Study on the Residential Pattern of Urumqi Based on Index Analysis Method: Postprint

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Abstract

As the capital city of Xinjiang, Urumqi serves as a crucial economic center in western China and plays a significant role in China's urban system structure. Research on Urumqi's population residential patterns provides guidance for the city's spatial planning. This study takes Urumqi as the research area, utilizing urban spatial expansion to verify the macro-characteristics of residential spatial pattern changes. Taking "residential pattern" as the entry point, we employ Moran's I and ArcGIS technology to analyze the residential patterns of populations with different attributes in this region. The results reveal that Urumqi's urban residential land primarily extends toward the Xinshi District in the northwest direction, expands in the Xishan (Western Mountain) direction, spreads along the Dongshan (Eastern Mountain) direction, and grows along the periphery of the old city district. Among different age groups, the clustering of school-age population and elderly population is relatively pronounced, whereas the clustering of working-age population is not significant. Regarding educational attainment, the Moran's I values for the proportion indicators of primary and junior high school population and college-educated and above population are relatively high, the oran's I value for the illiterate population proportion indicator is relatively low, and the high school population exhibits negative spatial correlation. From 2000 to 2016, the spatial differentiation indices for school-age population and elderly population increased across all areas, while the differentiation index for working-age population decreased in Shayibak District and Shuimogou District, indicating that the aging phenomenon is becoming increasingly prominent. Between 1990 and 2000, the illiterate population in Toutunhe District was in a relatively differentiated state; from 2000 to 2010, the differentiation level was high in Xinshi District; from 1990 to 2010, the differentiation phenomenon for primary and junior high school population, high school population, and college-educated and above population gradually decreased, the degree of mixed residence deepened, and residential differentiation phenomenon diminished.

Full Text

Preamble

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Residential Structure of Urumqi City Based on Index Analysis Method

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Abstract: As the capital city of Xinjiang, Urumqi is an important economic center in western China and plays a significant role in the national urban system. Studying the population living patterns of Urumqi could provide valuable insights for urban spatial planning. This paper takes Urumqi as the study area, uses urban spatial expansion to verify the macro-characteristics of residential pattern changes, and employs Moran's I and ArcGIS technology to analyze the residential patterns of different population attributes. The results indicate that urban residential land in Urumqi extends mainly in the northwest direction, the West Mountain direction, the East Mountain direction, and the outer edge of the old urban area. The agglomeration of middle-aged and elderly populations across different age groups is more pronounced, while the agglomeration of working-age population is not significant. Populations with different education levels—particularly those with primary and secondary school education and junior middle school education—show distinct patterns. The Moran's I value for primary/secondary school and junior middle school populations is higher than that for populations with different education levels. The illiterate population exhibits relatively low Moran's I values, while the high school population shows negative spatial correlation. The spatial differentiation index of school-age and elderly populations increased across all regions from 2000 to 2016, while the labor population differentiation index declined in Shayibake District and Shuimogou District, indicating that population aging is becoming increasingly evident. In 2000, the illiterate population was in a relatively differentiated state in Toutunhe District. The differentiation level was relatively high in Xinshi District from 2000 to 2010. From 1990 to 2010, the spatial mixing of populations with primary/junior middle school, senior middle school, and college-level education gradually deepened, and the phenomenon of residential differentiation decreased.

Keywords: Residential pattern; Spatial differentiation; Moran index; Urumqi City

1. Introduction

Urban residential patterns represent the spatial distribution characteristics of urban populations and reflect the degree of spatial differentiation among different social groups. Residential differentiation is a universal phenomenon in urban development, and its study has important theoretical and practical significance for urban planning and social development. Previous research on urban residential patterns has primarily focused on spatial distribution characteristics, influencing factors, and evolution mechanisms. In recent years, scholars have increasingly applied spatial analysis methods such as spatial autocorrelation and spatial regression to examine residential differentiation phenomena.

The spatial structure of residential patterns reveals the distribution characteristics of different social groups within urban space. Moran's I is an important indicator for measuring spatial autocorrelation, widely used to analyze the degree of spatial agglomeration of geographic phenomena. When Moran's I falls within the range of $[-1.0, 1.0]$, values greater than 0 indicate positive spatial correlation, values less than 0 indicate negative spatial correlation, and values equal to 0 indicate random spatial distribution. This paper employs Moran's I to analyze the spatial differentiation characteristics of different population groups in Urumqi.

1.1 Data Sources

The study utilizes Landsat 5 TM and Landsat 8 OLI_TIRS remote sensing imagery from 1990, 2000, 2010, and 2017. ArcGIS 10.4 software is used for image processing and spatial analysis. The spatial differentiation index is calculated based on population census data at the street/township level.

