



Characterization of the Spatial Distribution of the Urban Poor in Chongqing

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ABSTRACT. The challenge of urban poverty is a far-reaching social and economic obstacle that persists as cities progress worldwide. In China, the swift pace of urbanization and the continued advance of socialist development have elevated urban poverty to a central focus for scholars in diverse fields. To investigate the dispersion of low-income residents in Chongqing Municipality, this study draws on multidimensional and spatial poverty theories. It employs SPSS 27.0 for correlation and regression analysis to pinpoint indicators influencing poverty distribution. These include altitude, terrain variation, overall water resources, bus route availability, the proportion of young and middle-aged individuals in the population, per capita disposable income, and average years of education for those aged 15 and above. Additionally, ArcGIS software is utilized for visualizing spatial data and generating thematic maps to analyze poverty distribution in Chongqing. By outlining the specific characteristics of this spatial pattern and exploring the contributing factors, the study identifies key insights. Ultimately, it proposes tailored recommendations in alignment with current poverty alleviation policies in Chongqing Municipality.

Keywords: impoverished urban residents, geographic dispersion, targeted poverty alleviation

1 Introduction

The challenge of urban poverty is a socio-economic phenomenon that is pervasive in the course of urban development worldwide ^[1]. Even though China achieved the milestone of constructing a moderately prosperous society in 2020 and met the objective of eradicating absolute poverty, it must still grapple with the pressing issue of relative poverty in the years ahead. This is particularly evident in light of the evolution of China's socialist market economy, which has led to a discernible trend of socio-economic disparities and residential segregation within urban spaces ^[2]. This has resulted in the emergence of what is referred to as an "urban poverty zone," drawing significant attention from scholars across various disciplines to the plight of impoverished urban inhabitants.

Research on the spatial distribution of the impoverished population within geography focuses on measuring the differences among this population. Related research in

China began relatively late and only gained attention towards the end of the 1990s. This was due to factors such as economic structural adjustments, reforms in state-owned enterprises, and the loosening of household registration management systems [3]. Liang Hanmei [4] and other scholars conducted comprehensive discussions on the dynamic changes in China's urban impoverished population. They depicted the composition structure and spatial differentiation of this population. In the study of Nanjing's urban poverty spatial survey and analysis, scholars like Gu Chaolin [5] pointed out that contemporary urban poverty in China exhibits decentralization characteristics. Dang Yunxiao [6] and others employed spatial autocorrelation analysis and factor ecological analysis to analyze large-scale statistical data, focusing on the social attributes, spatial distribution characteristics, and clustering types of the low-income population. However, the majority of existing research in China tends to focus on poverty management strategies, models, and qualitative analysis of the causes of poverty. This approach often results in homogenizing the poverty status within a region, attributing poverty to a single cause [7], which is not conducive to addressing the poverty problem with its differentiated characteristics and does not facilitate targeted and effective poverty management. To overcome these limitations, it is important to employ relevant scientific tools and techniques for the spatial analysis of the impoverished population.

By integrating a range of multidimensional geographic factors and applying spatial and mathematical analyses [8], this study identifies key indicators that influence the distribution of poverty. This approach affords a more comprehensive comprehension of the spatial patterns of poverty. Additionally, it allows for the identification of the various underlying causes of poverty, offering valuable insights for shaping policies aimed at alleviating and ultimately eradicating relative poverty within urban communities. This research trajectory carries substantial practical significance in the broader objective of tackling urban poverty.

2 Research methodology

2.1 Research Regional Overview

Chongqing, located in the southwest of China's inland, is characterized by a hilly and mountainous landscape, earning it the name "Mountain City." It is a composite city, with large urban areas and sizable rural regions (Fig. 1). In 2020, Chongqing had a total of 265,000 individuals living in poverty, equating to a poverty incidence rate of 1.6%. There were 1,919 poor villages identified with poverty cards, representing 29.8% of the total number of administrative villages in the city. These poor villages are mainly concentrated in 10 districts and counties in the southeast and northeast regions of Chongqing.

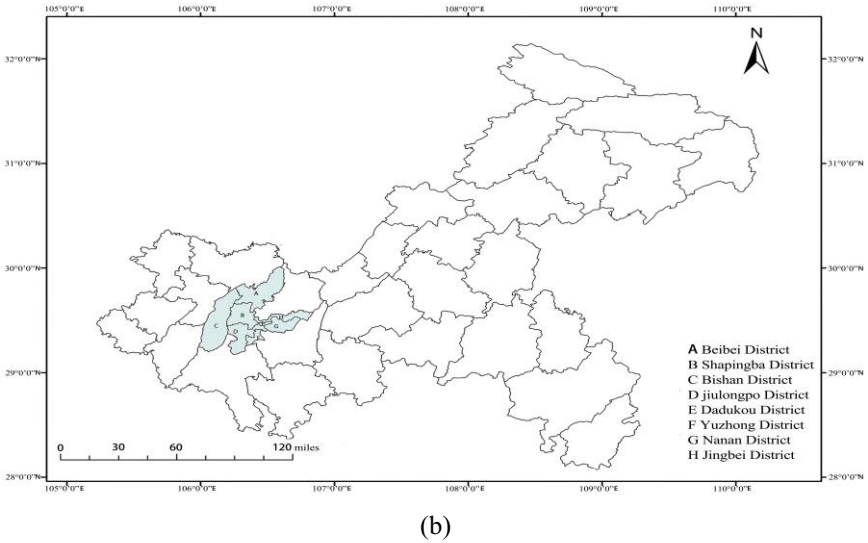
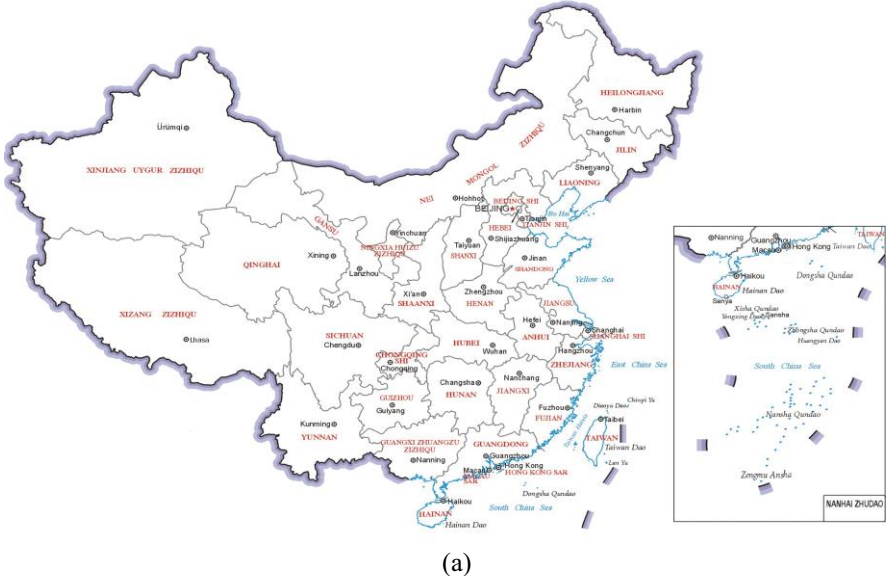


