

Original scientific article

# BIBLIOMETRIC MAPPING OF URBAN ECOLOGY AND URBAN DECLINE (2010–2024): TRENDS, THEMES AND NETWORK STRUCTURES

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Received: February 10, 2025 | Accepted: May 23, 2025

DOI: [10.5937/ZbDght2501048P](https://doi.org/10.5937/ZbDght2501048P)

## ABSTRACT

*This study presents a bibliometric mapping of research on urban ecology and urban decline from 2010 to 2024, identifying key publication trends, thematic structures, and network dynamics. Although a significant increase in research output was hypothesized, the Mann–Kendall trend test ( $p = 0.262$ ) did not confirm a consistent upward trend. Sub-period analyses also showed no significant monotonic patterns, though publication peaks in 2014, 2018, and 2021 suggest research surges linked to global and European initiatives. VOSviewer cluster analysis highlighted dominant themes centred on spatial and demographic aspects of decline, such as brownfields and land use, shifting after 2016 toward ecological, participatory, and community-focused approaches. Overlay visualizations indicate a move from descriptive to interventionist frameworks, reflecting changes in urban policy. Co-authorship and citation networks reveal the central role of European institutions, especially German researchers, in shaping the field. Scholars like Dagmar Carole Haase serve as key nodes in interdisciplinary collaboration. Despite thematic fragmentation, citation patterns suggest conceptual convergence around critical-interpretive and techno-ecological paradigms. Overall, the findings show a growing integration of transdisciplinary perspectives in line with sustainable urban transformation goals.*

**Keywords:** urban ecology; urban decline; urban shrinkage; bibliometric analysis; VOSviewer; Mann–Kendall test

## INTRODUCTION

Contrary to the global dominance of urban growth, urban development represents a complex process encompassing not only expansion (urban sprawl) but also the phenomenon of urban decline (Mykhnenko, 2023). Cities, which today host more than 55% of the world's population and generate over 80% of the global GDP (World Bank, 2023), simultaneously serve as hubs of economic productivity and hotspots of socio-ecological tensions. As contemporary cities often extend beyond their administrative boundaries during spatial expansion (Savić et al., 2022; Đerčan et al., 2019), and their development depends on the external mobilization of resources mediated by human activities as the dominant factor within urban ecosystems (Hickel et al., 2022), their environmental impact becomes increasingly pronounced and complex (Norrman, 2023). Although research in the field of urban ecology is predominantly focused on the processes of urban growth (Wilhelm Stanis et al.,

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2024), and traditional approaches to urban development continue to view it through the lens of expansion, there is a growing need to conceptually broaden the framework of urban ecology to include scenarios of contraction and depopulation (Tang et al., 2022; Hirt & Beauregard, 2019). Phenomena such as “shrinking cities” and “legacy cities” (Patra et al., 2018; Li & Mykhnenko, 2018) are spatially manifested through abandoned and dysfunctional zones, degradation of urban morphology and infrastructure, as well as the erosion of social fabric and institutional networks (Syssner, 2022). In the literature, the terms urban decline, urban shrinkage, and shrinking cities are often used interchangeably. For the purposes of bibliometric search strategy, all these terms were considered, but to ensure terminological consistency and readability, the term *urban decline* will be used throughout this study. This term encompasses the combined processes of demographic decline, economic stagnation, spatial degradation, and institutional erosion in urban environments (Mykhnenko, 2023; Haase et al., 2014). In the contemporary urbanization context, increasing attention is being paid to concepts such as green infrastructure and brownfield revitalization as means for transforming and reorganizing urban space (Cuthbert, 2017; Pinoncely, 2022; Masood & Russo, 2023). Sivak et al. (2021) note that vacant lots often remain excluded from both social and ecological functions. Urban regeneration is increasingly recognized as a key mechanism for sustainable urban development, focusing on the gradual integration of abandoned spaces into the urban fabric to enhance their social and ecological functions. Haase et al. (2014) emphasize that these globalization-driven processes deepen regional disparities and reduce the vitality of urban areas, particularly affecting small and medium-sized cities, where nearly half of the world’s urban population resides (Aoki, 2024; Besbris et al., 2024; Mujević, 2024). In the European context, nearly 45% of larger cities have already experienced or are still undergoing urban decline (Haase et al., 2014), while every fifth city has experienced population and spatial loss, according to the CIRES project conducted between 1990 and 2010 (Wolff & Wiechmann, 2018). Regionally, declining cities have emerged as a significant urbanization model, as confirmed by numerous studies in Belgium, France, the Netherlands, Romania, and Serbia (Segers et al., 2020; Augis et al., 2025; Hoekstra et al., 2020; Țăruș et al., 2022; Đerčan et al., 2017; Pogrmic et al., 2024). From the perspective of urban ecology, which views the city as an integrated socio-ecological system, the European Commission’s *Cities of Tomorrow* report (2011) highlights the growing disconnection between administrative boundaries and the actual physical, social, and ecological structures of European cities. This calls for a shift toward flexible, territorially integrated, and ecologically sustainable governance models (Ročak et al., 2016; Zhao et al., 2023). Urban policy strives to promote social cohesion, equitable housing, and the preservation of urban ecosystems, yet by the early 2010s, it was already facing a crisis (Geissdoerfer et al., 2017; Beunen et al., 2020; Khmara & Kronenberg, 2023; Cimbalević & Dunjić, 2023). Economic instability, social polarization, and the degradation of urban ecosystems have weakened the ability of cities to meet sustainability principles (Segers et al., 2020; Jiang et al., 2022; Grundel & Magnusson, 2023). In this context, Verma et al. (2020) emphasize the concept of the “ecology of the city,” which goes beyond the traditional study of nature in the city and instead integrates natural, social, and institutional flows to enable understanding and sustainable management. The emergence of “smart decline” or “planning for less” strategies (Yang et al., 2024) indicates a shift in urban policy away from rigid models of unconditional growth toward more adaptive restructuring approaches.

