frontiers | Frontiers in Environmental Science

TYPE Editorial
PUBLISHED 10 April 2025
DOI 10.3389/fenvs.2025.1601067

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OPEN ACCESS

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RECEIVED 27 March 2025
ACCEPTED 27 March 2025
PUBLISHED 10 April 2025

CITATION
García-Ayllón S and Pilz J (2025) Editorial: Territorial spatial evolution process and its ecological resilience, volume II.
Front. Environ. Sci. 13:1601067.
doi: 10.3389/fenvs.2025.1601067

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Editorial: Territorial spatial evolution process and its ecological resilience, volume II

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KEYWORDS

nature based solutions, ecological resilience, land use analysis, territorial diffuse anthropization, resilience-related indicators, ecological restoration policy, environmental management, remote sensing analysis

Editorial on the Research Topic
Territorial spatial evolution process and its ecological resilience, Volume II

1 Introduction

The analysis of anthropic impacts on the environment from a territorial perspective is possibly one of the most important fields of study in the current context of climate change. The evolution of land space demonstrates the shift of land use types from natural and semi-natural land (e.g., forest land and cropland) to built-up land, altering ecosystem cycling patterns and leading to degradation of ecosystem services in terms of regulation, provisioning and support. At the same time, production and living space crowding out ecological space brings high potential threats, such as soil erosion, forest productivity decline and habitat fragmentation. Accordingly, in response to the problems of imbalanced territorial space development, inefficient resource utilization and ecological environment degradation, how to improve the diversity, stability and sustainability of ecosystems is an urgent issue to promote modernization and green development in the new era of territorial space evolution.

Parallel to this phenomenon, there has been an increase in our capacity to monitor the characteristics of land space and its socioecological configuration. At a time when many voices are being raised in defense of climate denialism, it is important that diagnoses are based on methodologically rigorous processes. This Research Topic follows in the footsteps of its previous edition (García-Ayllón and Pilz, 2024) and aims to systematically investigate the evolutionary process of territorial space and ecological resilience to clarify the dynamic trend of ecological resilience under the action of nature and human. The proposed research framework focuses on the establishment of territorial space simulation models for enhancing ecological resilience to encourage the stability and sustainability of ecosystems and promote the modernization of the harmonious coexistence of human beings and nature.

FIGURE 1
Damage suffered in the area surrounding the Albufera Natural Park in Valencia (Spain) during the floods of October 2024, exacerbated by the ongoing territorial anthropization process in the area. Source: NASA Earth Observatory.

2 Overview of the state of the art

There are many ways for this accelerated epoch of the Anthropocene in which we currently find ourselves is expressed. Rising temperatures, increasing frequency of new types of wildfires, the so-called flash floods (Serra-Llobet et al., 2023), persistent droughts (Jodar-Abellan et al., 2019), coastal erosion (Bianco et al., 2020) and loss of soil value (Cao et al., 2024), reduced biodiversity (Ricotta and Szeidl, 2006), sea level rise on the coast (Bianco and García-Ayllón, 2021), etc. The effects that an incorrect transformation of land use can have on the appearance of many of the catastrophic phenomena with which our society lives are numerous that affect the natural ecosystems and even human security (see Figure 1), and sometimes even unsuspected (García-Ayllón et al., 2019). Among all of them, the impact of diffuse territorial anthropization is especially dangerous, a silent phenomenon derived from the processes of transformation of the soil by human beings, whose diversity of causes makes its diagnosis very complex. However, thanks to the important methodological and technological advances in this field we can now be aware of the magnitude of this problem and how its effects are expressed in the environment.

The new methodologies of spatial statistical analysis with GIS tools, technological advances in the field of recognition of land uses and conditions with satellite images through remote sensing or the existence of an ever-growing spatiotemporal cartographic database freely accessible to the entire planetary scientific community, are just some of the many tools that currently allow researchers to obtain more and more analyses and diagnoses sophisticated in this field. Good examples of these advances can be found in the innovative use of InVEST models.

For example, Wei et al. employs the Theil-Sen Median method combined with Mann-Kendall test to analyze the trend changes in habitat quality more accurately, utilizing high temporal resolution land use data to analyze in the area of Beijing from 1980 to 2020 through the habitat quality module of the InVEST model. Another interesting example in this field can be found in Liu et al., that explore the changing characteristics of land use/land cover (LULC), landscape pattern and ecosystem service (ES) and their drivers for regional ecosystem management and sustainable development in the Bohai Rim region of China, using the land use transfer matrix, landscape pattern index and InVEST models. Another interesting variant can be that of Xuan et al., who explore the relationship between ecosystem services and land use transition, using a InVEST model combined with a geographically weighted regression (GWR) model, to examine the impact of land use transition on ecosystem services in the Dongting Lake area in China.