Fig. 1. (a) Location map of Chongqing (b) Main urban area of Chongqing

2.2 Sources of research data

The choice of using data from the year 2020 is indeed significant, as it marks a crucial milestone for China's poverty eradication efforts. During this year, China achieved decisive victories in its battle against poverty. Given that 2020 is a notable year for poverty eradication, obtaining comprehensive and accurate data is highly probable.

For this study, the main sources of data include the 2021 Chongqing Statistical Yearbook, official websites of Chongqing districts^①, relevant government departments, and spatial data extracted from the Geospatial Data Cloud^②. These sources ensure access to reliable and up-to-date information, allowing for an accurate analysis of the spatial distribution of poverty in Chongqing.

2.3 Research Methodology and Selection of Indicators

Step 1: Utilizing SPSS 27.0, we conducted correlation and regression analyses to identify the factors that impact the distribution of poverty. The framework for these influencing factors encompassed four main categories: topography, transportation, economy, and population. These categories were selected based on prior research findings and the specific circumstances of Chongqing. To ensure precision, the data underwent two rounds of processing. The resultant indicators encompass altitude (measured in meters), terrain variation, total water resources (measured in cubic meters), count of public transportation routes, proportion of young and able-bodied individuals in the population, gender ratio (percentage of males and females), residents' disposable income (measured in thousand yuan), and years of education for individuals aged 15 years or older (measured in years). These indicators will be employed to scrutinize and comprehend the factors that influence the distribution of poverty in Chongqing.

It is required to investigate the relationship between the indicators of the influencing variables and the prevalence of poverty on the basis of the indicators chosen. First, Table 1 below shows the findings of the correlation analysis with the incidence of poverty as the dependent variable and the eight influencing factors as the independent variables.

Table 1. Pearson Related - Standard Format

Indicators	Poverty incidence rate (%)	Unit
Altitude	0.516**	m
Terrain undulation	0.555**	Degree
Total water resources	0.550**	m ³
Number of bus routes	-0.392*	Thousand dollars
The proportion of young and middle-aged people in the total population	-0.350*	%
Gender ratio	0.297	%
Per capital disposable income	-0.586**	Strips
Average years of education for population aged 15 and above	-0.391*	Years

Based on the analysis, it is evident that significant correlations exist between the prevalence of poverty and various contributing factors. Altitude, terrain variation, and total water resources demonstrate a notable positive association with poverty rates. Conversely, the availability of public transportation routes and the proportion of young adults in the population exhibit meaningful negative correlations with poverty. Gender

① <https://www.cq.gov.cn/>

② <https://www.gscloud.cn/#page1>

ratio doesn't show any discernible correlation with poverty, while both disposable income and years of education exhibit significant negative relationships. Noteworthy is the strong connection observed between topographical elements like altitude, terrain variation, and total water resources with poverty rates. Excluding gender ratio, Table 1 can be adjusted to highlight the identified factors influencing the distribution of the impoverished population in this study. Following the successful establishment of the indicator system, a Principal Component Analysis (PCA) was conducted. The analysis showed that the model has an extraction sums of squared loadings of 74.83%. This indicates that the seven selected indicators can account for 74.83% of the variation in poverty incidence, signifying the meaningfulness of the model construction.

Step 2: To enhance the effectiveness of summarizing findings, visualization tools are utilized^[9]. In this research, ArcGIS software is employed to visualize spatial data and generate thematic maps, facilitating the analysis of poverty distribution in Chongqing.

Step 3: Following the analysis, policy recommendations are developed to tackle urban poverty in Chongqing, taking into account variations across districts and counties. The overarching objective is to eradicate relative poverty and attain shared prosperity within urban areas.

3 Characteristics of the spatial distribution of the poor population in Chongqing

3.1 Characteristics of the overall spatial distribution of the poor

This study analyzed the distribution of the poverty population in Chongqing Municipality using the poverty incidence rate as an indicator. We focused on 38 districts and counties as our unit of analysis, studying the evolution of poverty characteristics from 2015 to 2020. In 2015, the majority of the impoverished population in Chongqing City was located in the northeast and outskirts of the main urban area, with the highest concentration in the northeast. Specifically, Wanzhou District and Jiangjin District had the highest number of poor individuals, while Chengkou County and Wuxi County had a minimal impoverished population. Within the city, Dadukou District, Chengkou County, Yubei District, and Yongchuan District had the lowest number of poor individuals. In 2020, the majority of the impoverished population still resided in northeastern Chongqing, particularly in Wanzhou District and Kaizhou District, indicating a relatively high level of poverty in these areas. However, when compared to 2015, there was a significant reduction in the impoverished population in the peripheral districts and counties of the main urban area. Overall, the overall degree of poverty within Chongqing City remained relatively low. Dadukou District, Chengkou County, Yubei District, Tongnan District, Bishan District, Wuxi County, and Tongliang District had a relatively lower impoverished population, with Dadukou District and Chengkou County being particularly noteworthy in this regard. In conclusion, the number of poor individuals in Chongqing has experienced a significant downward trend over the past

five years, with no substantial change in spatial distribution, which remained concentrated in the northeastern part of the city. However, the districts and counties on the periphery of the main urban area witnessed a significant reduction in poverty levels, highlighting the positive impact of relevant policies and measures (Fig. 2).

