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RIVER INFORMATION SYSTEMS – REVIEW, APPLICTIONS, AND CURRENT EXAMPLES FROM SERBIA

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ABSTRACT

There is a constant need for improvement in inland water navigation based on the implementation of innovative technologies. This is necessary to ensure better traffic management, safer navigation, more economically profitable navigation, and to make inland navigation more reliable. This paper provides a rare a general review of currently used employed technologies of river information systems (RIS), the ways how they are used in practice, and the current state of development in Serbia. Throughout recent history, RIS technologies have been constantly improving, and accordingly, new legal documents have been drafted and published. These provide a formal-legal basis for each one of RIS technologies, and make their standardization easier. As the technology keeps progressing, the RIS concept should be able to adapt to it, and keep improving inland waterway transport, especially given that this mode of transport has much potential for the future.

Keywords: *river; river information systems; geographic information systems; Serbia.*

INTRODUCTION

River Information Systems (RIS), or River Information Services (RIS) is the concept of harmonized telecommunication systems and information services, which have a goal to improve the safety and efficiency of inland waterways transport and connecting inland waterways with other modes of transportation. This concept integrates a variety of technologies connected to inland navigation, such as: „systems for vessel tracking and tracing“, „display of electronic navigational charts“, „notices to skippers“, etc. RIS has been developed as an open system, for all users of inland waterways. In inland navigation, just like in all kinds of transportation modes, there is a growing need for information exchange, and to adapt and implement innovations in river navigation. Of crucial significance is, especially, the exchange of information, related to all sorts of traffic and transport, which contributes to the safety and efficiency of inland transport and navigation (https://www.cesni.eu/en; http://www.plovput.rs).

Although inland waterway transport takes much longer and is not always possible due to limitations of inadequate and insufficient infrastructure, inland shipping is much cheaper and more environmentally friendly, and this mode of transportation can be seen as an adequate alternative for road transportation even in ur-

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ban areas. In some recent research, it has been shown that RIS can contribute to in freight transportation not only on longer routes but even in urban and inter-urban areas (Durajczyk, Drop, 2021).

Europe can be distinguished as the place of RIS initial development, and some European countries are regarded as proponents of the RIS, given that number of RIS services are in operation, such as IRIS I and II, DoRIS, RIS equipment program in Serbia, BulRIS, and much more, which has resulted in in number of directives and guidelines followed world over. But RIS system are being implemented in the USA, and in some Asian countries like China and South Korea (Inland Waterways Authority of India, 2021).

Given the fact that RIS is based on information connected to inland waterway transport, hence rivers as well and certain dynamics on them, it can be derived that the connection between RIS and GIS (Geography Information Systems) is quite evident, knowing that work object of GIS is spatial information. However, there is a lack of literature that explores the issue of RIS within geographical and geoinformation research. To this end, this paper will present a review of research on RIS and its prominent examples from Serbia that have a huge potential for further geographical analysis.

THE DEVELOPMENT OF THE RIS

For a very long time transport on waterways has been the most relevant mode of transport and given that it represents the oldest mean of inland transportation, it can be pointed out its significance since the beginning of transportation in general. Initially inland waterway transport (IWT) could only take place on natural rivers making use of wind as propulsion. Later canals were dug and for these waterways vessels were introduced that used a horse or even men for propulsion. The technological developments in road and rail transport together with network developments paved the way for larger improvements in the performances of these modes and hence created complete new competitive conditions between road, rail and inland waterway transport (Konings, Wiegmans, 2017).

Integrating as much as possible modes of transport is something towards all branches of inland transport should strive, as it leads to more efficient logistics in general.

Inland waterways are made of canals, lakes and navigable rivers, and together with roads, railway lines, and pipelines, they represent the surface transport infrastructure and can be used for the transport of goods (Platz, 2016).

Today information technology finds its way and purpose in almost every segment of human activity, and thus providing new solutions for existing problems. The case with inland waterway navigation does not differ from such case. Digitalization as an important source of growth, innovation and new business, is transforming our economy and society at the fast tempo. Although IWT lacks economics competitiveness in comparison to other modes of transportation, IWT is highly efficient in terms of greenhouse gas emission (Brugt et al. 2019; Specht et al. 2022).

RIS represents a concept that precedes the establishment of the CESNI/TI1 workgroup. This concept, in the present form, was created in the late 1990s and is based on the idea that river information serves inland waterway transport and traffic management, but this information needs to be standardized first, so compatibility of the services could be enabled. In mentioned manner RIS is contributing to efficiency improvement, and safety of navigation as well, and is making this source of traffic more environmentally friendly (https://www.cesni.eu/en).

Chronologically speaking, the history of the RIS development can be seen through several following stages, emphasized based on the significance of the events which have reflected on RIS development:

- 1998: European Union initiates the development of the concept of the River Information Systems. The potential of RIS to bring the position of inland navigation closer to a better position in the transport chain

[1] Information Technology Group of the European Committee for drawing up standards in the field of inland navigation

has also been recognized by international organizations such as „UNECE“, „River Commissions – CCNR“, „DC“, „Sava Commission“ and „International Association for Navigation (PIANC)“ (https://unece.org).

