Study on the integrated system of prediction of the range of volcanic collapse in Changbai Mountain

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Abstract. In view of the large amount of geological data, dispersion and the lack of time-consuming and error-prone and other routine statistics, the scope of volcanic collapse in Changbai Mountain area is comprehensively calculated. Analysis of relevant impact factors, such as rock, slope height, slope, human factors, etc. Using UDEC to simulate collapse and then use SPSS software to predict the range of influence and to carry out linear regression. Then analyze its correlation and discreteness, draw the linear regression equation, establish the prediction system of the range of the volcanic collapse of Changbai Mountain, and reach the database management and scope.

1. Introduction
Volcanic eruption is not only the most spectacular natural landscape on earth, but also a major disaster for mankind, once the volcanic eruption caused earthquakes, and then induced the collapse disaster, will cause great damage and loss to the ecological environment, tourism and personal safety in the region. On the basis of obtaining the survey data of Changbai Mountain volcanic collapse, this project will collect and organize the data to be fully analyzed, and the different types of collapses under the influence of volcanic earthquakes are used to predict and evaluate the collapse route and fall range of different types of collapses under the influence of volcanic earthquakes, and then determine the impact range of the collapses in Changbai Mountain area under volcanic earthquakes. On this basis, the regression analysis method of SPSS software obtains the prediction model of collapse range and establishes the Access data integration system, which will provide the basis for the prevention and control of collapse disaster, risk evaluation and forecast and early warning in the research area. Therefore, it is a very urgent task to study the impact of the collapse of Changbai Mountain volcano and accurately predict and evaluate it.

2. Studying the characteristics of collapse disaster in the studied area
Changbai Mountain has 246 collapses, according to the classification of the existing landslide and the development characteristics of the collapse of the research area, it is divided into whole, block, layer,
crack, fracture and scattered collapse, which is subdivided into debris rock, carbonated rock, crystalline rock and metamorphic rock and other combination steaming types. For example: Fusong County: Collapse is the most widely distributed, most frequent occurrence and more harmful type of geological disaster in Fusong County, with a total of 68 development altogether collapses. Distributed in Fusong - Wanliang, Fusong - Linjiang, Fusong - Changbai Highway along, and many in the form of collapse groups, the development width of 100 to 1000 m, collapse height of 20 to 70 m. The formation of collapse rock types include granite and granite flash rock, metamorphic rock and other rock types. Among them, mainly hard rock, accounting for 95.60% of the total number of unstable slope points.

3. **Collapse range prediction based on UDEC**

Collapse prediction is an important issue in this field of research, which is of great significance to disaster prevention and reduction. Using discrete element UDEC software to simulate the motion process of collapse, the relative error of the fall range and the actual fall range obtained by the field investigation is small, which shows that it is feasible to predict the collapse range by using UDEC, which is of great significance to the disaster prevention and mitigation in disaster-prone areas.

The software from the initial input parameters to generate model images and landslide simulation, the collapse scroll process of the collapse will be recorded, and then generate data, so that we can know the collapse of the collapse location, landslide distance and other important data, to carry out the disaster prevention work, so as to achieve disaster prevention and mitigation. Theoretically, no matter where we take its specimen to detect the parameters we need, we can use discrete element software Udec image model simulation, so as to obtain the safety of these rock bodies and prevent the collapse and other disasters to human hazards. The collapse of the study area selected the parameters such as slope, slope height, number of fissure groups, rock, seismic acceleration and other parameters, and quantified the parameters of rock ity, the UDEC simulation process is shown in Fig 1, Fig 2, the simulation results are shown in Table 1.

