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Analysis on the Spatial Differentiation Characteristics of Poverty Risk Caused by Disaster under the Stress of Geological Disasters – A Case Study of Sichuan Province

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Abstract

Research on the poverty risk caused by disasters in disaster - prone areas is a useful exploration to coordinate social economic development with disaster prevention and reduction, and is of great significance to regional sustainable development. Based on statistical data and spatial data, this paper takes Sichuan Province as the typical research area. Remote sensing and geographic information technology are used to study the poverty risk caused by disasters based on the quantitative evaluation of geological disasters risk and regional development level. the spatial differentiation characteristics of poverty risk caused by disasters are explored on the 1 km × 1 km grid scale. The results indicate that: (1) The overall risk of geological disasters in Sichuan Province is relatively high, with high and relatively high risk areas accounting for more than 40%, low and relatively low risk areas accounting for less than 30%. The risks in Mountain and Ravine Areas are significantly higher than other areas. (2) The regional development level in Sichuan Province is relatively high, but with significant the spatial differences. The development level of high-altitude areas and remote mountainous areas is quite different from that of the Chengdu Plain in the middle Sichuan Province. the problem of uneven development in the east, middle, and west is prominent. (3) The poverty risk caused by disasters is high, and the spatial pattern presents a characteristic of "high in the west and low in the east" with high positive spatial correlation. High - High Cluster Areas are mainly distributed in western and southwestern Sichuan. Low - Low Outlier Areas are mainly distributed in Chengdu Plain and Hilly Areas of Sichuan Basin. High - Low Outlier and Low - High Outlier Areas occupy a relatively small percentage with scattered distribution. This paper provides a reference for the coordinated management of disaster prevention and reduction, as well as social and economic development in underdeveloped areas.

1. Introduction

Looking back on the history of world development, natural disasters, diseases and epidemics have always been accompanied by the development of human society, resulting in a large number of casualties and heavy economic losses (Li et al 2020). China is a mountainous country with mountain areas accounting for 69.4% of the total land, and population in those areas accounting for more than one-third of the whole population. With complex and diverse geographical environments, the unique energy gradient in the mountain area usually induced geological disasters such as debris flow, landslide and collapse, causing serious loss of people's lives and property accompany by restricting regional development (Cui 2014). Due to geographical constraints, the economic development of mountain areas is lagging. All the 14 contiguous poverty-stricken areas in China before 2020 are in mountain areas, where low-income people are concentrated. The fragile ecological environment, frequent disasters and backward social as well as economic development have led to 20% of China's poor farmers being impoverished caused by disasters, which is ranking second among the factors causing poverty. Through the fight against poverty, China has eliminated absolute poverty and achieved remarkable achievements in disaster prevention, mitigation and relief to reduce poverty. And now the governance of relative poverty will focus on the work of agriculture, rural areas and farmers.

Recently, more and more scholars begin to pay attention to the relationship between poverty and disaster. Human and economic vulnerability to related disasters is highly related to economic development level (Wu et al 2018). World economic and social development has greatly promoted the human poverty reduction. However, disasters, wars, climate change and other factors have seriously restricted the process of global sustainable poverty reduction (Li et al 2020). From the perspective of the relationships among economic poverty, disaster risk and environmental degradation, economic poverty is the external driving force of the vicious cycle of "frequent disaster-ecological degradation-poverty intensification" (Ding et al 2013, Andrew and Mikhail 2017). Disasters will have direct or indirect short-term or long-term impacts and injuries on different levels of countries, regions, families, individuals, etc., especially on rural families in developing countries (Gignoux and Menéndez 2016). The asset stock of low-income families in disaster-prone areas is not enough and being vulnerable, which not only makes their assets vulnerable to lose, but also seriously worsens their income sources in the future, and then affects their post-disaster reconstruction and recovery capacity thus makes them fall into the persistent poverty trap (Bidisha et al 2021, Sakai et al 2017, Carter and Barrett 2006).

In recent years, scholars have made positive progress on the coupling among geographic patterns of poverty , poverty and geographic environmental factors (Berberich 2019; Elwood et al 2017; Jessie et al 2016, Zhou 2021, Li et al 2020). Poverty has a geographical spatial attribute (Besagni and Borgarello 2019, Iparraguirre 2012). Bird and Shepherd (2003) Pointed that the spatial poverty trap is the area with a small stock of "geographic capital" and high incidence of poverty. There is a coupling between economic poverty, disaster risk and environmental degradation.the poor tend to be concentrated in remote areas with poor natural environment,backward infrastructure and public service capacity (Ding et al 2013, Zhou 2021). The economic structure of agriculture in poverty-stricken areas is relatively homogeneous, and the livelihood of farmer is extremely dependent on natural resources and ecosystem services. so, the geographical distribution of environmental vulnerability and poverty is highly coupled (Barbier 2010). Disaster-prone areas have stronger social vulnerability, it is crucial to rely on community strength to cope with disasters (Kirby et al 2019, Rampengan et al 2014). Given this, some scholars have studied the relationship between the threat of geological disasters and the willingness of farmers relocation and discuss the livelihood issues of farmers under the stress of geological disasters (Xu et al 2017).