- 1998-2002: „PIANC2“ establishes a Permanent Working Group 24 for RIS concept development. (https://unece.org).
- 2003: With the support of the several Member States of the European Union, the European Commission took the initiative to issue a Directive on River Information Systems (https://unece.org).
- 2004: The revisions of 2002 were drafted and published as the 2004 RIS Guidelines. Following the publication of these Guidelines, further developments in systems and standards, as well as technical and practical improvements, take place (https://unece.org).
- 2004: The Working Party on Inland Water Transport of the UN Economic Commission for Europe adopts two resolutions, Resolution 573 and Resolution 584, on RIS (Inland Navigation Commission. Working Group 24, 2004) (United Nations, 2004a; United Nations, 2004b).
- 2006: The Working Party on Inland Water Transport of the UN Economic Commission for Europe adopts Resolution 63.5 „International Standard for Tracking and Tracing on Inland Waterways (VTT)“ (United Nations, 2006).
- 2007: Three RIS regulations are published: 1) 414/2007 – refers to technical guidelines for planning, implementation, and operational use of RIS (Official Journal of the European Union, 2007a); 2) 415/2007 – refers to the technical specification of the Vessel Tracking and Tracing system (VTT) (Official Journal of the European Union, 2007b); 3) 416/2007 – refers to technical specification for the „Notices to Skippers“ (NtS) (Official Journal of the European Union, 2007c)
- 2011: „PIANC“ establishes a Permanent Working Group 125, to keep the RIS Guidelines up to date. As a first result, in 2011 PIANC publishes the latest information related to the RIS Guidelines, after analyzing the status of RIS implementation at the global level. PIANC RIS Guidelines 2011 was officially accepted by: „UNECE“, „Rhine Commission“, „Sava Commission“, and „Danube Commission“ (https://unece.org).
- 2019: An update of the PIANC RIS Guidelines and revision of the RIS-related definitions were undertaken, due to following reasons: An essential change about the e-Navigation6 (concept governed by International Marine Organization-IMO) developments in the maritime domain is the alignment between RIS and e-Navigation, and consequently, as a first step the use of the same terminology. For this reason, some of the important terms were changed to be in line with the terms used in the domain of e-Navigation. Therefore, RIS definitions have been brought into a relationship with the maritime area (https://www.risdefinitions.org).

Some of the major new trends in the domain of RIS and inland navigation development in general are presented at the PIANC SMART Rivers conferences. Ever since 2004, this international event takes place every two years, under the umbrella of the World Association of Waterborne Transport Infrastructure (PIANC). The previous conference was held in Lyon, France in 2019, whilst the next conference will take place in October 2022, in Nanjing, China. Therefore when talking about future of the RIS and inland navigation, conclusions from the last held conference can be quite useful (https://www.smartrivers2022.com).

Investigation and implementation of the possibilities of the autonomous sailing or smart shipping is a next step in the evolution of inland navigation. With development of “smart ships”, the waterway authorities need to examine if their infrastructure needs to be more intelligent or smart. By taking the necessary legislative initiatives or by making adjustments to infrastructure, all research can be supported by the waterway authorities (Morlion G., 2019).

[2] World Association for Waterborne Transport Infrastructure

[3] Resolution No.57, Guidelines and Recommendations for River Information Services, Revision 1, ECE/TRANS/SC.3/165/Rev.1

[4] Resolution No.58, Guidelines and Recommendation for River Information Services, Revision 1, ECE/TRANS/SC.3/165/Rev.1

[5] Resolution No. 63, International Standard for Tracking and Tracing on Inland Waterways (VTT), Revision 1, ECE/TRANS/SC.3/176/Rec.1

[6] IMO definition: “ the harmonized collection, integration, exchange, presentation and analysis of marine information on board and ashore by electronic means to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment.“

THE COMPONENTS OF RIS

In this section, a review of the two most essential components of the RIS will be given. Those components could be defined as formal-legal ones (directives) and technologies used by this complex system (RIS technologies and RIS services).

EU DIRECTIVES

The harmonization of River Information Systems is regulated at the European level through the Directive of harmonization of River Information Systems on Inland Waterways on 20th October 2005. (European Commission, 2005).

The so-called "RIS Directive" contains mandatory technical legal measures for navigational equipment and electronic data exchange, together with minimum requirements for the implementation of RIS. This guarantees the emergence of a harmonized RIS application, based on internationally compatible technologies. Mentioned Directive regulates:

- Mandatory **technical standards** for RIS implementation, which are referring to:
  - Inland Automatic Identification System - Inland AIS
  - Inland Electronic Chart Display Information Service - Inland ENCs
  - Notices to Skippers - NtS
  - Electronic Ship Reporting - ERI
- Standardization of **vessel equipment**
- Standardization of **RIS data exchange** (https://unece.org).

RIS TECHNOLOGIES

The aforementioned "RIS Directive", specifically refers to the technical essence of RIS, and thus provides insight into some characteristics of the system. Therefore, the mentioned directive can be used as a mediator towards understanding exactly which technologies are in question, that is, the technical components of RIS itself.

