Original Research Article

Influencing factors of urban shrinkage in Shanxi province

Kaixi He, Yujun Pan, Yi Zhou, Zhengchao Ran

Yunnan Normal University, Kunming City, Yunnan Province, 650500, China

Abstract: As an aspect of urbanization, urban shrinkage has a significant impact on the development of cities. This paper analyzes the urban shrinkage status of each county in Shanxi Province based on the permanent population data of 2010, 2015, and 2020, using geographic detectors and other methods. The results show that: (1)The shrinking cities in Shanxi Province from 2010 to 2020 are mainly concentrated in the counties under city jurisdiction, and the shrinkage situation has not shown significant improvement.(2)The geographic detector analysis revealed that changes in the GDP growth rate, administrative level, and the straight-line distance to the nearest major city were the main factors contributing to urban shrinkage in Shanxi Province during the two periods. From 2015 to 2020, the change rate in the number of ordinary primary and secondary school students was also a significant influencing factor.

Keywords: Urban shrinkage; Geophysical detector; Shanxi province

1. Introduction

Urban shrinkage is a gradual phenomenon that manifests during the process of urbanization and is accompanied by population loss and sluggish economic development[1]. As a global phenomenon, the emergence of urban shrinkage poses significant challenges to the traditional urban development model. The definition of urban shrinkage has gone through a process of evolution from a single dimension to a multi-dimensional. For example, Zhang Shuai[2] and others believe that it should be considered comprehensively from the aspects of population, economy, and society. At present, it is internationally recognized that population loss is the core manifestation of urban shrinkage[3]. At the same time, the increase or decrease of population size is an important manifestation of urban vitality[4], and it is also the most sensitive factor in the development process of cities. Even when identifying urban shrinkage from multiple dimensions, it is based on the population dimension. Therefore, this paper argues that it is still reasonable to use a single resident population indicator to identify urban shrinkage. In terms of the spatiotemporal characteristics and influencing factors of shrinking cities, scholars at home and abroad have also done a lot of research. These studies provide a basis for policy research on urban shrinkage. At present, the emergence of other hot issues has expanded the research direction of urban shrinkage, such as the combination of urban shrinkage and carbon emissions[5], digital economy development[6], and high-quality development[7]. The in-depth discussion of these issues will deepen the understanding of the laws of urban development and optimize the governance of urban space.

Shanxi Province is a traditional resource-based city in China. In recent years, its economic development has lagged behind that of the eastern regions, leading to a gradual decline in its appeal to population. Shanxi Province has become one of the provinces experiencing significant population loss. Therefore, this paper analyzes the factors influencing urban shrinkage in Shanxi Province from a socio-economic perspective, using data from 2010, 2015, and 2020. The aim is to provide a reference for the province's territorial spatial planning and urban development.

2. Overview of the study area and data sources

2.1. Overview of the study area

Shanxi Province is located in north China. By the end of 2023, the permanent resident population of Shanxi Province was 34.6599 million, 153, 600 less than that at the end of last year. Among them, the permanent resident population in urban areas accounted for 64.97%. The GDP of Shanxi Province ranked 20th in the country.

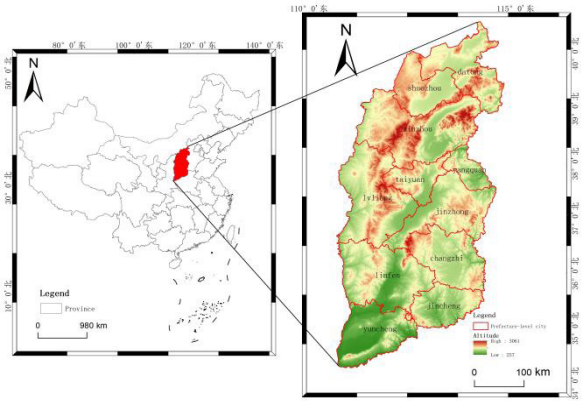

Figure 1. Location map of Shanxi province.