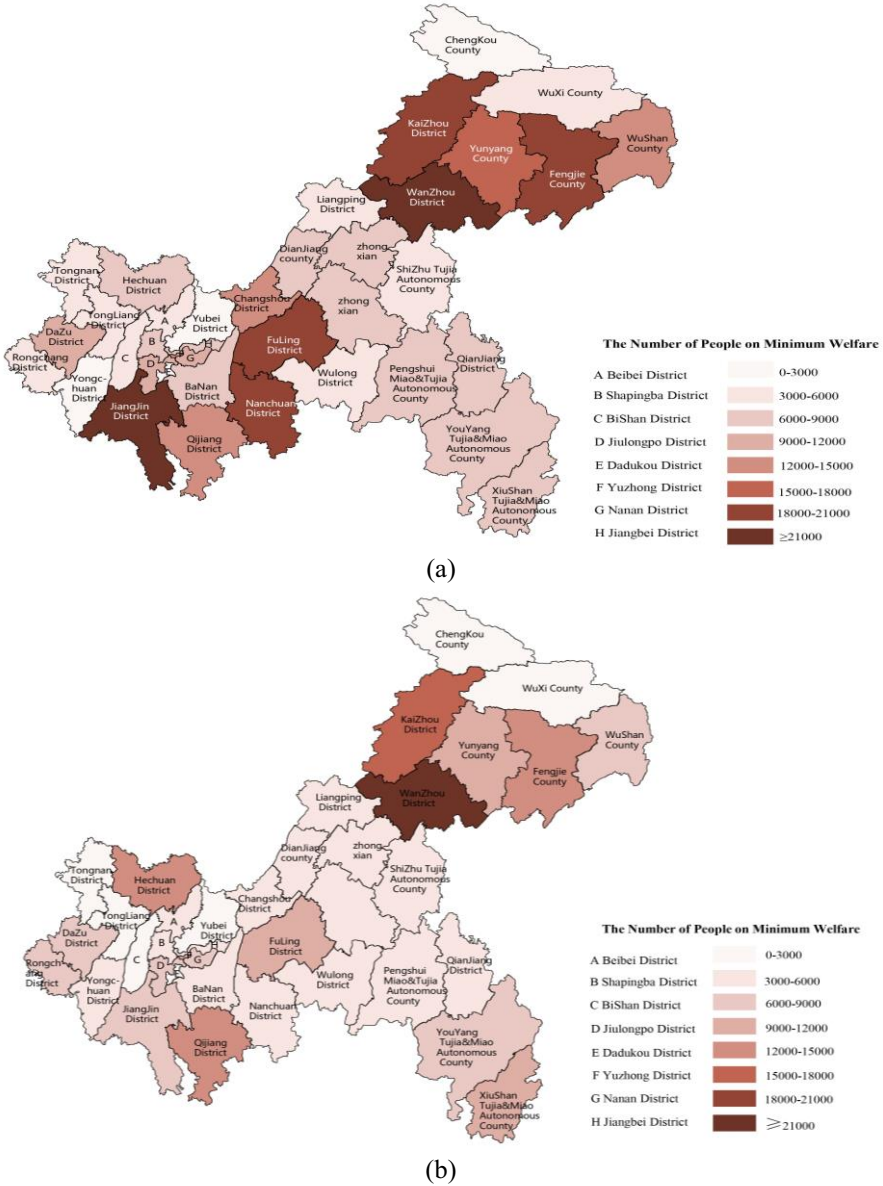


Fig. 2. (a) Spatial distribution of poor people in Chongqing in 2015; (b) Spatial distribution of poor people in Chongqing in 2020

From 2015 to 2020, there has been a significant reduction in the impoverished population in Chongqing Municipality. Specifically, the poverty population decreased by 110,565 individuals during this five-year period. This decline corresponds to a decrease in the poverty incidence rate by 29.5% overall (Fig.3). These statistics highlight the substantial changes that have occurred in the poverty population of Chongqing Municipality over the past five years. It also showcases the effectiveness of various measures implemented to alleviate poverty and provide assistance to those in need, as these efforts have yielded remarkable results.

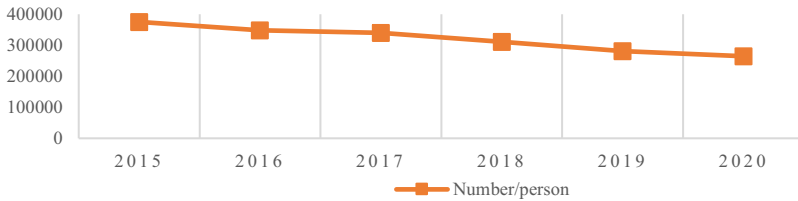


Fig. 3. Poverty in Chongqing over the years

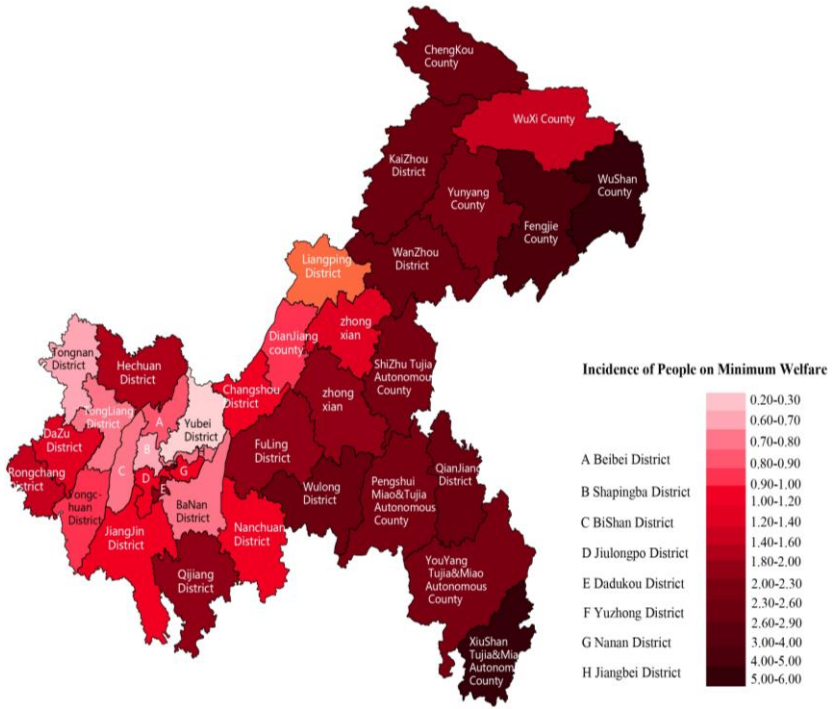
3.2 Comparative analysis of poverty incidence and poverty density