At present, most scholars focus on the natural attributes of geological disasters, but lacking researches on the social attributes between disasters and regional development, especially the quantitative evaluation from the geospatial perspective. Therefore, this paper is taking Sichuan Province as an research interest, and construct a geological disaster poverty risk evaluation model based on the relationship between disasters and regional development. the paper also quantitatively studies the poverty risk caused by disasters and its geospatial pattern in Sichuan Province, and provide a theoretical basis for coordinated management and administration of geological disasters and relative poverty.

2. Study Area and Data Sources

2.1 Overview of the Study Area

The geographical environment of Sichuan Province is complex, mainly mountains, plateaus and hills. The geological structure is changeable, the neotectonics is active, the geological disasters are frequent, and the spatial distribution types and development characteristics are different. The total area of geological disaster-prone areas accounts for 97% of the total land area of Sichuan province, which is one of the provinces with the most severe geological disasters in China. At the same time, Sichuan has four contiguous poverty-stricken areas before 2020, namely, the Qinba Mountains, the Wumeng Mountains, the Yi Area in Liangshan Mountain and the Tibetan-related areas in Sichuan, along with 88 poverty-stricken counties. At the end of 2013, the rural poverty population was 6.25 million, making it one of the impoverished counties and provinces with the most impoverished population in China.

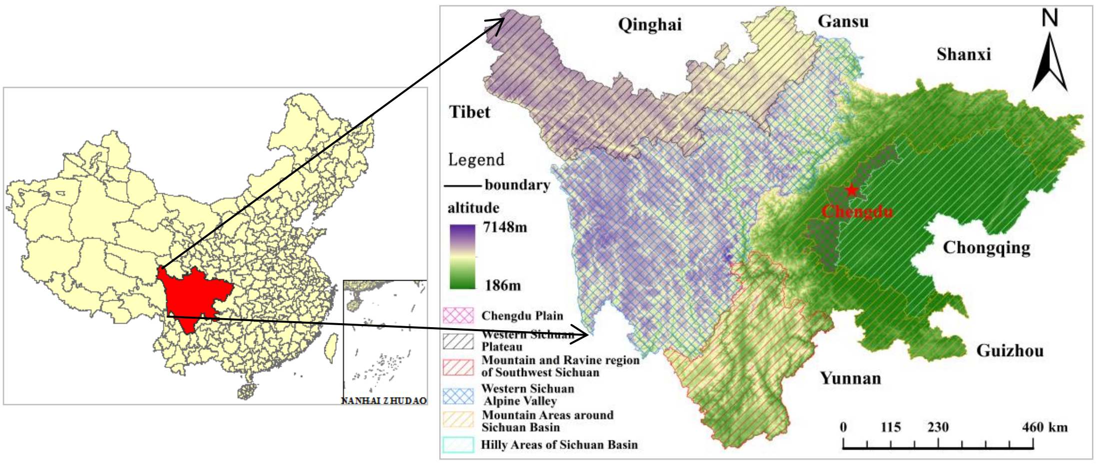

Figure 1 The Location of Sichuan Province

2.2 Data Sources and Processing

The data used in this paper mainly include spatial data, socioeconomic data and demographic data as follows. (1) Spatial data: 90m resolution DEM and 250m vegetation index data from Geospatial Data Cloud (http://www.gscloud.cn/); data of 35047geological disaster points are from Resources and Environmental Science and Data Center (http://www.resdc.cn/); engineering geological rock groups that classified according to the 1:500000 digital geological map of Sichuan Province; rainfall and other meteorological data from China Meteorological Data Network, (http://data. cma.cn); data on arable land, residential area, river system from Sichuan Land Use Change Data in 2018; traffic vector data from Geographic Data Sharing Infrastructure, College of Urban and Environmental Science, Peking University (https://geodata.pku.edu.cn/). (2) Socioeconomic and demographic data: per capita GDP, per capita disposable income of residents, average salary, number of primary and secondary schools are from the 2019 Sichuan Provincial Statistical Yearbook and the statistical yearbooks of cities; water resources data are from the 2019 Sichuan Provincial Water Resources Bulletin; data on medical and health institutions from 2019 Sichuan Provincial Medical and Health Yearbook.

All the data were entered into GIS geodatabase after preprocessing. Furthermore, the projection and coordinate system of all the data were transformed into UTM84N and WGS-84 projection,by GIS software.