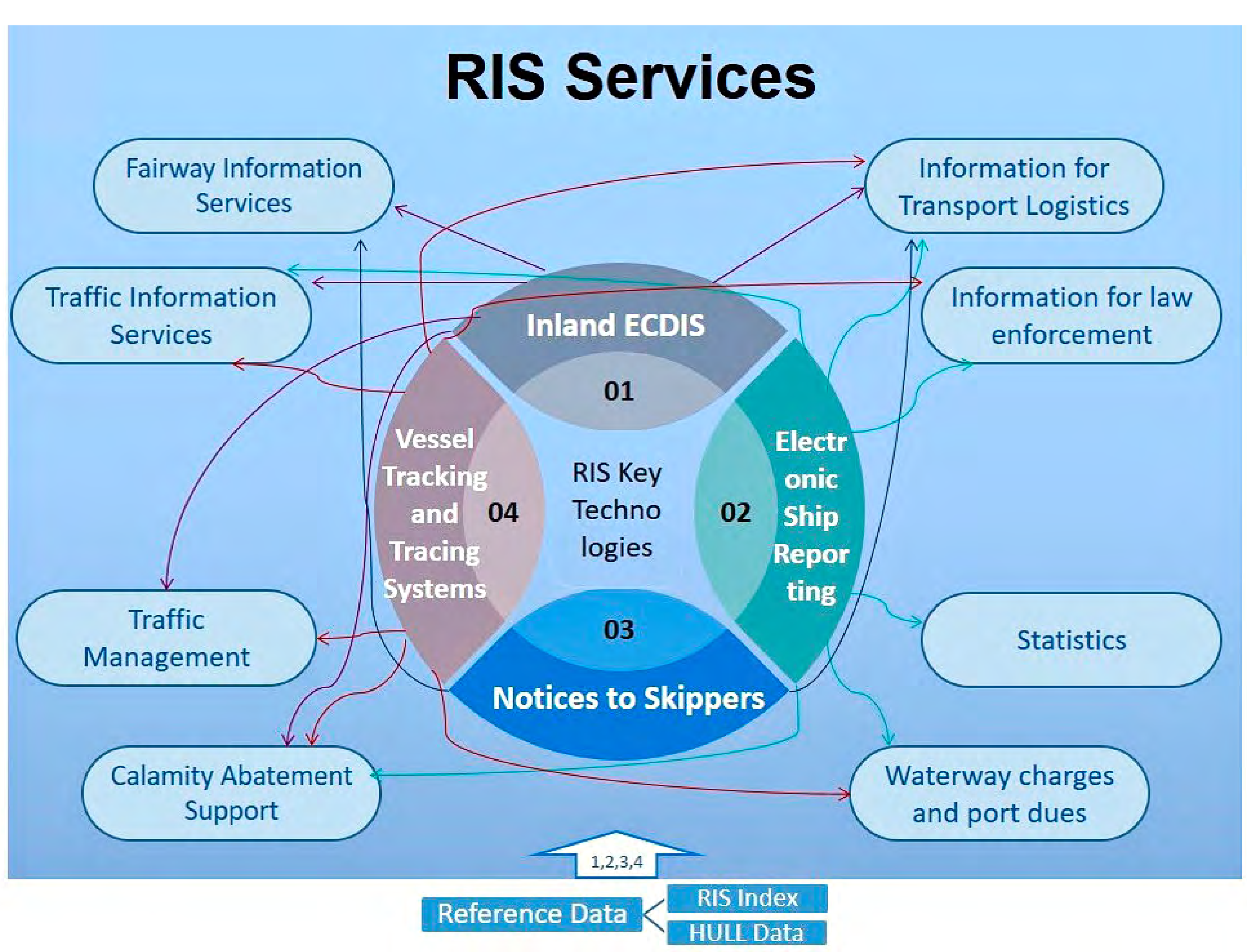

Figure 1. Graphic interpretation of RIS Key Technologies and RIS Services, and how they interact with each other (*https://www.pianc.org, modified*)

RIS includes the following systems: Inland ECDIS, Electronic Ship Reporting, Notices to Skippers, and Vessel Tracking and Tracing Systems. Each one of these technologies is distinguished by and is contributing to the efficiency of RIS, therefore, deserves a more detailed description, according to data of the European Committee for drawing up standards in the field of inland navigation (https://www.cesni.eu).

Inland Electronic Chart Display Information Service (Inland ECDIS)

Since the late 1990s, experiments have been conducted to use telematics for inland navigation support. During various research and development projects, the radar image in the skipper's wheelhouse was underlain by an electronic chart. Because of this, inland navigation became somewhat safer and more efficient. (https://www.ccr-zkr.org).

During the development of this technology, it was necessary to standardize it at the international level, to avoid any kind of difficulties in that regard. This was the reason why the already internationally presented Electronic Chart Display and Information System (ECDIS) system, which was originally developed for marine transport, is also being considered for inland navigation. The idea was to adapt the mentioned system to the new purpose and supplement it with certain characteristics, but not to change the original standard adopted by the "International Hydrographic Organization (IHO). In this way, it was possible to achieve compatibility between the original and the new system, which is important for the mouths of rivers into which seagoing ships could enter, along with river ships. (https://www.ccr-zkr.org).

Inland ECDIS has not only been adopted by NNCR, but also Danube Commission, UN-ECE, and PIANC, making it the first inland navigation standard to gain widespread international recognition (https://www.ccr-zkr.org).

This system has both information and navigation mode. **Information mode** is essentially an electronic atlas used to guide and provide information on the inland waterways. It isn't intended for vessel navigation. When connected to a navigation sensor that provides positioning information, the map can be automatically adjusted so that the position of the used vessel is fixed in the center of the screen. **Navigation mode** implies the use of this system to guide the vessel with the help of radar and certain maps. Equipment that can operate in navigation mode is classified as radar equipment. (https://www.ccr-zkr.org).

Inland ECDIS can be defined as a computer system for displaying electronic navigation charts (ENC) (Fig.2) of inland waterways, as well as additional information about the vessel's environment. (https://www.cesni.eu). The purpose of the Inland ECDIS system is to contribute to the safety and efficiency of navigation on inland waterways, reducing the burden on the skipper who operates the vessel and increasing skippers' aware-