Although there is an extensive body of literature separately addressing urban ecology and the phenomenon of urban decline (Du & Li, 2017), there remains a notable lack of integrated studies that systematically examine their interconnection, the impact of these processes on contemporary urban development, and their strategic implications for formulating and implementing urban policies. The insufficient theoretical articulation of the relationship between urban ecology and urban decline limits the analytical applicability of existing ecological models for studying declining cities, opening the space for a re-examination of their foundational premises. Previous conceptual frameworks in urban ecology have primarily focused on the challenges of urban growth—such as resource overuse, pollution, and biodiversity loss—while their application to urban decline, defined through demographic decline, deindustrialization, and spatial degradation, remains limited (Hartt, 2020; Stanford et al., 2022; Srinivasan & Yadav, 2023). Recent research indicates growing academic interest in both phenomena, with a marked increase in published works after 2008 (Verma et al., 2020). Howev-



er, synthetic studies that bridge these areas into a conceptually and analytically coherent framework are still lacking (Wu et al., 2023). Bibliometric analysis is increasingly employed as a tool for mapping thematic trends and research networks in this domain. For example, Wu et al. (2022) analyse the concept of shrinking cities in the context of post-industrial transformation. More recent studies have expanded this analytical framework toward smart decline, ecological restoration, and adaptive urban restructuring (Yang et al., 2025; Zhang et al., 2023). This research covers the period from 2010 to 2024, a time of notable expansion in scientific output related to these themes. Nevertheless, integrated studies that connect urban ecology, ecosystem services analysis, and urban decline into a unified analytical model capable of addressing the complexity of modern urban challenges remain scarce.

The main contribution of this study lies in the systematic bibliometric analysis that jointly addresses scientific production in the fields of urban ecology and urban decline from 2010 to 2024. The analysis begins with the application of the Mann–Kendall test to assess trends in the overall number of publications during this period, as well as the results of a separate trend analysis within three sub-periods (2010–2014, 2015–2019, 2020–2024), allowing for a more precise understanding of the dynamics of scholarly interest. Subsequently, methods such as keyword clustering, temporal dynamics analysis, and co-authorship and citation network mapping are applied, contributing to a deeper understanding of the structure, thematic directions, and evolutionary trajectories of these interrelated but often separately treated scientific domains. This study thereby expands the analytical scope of urban ecology and lays the groundwork for developing an integrated research framework that connects ecological sustainability, socioeconomic vitality, and spatial transformation of contemporary cities.

## Research Hypotheses

Starting from the growing academic interest in urban ecology and urban decline—particularly in the context of climate change, spatial degradation, and social inequality—this study poses the question of whether such increasing attention is reflected in the volume of scientific publications over the past decade. One would expect that heightened research activity would result in a steady increase in relevant scientific output. The decision to formulate hypotheses stems from the need to empirically test this theoretically grounded expectation using objective statistical methods.

Accordingly, the following hypotheses are formulated:

- **H<sub>0</sub>1:** There is no statistically significant monotonic trend in the number of scientific publications in the field of urban ecology and urban decline between 2010 and 2024.
- **H<sub>1</sub>1:** There is a statistically significant monotonic trend in the number of scientific publications in this field during the 2010–2024 period.
- **H<sub>0</sub>2:** None of the observed sub-periods (2010–2014, 2015–2019, 2020–2024) exhibit a statistically significant monotonic trend in the number of scientific publications.
- **H<sub>1</sub>2:** At least one of the observed sub-periods shows a statistically significant monotonic trend in the number of publications.
- **H<sub>0</sub>3:** In the literature on urban ecology and urban decline from 2010 to 2024, dominant themes are related to spatial aspects of urban decline, such as land use, brownfields, abandoned urban areas, and vacant lots.
- **H<sub>3</sub>1:** In the 2010–2024 period, research shows a shift from predominantly demographic-spatial themes to ecological and participatory aspects of urban development.
- **H<sub>4</sub>:** Between 2010 and 2024, research collaboration in this field has been organized through stable networks of scientific teams linked through European and international initiatives.
- **H<sub>5</sub>:** In the same period, the structure of scientific production is characterized by stable and interdisciplinary networks of influential researchers, reflected in their centrality within co-authorship and citation networks.