The poverty incidence rate is a vital indicator used to evaluate poverty eradication efforts. It measures the percentage of individuals below the national poverty line in a given year relative to the total population [10]. This indicator serves as a standardized national measurement of poverty level changes in a region, disregarding other poverty-related factors. The data used for this calculation is derived from a single source, making it an idealized method of measurement commonly used in practical assessments [11]. The formula for calculating the poverty incidence rate is as follows:

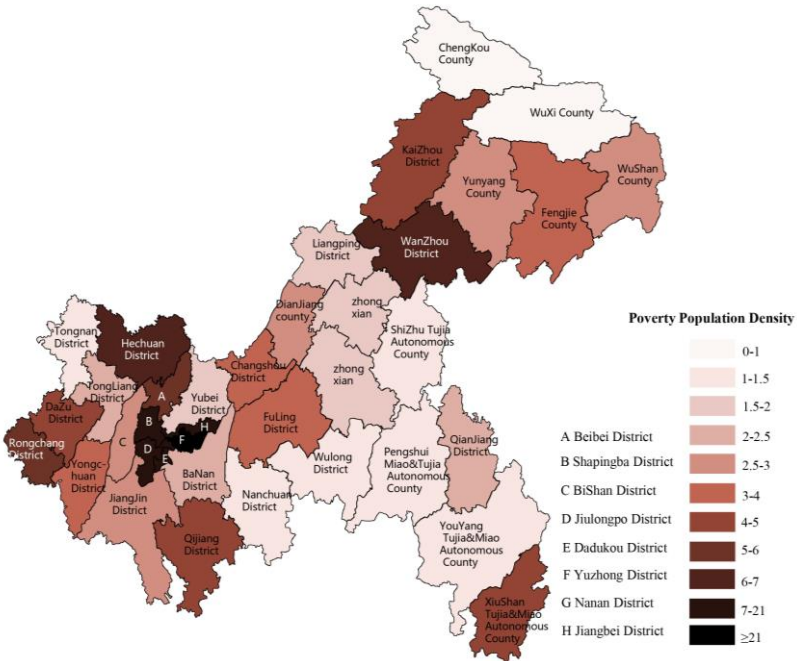
$$PH = q/n \times 100\%$$

PH represents the incidence of poverty, *q* represents the number of people below the national poverty line for a particular year, and *n* represents the total population.

Based on the statistical data analysis, the total population of individuals living in poverty in Chongqing Municipality in 2020 amounts to 264,654, resulting in a poverty incidence rate of 1.57%. The density of impoverished individuals is measured at 3.21 people per square kilometer. To provide a visual representation of poverty distribution, the poverty incidence data for the 38 districts and counties in Chongqing Municipality is presented in a zoning map. Additionally, the poverty population density is depicted hierarchically in the zoning map using the natural breakpoint method in ArcGIS. The poverty incidence rate is then transformed into graphical form and superimposed onto the poverty population density distribution map using ArcGIS (Fig. 4).



(a)



(b)

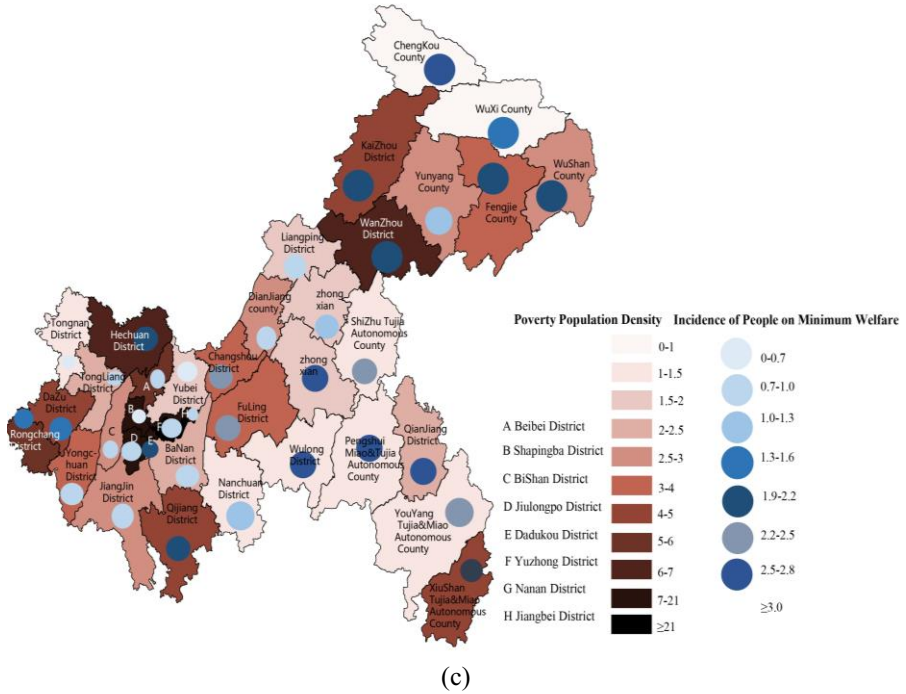


Fig. 4. (a) Spatial distribution of poverty incidence in 2020; (b) Spatial distribution of poverty population density in 2020;