3. Methods

3.1 Geological Disaster Risk Assessment

3.1.1 Deterministic Coefficient Method

The amount of information can objectively reflect the contribution of evaluation factors to the risk of geological disasters under different classification standards. The greater the index is, the higher the risk of geological disasters will be. Combined with the content of information, this paper uses the certainty factor (CF) to determine the weight. CF was proposed by Shortliffe and Buchanan (1975), which is usually used for sensitivity analysis of different factors, and gradually used for calculating the weight of each factor (Liang et al 2019). The method is as following:

$$CF=\begin{cases}\dfrac{PP_a-PP_s}{PP_a(1-PP_s)} & (PP_a\geq PP_s)\\[2ex] \dfrac{PP_a-PP_s}{PP_s(1-PP_a)} & (PP_a\leq PP_s)\end{cases} \tag{1}$$

In this formula, PP_a is the ratio of the number of geological disasters in factor a to the area of factor a; PP_s is the ratio of the number of geological disasters in the study area to the area of the study area. The variation range of CF is [-1,1]; a positive value indicates a high certainty of geological disaster occurrence, which is more likely to occur; a negative value represents a lower certainty of geological disaster occurrence, which is less likely to occur; when the calculation result is close to 0, it means that the factor cannot determine whether the geological disaster is likely to occur in this classification.

The weight ω_i is calculated as follows,

$$\omega_i=CF_{(i,\max)}-CF_{(i,\min)} \tag{2}$$

In the formula, $CF_{(i,\ max)}$ is the maximum value to determine the coefficient in each classification of factor *i*, and $CF_{(i, min)}$is the minimum value to determine the coefficient in each classification of factor *i*.

3.1.2 Risk Assessment Method

The disaster index is an indicator reflecting the scale of geological disasters in each evaluation unit, and the calculation formula is as follows,

$$V_i = \sum_{i=1}^{n} \omega_j \times y_j \qquad (j = 1,2,\Lambda\ n) \tag{3}$$

In this formula, V_i is the evaluation unit. V_i is the comprehensive risk index of geological disasters of the evaluation unit. ω_j is the weight value of the evaluation index *j* of the evaluation unit *i*. y_j is the normaliezed value of the evaluation index *j* of the evaluation unit *i*.

3.1.3 Geological Disaster Risk Assessment Index

Combining relevant research (Liang et al 2019, Luo et al 2020) and field investigation, the paper comprehensively considers topography, land cover, lithology, meteorology, hydrology. We selects 7 indicators as the risk assessment factors of geological disasters. The evaluation index system is shown in Table 1.

Table 1 Geological Disaster Risk Assessment Index System

Indicator	Weight (W_i)
Slope (°)	0.1673
Relief degree of land surface (m)	0.1233
Elevation (m)	0.2205
Vegetation coverage	0.1077
Engineering geological rock group	0.1424
Distance from fault (km)	0.0981
Daily mean maximum precipitation for years (mm)	0.1407

3.2 Regional Development Level Evaluation Method

3.2.1 Comprehensive Development Index Method

(1) Comprehensive Development Index

The Comprehensive Development Index (CDI) is used to reflect the comprehensive development level in the study area. the larger the index value, the richer the region will beand vice versa.. The CDI could be calculated as following (Liu et al 2020).

$$CDI = \sum_{i=1}^{n} \left(\sum_{j=1}^{m} F_{ij} \omega_{ij} \right) \omega_i \tag{4}$$

In the formula: *CDI* is the comprehensive development index; F_{ij} is the indicator value after standardized processing, ω_{ij} represents the index weight; ω_i represents the dimension weight; *n* is the number of dimensions, and *m* is the number of indicators corresponding to a certain dimension.

(2) Data normalized

The evaluation indicators of CDI include both positive and negative values.

Therefore, the standardization of data in this paper adopted the extreme difference standard method, and the specific formulas are as follows:

$$\text{positive indicator: } Y_{ij} = \frac{X_{ij} - X_{\min}}{X_{\max} - X_{\min}} \tag{5}$$

$$\text{negative indicator: } Y_{ij} = \frac{X_{\max} - X_{ij}}{X_{\max} - X_{\min}} \tag{6}$$

In those formulas, Y_{ij} is the indicator value after standardized processing; X_{ij} is the original data of the evaluation index *j* of the county *i* in Sichuan Province. X_{max} and X_{min} are the maximum and minimum values of the evaluation index *j*, respectively.

(3) Calculation of Index Weight

The calculation method of index weight can be divided into subjective method and objective method. In order to reduce subjective biases in expert judgments, incomplete data and objective biases caused by data quality problems, the Analytic Hierarchy Process (AHP) and Entropy Method are used to calculate weights, respectively (Ni et al 2009, Chen et al 2009). then the subjective and objective weights are added to get the comprehensive weight.

