. The southern and southwestern parts of the country are under Mediterranean influence, where the proximity of the Adriatic Sea acts as a source of heat and humidity, however the influence of the Adriatic is suppressed by high Dinarides that extend along the coast (Plavša, 2011). The prevailing meridional position of the river basins and the plains in the north allow deep penetration of polar air masses to the south.

Judging by the atmospheric processes and characteristics of the relief, precipitation in Serbia is temporarily and spatially unevenly distributed. Globally, precipitation decreases from west to east and is dependent on altitudes and movements of prevailing air masses (Romelić, 2008). In the lower regions, the annual precipitation ranges from 540 to 820 mm. Areas with an altitude of over 1000 m have an average of 700 to 1000 mm of precipitation, with some mountain peaks in the southwest of the country having heavy precipitation of up to 1500 m. Higher rainfall is in the warmer half of the year, with the exception of the southwestern areas where most rainfall is measured in the fall. It is rainiest in June, 12-13% more than the total annual rainfall. Rainfall is lower in February and October, while the occurrence of snow cover is characteristic of the colder part of the year from November to March and the highest number of days with snow cover in January. (http://www.hidmet.gov.rs/ciril/meteorologija/klimatologija_srbije.php). The northern part of the country is the driest and receives less than 600 mm per year, while the largest ranges occur in the southwestern mountains of Serbia, the mountain of Prokletije with an average amount of more than 1300 mm per year. The continental precipitation regime has much of the country, with the exception of southwestern Serbia, which has been subject to the Mediterranean precipitation regime (Lukovic, 2013). The effects of the Arctic and North Atlantic oscillations on precipitation anomalies can be observed between January-March and September-November for the pe-

riod 1958-2007. years. Since the beginning of measurements in Serbia, precipitation extremes have been:

- the driest year was 2000 when 223.1 mm was measured at the station in Kikinda
- the rainy year was 1937 when 1324.5 mm of precipitation was measured in Loznica
- the highest monthly rainfall was registered in June 1954 in Sremska Mitrovica with 308.9 mm of rainfall
- the highest daily rainfall was recorded on 10 October 1955 in Negotin with 211.1 mm of rainfall (Milošević, Savić, 2013).

Data sets and data methods

The paper analyzes seasonally and annually published data based on data collected for 5 synoptic stations (high) in the territory of Vojvodina (Novi Sad - Rimski Šančevi, Sombor, Sremska Mitrovica, Vršac and Zrenjanin), provided by the Republic Hydro-Meteorological Institute of Serbia.

Table 1. Main characteristics of meteorological station positions

Meteorological station	Coordinates	
	N	E
Novi Sad - Rimski Šančevi	45°20'	19°51'
Sombor	45°46'	19°09'
Sremska Mitrovica	45°06'	19°33'
Vršac	45°09'	21°19'
Zrenjanin	45°24'	20°21'

Source: Milošević, Savić, 2013.

Otherwise, the network of meteorological stations throughout the area is well distributed, with the exception of mountainous areas where uneven and sparse distributions are due to lack of measurements in these areas. A total of 76% of all weather stations are at altitudes from 0 to 500 m, which makes 62% of the territory, 13% at altitudes between 500 and 1000 m (27% of the territory) and 11% of stations have altitudes greater than 1000 m.

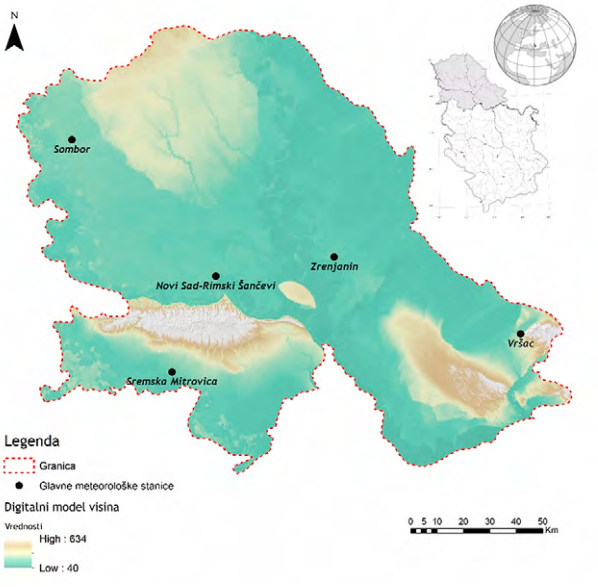

Figure 1. Geographical position of Serbia in relation to Europe and network of major meteorological stations in Vojvodina
Source: authors of the paper

Methodology

The paper calculates the seasonal and annual mean precipitation for all 5 stations from 1978 to 2018. Subsequently, the weather series of precipitation were analyzed on the basis of trend and correlation, and according to these data, the standard hypothesis test procedure to evaluate statistical significance of the results. To test hypotheses for long-term trends, we can consider two types of trends: the monotonic trend and the step (abrupt) trend (Hirsch et al., 1991). The paper used a monotonic trend because no visual changes revealed sudden changes in the datasets. A parametric or non-parametric method can be used to detect a trend depending on the data distribution. The Mann Kendall test and the Sin method (Helsel and Hirsch, 2002) were used to determine the significance and strength of the monotonic trend and the distribution of weather series. A 1-a / 2 quantal of the standard normal distribution was used to test the ascending (positive) or descending (negative) monotone trend at the significance level. The presence of a statistically significant trend was estimated using the Z value. A positive (negative) value of Z indicates an upward or a downward trend. The paper tested a significance level of 0.05 (Salmi et al., 2002).

Results

Trends in annual, seasonal and monthly precipitation are presented in tabular form. The results of the monotonic trend analysis are shown in Tables 2 and 3 for the monthly, seasonal and annual trends for 5 stations from 1978 to 2018.

Precipitation values trend analysis of annual and seasonal weather series (1978-2018)

Average annual precipitation in the studied area in the period 1978-2018. was 614.4 mm in total for all 5 stations. Only one station (Rimski Šančevi) has an average annual precipitation for the observed period of less than 600 mm, in this case 547.0 mm. The main station Zrenjanin has a slightly higher percentage of 600 mm per year for the observed period, and the highest average, ie. The station with the highest precipitation is Vrsac - 676,4 mm, because of the proximity of the Vrsac Mountains. The difference in precipitation is between Rimski Šančevi and Vršac (129.3 mm). There are similar results at the seasonal level. On the basis of the sum of average seasonal precipitation, most of it is excreted during the summer half of the year (199.6 mm), then during spring and autumn, and decreases in winter (118.6). Vrsac and Sombor (due to the proximity of Vrsac Hill and the Danube and with plenty of aerosols providing condensation nuclei) receive higher rainfall during the summer (June, July, August) (Vrsac - 228.6 mm, Sombor - 200.0 mm). In winter, the Vrsac Meteorological Station receives the highest precipitation of 133.4 mm compared to the other surveyed areas. Generally, the smallest amount of precipitation during one year and by seasons is received by the Rimski Šančevi main station. The difference between the summer and winter seasons is 81 mm.

Trends in annual, seasonal and monthly weather series of precipitation

Trends in annual precipitation show an increase at all analyzed stations (in order, Sombor, Rimski Šančevi, Zrenjanin, Vršac), mostly in Sombor where, based on the Mann Kendall test, the value of Z, for an annual rainfall for 40 years at a significance level of 10 % stands at 1.81, but shows a decrease of -0.10 at Sremska Mitrovica station. The positive trends at most stations are the result of rainy years and extreme rainfall over the period under review (1978-2018). Considering the monthly values for the investigated period, the significance level according to the Sin method, for the trend strength of 10% and 5% for the station Rimski Šančevi shows an increasing trend, ie. significance in February (0.485) and May (1.018). In March and April, a trend line was observed, with precipitation decreasing until May when the previously mentioned statistical significance of 5% was observed. In June and July there is an increase in rainfall, which is reflected in the autumn months - September and October, with the exception of November, when a decrease in the trend line was observed. For Sombor station, significance at the level of 5% is 0.610, showing a trend of increasing precipitation for February, and decreasing precipitation during March, April and June, when there is a gradual increase and recording of statistical significance of 10% (0.804) for September. At the Sremska Mitrovica synoptic station, a positive trend was observed for the observed period in January and February, and in March and April a negative trend line, which is reflected in the summer half of the year, more specifically in June, with a decrease of -1.032 in the level of statistical significance of 5 %, as in August. During September and October, there is an increase in the trend line until November when precipitation decreases noticeably. The Vrsac and Zrenjanin stations do not show significant significance according to the Mann Kendall test, but based on the test results one can conclude a trend of decreasing precipitation during December, March and April, and for the Vrsac station during June and July, and an increase in the end of summer half year and beginning autumn (from August to October), with a gradual increase in precipitation over the winter (December, January, February) at the station Zren-

Table 2. Average precipitation in (mm), seasonally and annually, 1978-2018

Meteorological stations	Winter	Spring	Summer	Autumn	Year
Novi Sad – Rimski Šančevi	101,2	134,7	180,8	130,3	547,0
Sombor	121,5	147,9	200,0	155,6	625,0
Sremska Mitrovica	119,1	155,1	196,4	157,6	628,2
Vršac	133,4	165,3	228,6	149,0	676,3
Zrenjanin	118,0	144,1	192,4	141,1	595,6
Total	118,6	149,4	199,6	146,7	614,4

Source: authors of the paper

janin. At all synoptic cells, cumulatively according to the nonparametric Sen method for trend magnitude, i.e. Significance of the same was observed in the decrease of rainfall in March and April, which has the consequence of increasing the period of droughts during the vegetative period as well as in the autumn half of the year (during November).

Taking into account the average rainfall for the period (1978-2018, Table 3) by seasons (winter, spring, summer, autumn) for all five stations based on the results of the Mann Kendall test and Sen's method for station Rimski Šančevi, that in the winter (February), the significance of 10% was (0.485), and during the spring (March, April) there is a decrease of precipitation, ie. negative trend, which gradually increases in May, where there is an increase in slope at the level of significance of 5%. The value of Sen's method is 1,018 for May. For the summer half of the year a decrease was observed in August, the significance is not statistically significant. During the fall season, there is a gradual increase in trend and statistical significance at the level of 10% of the average precipitation for the studied period. At the Sombor Main Station, statistical significance was observed at the level of 5% for the winter period of the year (February, 0.610). During March and April, the slope decreases, ie. precipitation, with no statistical significance for the spring season. During the summer half of the year, first of all, a negative trend occurs in June - a decrease in rainfall, and in July and August their gradual increase to see a 10% stratistical significance in the fall season by the Sen method in September (0.804). In November, as in most stations, there is a decrease in the trend line towards negative values. At Sremska Mitrovica station in the winter and spring season, precipitation was decreased, the trend line is in a declining slope, especially in December, March and April with no statistical significance. In the summer half of the year (June and August), statistical significance was observed at the level of 5% and precipitation decrease (negative slope, -1,032, -0,447), while in the autumn half of the year an increased trend was observed, but without statistical significance for this season. During winter, precipitation was observed at Vršac station without statistical significance with extension and during spring and early summer season (March, April, June). During the fall, there is an increase in the trend line, ie. precipitation in this season with the exception of November when the trend line is gradually declining. At the main station in Zrenjanin, a positive trend line was observed for the winter period but without statistical significance, and in the spring period of the year a negative trend, ie. precipitation decreases with the extension and during the summer season (June), while a positive trend is present in July and August. In the autumn, a positive trend was observed, ie. precipitation increase for the period 1978-2018. year by season, except in November, when the trend line recorded a gradual decline and continues to the winter season by this pattern.

Table 3. Trend analysis for the study period (1978-2018) by season by Mann Kendall test and Sen's method

Meteorological stations	Winter	Spring	Summer	Autumn
	Test Z / Q	Test Z / Q	Test Z / Q	Test Z / Q
Rimski Šančevi	1,02 / 4,06 +	-0,33 / -1,02 *	0,24 / 1,93	1,52 / 6,69 +
Sombor	0,11 / 3,72	0,00 / -9,09	-0,10 / -1,02	1,89 / 8,04 +
Sremska Mitrovica	-0,24 / -9,81	-0,07 / -2,62	-2,17 / -1,03 *	0,83 / 4,32
Vršac	-0,75 / -3,27	-0,04 / -1,62	-0,64 / -4,95	0,27 / 1,31
Zrenjanin	0,03 / 4,67	-0,40 / -1,68	-1,25 / -6,58	1,47 / 5,87

Source: authors of the paper

Based on the IPCC scenario for southern Europe, the annual precipitation will decrease by 5% to 15% in the summer and increase by 2020 during the winter (Popovic, Jovanovic, 1994). However, based on the results of the study area, it is obvious that the annual precipitation sums and the average for the observed period show a tendency to increase in the summer half of the year, and decrease during the winter months. Based on these results, it can be concluded that there are three precipitation trends in the Pannonian part of Serbia:

1. negative trend during winter and spring
2. a positive trend during the summer and fall
3. a positive trend on an annual basis

Precipitation regime analysis

A very important characteristic of precipitation in addition to quantity is the regime or its distribution. This is determined by the formula:

$$r = [(Rx–Rn)/Rg]\cdot 100\%,$$

where Rx is the rainfall in the wet month, Rn is the rainfall in the dry month and Rg is the annual rainfall (Lazić, Pavić, 2003).

In the investigated area in Vojvodina, at meteorological stations Novi Sad - Rimski Šančevi, Sombor, Sremska Mitrovica, Vršac and Zrenjanin, there is a global trend of decreasing precipitation, which means that the distribution of precipitation throughout the year is uniform.

Analysis of dry and wet periods

The characteristic occurrence of drought can be determined on the basis of several components: high air temperature, insufficient rainfalls, low relative air humidity, periods of no rainfall, some dryness indexes, high evapotranspiration. In the investigated period, four shorter periods with different precipitation characteristics can be distinguished:

- First period from 1978 to 1988 with deficit of precipitation;
- Second period from 1989 to 2000 with excess of precipitation;
- Third period from 2001 to 2010 with excess of precipitation and
- Forth period from 2011 to 2018 with deficit of precipitation.

For Rimski Sancevi station, in the first period (1978 to 1988) the dry years were 1979 (- 520.3), 1982 (- 534 mm), 1983 (- 479.2 mm), 1986 (- 481.3 mm).) and 1988 (- 470.2) relative to the average. Other years are normal, precipitation was about average (640.9 mm). During the second period (1989-2000) relative to the standard average, dry years were 1989 (- 507 mm), 1990 (- 450.7 mm), 1992 (- 533.8 mm), 1993 (- 473.9) and 2000 (- 287.8 mm). Of the 11 years, four years had more than average rainfall in 1996, 1997, 1998, 1999 over 750 mm of rainfall per year. The third period (2001-2010) is characterized by a wet period, where from 10 years 5 years had more than average, with the highest sum in 2010 of 1041.9 mm. It was dry in 2002 (- 481.9 mm), 2003 (- 509.2 mm) and 2008 (- 528 mm). Other years are normal, precipitation was about average. During the last fourth period (2011-2018) of 8 years, 3 years were dry 2011 (- 384.6 mm), 2012 (-485.1 mm), 2017 (- 513.1 mm), and two years were wet (2013 and 2016) over 730 mm over average.

For Sombor Station in the first period (1978 to 1988) 5 of the 11 years were drier than average. The dry years were 1978 (- 512.9), 1982 (- 517.3 mm), 1983 (- 475.5 mm), 1986 (- 502.9 mm) and 1988 (- 456.1 mm). One year was wet with excess rainfall, 1987 (716.3 mm). Other years are normal, precipitation was about average (610 mm). In the period 1989-2000. compared to the standard average, dry years were 1990 (- 473.1 mm) and 2000 (- 277.5 mm). Two years of the eleven had more than average in 1995 and 1999 over 700 mm of precipitation per year. The third period (2001-2010) is characterized by a wet period, where from 10 years 5 years had more precipitation than average, with the highest sum in 2010 (1035.6 mm). It was dry in 2002 (- 523.4 mm), and 2009 (- 528.3 mm). Other years are normal, precipitation was about average. During the last fourth period (2011-2018) of 8 years, 2 years were drier 2011 (- 403.8 mm), 2012 (-452.6 mm), and three years were wet (2013, 2014 and 2018) over 779 mm compared to an average of 610 mm.

At the Sremska Mitrovica meteorological station in the first period (1978 to 1988) 4 of the 11 years were humid, with increased rainfall over 647 mm relative to the average, and two droughts years. The dry years were 1983 (- 533 mm) and 1988 (- 426.7). Other years are normal, precipitation was about average (613 mm). In the period 1989-2000. compared to the standard average, 5 years had less precipitation than average: 1990, 1992, 1993, 1994, and 2000 as the driest year (- 277.5 mm). Of the 11 years, four years had more than average in 1991, 1996, 1998 and 1999 over 681 mm of precipitation per year. For the period 2001-2010. four years wet, four years dry, with the highest in 2001 (863.5 mm). The driest year was 2003 (- 483 mm). In the period (2011-2018) of 8 years, 3 years were dry 2011 (- 430 mm), 2012 (-452.9 mm) and 2017 (-533.2), and only one year was wet, 2014 with 761, 1 mm compared to the average of 613 mm.