(c) Spatial overlay of poverty incidence and poverty density in 2020

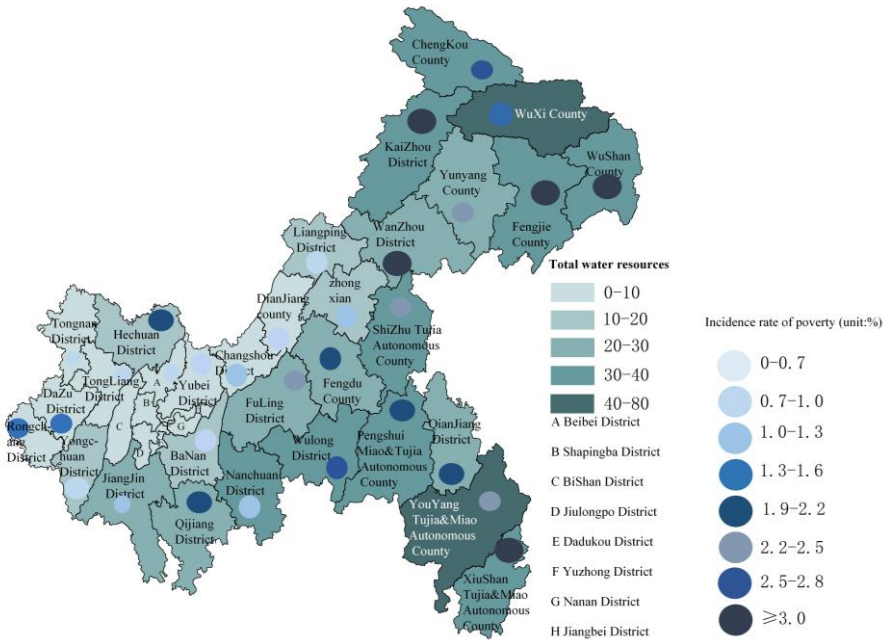
Out of the 38 districts and counties within Chongqing Municipality, 17 of them exhibit a poverty incidence rate equal to or higher than 1.57%, constituting 44.7% of the total. Similarly, 16 districts and counties display a poverty population density of 3.21 persons per square kilometer or higher, accounting for 42.1% of the total. Xiushan County shows the highest poverty incidence rate at 5.46%, while Yubei District has the lowest poverty incidence rate at 0.23%. Regarding poverty population density, Yuzhong District has the highest value with 45.07 persons per square kilometer, while Chengkou County has the lowest value at 0.58 persons per square kilometer.

The distribution of poverty incidence and poverty population density in Chongqing Municipality has both similarities and differences. The northeastern region consistently exhibits higher poverty levels, while the central region has relatively lower poverty levels. The poverty incidence rate shows a concentrated pattern, with high values in the east and low values in the west, gradually decreasing from east to west. In contrast, the poverty population density is more dispersed, with higher values in the western and northeastern parts of the city. Chengkou and Wuxi counties have the lowest poverty population density, while the central region has relatively low levels. The main urban area of Chongqing has a relatively low poverty incidence rate but the highest poverty population density, indicating a concentration of impoverished individuals in this area.

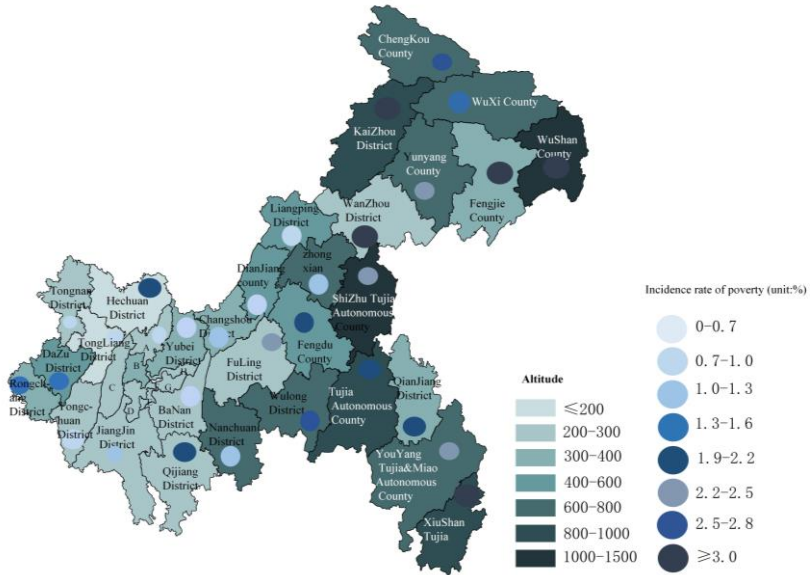
4 Analysis of Influencing Factors on the Poverty Population in Chongqing

By superimposing the spatial distribution maps of poverty incidence and its underlying causes in Chongqing Municipality, this study employed a regression model to grasp the effect of factors leading to poverty on the distribution of the impoverished population. This analysis enabled us to pinpoint the elements that influence the spatial dispersion of the impoverished populace in Chongqing Municipality. Subsequently, we conducted a comprehensive examination to provide recommendations for eradicating relative poverty and fostering inclusive prosperity across urban areas.

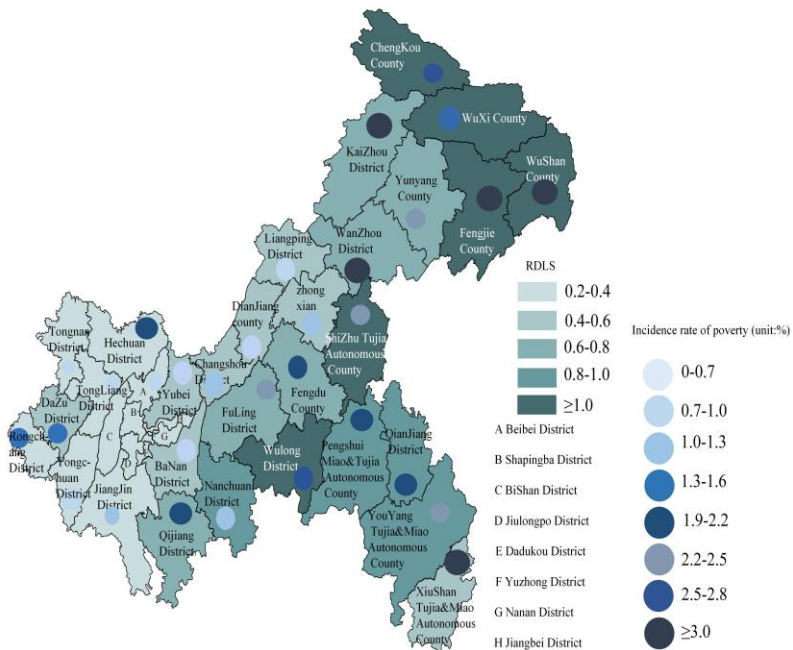
Initially, the study focused on the impact of terrain factors, specifically total water resources, altitude, and terrain undulation, on the distribution of the impoverished population. Figure 5 illustrates a comparison between the distribution map of poverty incidence and the map of topographic factors. Regression analysis was conducted, with poverty incidence as the dependent variable and the three influencing factors as independent variables. A logarithmic regression function was selected, displaying a high level of model fit, as illustrated in Figure 6.