3.2.2 CDI Evaluation System

According to specific research needs, the relationships between research results and socioeconomic development level in Sichuan Province are considered (Alkire and Foster 2011, Schleicher et al, 2018, Jin et al 2020, Liu et al 2020). and we measured CDI from four dimensions (resource, economic, income, education & medical care) and 18 indicators (Table 2).

Table2 CDI Evaluation System

Dimension	**Indicator**	**Combination weight (W_{ij})**
Resource endowment	Per capita area of cultivated land area (hm^2 / person)	0.0795
	Per capita water resources (m^3 / person)	0.0346
	Per capita village area (m^2 / person)	0.0497
	Transportation resources (Km / km^2)	0.0720
The level of economic development	Per capita GDP (10^4 yuan¥)	0.0276
	Urbanization rate (%)	0.0330
	General public budget revenue (10^8 yuan¥)	0.0267
	Total investment in fixed assets (10^8 yuan¥)	0.0309
	Employment situation (10^4 people)	0.0560
Income level	Per capita disposable income (yuan¥)	0.0644
	average salary (yuan¥)	0.0350
	per capita grain output (kg / person)	0.0797
	Rural poverty incidence (%)	0.1966

	Number of primary and secondary schools	0.0132
	Teacher-student ratio	0.0216
Education & medical care service	Medical and health institutions	0.0453
	Number of beds per thousand registered population (Bed / 1000 people)	0.0478
	Health technical personnel (people)	0.0367

3.3 Evaluation Method of the Poverty Risk Caused by Geological Disaster

According to the general risk assessment formula, the poverty risk caused by geological disasters consists of geological disaster risk and the regional development level (Tian and Zhang 2016). The formula is as follows:

$$R_m = \sum V_i \times CDI_j \tag{7}$$

In this formula, R_m is the risk index of poverty caused by geological disasters. The higher the index , the higher the poverty risk caused by disasters is. V_i is the risk of geological disasters. CDI_J is a regional comprehensive development index.

The evaluation process of poverty risk caused by geological disasters is shown in Figure 2.

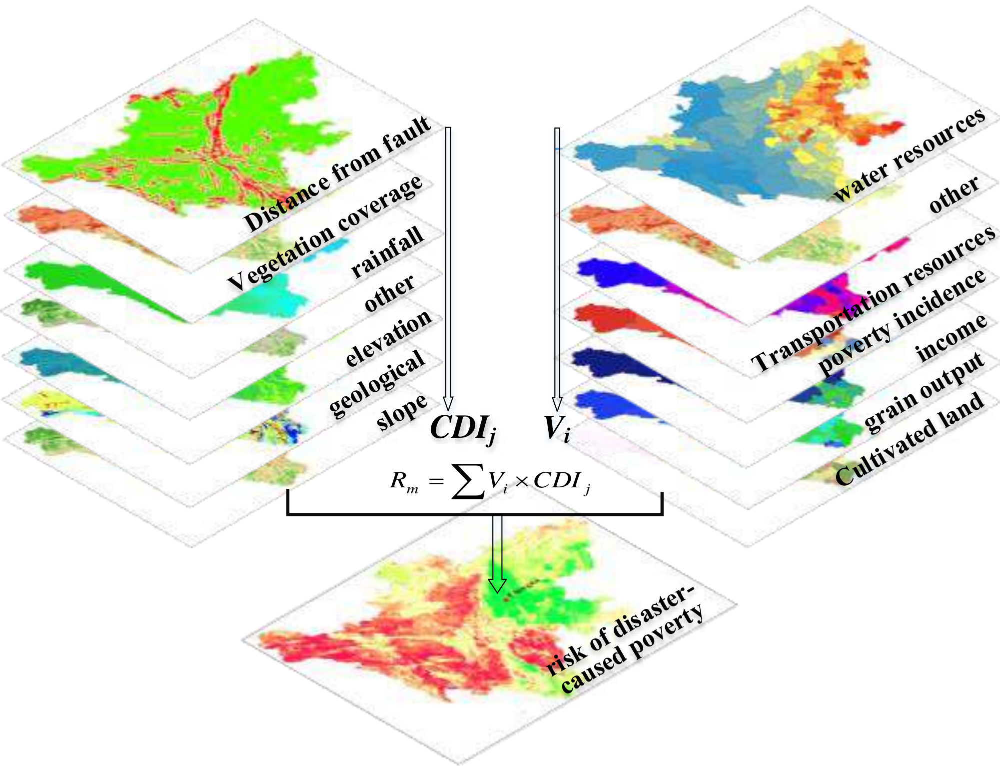

Figure 2 The Evaluation Process of Poverty Risk Caused by Geological Disasters

3.4 Exploratory Spatial Analysis Method

3.4.1 Global Spatial Autocorrelation

Global Moran’s I is used to describe the spatial differentiation characteristics of poverty risk caused by disasters in the study area. The formula is as follows:

$$I = \frac{n\sum_{i=1}^{n}\sum_{j=1}^{n} w_{i,j}\left(x_i - \bar{x}\right)\left(x_j - \bar{x}\right)}{\sum_{i=1}^{n}\sum_{j=1}^{n}\omega_{ij}\sum_{i=1}^{n}\left(xi - \bar{x}\right)^2} \qquad (8)$$

In this formula, w_{ij} is the spatial weight; x is the mean value of the attribute; x_i and x_j are the attribute values of the elements i and j, respectively; n is the number of units, and the correlation is considered significant when ∣Z∣>1.96.

