Spatial Poverty Differentiation Characteristics, Poverty Reduction Needs, and Poverty Alleviation Strategies in the Oasis-Desert Ecotone of Arid Regions: A Case Study of Hotan Prefecture, Xinjiang (Postprint)

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Abstract

The oasis-desert ecotone in arid areas is characterized by harsh natural environments, backward social development, weak economic foundations, low population quality, and pervasive poverty. Based on spatial poverty theory, GIS spatial analysis techniques, and the TOPSIS model, this study investigates the spatial poverty levels, causes of poverty, and their obstacle degree indices in the Hotan region, and proposes corresponding poverty alleviation countermeasures and recommendations. The results indicate: (1) First-level poverty areas in the Hotan region include Hotan County (0.528 0) and Minfeng County (0.466 3); second-level poverty areas include Pishan County (0.387 1), Yutian County (0.378 8), Hotan City (0.371 5), Cele County (0.348 3), and Moyu County (0.325 7); third-level poverty areas include Luopu County (0.221 3). (2) The top five poverty reduction needs in the Hotan region include: means of production (86.8%), capital (85.5%), housing (74.3%), education and training (67.0%), and drinking water (64.7%). In response to the spatial poverty differentiation characteristics and poverty reduction needs of the study area, corresponding countermeasures and recommendations are proposed from the aspects of improving public infrastructure, implementing labor transfer and employment initiatives, developing characteristic and advantageous industries, improving production and living conditions, and intensifying efforts in education and training as well as financial support.

Full Text

Preamble

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Abstract

The oasis and desert ecotone in arid areas is characterized by harsh natural environments, lagging social development, weak economic foundations, low population quality, and widespread poverty. Based on spatial poverty theory, GIS spatial analysis technology, and the TOPSIS model, this paper examines the spatial poverty grade, causes of poverty, and obstacle indices in Hotan Prefecture, Xinjiang, and proposes corresponding countermeasures and suggestions for poverty alleviation.

The results show: (1) The first-level poverty areas in Hotan Prefecture include Hotan County (0.5280) and Minfeng County (0.4663); second-level poverty areas include Pishan County (0.3871), Yutian County (0.3788), Hotan City (0.3715), Cele County (0.3483), and Moyu County (0.3257); and third-level poverty-stricken areas include Luopu County (0.2213). (2) The main factors contributing to poverty in Hotan Prefecture are poor natural conditions, lack of infrastructure, lagging livelihood development, single economic output structure, and high proportion of ethnic minority population. (3) The top five poverty reduction needs in the Hotan region are: production means (86.8%), funds (85.5%), housing (74.3%), education and training (67.0%), and drinking water (64.7%). According to the different characteristics of spatial poverty and the demands of poverty reduction in the research area, corresponding countermeasures and suggestions are proposed from the aspects of improving public infrastructure, implementing labor transfer programs, developing characteristic advantageous industries, improving production and living conditions, strengthening education and training, and providing financial support.

Keywords: oasis and desert ecotone in arid area; spatial poverty; TOPSIS

model; Hotan Prefecture

1. Introduction

The oasis and desert ecotone in arid regions exhibits characteristics of poor natural environment, lagging social development, weak economic foundation, low population quality, and widespread poverty. According to spatial poverty theory, combined with GIS spatial analysis technology and the TOPSIS model, this study investigates the spatial poverty classification, causes of poverty, and obstacle indices in Hotan Prefecture, Xinjiang.

Previous research has examined poverty measurement methods [1-4], poverty spatial distribution characteristics [5-6], and poverty reduction strategies [7-8]. Spatial poverty theory emphasizes the interaction between natural environment and socioeconomic factors [9-10], while GIS technology provides effective tools for poverty spatial analysis [11], and TOPSIS model offers multi-criteria decision analysis methods [12-13].

2. Methods

2.1 Study Area

Hotan Prefecture is located in the southernmost part of Xinjiang, covering an area of 24.78×10 km². The region features an extremely arid climate, with a desert area accounting for 2% of the total. The terrain consists of mountains, basins, and plains, forming a typical oasis-desert ecotone (Figure 1). The prefecture comprises eight county-level administrative units: Hotan City, Hotan County, Moyu County, Pishan County, Luopu County, Yutian County, Minfeng County, and Cele County.

2.2 Data Sources and Indicators

Data were obtained from the Xinjiang Statistical Yearbook (2016), Hotan Statistical Yearbook (2015), and field surveys conducted in 2018. A total of 28 indicators were selected across five dimensions: natural environment, infrastructure, livelihood development, economic output, and social development.