For Vrsac station, in the first period (1978 to 1988), the dry years were 1983 (- 452.3 mm), 1986 (- 503.9 mm) and 1988 (- 551.7) compared to the average for the dry

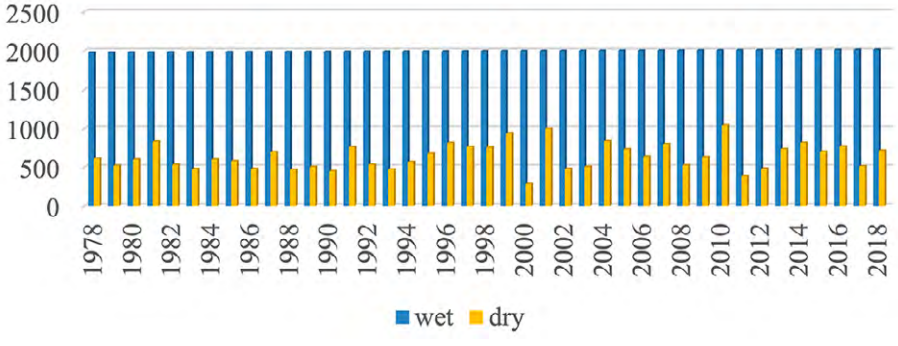

Figure 2. Analysis of dry and wet periods for meteorological station Rimski Sancevi for period 1978-2018
Source: autors of the paper

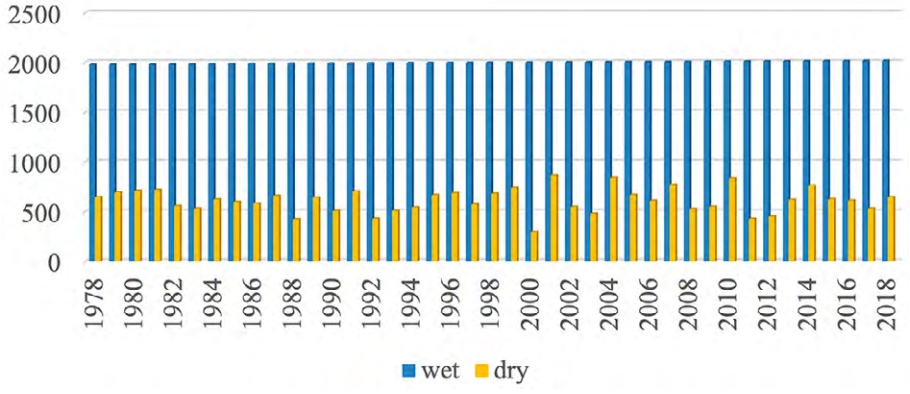

Figure 3. Analysis of dry and wet periods for meteorological station Sremska Mitrovica for period 1978-2018
Source: autors of the paper

period of -584,8 mm. Other years are normal, rainfall was about average (660 mm) with the exception of 1979 and excess rainfall when the total measured amount was 738.9 mm. During the second period (1989-2000) more droughts were identified, 5 of the total 11 years were driest with the lowest maximum rainfall in 2000 (- 327.2 mm). Wet period, with more than 900 mm of precipitation, was measured during 1995 and 1999. The third period (2001-2010) was characterized by a wet period, where from 10 years 4 years had more precipitation than average, with the highest sum in 2005 (982.9 mm). It was dry in 2002 (- 504 mm), 2003 (- 485.4 mm) and 2008 (- 499.8 mm). Other years are normal, precipitation was about average (660 mm). During the last fourth period (2011-2018) of 8 years, 3 years were dry in 2011 (- 484.8 mm), 2015 (-514.7 mm), 2017 (- 517 mm), and three years were wet (2014. and 2016, 2018) over 750 mm relative to average.

For the Zrenjanin meteorological station in the first period (1978 to 1988) 4 of the 11 years were dry. The dry years were 1983 (- 396 mm), 1984 (- 493 mm), 1986 (- 485.3 mm) and 1988 (- 486.2 mm). One year was wet with excess rainfall, 1981 (681 mm). Other years are normal, precipitation was about average (581.3 mm). In the period 1989-2000. compared to the standard average of the dry period of 509.8 mm, there were 5 dry years of 1990, 1992, 1993, 1994 and 2000 with the least amount of precipitation (- 278.5 mm). Four years of the 11 had more precipitation than average in 1991, 1995, 1996 and 1999 with the highest total annual rainfall of 884.6 mm. The third period (2001-2010) is characterized by a wet period, where from 10 years 5 years had more precipitation than average, with the highest sum in 2010 (910.3 mm). It was dry in 2002 (- 410.4 mm), 2003 (- 496.6 mm) and 2008 (- 420.5 mm). Other years are normal, precipitation was about average. During the last fourth period (2011-2018) of 8 years, 2 years were dry in 2011 (- 390.1 mm), 2017 (-368.2 mm), and two years were wet (2014 and 2016) over 748.8 mm compared to the average of 581.3 mm.

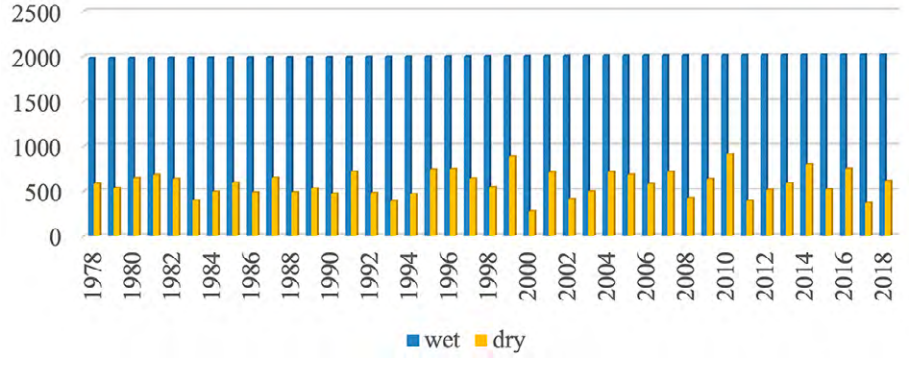

Figure 4. Analysis of dry and wet periods for meteorological station Zrenjanin for period 1978-2018
Source: autors of the paper

CONCLUSION

In the Pannonian part of Serbia, the average annual precipitation for the observed period is 614.4 mm. The highest rainfall in the study area is during the summer half of the year (199.6) and the lowest precipitation in the winter (118.6). Trends in annual precipitation are positive at most meteorological stations with statistical

significance, especially for Sombor station, then Rimski Šančeva, Zrenjanin and Vršac for the period 1978-2018. During the winter half of the year, two out of five stations (Sremska Mitrovica and Vrsac) show negative trends in precipitation. A negative trend of precipitation is also present in spring at all stations in the Pannonian part of Serbia. During the summer half of the year, all stations show a positive trend in precipitation, which continues into the fall and is statistically significant, but to a small extent. Negative trends are present in winter and in spring compared to higher values observed in summer half year and during autumn in most stations. The survey for the mentioned period gives similar results to those of Tosic for Serbia and Montenegro, where a negative trend of precipitation for the period from 1951 to 2000 was observed. In general, the precipitation trend shows a less significant trend of increasing / decreasing precipitation for the period under study. However, when processing data in the Mann Kendall test, a slight tendency towards dry conditions in the winter and in the spring, seasonally, and conditions of increased humidity during the fall were detected. According to Tosic (2004), the positive trend of precipitation during the fall may be the result of temporary atmospheric instability that produces heavy rainfall and cold fronts from the northwest. If negative seasonal patterns of precipitation trends become more pronounced in the future, they may have a negative impact on agricultural, environmental, economic and social processes. Reducing rainfall during winter and spring at the beginning of the growing season will have an adverse effect on agriculture and an increased risk of drought (Rodrı´guez-Puebla et al. 2007). Considering that the total area of agricultural land in Serbia is 70%, and irrigated areas 3.7% of the total agricultural land, annual rainfall is insufficient and periods of drought are evident in the northern province based on the data of the surveyed period (Ørum et al. 2010). The consequence of a decrease in rainfall during the spring season can affect groundwater levels, changing fluvial regimes and directly affect hydroelectric power generation (Paredes et al. 2006).

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GEOBIA AS A REMOTE SENSING TOOL FOR ANALYZING VHR IMAGERY

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Abstract

In the last two decades (since 2000), Geographic Object-Based Image Analysis (GEOBIA) methods have developed. The problem of image noise, so-called "salt and pepper" in pixel-based image classification, is probably the main driving force that led to the rise of different object-based classification techniques. Mainly, GEOBIA was used to derive different land use classes from Very High Resolution (VHR) imagery. This paper deals with the possibility of Object-based segmentation and classification of orthophoto imagery. Orthophoto imagery, obtained from the National Spatial Data Infrastructure, was taken for 3 case study areas in the City of Niš. After the mosaicing of imagery, the process of segmentation was performed. Accuracy assessment was done by using ground truth data. Results showed that the classified imagery was accurate more than 85%.

Keywords: Object-based image classification, remote sensing, urban areas

Introduction

The application of remote sensing techniques for monitoring environmental issues has been rapidly grown in the last couple of decades. Satellite and air-born imagery were used for spatial visualization and geospatial analysis in agriculture, forestry, urban development, and many other fields. With the development of the Landsat program of the National Aeronautics and Space Administration (NASA) in 1972, a new era of space technology was born. Moderate-resolution of 30 meters per pixel and fine temporal resolution with 18 days of revisit time was new in earth observation from space. With the development of new sensors, high–resolution imagery (Sentinel 2) has become accessible to scientists giving great opportunity to do analysis. With further development of satellite and air-born sensors, Very High Resolution (VHR) imagery was produced with and spatial resolution of a couple of meters or even with tens of centimeters. With this, it becomes possible to reduce the costs of ground experiments and to improve accuracy.

VHR Imagery has a vast spectrum of applications, especially in urban studies. In 2018 the global urban population was more than 55% of the worldwide population, and it is expected to increase to 68% in 2050 (United Nations, 2018). That indicates the importance of urban planning and the sustainable development of cities. With the development of classification methods, we tried to avoid the traditional "salt and pepper" problem in pixel-based classification, so the Geographic Object-Based Image Analysis (GEOBIA) was used to derive land use classes. After 2000 the Object-based methods in remote sensing have rapid growth (Blaschke & Hay, 2001).

This paper aims to present the possibilities of GEOBIA in land use and land cover mapping in different environments of urban and suburban areas. We have investigated the accuracy of the object-based extraction of features to achieve a result that would be accurate more than 85%. The paper is organized as follows: 1. Introduction, 2. Study site, 3. Data and methods, 4. Results and discussion, and 5. Conclusion.

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Study sites

In this paper, we have tested the GEOBIA in three different environments in the urban area in the City of Niš. The City of Niš is the major city in the administrative region of South and Eastern Serbia, with a population of 260,237 in 2011 (Statistical office of the Republic of Serbia, 2014). In the period 1961–2011, urban growth was detected. The increase in the population was more than 120,000 in this period.

Study sites were three rectangles with an area of 0.1 km² per each. The first one was in a highly urbanized area on the broader city centrum in municipality Medijana. This area was built as a residential and business area in 1970–1980 during the socialism era. This study site is named "Zona" after the names of shopping centers within that area. The other site is a medium urbanized area with many big objects such as a shopping mall and gas station. The name for this area is "Merkator". The third investigated site is positioned in the city's suburban area, in the settlement so-called "Brzi Brod", with a lot of area under grass and low vegetation.

Figure 1. Study sites

Data and methods

Data for the research were chosen according to the characteristics of the applied methodology. VHR Imagery was downloaded from the National Spatial Data Infrastructure (geosrbija.rs). More than 45 orthophoto images were used. The imagery was obtained in 2011 and 2013 with a spatial resolution of 0.15m (15cm). The imagery represents RGB images with bands in the visible spectrum.

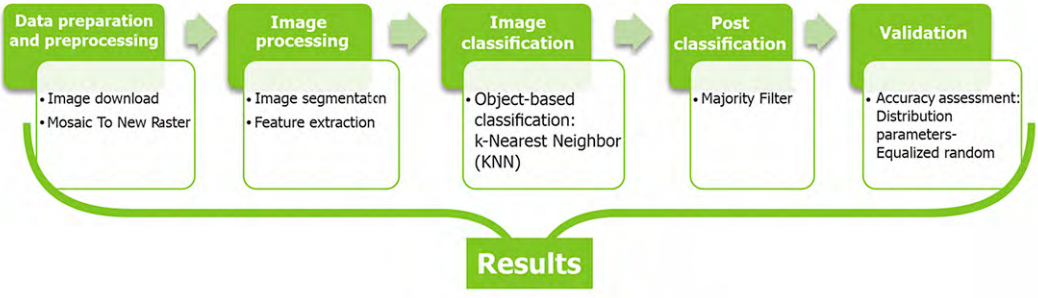

Figure 2. Workflow

The workflow encompasses the following steps: Dataset preprocessing, image segmentation, classification, image enhancement (postprocessing), and validation. The imagery was mosaiced, and the new raster was obtained. The dataset was already georeferenced in the WGS84 ellipsoid and projected in UTM 34N. After mosaicking, the process of segmentation was performed, and the features were extracted. Image segmentation is a process of separating different regions based on the similarities of pixel values (Myint et al., 2011). According to visual interpretation and knowledge from the field, we have used the segments for object-based classification. The K-nearest neighbor algorithm (kNN) was applied. Using the ENVI software, seven different classes of land use were derived at the sites "Merkator" and "Brzi Brod", and the eight land use classes are at the "Medijana" site. The second study area doesn't have the class of water. The study site "Brzi Brod" doesn't have tall buildings, so it lacks the Building class representing the sidewalls of high buildings. The post-classification process includes image filtering for image enhancement. The majority filter with a 3×3 moving window was applied, and the validation of classified results was the last step. The statistical techniques of overall, user and producer accuracy assessment and Kappa statistics were performed.

Results and discussion

The Segmentation procedure of Scale is 50.00, and the merge level full Lambda Schedule was set on more than 95.00 (Table 1.). The high value of the merge level was set up to derive grass and bushes as one class automatically.

The highest number of segments in the "Zona" area was a result of the significant number of small objects such as cars and individual trees. Objects with higher spatial coverage led to a lower number of segments detected by GEOBIA at the "Merkator" region of interest and "Brzi Brod" mainly.

more than 50 training areas were necessary for deriving the low vegetation class.

GEOBIA has its wide use in land use planning (Valožić L. 2014; Mesev V. 2010; Salehi B. et al., 2012; Blasche T. et al. 2011). After decades that pixel-based classification techniques dominated in the 20th Century, Object-oriented methods started to prevail. The most significant impact that GEOBIA achieved is a reduction of the so-called salt and pepper problem during the classification process.

Eight classes have been detected at the "Zona" region (Figure 4.). Most of the area is under Class 4 and 5, representing the paved area and low vegetation. The paved area is composed of streets, pedestrian paths, parking slots, and small pedestrian bridges. Low veg-

Table 1. Parameters for the segmentation process

Image	ALGORITHM		Area	No. of segments
	Edge SEGMENT_VALUE	Full Lambda Schedule MERGE_VALUE		
Zona	49.00	99.00	104,648m²	9,773
Merkator	50.00	95.00	104,649m²	5,670
Brzi Brod	47.00	97.00	104,628m²	1,404

Figure 3. Segmentation results

The classification was performed using between 10 to 50 training areas per class. Ten training objects were used to classify roads and other paved areas, and

Table 2. Land use classes

Class	Zona		Merkator		Brzi Brod	
	Pixel no.	Area m²	Pixel no.	Area m²	Pixel no.	Area m²
1. Roofs	679,529	16,579	714,304	17,436	588,586	14,370
2. High vegetation	686,385	16,767	283,505	6,927	682,276	16,657
3. Water	42,001	1,026	/	/	169,511	4,138
4. Paved area	986,010	24,076	1,647,130	40,206	598,381	14,609
5. Low vegetation	1,063,534	25,975	1,222,292	29,828	2,060,198	50,298
6. Building	176,622	4,315	176,208	4,300	/	/
7. Cars	95,360	2,329	41,401	1,011	7,642	187
8. Shadows	556,091	13,581	200,692	4	178,938	4,369

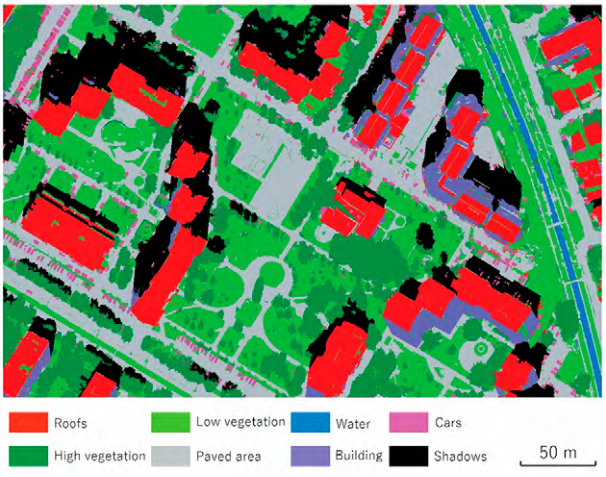

Figure 4. Land cover classes at the "Zona"

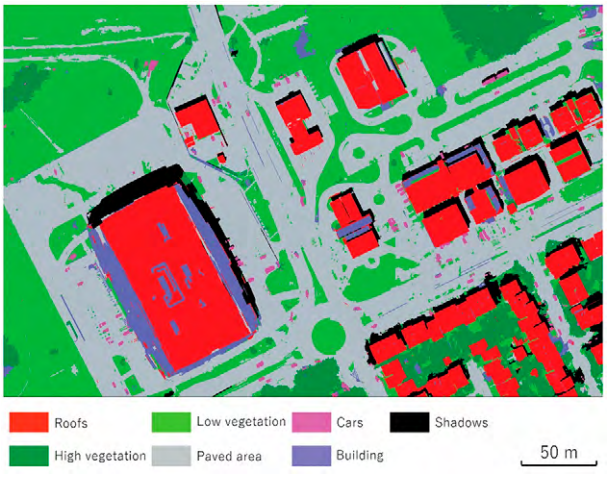

Figure 5. Land cover classes at the "Merkator" site

etation represents the grass and hedge. Roofs of the buildings cover about 15% of the territory, and the same percent is under the high vegetation.

Merkator area represents the middle-high urbanized area with mixed land-use types (small industry, trade, residential buildings). About 40% of the total area is paved. Boulevards and parking slots of the shopping mall take most of it. Low vegetation class is detected in the southeast and northern parts of the area. This area is close to the river Nišava and Gabrovačka.

Brzi Brod, the low-urbanized site settled on the left side of the Nišava river, is 7 km away from the City center. Grass and bushes near the river take almost 50% of the area. The southern part of a study site is part of the settlement with individual houses, where

Figure 6. Land cover classes at the "Brzi Brod" site

Figure 7. Randomly distributed points for accuracy assessment of the "Merkator" site

Table 3. Accuracy assessment

Class	Zona			Merkator			Brzi Brod		
	Producers Accuracy	Users Accuracy	KAPPA (K^) STATISTICS	Producers Accuracy	Users Accuracy	KAPPA (K^) STATISTICS	Producers Accuracy	Users Accuracy	KAPPA (K^) STATISTICS
1.	90.00%	90.00%	0.8857	90.00%	90.00%	0.8833	88.89%	80.00%	0.7705
2.	81.82%	90.00%	0.8841	100.00%	90.00%	0.8852	76.92%	100.00%	1.0000
3.	100.00%	100.00%	1.0000	/	/	/	90.91%	100.00%	1.0000
4.	76.92%	100.00%	1.0000	76.92%	100.00%	1.0000	76.92%	100.00%	1.0000
5.	100.00%	90.00%	0.8873	88.89%	80.00%	0.7705	88.89%	80.00%	0.7705
6.	81.82%	90.00%	0.8841	100.00%	90.00%	0.8852	/	/	/
7.	100.00%	30.00%	0.2727	100.00%	70.00%	0.6667	100.00%	70.00%	0.6667
8.	76.92%	100.00%	1.0000	76.92%	100.00%	1.0000	100.00%	80.00%	0.7742
	Overall Classification Accuracy = 86.25%		Overall Kappa Statistics = 0.8429	Overall Classification Accuracy = 88.57%		Overall Kappa Statistics = 0.8667	Overall Classification Accuracy = 87.14%		Overall Kappa Statistics = 0.8500

the "Roofs" class represents 14% of the total area. Classes "Paved area" and "High vegetation" takes 15% each.