3.4.2 Local Spatial Autocorrelation

Local autocorrelation reveals the local clustering characteristics of spatial unit attributes by analyzing the difference degree and significance level between spatial unit and surrounding units. the formula is as follows:

$$I_i(d) = \frac{n(x_i - \bar{x})\sum_{j=1}^{n} w_{ij}(x_j - \bar{x})}{\sum_{i=1}^{n}(x_j - \bar{x})^2} \qquad (9)$$

4. Results and Analysis

4.1 Analysis of Geological Disaster Risk

Formula1-3, was used to calculate the geological disaster index by GIS software. the study area was classified into five grades by natural breakpoint method: Relatively low risk, Low risk, Moderate risk, High risk and Relatively high risk (Figure 3).

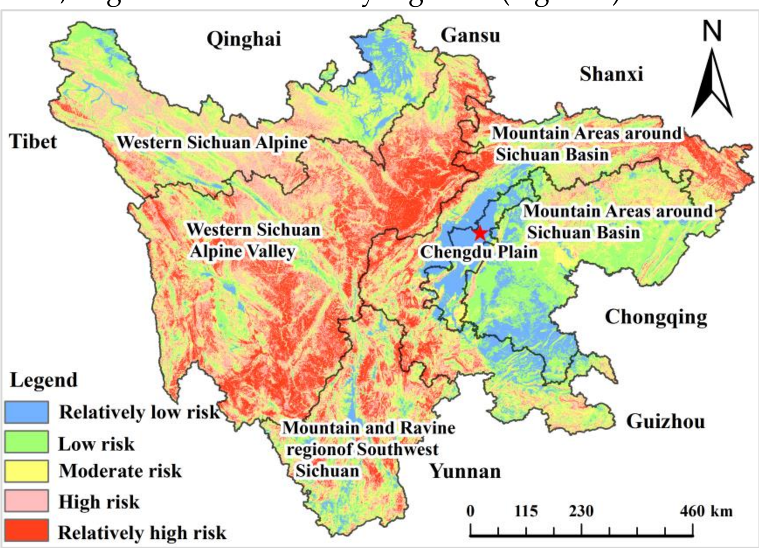

Figure 3 Classification Results of Geological Disaster Risk

As shown in Figure 3, with respect to spatial pattern of geological disaster, the relatively high risk areas are mainly distributed in Western Sichuan Alpine Valley, Mountain and Ravine region of Southwest Sichuan and Mountain Areas around Sichuan Basin. High risk areas are less distributed in Chengdu Plain and Hilly Areas of Sichuan Basin, while the other 4 areas have a higher distribution proportion. Similar to high risk areas, the moderate risk areas are less distributed in Chengdu Plain, and the other 5 areas account for a relatively high proportion. The relatively low risk areas are concentrated in Hilly Areas of Sichuan Basin, while the risks in other 5 areas are relatively not significant . The low risk areas are mainly distributed in Chengdu plain and Hilly Areas of Sichuan Basin, while the other 4 areas are sporadically distributed.

the statistics results of the numbers of geological disasters risk areas of various grades are as follows. the area of relatively high risk area is 73574.81 km^2, accounts for 14.14%; the area of high risk area is 137037.55 km^2, accounts for 28.20%; the area of moderate risk area is 130,263.67 km^2, accounts for 26.80%; the area of relatively low risk area is 99829.32 km^2, accounts for 20.54%; the area of low risk area is 45294.65 km^2, accounts for 9.32%. the risk of geological disasters in Sichuan Province is relatively high in the whole area and widely distributed. its distribution is closely related to the topography and landforms, thus presenting significant geographic spatial differences.

4.2 Analysis of Regional Development

considering the county-level administrative divisions as the evaluation unit, the comprehensive development index (CDI) of each region was calculated respectively by GIS software according to formulas 4-6. the development level index of 183 districts and counties was divided into 5 grades through natural breakpoint method (Figure 4), which are High, Relatively high, Medium, Relatively low and Low.