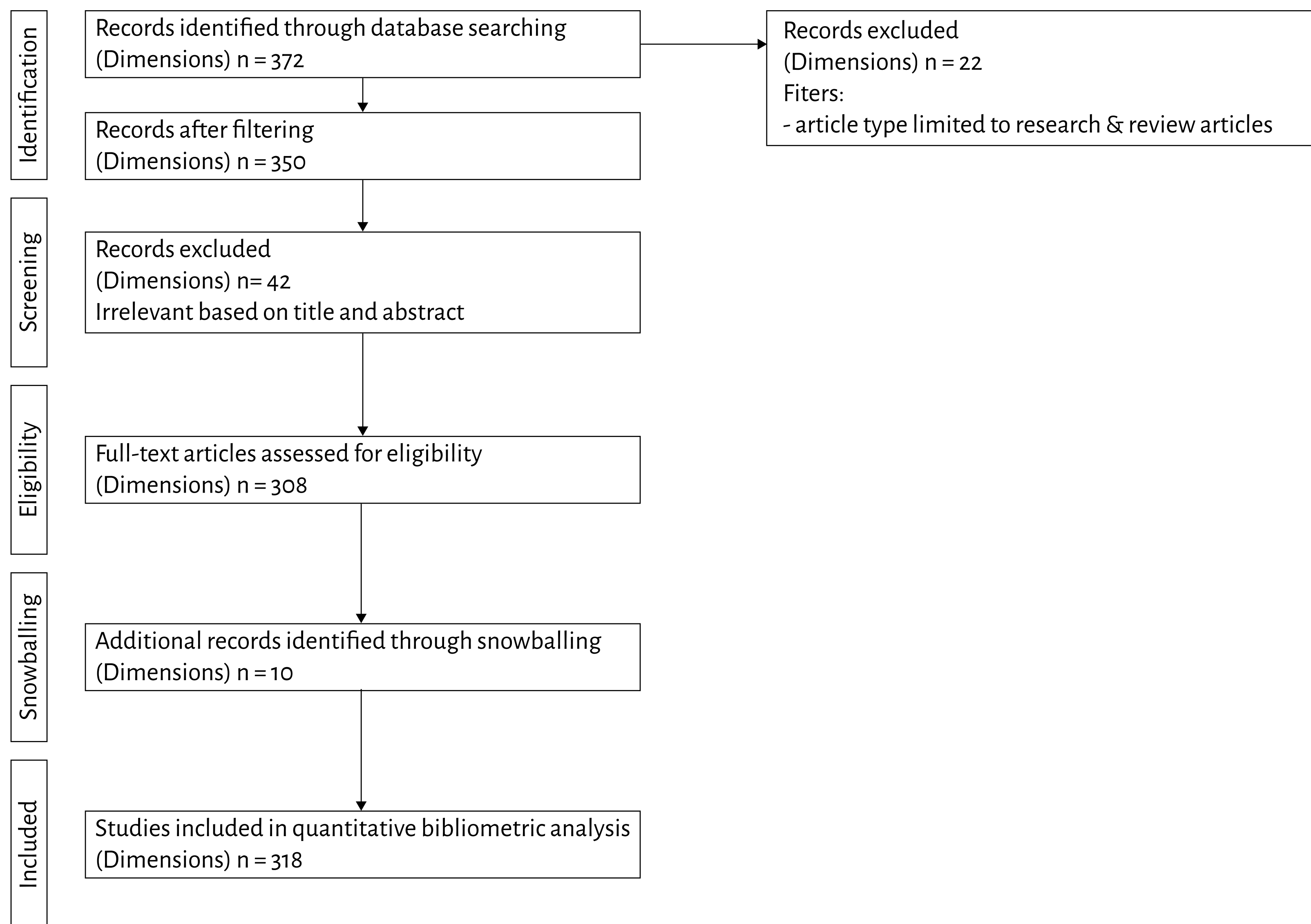


## METHODOLOGY

This study employs bibliometric and statistical techniques to analyse trends, thematic structures, and network connectivity within the scientific production related to urban ecology and urban decline. The time frame from 2010 to 2024 was selected to identify evolutionary patterns in research and includes the most recent five-year period (2020–2024), in line with current practices in bibliometric studies focused on the assessment of the contemporaneity of scientific discourse. The research was conducted in three phases: collection of relevant literature, content and contextual analysis of publications, and application of quantitative tools for bibliometric evaluation of scientific output. The primary data source was the *Dimensions* database, selected for its breadth, interdisciplinary coverage, and open accessibility. Data were downloaded in RIS format, initially processed in Microsoft Excel for the application of the Mann–Kendall test and then imported into *VOSviewer* software for the visualization of thematic clusters, co-authorship networks, and temporal dynamics of key terms (Eck & Waltman, 2023; Kirby, 2023; Pascariu et al., 2023). The literature search was finalized on June 1, 2025. In line with the thematic focus of the study, which explores the relationship between urban ecology and urban decline, the key search terms included “urban ecology,” “urban decline,” and “urban shrinkage,” given their frequent interchangeable use in relevant literature. Using the Boolean operator AND, the search was conducted with the query: “urban ecology” AND (“urban decline” OR “urban shrinkage”), with the requirement that “urban ecology” appear in the title or abstract, and at least one of the remaining two terms be additionally present. After filtering by publication type (peer-reviewed research and review articles), language (English), and manual relevance check, a final and thematically consistent set of publications was obtained, serving as the basis for further analysis.

### *Data Collection*

The literature selection process was conducted in accordance with the principles of systematicity, transparency, and reproducibility, and included five consecutive steps. The initial search in the *Dimensions* database identified 372 records. In the second step, a filter was applied by article type—only research and review articles were included, while conference abstracts, editorial notes, and non-peer-reviewed formats were excluded—reducing the dataset to 350 records. The third step involved manual screening of titles and abstracts, which resulted in the exclusion of 42 irrelevant records, leaving 308 full-text articles for eligibility assessment. In the fourth step, the *snowballing* method was applied, through which 10 additional influential articles were identified based on their frequent citation within the selected corpus. The final dataset included 318 publications, forming a thematically consistent and methodologically robust basis for further bibliometric analysis.



**Figure 1.** Flow-chart of the literature selection and review process using initial keywords and Dimensions database

## Bibliometric Analysis

To analyse publication trends, the non-parametric Mann–Kendall test was applied, which allows for the detection of monotonic trends in time series data without assuming a normal distribution. The analysis covered the entire period from 2010 to 2024, as well as three defined sub-periods, enabling a more precise assessment of the dynamics of scientific interest in the studied topic.

The bibliometric analysis was conducted using *VOSviewer* (version 1.6.20). Term co-occurrence analysis was performed to identify thematic clusters (with minimum occurrence thresholds); temporal dynamics of terms were examined through overlay visualization to track the evolution and topicality of research themes; co-authorship networks were analysed to identify leading researchers and research groups; and author citation analysis was conducted to assess scientific impact. The results were presented in the form of network maps, with colours indicating clusters, node size representing frequency or citation count, and link thickness reflecting the strength of interconnections.



## RESULTS

### Publication Trends

Using the *Mann–Kendall* test, a time series analysis was conducted for indicators related to urban ecology and urban decline over the period 2010–2024 (Table 1). The *S* statistic was 48, indicating more positive than negative pairs in the dataset. The normalized *Z* value was 1.12, while the *p*-value was 0.262, which exceeds the significance level of  $\alpha = 0.05$ . Therefore, no statistically significant monotonic increasing trend was detected in the number of publications in the field of urban ecology and urban decline during the observed period. Although a trend may exist in practice, it was not confirmed statistically at the 5% significance level. Based on the obtained results, there is insufficient evidence to reject the null hypothesis ( $H_01$ ), which states that there is no statistically significant monotonic trend; thus, the null hypothesis is retained in this case. Accordingly, the alternative hypothesis ( $H_11$ ), which assumes the existence of a statistically significant monotonic trend, is not supported.

**Table 1.** Results of the Mann–Kendall test for trend analysis in the number of publications in the field of urban ecology and urban decline (2010–2024)

Indicator	Value
<i>S</i> statistic	48
<i>Z</i> statistic	1.12
<i>p</i> -value	0.262
Significance level ( $\alpha$ )	> 0.05 → trend not statistically significant

**Table 2.** Results of the Mann–Kendall test for trend analysis in the number of publications across three sub-periods (2010–2024)

Period	<i>S</i> statistic	<i>Z</i> statistic	<i>p</i> -value	Significance level ( $\alpha$ )
2010–2014	8	1.315	0.19	< 0.05
2015–2019	5	0.98	0.33	> 0.05
2020–2024	-6	-1.70	0.09	> 0.05

Based on the results presented in Table 2, three sub-periods within the overall time frame of 2010–2024 were analysed to assess the validity of the supplementary hypotheses ( $H_02$  and  $H_12$ ). In each of the observed segments (2010–2014, 2015–2019, 2020–2024), no statistically significant monotonic trend was identified in the number of scientific publications, as all *p*-values exceeded the significance threshold of  $\alpha = 0.05$ .