Validation has been done through the error matrix. Different features of the error matrix were calculated to assess accuracy. Kappa coefficient, overall accuracy, user accuracy (UA), and producer (PA) accuracy showed slightly different accuracy of the three study areas. Still, the overall accuracy is consistently above 86%.

Besides the debate about the limitations of Kappa indices (Pontius R. G. & Millons M. 2011), these methods are still the most approachable and used in the last decade (Bharatkar P. & Patel R. 2013). Kappa statistics showed the results, which are higher than 0.84 for all study sites, while the UA and PA are 76.92% – 100 %.

Conclusion

Urban planning requires adequate and up–to–date remote sensing data for better implementation of solutions. This data could be satellite or airborne imagery. Analyzing some urban areas by earth observation has a significant impact on the spatial organization of the same. With higher usage of aerial imagery, the cost of the analysis could be reduced.

GEOBIA showed significant results in the classification of different land cover classes in urban areas. We have tested the possibility of Object-based classification of land cover types in three different environments in the urban area of the City of Niš. The most accurate results were obtained in the middle-high urbanized area of study site Merkator, with more than 88% of Overall accuracy and 0.86 of Kappa statistics. The results of different land cover types obtained should be helpful for urban planners in the decision-making process.

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SNOW COVERS RESEARCH OF MOUNTAINOUS AREA IN CONNECTION WITH WINTER TOURISM DEVELOPMENT (LAGO-NAKI PLATEAU, RUSSIA)

Anatoly Pogorelov[A], Evgeny Boyko[A], Petr Netrebin[A], Marina Kuzyakina[A], Svetlana Zyryanova[A]

Abstract

The article presents the results of snow covers research on the ground of airborne laser scanning in connection with winter tourism and winter sports development (skiing, snowboarding). The development of laser-location technology gave a new capacity for snow cover thickness measurement on a new technological level. The surface was scanned with density up to several points for 1 square meter regardless to relief complexity. On Lago-Naki plateau such snow-measuring research in Russia was conducted for the first time in the upper reaches of The Pshekha and The Belaya rivers beside mountain ranges of Psheha-Su and Fisht. The results of these high-accuracy measurements significantly enriched our perception of snow cover bedding not only on Lago-Naki plateau, but on highlands in general.

Keywords: Snow covers, Lago-Naki plateau, nival-glacial system

Introduction

Snow cover acts as an initial component of the nival-glacial system in the mountains, directly participating in the formation of glaciers and snowfields, influencing their dynamics. Snow cover should be mentioned in connection with avalanches in the mountains. In the conditions of the Lago-Naki plateau, snow cover is important for understanding the originality of geomorphological (leveling processes) and hydrological (formation of snow runoff) processes in combination with karst. In addition, seasonal snow is a key resource for winter recreation and winter sports on Lago-Naki plateau. It is impossible to imagine the Lago-Naki plateau highlands snowless-it is snow that enhances the recreational and aesthetic appeal of the mountains.

In the physical sense, falling snow exists in a thermal "corridor" close to the phase transitions of water, so it has a large spatial and temporal variability, making it difficult to study and quantitative measurements in the mountains. The main measured characteristics of the snow cover are: thickness, density, water equivalent (snow reserve), as well as regime indicators-the duration of occurrence, the date of formation and destruction of the stable snow cover.

Materials and methods

Sources of initial snowdimensional data. A variety of information about the snow cover Lago-Naki contained in a number of works [1-20]. Regular measurements of snow cover on fixed snow measuring routes are carried out by the hydrometeorological service. Generalized data on snow-measuring routes are given [15]. The main purpose of such observations is to assess snow accumulation in the catchments of the rivers Przekhi and Belaya in the aspect of seasonal formation of river flow. Unlike other mountainous areas of the Western Caucasus, the Lago-Naki plateau has a relatively good exploration of the snow cover. With-

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Table 1. Information about snow points (SP) of snow measuring routes

Snow measuring point (SMP)	Location	Year of foundation	Height above sea level of the snow measuring point, m
Route v. Chernigovskoe – m. Fisht			
1	near the village Chernigovskoe	1978	300
2	4.3 km to the East of SMP-1	1978	310
3	5,7 km to the South of SMP-2	1978	370
4	5,2 km to the South of SMP-3	1978	720
5	5,5 km to the South of SMP-4	1978	740
6	6,5 km to the South of SMP-5	1978	985
6a	4,0 km from the SMP-6, near the bridge	1978	1130
7	4,0 km to the Southwest of SMP-6	1978	1230
8	1,0 km from the SMP-7	1978	1460
9	1,0 km to the South of SMP-8	1978	1570
10	1,0 km to the South of SMP-9	1978	1730
11	2,0 km to the South of SMP-10	1978	1810
Route v. Dakhovskaya – m. Oshten			
1	on the right bank of the Belaya river, near the bridge	1974	460
2	5,0 km to the West of SMP-1	1974	720
3	5,0 km to the West of SMP-2	1974	900
4	5,0 km to the Southwest of SMP-3	1974	1180
5	4,5 km to the Southwest of SMP-4	1974	1260
6	5,0 km to the South of SMP-5	1974	1410
7	2 km below the camp site «Lago-Naki»	1974	1490
7a	near the camp site «Lago-Naki»	1977	1650
8	3,0 above camp site «Lago-Naki»	1974	1750
9	0,5 km from the forest border	1974	1850
10	on the plateau, 5,0 km to the South of SMP-9	1974	2040
11	2,5 km to the Southwest of SMP-10	1974	2020

in the borders of the highlands there are points of two ground snow-measuring routes of Sevkavgidromet: the village of Chernigov - mount Fisht and the village of Dakhovskaya - mount Oshten (table. 1)

With the development of laser-location technologies, it became possible to measure the thickness of the snow cover in the mountains at a new technological level-from the Board of an air vessel in the scanning band of the surface with a density of measurements, regardless of the complexity of the terrain, up to several points per 1 m^2. Lago-Naki for the first time in practice of domestic types, research similar measurements were made in the upper Psihi and Belaya close arrays Pshekha-su and Fisht. The results of these measurements greatly expanded knowledge about peculiarities of snow cover not only on the Lago-Naki plateau, but in the mountain area in General

Distribution factors. The spatial structure of snow cover in the mountains, in the Lago-Naki highlands in particular, is influenced by two main groups of factors: a) the nature of the earth's surface (topography and vegetation cover) and b) the meteorological factor (precipitation, wind, radiation regime, temperature and humidity). The last group of indicators is closely related to the height of the terrain, and each of these indicators has its own characteristic local dependence on height. Thus, the air temperature decreases with altitude mainly in accordance with the vertical thermal gradient. It should be said that the relief (surface morphology, steepness and exposure of slopes, mutual arrangement of ridges and basins, etc.) directly or indirectly determines the local structure of the fields of the mentioned meteorological indicators. The combination of these factors makes the structure of the snow cover field in the mountains extremely heterogeneous; this is especially true for the distribution of snow cover at the micro-scale level-the scale of small landforms (horizontal bends of slopes, erosion-denudation forms, sinkholes and basins, etc.) with a highly variable morphology. Under the cover of forest vegetation, including characteristic Lago-Naki coniferous and mixed forests, snow cover is distributed relatively evenly in comparison with open slopes.

Results

Analysis of the distribution of snow cover characteristics. The consideration of the snow cover as a specific resource determines the methods of its study and the accuracy of the analysis. From a hydrological point of view, it is important to evaluate snow accumulation for the period (decade) of its maximum during the winter. For measurements at snow points, according to the methods of hydrometeorological observations, it is necessary to dig a pit and measure the density and thickness of the snow layer along the entire vertical by sampling (Fig. 1). The sites of snow points on snow measuring routes within the boundaries of Lago-Naki (Fig. 2) are representative of the assessment of snow accumulation in catchments, since they reflect the background, i.e. average snow accumulation at its altitude levels in the given landscape conditions (table 2).

In the highlands, snow reserves increase with the height of the terrain, since in general, precipitation increases and the proportion of solid precipitation (snow) increases with height, and, in addition, the air temperature decreases, which together leads to an increase in the duration of snow cover. At elevations of 1800-2000 m, the average snow cover during the period of maximum snow accumulation reaches 170-200 cm or more, and snowreserves reach a water layer of 600-1000 mm (table 2).

Dependences of snow accumulation on the height of the terrain in different parts of the Lago-Naki Highlands differ (Fig. 3), experiencing the influence of oroclimatic effects, namely, the barrier effect.

Figure 1. A pit for measuring the thickness, density and water equivalent of snow (snow reserve) on the snow measuring point № 10 of the snow-measuring route in the river basin. Pshekha. 03/15/1980.
Photo by A. Tokarev

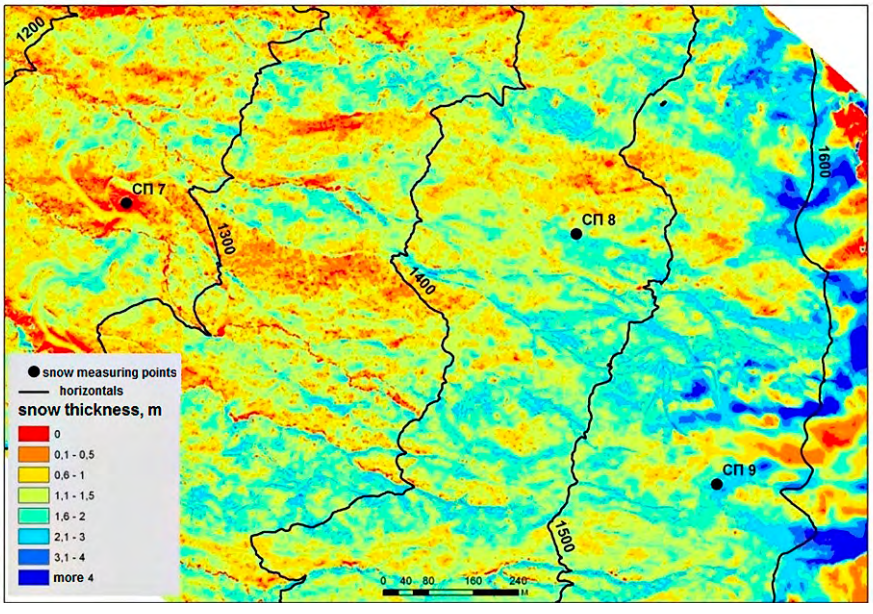

Figure 2. The location of snow gauging stations SMP-7, SMP-8 and SMP-9 in the upper river. Pshekha on a snowy measured route v. Chernigovskoye – m. Fisht (above). Below is the distribution of the thickness of the snow cover in the upper Pshekha river according to aerial laser shooting (april 2007)

Table 2. Long-term average thickness, cm (in the numerator) and water equivalent of snow cover, mm (in the denominator) according to points of ground snow measuring routes

Height of the snow measuring point, m	Snow measuring point (SMP) number	Month				
		XII	I	II	III	IV
Route v. Chernigovskoye – m. Fisht (1978-2019)						
300	1	*	8/15	4/12	*	
310	2	*	9/18	3/7	*	
370	3	*	13/25	5/13	*	
720	4	*	17/31	11/27	*	
740	5	12/19	31/72	26/72	13/40	*
985	6	17/25	52/128	46/135	36/127	*
1130	6a	18/-	54/-	52/-	46/-	*
1230	7	28/37	75/205	75/243	101/378	*
1460	8	55/109	122/344	125/397	169/639	73/331
1570	9	72/159	158/472	172/573	214/820	125/602
1730	10	65/199	138/449	150/561	202/801	153/783
1810	11	92/233	180/570	210/724	259/993	200/950
Route v. Dakhovskaya – m. Oshten (1974-2019)						
460	1	*	5/9	4/7	*	*
720	2	*	5/10	5/14	*	*
900	3	5/10	16/37	17/43	*	*
1180	4	9/19	28/70	33/87	21/62	*
1260	5	9/17	30/78	36/92	26/80	*
1410	6	16/33	41/98	51/138	43/135	*
1490	7	17/-	42/-	54/-	45/134	*
1650	7a	32/72	54/161	74/273	72/258	*
1750	8	43/106	84/234	112/343	118/407	61/230
1850	9	68/161	138/390	172/546	156/580	112/482
2040	10	74/-	137/-	203/-	166/-	181/-
2020	11	57/171	91/306	137/492	161/641	128/590

Note. Hereinafter, the "" sign means that snow cover was noted in less than 50% of winters; "-" sign – measurements were not performed.*

So, the upper river. In winter, Kurdzhipsa is in the "snowy" shadow of the Fisht, Oshten and Psheha-Su massifs intercepting precipitation of moisture-bearing streams. Upper river Pshekhs, located to the west of the elevated Fisht and Pshekha-Su massifs, do not experience the shielding effect of these uplifts, therefore, not "dehydrated" moisture-bearing streams penetrate here from the Black Sea.

The density of the snow cover, along with the thickness, is a function of the snow cover; in addition, the density of snow affects its physical properties (porosity, water-holding capacity, heat capacity, etc.). Altitude and in the timing changes in the density of snow cover on the Lago-Naki plateau are described in Table 3. In the first half of winter, as the thickness of the snow cover increases, the density is influenced by gravitational compaction. From here the regularity of increase in snow density with the height of the area is obvious. In the highlands, gravity compaction can continue until April inclusive. During the period of snowmelt, the start dates of which are also determined by the height of the terrain, the density values are already growing mainly under the influence of the infiltration compaction of the snow mass.

The distribution of snow cover at the micro- and mesoscale, i.e. at the level of human perception, differs significantly from the distribution of background snow reserves. For the organization of skiing and winter sports on natural slopes, knowledge of the variability of the thickness of the snow cover at the level of perception of skiers is important. For these purposes, we will use the data of airborne laser scanning performed in 2007 during the period of maximum snow accumulation in the Pshekhi and Belaya basins. One of the studied sites characteristic of winter is the surface of the Lago-Naki plateau on the northeastern

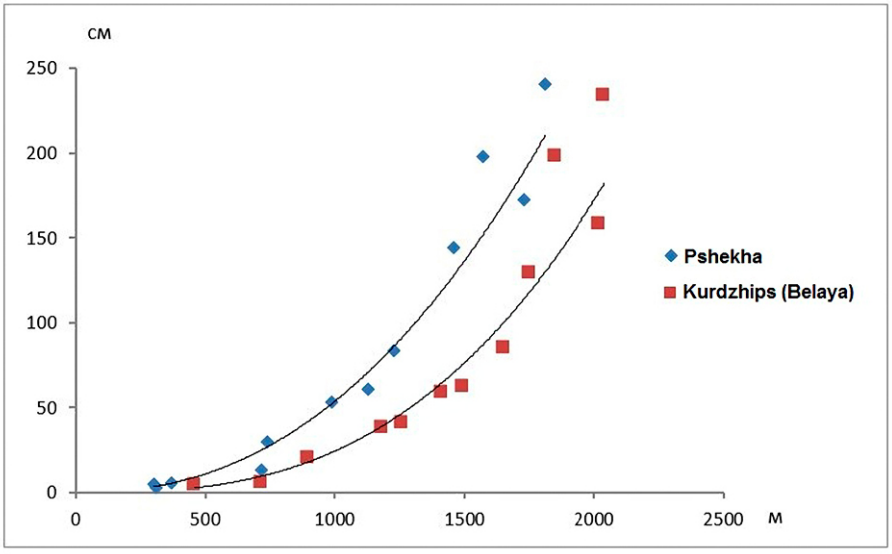

Figure 3. Changes in the average thickness of the snow cover with the height of the terrain on the Lago-Naki plateau

Table 3. Long-term average snow cover density (kg / m³) according to ground snow route points

Height of the snow measuring point, m	Snow measuring point (SMP) number	Month				
		XII	I	II	III	IV
Route v. Chernigovskoye – m. Fisht (1978-2019 rr.)						
300	1	*	180	260	*	
310	2	*	220	240	*	
370	3	*	210	240	*	
720	4	*	190	250	*	
740	5	180	250	260	300	*
985	6	150	230	280	360	*
1230	7	170	260	330	380	*
1460	8	190	270	320	390	440
1570	9	220	290	330	400	480
1730	10	270	320	370	420	500
1810	11	260	310	330	400	480
Route v. Dakhovskaya – m. Oshten (1974-2019 rr.)						
460	1	*	190	220	*	*
720	2	*	210	230	*	*
900	3	190	230	230	*	*
1180	4	200	240	240	300	*
1260	5	200	250	240	310	*
1410	6	220	230	260	310	*
1650	7a	240	240	310	360	*
1750	8	220	270	300	340	410
1850	9	230	270	310	370	440
2040	10	-	-	-	400	-
2020	11	280	320	350	390	440

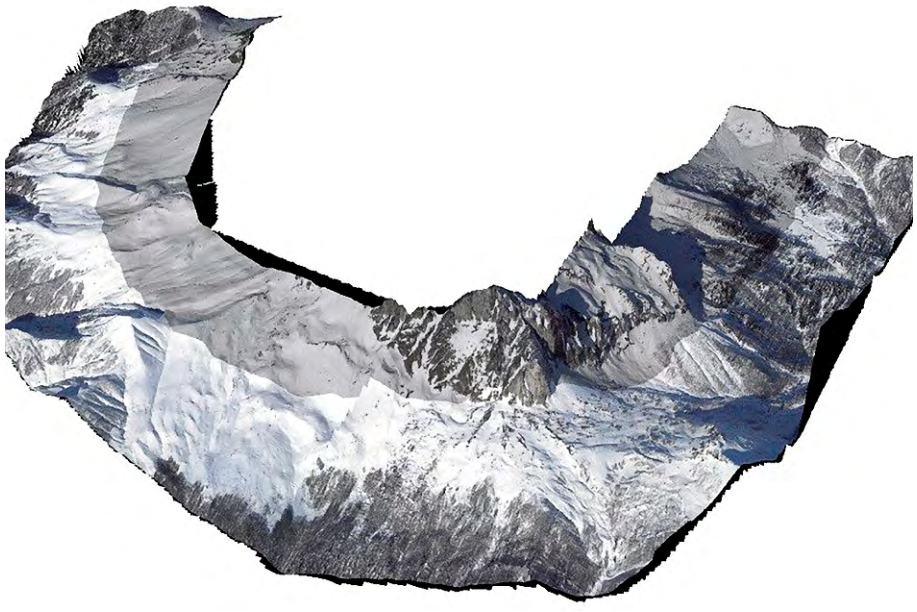

Figure 4. A fragment of a three-dimensional model of the Belorechensky and Cherkessky passes area draped with an aerial photograph. Airborne Laser Scanning and Snow Measurement Site

slopes of the Fisht massif at altitudes of 1650–2200 m (Fig. 4).