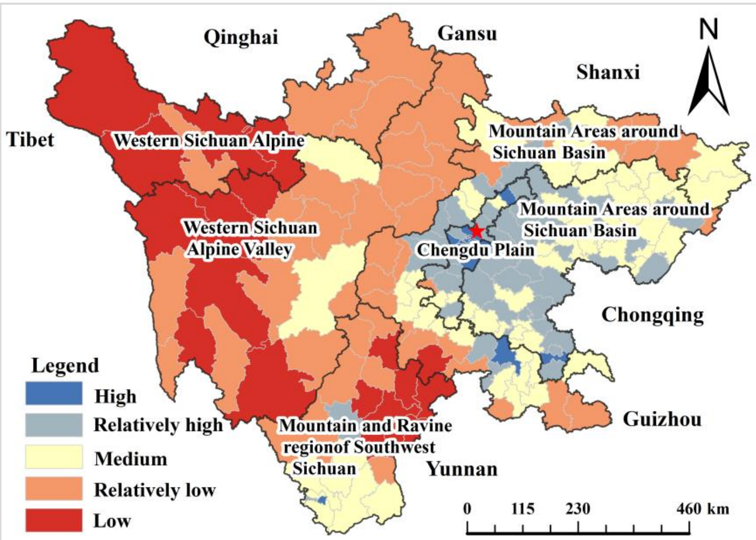

Figure 4 Multidimensional Development Level Grading Results

As shown in Figure 4, the development of every district and county in Sichuan province varies greatly. From the perspective of spatial pattern, the areas with low and relatively low comprehensive development level are mainly located in the Western Sichuan Plateau Area, Mountain and Ravine Area of Western Sichuan and Mountain and Ravine region of Southwest Sichuan. The areas with medium comprehensive development level are mainly located in Hilly Areas of Sichuan Basin and Mountain Areas around

Sichuan Basin, while the other areas are scattered. The areas with relatively high development level are mainly located in Hilly Areas of Sichuan Basin and Chengdu Plain area; areas with high level development level is relatively small, mostly located in Chengdu Plain Area., the normal distribution characteristics are significant considering the proportions of various development grades. thehigh development level counties accounts for 6.56% in number; the relatively high development level counties accounts for 25.14% in number. The number with medium level counties accounts for 33.33%, the number with relatively low level counties accounts for 24.04%, the number with low level counties accounts for 10.93%. In general, with the Chengdu Plain being in the center of Sichan Province, the level of comprehensive development in Sichuan Province is lower as it goes outwards of Chengdu Plain . the level of comprehensive development in mountainous areas and high-altitude areas is obviously low, which is basically consistent with the spatial distribution of 88 counties out of poverty, indicating that these areas will remain the work focus of agriculture, ruralareas and peasantry in the future.

4.3 Analysis of Poverty Risk Caused by Disasters

4.3.1 Overall Characteristics of Poverty Risk Caused by Disasters

Based on the evaluation of geological disaster risk and regional development, the poverty risk caused by disasters in the study area was calculated. and the natural breakpoint method was used to divide the risk of poverty into 5 grades: High, Relatively high, Medium, Relatively low, and Low (Figure 5). The overall spatial pattern of poverty risk in the study area are high in the west and low in the east. Due to the lag of comprehensive development, higher social and economic vulnerability, and weak ability to resist geological disasters, families' livelihood in Western Sichuan Alpine Valley as well as Western Sichuan Alpine is more vulnerable to geological disasters than that in the central and eastern regions of Sichuan Province. the poverty risk caused by disasters is higher. Instead, cities such as DongDu and Mianyang in the central part, Suining and Nanchong in the east, Yibin and Luzhou in the southeast, and Panzhihua in the south all have relatively low risk of poverty caused by disasters, mainly attribute to their high social and economic level or low risk of regional geological disasters.

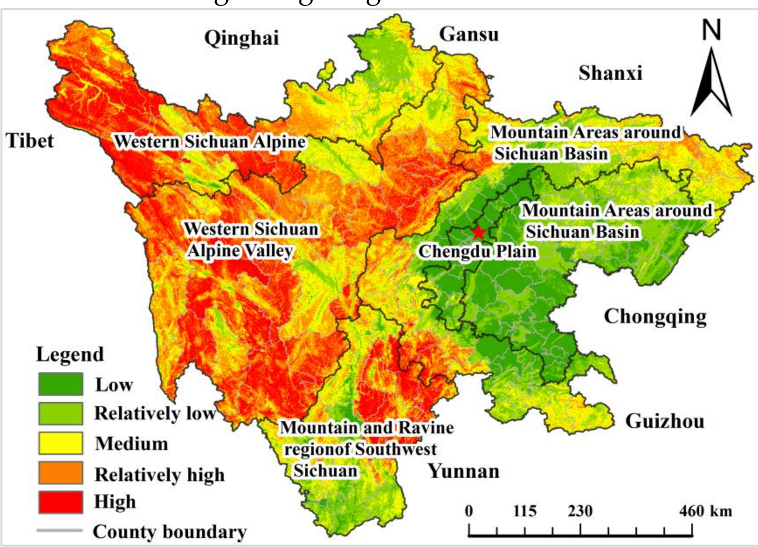

Figure 5 Distribution of The Poverty Risk Caused by Disasters

The statistical results of the areas of poverty risk grades caused by disaster are presented in Figure 6. the area of high risk area was 73574.81km², and the area of relatively high risk area was the largest, reaching 137037.55km². the area of medium risk area is close to that of high risk area, accounting for 130,263.67 km². the area of low risk area is 99,829.32 km². the area of relatively low risk area is account for the smallest at 45,294.65 km². the results indicate a high overall poverty risk caused by disasters in Sichuan Province.