A different but also interesting approach in the methodological advances of this discipline can also be found in the exploration of the multifunctional trade-off and synergy relationship of cultivated land for protecting cultivated land resources. Fang et al. evaluate obtaining very relevant results in this field the three-dimensional functional level of "production-society-ecology" of cultivated land from 2010 to 2020 using the coupling coordination degree model, land system function trade-off degree model, and K-means clustering analysis method to analyze the trade-off and synergy relationship between cultivated land functions in the Yellow River Basin.

In this field we must not forget more traditional, but also very useful, visions such as those derived from advances in the analysis and interpretation of historical cartography. Traditional analyses based solely on historical records may lack precision due to deviations and artistic interpretations found in ancient maps. However, considering the reciprocal compatibility between local geomorphology, undulating terrains, and water bodies allows for accurate reduction of the land use morphology by inferring and validating its geographical features. For example, Wang and Cheng combine historical interpretation and geographical analysis to reconstruct the historical shape of Xuanwu Lake, uncover the intrinsic mechanisms driving spatial changes over time, and analyze the morphological changes and connectivity patterns of its hydrological system.

An approach that is also traditional, but full of new possibilities for improvement, is the socio-ecological analysis of natural spaces as a design tool in the field of strategic planning of the territory. In this field, ecological restoration holds great significance in addressing environmental degradation and rock desertification in karst areas, for example. In these cases, zoning strategy is a fundamental task in understanding the interrelationship between human-environment to foster sustainable development. Liu et al. explore "social-ecological" system and conduct a case study on the karst region in Guangdong Province, China. They performed an evaluation framework using remote sensing computing cloud service platforms, consisting of "development pressure," "sensitivity status," and "resilience potential," showing how regions with high pressure of development are predominantly located in high-density urban areas.

Other approaches with a more numerical focus are also booming thanks to the growth and technological progress of geostatistics in the field of human-land relationship studies at the regional scale. For example, Zhou and Huang adopts an integrative approach to investigate spatiotemporal patterns, influencing factors, and

