Characteristics, Driving Factors and Classified Guidance of Construction Land Growth in Small and Medium-sized Cities in Northwest China: Postprint

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Abstract

Investigating the land use growth characteristics and driving mechanisms of small and medium-sized cities from the perspective of China' s Northwest geographical region represents a breakthrough for high-quality urban management in the new era, and constitutes a key point for promoting the formation of a new pattern of coordinated development in this region. By interpreting remote sensing imagery and large-scale auxiliary data of small and medium-sized cities in Northwest China over the past 15 years, this study first employs methods of annual average growth rate, centroid migration rate, topological relationships, and fractal dimension to respectively measure the rate, directionality, pattern, and boundary morphological characteristics of construction land growth, in order to understand its temporal dispersion, spatial variation, and degree of aggregation. Based on this, the driving factors for growth in cities with different characteristics are proposed: the introduction of key industries or primary functions promotes medium-to-high-speed extensive growth in cities; interference from land ownership rights in urban fringe areas leads to low-rate, weak-directionality + extensive irregular proliferation; slow and orderly construction of new towns promotes low-rate, regularized extensive growth in cities; and infill development of land between urban districts promotes low-rate, weak-directionality infill growth. On this basis, classification-guided strategies for cities with different growth drivers are proposed, providing recommendations for future decision-making in urban land use planning and control.

Full Text

Preamble

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Abstract:
Research on the characteristics and dynamic mechanisms of construction land use growth in small and medium-sized cities represents a breakthrough point for urban management and high-quality development control in the new era from the geographical zone perspective in Northwest China. It is also key to promoting a new pattern of coordinated development in corresponding regions. Based on the interpretation of remotely sensed images and large-scale supplementary data of small and medium-sized cities in Northwest China over the past 15 years, the temporal discreteness, spatial differences, and aggregation extent of growth were analyzed using methods of annual growth rate, centroid migration rate, topological relation, and fractal dimension to measure the rate, direction, pattern, and boundary shape of urban construction land use growth. The study investigated growth motivations and summarized them as follows: the implantation of key industry or main function promotes urban extroverted growth with medium or high-speed axial growth; the disturbance of land ownership in urban fringes leads to directionless irregular growth with low speed, yet this irregularity was gradually forced to become regularized by the slow and well-organized construction in the fringes; the fill-up type development of land use between urban districts impels this padding-like type of growth with low speed and weak direction. Based on these findings, this paper puts forward classification and guidance strategies for cities with different growth driving forces in their future urban land use planning and control decisions.

Keywords: Small and medium-sized cities in Northwest China; urban growth; spatial-temporal characteristics; motivation analysis

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1. Introduction

Research on construction land expansion in small and medium-sized cities of Northwest China over nearly 15 years reveals significant spatial-temporal dynamics. The analysis employs remote sensing imagery interpretation combined with large-scale supplementary data to quantify growth patterns. Three primary growth motivations emerge from the analysis: (1) key industry or main function implantation driving medium-to-high-speed axial growth; (2) land ownership disturbances in urban fringes causing initially directionless, low-speed ir-

regular growth that gradually regularizes through organized construction; and (3) fill-up development between urban districts creating padding-like, low-speed, weakly-directed growth.

2. Methods

The methodological framework incorporates four key measurement approaches:

2.1 Temporal Analysis

Annual growth rate calculations quantify the temporal discreteness of construction land expansion across different urban scales.

2.2 Spatial Dynamics

Centroid migration rate analysis tracks directional shifts in urban growth centers, revealing spatial displacement patterns.

2.3 Structural Patterns

Topological relation methods examine the connectivity and configuration of growth patches, while fractal dimension measurements assess boundary shape complexity and aggregation extent.

3. Results

3.1 Growth Rate Variations

Cities exhibit distinct growth velocities, with key functional zones demonstrating medium to high-speed expansion along major axes. The annual growth rate method reveals significant temporal clustering in construction land development.

3.2 Spatial Distribution Patterns

Centroid migration analysis shows directional preferences in growth, while fractal dimension results indicate varying boundary regularity across urban typologies. The topological analysis demonstrates how different growth motivations create characteristic spatial configurations.

3.3 Driving Force Classification

Three primary motivation types are identified: (1) function-driven axial growth, (2) ownership-disturbance-driven irregular fringe growth, and (3) infill-driven padding growth. Each type exhibits unique signatures in rate, direction, and spatial pattern metrics.

4. Discussion

The findings suggest that growth irregularities in urban fringes, while initially chaotic, undergo progressive regularization through planned development interventions. This has important implications for land use policy, indicating that proactive planning can transform spontaneous growth into ordered expansion. The classification framework provides a basis for tailored urban planning strategies that account for different driving force combinations.

5. Conclusion

This research establishes a comprehensive analytical framework for understanding construction land growth in Northwest China' s small and medium-sized cities. By integrating temporal, spatial, and structural analysis methods, the study reveals how different driving forces produce distinct growth patterns. The proposed classification and guidance strategies offer practical tools for urban planners to manage future land use development more effectively.

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