(a)



(b)



(c)

Fig. 5. (a) Spatial overlay of total water resources and poverty incidence; (b) Spatial overlay of altitude and poverty incidence; (c) Spatial overlay of terrain undulation and poverty incidence

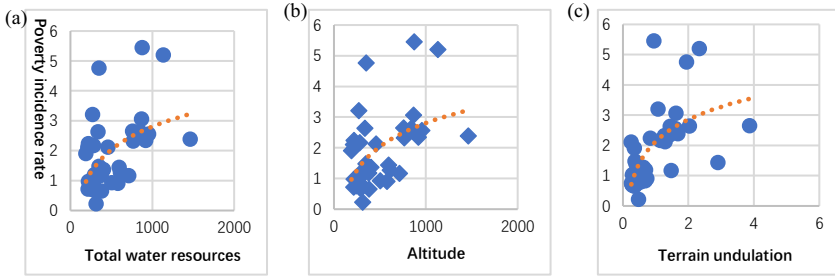


Fig. 6. (a) Scatterplot of total water resources superimposed on the incidence of poverty; (b) Scatterplot of altitude superimposed on the incidence of poverty; (c)

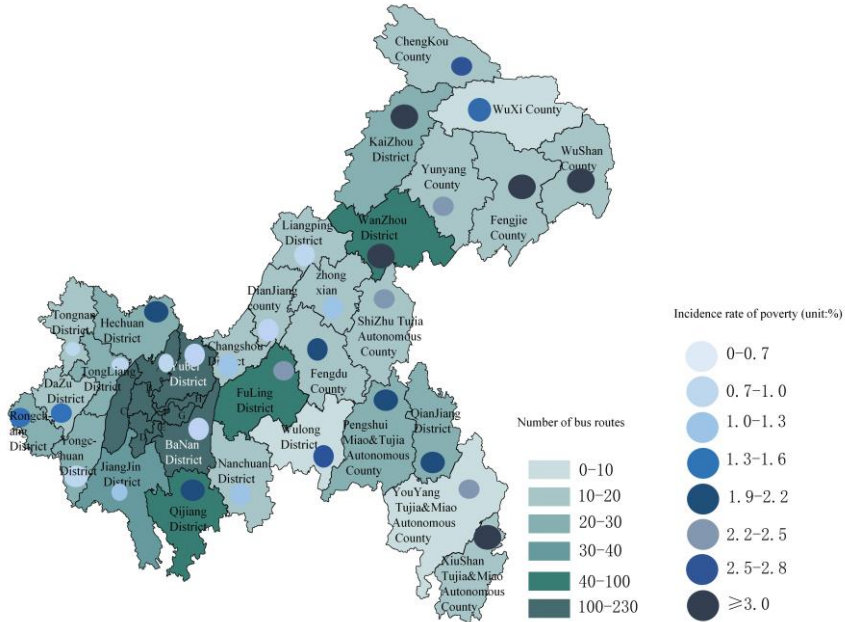
In Chongqing city, the presence of abundant water resources and a well-developed water system contribute to the favorable conditions for agriculture and animal husbandry. This, in turn, improves the environmental carrying capacity and leads to a concentration of population and various economic activities^[12]. However, when other geographic factors such as mountainous terrain and significant ground undulations are present, the carrying capacity of the land is reduced. This restricts the development of the region and consequently increases the incidence of poverty.

The average poverty incidence in Chongqing is 1.57%, and it is found that areas with a higher poverty incidence tend to be located at elevations of 700 meters or above. There is a certain correlation between the incidence of poverty and the degree of terrain relief in Chongqing. The spatial distribution of terrain relief in Chongqing shows higher values in the eastern and southern parts, with the highest values in Chengkou County and the lowest in Yuzhong District. The overall poverty incidence rate is higher in the western region compared to the central region, with lower values concentrated in urban areas like Yuzhong District. Furthermore, the general trend of higher poverty incidence in areas with greater ups and downs holds true. For instance, areas like Wushan County, Wuxi County, and Fengjie County with higher terrain variation also exhibit higher poverty incidence, while areas like the main urban area and Yubei District with lesser terrain variation have lower poverty incidence.

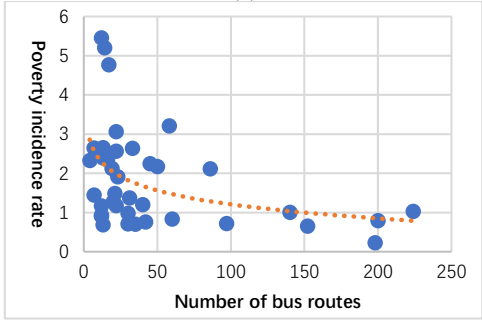
The saying "To get rich, build roads first" has gained popularity and consensus among people. When analyzing the reasons behind the "China Miracle", it becomes evident that the construction of transportation infrastructure has played a crucial role. In the eastern coastal areas, where residents have higher incomes compared to the central and western regions, the overall level of transportation infrastructure is also significantly more advanced. This indicates a close correlation between the level of transportation infrastructure and economic development in different regions^[13].

In this context, the study incorporates the number of bus routes as a traffic-related influencing factor to assess the distribution of the impoverished population. Spatial analysis of poverty incidence in Chongqing Municipality reveals a noteworthy pattern: areas with lower poverty rates tend to exhibit a more extensive presence of public transportation infrastructure. This is evident in regions like Yubei District in the central urban area, Banan District, as well as areas with a denser network of transportation routes

in the southwest, such as Tongnan District and Hechuan District, where poverty incidence is comparatively lower. The correlation between the distribution of public transportation and poverty incidence is visually depicted in Figure 7. Furthermore, regression analysis is included to gain a deeper understanding of this relationship.



