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# Research on prediction method and system of geological hazard and precipitation based on K-chart

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**ABSTRACT**

In order to predict geological hazard and precipitation effectively, we analyze the existing geological hazard and precipitation prediction work, as well as the existing geological hazard and precipitation prediction method and monitoring system. Then, the current methods are analyzed and compared. Then the factors of geological hazards are discussed and understood, and the prediction methods and systems of geological hazards and precipitation are fully understood. Then, the method and system of geological disaster and precipitation prediction based on K-chart are proposed. It is found that k-chart can integrate all aspects of geological disaster monitoring data through a single graph, providing data analysis basis for geological disaster prediction, and effectively improving the analysis ability of geological disaster system. Thus, the prediction efficiency and accuracy of geological disasters and precipitation are improved, and the impact on nature and life and economic loss caused by geological disasters and precipitation are reduced.

*Keywords:* Geological disaster; Prediction method; K-line chart; Monitoring and prediction system

## 1. Introduction

As one of the important non-engineering measures for flood control and disaster reduction, flood forecast can help people resist flood and make rational use of flood resources. The theory and method of flood forecast are of great significance to people's production and life. After years of development, flood forecasting has made great progress in basic theory and technical methods. The flood forecasting methods mainly include practical flood forecasting scheme and flood forecasting mathematical model. The practical flood forecast scheme is the experience of the hydrologist in the long-term practice work, and has high forecast accuracy. The methods of the practical flood forecast scheme are still widely used in China, including the corresponding water level (discharge) method, the synthetic discharge method, the water level (discharge) rise and difference method and the rainfall-runoff method.

Geological disasters are rock and soil movement events on the surface of the earth, which occur all over the world. China as a vast country with diverse geologies, geological disasters are not uncommon. To monitor and predict geological disasters, scholars all over the world are researching the causes of geological disasters, as well as the prediction and monitoring methods [1].

The geological disasters impact human life and national production, endangering people's lives and property and causing losses to the national economy. Generally, geological disasters include, debris flow, landslide, and ground collapse, which are related to factors, such as geological processes, all of which threaten people's lives and property.

Today, the capacity to predict and handle geological disasters may well reflect the social structure and civilization of a nation or even the human race. Scholars have studied and invented the most advanced technical means against geological disasters, and government organizations have established many remedial measures. With cooperation, geological disasters can be predicted, thereby reducing or avoiding the adverse consequences [2].

K-line chart is used in the financial market and has unique features in data arrangement and drawing. Using the K-line chart, people can find different meanings of data according to the shape of these K-line charts and find out the rules in the change of form [3].

Here, the characteristics of the k-line graph are analyzed. Based on the data records and the causes of geological disasters, the prediction method and system of geological disasters and precipitation are put forward according to the K-chart, and the occurrence mechanism of geological disasters and precipitation is deeply analyzed, which provides the practical basis for the prediction method and system of geological disasters and precipitation.

## 2. Overview of geological disasters and K-line chart

### *2.1. Geological disasters*

Introducing rainfall forecast information into flood forecast can prolong the forecast period of flood forecast. With the rapid development of numerical prediction technology, atmospheric sounding technology and computer technology, hydrometeorology has become a developing trend of flood forecasting technology. Precipitation is an important input information in flood forecasting, and its accuracy is an important factor affecting the accuracy of flood forecasting. However, precipitation is a difficult weather phenomenon to simulate, and the forecast of precipitation is also uncertain due to the uncertainty of numerical model and initial atmospheric field. If we only blindly pursue high precision precipitation forecast information to improve flood forecast, it may lead to a misunderstanding of hydrometeorological affinity research. The ensemble forecast of rainfall can take the uncertainty of rainfall into consideration, and the ensemble forecast product can be applied to the flood forecast to take the uncertainty of flood forecast into consideration. In recent years, the establishment of database has brought more convenience for hydrologers to combine rainfall ensemble forecast with hydrological forecast. In other words, the flood forecast of the pro-ensemble forecast system is the developing trend. In addition, the precipitation integration of multi-model ensemble forecast is an important means to improve the accuracy of precipitation forecast.

Geological disasters, multi-factor destructive geological phenomena, can be followed in the distribution law of time and space. They may occur naturally and artificially, damaging the environment and threatening people's lives and property [4].

