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Analysis of Earthquake Distribution Characteristics in Southwest China

Yaode Wang[1, a, *]

[1]State Key Laboratory of Oil and Gas Reservoir Geology and Exploitation, School of Geoscience and Technology, Southwest Petroleum University, Chengdu 610500, China.

[a]Corresponding author e-mail: available1516@163.com

Abstract

It is very important to understand the temporal and spatial patterns of historical earthquake disasters for formulating effective disaster reduction measures. Based on the data of earthquake points in Southwest China from 2009 to 2011, the temporal and spatial variations of earthquakes in this region are studied. We find that the occurrence of earthquakes in this area has the characteristics of agglomeration, but the agglomeration characteristics decrease year by year. This study will provide new ideas for seismic research.

Keywords

Southwest china, global moran's I, earthquake, temporal and spatial distribution.

1. Introduction

China has been a country with frequent earthquakes since ancient times. In December 2018, the global earthquake model foundation released a report on the estimation of global earthquake disasters and risks. The report pointed out that China is the country with the second largest economic loss caused by earthquakes in the world. Therefore, the study of seismic characteristics has become an urgent task. Many scholars have found that seismic activity is stronger in the west than in the east of China [1, 2]. Wang et al. [3] and Yang et al. [4] all noted that western China was the region with the highest frequency of earthquake disasters [5]. Thus, it will be of practical significance to study the temporal and spatial distribution of earthquakes in Western China.

Therefore, the purpose of this paper is to study the spatial distribution and annual variation of earthquakes in Southwest China from 2009 to 2011. First, we use the method of spatial connection to insert the attribute value of point data in space into the surface data, and then use the global Moran's I to analyze the three-year data. Finally, we get the spatial clustering characteristics of earthquakes in these three years. These results can help us understand the temporal and spatial characteristics of earthquake occurrence and provide strategies for future earthquake prevention and mitigation.

2. Data Sources and Method

2.1. Data Sources

Our data are from the national earthquake data center (http://data.earthquake.cn/). The data contains the longitude and latitude, time, depth, magnitude, location and type of earthquake. In order to understand this data more intuitively, we use geographic information technology to visualize the spatial point data of China Earthquake in 2009. The following seismic spatial distribution map is obtained.

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Figure 1. Distribution map of earthquake points in China

2.2. Global Moran's I

The essence of Moran's I is to detect whether there is spatial interdependence in the study area. Since the global Moran's I is the estimated value of the coefficient of spatial autocorrelation regression equation, its value range is [-1,1]. The value of global Moran's I from 0 to 1 is positive correlation, indicating that similar attributes are clustered together (i.e., high value adjacent or low value adjacent); global Moran's I between 0 and -1 indicates negative correlation, indicating that different attributes are clustered together (i.e., high value and low value are adjacent to each other); close to 0, it indicates random distribution, or there is no spatial autocorrelation. The global Moran's I is calculated as follows:

$$I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \overline{x})(y_i - \overline{y})}{S^2 \sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \tag{1}$$

Where $(x_i - \overline{x})$ is the deviation between the attribute of element i and its average value, w_{ij} represents the spatial weight between element i and element j , n is equal to the total number of elements, S represents the aggregation of all spatial weights.

3. Results and Discussion

We calculated the change of global Moran's I in Southwest China in 2009, 2010 and 2011. Through ArcGIS software calculation, it is found that P value of all years is less than 0.05, which means that it has passed the 95% confidence test, and the score of Z value exceeds the critical value of 1.65(reject threshold set by zero hypothesis). This shows that our results are statistically significant and reliable.

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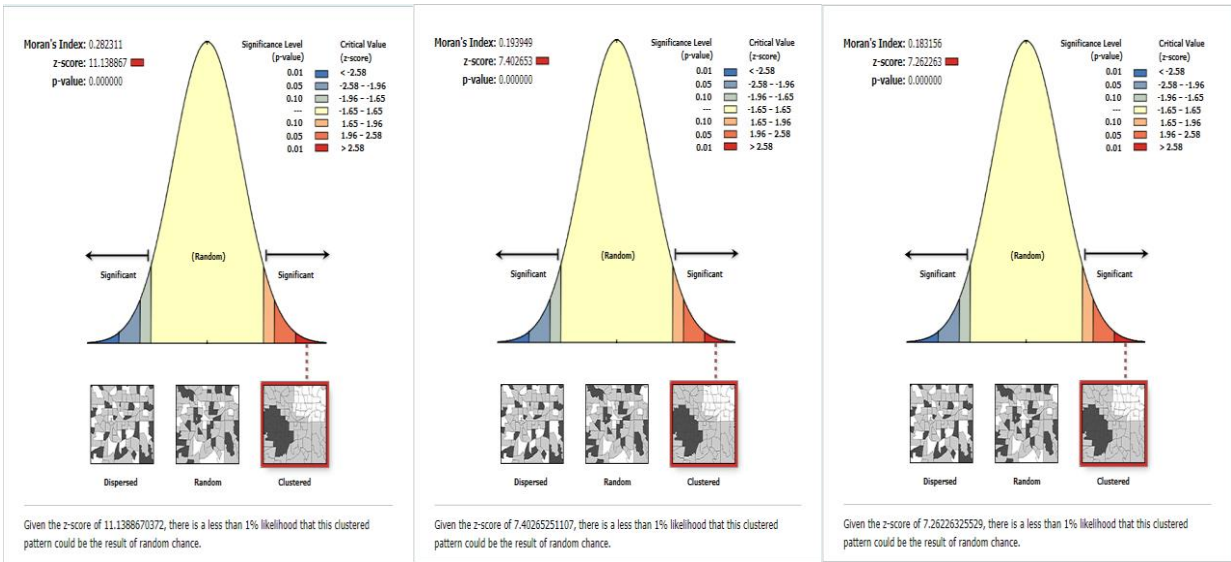

Figure 2. The Global Moran's I from 2009 to 2011

According to figure 2, the Moran's I in 2009 was 0.282, the Moran's I in 2010 was 0.194, and the Moran's I in 2011 was 0.183. This shows that in the case of a given sample, the data presents a positive spatial correlation : high value and high value cluster together, low value and low value cluster, showing positive correlation pattern in space, and tending to occur spatial clustering phenomenon.

From the perspective of temporal, from 2009 to 2011, the Moran's I showed a trend of gradual decline. In other words, the spatial positive correlation is gradually weakening, and the spatial relationship of sample points is likely to develop in the direction of random distribution.

Through the spatial autocorrelation analysis of the earthquake occurrence probability in Southwest China, we find that there is a positive correlation between the occurrence of earthquakes in Southwest China, that is, the areas with high earthquake incidence (counties) and the surrounding areas (counties) also have frequent earthquakes. And those areas (counties) with low incidence of earthquakes are not prone to earthquakes in the surrounding areas (counties). Thus, the spatial clustering phenomenon of earthquake occurrence is formed. In terms of time, although there is still a positive correlation between earthquake occurrence in Southwest China from 2009 to 2011, the positive correlation is gradually decreasing. The spatial characteristics of earthquake occurrence change from high concentration to random occurrence.

4. Conclusion

With the recent socioeconomic development and population growth. Earthquake disaster and its impact on human society have attracted the attention of the international community. The study on the temporal and spatial of earthquakes will help us to understand the regional differences and different characteristics of earthquakes, so as to help the rulers to formulate disaster reduction measures.

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