(a)

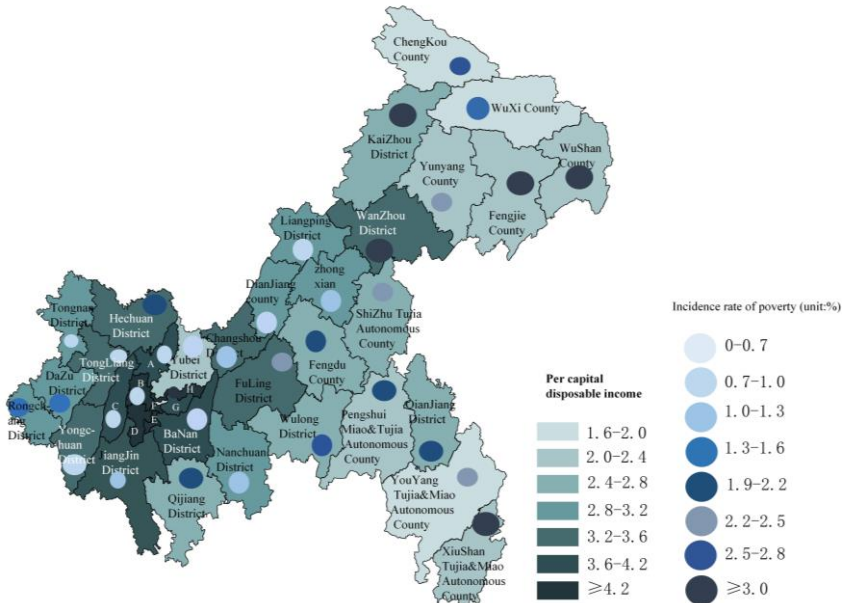


(b)

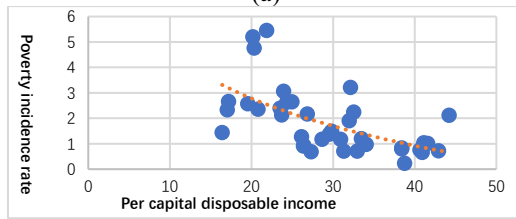
Fig. 7. (a) Spatial overlay of number of bus routes and incidence of poverty; (b) Scatterplot of number of bus routes superimposed on the incidence of poverty

Next, the per capita disposable income of residents is considered as an economic factor to examine the distribution of the impoverished population. Utilizing spatially analyzed data on poverty occurrence, a map depicting the distribution of poverty incidence is generated. This map is then overlaid with the per capita disposable income of residents. Following this, a regression analysis is performed using this overlay, as depicted in Figure 8.

In Chongqing, the per capita disposable income amounts to approximately 30,824 yuan, while the average poverty incidence rate stands at 1.6%. It is observed that regions within Chongqing that exhibit higher per capita disposable incomes tend to have lower rates of poverty. This is particularly noticeable in the main urban areas and the southwestern part of Chongqing. On the other hand, regions with relatively lower per capita disposable incomes, such as the southeastern and northeastern parts of Chongqing, experience higher poverty incidence. In these areas, a majority of the population has a per capita disposable income that is below the overall average of 30,824 yuan in Chongqing. Interestingly, certain localized areas defy the expected correlation between income and poverty rates. For instance, the Wanzhou District demonstrates a higher incidence of poverty compared to its income level, yet it also boasts relatively higher per capita disposable incomes.



(a)



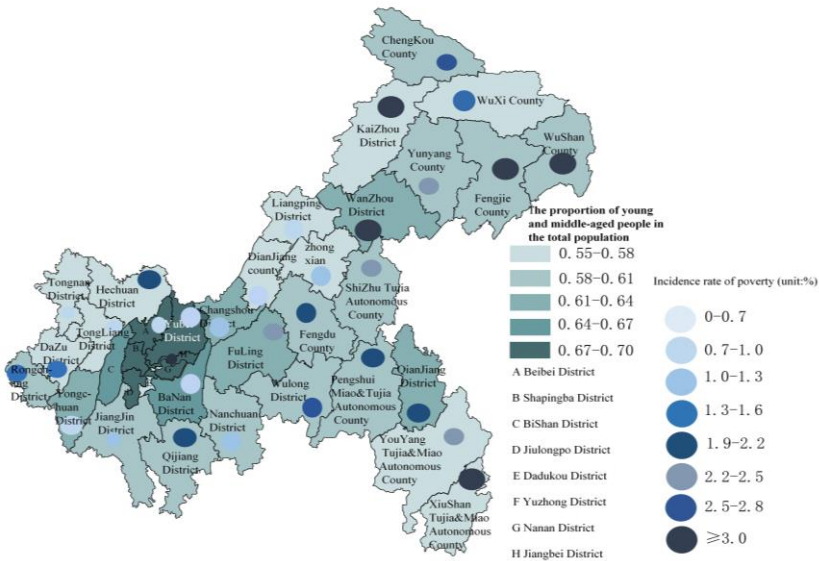
(b)

Fig. 8. (a) Spatial overlay of per capital disposal income of citizens and incidence of poverty; (b) Scatterplot of per capital disposal income of citizens superimposed on the incidence of poverty

Lastly, considering the proportion of young adults in the overall population and the average years of education for individuals aged 15 and above as demographic factors, we examine the distribution of the impoverished population. In Chongqing Municipality, young adults are defined as individuals aged 15-59. In 2020, this demographic is projected to reach 1994.54 million, constituting 62.22% of the total population.

As demonstrated in Figure 9 and Figure 10, areas with a significant concentration of young adults in Chongqing are predominantly situated in the primary urban zones of the southwest, along with surrounding districts and counties. Noteworthy areas include Yuzhong, Dadukou, Jiangbei, Shapingba, Jiulongpo, Nanan, Beibei, and Yubei districts, where the proportion of young adults is highest, at 69.61%. Conversely, eastern districts and counties, known for their higher poverty rates, display a notably lower percentage of young adults, averaging no more than 60.00%. Furthermore, districts and counties in the northwestern and southern regions, located farther from the primary urban areas, also demonstrate a lower percentage of young adults, with a minimum of 57.47%. A clear correlation emerges between regions with a higher proportion of young adults and a lower incidence of poverty, as opposed to regions with a relatively smaller proportion of young adults, which tend to experience higher poverty rates.

One significant factor influencing the proportion of the poor population is the level of education. Individuals with fewer years of schooling and lower education levels are more likely to fall into poverty [14]. This study examines the average years of education among individuals aged 15 and above in each district and county as an example. By overlaying the spatial data of poverty incidence with the distribution map of the average years of education, the researchers conduct regression analyses to determine the relationship between lower poverty incidence in regions with higher average years of education and higher poverty incidence in regions with relatively lower average years of education.