In the first sub-period (2010–2014), the *p*-value of 0.19 suggests a slight positive trend, though it lacks statistical significance. Similarly, the second period (2015–2019) also shows a weak upward trend ( $p = 0.33$ ), indicating a relatively stable phase without notable growth. In the third sub-period (2020–2024), the *p*-value of 0.09 points to a negative tendency, which, although closer to the significance threshold, also remains statistically insignificant. Accordingly, there is no basis to reject the null hypothesis  $H_02$ , which posits that none of the sub-periods exhibit a statistically significant monotonic trend. The alternative hypothesis  $H_12$ , which assumes that such a trend is present in at least one segment, is not supported by the findings. Nevertheless, the direction of the *S* and *Z* statistic values indicates subtle shifts in the dynamics of scientific output—from a slight increase, through stability, to a potential decline.

## Key Research Themes

To analyse the key research themes in the field of urban ecology and urban decline, bibliometric data were retrieved from the Dimensions database and imported into the VOSviewer software in RIS format.

## Data Processing and Selection

In constructing the term co-occurrence map, a threshold of at least 11 occurrences was applied to ensure a balance between comprehensiveness and clarity. This threshold was chosen in line with VOSviewer's recommended guidelines, as it reduces the number of displayed terms to a manageable range of 100 to 150 of the most relevant ones, thus achieving a suitable compromise between network density and readability. Out of a total of 7,954 identified terms, 151 met the frequency criterion, forming the initial corpus for further analysis.

In the next step, a relevance score was calculated for each term, based on a combination of frequency, network centrality, and conceptual uniqueness. According to the default threshold of 60%, the analysis included the 91 most relevant terms. Following final filtering, three terms (*view*, *construction*, *culture*) were excluded due to a lack of meaningful connections with other terms, which could have disrupted the structure of the network. The final number of terms included in the analysis was 88.

## Map Structure and Clustering

Based on the co-occurrence analysis of the selected terms, a network was generated comprising 3,180 links with a total link strength of 9,310, indicating a strong thematic interconnectedness within the corpus. Through automatic clustering, the terms were grouped into four thematic clusters, each marked with a distinct colour:

- Cluster 1 (red): Urbanization, urban dynamics, and demographic decline ( $n = 31$  terms)
- Cluster 2 (green): Community, social aspects, and participation ( $n = 26$  terms)
- Cluster 3 (blue): Nature, ecological concepts, and green infrastructure ( $n = 24$  terms)
- Cluster 4 (yellow): Interdisciplinary terminology and high-level abstract concepts ( $n = 7$  terms)

## Visualization Features

The resulting map (Figure 2) displays 88 term nodes distributed across four thematic cores. Node size reflects the frequency of occurrence, while colour indicates cluster affiliation. This type of visualization enables the identification of structural patterns in scientific production related to urban decline and urban ecology.

The analysis of the term co-occurrence map confirms hypothesis H<sub>03</sub>. Spatial aspects of urban decline—such as brownfield sites, land use, abandoned areas, and underutilized plots—emerge as key terms in the scientific literature. Their high frequency and interconnectedness within the largest thematic cluster indicate their dominant role in research conducted between 2010 and 2024. The red cluster, being the largest and most conceptually consistent, brings together precisely these terms, thereby directly supporting the hypothesis.



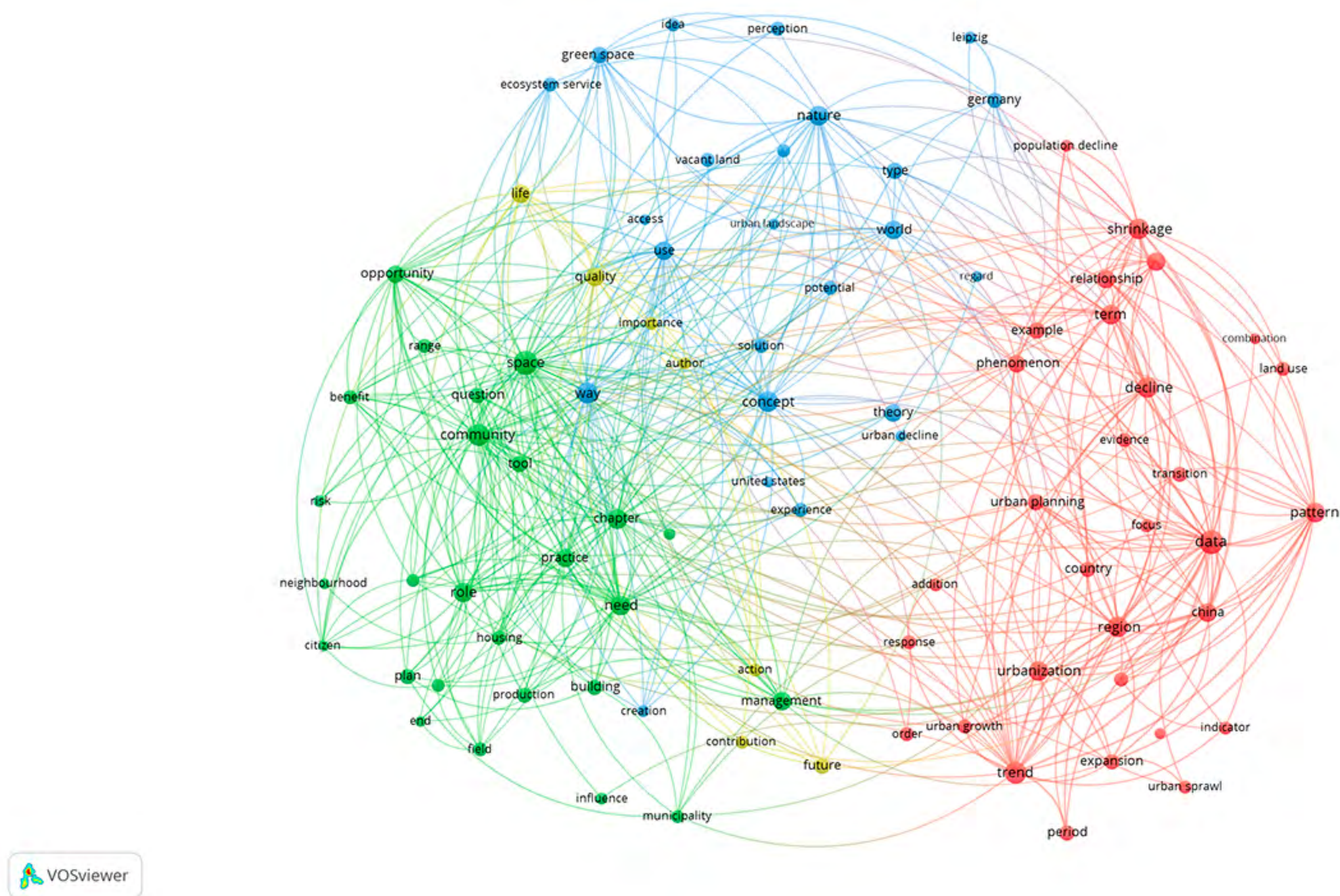


Figure 2. VOSviewer co-occurrence map of terms in research on urban decline and urban ecology (2010–2024)