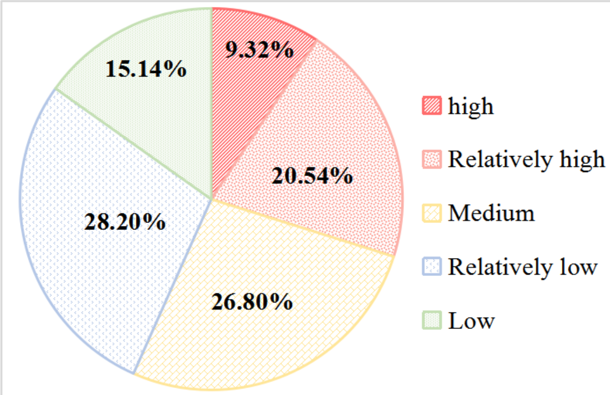

Figure 6 Proportion of Different Grades of Poverty Risk Caused by Disasters in the Study Area

4.3.2 Spatial Distribution Characteristics of Poverty Risk Caused by Disasters

The evaluation results of poverty caused by disasters in the study area were gridded with a grid size of 1km×1km, and the Moran's I index at the grid scale is calculated. the Moran's I index of poverty caused by disasters in Sichuan Province is 0.767, the value of $p < 0.001$, indicating that there is a significant positive spatial correlation between disaster and poverty risk in Sichuan Province at the grid scale of 1km×1km. the disaster risk caused by poverty is spatially dependent and clustered. That is, the risk of poverty caused by disasters has regional characteristics.

The local indications of Spatial Association (LISA) is used to study the local clustering characteristics of spatial unit attributes of poverty risk caused by disasters in Sichuan Province, and the spatial clustering is divided into four types. High-High Cluster, research grid and neighboring grids are at high risk of poverty caused by disasters; High-Low Outlier, The risk of poverty caused by disasters in the research grid is high, while the risk of poverty caused by disasters in the neighboring grid is low; Low-High Outlier, The risk of poverty caused by disasters in the research grid is low, and the risk of poverty caused by disasters in the surrounding neighborhood grid is relatively high; Low-Low Cluster, the risk of poverty caused by disaster is low in research grid and neighboring grid. The local spatial autocorrelation of poverty caused by disaster is shown in Figure 7.

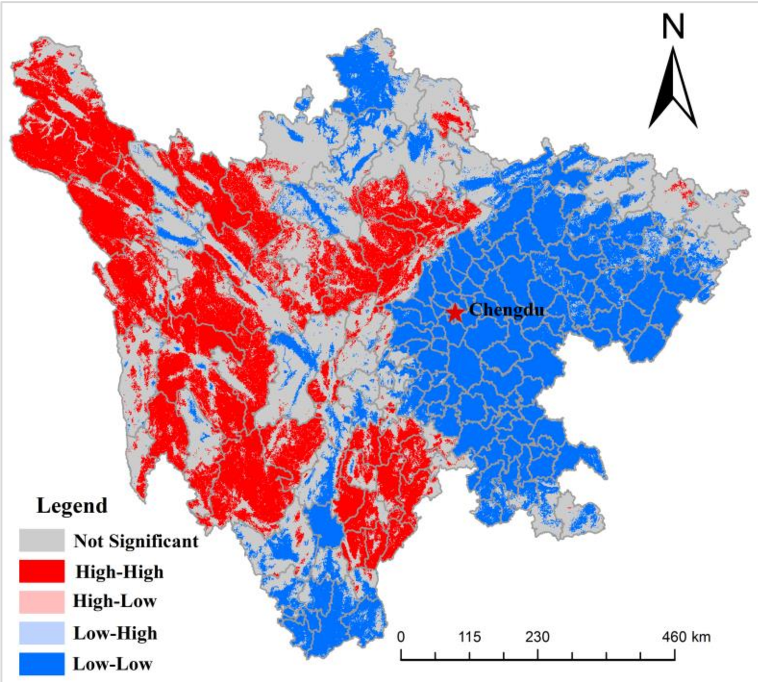

Figure 7 LISA Clustering Map of the Poverty Risk Caused by Disasters in the Study Area

The results show that the spatial clustering characteristics of poverty risk caused by disasters in Sichuan Province are different, showing a clustering characteristic of "high in the west and low in the east". High-High and Low-Low Cluster is obvious, while the High-Low and Low-High Outlier is not significant. The details are as following.