Geological disasters are partly natural disasters and partly man-made disasters. Fig. 1 has summarized the factors of geological disasters.

Fig. 1 shows that the natural factors and human factors of geological disasters are diverse. geological disasters often affect people's lives and damage social public facilities, or even cause a more devastating impact.

Generally, the process of geological disasters can be divided into several stages: breeding, occurrence, development, decline, and stability. Different stages of geological movement show distinct data information, and different geology will form different geological disasters. Through the exploration of different geological disasters, the occurrence laws of geological disasters can be obtained to prevent or predict them [5].

### *2.2. Monitoring and prediction method and system of geological disaster*

Human civilization has witnessed and recorded the occurrence of geological disasters for a long time, and geological disasters evolve gradually, from quantitative change to qualitative change. Geological disasters can be monitored during evolution, based upon which their occurrence can be predicted to reduce their harms [6].

With science and technological advancement, great breakthroughs have been made in the research methods of geological disasters, such as RS (Remote Sensing), GPS (Global Positioning System), and scoring method, supporting the in-depth research on geological disasters [7].

Compared with international standards, the research on geological disasters in China is backward, but some practical application methods and theoretical basis have been developed, including some simple monitoring methods, such as pile burying method, nail burying method, and patch method. Although these methods cannot obtain data, they can directly judge the changes of geological disasters [8,9].

To predict geological disasters, it is necessary to understand the activity law, formation conditions, occurrence mechanism, and disaster bearing capacity of regional geological disasters, thus predicting the occurrence, development, change, degree, and damage of geological disasters through logical reasoning, comprehensive analysis, and numerical simulation methods. Meanwhile, the formation conditions and activities of geological disasters must be fully grasped, an effective monitoring system should be established, and scientific prediction theories and methods should be utilized. The main prediction methods include correlation analysis, analogy analysis, expert consultation method, and computer simulation. In practical research, hybrid prediction methods are usually applied [10].

Currently, only three types of geological disaster monitoring systems have been developed, as shown in Fig. 2.

Fig. 2 demonstrates that three types of geological disaster monitoring systems monitor, record, analyze, and upload real-time data to the relevant organization structure, which

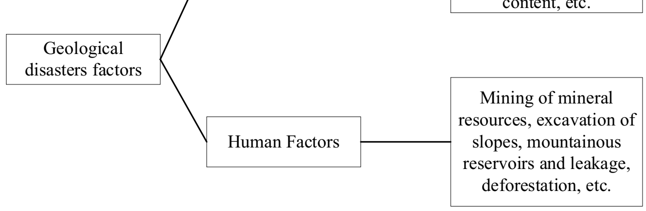


Fig. 1. Factors in the occurrence of geological disasters.

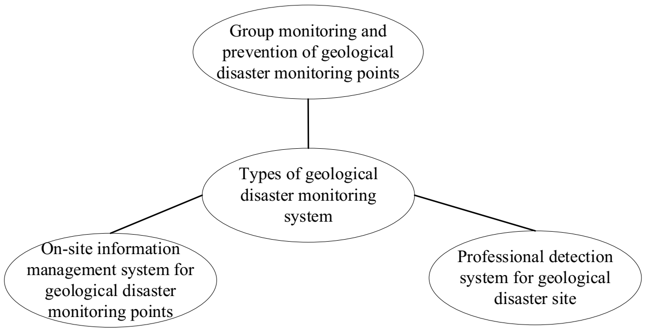


Fig. 2. Types of geological disaster monitoring systems.

can quickly make corresponding measures through the relevant units.

Presently, geological disasters are predicted mainly through the analysis of collected data of the sensor equipment at each monitoring point. Further processing is needed for higher accuracy and better performance. Under technological innovations, the prediction accuracy for geological disasters can be much improved than that under the probability theory. Scientific analysis and basic theories have suggested that there are signs for geological disasters, through which prediction systems can be optimized. The constructed geological disaster system should have features, such as reusability, real-time data acquisition, reliability, and timeliness, thereby effectively monitoring and predicting geological disasters [11].

