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Multi-source Data in the Geological Disasters Early Warning for Power-Grid

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Abstract: In China, the frequent occurrences of geological disasters have negative effects on the people's production, life and many other fields. In the field of power-grid constructions, due to the long-term exposure of power-transmission lines to the natural environment, severe natural disasters, such as heavy rains, landslides, and collapses, will put power-transmission lines in great dangers, and will cause a lot of property loss. Therefore, the effective detection and the early warning of geological disasters are valid approaches to improve the governance and management of geological disasters. First of all, this paper analyzes the characteristics of the prevention and control of power-transmission lines, and then puts forward the main data affecting the early warning of geological disasters, which provides a theoretical basis for further realizing the early warning of geological disasters.

Keywords: Power-transmission lines, Geological disasters, Monitoring and warning, Multi-source data

1. Introduction.

The monitoring and early warning of geological disasters play an important role in power-transmission projects. Through the accurate assessment of data related to geological disasters, in can effectively improve the governance and control ability of geological disasters to power-grid and reduce the losses caused by disasters as much as possible[1].

The prevention and control of geological disaster on power-transmission lines mainly have the following characteristics. First, the large amount of prevention and control work: Due to the long distance and a large amount of towers of power-transmission lines, the hidden danger spots of geological disasters are not concentrated in certain areas, but are relatively scattered. Besides, the individual differences are very large. It can only be disposed of separately for each risk point tower instead of intensively use prevention and control measurements. Second, high requirements of prevention and control: Although avoidance measures of geological disasters have been taken into account when the route planning and design, the line towers are a series system. After the geological disasters risks of multiple scatters are superimposed, it will have certain impact on the overall reliability of the line. Hence, even if a disaster occurs at any point, it will have a systemic impact on the entire normal power-transmission line which are hundreds to thousands kilometers. Third, high cost of prevention and control: Due to the lack of monitoring data, it is difficult to grasp the risk status of geological disasters in time, and the risks and pressures of operation and maintenance work is large. When the accumulated risks develop to a certain extent, the difficulty of large-scale thorough governance of scattered risk spots increases and the cost is huge.

2. Main data of geological disasters monitoring for power-grid

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According to the characteristics of geological disasters prevention and control work, how to accurately predict and forecast geological disasters is the crucial content of our research. Therefore, it is necessary to accurately measure and record the rules of geological disasters and dynamics of various factors causing disasters[2]. At present, the main detection methods of geological disasters can be divided into simple detection methods and instrument detection methods. Simple detection methods include deformation displacement monitoring method, crack relative displacement monitoring methods, and visual inspection, etc. The instrument detection method is mainly used to detect dangerous hidden spots. The rules of geological disasters include the changes of various precursor phenomena before the occurrence of geological disasters and the processes after the occurrence of geological disasters. Factors causing geological disasters include[3,4]: 1. Meteorological factors, e.g., precipitation and temperature. 2. Terrestrial hydrological factors, e.g., water level, flow rate. 3. Marine hydrological factors, e.g., tide levels, waves. 4. Other factors, e.g., ground stress, ground temperature, topographic deformation, fault displacement, underground water level, and groundwater chemical composition. By observing and measuring the above-mentioned rules of geological disasters and various inducement, it is helpful to control the occurrence of geological disasters, improve the ability of power-transmission lines to prevent disasters so as to achieve the goal of active prevention and early emergency disposal[5].

2.1. Application of multi-source data in the early warning and monitoring of geological disasters for power-grid

According to the characteristics of geological disasters in power-transmission lines, combing with current status of geological disaster warning[6], it is necessary to investigate the hidden dangers of geological disasters and build the corresponding database during the operation stage of the power grid. The goal of the early warning and monitoring system of geological disasters for power-transmission lines is to realize the monitoring and early warning data and reporting of the geological disasters through the calculation of the early warning model based on the precipitation, topography, seismic intensity, slope, and rock and soil types[7,8]. Therefore, the multi-source data for power-grid early warning system of geological disasters mainly have three types: 1) Precipitation, 2) Disasters susceptibility evaluation, 3) Early warning report.

2.2. Precipitation data

During the construction of power-transmission lines, landslides have great danger to power-lines, cause high cost of reconstruction and recovery after disasters, and huge losses because of power outages, which have a huge negative impact on people’s lives. Among the precipitating factors of landslides, the rainfall is most important factor. Statistical results show that 90% landslides are directly induced by or related to rainfalls. Hence, studying the change of rainfall can provide a strong reference for the monitoring and early warning of geological disasters on power-transmission lines.

2.3. Disaster susceptibility evaluation

There are two types of influencing factors of geological disaster susceptibility, which are environmental factors and trigger factors. Each factor is divided into several factors as shown in Figure 1. The bottom layer, which are the different states of each factors, is not listed.

