

Spatiotemporal Variation Analysis of Urbanization Quality in Northwest China (Postprint)

Authors: Bao Chao, Zou Jianjun, Bao Chao

Date: 2019-09-11T00:00:00+00:00

Abstract

The Chinese government has in recent years vigorously promoted new-type urbanization, focusing on urban sustainability and emphasizing the transformation of urbanization development patterns from “quantity growth-oriented” to “quality improvement-oriented.” However, consensus on the connotation of urbanization quality has not been reached, and Chinese government departments have not released an authoritative urbanization quality evaluation system. To this end, this paper establishes a comprehensive evaluation index system for urbanization quality and determines grading standards for indicators at all levels based on domestic and international development experience. Employing the Analytic Hierarchy Process supported by fuzzy membership functions and entropy techniques, this study conducts quantitative measurement and detailed analysis of the spatiotemporal variation characteristics of urbanization quality at the prefecture and city level in Northwest China from 2000 to 2014. The results indicate: (1) Compared with advanced domestic and international standards, the comprehensive urbanization quality index for the entire Northwest China region has consistently ranged between 0.4 and 0.5, remaining at a medium level, yet showing a slow fluctuating upward trend overall. This demonstrates that Northwest China still possesses considerable potential for urbanization quality improvement, and governments at all levels must formulate various policies to vigorously enhance urbanization quality in the future. (2) Historically, the quality of urbanization by component across the Northwest China region has generally exhibited the pattern of “urban ecological environmental quality > urban social development quality > urban economic development quality > urban-rural and regional integration quality.” Among these, urban ecological environmental quality has consistently remained high-quality, but has shown a declining trend in recent years; urban social development quality has transitioned from lower to medium and higher quality; urban economic development quality has shifted from lower to medium quality; and urban-rural and regional integration quality has remained at lower or medium quality, but has shown a slowly ris-

ing trend in recent years. Therefore, Northwest China should coordinate the relationships among these four indicators based on the aforementioned characteristics. (3) Spatially, the urbanization quality in Northwest China has long exhibited a pattern of widespread distribution of medium-quality cities alongside sporadic distribution of lower- and higher-quality cities. Moreover, the spatial distribution of component-specific urbanization quality all demonstrates strong regularity, but they show no significant correlation with the spatiotemporal distribution of population urbanization rate. This indicates that in the process of implementing the new-type urbanization strategy, Northwest China should, according to the specific conditions of each prefecture and city, adapt measures to local conditions and coordinate the relationship between urbanization quantity and quality. This paper provides assistance for scientifically understanding the spatiotemporal characteristics of urbanization quality in Northwest China and can also provide effective reference for the scientific evaluation of urbanization quality in similar regions.

Full Text

Preamble

DOI: 10.12118/j.issn.1000-6060.2019.05.20

Journal: Arid Land Geography (ChinaXiv Partner Journal)

Authors: BAO Chao^{1,2,3}, ZOU Jun-jun^{1,2,3}

¹ Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China

² Key Laboratory of Regional Sustainable Development Modeling, Chinese Academy of Sciences, Beijing 100101, China

³ College of Resources and Environment, University of Chinese Academy of Sciences, Beijing 100049, China

Abstract: In recent years, the Chinese government has promoted the concept of New-type Urbanization, which stresses urban sustainability and focuses primarily on urbanization quality instead of urbanization quantity. However, how to define and measure urbanization quality has not been authoritatively released by the Chinese government. Therefore, this paper constructed an integrated index system to measure urbanization quality based on its connotation, and ascertained the grading standards for each specific indicator and their integrated indexes according to domestic and overseas experiences. Using the statistical data of 51 prefecture-level regions in Northwest China during the time period from 2000 to 2014 and a multi-objective membership function and an AHP model reformed by entropy technology, the spatiotemporal variation of urbanization quality was analyzed in detail. The results show as follows: (1) Compared with the advanced standards in China and abroad, the integrated indexes of urbanization quality of Northwest China were between 0.4 and 0.5, belonging to the medium level all the time. However, it has a trend to increase slowly on the whole. It indicates that Northwest China has great potential to

improve the urbanization quality, and the government should pay more attention to make policies on improving the urbanization quality of Northwest China in the future. (2) Among the secondary indexes of urbanization quality, the urban eco-environmental quality was the largest. It belonged to higher quality all along but had a trend of deterioration in recent years. The urban social development quality was the second largest. It was improved from lower to medium and higher quality. The urban economic development quality was the third largest. It belonged to the transitional type between lower and medium quality. The urban-rural and regional integration quality was the smallest. It belonged to medium or lower quality during the period. However, it had a slow increasing trend in recent years. Therefore, Northwest China should deal with the coordinated development at the four aspects of urbanization quality. (3) From a spatial point of view, prefecture-level regions with medium urbanization quality were widely distributed, while prefecture-level regions with lower and higher urbanization quality were sporadically distributed. The spatiotemporal distributions of the four secondary indexes of urbanization quality also showed strong regularities. However, they had no significant relevance to the spatiotemporal distribution of population urbanization rate. It indicates that Northwest China should promote the coordinated development of urbanization quality and quantity according to local conditions when carrying out the New-type Urbanization Strategy. This paper might help scientifically understand the spatiotemporal features of the urbanization quality in Northwest China, and also provides an effective index system about the urbanization quality for similar regions.