### Temporal Analysis of Research Themes (Overlay Visualization)

As part of the analysis of terminological dynamics, the Overlay Visualization function in VOSviewer was applied, where the colour of nodes represents the average year of term occurrence in the scientific literature. Older terms are shown in shades of blue, while newer ones appear in a spectrum ranging from light green to yellow.

It was observed that during the period 2010–2015, terms such as *urban decline*, *population decline*, *shrinking*, *Germany*, *Leipzig*, and *urban sprawl* were dominant, indicating an early focus on demographic and spatial planning aspects of urban decline, particularly in the Western European context.

In contrast, in the more recent period (2018–2024), terms such as *green space*, *ecosystem service*, *nature*, *vacant land*, and *urban landscape*, along with *community*, *participation*, *practice*, and *citizen*, have become increasingly prominent. Their central position in the network points to a thematic shift toward ecological and participatory aspects of urban decline and development (Figure 3).

Hypothesis H<sub>3</sub>1, which posits that from 2010 to 2024, research on urban decline and urban ecology evolved from demographic-spatial to ecological and participatory themes, is empirically confirmed by the temporal analysis of term co-occurrence.







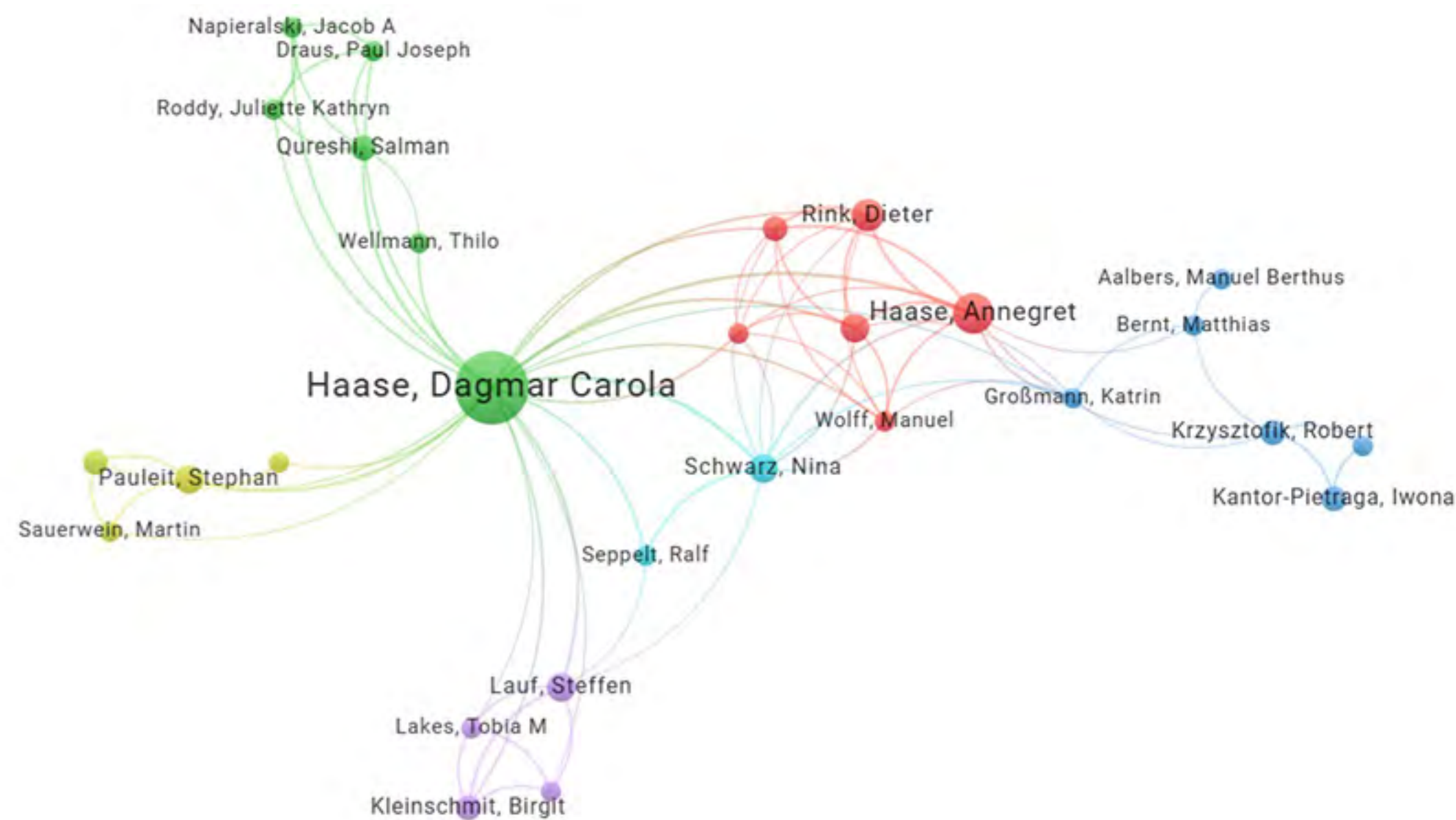


Figure 4. VOSviewer co-authorship map of researchers in the field of urban ecology and urban decline (2010–2024)

### Citation Analysis Results

In order to identify the most influential researchers in the field of urban ecology and urban decline, a direct citation analysis was conducted. A total of 68 authors who met the minimum thresholds in terms of the number of published papers and total received citations in the period from 2010 to 2024 were included in the analysis.

The analysis identified 274 citation links and 551 citations in total, indicating a moderate to high level of mutual academic recognition within the field. Researchers were grouped into ten thematic clusters, reflecting the presence of multiple research streams, including infrastructure-based urban ecology, social ecology, urban planning, and environmental justice.