2.2. Data sources

The demographic and socio-economic data used in this paper are from statistical yearbooks and statistical bulletins of various regions; the straight-line distance to the nearest metropolis is directly obtained from the distance measurement function of the Gaode Map APP. The data that is difficult to obtain is supplemented by linear interpolation.

2.3. Research methods

(1) Shrinkage Model: $P_{m-n}=(\frac{P_m}{P_n}-1)*100\%$

P_m and P_n represent the number of permanent residents in each county and district of Shanxi Province at the end of years m and n, respectively. P_{m-n} indicates the degree of urban shrinkage; if $P_{m-n}> 0$, it indicates a growth state during that time period; otherwise, it indicates a contraction state.

(2) Geographic Detector: $q=1-\frac{1}{N\sigma^2}\sum_{h=1}^{L} N_h\sigma_h^2$

The q-value ranges between 0 and 1, with its magnitude reflecting the explanatory power of influencing factors on urban shrinkage: a higher q-value indicates stronger explanatory power of the factor for urban shrinkage, while a lower q-value signifies weaker explanatory power.

3. Analysis of the results of urban shrinkage

Referring to the research of domestic scholars the contraction intensity of each county in the study area was divided into four levels: urban growth ($P_{m-n}>0$), mild contraction ($-5\%<P_{m-n}<0$), moderate contraction ($-10\%<P_{m-n}<-5\%$), and severe contraction ($P_{m-n}<-10\%$). According to the shrinkage model, the shrinkage city was identified and visualized with ArcGIS, and the results are as follows:

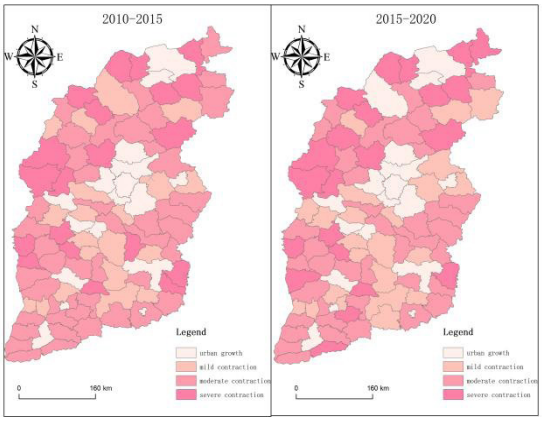

Figure 2. 2010 to 2015 and 2015 to 2020.

In terms of quantity, there were 85 and 84 counties in Shanxi Province that contracted from 2010 to 2015 and 2015 to 2020, accounting for 83.33% and 82.35% respectively. From 2010 to 2015, there were 20, 45 and 20 counties with young, moderate and severe contractions, respectively. From 2015 to 2020, there were 23, 39, and 22, respectively. Therefore, the counties and districts of Shanxi Province mainly showed a state of contraction, and the contraction situation did not improve significantly.From the perspective of the change rate of contraction, from 2010 to 2020, only Shuozhou City has changed from contraction to growth, and the rest of the districts and counties have continued to grow or contract. However, the rate of change in the degree of urban contraction has changed significantly. Among the more than 80% of the shrinking counties in Shanxi Province, 48.24% of the counties and districts are still deepening, such as Yingxian and Xingxian, among which the change rate of Tianzhen County has reached -9.13%, which should be particularly noteworthy.

4. Analysis of influencing factors of shrinking cities

In this paper, the rate of change of permanent population was taken as the dependent variable, combined with the socio-economic status of Shanxi Province, and 10 indicators were selected as independent variables to construct the index system of influencing factors of urban shrinkage in Shanxi Province. The selected factors are analyzed by using the geographic detector, and the results are as follows:

Table 1. Single-factor detection and analysis results of influencing factors of urban shrinkage.

