Evaluation of Land Use Multifunctionality in Lanzhou City Based on Improved TOPSIS Method (Postprint)

Authors: Zhang Yida, Liu Xuelu, Yahong Fan, Liu Yongkang

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Abstract

This study employs the improved TOPSIS method to evaluate the multifunctionality and dysfunction degree of land use in Lanzhou from 1995 to 2015, aiming to elucidate the temporal variation characteristics and patterns of land use multifunctionality in Lanzhou based on sustainable utilization. The results indicate: (1) The overall land use function in Lanzhou demonstrates a continuously rising trend, functional coordination experiences an initial decline followed by a subsequent increase, functions become increasingly diversified, and the functional focus shifts from social function to economic function. (2) Both economic and social functions have entered a stage of rapid development, while ecological function undergoes a process of continuous decline followed by gradual increase. (3) The dysfunction degrees of both economic and social functions decrease over time, whereas the dysfunction degree of ecological function continues to rise and has become the land function with the greatest dysfunction degree. In the future, Lanzhou should prioritize enhancing ecological function, focus on the bottleneck functions within economic and social functions—namely agricultural production and cultural leisure functions, improve coordination among land use functions, and achieve multifunctional land use and sustainable development.

Full Text

1. Study Area and Methods

1.1 Study Area

Lanzhou City, the capital of Gansu Province in northwestern China, serves as the study area for this research. The city has experienced rapid economic growth and urbanization from 1995 to 2015. Statistical data reveal that the regional GDP increased dramatically from 309×10^8 yuan in 2000 to 2095×10^8 yuan in 2015, representing an average annual growth rate of 13.6%. Concurrently, the

permanent population grew from 2.90×10^6 to 3.22×10^6 residents during the same period. The study area encompasses the main urban districts of Lanzhou, focusing on the spatial and temporal evolution of land use multifunctionality.

1.3.3 Indicator System Construction

The evaluation indicator system for land use functions comprises multiple dimensions:

- **X1**: Land use function intensity (positive indicator)
- **X2**: Per capita GDP (positive)
- **X3**: Land development intensity (positive)
- **X4**: Construction land density (positive)
- **X5**: Total GDP (positive)
- **X6**: Per capita disposable income (positive)
- **X7**: Fixed asset investment intensity (positive)
- **X8**: $ X 8 7(cid:252)(cid:253)(cid:254)(cid:255)$ (negative indicator)
- **X9**: $p_{\text{¡}} * X10Q(cid:128)(cid:131)$ (positive)
- **X11**: $(cid:252)[0 0180 0130 0220 0630 1870 0080 0030 0010 0080 0140 017 \cdot dX12$

These indicators collectively reflect the economic, social, and ecological dimensions of land use multifunctionality. The positive/negative orientation of each indicator is noted in parentheses, where positive indicators represent beneficial effects and negative indicators represent constraints or adverse impacts.

1.3.2 Data Sources and Processing

The research employs statistical yearbook data for Lanzhou City covering the period 1995–2015. The dataset includes socioeconomic statistics, land use survey data, and environmental monitoring records. All data underwent standardization processing to eliminate dimensional differences before applying the improved TOPSIS evaluation method.

2. Spatiotemporal Evolution of Land Use Functions

2.3 Economic Function Evolution

The economic function of land use in Lanzhou exhibited distinct phased characteristics. During 1995–2002, the economic function index showed steady growth, driven primarily by industrial development and infrastructure expansion. The period 2007–2015 witnessed accelerated improvement, with the economic function index increasing from 0.25 to 0.68, reflecting the city' s rapid urbanization and economic restructuring. Key contributing factors included the growth of construction land scale, expansion of industrial zones, and significant increases in land output efficiency.

2.4 Social Function Evolution

The social function demonstrated a consistent upward trajectory throughout the study period. From 1995–2000, the social function index rose gradually from 0.15 to 0.28, indicating initial improvements in living standards and public services. The period 2001–2006 saw more rapid enhancement, with the index reaching 0.45 by 2006. Although the growth rate moderated during 2007–2015, the social function continued to strengthen, reaching 0.61 by 2015, reflecting improved social welfare, education, and healthcare facilities.

2.5 Ecological Function Evolution

In contrast to economic and social functions, the ecological function experienced a declining trend from 1995–2008, with the index dropping from 0.52 to 0.31. This decline was attributed to rapid urban expansion, increased construction land, and environmental pressures. However, after 2008, the ecological function showed signs of gradual recovery, rising to 0.38 by 2015, indicating the initial effects of environmental protection policies and ecological restoration projects. Nevertheless, the ecological function remains the weakest component of land use multifunctionality in Lanzhou.

3. Obstacle Degree Analysis

[TABLE:N] presents the obstacle degrees for various land use functions in Lanzhou from 1995 to 2015. The analysis reveals that:

- **Economic function obstacles** decreased significantly over time, from 0.129 in 1995 to 0.013 in 2015, indicating improving economic efficiency and land productivity.
- **Social function obstacles** also declined, though at a slower pace, from 0.113 to 0.021, reflecting gradual improvements in social equity and service provision.
- **Ecological function obstacles** increased markedly, from 0.071 in 1995 to 0.252 in 2015, becoming the primary constraint on overall land use multifunctionality.

The rising obstacle degree of ecological function highlights the growing conflict between urban development and environmental protection. This trend underscores the urgent need for sustainable land use strategies that prioritize ecological restoration and green infrastructure development.

4. Discussion and Conclusions

The improved TOPSIS evaluation demonstrates that Lanzhou' s land use multifunctionality has undergone significant transformation from 1995–2015. While economic and social functions have improved substantially, the ecological function has deteriorated and now represents the main obstacle to sustainable land

use. The functional focus has shifted from social to economic priorities, with ecological considerations requiring greater attention.

Future land use planning in Lanzhou should emphasize: 1. Enhancing ecological function through green space expansion and environmental remediation 2. Improving agricultural production and cultural leisure functions as complements to economic development 3. Strengthening coordination among different land use functions to achieve balanced multifunctionality

The findings provide scientific guidance for optimizing land use structure and promoting sustainable urban development in Lanzhou and similar arid region cities.

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Note: Figure translations are in progress. See original paper for figures.