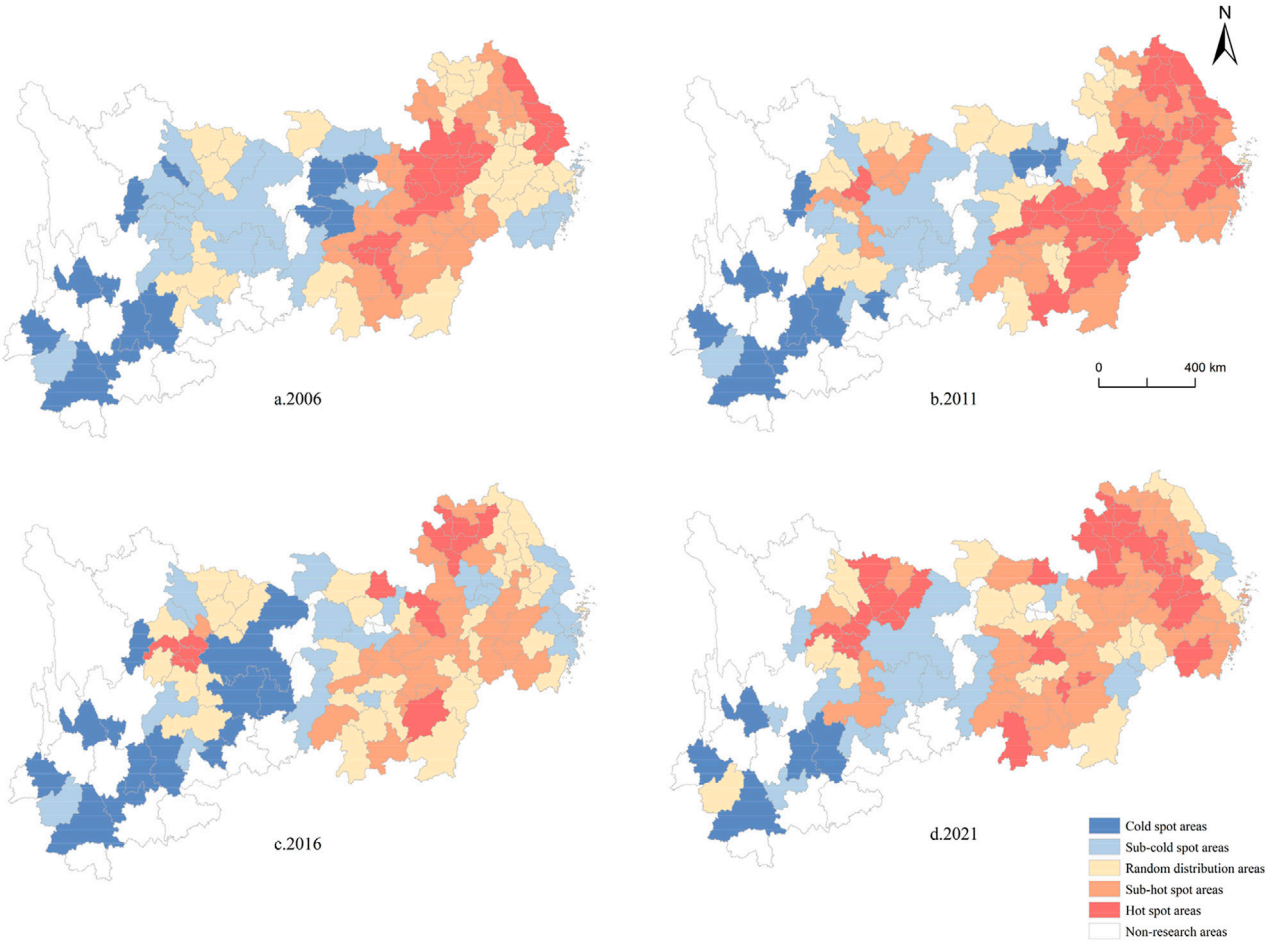

FIGURE 2
Spatial distribution of cold and hot spots of the coupled coordination degree between population urbanization and land urbanization in the Yangtze. Source: Zhou and Huang.

driving mechanisms of the coupling coordination between population urbanization and land urbanization in the Yangtze River Economic Belt (see Figure 2). By combining the coupling coordination degree model, exploratory spatial data analysis (ESDA), and panel data model, they provide new insights into the heterogeneity and spatial dependence of human-land dynamics in this region, revealing regional disparities, spatial clusters, and key influencing factors shaping the coupling coordination, which represents valuable knowledge for sustainable urbanization and regional development policies.

2.1 River economic belt

Liu and Ma employ double fixed-effects models, spatial econometric models, and instrumental variables methods to empirically explore how the digital economy influences environmental pollution, using panel data from 30 provinces in China spanning the years 2011–2022. Their results demonstrate that the digital economy significantly lowers environmental pollution: the primary mechanism is through the government's environmental governance behaviors, which are positively moderated by public environmental concerns, enhancing effectiveness. In addition, the digital economy induces a spatial spillover effect on environmental pollution since this promotion of collaborative management between the government and the public is poised to become a pivotal direction in future environmental governance.

Finally, we have continuous improvements that occur in the field of remote sensing thanks to the generalization of researchers' access to increasingly dense, accurate satellite information with a higher level of coverage throughout the planet. In this field, Wu et al. study fluvial islands, which are vital ecosystemic areas from both morphological and ecological perspectives and consequently have been hotspots of morphodynamic research in large rivers around the world. This study selected 14 representative fluvial islands in the lower reaches of the Yangtze River and explored their spatial-temporal evolution, including their shape and area dynamics during 1945–2016, by interpreting remote sensing images and analyzing the hydrological data. Results indicated that the total area of the 14 fluvial islands showed a growing trend at an average rate of 0.30 km2 yr−1 during the 72 years, providing an important reference for sustainable utilization and management of fluvial islands.

3 Conclusion

Spatial analysis in the field of the correlation between territory and environment is a discipline in continuous growth, in which new variants and new work formulas appear every day. We can conclude, therefore, that the field of territorial analysis of environmental evolution processes is a field of scientific research with a great future due to its continuous progress and improvement. The resilience of territory in the current context of climate change has traditionally been a variable that is difficult to measure. However, methodological and technological improvements in this field, together with progress in access to information (especially in those developing countries currently at greater risk of anthropization), are a fundamental variable in this respect.

Even so, we must continue to deepen this dynamic in a changing world, given that the understanding of the complex correlation between the phenomena of territorial anthropization and its implications in the analysis of behavioral patterns in the environmental and ecological field is also increasingly difficult and sophisticated. There is no alternative to this path in the current context of climate emergency, even more so if the aim is to fight in a convincing and effective way against denialist theories that question this correlation, which is not always evident at first glance. Science is the path, and research is its best tool.

Author contributions

SG-A: Project administration, Formal Analysis, Conceptualization, Writing – review and editing, Writing – original draft. JP: Writing – review and editing, Supervision, Writing – original draft, Validation, Conceptualization, Formal Analysis, Project administration.

Funding

The author(s) declare that no financial support was received for the research and/or publication of this article.

Acknowledgments

We deeply thank all the authors and reviewers who have participated in this Research Topic.

Conflict of interest

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