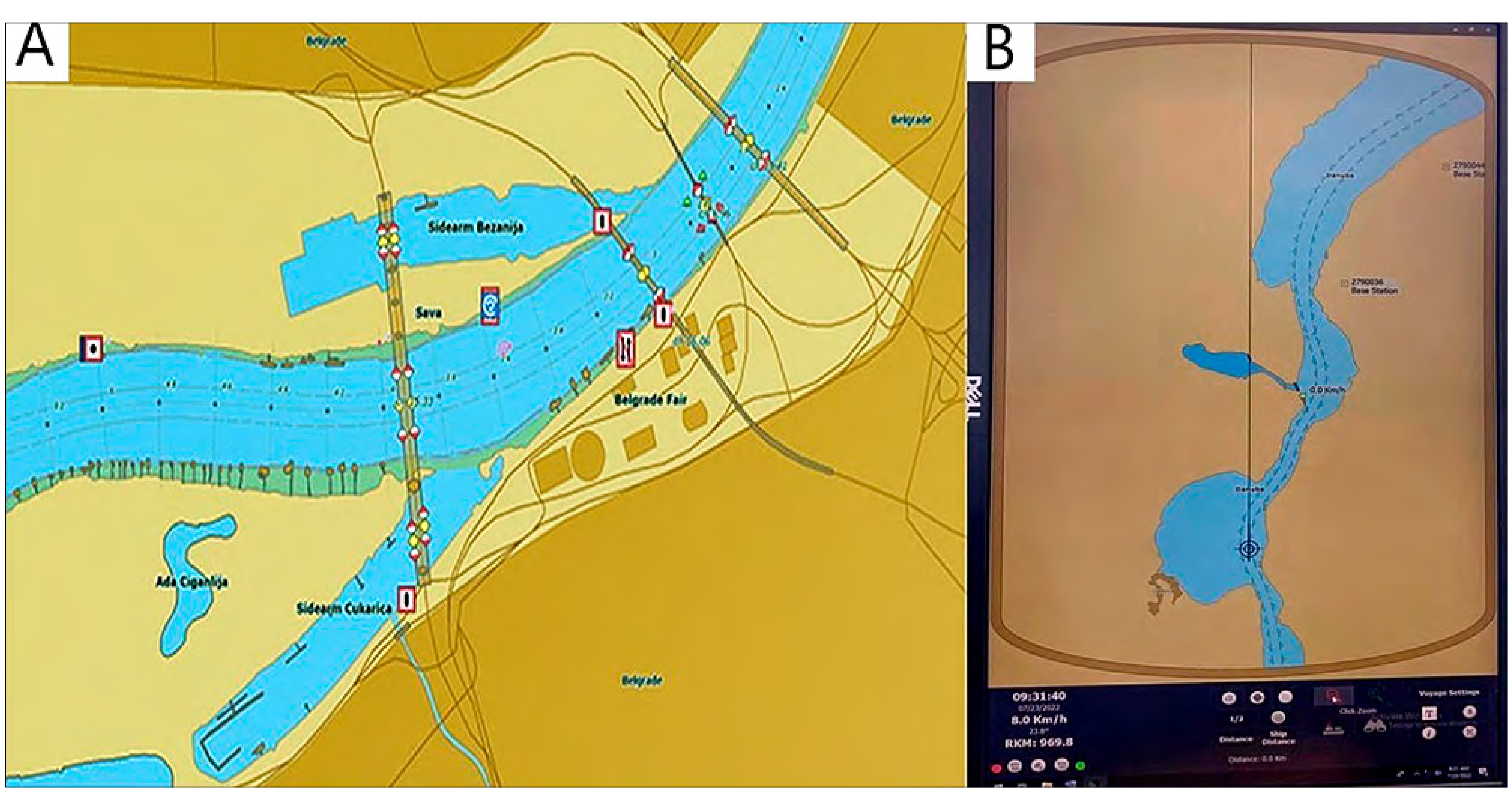

Figure 2. A) *Electronic Navigation Chart example - Danube river in Serbia(http://www.plovput.rs/electronic-navigational-charts); B)Electronic Navigation Chart example – Danube river in Serbia*
(photo by Puhar, 2022)

ness of the situation. Inland ECDIS systems combine RIS information via multiple sources such as Inland AIS equipment into a single display system (multiscreen, if available) (https://www.cesni.eu).

Electronic Ship Reporting

Electronic ship reporting and electronic messages could be viewed as a path leading to a paperless environment, in the world of inland navigation. All the necessary information is available promptly and in the right place. Messages are sent to stakeholders, to ensure fast shipments and transparent procedures with appropriate controls and simplified water transport processes (https://www.cesni.eu).

Vessel information and cargo data, which are transported over long distances, are very important for all participants in transport operations, such as authorities, port operators, emergency services, operators of ship locks, and fleet operators. The previously mentioned reasons are the reasons why an Electronic Ship Reporting system is being installed, and its purpose. (https://www.cesni.eu).

This standard, based on standards and classifications applied at the international level, defines the rules for the exchange of such electronic messages, making the repetition of messages in cross-border traffic unnecessary. Also, in this standard is introduced the "XML" specification for electronic messages used in inland waterways navigation, in response to the growing use of "XML" syntax-based systems to transmit information. (https://www.ccr-zkr.org/).

By raising questions like how to provide information from a ship to a public administration, in Europe has currently been raised a discussion, and two models have been considered (Niedzielski et al., 2021):

1. "Introducing the obligation for the master/shipowner to report all necessary information before starting a journey on a dedicated public administration platform in the country of departure. In this model international cooperation of water administrations is necessary to exchange information about the planned cross-border trip, because the idea of the ERI is that the information should be entered into the system once and the instituitions concerned receive it in a timely manner. A huge challenge for this information delivery model is the need for international exchange of often sensitive data, which is often incompatible with local data protetction regulations (e.g. in Germany)" (Niedzielski et al., 2021).
2. "Entering data into the ships systems. In this case, the ship is the source of information that is transferred to the appropriate institutions via the technical infrastructure of a given country. Each authorized institution can obtain only those from the available pool of data that it needs (e.g. different data will be provided to border guards and other data to the lock operator). This technical solution is at the initial stage of development" (Niedzielski et al., 2021).