### *2.3. Overview and features of K-line chart*

As a technical analysis graph, K-line initially records the fluctuation of commodity prices and later used in the financial market because of its unique chart recording method. The chart drawn in this way is very similar to a candle with black and white, so it is also called Yin and Yang (which represents two opposite sides of one thing in Chinese) line chart. Through the K-line chart, people can completely and faithfully record the daily, weekly, and quarterly situations of a commodity or market. After a period of inventory, a special regional form can be formed on the chart. Different regional forms have different display meanings. The regularity can be found out and applied to the actual situation.

Fig. 3 indicates the recording method of the K-line chart.

In Fig. 3, the way the K-line chart records data in the financial market can show various information, which is directly represented in the chart. The K-line chart of recording market status can appear in various forms, such as big Yangxian and big Yinxian (A big positive line and a big negative line in Chinese). These charts are faithful and intuitive to the data information of a specific stage, so people can judge the existing data most intuitively. According to the data of different times and conditions, the latest data can be comprehensively analyzed.

K-line chart can comprehensively and thoroughly observe the actual market change. Still, it has some shortcomings: the drawing method is very complicated, the most difficult one among various types of trend charts; and there are many

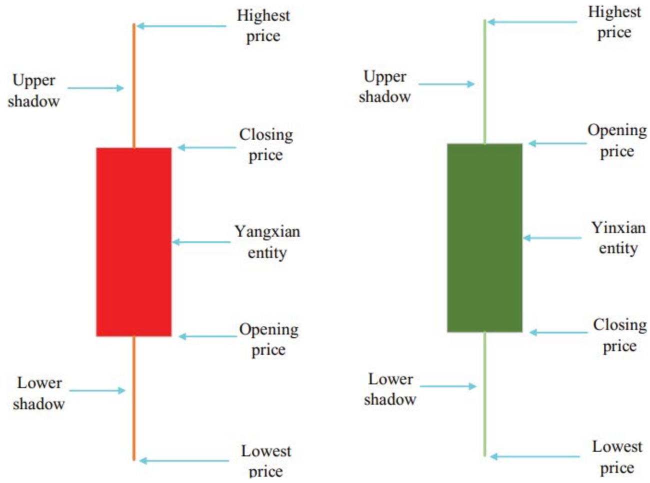


Fig. 3. K-line chart recording method.

changes in the double lines of Yin and Yang, which makes the workload and difficulty of drawing K-line chart greater than other trend analysis charts [12].

### *2.4. K-line chart and geological disaster prediction*

K-line chart, as a more complex chart drawing method, can draw the daily, monthly, or annual monitoring data information by recording the data of different geological disasters, which can reflect the features of various geological disasters analyze previous geological disasters. In this way, a database of real data is formed. Then, the real-time data of the current geological disaster monitoring points are drawn, and the possibility of geological disasters is calculated through the data analysis of the monitoring and prediction system. The more obvious the trend of the K-line chart of the new data is, the more similar it is to the chart recorded in the past, the greater the possibility of geological disasters is. For example, for the monitoring and prediction of the earthquake, which is unpredictable so far, the K-line chart recording method can effectively draw and integrate voluminous seismic monitoring data and then compare them with the real-time data, thus improving the monitoring and prediction effect.

Here, the geological disaster prediction method and system research based on the K-line chart is proposed, which can improve the monitoring efficiency of geological disasters technically, and it effective, feasible, and can be further optimized through data algorithm.

## 3. Analysis and research on K-line graph and geological disaster prediction

### *3.1. Analysis of geological disaster types*

Different geological disasters have different occurrence phenomena and precursors, as shown in Table 1.

Table 1 shows that these geological disasters are traceable before they occur, and the relevant data can be recorded and analyzed. Generally, landslide, collapse, and debris flow are interrelated, transformed, and inseparable. The precursors