![Figure 1. Collapse calculation model](image1)

![Figure 2. Block displacement](image2)
Table 1. Partial collapse range value

| Number | Slope-foot elevation(m) | Stratigraphic rock | Slope (m) | Slope height (m) | Slope pattern | Rock structure | Human factors | Collapse Range value(m) |
|--------|-------------------------|--------------------|-----------|-----------------|-------------|---------------|---------------|------------------------|
| 01     | 0.63                    | 1.00               | 0.89      | 0.17            | 0.75        | 0.50          | 1.00          | 5.8                    |
| 02     | 0.01                    | 0.90               | 0.72      | 0.38            | 0.75        | 0.60          | 0.25          | 6                     |
| 03     | 0.01                    | 0.90               | 0.94      | 1.00            | 0.75        | 0.60          | 0.25          | 7.3                    |
| 04     | 0.01                    | 0.90               | 0.83      | 1.00            | 0.75        | 0.60          | 1.00          | 5.5                    |
| 05     | 0.01                    | 0.90               | 0.83      | 1.00            | 1.00        | 0.60          | 1.00          | 6.7                    |
| 06     | 0.01                    | 0.90               | 0.80      | 0.83            | 0.75        | 0.60          | 1.00          | 6.1                    |
| 07     | 0.43                    | 1.00               | 0.89      | 0.22            | 0.75        | 0.50          | 1.00          | 12.3                   |
| 08     | 0.41                    | 1.00               | 0.89      | 0.17            | 0.75        | 0.50          | 0.75          | 10.5                   |
| 09     | 0.57                    | 0.80               | 0.78      | 0.21            | 0.50        | 0.75          | 1.00          | 7.2                    |
| 10     | 0.61                    | 1.00               | 0.83      | 0.13            | 0.50        | 0.50          | 0.75          | 5.8                    |
| 11     | 0.61                    | 1.00               | 0.94      | 0.13            | 0.75        | 0.50          | 0.75          | 8.5                    |
| 12     | 0.57                    | 0.80               | 0.86      | 0.19            | 0.75        | 0.50          | 1.00          | 9.6                    |
| 13     | 0.59                    | 1.00               | 0.83      | 0.21            | 0.50        | 0.50          | 1.00          | 9.2                    |
| 14     | 0.60                    | 1.00               | 0.83      | 0.13            | 0.75        | 0.50          | 0.75          | 8.8                    |
| 15     | 0.59                    | 1.00               | 0.83      | 0.33            | 0.75        | 0.50          | 1.00          | 13.6                   |
| 16     | 0.54                    | 1.00               | 0.50      | 0.15            | 0.75        | 0.50          | 0.75          | 11.9                   |
| 17     | 0.13                    | 1.00               | 0.91      | 0.13            | 0.75        | 0.50          | 0.75          | 8.1                    |
| 18     | 0.23                    | 0.80               | 0.76      | 0.14            | 0.75        | 0.50          | 0.75          | 6.9                    |
| 19     | 0.23                    | 1.00               | 0.87      | 0.25            | 0.75        | 0.50          | 1.00          | 9.8                    |
| 20     | 0.65                    | 0.30               | 0.98      | 0.21            | 0.75        | 0.50          | 1.00          | 13.9                   |

4. The establishment of regression model

4.1. Selection of evaluation factors

In this paper, the evaluation model is verified by the landslide in Changbaishan area. Select the eight indicators of elevation xi1, formation rock xi2, slope xi3, slope height xi4, slope-shaped attitude xi5, rock structure xi6, annual rainfall xi7 and human factor xi8 as prediction indicators, 107 collapse data as a sample data, because the value of the variable scangs can be used to expand the evaluation results and level characteristics reflected the degree of deviation, expert scoring results manual assignment, take log off into the model for testing.

4.2. Results Analysis

Table 2. Model summary table

| Model | R       | Party R | Adjusted Party R | Error of standard estimates | Changing statistics |
|-------|---------|---------|------------------|----------------------------|--------------------|
|       | R-side change | F change | Degrees of Freedom 1 | Degrees of Freedom 2 | Significant F-change |
| 1     | 0.747a  | 0.558   | 0.434            | 2.4160                    | 0.558 4.502 7 25 0.002 |

a. Predictors: (Constant), Human factors, Slope, Slope pattern, Stratigraphic rock, Rock structure, Slope-foot elevation, Slope height.

b. Dependent variables: Collapse range value.

The compound correlation coefficient R=0.747, close to 1, and the linear correlation between the variables is more significant. The coefficient of determination, R2=0.558, the coefficient has a greater influence on the dependent variable, which changes 55.8% of the total change, and the observation
point is more densely distributed near the regression line. Adjusting \( R^2 \) to 0.434, the model fits more ideally. The standard error of the estimate is 2.416, the actual value is close to the estimate, and the regression model is well fitted.