The distribution of snow cover is extremely heterogeneous and is subordinate to surface morphology at the mesoscale and microscale levels. Active snow and snow transfer in the Alpine and subalpine zones leads to a redistribution of precipitated solid precipitation - accumulation of snow in the lowering of the relief and exposure of protruding surfaces. This is very clearly visible on the map (Fig. 5), as well as a linear profile reflecting the distribution of snow cover thickness over a 2 km stretch. The view of the graph, in fact, demonstrates the "rhythm" of the mesorelief of different genesis (erosion-denudation surfaces, areas of landslide-scree demolition and accumulation, local faults, etc.) and morphology (concave and convex surfaces, slopes of different steepness, etc.). The thickness of the snow cover in this section varies from 0 to 8.5 m with an average value of 3.7 m.

The distribution of snow cover at the micro level is affected by vegetation. The nature of the spatial variability of the thickness of the snow cover is significantly different, on the one hand, in the alpine zone, where the influence of vegetation is minimal, and, on

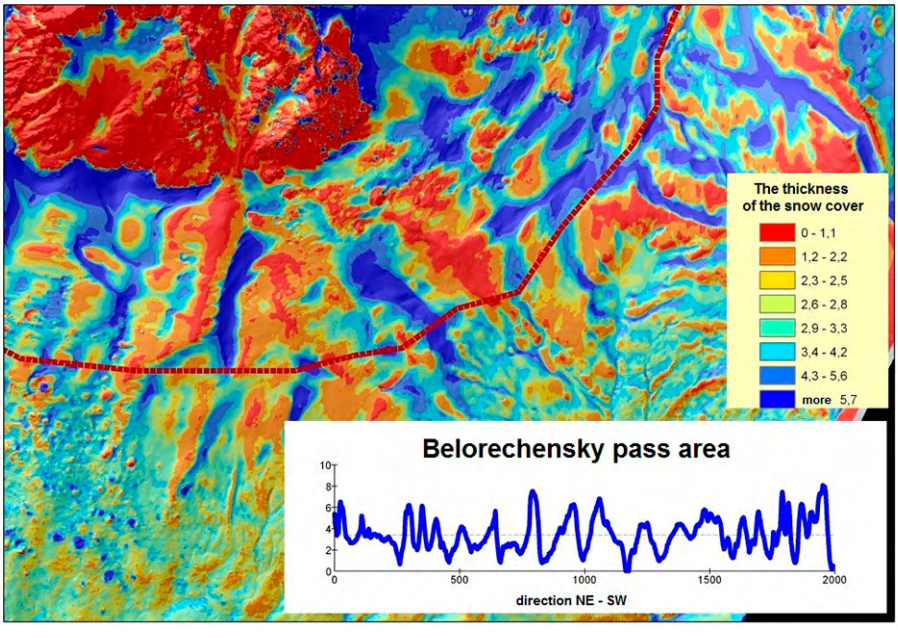

Figure 5. Distribution of snow cover thickness in the area of the measurement site. The red dashed line is a linear profile of the thickness of the snow cover. Spatial resolution 1 m

the other hand, in the forest zone (Fig. 2). In the forest, snowstorm-and-wind activity, as a rule, is drastically reduced, which contributes to a decrease in the redistribution of snow and the formation of a generally relatively insignificant field of snow cover. At the same time, at the borders of the forest zone, where the transporting capacity of the snow-wind flow decreases sharply, the formation of bands of increased snow accumulation is everywhere observed. The width of such a band of forced snow accumulation can reach 10-30 m. Figure 6 illustrates typical examples of such formations.

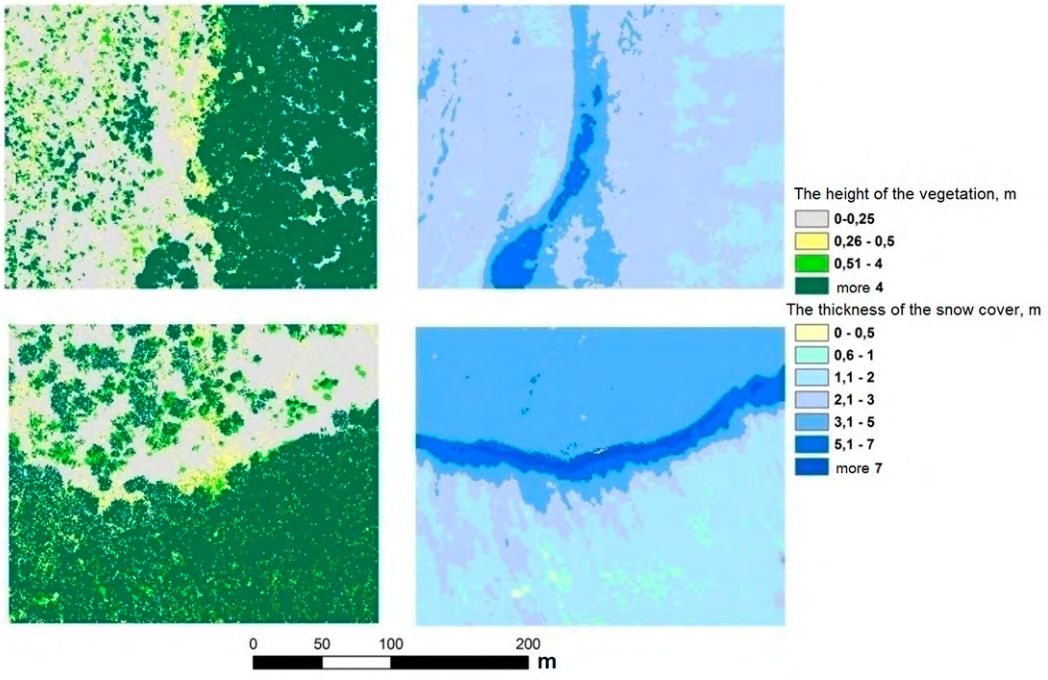

Figure 6. The influence of the outer border of the forest zone on the distribution of snow cover on the Lago-Naki Highlands [1]

Snowstorm-wind factor. In the Lago-Naki Highlands, with an increase in the absolute height above the forest boundary, wind speeds noticeably increase, and consequently, snowstorm transport. On plateau-like surfaces and open snowy slopes in winter with strong winds, a general or low snowstorm often occurs. With a blowing snow typical, for example, for the surfaces of the massifs of Abadzesh, Murzikao, Messo, the Lago-Naki Range and other similar sites, horizontal visibility at the height of human growth can decrease to several hundred and even tens of meters. At the same time, vertical visibility practically does not deteriorate. The average duration of a blizzard is usually 5-10 hours, but in some cases it can last more than a day. Snowstorm is one of the most significant dangers for travelers in the winter.

Ground-filled air currents saturated with snow transfer snow to the lowering of the relief, thereby forming a mesoscale mosaic in its distribution (Fig. 2, 5), contributing to the formation of snowfields of different sizes. Blizzard snow is carried away from convex and level surfaces and is deposited from the windy side on steep slopes, in karst funnels and erosion depressions, forming numerous snowfields. It is due to the snowstorm transport that Lago-Naki typical local forms of snow surfaces are formed - cornices (up to 10 m thick or more) on the leeward sides of ridges and obstructions (up to 0.2-0.5 m high).

Performance characteristics. The dates of formation and destruction of stable snow cover, the duration of its occurrence in different parts of the Lago-Naki Highlands depend mainly on the absolute height and local snow cover (maximum snow cover thickness during the winter). 3-5 weeks after the appearance of the first snow in the mountains, a stable snow cover is established that lies throughout the winter. In some years, at all altitude levels of the highland, snow cover can appear much earlier than usual: at 100-2000 m - already in the first ten days of September, and at marks of 600-1000 m - at the end of September - early October. In warm winters, in the studied region up to a height of 1000 m, the snow cover may not be established or is subject to melting.

Earlier, snow cover appears at the highest elevations. So, at altitudes of 1000-1500 m, snow cover is usually established in the third decade of October - the first decade of November. Over 1000 m, the snow lies on the slopes for several months. The duration of its occurrence ranges from 100 (at an altitude of 1000 m) to 250 days at an altitude of 2200 m. By the end of March, at altitudes of up to 700 m, snow cover grad-

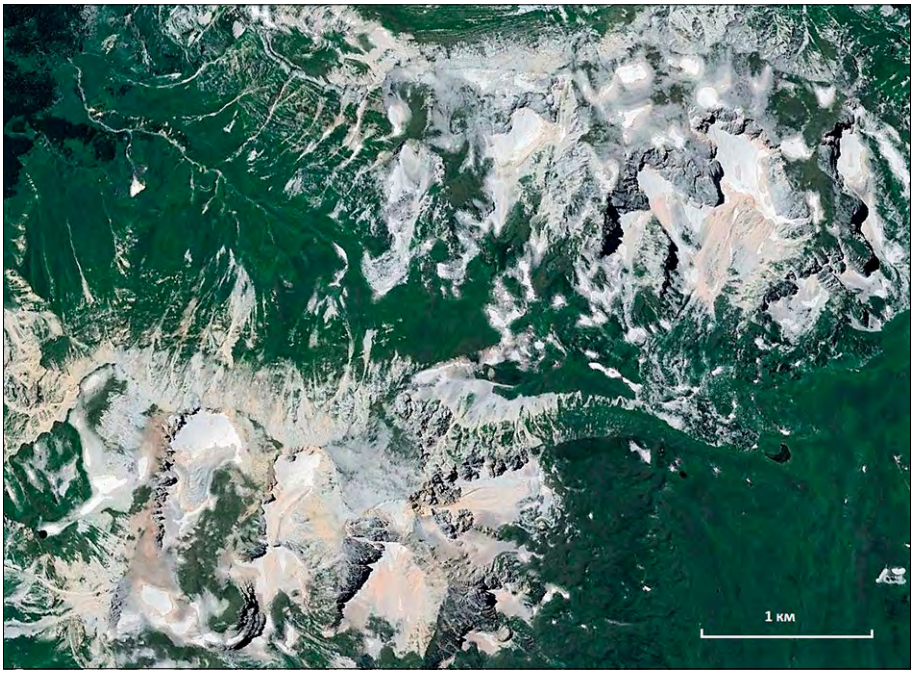

Figure 7. Snowfields on the slopes of the Oshten and Psheha-Su mountains 07/31/2017
(Google Earth service data)

ually disappears, and by the end of the second decade of April, the slopes are usually cleared of snow below 1000 m. During May and early June, at altitudes of 1500-2000 m, snow cover is everywhere destroyed. In the high-mountain zone at elevations of 2000 m and above, snow stays stable until mid-June, and individual snowfields under favorable conditions (snowy winters, cool summers) can persist throughout the summer, giving these parts of the highlands a high-mountain "nival" flavor (fig. 7).

Table 4 gives the equations for calculating the average long-term formation and destruction of a stable snow cover according to the height of the area and the local maximum winter thickness of the snow cover. Dates were counted from September 1 and February 1, respectively.

Table 4. Equations for calculating the average dates of formation of D0 and destruction of Dp of stable snow cover [15] *

The regression equation	R^2	σ	Δ
D_0 =-33H-0,06h_{max} + 155,2	0,90	7,8	+1
D_p =-46H+0,28h_{max} - 37,3	0,89	8,7	-1

** **H** – the height of the terrain, km; $\mathbf{h}_{max}$ – average maximum snow cover thickness, cm; R^2 – is the coefficient of determination; σ – is the mean square error of the equation, days; Δ – average calculation errors, days*

Conclusions

The long-term dynamics of winter snowfall in the highlands is analyzed according to regular snow-measuring data. The maximum snow accumulation in the catchments of mountain rivers is recorded, as a rule, in March. As a representative point for the analysis of the long-term dynamics of the snow cover, snow station 9 was used along route v. Chernigovskaya - Mount Fisht (1570 m) at the foot of Mount Psheha-Su (Fig. 2). The snow station is located on the border of the forest and is not subject to random variability of snow accumulation indicators caused by the regime of snow-storm activity. The analyzed period is 1979-2019. (Fig. 8) is sufficient for statistical estimates of long-term variability. The long-term variability of snowfall (snow reserves) is regulated by winter precipitation and thermal conditions. According to SP data, 9 extremes of snow reserves in March for the period of maximum annual snow accumulation were recorded in 1987 (1776 mm) and 1999 (375 mm). The interannual variability of snow reserves for the study period is characterized by a standard deviation of 299 mm and a coefficient of

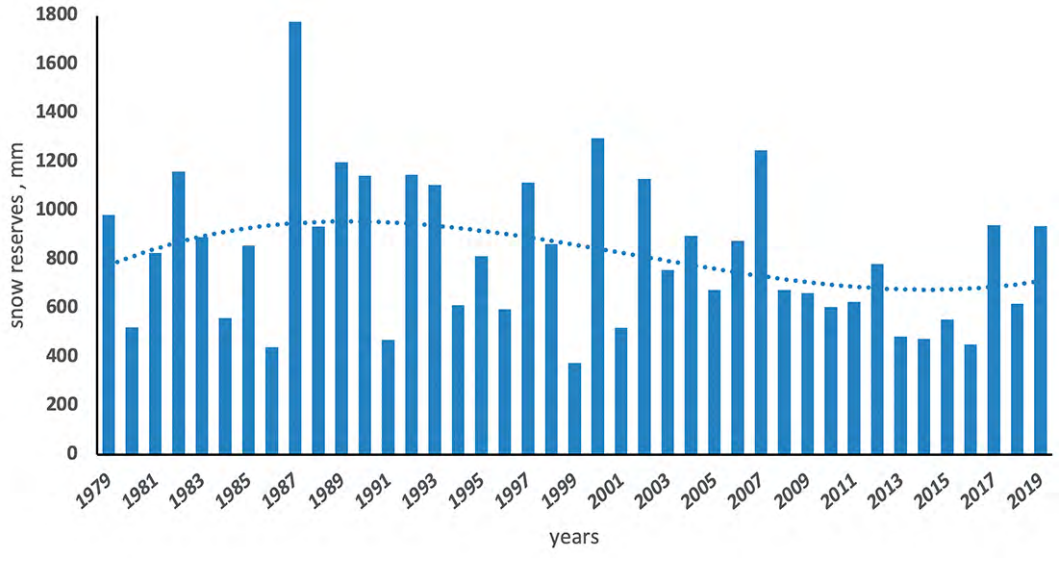

Figure 8. Long-term variability of snow reserves in March at snow point 9 of route v. Chernigovskaya – m. Fisht (eastern foot of Mount Pshekha-Su, 1570 m)

variation of 0.36 with an average value of the water equivalent of snow of 820 mm. Thus, a sufficiently high variability of snow accumulation from year to year should be noted.

Judging by the schedule (Fig. 8), the period 1979-2019. on the whole, it is characterized by a negative trend of winter snowfall, mainly due to snowy winters after 2000. So, if the average snow reserves in 1979-2000. amounted to 895 mm, then in 2001-2019 - only 732 mm. However, it is clear that the centuries-old trend of snowfall is non-linear and is able to change its sign, as can be seen in the graph.

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ANALYSIS OF THE IMPACT OF THE HYDRO POWER PLANT ON A DEVELOPMENT OF A BAJINA BAŠTA MUNICIPALITY

Dajana Tešić[A]

Abstract

A detailed study of the impact of the hydro power plant Bajina Bašta on the Bajina Bašta municipality was completed with the use of ArcMap 10.4 software. For the purpose of calculating and allocating the parameters for further analysis, topographic map of drawing scale 1:50 000 was digitized and the digital elevation model was created. This method of work gave precise values of slope, landslides and its complete overview. Also, in this study, the CORINE land cover inventory was used for the purpose of land cover changes analysis. These parameters indicate the development of the Municipality. The paper describes the impact of the hydro power plant on the population, economy and also on the natural resources of the Bajina Bašta municipality.

Keywords: GIS, Bajina Bašta, hydropower plant, CORINE land cover, DEM

Introduction

Nowadays, researchers are showing an increased interest for the importance of sustainable energy, especially because it has been noticed that fossil fuel is costly and has a large negative effect to the environment. Renewable energy presents the most suitable solution to get a great connection between renewable energy and sustainable development. The role of renewable energy has been defined as a great significance for the global environmental concerns. Hydropower is an efficient type example of renewable energy and its potential application to future power generation cannot be underestimated (Elbatran et al., 2015). Hydroelectric power plants do not use up resources to create electricity nor do they pollute the air, land or water, as other power plants may. Hydroelectric power comes from flowing water as well as increased water level during winter and spring runoff in mountain streams. Water, when it is falling by the force of gravity, can be used to turn turbines and generators that produce electricity (Abbasi and Abbasi, 2011). According to the International Hydropower Association (IHA), "hydropower is a versatile, flexible technology that at its smallest can power a single home, and at its largest can supply industry and the public with renewable electricity on a national and even regional scale. In terms of generation capacity, hydro accounts for eight of the world's ten biggest power stations." Yüksel (2010) concluded that hydropower does not pollute the air we breathe in the way that the energy source does not produce any air pollutants. Unlike thermal power plants for example, there are no gaseous of fly ash emissions emitted during the production. The fact that hydropower often replaces fossil-fired generation, it can therefore also be said that it is reducing the problem with acid rain and smog (Yüksel, 2010). Despite all these advantages hydropower plants have, there may also be negative impacts. Lately the impact on the ecological aspects from the power plants has received attention. In the report from World Commission on Dams (2010), it is stated that dams will have effects e.g. on the terrestrial ecosystem and biodiversity, the flow regime, migration of aquatic organisms, and can cause emissions of greenhouse gases. Bratrich et al. (2004) state that hydro-

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power affects the flow regime, migration of organisms and transport of nutrients and sediments. The article will also show that the level of industrial development can be seen by comparing the income from industry and agriculture. It observes urban development in relation to the quality of the constructed facilities and urban functions, and social development in relation to demographic change, referring to the number of inhabitants and the structure of employment by activity (Vučetić, 2018). The main object of this research is the economic, ecological, spatial and social impact of the construction of the hydro power plant „Bajina Bašta" on the developement of the Bajina Bašta municipality. The overall scientific aim of the study is to establish a link between the construction of a hydropower plant and the development of the Municipality.