Dagmar Carola Haase occupies the most central position in the network, exhibiting the highest number of citation links with other authors. This indicates her significant scientific relevance and influence across multiple thematic sub-disciplines. Her role as a key connecting node suggests high visibility in scientific discourse, as well as a potential role in shaping research agendas at the international level.

In addition to Haase, other highly positioned researchers within the citation network include Dieter Rink, Nadja Kabisch, Stephan Pauleit, and Nina Schwarz. Their influence spans diverse domains: Rink and Kabisch in the field of social ecology and urban systems adaptation; Pauleit in green infrastructure and urban resilience; and Schwarz in spatial analysis and urban process modelling.

The thematic diversity among highly cited authors supports the notion of the interdisciplinary nature of research in this field, as well as its evolution toward complex, systems-based approaches in analysing the urban environment. The presence of multiple thematic clusters within the citation network further confirms that the scientific community in this area is developing through parallel yet mutually communicative streams.

Based on the obtained results, hypothesis  $H_5$  is confirmed. The centrality of certain authors (notably D. C. Haase), their role in linking multiple thematic streams, and the presence of interdisciplinary networks with stable citation patterns indicate the existence of influential research cores. At the same time, the network structure reveals the maturity and cooperativeness of the scientific community, where thematically and methodologically complementary groups are being formed and sustained.



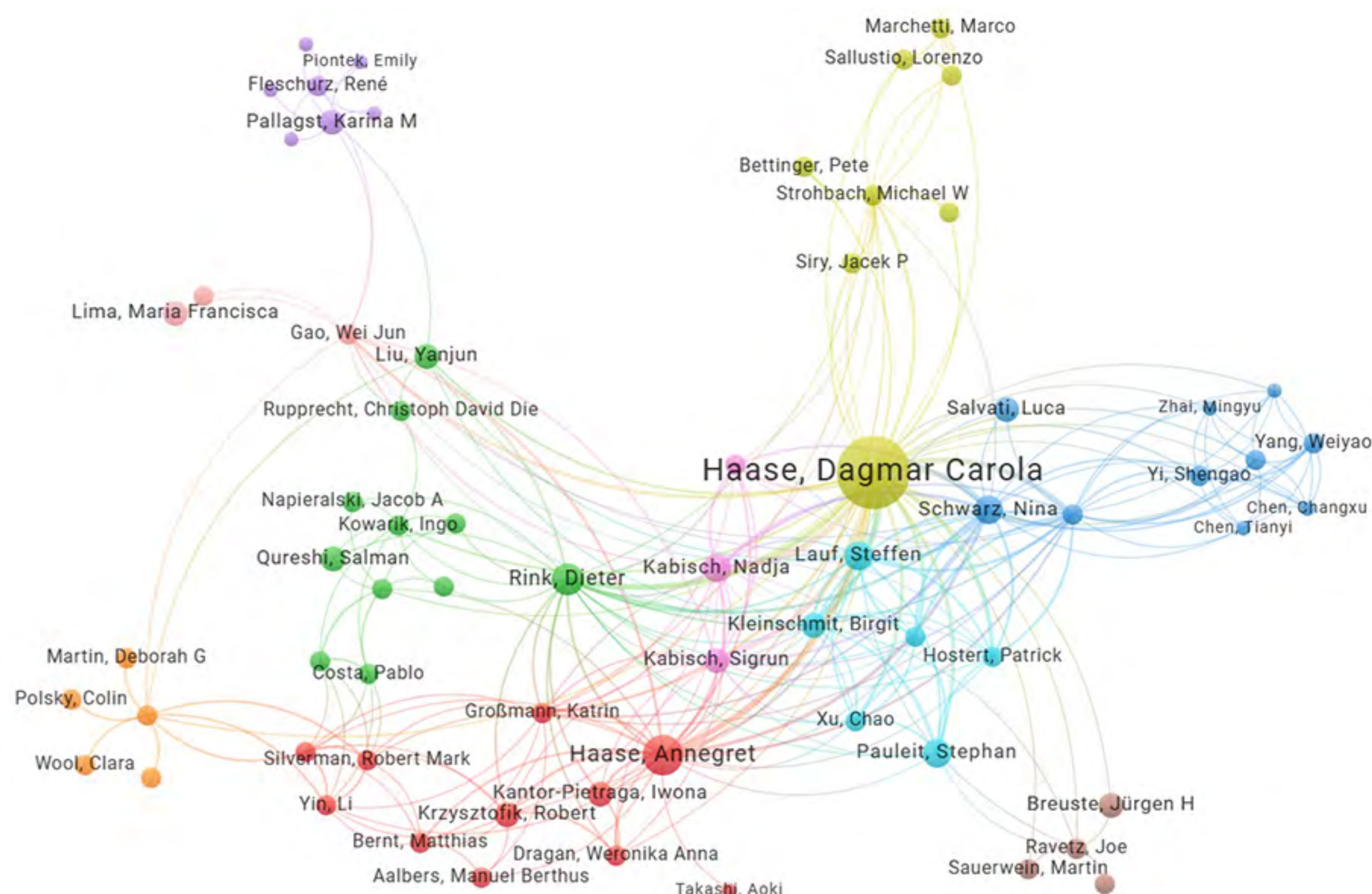


Figure 5. VOSviewer citation map of researchers in the field of urban ecology and urban decline (2010–2024)

## DISCUSSION

Although hypothesis  $H_1$  assumed the existence of a statistically significant trend in the volume of scientific publications in the field of urban ecology and urban decline during the period 2010–2024, the applied Mann–Kendall test did not confirm this assumption. Based on the obtained results, the null hypothesis ( $H_0$ ), which posits that no such trend exists, was not rejected ( $p = 0.262$ ), indicating that the alternative hypothesis was not supported. This finding suggests that, despite the increasing global relevance of sustainable urban development issues, scientific output in this area has not grown in a statistically significant manner over the observed period. Nevertheless, the positive value of the  $S$  statistic (48) indicates a potential, albeit insufficiently pronounced, upward trend.

One possible explanation for this outcome lies in the fact that ecology itself is already a highly broad scientific domain, and urban ecology, as one of its subfields, is even more complex due to its integration of ecological, spatial, social, and infrastructural dimensions. As a result, research in this field often appears under diverse thematic frameworks and within different disciplinary domains, which can lead to the dispersion of outputs across indexed databases. In this context, the present study focused on two broadly defined yet frequently interrelated domains—urban ecology and urban decline—which posed a challenge for the analysis of publication trends.