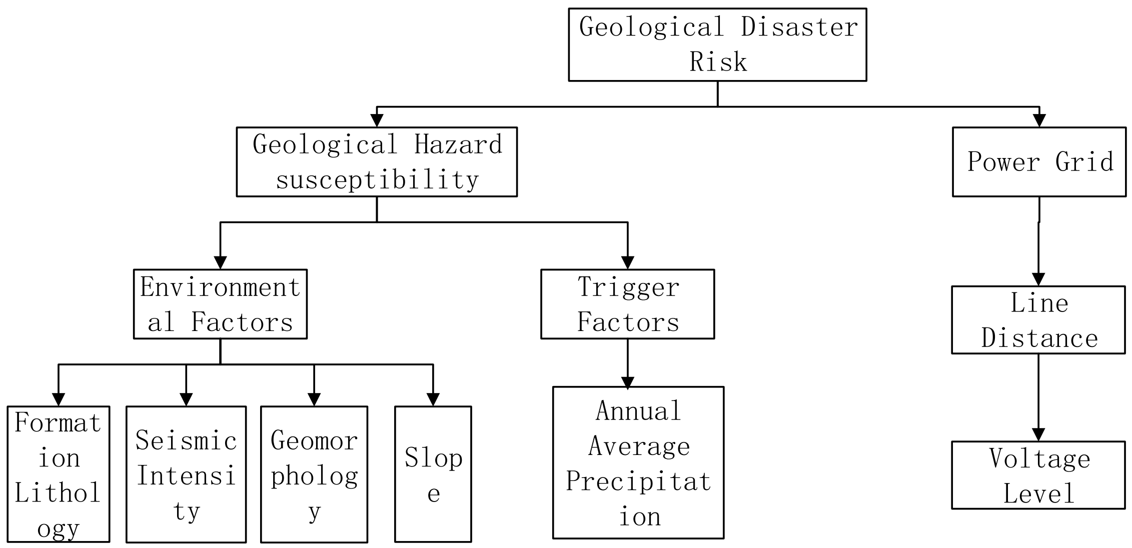

Fig 1: Hierarchical division diagram

The landslide hazard susceptibility evaluation is carried out on the site where the landslides may occur[9]. Seismic intensity, geomorphology, terrain slope, precipitation, and formation lithology were selected as factors influencing landslides. Each factor was graded by different indicators and divided into different levels. The higher the level is, the more dangerous it is. Each level corresponds to a value calculated by the weighted summation. For example, seismic factors are graded using seismic intensity. Precipitation factor are graded using annual average rainfall. The detailed factors are graded as follows:

Table 1: Grads of seismic factors

Hazard level	1	2	3	4	5
Seismic Intensity	＜VI	VI~VII	VII~VIII	VIII~IX	>IX

Table 2: Grads of geomorphology factors

Level	1	2	3	4	5
Geomorphology	Plain	Hill	Mountain	Plateau	Lower and Middle Mountain

Table 3: Grads of slope factors

level	1	2	3	4
Slope（°）	＜15	15~25	＞40	25＜Y≤40

Table 4: Grads of precipitation factors

Hazard Lelel	1	2	3	4	5
Annual Average Rainfall（mm）	＜400	400~800	800~1200	1200~1600	＞1600

Table 5: Grads of lithology factors

Level	1	2	3	4	5
engineering geological petro fabric	Loose soil, Intrusive rock	Massive metamorphic rock	extrusive rock, Clastic Rock	Flaked、Tabular metamorphic rocks	Carbonate Rock, Collapsible Loess

2.4. Early warning report

The geological disaster evaluation and early warning of overhead transmission lines selects indicators such as lithology, geomorphology, slope, seismic intensity, and precipitation. Refer to the Notice of the Ministry of Land and Resources and the China Meteorological Administration on Jointly Conducting Meteorological Forecasting and Warning for Geological Disasters in Flood Season, divide the geological hazard warning into five risk levels. The classification and expression of each risk level are shown in Table 6.

Table 6 Warning risk level and presentation of geological hazard

Risk Level	Likelihood of occurrence	Presentation	Lgend
I	Very Low	Blue	
II	Low	Green	
III	Relatively High	Yellow	
IV	High	Orange	
V	Very High	Red	

According to the future 24-hour and 72-hour numerical weather forecasting, combined with internal parameters like slopes, the early warning report will generate corresponding warning layers for the short-term and medium-term warnings of landslide area risks in reach region. Based on the regional warning results and the distribution of power-transmission lines, the UHV AC and DC lines located in the Grade IV and V risk sections of geological disasters and the risk levels of the key towers are listed.

3. Conclusions

Based on the characteristics of power-transmission lines protections, this paper analyzes the key data of geological disasters monitoring and early warning in power-grid constructions, and provides a data foundation for the monitoring and early warning system. In the construction of the monitoring and early warning system, the measured and collected activity characteristics of geological disasters and the values of various factors introducing disasters are set as the original data. These data were used by the early warning models to achieve the purpose of monitoring and warning. It can effectively improve the ability of power-transmission lines to prevent disasters, and timely make respond measurements to reduce the losses caused by natural disasters.

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