Study area

The territory of the municipality of Bajina Bašta is located in the western part of the Republic of Serbia, and according to the administrative division it belongs to the Zlatibor administrative district (Fig. 1). Geographically, the Municipality belongs to the Starovlaško-Raška Heights (southern part of the Municipality - Tara area) and the Podrinje and Podgorina areas in the northern part of the Municipality.

The area of the Municipality is restricted from the north and west along the Drina River and by land across the mountain ridges of Tara, Zvijezda and Stolac (56 km state border), from the northeast Podrinje-Valjevo mountains (border with the municipality of Ljubovija and the City of Valjevo), from the east by the mountains of Crna Gora and Jelov gora (towards the municipality of Kosjerić), and from the south by Kadinjača, Ponikve and the Tara zone with the administrative area of the City of Užice (Fig.2). This city is located at 265 meters above sea level. The area of Bajina Bašta Municipality covers an area of 673 km².

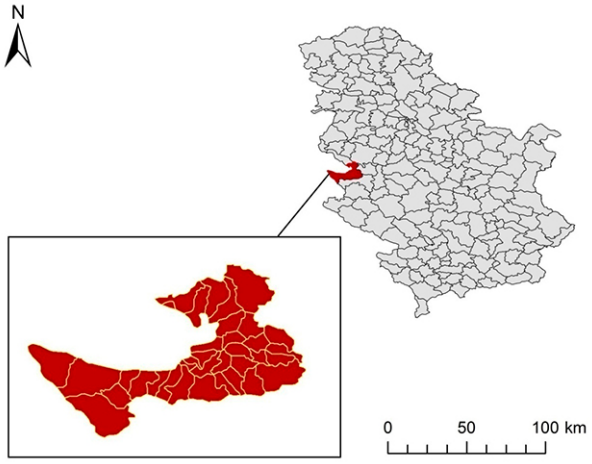

Figure 1. Location of the study area in Serbia

The city is located at 43° 57' north latitude and 19° 33' east longitude (Bučevac, 1969). The average elevation of Bajina Bašta municipality is 533 m asl. The high-

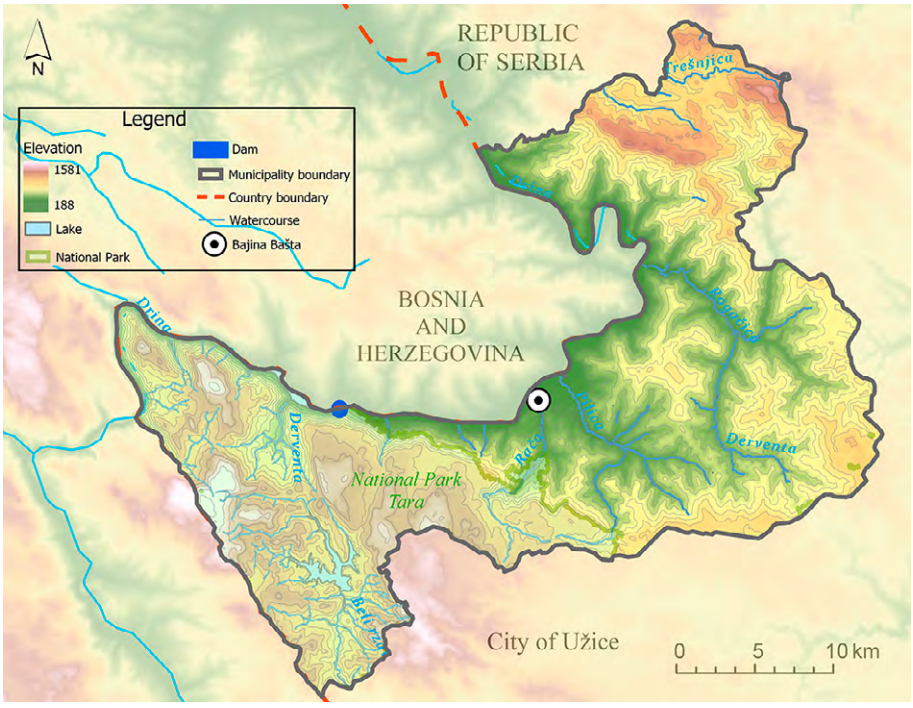

Figure 2. Relief of the Bajina Bašta municipality

est peak Kozji rid stands out from the surrounding mountains reaching 1,591 m while the lowest elevation is the height of Lake Perućac (291 m) (Spatial Plan of the municipality of Bajina Bašta, 2012). The municipality of Bajina Bašta is located in an area with a temperate continental climate, with an increase in humidity after the construction of artificial lakes. The temperature very strongly depends on the altitude. In the Tara area, the average air temperature in January is 3.8 °C and this is the coldest month. The warmest month here is August, with a temperature of 16.6 °C. The absolute minimum temperatures were recorded in January - 20 °C, and the absolute maximum in July, 29 °C. Annual rainfall for this part of Tara is 900 to 1000 mm/year, at Zaovine also 900 mm/year, and in Rastište this number is 662 mm. The wettest month is May - 127 mm, and the driest February - 49 mm. The Drina River has a length of 359.4 km, and a catchment area of 19.926 km² (6.007 km² in Serbia). It is the right tributary of the Sava River and the hydro power plant (HPP) "Bajina Bašta" is constructed on it. Lake Perućac is a hydroaccumulation and has a surface of 12.4 km², with a maximum depth of 85 m. It was formed by the partition of the middle course of the Drina upstream of Perućac, near the town of Kilavica (881.5 m asl). The main purpose of the lake is to produce energy (Bajina Bašta Hydro Power Plant). Lake Zaovine is located on the Tara Mountains near Zaovine and is artificial in its origin. It originated from 1975 to 1983, when the White Rzav (Beli Rzav) river was blocked by dams near Kik Peak. The researched hydro power plant belongs to the Perućac settlement. The Bajina Bašta Hydroelectric Power Plant operates within the companies of the Drina-Lim hydroelectric power plants that are part of the Electric Power Industry of Serbia. Construction of the hydropower plant began in 1959 and was completed in 1966.

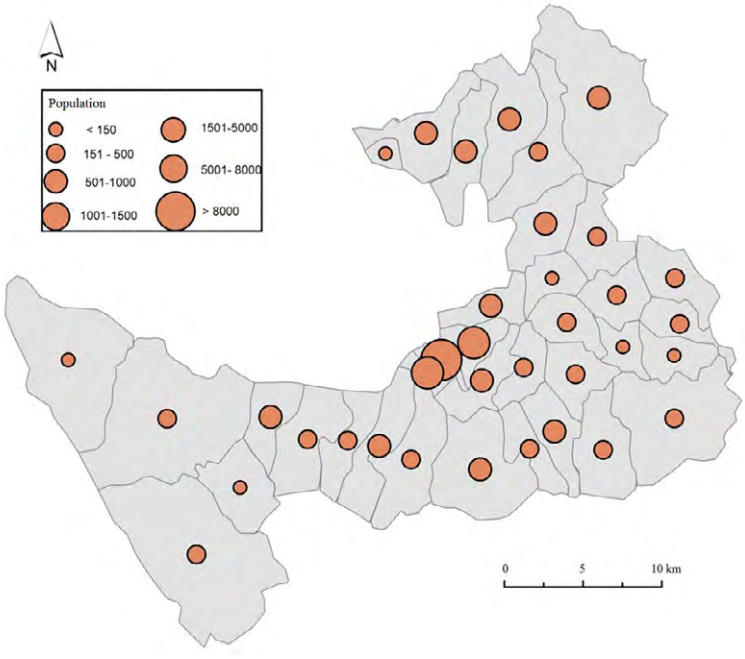

Figure 3. Population of the Bajina Bašta municipality in 2011

According to the last Population Census (2011), the municipality of Bajina Bašta has a population of 26,022 and the city of Bajina Bašta itself has 9,148 inhabitants, representing almost 33% of the population of the municipality of Bajina Bašta (Fig. 3).

Material and Methods

The starting point for performing a GIS-based analysis of the impact of the hydro power plant on a development of a municipality is the collection of the data considered to have an influence for this study. The selection of causal factors depends on the scale of analysis and the characteristics of the study area. In this study, for assessing and mapping the impact of the hydropower plant in the Bajina Bašta municipality, the following predisposing factors were selected: changes in land use, changes in numbers of inhabitants, level of urbanization after the construction, number of inhabitants employed in industry, changes in standard of living, etc. These factors are chosen after thorough review of the research literature. The main data required for the analysis in this study is obtained from numerous sources due to the exten-

Table 1. Sources of data used for the study

Data	Description	Source
Landsat 8 OLI	Downloaded	https://earthexplorer.usgs.gov
Aster GDEM (Digital Elevation Model DEM)	Downloaded	https://earthexplorer.usgs.gov
Roads	Downloaded	http://download.geofabrik.de/
Land use	Downloaded	https://land.copernicus.eu/
Slope angle	Derived	from DEM 30 m
Elevation (m)	Derived	from DEM 30 m
Aspect	Derived	from DEM 30 m
Rivers	Extracted	from DEM 30 m
Demographic Statistics	Obtained from Statistical Office of Serbia	https://www.stat.gov.rs/en-US
Climate data	Obtained from Hydrometeorogical Service of Serbia	http://www.hidmet.gov.rs/

siveness of the topic. The data and sources and presented in Table 1.

In subsequent parts of the study, the first step is the preparation of the digital elevation model (DEM). By using a DEM of 30 × 30 m resolution, digitized from topographic map of drawing scale 1:50 000, the slope angle and elevation are identified in ArcMap 10.4 software. To calculate the morphometric data, a digital relief model was used to generate the slope layers within the study area. Regarding the slope of the terrain, unfavorable terrains from this aspect (over 30% of the slope) are located predominantly in the area of Tara and Zvijezda, while favorable terrains are located in the valley belt of the Drina and its tributaries Rogačica and Pilica (Spatial plan of the municipality of Bajina Bašta, 2012). Fig. 4 shows the slope of the municipality. The green shows the slope of the municipality up to 15°, while the yellow and red show the higher slope of the terrain. The highest slope (40-80°) is in the western part of the Municipality, in the area of Tara NP. It can be noticed that the smallest slope of the terrain is in the area of Bajina Bašta settlement.

The Digital Elevation Model (DEM) provides a digital representation of a portion of the earth's terrain over a two-dimensional surface. As GIS supports the structure of the DEM database, the efficiency and usefulness of DEMs in hydrological modeling by means of drainage analysis, watershed and stream network delineation etc. has increased tremendously. During the last decade there has been a huge development in Hydrologic Modeling using GIS and DEM Based on

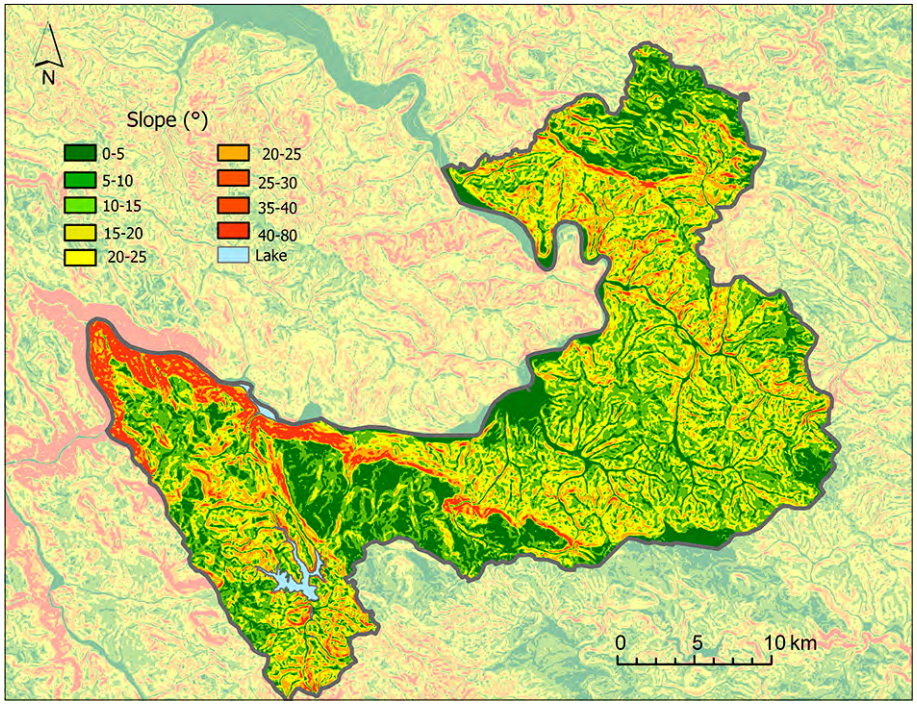

Figure 4. Slope map

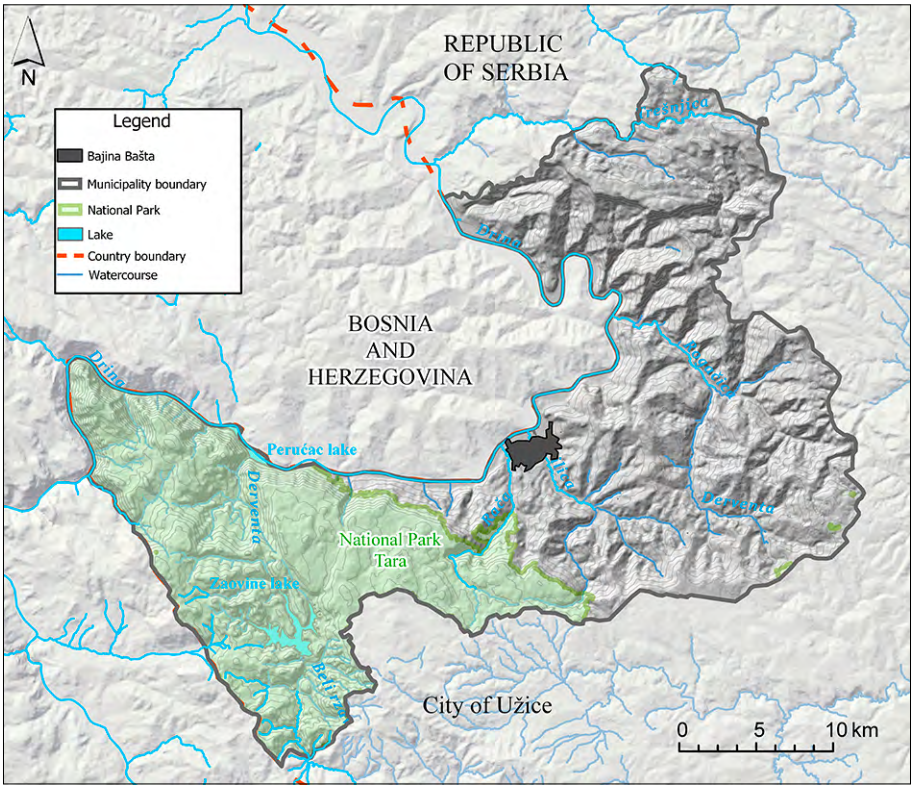

Figure 5. Hydrology map

DEM the hydrology of the study area is derived (Fig. 5). Digital elevation models (DEMs) are a useful data source for the automatic delineation of flow paths, sub watersheds and channel networks for hydrologic modeling (Prodanović et al., 2018).

The CORINE Land Cover (CLC) inventory was initiated in 1985 (reference year 1990). Updates have been produced in 2000, 2006, 2012, and 2018. Projects are completed by the European Environment Agency (EEA), and its key objective was to further document the changes in land cover, and to collect and update comparable data in Europe. It consists of an inventory of land cover in 44 classes. CLC uses a Minimum Mapping Unit (MMU) of 25 hectares (ha) for areal phenomena and a minimum width of 100 m for linear phenomena. The time series are complemented by change layers, which highlight changes in land cover with an MMU of 5 ha (Cieślak, 2017).

Results and Discussion

Based on the analysis of natural and socio-cultural factors on the territory of Bajina Bašta municipality, an evaluation of all geographical factors that had an impact on the development of the Municipality was made. Positive impacts mainly relate to water supply, irrigation or drainage, tourism and recreation, while negative impacts relate to the impact of hydropower facilities on water quality, coastal areas and surrounding land. Negative environmental impacts are of mild intensity but are extremely complex, such as activation of potential landslides, change of microclimate, blocking of important migration routes for fish, deteriorating water quality and disrupting the natural ecology of rivers. Many species of fish depend on inland rivers for reproduction; by blocking a river's flow with dams, fish cannot reach their breeding grounds. Over time, dammed rivers lead to drastically reduced fish population, which has negative implications for the health of river ecosystems as well as for human food stocks (Thoradeniya et al., 2007). Additionally, damming rivers also often reduces water and sediment flow to dangerous levels, which impacts downstream of wildlife populations. On a similar note, many large hydropower facilities lead to an altering of the surrounding landscape, especially around reservoirs created by damming rivers. Just as reducing downstream water flow can cause a loss of habitat, creating reservoirs to generate electricity in storage and pumped storage hydropower systems often cause upstream flooding that destroys wildlife habitats, scenic areas, and prime farming land. In some instances, this flooding can even force human populations to relocate (Bratrich et al., 2004).