(a)

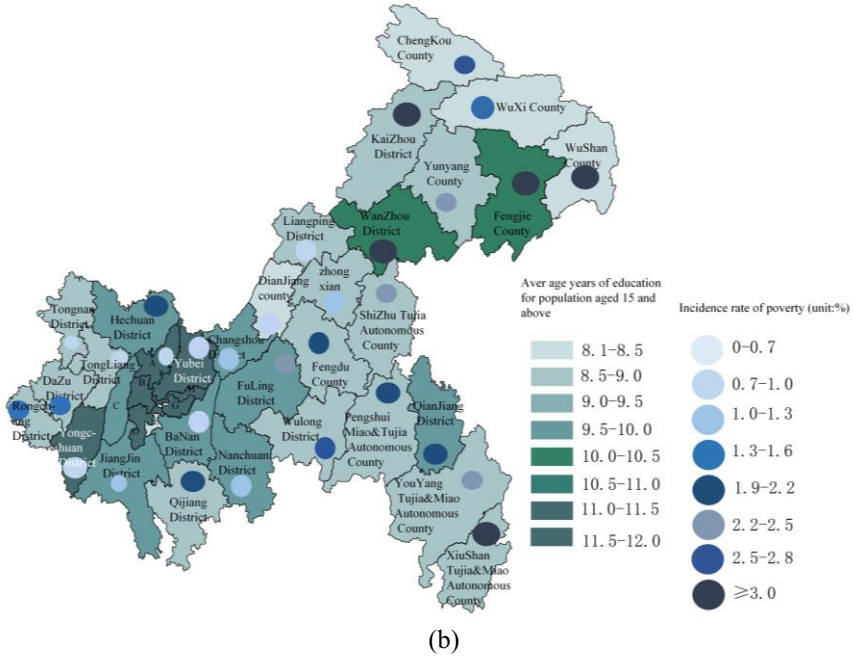


Fig. 9. (a) Spatial overlay of the proportion of young adults in the total population and incidence of poverty; (b) Spatial overlay of average years of education for population aged 15 and above and incidence of poverty

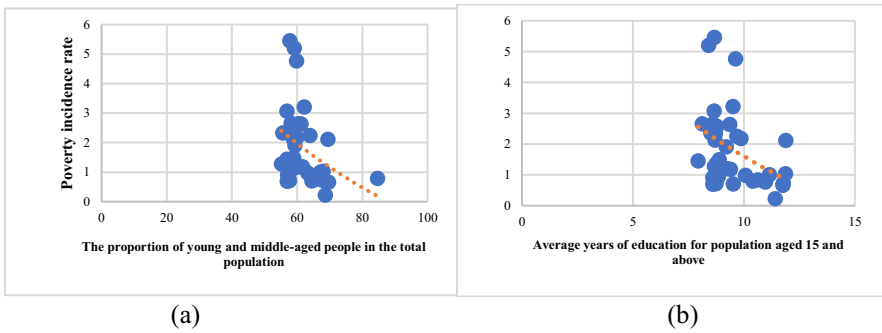


Fig. 10. (a) Scatterplot of the proportion of young and middle-aged people in the total population superimposed on the incidence of poverty; (b) Scatterplot of average years of education for population aged 15 superimposed on the incidence of poverty

5 Suggestions

In light of the aforementioned findings, this study compiled a set of poverty alleviation policies [15] and initiatives that Chongqing Municipality has implemented or plans to introduce in order to address the issue of poverty.

(1) Strengthening infrastructure: The Chongqing Municipal Party Committee and municipal government have placed significant emphasis on improving the impoverished counties and districts. One of their main priorities is the planning and construction of transportation infrastructure. A particular focus is addressing the challenge of "mountain high roads." Efforts have been made to provide subsidies for village road upgrades, increasing the subsidy from 500,000 yuan to 550,000 yuan per kilometer. The objective is to ensure that all townships and villages have access to hardened roads. Additionally, consideration is given to connecting natural villages with larger populations to these upgraded roads. The provision of electricity to all impoverished villages has been accomplished, while efforts to enhance broadband network coverage have been deepened. Furthermore, a long-term management and care mechanism has been established to ensure the safety of rural drinking water projects.

(2) Integration of population planning and poverty alleviation and development: Chongqing Municipal Government integrates population planning with poverty alleviation and development. It aligns policies with local needs, focusing on improving benefits, public services, facilities, and mobile services in population and family planning. Specialized training and knowledge exchange are prioritized in impoverished areas to enhance team capacity. This initiative is in line with state-level guidance on this integration.

(3) Education for Poverty Alleviation: Chongqing Municipality has implemented education policies to alleviate poverty, focusing on improving opportunities for disadvantaged students. This includes renovating schools, enhancing high school facilities in impoverished areas, and strengthening financing for economically challenged students. Additionally, efforts have been made to promote cultural resource-sharing projects for wider accessibility.

6 Conclusions

The analysis utilized data from the Seventh Population Census of Chongqing Municipality and Chongqing Municipal Statistical Yearbook, along with information on the incidence of poverty in the region. The objective was to examine the general characteristics of the spatial distribution of the impoverished population and determine whether there were any correlations in their geographical distribution. The study's primary focus and key conclusions are outlined as follows.

The spatial distribution of poverty in Chongqing Municipality reveals a notable pattern. Firstly, there is a higher concentration of poor individuals in the northern areas compared to the southern regions. Specifically, the northeast exhibits a larger number of impoverished individuals, while the southwest has a relatively lower concentration of poverty. Moreover, when examining the density of poverty in different areas, it is observed that the northeast and southwest directions have a higher density of poverty, while the central region experiences a relatively lower density. This distribution pattern suggests an incremental increase in poverty as one moves from the middle towards the sides of the region.

Furthermore, this research utilizes districts as the primary units of analysis to examine how poverty-causing factors impact the spatial distribution of poverty within counties. These factors are classified into four key categories: topography, transportation, economy, and population. To summarize the findings, among the topographic factors investigated, both elevation and topographic relief exhibit significant associations with the incidence of poverty. Higher elevation is linked to a greater incidence of poverty, while increased topographic relief also corresponds to a higher poverty rate. However, no significant correlation is observed between watershed distribution and the incidence of poverty. Within the transportation factors, the public road network displays a stronger correlation with poverty rates. Higher road concentration is associated with a lower incidence of poverty, underscoring the significance of well-developed transportation infrastructure for poverty alleviation. In terms of economic factors, there is a noteworthy correlation between the disposable income of residents and the incidence of poverty. Areas with higher disposable incomes tend to experience lower poverty rates, emphasizing the role of economic well-being in poverty reduction efforts. Demographic factors also play a role, with the age composition, and average years of schooling demonstrating correlations with poverty rates. A lower average number of years of schooling among individuals aged 15 and older corresponds to a higher poverty rate, further highlighting the importance of education in poverty reduction strategies.

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