Notices to Skippers (NtS)

State and local authorities are obliged to inform users about issues related to the waterway, which may affect their accessibility and safety. The Notices to Skippers system serves to enable communication-related to information such as the status of waterway infrastructures (i.e. bridges and locks), breakdowns on navigation aids, temporary blockades of certain waterway sectors or works on them, water level information, information on the state of ice or other hydro-meteorological phenomena. The international standard for "NtS" system provides a standardized data format that can be used either for publishing notices on the Internet (pull services) or for distribution via e-mail (push services) (https://www.cesni.eu).

Fairway Information Services (FIS) contains geographical, hydrological, and administrative data used by skippers and fleet managers to plan, execute and track voyages. FIS provides dynamic information (water levels, water level forecasting, etc.), as well as static information (regular operating time for locks and bridges, etc.), all related to the use of inland waterway infrastructure. Traditionally, the FIS provides visual aids for navigation and notification to skippers on paper or by landline. GSM-powered mobile phones have added new voice and data communication capabilities, but GSM is not available in all places at all times. Customized FIS for waterways can be "delivered" via radiotelephone services on inland waterways, over the Internet or electronic navigation charts, such as Inland ECDIS. The NtS system has been standardized to facilitate communication between users from different countries, to ensure the use of standardized vocabulary in combina-

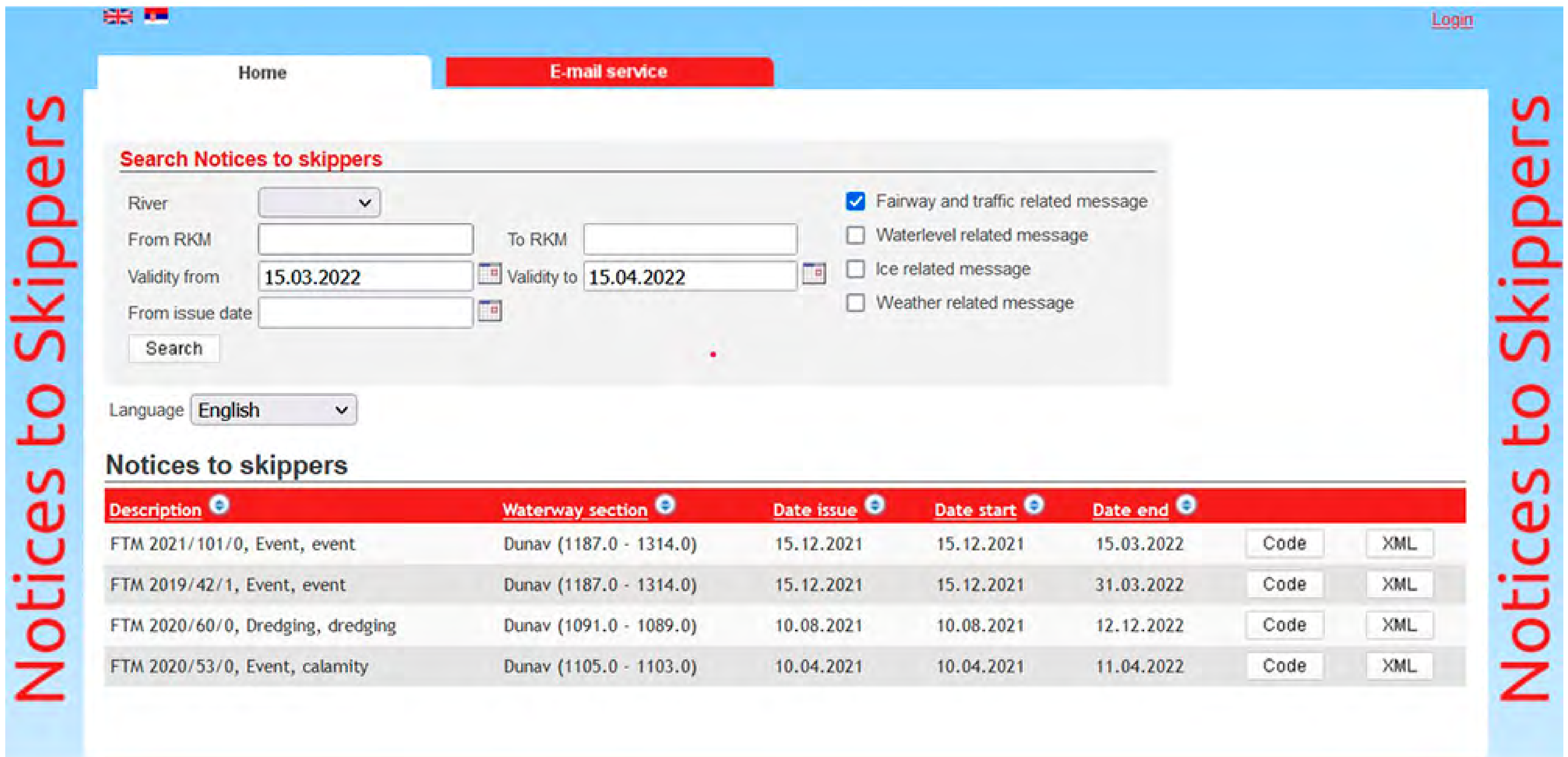

Figure 3. The interface of the Internet notification system
(*http://nts.risserbia.rs*)

tion with a list of codes, and for similar reasons introduced to facilitate safer navigation of inland waterways. (https://www.ccr-zkr.org).

In Serbia, users of waterways are provided with access to the notification system via the Internet, through the official website of the Directorate for Inland Waterways "Plovput" (http://www.plovput.rs). The interface of the Internet notification system, available in Serbia, is shown in Fig.3. A choice is offered for displaying information for the parts of the Danube, Sava, and Tisa rivers that flow through the Republic of Serbia.