(1) High-High Cluster Area: With a total area of 142,418.80 km^2. the type is mainly distributed in most districts and counties of Ganzi Prefecture, Wenchuan County, Li County and Mao County in Aba Prefecture, and Liangshan Prefecture in western Sichuan. these areas accounts for 29.30% of the province's land area. Located in the southeastern edge of the Qinghai-Tibetan Plateau, the above three areas, with the main topography of high Mountains, Ravines and Plateaus, are all contiguous poverty-stricken areas in China until 2020. At the same time, geological disasters occur frequently in this area, and the damage intensity is high. In recent years, major natural disasters impact frequently in these areas, such as Wenchuan earthquake, Xinmo Village high-position landslidein Diexi Town, Wenchuan torrent and debris flow , Danba County torrent and debris flow. The interweaving of development lagging and the geological disasters is the most important characteristics in High-High Cluster Area.

(2) Low-Low Cluster Area: With a total area of 163,890.440km^2, these areas are mainly distributed in the Chengdu Plain represented by Chengdu, Hilly Areas of Sichuan Basin represented by Neijiang, as well as a few places of Panzhihua in southern Sichuan, totally accounts for 33.72% of the province's land area. The Low-Low Cluster Area is characterized by plains and shallow hills with high regional economic level. these areas havefewer geological disasters accompanied by strong regional disaster capacity and low disasters-caused poverty risk.

(3) The areas of High-Low Outlier and Low-High Outlier are 152.63km^2 and 798.17km^2 respectively, accounting for 0.03% and 0.16% of the province's land area, respectively.

Those two area type are mainly scattered in the borders between High-High and Low-Low Cluster Areas.

5. Conclusions and Discussion

Based on the quantitative evaluation of geological disaster risk and regional development, the poverty risk caused by disasters and their spatial differentiation characteristics were explored in Sichuan Province as the research interest. The results are as following.

(1) The overall risk of geological disasters in Sichuan Province is relatively high, with high and relatively high risk areas accounting for 43.34%, low and relatively low risk areas accounting for 29.86%, and medium risk areas accounting for 26.80%. Due to the topography, geological structure, human activities and other factors, the risk of geological disasters has obvious spatial clustering and differentiation. The risk of geological disasters in Mountain and Ravine Area is significantly higher than that in other areas, while the risk of geological disasters in Chengdu Plain and its eastern adjacent areas is significantly low.

(2) In recent years, the medical care, education security, infrastructure construction and other improvements in Sichuan Province have been improved gradually. the residents' income and the efficiency of resource utilization have been improved constantly.the national economy and society are developing steadily. The percentage of areas in High and Relatively High development level is 31.70%, the percentage of Medium level areas accounts for 33.33%. the percentage of Low and Relatively Low areas is 34.97%. The spatial differences of regional development level are prominent.the overall development of high altitude areas and remote mountain areas in western Sichuan is low on the whole, while the development level of plain areas and hilly areas are of high advantages.

(3) The area proportion of the poverty risk grades caused by disasters in Sichuan Province shows the characteristics of medium risk area > relatively low risk area > relatively high risk area > low risk area > high risk area.the spatial pattern shows the characteristic of "high in the west and low in the east". There was a significant positive spatial correlation between poverty risk and disasters. High-High Cluster mainly distributed in Garze Tibetan Autonomous Prefecture, Liangshan Yi Autonomous Prefecture and other areas in western Sichuan and southwestern Sichuan, accounts for 29.30% of the total area. Low-Low Cluster areas are mainly distributed in Chengdu Plain and Hilly Areas of Sichuan Basin, accounting for 33.72% of the total area; High-Low and Low-High Outlier Areas are small and scattered randomly.

(4) There is a geospatial coupling between regional development level and geological disaster risk in Sichuan Province. It is necessary to coordinate society and economic development with disaster reduction and prevention management, develop ecological agriculture and green industries according to local conditions. it is also important to improve the industrial structure towards the direction of green and sustainable development, thus reduce the dependence on natural resources and enhance the ability to resist disasters from the regional and personal perspectives, to ensure the coordinated development of economy, society and ecology.

Ethical Approval

The paper meets the ethical requirements and standards.

Consent to Participate

Not applicable.

Consent to Publish

The author agrees to participate in the publication of the paper

Data availability statement

The data that support the findings of this studyare available upon reasonable request from theAuthors.

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Conflicts of interest

The authors declare that they have no competing interests.

Authors' contributions

Writing — review and editing, Mingshun Xiang; formal analysis and investigation, Jin Yang; investigation and validation, linsen Duan and Wenheng Li; resources, Fengran Wei; data curation , Wenbo Yang and Chunjian Wang; supervision, Qiuchi Deng.

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