This choice, however, enabled a comprehensive insight into the dynamics of research within the context of global sustainable urban development challenges. The literature review revealed that key aspects of urban ecology are often not explicitly identified as keywords in article titles or abstracts, pointing to a lack of consistency in categorization and indexing. Specific subfields such as waste management or green infrastructure may follow different trends that are not necessarily visible in the context of such a broadly defined analysis. Future studies focusing on narrower thematic scopes could offer a more precise understanding of the



evolution of scientific production within individual subdisciplines. Additionally, publication trends may also be influenced by external factors, such as the funding priorities of research institutions or, as noted by Pelorosso et al. (2017) and Xie et al. (2018), the persistence of dominant global research agendas.

To ensure more accurate monitoring of scientific production dynamics, the results of the Mann-Kendall test were analysed for three distinct subperiods within the 2010–2024 time frame. None of these subperiods demonstrated a statistically significant monotonic trend in the number of published articles, leading to the non-rejection of the null hypothesis  $H_0$ , which assumes that no subperiod shows a statistically significant trend. Therefore, the alternative hypothesis  $H_1$ , which suggests that at least one of the subperiods has such a trend, was not confirmed. Nevertheless, the directionality of the S and Z statistics within individual intervals indicates the presence of dynamics that, while statistically insignificant, carry analytical value. The first subperiod (2010–2014) is characterized by a moderate, yet statistically negligible, increase ( $p = 0.19$ ), which can be interpreted as the initial phase of growing interest in the topics of shrinking cities and urban ecological transformation. This trend coincides with the implementation of the COST Action *Cities Regrowing Smaller – Fostering Knowledge on Regeneration Strategies in Shrinking Cities across Europe* (TU0803) (2009–2013), which made a crucial contribution to the conceptualization and methodological articulation. The COST Action document itself emphasizes that one of the key urban challenges in the coming decades will be precisely finding responses to the consequences of urban decline (COST, 2008). A particularly important role in the promotion of regeneration policies was played by the URBACT publication *From Crisis to Choice: Rethinking the Future of Shrinking Cities* (2013), which encourages the adoption of realistic strategies emerging from the local experiences of shrinking cities.

The second subperiod (2015–2019) shows a stable, but very weak positive trend ( $p = 0.33$ ), which may suggest a phase of thematic consolidation. During this period, significant European projects such as *Shrink Smart* and *3S RECIPE – Smart Shrinkage Solutions* (2017–2020), funded under the FP7 and Horizon 2020 programs, contributed to the development of comparative and interdisciplinary studies in different urban contexts. The *3S RECIPE* project, conducted in collaboration with nine European universities, included case studies in seven cities (e.g., Stoke-on-Trent, Porto, Maastricht, Zonguldak), and highlighted causes such as economic decline, suburbanization, and spatial isolation as key drivers of urban decline.

In contrast, the most recent subperiod (2020–2024) indicates a slight negative trend ( $p = 0.09$ ), which, although not statistically significant, warrants critical attention. A potential explanation lies in the conclusion of previous projects, along with the delayed emergence of results from new initiatives (e.g., the European Green Deal, launched by the European Commission in 2019 with the aim of achieving climate neutrality by 2050, or Horizon Europe programs which only began after 2021), complicates the direct connection between research intensity and publication output. The European Green Deal sets a target to reduce net greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels. Another challenge is the interdisciplinary dispersion of publications, which may affect their visibility in certain indexing systems.

Fluctuations in publication numbers—such as peaks in 2014, 2018, and 2021—can be associated with the global increase in interest in climate change, urban resilience, and the need for sustainable approaches in urban planning. These surges in production reflect the complex interaction between scientific processes and global political frameworks, such as the Paris Agreement (2015) and the 2030 Agenda, highlighting the growing connection between urban ecology and broader socio-political and financial discourses.

The co-occurrence clustering of terms in VOSviewer identified a spatial cluster (red), with dominant terms such as *brownfield*, *vacant land*, *urban planning*, and *land use*, indicating a research focus on physical transformation and land-use changes. This trend aligns with previous studies emphasizing the importance of regenerating degraded urban areas through urban planning and revitalization (Strohbach et al., 2012; Wellmann et al., 2020; Wei & Ewing, 2018). Research on brownfields—abandoned industrial and commercial zones—highlights their potential for ecological and urban planning interventions (Davids, 2023). The example of Leipzig illustrates the effects of brownfield afforestation on CO<sub>2</sub> emission reduction (Haase, 2013), positioning this practice as a key component of sustainable urban development (Park et al., 2023). Based on the results, hypothesis  $H_0$  can be confirmed, indicating that the dominant themes in the literature between 2010 and 2024 were primarily related to the spatial and demographic aspects of urban decline. At the same time,



recent studies increasingly emphasize the social and economic dimensions of urban decline (green cluster), with a focus on social inclusion and civic initiatives, in line with approaches of urban redesign and participatory planning (blue and yellow clusters).

The temporal context analysis, in light of the urban development model by Van den Berg et al. (1982), further emphasizes that urban decline does not occur synchronously on a global scale. While it has been present for decades in some regions, others are only now experiencing it as a consequence of contemporary demographic and economic shifts. Observed processes of depopulation, infrastructure degradation, and the perforation of urban fabric present both challenges and opportunities for reurbanization, green space expansion, and the development of urban agriculture (Kremer & DeLiberty, 2011).