1.2 Methods

The research methodology involves calculating global and local Moran's I values to measure spatial autocorrelation. The spatial differentiation index is constructed to analyze the degree of residential differentiation among different population groups. The formula for Moran's I is:

$$I = \frac{n}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \cdot \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^{n}(x_i - \bar{x})^2}$$

where n is the number of spatial units, x_i and x_j are attribute values for units i and j, $\bar{x}$ is the mean value, and w_{ij} is the spatial weight matrix.

3. Results and Analysis

3.1 Spatial Differentiation of Age Groups

The global Moran's I values for different age populations in Urumqi (Table 2) show positive spatial autocorrelation for all age groups. The elderly population exhibits the highest Moran's I value (0.182437), indicating strong spatial agglomeration. The working-age population shows a moderate Moran's I value (0.104728), while the school-age population has a Moran's I of 0.133356, both suggesting significant but weaker spatial clustering compared to the elderly population.

Table 2 Global Moran's I Index of Different Age Populations in Urumqi

Age Group	Moran's I	VAR(I)	Z-score
Elderly	0.067532	-0.015385	0.006308
Working-age	0.014521	-0.015385	0.004173
School-age	0.059880	-0.015385	0.005842

The spatial differentiation index for different age groups in 2000 and 2016 (Table 3) reveals that the elderly population differentiation index increased in all districts, particularly in Toutunhe District (0.316) and Xinshi District (0.205). The school-age population differentiation index also increased, while the working-age population differentiation index decreased in Shayibake and Shuimogou Districts, indicating reduced spatial segregation among working-age residents.

Table 3 Spatial Differentiation Index of Different Ages in Urumqi for 2000 and 2016

Elderly District 2000	Elderly 2016	Working-age 2000	Working-age 2016	School-age 2000	School-age 2016
District 1 0.016	0.108	0.092	0.016	0.064	0.047
District 2 0.016	0.175	0.159	0.093	0.108	0.015
District 3 0.073	0.066	-0.007	0.135	0.134	-0.001

3.2 Spatial Differentiation of Education Levels

The global Moran's I values for different education levels (Table 4) demonstrate that the primary/junior middle school population exhibits the strongest positive spatial autocorrelation (Moran's I = 0.186829, Z-score = 7.399154). The illiterate population shows moderate spatial clustering (Moran's I = 0.097674,

Z-score = 4.149459). Notably, the high school population displays negative spatial autocorrelation (Moran's I = -0.015385), suggesting a dispersed distribution pattern.

Table 4 Global Moran's I Index of Different Education Levels in Urumqi

Education Level	Moran's I	VAR(I)	Z-score
Illiterate	0.097674	-0.015385	0.000742
Primary/Junior Middle	0.136283	-0.015385	0.000748
High School	-0.000027	-0.015385	0.000734
College+	0.186829	-0.015385	0.000747

The spatial differentiation index for education levels from 1990 to 2010 (Table 5) shows that the illiterate population maintained relatively high differentiation in Toutunhe District (0.420 in 2010). The primary/junior middle school population differentiation index decreased from 0.202 in 1990 to 0.124 in 2010 in some districts, indicating enhanced spatial mixing. The college-educated population showed increased differentiation in certain districts, reaching 0.482 in Xinshi District by 2010.

Table 5 Spatial Differentiation Index of Different Education Levels in Urumqi for 1990, 2000, and 2010

District	Illiterate 1990	Illiterate 2000	Illiterate 2010	Primary/Junior 1990	Primary/Junior 2000	Primary/Junior 2010
District A	0.016	0.066	0.202	0.016	0.082	0.284
District B	0.016	0.028	0.124	0.016	0.139	0.276
District C	0.130	0.206	0.279	0.468	0.221	0.210

The analysis reveals that from 2000 to 2016, the spatial differentiation index for school-age and elderly populations increased across all districts, while the working-age population differentiation index declined in Shayibake and Shuimogou Districts. This trend reflects the growing phenomenon of population aging and changing residential preferences among different age cohorts. For education levels, the spatial mixing of populations with primary/junior middle school, senior middle school, and college education gradually deepened between 1990 and 2010, indicating a reduction in residential differentiation based on educational attainment.

References

[16-18] Studies on urban residential patterns and spatial differentiation.
[19] Theoretical frameworks for urban social geography.
[20-21] Methodological approaches to spatial autocorrelation analysis.
[22] Applications of GIS in urban studies.
[24] Technical specifications for Moran's I calculation.

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