The construction of the hydropower plant has caused many changes in the area of Bajina Bašta mu-

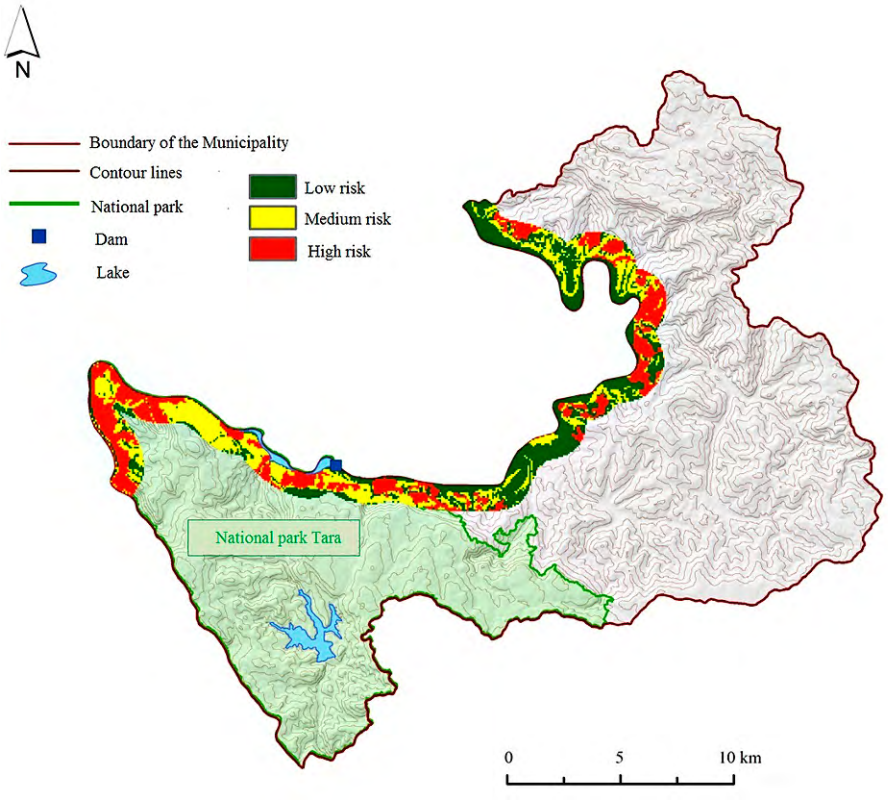

Figure 6. Potential landslides in the study area

nicipality. HPP Bajina Bašta had the greatest influence on transform of land use. Other geographical factors which were influenced by the construction of the hydro power plant are hydrology, population and economy. Changing the flow of the Drina River and using river energy for hydro accumulation purposes, as well as changing groundwater levels, leads to an increased risk of landslides. The risk of landslides in the Drina River valley is shown in fig. 6, as well as in the vicinity of the hydroelectric power plant "Bajina Bašta.", since this area is directly threatened by landslides due to anthropogenic activity. The map shows that the highest risk of landslides is in the western part of the Tara NP and in the northern part of the Municipality.

A 2012 Corine Land Cover analysis of the European Environment Agency database shows the presence of 15 of the 44 CLC nomenclature classes (Table 2). Broad-leaved forests dominate with over 36% of the

Table 2. Land use

Code	Land use	Area (km²)	%
112	Discontinuous urban fabric	4.76	0.70
121	Industrial or commercial units	0.37	0.05
124	Airports	1.10	0.16
142	Sport and leisure facilities	0.37	0.06
211	Non-irrigated arable land	4.24	0.62
231	Pastures	14.81	2.19
242	Complex cultivation patterns	45.40	6.72
243	Land principally occupied by agriculture	4.76	0.71
311	Broad-leaved forest	247.12	36.59
312	Coniferous forest	25.74	3.81
313	Mixed forest	113.68	16.83
321	Natural grasslands	2.95	0.44
324	Transitional woodland-shrub	43.72	6.47
511	Water courses	3.80	0.56
512	Water bodies	5.35	0.79

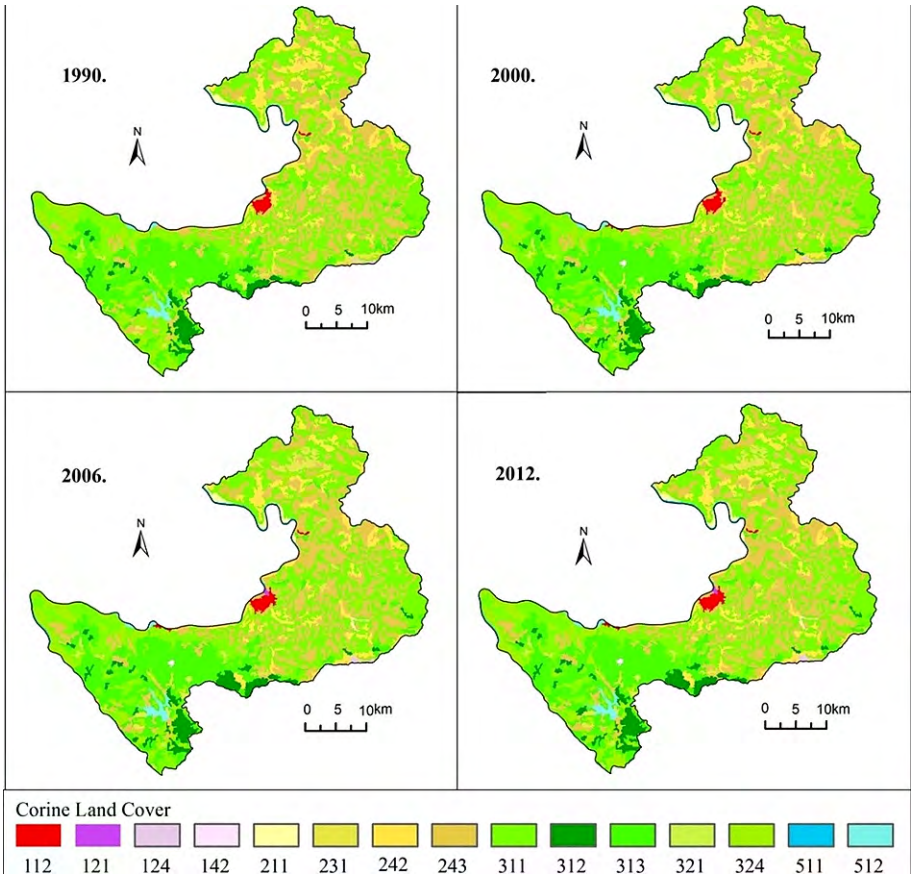

Figure 7. Land use in the Bajina Bašta municipality

total municipality territory. Coniferous and mixed forests cover almost 20% of the municipality of Bajina Bašta. Analysis of the contributions of individual categories and classes of land use occupied by urban development in Bajina Bašta in the period 1990-2012. shows that most of the land is under pastures, as well as mixed agricultural areas (Fig. 7).

During the period of socialist modernization, the development of Bajina Bašta was a part of a significant development project focused on the improvement of the production process, as defined by the new socioeconomic order. Simultaneously, the construction of Bajina Bašta hydroelectric power station had an important impact on both macro and micro levels. It indirectly influenced the development of industry, urbanization and social change, and directly contributed to investment into the town. New production nodes were opened and the income increased, as well as the number of workers and the level of investment. The number of inhabitants was also higher due to migrations, and this new condition generated new urban needs, which shaped the physical and functional structure of Bajina Bašta. As in the case of all mega projects, including the most recent ones, the planning process was focused on urban regulation, the establishment or reconstruction of infrastructural networks and the upgrading of public space. Consequently, the improvement of urban activities, building of new structures and electrification, contributed to the overall development of the social and living quality of the Bajina Bašta settlement, which transformed from being an undeveloped small town into an urban settlement based on the imperatives of socialist urbanization (Vučetić, 2018).

The map of the population between 1961 and 1991 is made using the point method (Figure 8). The point method is used to represent absolute values and indicators, with points spread throughout the mapping territory. The census years were taken into account for the analysis of the change of population because during this period HPP Bajina Bašta was built (1966) and in the following years the influence of this facility on the number and distribution of the inhabitants in the Municipality was felt most. The situation in the Bajina Bašta settlement is much different compared to the whole municipality situtation. During the 20th century, the settlement of Bajina Bašta constantly increased its population to reach a maximum in 2002 (9,543 inhabitants). The largest increase in population was in the intercensus period from 1961 to 1971 (increase of 2,567 inhabitants), which can be directly related to the construction of the Bajina Basta HPP. From 1961 to 1981, the population decreased in thirty-five settlements, while in Bajina Bašta and Perućac, where the

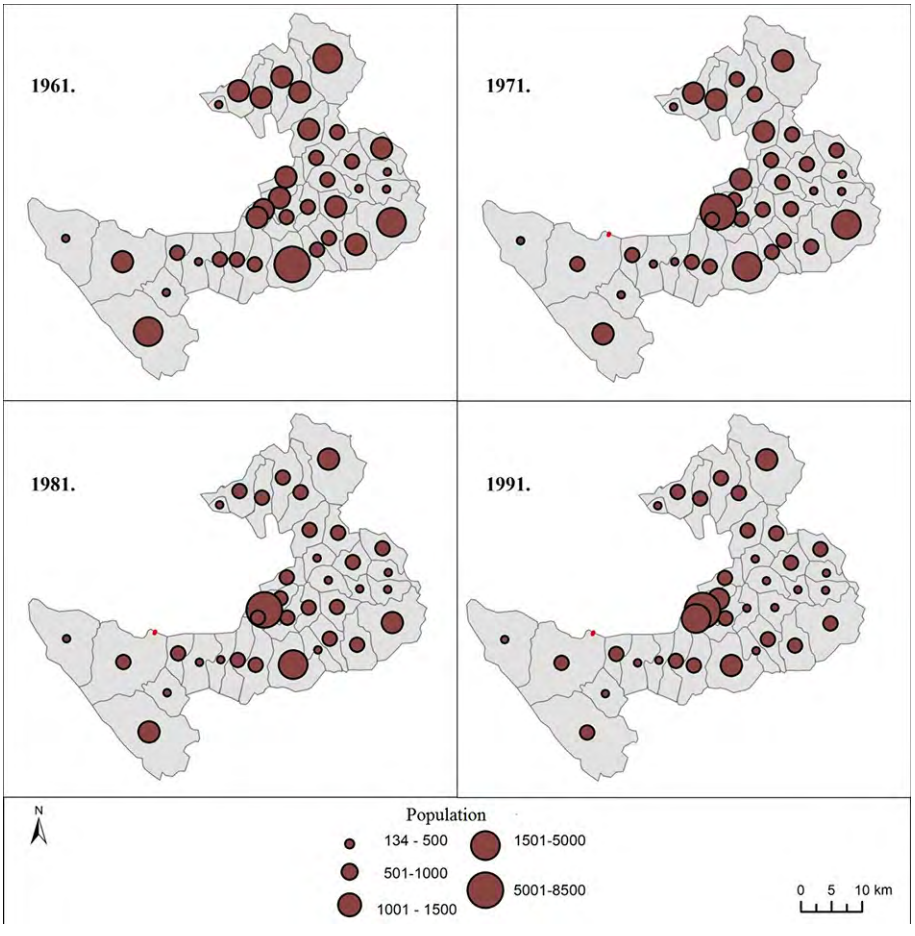

Figure 8. Population change from 1961 to 1991

facility is located, there was an increase. From 1971 to 1981, the number of inhabitants also increased in the suburban settlements of Lug and Višesava, which during this period became part of the wider urban area of Bajina Bašta settlement.

This increase is explained by the improvement of social and material living conditions due to the construction of the hydroelectric power plant. The population in the municipality is decreasing, while in the settlement of Bajina Bašta it is increasing. The reason for the increase in the population in the city is the migration from other parts of the Municipality. The proof of this statement is the decrease in the number of inhabitants of other settlements in the municipality of Bajina Bašta, which reached their maximum in 1953 and have been losing population ever since. Part of the population moved to the largest settlement of the municipality, Bajina Bašta, but also to other parts of Serbia. During the period from 1960 to 1965, during intensive construction works, the largest number of employees in the municipality was recorded, between 4,000 and 5,000 workers. After the plant was put into operation in 1966, which followed the dynamic development of the industry, the number of workers in production increased by 381 and by 90 in non-economic activities. Already the following year, due to the completion of works, the number of workers decreased significantly compared to 1965. The subsequent expansion of investment in the economy contributed to a 26.9% increase in employment in the coming period. In 1989, which is considered to be the most successful in the observed period, the percentage of employed population of Bajina Bašta settlement was above the average of the municipality and Central Serbia, as a result of the pronounced polarization at the municipal level and greater overall economic development (Table 3).

Industrial development was closely linked to the process of urbanization, and its influence on urban

Table 3. Comparation of the municipality and city population with employment trends 1989.

Year	Number of the employed inhabitants	% of total population	Number of the employed in the city	% of total population of the city of Bajina Bašta	% of total employed inhabitant in Serbia
1989.	7.306	24,5%	5.260	62 %	44%

transformation was especially noticeable after the construction of the HPP. Urban sprawl and urban development also followed industrial expansion because industrial nodes attracted the workforce. New infrastructure and services became a necessity, while urbanization started where resources, the workforce and roads were available. Industrialization also caused changes in the organization of production and consumption, influencing both the living and working environment. New urban activities imposed different spatial demands and architectural typologies, while cities became nodes of socio-technical change. If population growth is not managed, it causes urban sprawl from the free developing and non-coordinated growth of cities (Gonzales, 2016). The incidence of informal development is present in the majority of South East European countries. It represents one of the main features of the process of urbanization from the second half of the 20th century onwards in Serbia, in which residential settlements of low or medium density emerged owing to the uncontrolled construction of single family housing on mostly private agricultural land in suburban areas (Bajić, Petrić, Nikolić, 2016). Cities developed around industrial complexes, while factories, along with the residential areas for workers and accompanying services, became the main elements of new urban systems. The accelerating economic growth on the local level resulted in a higher living standard, especially in the domain of personal consumption and housing. Simultaneously, the capital accumulation enabled investments in other areas of national development, which established the foundation for systematic urban growth and an influx of foreign experiences in planning practice that began in the 1960s (Stupar, 2015).

After WWII, the economic development of the Municipality of Bajina Bašta was insignificant, based on small-scale production and an exchange economy. 91.4% of the inhabitants focused on outdated agriculture, while other sectors did not develop (Bučevac, 1969). The period of preparation works for Bajina Bašta hydroelectric power station marked significant economic progress for the municipality, based upon an increase in industrial production. The economic structure changed fast after the opening of the facility in 1966, which was the major driver of growth, and also an important factor in the economy and work ethics. As a result of these processes, some new production nodes were opened, focusing on industry based on wood, textile, construction materials, metal, and electricity production. The intensification of production caused the restructuring of the economy, i.e. industry's share of the national income increased to 40% in 1966. Meanwhile, the Bajina Bašta plant became a key factor in the social and economic development of the settlement. After the first year of its work, the gross domestic product and national income on a local level were significantly increased. The value of industrial production in 1967 increased by 130% compared to the previous year. Taking into consideration the share of the Bajina Bašta plant, this value was even higher – 350%, indicating that the value of industrial production achieved in the hydroelectric power station was equal to the value produced by other sectors of industry. Migration also influenced the working structure. New jobs were created by opening the Bajina Bašta hydroelectric station and the introduction of complementary activities. During the construction of the Bajina Bašta plant, the number of employed people in the municipality was the highest – between 4,000 and 5,000 workers (Bučevac, 1969), while the first decade of its activity was marked by an increased number of people working in the industrial sector (from 335 in 1961 to 3,459 in 1989). The share of agricultural workers significantly changed in the years to follow. During this period, the progress of industry and the economy was evident, triggering the growth of nonagricultural sectors (Table 4).

Table 4. Number of inhabitants employed in industry

1974 year	1989 year	1994 year	2015 year
1171	3459	2042	650

Conclusion

The construction of the Bajina Bašta hydroelectric power station, in the middle section of the Drina River in western Serbia, was one of the development projects, and it triggered the transformation of the environment, upgrading the pre-war small town of Bajina Bašta into a new urban node, adjusted to the socialist imperatives and standards of progress. However, the development itself was not strategically planned, and urban transformation did not adequately respond to dynamic changes caused by intensive migration over a short period of time. This also caused several problems which occurred in the organization of the physical and functional urban structure – e.g. a misbalance between the urban center and urban suburbs, a poor infrastructural base, a low level of urban services and the uneconomical use of spatial resources situated in the larger urban zone. Considering the process of industrialization as the main premise of modernity promoted by socialist ideology, the transformation of Bajina Bašta, perceived on the level of urbanization and

socio-technical change, was mostly focused on the urban center and its extension, i.e. the area which was already subordinated to urban regulation. Consequently, the existing urban structure was upgraded. In the other area (the larger urban zone), modernization did not result in a higher level of urbanization. Therefore, the new structure and its regulation typologically remained more rural than urban. One of the resons for this condition was the lack of planning documents and initiatives on the local level. After the first phase of growth, fostered by general economic development and direct investment from the power station, the settlement became unable to absorb the increasing number of inhabitants and respond to their growing needs.

Rather than implementing general bureaucratic monitoring requirements, the scientific community should realize that upgrading hydropower plants represents large-scale ecological experiments, which provide ample opportunity to answer fundamental questions regarding the driving forces and adaptability of aquatic ecosystems in rivers affected by hydropower production. Improving the ecological performance of such large-scale projects remains an enormous challenge. Constructing migratory corridors are other mitigation actions for migrating animals. To facilitate for the migration of the species in the streams it is therefore desirable to construct corridors. Fish friendly turbine technology is an emerging technology that provides a safe approach for fish passing though the turbines by minimizing the risk of injury or even death.

Since the settlement of Bajina Bašta is a part of the transboundary area within the Drina belt, in the future it will be the subject of new development projects and initiatives aimed at spatial and economic integration and sustainable urban development. This is confirmed by examples of projects that have been implemented in the EU and are related to trans-boundary river or mountain belts (Danube Regional Project, Regionalalp, ESDP, etc.), and which are the frameworks for formulating, harmonizing and implementing development goals. One of the basic tasks of the future development of the Bajina Bašta settlement will be to identify instruments for the integral guidance of spatial development, with indications of priorities and benefits for the development of activities. The Drina Belt should have an integrative role in the use of water, environmental protection, economic development, use and affirmation of tourist resources and traffic connections between Serbia and the Republic of Srpska.

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RURAL (AGRARIAN) TOURISM IN THE SOUTH OF RUSSIA

Tatiana Volkova[A], Mikhail Belikov[A], Kondrashina Margarita[A]

Abstract

Rural (agrarian) tourism is considered a fairly new trend in the tourism industry of the Krasnodar Region. The history of rural tourism development, which is considered by many authors as a new type of tourism activity in Russia, can be traced at all stages of the history of tourism development. It is with the development of country tourism that the economic development of the Black Sea coast is inextricably linked. In different historical periods, rural tourism manifested itself in different types of recreational occupation and activities (country tourism, Soviet labor and recreation camps, labor semesters, etc.), which suggests the existence of prototypes of rural tourism in pre-Soviet and Soviet times. According to the results of the retrospective analysis, it can be concluded that the history of the development of rural tourism at the South of Russia is significant; it is inextricably linked with the development of tourist and recreational activities of Russia and Krasnodar Region.