Vessel Tracking and Tracing (VTT)

Vessel Tracking and Tracing (VTT) in inland navigation is an important component of the RIS system, contributing to greater safety and better efficiency of inland waterway navigation. This system supports the following: onboard navigation, Vessel Traffic Management (VTM) from shore, transport management, port infrastructure charges, etc. This exchange of information is supported by the Automatic Identification System (Inland AIS), a broadcasting system based on the transmission of high-frequency radio signals between ship AIS stations (mobile stations) and coastal AIS stations. Each type of transmission is standardized for broadcasting and receiving by Inland AIS equipment (https://www.cesni.eu).

Before the development of this system, there was an obvious need to develop and implement systems that allow for the automatic exchange of navigation data between ships and the coast. These systems support automatic identification as well as inland navigation tracking and tracing solutions. The vessel tracking function provides a consistent update of information on the status and position of the vessel, as well as some of its other characteristics, including specific cargo details. The function of locating the vessel enables the determination of its exact position. Together, these systems support the safety and smooth management of inland waterway traffic. (https://www.ccr-zkr.org).

RIS SERVICES

Functional decomposition of RIS enables the allocation of information supply in response to user demand. Proper access, assessment, processing and dissemination of information to various users are multilevel and the process can be regarded as complex one, since there are multiple stakeholders (James K., et al., 2019).

RIS Information can be differed on different information levels. Fairway information contains the data of the waterway only. Traffic information possess the information on vessels in the RIS area. Traffic information can be divided in tactical traffic information and strategic traffic information. Traffic information is provided by traffic images (IWA, 2021).

RIS Services are consisting of the following: *Fairway information service, Traffic information, Traffic management, Calamity abatement support, Information for transport logistics, Information for law enforcement, Statistical information, Waterway charges and harbour dues* (James K., et al., 2019).

Fairway information service

Fairway information consists of information regarding the geography of the navigation area, water depth contours in the navigation fairway, long term and temporary obstructions in the fairway navigational aids and traffic signs, meteorological information, restrictions caused by flood and ice, landslide and rock fill, physical constrains like locks or bridges and their operating times, navigational rules, regulations and recommendations and rates of waterway infrastructure charges. All of previously mentioned can be divided in urgent, dynamic and static categories (James K., et al., 2019).

Traffic information

The main components of traffic information are tactical and strategic information. Presentation of own vessels position and presentation of other vessels positions are of dynamic nature. Tactical traffic information makes use of radar as well as vessel tracking and tracing systems such as AIS. Strategic traffic information makes use of electronic vessel reporting systems like data base of vessel's cargo, voice and data by VHF etc. Strategic traffic information which are medium and long term related include presentation of fairway information, presentation of vessel characteristics and presentation of intended destinations which are static in nature. Presentation of vessel's position in large surroundings, medium and long term assessment of traffic situation, cargo characteristics are categorized as dynamic. Presentation of information on accidents/incidents in the coverage area is of urgent nature and requires immediate action (James K., et al., 2019).

Traffic management

Vessel traffic services (VTS) center is doing traffic management and emphasis is given to traffic organization considering the local difficult situations such as narrow fairways, narrow bridges, faster water currents, bends, etc. Presentation of vessel's position in large surroundings, monitoring of passing and maneuverings arrangements, short term assessment of traffic situations and organization and regulation of traffic flow in RIS coverage area of dynamic nature and has to be updated real-time (James K., et al., 2019).

Calamity abatement support

Before the vessel's voyage, it is needed for vessel to register at the RIS center. During the voyage, transport data are uploaded and updated. In case of accidents details will be communicated to the emergency services without delay. Vessel master shall provide the required data. The vessel should be provided with appropriate means of communication. The vessel's position and data should be reported while entering and leaving the RIS area and also at specified reporting points within the RIS area, and any change in data should be reported. If there are any stoppages for longer periods, report should be sent at the commencement and end of the stoppage period. This information is of urgent nature (James K.., et al., 2019).

Information for transport logistics

Transport logistics management consists of: transport management (deals with presentation of estimated time of arrival of vessels - ETA), intermodal port and terminal management (deals with required time of arrival of the vessels - RTA), cargo and freight management (deals with information on fleet of vessels and characteristics of theirs and cargo transported) (James K., et al., 2019).

Information for law enforcement

Law enforcement makes sure that residents of a particular jurisdiction follow its law. When crossing national borders and completing obligatory procedures like immigration, custom clearance, etc., vessel operators must abide by local regulations. Information for law enforcement (ILE) covers cross border management, immigration of personnel etc. This information are of static nature (James K., et al., 2019).

Statistical information

This kind of freight statistics data is typically needed for tracking, benchmarking, and logn-term planning. In order to take future statistical analysis, canal authorities should observe and record the transit of vessels, as well as their type, capacity, cargo, and other data, at specific places of the waterway (such as locks and ports). This data are time dependant and therefore dynamic in nature (James K., et al., 2019).

Waterway charges and harbour dues

Waterway charges and harbour dues which are usually of a static nature and are also informed through RIS centre. Communication has to be sent to the affected parties if there are changes in the waterway charges. Vessel masters, lock and bridge operators, waterway authorities and cargo shippers are the main users (James K., et al., 2019).

RIS IN SERBIA

River Information Systems, as they represent the future of inland waterways transportation innovations, in technological terms, provide many benefits from their use, which has already been discussed. So, Serbia, through which important European rivers flow, of which the Danube is especially important (represents the Pan-European Corridor VII), and the Sava, only on 06.06.2017. became an observer country at the European Committee for the Standardization of Inland Waterways (CESNI). This, of course, is a step forward that leads to better inland waterways integration and easier traffic connections with the member states of CESNI.

