Research on the Distribution Law of Influencing Factors of Landslides in Wumeng Mountainous Area of Guizhou

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Abstract. Taking Wumeng mountainous area in Guizhou province as the study area, by collecting landslide data and on-the-spot investigation records, a spatial database of 939 landslides and related influencing factors on GIS platform are established. The influence of altitude, relative height difference, slope angle, slope aspect, the shortest distance from landslide to rivers is studied. The results show that the number of landslides decreases exponentially with the shortest distance to the rivers. The most important factor affecting landslides distribution is topography and morphological, especially slope. The research can help human beings get along better with the surrounding nature environment and provide a basis and reference for environmental governance, landslide prevention and mitigation work.

1. Introduction

The natural environment is vital to the survival and development of human beings, especially people who living in mountainous areas are facing great threat of natural hazards such as landslide. Wumeng Mountainous Area, located in in Guizhou Province, is a contiguous mountainous area with fragile geological environment. Geological hazards such as landslides are developed in this area due to strong human engineering activities. It is one of the geological hazards prone area in Guizhou Province and even within the whole country. The potential threats of landslide not only seriously threaten the lives and property of people living in the Wumeng mountainous area, but also severely restricts local economic and social development.

Some scholars have studied the distribution of geological hazards. Jie Zhang et al. [1] studied the distribution of geological hazards in the whole area of the middle section of the Ailao Mountain. Ya Zhu [2] analysed the distribution characteristics and extreme precipitation factors of geological hazards in Yunnan mountain torrents. Qinhua Zhang [3] studied the types, scale, development characteristics, distribution characteristics and forming conditions of geological hazards in Jingyang County. At present, the study of geological hazards in the Wumeng mountain area is limited to local area rather than the whole area or limit to a specific hazard[4-7].

Obviously, the study of regional distribution law of geological hazards in Wumeng Mountains is very deficient, and the law of the number of landslides and the shortest distance from landslides to rivers has not been studied.

Based on the author's presiding over the risk landslide hazard zoning and meteorological warning and forecasting research in Wumeng Mountainous Area of Guizhou Province, combined with the...
detailed investigation of landslide disasters, this paper elaborates the distribution law of landslide hazard in the study area from the aspects of topography, elevation and river distribution.

2. Distribution law of landslides on topography
The influence of topography condition on landslide geological hazard is mainly determined by slope type, slope aspect, slope angle.

2.1. Slope type
Under the impact of human engineering activities, especially the construction of local residents' sloping houses, most of the terrain in the study area forms linear slope or ladder slope after slicing. It is easy to form shallow surface collapse or slope debris flow under the action of gravity and rainfall since the linear slope is not conductive to the stability of rock and soil. Because of the change of the original stress distribution, the ladder slope may become the shear outlet of the landslide. Therefore, the linear slope and the ladder slope are the main slope types of geological disasters in the study area.

2.2. Slope aspect
Under the effects of regional structure, the western mountain body of the study area is generally cut into northeast-southwest trend and partly northwest-southeast. The terrain slope is mainly within 0°~20°, 140°~180°, 250°~270° and 350°~360°. The annual monsoon warm and humid airflow mostly stays in the east and south of the study area. Due to the affection of airflow, the number of geological hazards in the east and south of the slope is more than that in the north and east of the slope. According to statistics, the geological hazards with 45°~135° slope aspect are the most developed. Development of geological hazards in various terrain and slope aspect is shown in figure 1.

![Figure 1. Relationship between landslides and slope aspect](image)

2.3. Slope angle
Geological hazards are distributed in the range of 12°~61°in the study area, mainly in the range of 20°~50°, accounting for 96.66% of the total number of landslides, among which the range of 20°~40°is the most concentrated. The study area is a typical mountainous area, 80% of the land area is mountainous, with undulating terrain. The terrain suitable for living and farming has a slope between 20°and 40°, in which the human activity is stronger. The disturbance to the geological environment is also greater, so the geological hazards in this area are most developed and distributed densely (as is shown in figure 2).
Figure 2. Landslides on slope angle map

Table 1. Development table of landslides with different slope angle

| Slope type | 10º~20º | 20º~30º | 30º~40º | 40º~50º | 50º~60º | ≥60º |
|------------|---------|---------|---------|---------|---------|------|
| Landslide  | Quantity| 122     | 116     | 178     | 135     | 7    |
|            | Percentage| 30.86   | 14.38   | 8.52    | 2.34    | 0.75 |
| Unstable slope | Quantity | 75       | 72       | 131     | 105     | 7    |
|            | Percentage| 21.83   | 11.18   | 6.39    | 1.17    | 0.75 |

3. Distribution law of landslides on elevation

The landslides in the study area are mainly distributed in the range of 500~2887m in elevation. There are 309 landslides in the range of 1000~1500m in elevation, accounting for 32.91% of the total landslides; There are 423 landslides in the range of 1500~2000m in elevation, accounting for 45.05% of the total landslides; The number of landslides in the area of elevation>2400m is less, only 13, accounting for 1.38% of the total landslides.

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Figure 3. The distribution of landslides on elevation
From the perspective of the density of landslides, the density of landslides in the range of 1000–1500m in elevation is 50.37/10 km²; The density of landslides in the range of 1500–2000m in elevation is 52.35/10 km²; The density of landslides with elevation greater than 2500m is the largest, 41.40 places /10km²; The density of landslides with elevation less than 1000m is the smallest, only 12.99 places /10km².

4. Distribution law of landslides on the shortest distance to the rivers

The development of landslides is closely related to the surface rivers, mainly due to the erosion of the slope by rivers. The balance of the slope will be broken and the anti-sliding force of the slope will be reduced when the soil at the foot of the slope is wash away, which will leads to the instability of the slope and the occurrence of landslide.

The shortest distance from each landslide to the rivers are calculated by the spatial analysis function of GIS, and the number of landslides in each section is counted every 200m (as is shown in figure 5). The number of landslides in the area is inversely correlated with the shortest distance from the river, that is, the closer to the river, the development density of landslides is higher.

Select the exponential model to fit the distance and the number of landslides: Coefficients (with 95% confidence bounds):
The exponential function relation between the shortest distance from landslides to rivers and the number of landslides is obtained.

\[
\text{count} = 401 \times e^{-0.001817x}
\]

where:
- \(a = 401\)
- \(b = -0.001817\)

The fitting parameter Adjusted R-square is 0.9908, which indicates that the selection and fitting of the model is very successful.

5. Summary
Landslide hazards have always been threats to the residents in mountainous areas. The management and prevention of landslide hazards cannot be ignored. In this paper, the geological hazard database of Wumeng mountains is established based on GIS, and the distribution of landslides in Wumeng mountains of Guizhou province is summarized systematically by means of spatial analysis and mathematical statistics. Especially, it is found that the number of landslides decreases exponentially with the shortest distance to rivers. The research on the distribution of landslides is not only of great significance to hazard prevention and mitigation in the region, but also provides scientific basis for land use planning. Mastering the law of landslides distribution is conducive to promoting harmonious coexistence between human and the natural environment.

Acknowledgement
This research was financially supported by the National Natural Science Foundation of China (41877263); the National Key R & D Program of China (2017YFC1501302), and the Fundamental Research Funds for the Central Universities (No.CUGCJ1802).

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