Keywords: South Of Russia, Black Sea Coast, Krasnodar Region, Rural Tourism, Agricultural Tourism, Regional Tourism, Tourist And Recreational Complex

Introduction

The development of tourist and recreational sphere in the South of Russia is caused by many factors both natural and socio-economic. Their role is changing depending on the level of the tourist and recreational system and its interaction with the natural and social systems at different stages of the development. The main recreational resource that attracts tourists to the South of Russia today is the beaches of warm seas (this situation has developed historically and is reinforced by the geopolitical changes happening nowadays). The process of intensifying the use of the territory is developing at a rapid pace which leads to an increase in the level of exposure of holiday-makers to natural complexes.

Krasnodar region is one of the most popular tourist and recreational regions of Russia due to a variety of factors. The main seaside and mountain resorts of Russia are concentrated here. The first resorts of the Krasnodar region arose on the basis of resort mineral water assets, later years began to develop sea, and even later - mountain resorts. The development of resorts as an independent industry began half a century after Russians had begun to develop the present territory of Krasnodar region. The settlement of the outer Kuban mountain regions by Russians began much later than the development of the lowland regions. The interest of the Russian government in the outer Kuban territories was explained by the prospect of oil fields in them, the organization of recreation and treatment was not even considered, although the mineral waters of the Psekupsk fields were described in details in 1829. For the first time, the resort economy stands out as a separate sector of the national economy in the period of intensified development of the city of Gelendzhik at the end of the XIX century.

Nowadays the tourist and recreational complex of the South of Russia is characterized by uneven tourist and recreational use: the Black Sea coast resorts traditionally occupy leading positions. In 2016, the total number of accommodation facilities in the region amounted to 3,929 objects, and their average annual load was 58%. The flow of tourists in 2016 increased sig-

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nificantly and amounted to 15.8 million people. In 2018 the resorts of the Krasnodar region host more than 17 million people. In the framework of the "Concept for the development of a sanatorium-resort and tourist complex of the Krasnodar region up to 2030", the Ministry of Resorts, Tourism and the Olympic Heritage of Krasnodar region cites the following forecast indicators for the time period from 2017 to 2021 and by 2030. According to the ministry a positive dynamics of tourist flow to the region is predicted. From 2016 to 2021 it should increase by 2.2 million people and reach 18 million people and by 2030 to reach the number of 20 million people. The growth rate is 126.6%. Considering the positive dynamics of growth of tourist flow to the region an increase in the anthropogenic load on natural complexes within the region is also predicted.

Methods

The study of the main stages of rural (agrarian) tourism development in the territory of the Krasnodar region was based on the historical and geographical method using retrospective analysis, statistical and comparative-historical methods. The main information sources along with modern publications of a historical and geographical nature were archival materials of local lore of the late XIX - XX centuries.

Results

A classic agricultural tourism uses human, material, and land resources of farms or other private households, as well as produced goods for providing accommodation, board and other forms of services to tourists. It is not necessary for farms to provide the entire range of these services; they can specialize in one or several ones (Zaburanna, 2015).

The development of rural tourism in the Krasnodar Region is justified and necessary: it is the most important agricultural region of the country (7% of Russia's gross agricultural output, 1st place in Russia). Naturally, the territory of the region consists of two parts. The northern and central parts, including the Kuban – Priazovskaya lowland, are consisted of steppes with chernozemic soils, and the southern part includes almost the entire Black Sea coast and is consisted mainly of the mountain surface. The steppe part of the Krasnodar Region is very favorable for agriculture and almost its entire territory is arable land for crop production. Agricultural lands occupy ≈ 62% of the territory.

The concept of the development of rural (agrarian) tourism adopted in the Krasnodar Region fully demonstrates the sustainability of this type of tourism (Volkova et al., 2017). In one of the definitions of the Concept, rural tourism refers to the type of tourism focused on the use of natural, cultural, historical and agricultural resources of rural areas, carried out for the purpose of recreation, familiarization with agricultural production and participation in agricultural activities. The development and implementation of the Concept, as well as the analysis of the agro-tourism potential of the Krasnodar Region, confirm the prospects for the development of this type of tourism, despite the territorial asymmetry (however, characteristic of the development of the entire TRK of the region).

The social and socio-cultural goals outlined in the concept include: protecting and restoring landscapes; preserving and restoring the cultural and natural population; supporting the production of environmentally friendly food; creating an ecological and respectful attitude to the land (Volkova et al., 2017). Thus, the development of rural (agrarian) tourism in the territory of the Krasnodar Region is one of many steps on the path to sustainable development of the industry, which can reduce the load on the natural environment.

The development of sanatorium and health resort business on the lands that are currently geographically related to the Krasnodar Region went along with the economic development of the territory. Of course, no one denies and in no way belittles the fact that it was with the creation of the Black Sea coastline and the emergence of hospitals in the fortifications that the scientific base of the resort business of the Krasnodar Region began to develop. But at that time there was an acute question of the development of the territory, which could not be resolved by the forces of individual military garrisons. It is about the second half of the 19th century. The Black Sea District has already been established as an administrative unit; the port cities of Anapa and Novorossiysk have been also established. It was during this period that the "Regulation on the Settlement of the Black Sea District and its Management" said: "... the space between the Tuapse and Mzymta rivers, from the sea shore to the peaks of the Main Caucasian Range, is intended for rural civilian settlements ...".

In 1896, a decision was made to designate the coastal strip of the Black Sea District, "the most suitable for high culture", to distribute in small sections (no more

than 10 acres) for the construction of summer cottages and cultivate vineyards, orchards and other cultural plantings on them. It was the implementation of this decision that gave impetus to the development of territories, which in our time are among the most developed in terms of tourism. Land was distributed on condition that the land user fulfilled certain conditions: the owner was obliged to start work in the first year and plant the plants first at least on a part of the area, and within five years to erect buildings. If these and other conditions were not fulfilled, the site was taken away. Over time, the Black Sea coast of the Caucasus began to be inhabited by intelligent and very wealthy citizens who sought to find harmony and comfort in the conditions of wonderful nature near the warm waters of the Black Sea. The Black Sea coast of the Caucasus in Russia began to be called the "summer residence of the Russian brainpower." At the summer cottages, the first baths were built, which were used by the owners and their guests. Owners of the cottages were the first to appreciate the natural and climatic features of the region, realized its resort predestination as a whole, and began to invest personal funds in the development of the Black Sea coast. They became a kind of catalyst for the development of resort business in the region, the starters of many advanced initiatives. Thus, it can be said that the emergence of the sanatorium and health resort of the Black sea coast is inextricably linked with agro-recreational activities, to which country recreation, characteristic of that period of time, can be attributed. Moreover, even today, these summer cottages and their territories are used in tourist and excursion activities. For example, the cottage of the merchant Vasily Alekseevich Khludov, who spent about 2.5 million rubles on the purchase and improvement of his estate in 1882. The total area of the merchant's estate was about 1900 acres (1 tithe = 1.09 hectares). Orchards occupied an area of 120 acres, 90 acres were occupied by the vineyard, founded in 1890, 75 acres - the apple orchard. In 1896, on the flat part of the estate, according to the project of the famous architect Lev Nikolayevich Kekushev, a house was built in the fashionable pseudo-Russian style with modern elements (the original structure did not survive to this day, it was declared damaged in 2009 and demolished; the construction of a new building was started) Today, the territory of the estate of the merchant Khludov has turned into a Riviera park in Sochi.

Depending on the goals, there existed and exist many subspecies of rural (agrarian) tourism, including educational, agricultural (participation in agricultural work), culinary, ethnographic, cognitive, etc. That is why we can assume that since the foundation of the USSR, almost the entire population has been involved in the field of rural tourism. Starting from the school bench, the child was included in the agritourism system: schoolchildren went with overnight stays to clean the nearby agricultural enterprises. In universities and colleges, students also took part in agricultural work, passing - usually during September - the so-called "labor term". The armed forces of the USSR were constantly involved in harvesting work. Drivers in cars typically participated in harvesting crops across the country. Other servicemen were sent to harvest crops grown within the area in which the military unit is located. For example, in the fall season, soldiers went out overnight (visitor) to harvest potatoes in the Podolsky Region of the Moscow Territory. Employees of many enterprises, universities and colleges, research institutes and other organizations were also involved in similar work. It was "the help of the city for the village." If we combine all of the above categories of pupils, students, military personnel, workers, office workers, "assistant professors with candidates", summer residents and ecotourists, it turns out that rural tourism, including rural with agricultural work, covered almost 100% of the urban population of the RSFSR, which amounted to 109.1 million people in 1989. (74% of the total population of the country): part with simultaneous residence in the countryside (tourists), part - without accommodation (visitor). We can also add military men from the countryside that will fill up those citizens who miraculously did not fall into the number of agritourists. They traveled as if without fail, but at their own request, because every unwilling person could take liberation on some pretext. But the vast majority of these agritourists traveled of their own accord, and with joy, because everyone understood that they were going not only (and not so much) to work, but also to relax: in the evenings - dances, games, songs by the fire, on weekends - excursions to remarkable places, museums.

Thus, many types of tourism were combined (rural, educational, ethnic, wine, etc.), and agricultural tourism acquired a collective form, becoming combined. Accommodation usually took place in dormitories, labor and children's camps, less often - in the homes of local residents and administrative, warehouse buildings, equipped for temporary accommodation (in case of shortage of places).

The changes that took place in Russia in the early 90s led to the complete "destruction" of the existing agritourism system. The socio-economic processes characteristic of that time had a significant impact both on the tourism industry and on agritourism in particular. The processes launched by the political, economic and social spheres of life still affect the development of tourism in Russia.

In the early 1990s a significant part of the land passed into the ownership of citizens and communi-

ties. This process took place against the background of a reduction in the area of land used. According to Russian statistics, in 2006 the area of farmland increased from 6.5 to 21.6 million hectares, the area of personal subsistence farming – from 6.4 to 8.1 million hectares, but the lands of cooperative and individual gardens and vegetable gardens decreased slightly (from 1.7 to 0.8 million ha).

The agricultural component (agricultural production) sharply increased in the structure of the townspeople's activity in connection with changes in the economic situation in the country, but recreation was still of great importance for urban residents. Rest of the townspeople in their summer cottages and garden plots was carried out within the framework of special territorial and economic formations – territorial recreational systems of a summer cottage type. With the development of such entities, the content of the concept of "cottage" changed. In the studied period of time, it was used both in a narrow (recreational dwelling), and in a broader sense (suburban land). Both this and the other equally correspond to the historically established meaning of the term "summer cottage". With an increase in living standards, rest in one's own home in nature will remain an important need, the implementation of which is now being carried out by agritourism enterprises, while growing vegetables is turning more and more into a hobby, into additional exotic characteristic of being in rural areas rather than a necessity.

Currently, there are a large number of approaches to determining the nature of rural tourism. Obviously, the main reason for this is the variety of types of recreational activities and occupation, which can conditionally be classified as rural tourism. At the same time, the degree of the involvement of the tourist services consumer in rural life is of great importance, for the sake of acquaintance with which, theoretically, a tourist chose a rural area as a vacation spot. The active development of agritourism in the Krasnodar Region helps to solve two very important tasks: diversification of tourism products within the territory of the region and rural development, improving the living standards of rural residents by organizing new jobs, increasing the prestige of living in rural areas, and developing common infrastructure in the countryside, as well as increasing the investment attractiveness of the village.

Features of the development of agritourism in the Krasnodar Region are:

1. Enterprises that provide services of this kind, for the most part, are primarily tourism, not agricultural.
2. The main geographical directions of the development of agritourism are the Azov-Black Sea coast and the mountain-foothill zone, while the steppe zone in this respect is significantly behind.

Tourist activity in the conditions of a modern village on the territory of the Krasnodar Region often consists in including visits to farmsteads in the program of excursion tours, in organizing one-day excursions from nearby resort areas of the region. The organization of weekend tours with short-term tourist accommodation is relevant. Organizing and conducting events on the territory of rural farmsteads (weddings, banquets, corporate events) is becoming popular. All of the above is combined with a tasting of local products, the sale of souvenir and consumer goods. Agritourism in modern conditions combines the elements of recreational, active, educational, consumer, gastronomic, ethnographic tourism.

Over the past few years, the regional administration has been actively working on the development of new types of tourism, which allow "delaying" part of the holidaymakers on the territory, previously not so active in organizing tourism and recreation. One of the evidence of this process is the Concept of development of rural (agrarian) tourism in the Krasnodar Region for 2017-2020, adopted in the Krasnodar Region. Currently, the Ministry of Resorts, Tourism and the Olympic Heritage is intensifying the discussion of the project "Concepts for the development of the sanatorium and health resort and tourist complex of the Krasnodar Region until 2030" according to which the development of such types of tourism as: beach and sea; health resort; cultural and educational; mountain climatic; olympic and cruise; business, eventful; rural (agrarian). According to this Concept, rural (agrarian) tourism is supposed to be developed on the territory of 10 municipal districts: the resort city of Anapa, the city of Novorossiysk, the resort city of Sochi, Temryuk district, Yeisk district, Crimean region, Abinsky district, Seversky district, Mostovsky district and the city of Armavir.

Conclusion

Today we can talk about the possibility and even the need to revive rural tourism with agricultural work on a voluntary basis, as many students would like to earn extra money and relax (young people always advocate active and inexpensive vacations). This opportunity can be provided to them by the heads of agricultural companies and farmers (PJSC "Abrau-Durso", "Fanagoria", farms are ready to take for seasonal work),

which make their proposals to universities and colleges. These enterprises are really interested in solving personnel problems.

The development of rural tourism as an alternative type of tourism activity is relevant for the unloading of roads of the Black Sea coast: it is necessary to develop programs related to the redistribution of tourist flows both at the coast level (between the resort areas of the Black Sea and Azov coast), and at the level of the entire territory of the region, it is necessary to stimulate redirection of tourists from the narrow coastal territory to the steppe and mountain foothill areas of the region. The redistribution of tourist flows can be ensured by the development of special tourist zones, the development of tourist infrastructure, the offer of new types of tourism for this territory, such as agritourism, ethnographic tourism, etc.

The history of the development of tourism is significant, it is inextricably linked with the development of tourist and recreational activities in Russia and the Krasnodar Region. On the territory there is a rich recreational potential for the development of a number of types of tourism, as for the potential for the development of agrarian tourism, there are also prerequisites (recreational resources) for the development of this type of tourism.

The developed tourist infrastructure creates prospects for stable development of agritourism, its attractiveness and the functioning in the future. Agritourism in the Krasnodar Rgion is gradually gaining importance, becoming relevant and attractive, it is expanding the possibilities of tourism in the region, has a positive effect on the development of rural territories of the region. Also, rural tourism in the region will become an important element for the development of the whole economy of the region in the future, improving the quality of life in rural areas, infrastructure development. Rural tourism product has already become popular in the region, and in the future this trend is likely to continue. At the same time, the sustainable development of tourism ensures the unity of three components:

1. environmental sustainability through the development of tourism and recreation in harmony with the main environmental processes;
2. economic stability due to income from tourism as an effective sector of the local economy;
3. socio-cultural stability, which allows increasing employment and incomes of the population of the regions, to preserve historical and cultural monuments, to strengthen local identity and the existing way of life.

Sustainable tourism affects such important aspects as a competitive and socially responsible tourism business, employment opportunities in this sector and the benefits of tourism activities for the local community. This requires the preservation of cultural integrity and the integration of resources, environmental protection and cultural heritage in tourism-related programs. Extensive attempts to implement the principles of sustainable tourism development are made both at the regional level and at the level of tourism enterprises. Many eco-hotels, agritourism farms are created, where the tourist can join the nature and a balance of economic benefits and environmental component is ensured here. For example, in the Krasnodar Region, the number of agro-tourism enterprises has doubled over the past 2 years to 117. Organizations such as the International Hotel and Restaurant Association (IHRA), the International Hotels Environment Initiative, the UNEP Industrial and Environmental Department, World Travel and Tourism Council (WTTC), International Association of Scientific Experts in Tourism (AIEST), as well as the efforts of several leading hotels are helping to create more environmentally friendly conditions.

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CLIMATE CHARACTERISTICS OF POLIMLJE

Duško Vujačić[A], Goran Barović[B], Đurđica Perović[A]

Abstract

The climate has a great impact on the formation and composition of the soil, the abundance of water, the formation of specific forms of relief, as well as the distribution and richness of the flora and fauna. Therefore, the weather and climate significantly affect the life of people dwelling in a particular area. Specific factors that particularly affect the local climate of a place are latitude, distance from the sea, relief, altitude, water reservoirs, vegetation cover and anthropogenic influence. The area of Polimlje has been distinguished due to the fact that it is located in a zone where intense exchange of warm air masses going north and cold air masses going from the north to the south takes place. Above this boundary zone, collisions and mixing of these air masses with remarkably different physical and meteorological properties are very common. When transporting these air masses, orography, its orientation, the proximity of the sea (Adriatic), the proximity of a large body of water such as the Mediterranean Sea, the proximity of a large continental area in the north direction, etc. become conspicuous. The geographical position of Polimlje is such that these systems strongly affect the weather and define the most diverse types of climates from extremely harsh to very favourable in all seasons. The climate of the Polimlje area is determined by several action centres: Genoa cyclone, Adriatic cyclone, Icelandic depression, Black Sea depression, Azores anticyclone, Siberian anticyclone, Central European anticyclone, cold front system from the north - Arctic cold front and warm tropical front from the south. Each of them is distinguished by specific weather conditions which determine the effect of these centers or systems. In practice, the effects are very often intertwined, which results in a sudden change in the effect of the centers, since weather conditions are extremely variable, followed by rapid weather changes and stormy meteorological events. Studying the weather and climate should help solve numerous problems of the economy and society to improve people's living conditions. The parameters used as input data to the WIntErO model: air temperature and precipitation as the ones of paramount importance, and to provide a more detailed representation of the climate-related area, it is desirable to also analyze the air humidity data.

Keywords: climate, Polimlje, air masses

CLIMATE CHARACTERISTICS

Climate has a great influence on the formation and composition of the soil, the quality and features of water, the formation of certain forms of relief, the distribution and richness of flora and fauna. Weather and climate significantly affect the entire life of people inhabiting a specific area. The factors that significantly affect the local climate of a place are: latitude, distance from the sea, relief, altitude, water reservoirs, vegetation as well as anthropogenic impacts.

