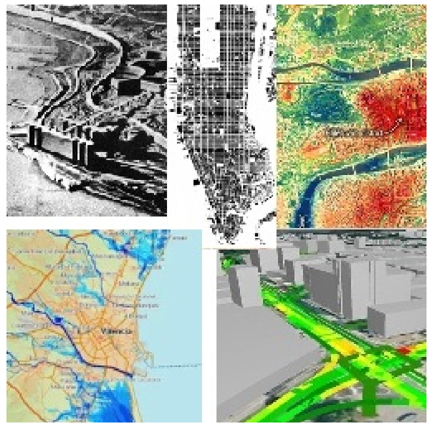

The 3rd International Conference on Future Challenges in Sustainable Urban Planning & Territorial Management

Optimization and Improvement Strategies for Urban Ecological Space

Jing Zhang1*
Polytechnic University of Madrid.

POLITÉCNICA

Introduction

Urban ecological space is increasingly challenged by compact urban development, climate stress, and population concentration, revealing the limitations of fragmented green space planning and static evaluation approaches.

This study positions GIS-based spatial analysis as a central methodological framework for understanding and optimizing urban ecological space. Rather than treating green infrastructure as isolated elements, the research employs spatial metrics, ecosystem service proxies, and scenario-based modelling to evaluate ecological performance across a continuous urban terrain. By integrating urban growth dynamics, spatial aesthetics, and digital analytical techniques within a unified GIS environment, the study proposes a system-oriented approach that supports sustainable, resilient, and human-centered urban ecological development.

Spatial configuration as analytical driver

GIS Workflow Thumbnail

Spatial Data → Spatial Analysis → Indicators → Scenarios → Decision Support

Aim and research question

This proposal aims to establish a GIS-based analytical framework for optimizing urban ecological space under compact urban conditions. The research asks how spatial configuration and ecosystem service efficiency can be quantitatively evaluated and scenario-tested through GIS to support planning decisions that improve ecological performance and human comfort without expanding urban land consumption.

Methodology GIS-based Spatial Analysis Framework

This study adopts a GIS-based spatial analysis framework to evaluate and optimize urban ecological space under compact urban conditions. The methodology integrates spatial data processing, indicator-based evaluation, and scenario comparison to support planning-oriented decision-making.

Spatial datasets include land use and land cover, green and blue infrastructure, impervious surface distribution, population exposure proxies, and street network data. All datasets are processed within a unified GIS environment to ensure spatial consistency.

Spatial analysis focuses on three analytical dimensions:
1. ecological structure, assessed through fragmentation and connectivity metrics;
2. ecosystem service potential, estimated via spatial proxies for cooling, runoff retention, and access to green space;
3. spatial equity, evaluated through accessibility thresholds and service distribution.

Based on the baseline spatial condition derived from GIS analysis, multiple spatial scenarios are constructed by modifying green infrastructure configuration and connectivity patterns. Each scenario is evaluated using a multi-criteria comparison of spatial indicators, allowing relative performance gains and trade-offs to be identified.

Legend

1. Ecological Structure
- *Fragmentation index*
- *Ecological connectivity*
- *Structural metrics*

2. Ecosystem Service Potential
- *Cooling proxy*
- *Runoff retention proxy*
- *Green space provision*

3. Spatial Equity
- *Accessibility*
- *Threshold-based service coverage*
- *Service distribution*

1. Ecological Structure *2. Ecosystem Service Potential* *3. Spatial Equity*

Conclusion

This study demonstrates that the optimization of urban ecological space benefits from a GIS-based, system-oriented approach that integrates spatial restructuring, ecosystem service efficiency, and planning coordination. By enabling spatially explicit evaluation, indicator-based comparison, and scenario testing, GIS-based spatial analysis supports a shift from fragmented green space protection toward holistic ecological optimization, enhancing urban environmental performance and resilience.

Future research should expand the integration of adaptive governance frameworks with GIS-enabled monitoring, scenario updating, and participatory spatial tools, strengthening the long-term capacity of urban ecological systems to respond to environmental and social change.