Table 1
Analysis of the types of geological disasters and their precursors

| Types | Definitions | Precursors |
|---|---|---|
| Landslide | The rock mass on the slope slides down along a weak plane or belt under gravity. | There are transverse and longitudinal cracks in the front edge of the landslide, and the phenomenon of dragon-riding appears in the front soil. The rock and soil mass in the sliding zone make a sound due to the friction and dislocation, and water or gas emerges from the cracks. |
| Collapse | Under gravity, the rock and soil on the steep slope abruptly break away from the parent rock and fall and accumulate. | At the edge of the collapse, block loss, rockfall, and small collapse constantly occur. New cracks appear in the footsteps of the collapse. The sound of tearing and rubbing rocks can be heard occasionally. There are anomalies of heat, rivers, groundwater, and animals. |
| Debris flow | It is a unique geological disaster phenomenon in the mountainous area. It is a special flood with many solid materials, such as sediment and stones, formed by precipitation. | There is a roar in the ditch, the main river water rise, and the normal water is interrupted. Abnormal animals and plant activities occur. For example, pigs and dogs do not sleep, and fabric morphology changes. |
| Ground collapse | Under the action of natural or human factors, the surface rock and soil fall and collapse on the ground. | The abnormal changes of oil and gas wells in the whole year. Ground deformation occurs. The buildings make noise, incline, or crack. Surface water causes bubbles on the ground. Plants transfigure, and animals panic. |

of geological disasters can remind people of related disasters so that people can avoid or reduce the impact and loss caused by geological disasters.

These geological disasters have distinct features. For example, the probability of landslide occurrence is closely related to the slope, length, and width of the area, as shown in Table 2.

Table 2 displays that the occurrence of landslides is influenced by precipitation, as well as the slope, length, and width of the area. These factors comprehensively cause geological disasters. Comprehensive data analysis is the probability of landslide monitoring and prediction. Similarly, other geological disasters are caused by multiple factors.

People can either avoid or evacuate from geological disasters. For those projects and personnel in dangerous areas, the methods of prevention, avoidance, evacuation, and governance are adopted. The causes of geological disasters are very complex, so geological disasters are divided into different types from different angles and standards. For example, collapse, landslide, and debris flow belong to sudden geological disasters, while soil erosion and land desertification are called slow change geological disasters or environmental geological disasters. To deal with various geological disasters, effective and corresponding measures should be formulated according to the specific situations [13].

### 3.2. Geological disaster monitoring and prediction system

Fig. 4 illustrates the database system function module of the geological disaster monitoring system.

Fig. 4 implies that the database system modules can analyze the collected data through cooperation. Different

Table 2
Features and occurrence probability of landslides

| Slope | | Length | | Width | |
|---|---|---|---|---|---|
| <25° | 10.8% | <50 m | 60.7% | <50 m | 47.4% |
| 25°–45° | 29.3% | 50–150 m | 19.9% | 50–100 m | 10.3% |
| 45°–60° | 38.4% | 150–200 m | 9.6% | 100–200 m | 32.6% |
| >60° | 21.5% | >200 m | 9.8% | >200 m | 9.7% |

types of geological disasters have different data types, and different data types need different analysis methods.

According to the features of geological disasters and the overall goal of the system, the proposed geological disasters monitoring system collects and analyzes the data of monitoring points and designs and implements the early-warning model of geological disasters, so that it can predict the data factors of monitoring points. Finally, various types of data reports are generated and fed back to relevant departments.

To ensure the function and application of the geological disaster system, the overall system is designed based on specific principles, as shown in Fig. 5.

Fig. 5 indicates that there are four principles of the geological disaster system, which can ensure the usability, feasibility, maintenance of the proposed system, which are very important for the monitoring and prediction of geological disasters.

The prediction and early-warning model is composed of input neurons, learning sample set, number of neurons in the output layer, and hidden layer. The hidden layer has a great influence on the overall system operation and is mostly influenced by the NN (Neural Network) algorithm [14].

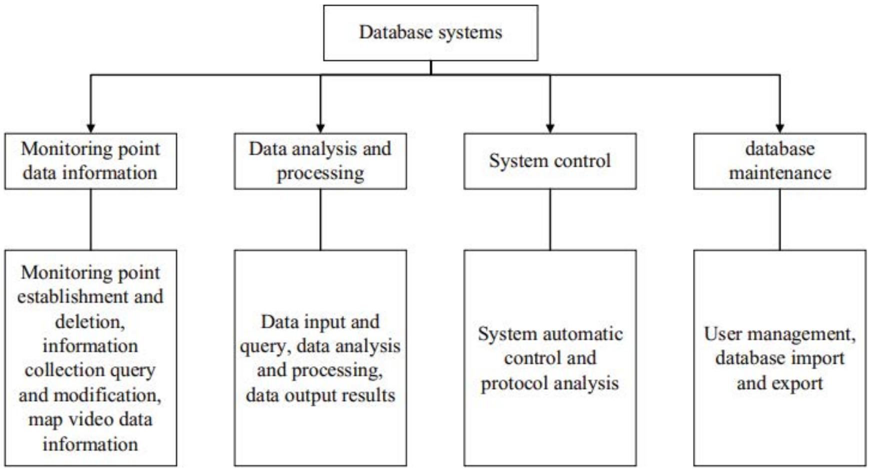


Fig. 4. Schematic diagrams of database system modules.