The position of Polimlje is such that these systems strongly influence the weather conditions and define the most diverse types of climate from extremely harsh to very favorable, in all seasons.

The climate of the area of Polimlje is determined by several action centers. The most important meteorological centers that affect the weather and climate are Genoa cyclone, Adriatic cyclone, Icelandic depression, Black Sea depression, Azores anticyclone, Siberian anticyclone, Central European anticyclone, cold frontal

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system from the north - Arctic cold front and warm-tropical front from the south.

Each of these centers or systems is associated with specific and distinguished weather conditions. However, in practice, the actions intertwine or there is a sudden change in the action of the centers, which results in the extremely changeable weather conditions, followed by sudden weather changes and turbulent meteorological events.

The study of weather and climate should help solve many problems of the economy and society, all to improve people's living conditions.

The following parameters used as input data for the WIntErO model are: air temperature and precipitation, as the most important one, while for a more detailed presentation of the area concerning climatic characteristics, it would be recommended to amalitate the data concerning relative air humidity.

Data from the Institute of Hydrometeorology and Seismology (ZHMS) from the climatological stations Plav, Berane and Bijelo Polje as well as those obtained from the Republic Hydrometeorological Service of Serbia (RHMZS) from the meteorological station Sjenica were used to describe the climatic characteristics of Polimlje, which is the subject of this study.

the inputs needed to calculate the WIntErO model (torrential rain height, hb; mean annual air temperature, t0; mean annual rainfall, Hgod).

Air Temperature

Air temperature is one of the most important meteorological elements, due to the fact that the changes in the thermal state of the air cause changes in other meteorological elements and phenomena. This fact indicates that temperature data serve as a basis for analysis and interpretation of almost all weather and climatic characteristics. The significant hydrothermal analyzes (precipitation and temperature) related to the studies of macroclimate and climatic regionalization of large areas are mostly based on the so-called hydro-thermal analysis.

Comparing the obtained data, we can conclude that air temperatures, viewed by months as well as on an annual basis, are quite uniform in the river basin of Lim, which can be best seen in the graph (Graph 2).

The lowest measured values of mean monthly air temperatures in the studied area are in January (from -1.7 °C to -1.0 °C), February (from -0.3 °C to 1.2 °C) in December -0.6 °C to 0.0 °C), while the highest values of air temperature vary depending on the location, so

Table 2. Rank and position of selected meteorological stations

Station	Rank	Latitude	Longitude	Elevation (m)
Plav (P)	Climatological	42°36'	19°57'	933
Berane (B)	Climatological	42°51'	19°53'	691
Bijelo Polje (BP)	Climatological	43°02'	19°44'	606
Sjenica (S)	Synoptic	43°17'	20°00'	1038

(Izvor: ZHMSCG i RHMZS)

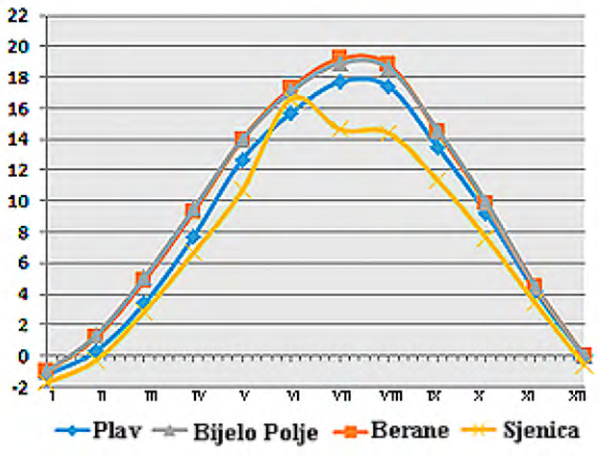
The layout and number of stations, as well as the climatic elements used during the processing, were conditioned by the length, i.e. a series of data as well as the rank of the stations themselves. In the considered area, only the station *Sjenica* has got the rank of synoptic (measurements and observations are performed every hour) station, while the other stations have the rank of climatological (three observation terms: 7, 14 and 21 h) ones. Analyses of these studies targeted the processing of data for air temperature and precipitation, as the main climatic elements needed to obtain

in Sjenica the warmest is June (16.6 °C) while in the other three stations (Plav, Berane and Bijelo Polje) the highest value has been recorded in the month of July (from 17.7 °C to 19.2 °C). Based on the table (Table 2), it can be noticed that the minimum mean monthly air temperatures most often occur in the winter period of the year (December, January, and February), while the maximum mean monthly air temperatures occur in the summer part of the year (July, July, and August).). The spring (March, April, and May) and autumn (September, October, and November) months

Table 3. Mean monthly and mean annual air temperature at selected stations in the period 1966 - 2015.

Place	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean value
Plav	-1,2	0,2	3,4	7,6	12,7	15,7	17,7	17,4	13,4	9,1	4,2	0,0	8,4
Berane	-1,1	1,1	4,9	9,2	14,0	17,2	19,2	18,8	14,5	9,8	4,5	0,0	9,4
Bijelo Polje	-1,0	1,2	5,1	9,4	14,0	17,0	18,9	18,5	14,6	9,9	4,5	0,0	9,3
Sjenica	-1,7	-0,3	2,9	6,7	10,7	16,6	14,6	14,4	11,3	7,6	3,4	-0,6	7,1

(Source: ZHMS and RHMZS)



Graph 2. Mean monthly and mean annual air temperature at selected stations in the period 1966-2015

are characterized by approximately the same values of temperatures (medium) as well as that they quite coincide with the annual average.

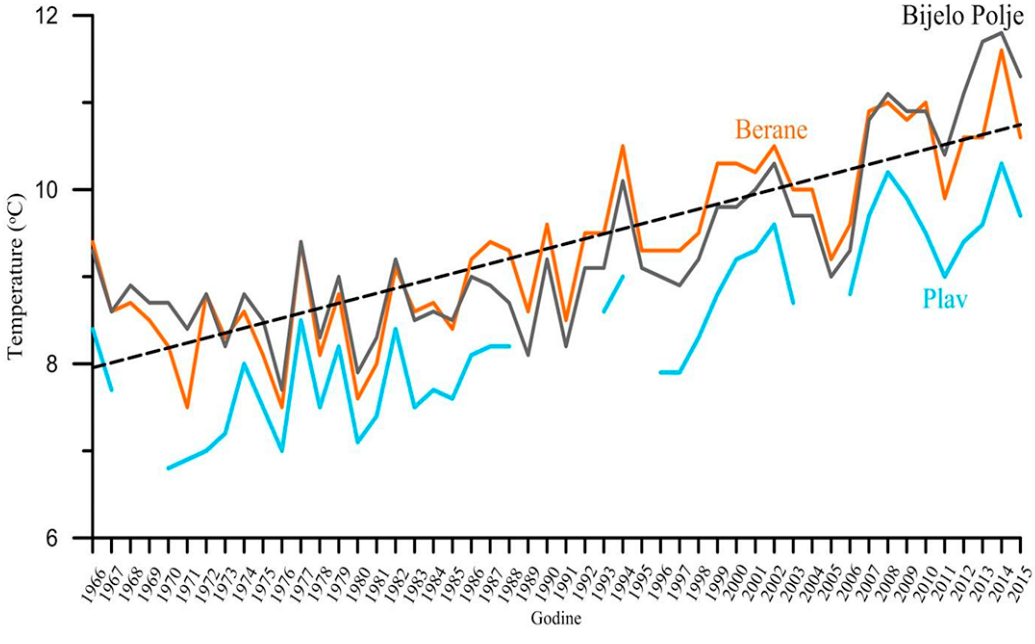
Since the astronomical criterion does not coincide with the meteorological one, and for the purpose of better classification and analysis of temperature values, as well as a mpre precise determination of their monthly movement, we used the meteorological division of the seasons (spring: March, April, May) (March 1 - May 31), summer: June, July, August (June 1 - August 31), autumn: September, October, November (September 1 - November 30) and winter: December, January, February (December 1 - February 28/29.

The results indicate that, in the period from 1966 to 2015, the amplitude of fluctuations in average annual air temperatures was 2.3 ° C and that the Pešter area was the coldest part of the researched area. This is not surprising considering that valleys, especially in high mountainous areas, affect the accumulation of cold air and the formation of extremely low temperatures, which contributes to radiative cooling of the air, especially in situations where there is high air permeability. Due to this condition, inversion layers appear, 300-500 m thick, on such plateaus and high valleys as those that can be found in the Pešter area.

Graph 3 reveals that the trend of mean annual temperatures is the same for the observed stations, with noticeably lower values for the Plav station compared to the other two. Based on the graph, two characteristic periods can be distinguished - from 1966 to 1985, when the trend was stagnant, and in the rest of the observed period, the growth trend of average annual temperatures was emphasized.

Precipitation

The annual amount of precipitation and its distribution by seasons and months (known as *the pluviometric regime*) is one of the main climatic characteristics of an area. The amount of precipitation during the year depends on and is related to the annual movements of temperature, relative humidity and clouds. These parameters cause convective processes in the atmosphere, condensation of water vapor and its excretion into the ground in a liquid or solid-state. In addition to the above parameters, in the study area, orography has a significant impact on precipitation excretion. Convective precipitation is also noticed during the summer months.



Graph 3. Movement of average annual temperatures for the stations Plav, Berane and Bijelo Polje in the period 1966-2015

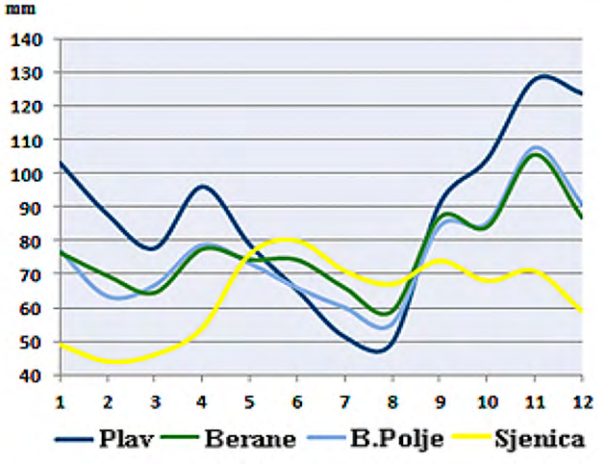
Table 4. Mean monthly and anual precipitation (data expressed in mm) in the period 1966-2015.

Stanica	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Sum
Plav	103	88	78	96	79	65	51	50	91	104	128	124	1057
Berane	77	63	67	79	73	66	60	55	84	85	108	91	908
B. Polje	76	70	64	78	74	74	66	59	87	84	106	87	925
Sjenica	49	44	46	54	76	80	71	67	74	68	71	59	760

(Source: ZHMSCG and RHMZS)

The average annual rainfall of the analyzed period, measured at these stations, ranges from 1067 mm in Plav, 911 mm in Berane, 925 mm in Bijelo Polje, and 760 mm in Sjenica.

The analyzed data showed in Table 5 and Graph 4 clearly indicate that the maximum amount of precipitation occurs in November at the stations Plav (122 mm), Berane (89 mm) and Bijelo Polje (86 mm), which are located in the basin of the river Lim (in the valley) from the station in Sjenica, located in the at the highest altitude of the north-eastern part of the researched area, where the maximum precipitation occurs in July (80 mm). Therefore, it can be concluded that the highest amount of precipitation in the studied area is excreted in autumn and the lowest in summer, where the amount of precipitation increases with increasing altitude (γP = 43.4 mm / 100 m in the profile Bijelo Polje - Plav) while on the profile Bijelo Polje - Sjenica it decreases. Mostly descending circulating movements occur in the area of Pešter, which is reflected in unfavorable conditions for the formation of precipitation. In winter, increased air pressure (Siberian anticyclone) with cold and stable weather usually occurs in this area, and in summer, descending air currents in combination with low relative humidity are dominant over this space, where the so-called precipitation inversions can be identified. In other words, adjacent rain gauge (precipitation) stations at lower altitudes receive a higher amount of precipitation. For example, Sjenica, which lies at an altitude of 1038 m, received a significantly lower amount of precipitation (760 mm) than the surrounding rainwater stations in the study area Plav (933 m - 1057 mm), Berane (961 m - 608 mm) and Bijelo Polje 606 m - 925 mm).



Graph 4. Average monthly precipitation

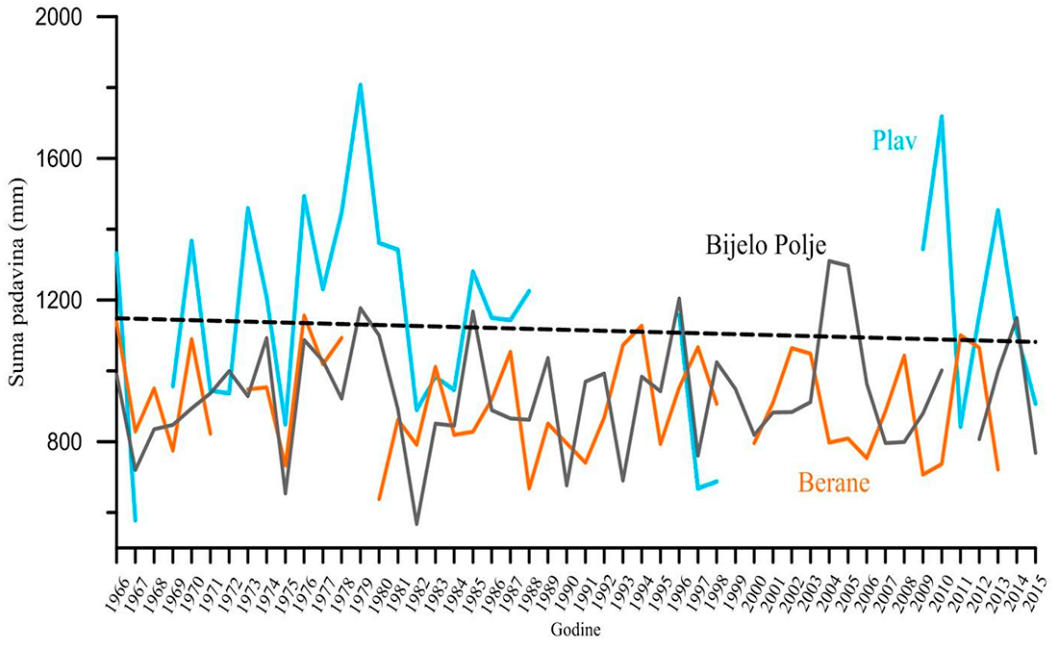
The change in the amount of annual precipitation identified for the observed stations indicates a mismatch of years with higher and lower amounts of precipitation obtained at the stations Bijelo Polje and Berane, which have a similar average annual precipitation amount. The movement of annual precipitation amounts for the Plav station in the first part of the observed period corresponds to the trend of the Bijelo Polje station. In general, in the entire observed period, the linear trend of annual precipitation amounts for the Bijelo Polje station has a downward character (Chart 5).

One of the ways to better and better present the precipitation regime is to analyze the relative annual precipitation fluctuations (R).

Analyzing precipitation according to the above pattern, values ranging from 7.4% in Plav, 5.8% in Berane, 5.1% in Bijelo Polje and 4.7% in Sjenica were obtained. The smaller the relative annual fluctuation of precipitation, the more evenly distributed the precipitation during the year, and vice versa.

The spatial distribution of precipitation in the basin is reflected through several factors: the position of the basin concerning the main source of moisture (Adriatic Sea) and the direction and provision of mountain ranges (Prokletije, Komovi, Bjelasica) have the greatest influence on the precipitation regime in this area. It is generally known that the amount of moisture in the air masses decreases as they move away from the sea, ie. from moisture sources. With such a movement, the air masses are not replenished with a sufficient amount of moisture from the dry air, which is above the land (continent). By moving away from the sea, such air masses become drier, and thus the number defining the precipitation decreases, which is confirmed by the results obtained in Sjenica.

The relief and ascending air currents, ie. air condensation over mountain massifs, result in the condensation of water vapor, as well as precipitation on windless sides of mountains often, as is the case with the area of Plav and its surroundings in the hinterland of the Prokletije massif, which, also, represent



Graph 5. The change of the amount of average annual precipitation identified at the stations Plav, Berane and Bijelo Polje in the period 1966-2015

the highest point of the basin (Zla Kolata 2534 m) and which by their direction and direction of supply affect the amount and distribution of precipitation. Moving further to the north and northeast (Berane, Bijelo Polje, Sjenica), the amount of precipitation decreases, due to the dynamic heating of the air that descends through the windward side of hills and mountains, which causes gradual clearing and reduction of precipitation. Therefore an inversion of precipitation frequently occurs, caused by a decrease in specific humidity with height (in convection currents).

The precipitation regime of this area could be an adequate indicator of the regional distribution of air masses. One of the ways to determine the type of pluviometric regime of an area is to analyze the amount (sum) of precipitation by season. It is considered that the maritime regime includes those territories in which a larger amount of precipitation fell during autumn and (or) winter, while the continental pluviometric regime includes those places or areas where the maximum precipitation occurs in spring or summer.

According to this precipitation distribution, the basin of the river Lim (up to HPP Potpeć) belongs to the Mediterranean pluviometric regime, which is somewhat modified by the mountain and continental precipitation regime. On the whole, the objective of this article is the identification of rather strong maritime masses not only in Morača and Lim valleys, but also in the southwestern part of Serbia.

CONCLUSION

The specificity of the position of Polimlje is in the fact that it has been located in a zone of a very pronounced thermal asymmetry between cold northern Europe and very warm northern Africa, where there is an intensive exchange of warm air masses going north and cold air masses going north from the north. Above this border area, these air masses very often collide and mix with extremely different physical and meteorological properties. During the transport of these air masses, orographs, their orientation, proximity to the sea (Adriatic), proximity to a large body of water such as the Mediterranean Sea, proximity to a large continental area in the direction of the north, etc. come to the fore.

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91(082)

THE Serbian Congress of Geographers (5 ; 2021 ; Novi Sad)
Collection of papers [Elektronski izvor] / The 5th Serbian Congress of Geographers "Innovative Approach and Perspectives of the Applied Geography", 9-11th, September, 2021, Novi Sad. - Novi Sad : Faculty of Sciences, Department of Geography, Tourism and Hotel Management, 2021

Način pristupa (URL): http://www.dgt.uns.ac.rs/udzbenici/. - Nasl. sa naslovnog ekrana. - Bibliografija uz svaki rad.

ISBN 978-86-7031-589-1
a) Географија -- Зборници

COBISS.SR-ID 47951113