	q 值		**p 值**	
	2010-2015	**2015-2020**	**2010-2015**	**2015-2020**
X_1(GDP growth rate)	0.0965	0.0921	0.2443	0.1874
X_2(Per capita GDP growth rate)	0.2925	0.2111	0.0005	0.0062
X_3(Change rate of total retail sales of social consumer goods)	0.0636	0.1264	0.8210	0.1572
X_4(Change rate of general public budget revenue)	0.2019	0.1552	0.0389	0.1454
X_5(Change rate of output value ratio of secondary industry)	0.1229	0.1374	0.2725	0.0443
X_6(Change rate of output value ratio of the tertiary industry)	0.0393	0.1240	0.8109	0.1684
X_7(Change rate of number of students in regular primary and secondary schools)	0.5048	0.2059	0.0000	0.0170
X_8(Change rate of beds in health institutions)	0.5048	0.1673	0.0740	0.0277
X_9(The straight-line distance to the nearest metropolitan area)	0.2908	0.2453	0.0027	0.0097
X_{10}(Urban administrative levels)	0.5019	0.4832	0.0000	0.0000

As shown in Table1, from 2010 to 2015, the five factors that passed the 0.05 significance test were ranked by their q values as follows: X_7>X_{10}>X_2>X_9>X_4. During this period, the primary factor affecting urban shrinkage in Shanxi Province was the rate of change in the number of students enrolled in ordinary primary and second-

ary schools(X_7). This is due to the relatively backward educational resources in Shanxi and the significant disparity between urban and rural education levels, leading local residents to prefer sending their children to areas with better educational opportunities. The second most significant factor was the administrative level of the city (X_{10}), as county-level cities and district-level cities are concentrated with high-quality regional resources, making them the main destinations for population migration within Shanxi. The third factor was the rate of change in per capita GDP(X_2), which reflects the direction of population migration influenced by the region's economic development. The fourth factor was the distance to the nearest major metropolitan area(X_9), as Shanxi, located at the intersection of the Beijing-Tianjin-Hebei, Guanzhong Plain, and Central Plains urban agglomerations, serves as a talent reserve for surrounding metropolitan areas due to its geographical proximity and economic disparities. The fifth factor, the lowest, was the rate of change in general public budget revenue(X_4), which primarily reflects a region's fiscal autonomy and is an important indicator of regional economic conditions, closely related to population migration.

From 2015 to 2020, the factors that passed the 0.05 significance test were ranked by their q-values as follows: $X_{10}>X_9>X_2>X_7>X_8>X_5$. Unlike the previous five years, the rate of change in general public budget revenue(X_4) did not pass the test. The new factor that passed the test is the rate of change in the proportion of the secondary industry's output (X_5). Shanxi Province, a major coal-producing province, has seen its economy significantly boosted by coal resources, which are a key pillar of the secondary industry. However, with the start of capacity reduction, the coal industry in Shanxi has rapidly declined, leading to a significant reduction in jobs and increased population migration. Another new factor is the rate of change in the number of hospital beds(X_8). As the aging population increases and the coal industry harms workers' health, medical standards have become a critical factor affecting local population migration.

5. Conclusion and discussion

5.1. Conclusion

Through the analysis of the spatial and temporal evolution and influencing factors of urban contraction in Shanxi Province, the following conclusions can be drawn:

(1)Shanxi Province is generally in a state of contraction. In the two periods, the number of counties and districts in contraction in Shanxi Province remains stable, and the change rate of contraction degree of 48.24% of counties and districts is negative, indicating that the contraction situation is more serious.

(2)The results of the factor detection of the geophysical detector show that the change rate of per capita GDP, administrative level and straight-line distance to the nearest metropolis are the main reasons for urban contraction in counties and districts of Shanxi Province during the two periods.

5.2. Discussion

In urban development, population is both a production factor and a consumer entity, playing a fundamental role. Population decline often results from economic downturns and resource depletion. Therefore, population indicators serve as a direct measure of urban shrinkage, with population loss being the core manifestation of this phenomenon. Thus, alleviating population loss is crucial for addressing urban shrinkage. Domestic scholars have proposed a series of suggestions, including adjustments to industrial structures. However, in the context of the 'strong provincial capital' strategy and negative population growth, people will continue to migrate to developed cities, particularly those represented by provincial capitals, leading to continued or even more severe shrinkage in smaller and medium-sized cities.

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