For RIS implementation, a quite important role has GIS (geographic information systems), because both of them share the main object of interest – geospatial data. Since GIS represents a computer system for capturing, storing, querying, analyzing, and displaying geospatial data, and given that geospatial data describe the location and attributes of spatial features, the link between RIS and GIS can be highlighted (Chang, 2017).

RIS IMPLEMENTATION ON DANUBE

The Danube, as one of the most important rivers in Europe, and partly flowing through Serbia, provides a great potential for economic development, especially for cities locates on the banks of the Danube.

The Danube is navigable in the length of 2.414 km, and then navigation continues along the Danube-Main canal and further downstream on the Rhine to the port of Rotterdam on the North Sea coast. The Danube is navigable throughout its whole length in Serbia. On the territory of Serbia, the Danube enters 8km upstream from Bezdan at 80 m.a.s.l., and leaves Serbia at the mouth of the Timok river at 30 m.a.s.l. (Gavrilović, Dukić, 2014).

As already mentioned, the responsible entity that deals with the implementation of RIS on waterways in Serbia is the Directorate for Waterways “Plovput”, situated in the capital of Serbia, Belgrade. Taking this into account, within the analysis of the state of RIS implementation on the Danube, it is quite logical to use the official information of “Plovput” about the implementation of RIS on the Danube as the main source of the current situation.

According to information publicly available on the official website of “Plovput”, Electronic Navigation Charts (ENC) has been developed in “Plovput” for the entire course of the Danube (590km) and Tisa (160km)

Figure 4. The Danube, an international waterway
(*https://www.viadonau.org*)

rivers through Serbia, following the "Inland ECIDS" standard. Four base stations for monitoring navigation have been set up on the Danube (Belgrade, Novi Sad, HPP "Djerdap 1", HPP "Djerdap 2"), which covers over 200km of the river. At the end of 2007, the RIS center started operating, from which ships are located and monitored in real-time. One of the services that "Plovput" provides to inland waterway users is the Notices to Skippers system. (http://www.plovput.rs/implementation-of-river-information-services-on-danube-river-in-serbia).

About initiative meeting and first steps towards implementation of RIS on the Danube can be found on the official website of "Plovput": „ Kick-off meeting for the project "Implementation of River Information Services on the Danube River in Serbia" was held on September the 18th 2009, in facilities of the Delegation of the European Commission in Belgrade. Representatives of a Delegation of the European Commission in Belgrade, Plovput (beneficiary of the project and future RIS operator in Serbia), and a consortium led by Selex Sistemi Integrati (a company that will perform system integration), took part in the meeting. Also, a consortium led by ic Consulenten Ziviltechniker gmbh (a company which will be in charge of supervision on Implementation of RIS on the Danube River in Serbia) participated at the meeting." (http://www.plovput.rs/implementation-of-river-information-services-on-danube-river-in-serbia).

The same source states the following about the project: „Implementation of the project Implementation of River Information Services in Serbia, financed from IPA 2007, started in 2009, and lasted until 2014. The result of this project is an operational RIS system, consisting of sub-systems for tracking and tracing of vessels (15 base stations), notices to skippers, voyage planning, correction of GDP signal according to IALA standard,

Figure 5. Display of the „DanubeGIS" platform
(*https://www.danubegis.org/*)

etc. Having in mind its concept and design, the RIS system in Serbia is one of the most sophisticated systems on the whole stretch of the Danube River.” (http://www.plovput.rs/implementation-of-river-information-services-on-danube-river-in-serbia).

The Directorate for Inland Waterways “Plovput” is an assignee of the project “Implementation of River Information Services in Serbia” (http://www.plovput.rs/implementation-of-river-information-services-on-danube-river-in-serbia).

The “Danube GIS” platform is very useful, both for the analysis of various conditions on the river and for the general insight into the Danube river system (Fig.5). This platform is available for free use and provides access to data and maps for the entire Danube basin.

RIS IMPLEMENTATION ON SAVA

Sava River has a total length of 945 km, of which 207 km flows through Serbia, and the total drop in the flow through Serbia is 8,71 m, where it represents a typical plain river. The Sava enters Serbia near the village of Jamene, in the Srem District of the autonomous province of Vojvodina (Gavrilović, Dukić, 2014).

Regarding the implementation of RIS on the Sava River, the Directorate for Waterways of “Plovput” is also responsible for this endeavor. The “Plovput” project whose main goal is the implementation of RIS on the Sava River, is entitled “Detailed design and installation of prototype for river information services on the Sava River”, and contains the following items and description: „The objective of the project is the preparation of design and tender documentation for implementation of RIS on the Sava River. This project should serve as the basis for the harmonized implementation of RIS aligned with measures already taken on the Danube River in Serbia and Croatia, and aligned with EU RIS Directives. Implementation of RIS on the Sava River aims to improve safety and efficiency of inland navigation, as well as to protect the environment.“ (http://www.plovput.rs/implementation-of-river-information-services-on-sava-river).