Keywords: urbanization quality; integrated assessment; spatiotemporal evolution; northwest China

2 Data and Methods

2.1 Data Sources

This study utilized statistical data from 51 prefecture-level regions in Northwest China spanning the period 2000–2014. The dataset encompassed five key dimensions: demographic, economic, social, environmental, and land use indicators. All data were obtained from authoritative sources including the *China Statistical Yearbook for Regional Economy*, *China Urban Statistical Yearbook*, and provincial statistical yearbooks of Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang.

2.2 Evaluation Indicator System and Weights

An integrated evaluation index system was constructed comprising four secondary indicators: urban economic development quality, urban social development quality, urban eco-environmental quality, and urban-rural/regional integration quality. Each secondary indicator contained multiple tertiary indicators,

with weights determined through an Analytic Hierarchy Process (AHP) model refined by entropy technology to ensure objectivity.

presents the complete evaluation indicators and their corresponding weights for assessing urbanization quality in Northwest China. The weight distribution reveals that urban eco-environmental quality (0.2986) and urban social development quality (0.2596) constitute the primary components, reflecting the emphasis on sustainable and inclusive urbanization.

2.3 Grading Standards and Threshold Values

Grading standards were established based on international benchmarks, national standards, and the actual development conditions of Northwest China. Each indicator was classified into five quality levels: low, medium-low, medium, medium-high, and high. details the specific threshold values for each evaluation indicator, providing a standardized framework for comparative analysis across regions and time periods.

The multi-objective membership function was employed to calculate the degree of membership for each indicator across different quality levels. The linear interpolation formula is expressed as:

$$s_{\lambda ij} = \frac{k_{n+1} - k_n}{u_{n+1} - u_n} \times (x_{\lambda ij} - u_n) + k_n \quad \text{for} \quad u_n \leq x_{\lambda ij} \leq u_{n+1} \quad (1 \leq n \leq 5)$$

where $s_{\lambda ij}$ represents the membership degree, $x_{\lambda ij}$ is the actual value of indicator j for region i , k_n denotes the standard value for quality level n , and u_n represents the threshold value for quality level n .

3 Results

3.1 Temporal Variation of Urbanization Quality

The comprehensive urbanization quality index for Northwest China exhibited a gradual upward trend from 2000 to 2014, increasing from 0.4172 to 0.4240 [Figure 1: see original paper]. Despite this positive trajectory, the values remained consistently within the 0.4-0.5 range, indicating medium-quality urbanization throughout the study period. Notable fluctuations occurred during key transition years: a decline to 0.3609 in 2004, followed by recovery and eventual growth to 0.4664 by 2014.

Among the four secondary indicators, urban eco-environmental quality demonstrated the highest values but showed signs of recent deterioration. Urban social development quality experienced the most significant improvement, evolving from lower to higher quality categories. Urban economic development quality

remained in a transitional state between lower and medium levels, while urban-rural/regional integration quality, though the lowest among the four components, displayed a slow but steady increasing trend in recent years.

3.2 Spatial Variation of Urbanization Quality

The spatial distribution of urbanization quality across Northwest China's 51 prefecture-level regions revealed distinct patterns [Figure 3: see original paper]. Regions with medium-quality urbanization were widely distributed, forming the dominant pattern, while areas with lower and higher quality urbanization appeared sporadically. The spatial distribution of the four secondary indicators also exhibited strong regularities [FIGURE:4, FIGURE:5, FIGURE:6, FIGURE:7], though these patterns showed no significant correlation with population urbanization rates.

The urban economic development quality displayed considerable spatial heterogeneity, with higher values concentrated in provincial capitals and resource-rich regions. Urban social development quality showed a more balanced distribution, with improvement trends evident across most regions. Urban eco-environmental quality varied markedly, with better performance in areas with lower industrial density. Urban-rural/regional integration quality remained relatively low throughout the region, highlighting the persistent challenge of coordinated development.

4 Discussion and Conclusions

The analysis reveals that urbanization quality in Northwest China has maintained a medium level (0.4–0.5) throughout 2000–2014, with gradual improvement potential. The region faces the dual challenge of enhancing urbanization quality while managing quantity growth. The four-dimensional evaluation framework demonstrates that eco-environmental and social development aspects require particular attention, with the former showing deterioration trends and the latter offering improvement opportunities.

Policy implications suggest that Northwest China should implement differentiated strategies according to local conditions, promoting coordinated development across economic, social, environmental, and integration dimensions. The established index system provides a robust tool for monitoring and guiding New-type Urbanization strategies not only for Northwest China but also for similar arid and semi-arid regions.

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