The results of the overlay visualization analysis indicate a significant evolution in the research discourse on urban decline and urban ecology between 2010 and 2024. Temporal analysis of key terms reveals a clear paradigmatic shift, characterized by a movement from analytical and descriptive-structural approaches toward more interventionist and transformative frameworks that incorporate ecological, social, and participatory dimensions of urban development. This shift is not only thematic but also epistemological and methodological, signalling a notable reorientation of the field toward the integration of new conceptual and theoretical approaches. Between 2010 and 2015, the dominant terms included *urban decline*, *population decline*, *shrinking city*, and *urban sprawl*, reflecting a research focus on urban decline through the lens of demographic loss and spatial degradation, particularly in Western contexts such as Germany and the United States. These terms align with a theoretical framework in which urban decline is viewed as a negative process involving the loss of resources and urban potential. Their prevalence can be interpreted as a reflection of dominant paradigms emphasizing the adverse effects of urban decline, with limited engagement in concepts of adaptation or renewal. However, post-2016 data reveal a marked shift in terminology and research focus. Terms such as *green space*, *ecosystem service*, *community*, *citizen*, *role*, *practice*, and *participation* appear with increasing frequency, indicating a growing emphasis on ecological and social aspects of urban development. These shifts in research interests and terminology support hypothesis H<sub>3</sub>1, which suggests a transition from predominantly spatial-demographic themes to more integrated and multidimensional approaches encompassing ecological and participatory aspects of urban transformation. These findings reinforce the notion that researchers are increasingly highlighting the importance of urban ecological sustainability and the active role of local communities in urban change. Moreover, the absence of yellow terms—typically representing the most recent concepts—can be interpreted as a sign of terminological stabilization, with certain terms becoming embedded in the established scientific discourse. This suggests a potential inflection point in research, either reflecting the maturation of the discipline through stabilized terminology or signalling the emergence of new research orientations in the near future. In a broader context, these findings support the argument that the evolution of research discourse on urban decline mirrors changes in urban policies and practices, which are increasingly oriented toward socially and environmentally responsible urbanism. The shift in key terms and research interests not only reflects new scientific priorities but also a transformation in value orientations toward more inclusive and equitable urban development. Furthermore, this evolution in thematic focus and methodological approaches reveals a growing need for interdisciplinary integration in understanding urban challenges, pointing to the necessity of developing new theoretical frameworks that incorporate environmental concerns, social justice, and community participation as central elements of both urban decline and urban revitalization.

The co-authorship collaboration network clearly illustrates the internationalized and interdisciplinary character of the research field encompassing urban ecology and urban decline. At the centre of this network is Dagmar Carola Haase, who functions as a key bridging actor, linking various research centres and thematic groups. Her collaborations with researchers such as Wellmann Thilo, Qureshi Salman, Roddy Juliette Kathryn, and others highlight the capacity to build productive scientific networks that transcend disciplinary and national boundaries—an essential trait for fields that require systemic approaches to urban transformation. The confirmation of hypothesis H<sub>4</sub> is grounded in the evident dynamics of international collaboration, which persists and evolves through stable networks that integrate technical, ecological, and social aspects of



urban decline and environmental challenges. Simultaneously, the identification of several densely connected clusters confirms the existence of diverse epistemological and methodological approaches, reflecting the interdisciplinary and fragmented nature of the research domain. The high level of autonomy observed in certain research cores suggests the presence of distinct theoretical traditions and the potential for convergence through intermediary authors and transnational collaboration. Research clusters including scholars such as Haase Annegret, Rink Dieter, and Wolff Manuel are focused on the socio-spatial dimensions of urban decline, while researchers like Pauleit Stephan and Seppelt Ralf concentrate on the systemic management of urban ecosystems and the application of spatial models. In contrast to the co-authorship network—which reveals institutional ties—the citation network sheds light on theoretical foundations and paradigmatic flows of knowledge. It identifies which ideas are considered seminal and to what extent particular works are used as references for further research. The central position of Dagmar Carola Haase within the citation network points to the consolidated scientific impact of her work, which serves as conceptual hubs within the broader network. Her theoretical and methodological articulation of urban decline and the social aspect of urban transformation unites diverse paradigms within the field. The presence of such integrative figures signals a process of epistemological consolidation rather than radical fragmentation. Ten thematically defined citation clusters indicate a wide range of research interests without significant fragmentation. The parallel existence of socio-political and techno-ecological approaches—evident in the works of Rink Dieter and Pauleit Stephan—suggests the coexistence of two major paradigms: the critical-interpretive and the technical-engineering. This implies that urban ecology is approaching interdisciplinary equilibrium, in which traditional divisions between quantitative and qualitative methods are gradually being bridged. The high degree of intra-cluster citation points to the existence of epistemic communities, which help stabilize the field and form coherent theoretical corpuses. However, this also carries the risk of epistemic closure and limited openness to alternative approaches. Institutional and geographic analysis reveals the dominance of European research centres, with Germany, the United Kingdom, and the United States serving as epistemic centres of influence. The limited presence of prominent scholars from developing regions highlights the uneven geographic distribution of scientific authority, prompting consideration of the concept of the “epistemic North.” At the same time, the growing academic influence of China must be acknowledged. According to data by Li & Mykhnenko (2018), between 1990 and 2000 approximately 7% of Chinese cities (164 cities) were affected by urban decline, while between 2000 and 2010 that figure rose to over 10%, encompassing 281 cities.

In conclusion, the results of the citation analysis challenge assumptions about urban ecology and urban decline being poorly connected and theoretically fragmented fields. Rather, they point to centralized flows of influence and a degree of theoretical stabilization. Additionally, hypothesis H<sub>5</sub>—pertaining to stable and interdisciplinary networks of prominent researchers—is confirmed, as evidenced by the observed stability of influence flows and the centralized position of leading authors within the citation landscape.

## CONCLUSION

This study provides a bibliometric analysis of scientific production at the intersection of urban ecology and urban decline between 2010 and 2024, with the aim of identifying research trajectories, thematic reorientations, and patterns of scholarly collaboration. The results indicate a shift from traditional spatial and infrastructural topics toward an increasing integration of sustainability concepts, ecosystem services, and participatory governance. This transformation reflects a broader turn toward interdisciplinary and inclusive approaches to urban challenges, aligned with contemporary political and scientific agendas.

Network analyses reveal the presence of relatively stable and internationalized research communities, primarily led by institutions and authors based in Europe and other highly developed regions. At the same time, the analysis highlights the underrepresentation of research originating from the global periphery, pointing to a need for greater epistemic inclusivity within the field.



The limitations of this study are primarily related to the use of a single database—Dimensions—which, despite its extensive coverage, may result in the omission of relevant publications indexed elsewhere, especially those published in other languages or within grey literature. Additionally, the broad thematic scope of this analysis carries the risk of diluting narrower research trends characteristic of specific subdisciplines.

Future studies could focus on comparative analyses involving multiple databases, thematic case studies targeting specific research strands (such as climate-adaptive urban design, environmental justice in post-industrial cities, or urban socio-ecological resilience), and regionally grounded approaches that allow for a more nuanced understanding of urban contexts. Such directions may deepen insight into the interactions between degradation processes and the potential for ecological renewal in diverse urban settings.

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**CONFLICTS OF INTEREST** The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. © 2025 by the authors. This article is an open-access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).

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