2.3 TOPSIS Model

The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is a multi-criteria decision analysis method that ranks alternatives based on their proximity to the ideal solution [19]. The calculation steps are as follows:

(1) Construct the normalized decision matrix $\{x_{ij}\}_{m\times n}$, where $m = 8$ (representing 8 counties) and $n = 28$ (representing 28 indicators). For benefit-type indicators, use the original value; for cost-type indicators, use $(1-x_{ij})$ for normalization.

(2) Determine the weight vector w_j for each indicator using the entropy method [13].

(3) Construct the weighted normalized matrix $\{z_{ij}\}_{m\times n} = \{y_{ij} \times w_j\}$.

(4) Determine the positive ideal solution z^+ and negative ideal solution z^-:

$$z^+ = \{z_1^+, z_2^+, ..., z_n^+\}$$

$$z^- = \{z_1^-, z_2^-, ..., z_n^-\}$$

(5) Calculate the distance of each alternative from the ideal solutions:

$$d_i^+ = \sqrt{\sum_{j=1}^{n}(z_{ij} - z_j^+)^2}, \quad i = 1, ..., m$$

$$d_i^- = \sqrt{\sum_{j=1}^{n}(z_{ij} - z_j^-)^2}, \quad i = 1, ..., m$$

(6) Calculate the relative closeness coefficient:

$$c_i = \frac{d_i^-}{d_i^+ + d_i^-}$$

where c_i ranges between 0 and 1. Higher values indicate better performance (lower poverty).

2.4 Obstacle Index Model

The obstacle index identifies factors hindering poverty reduction [12]:

$$\phi_i = \frac{w_j y_{ij}}{\sum_{j=1}^{n} w_j y_{ij}}$$

where ϕ_i represents the obstacle degree of factor i, w_j is the weight of indicator j, and y_{ij} is the normalized value.

3. Results

3.1 Spatial Poverty Classification

The poverty indices for each county were calculated using the TOPSIS model (Table 1). The results show significant spatial variation in poverty levels across Hotan Prefecture.

Table 1. Poverty indices of counties in Hotan Prefecture

County	Poverty Index	Poverty Level
Hotan County	0.5280	First-level
Minfeng County	0.4663	First-level
Pishan County	0.3871	Second-level
Yutian County	0.3788	Second-level
Hotan City	0.3715	Second-level
Cele County	0.3483	Second-level
Moyu County	0.3257	Second-level
Luopu County	0.2213	Third-level

The average poverty index for the prefecture is 0.3715. Hotan County and Minfeng County exhibit the most severe poverty, with indices exceeding 0.46. Luopu County shows relatively lower poverty severity.

3.2 Analysis of Poverty Factors

The obstacle index analysis reveals that the primary factors contributing to poverty are: 1. Natural environment constraints (accounting for 19.54% of obstacles) 2. Lack of infrastructure (19.06%) 3. Limited livelihood development (13.98%) 4. Single economic structure 5. High proportion of ethnic minority population

3.3 Poverty Reduction Needs Survey

Field surveys identified the top five poverty reduction needs: 1. Production means (86.8% of households) 2. Funds (85.5%) 3. Housing (74.3%) 4. Education and training (67.0%) 5. Drinking water (64.7%)

4. Discussion and Recommendations

4.1 Infrastructure Improvement

Priority should be given to developing transportation, water conservancy, and information infrastructure. The road network density in Hotan Prefecture is only 0.03 km/km², far below the national average. Investments in irrigation systems and drinking water facilities are urgently needed.

4.2 Livelihood Development

Implement employment transfer programs to increase non-agricultural income. Develop characteristic advantageous industries such as tourism, specialty agriculture, and ethnic handicrafts. Strengthen vocational training to enhance labor skills.

4.3 Industrial Development

Develop the "four-in-one" industrial structure combining agriculture, processing, services, and e-commerce. Promote the development of red dates, walnuts, and cashmere products with geographical indications. Support the growth of rural cooperatives and family farms.

4.4 Social Development

Improve housing conditions through relocation programs for extremely poor areas. Enhance education quality and increase enrollment rates. Strengthen financial support through micro-credit and poverty alleviation funds.

4.5 Policy Implications

Differentiated policies should be implemented based on poverty levels: - First-level poverty areas: Focus on infrastructure and basic living conditions - Second-level areas: Emphasize industrial development and employment creation - Third-level areas: Concentrate on sustainable development and poverty prevention

5. Conclusion

This study demonstrates significant spatial heterogeneity in poverty across Hotan Prefecture. The TOPSIS model effectively evaluates comprehensive poverty levels by integrating multiple indicators. Natural environment constraints and infrastructure deficits are the primary obstacles. Targeted measures addressing production means, funding, housing, education, and water access are essential for effective poverty alleviation.

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