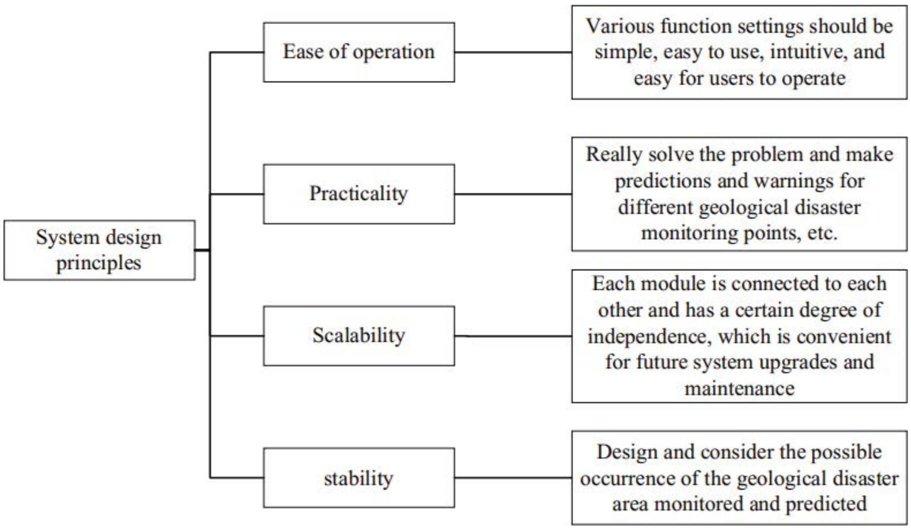


Fig. 5. Principles of geological disaster system design.

The proposed system quickly collects the data information of rainfall, ground fission, and groundwater level of monitoring points through advanced technologies and equipment, such as monitoring equipment and data algorithm. After analysis of these data, the specific situation of the monitoring points of the earth quality disaster is understood. Thus, the possibility of geological disasters in the area is judged, and the life and property threat to people's production and life caused by these geological disasters is minimized [15].

### *3.3. Geological disaster monitoring and prediction based on K-line chart*

The K-line chart is a new data integration method for the collected geological disaster data and can express various information in the chart, which can effectively reflect the occurrence of multi-factor geological disasters. In other words, the K-line chart in geological disaster monitoring data is a graph combining multiple factors, facilitating the analysis of various geological disaster data.

The K-line chart can comprehensively analyze the factors of geological disasters through a single and integral chart rather than a combination of the scatted analytical data of multiple factors. Hence, the K-line chart can comprehensively grasp the geological disaster data and analyze and predict the geological disaster situation in this region accordingly.

Moreover, the drawn K-line chart forms a new geological disaster database, which can clearly and comprehensively analyze geological disasters, enrich the whole geological disaster database, thus improve the performance and accuracy of the geological disaster monitoring and prediction system. According to the K-line chart of different periods, geological disasters can be predicted and analyzed for a specific region. The analysis results are more comprehensive and specific than the previous factors, with higher accuracy and system performance.

## 4. Conclusions

This paper summarizes the factors of geological hazards and precipitation, explains the types and causes of geological hazards, and analyzes the application and characteristics of k-chart. Finally, geological hazards and precipitation monitoring and research are put forward. The analysis results show that the performance of the geological hazard system based on k-chart is greatly improved. The data analysis features of the K chart provide researchers with a deeper understanding of geological hazards, make full use of the data collected, and clearly point out the development prospect of geological hazards research. The prediction methods and systematic research of geological hazards and precipitation based on the K-chart are helpful to the in-depth study of various regional geological hazards and precipitation, promote the study of geological hazards and precipitation in China, reduce the impact of local geological hazards and precipitation on the environment and life, and thus reduce the loss of people's lives and property and national economy.

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