Specific activities of the project, according to the Directorate for Waterways “Plovput” (http://www.plovput.rs/implementation-of-river-information-services-on-sava-river), include:

- “Evaluation of up to now implementation of RIS on the Danube and Sava rivers in Serbia and Croatia;
- Preparation of detailed design for RIS system, including possible phases of implementation with an assessment of costs;
- Performing field survey for configuration of the proposed AIS base stations network;

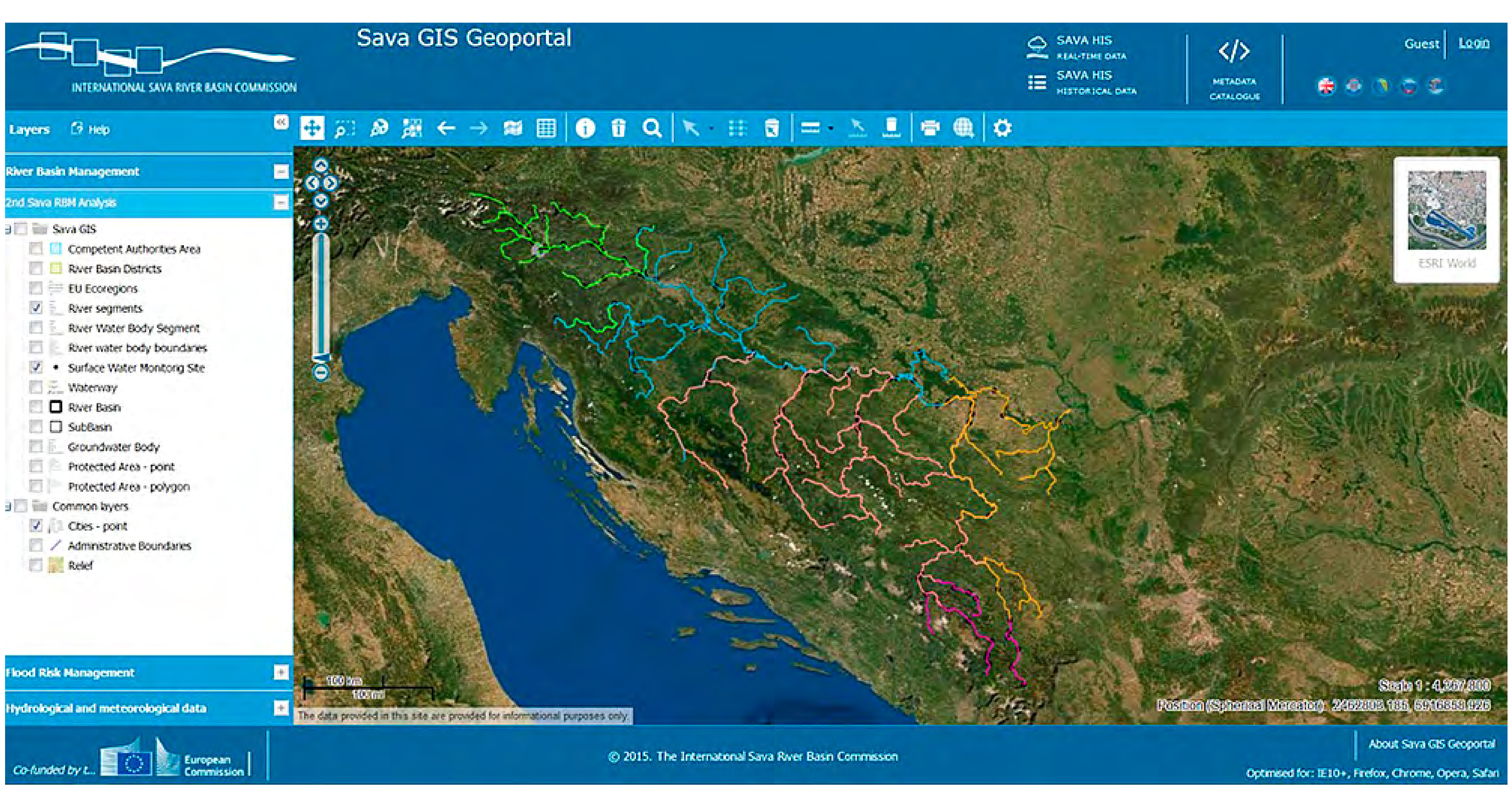

Figure 6. “Sava GIS Geoportal” platform interface
(*https://www.savagis.org*)

– Harmonizing monitoring for the proposed system with at least three EU member countries, as well as with Serbia and Croatia (for Sava and Danube rivers);
– Assessment of costs for implementation of the proposed RIS system;
– Preparation of implementation plan for the proposed RIS system;
– Preparation of technical specifications for implementation of the proposed RIS system;
– Preparation of tender documentation for implementation of the proposed RIS system;
– Preparation of Environmental Impact Assessment for implementation of RIS on the Sava River."

The Directorate for Waterways "Plovput" is a member of the international consortium that is implementing this project (http://www.plovput.rs/implementation-of-river-information-services-on-sava-river).

As with all hydrological research objects, geographic information systems can greatly help river research from a variety of perspectives. The already mentioned ease in exploring the Danube, in the form of "Danube-GIS", has its counterpart for the Sava River, and that is the platform "Sava Gis Geoportal" (Fig.6). On this platform, among other things, it is possible to have a more detailed view of the watercourse sector, the Sava waterway, the river basin and the like.

CONCLUSION

Given the almost limitless benefits that can come from using information technology in almost every aspect of human life, and especially in the economy, it's easy to see why the same approach needs to be employed in inland waterway transport. Similar to other types of traffic waterway transport necessitates information exchange that is most efficiently provided by RIS concept. The main benefit of RIS is that it makes traffic on inland waterways safer and more efficient, which is exactly what was said to be one of the benefits. It's also necessary to discuss the link between RIS and GIS, since both of them work with geospatial data in a certain manner. Legal regulations that accompany and support each of the RIS technologies are an important asset. The Inland Electronic Chart Display Information Service (Inland ECDIS), Electronic Ship Reporting, Notices to Skippers (NtS), and Vessel Tracking and Tracing (VTT) technologies are also the core components of RIS. Each of these unique technologies adds to the efficiency of RIS differently.

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