### Table 3. Anova table

| Model          | The sum of squares | Freedom | Average party | F     | Significant |
|----------------|--------------------|---------|---------------|-------|-------------|
| Regression     | 183.939            | 7       | 26.277        | 4.502 | 0.002b      |
| Residuals      | 145.922            | 25      | 5.837         |       |             |
| Total          | 329.861            | 32      |               |       |             |

a. Dependent variables: Collapse range value.

b. Predictors: (Constant), Human factors, Slope, Slope pattern, Stratigraphic rock, Rock structure, Slope-foot elevation, Slope height.

The corresponding degrees of freedom are 7,25/32. Check the F distribution table \( F_0(7, 25) < F = 4.502 \), and the value of the significance level \( \text{Sig} = 0.002 < 0.05 \), indicates acceptance of \( x_1, x_2 \), ... The conclusion that there is a linear regression relationship between \( x_k \) and \( y \) makes sense for this set of regression coefficients.

### Table 4. Coefficient table

| Model          | Unstandardized factor | Standardized factor | t | Significance | B to get 95% confidence interval | Correlation | Collinear statistics |
|----------------|-----------------------|---------------------|---|--------------|---------------------------------|-------------|---------------------|
|                | B                     | Standard error      |   |              | Lower order | Ceiling order | Deviation | Part | Tolerance | VIF |
| Constant       | 5.024                 | 12.10               | 0.41 | 0.682 | -19.9 | 29.95 |          |          |          |     |
| Slope-foot elevation | 8.249             | 1.852              | 0.720 | 4.45 | 0.000 | 4.435 | 12.06 | 0.60 | 0.665 | 0.59 | 0.677 | 1.47 | 8 |
| Stratigraphic rock | -0.072           | 3.346              | -0.003 | -0.02 | 0.983 | -6.96 | 6.820 | -0.05 | -0.04 | -0.1 | 0.850 | 1.17 | 7 |
| Slope          | 3.651                 | 5.228              | 0.099 | 0.69 | 0.491 | -7.11 | 14.42 | 0.24 | 0.138 | 0.09 | 0.873 | 1.14 | 5 |
| Slope height   | 1.030                 | 2.440              | 0.084 | 0.42 | 0.677 | -3.99 | 6.055 | -0.21 | 0.084 | 0.06 | 0.450 | 2.22 | 3 |
| Slope pattern  | 9.717                 | 6.274              | 0.263 | 1.54 | 0.134 | -3.20 | 22.63 | 0.10 | 0.296 | 0.21 | 0.612 | 1.63 | 5 |
| Rock structure | -12.8                | 11.46              | -0.219 | -1.12 | 0.273 | -36.4 | 10.75 | -0.41 | -0.22 | -0.2 | 0.465 | 2.15 | 1 |
| Human factors  | -2.51                | 1.839              | -0.194 | -1.37 | 0.183 | -6.30 | 1.269 | 0.00 | 0.267 | -0.2 | 0.881 | 1.13 | 5 |

a. Dependent variables: Collapse range value.
Table 5. Residual statistics table

|                          | Min  | Max  | Average | Standard deviation | Number of cases |
|--------------------------|------|------|---------|--------------------|-----------------|
| Predicted values         | 5.423| 14.775| 9.658   | 2.3975             | 33              |
| Standard forecasts       | -1.766| 2.134| 0.000   | 1.000              | 33              |
| Standard error of the predicted value | 0.552| 2.295| 1.103   | 0.452              | 33              |
| Adjusted Forecast        | -11.020| 13.156| 9.023   | 4.2122             | 33              |
| Residuals                | -6.1095| 3.5250| 0.000   | 2.134              | 33              |
| Standard variance        | -2.529| 1.459| 0.000   | 0.884              | 33              |
| Reject residuals         | -6.7763| 18.2204| 0.6345  | 4.3128             | 33              |
| Mars Distance(D)         | 0.703| 27.910| 6.788   | 6.712              | 33              |
| Cook Distance            | 0.000| 6.416| 0.252   | 1.113              | 33              |
| Centered leverage value  | 0.022| 0.872| 0.212   | 0.210              | 33              |

Figure 3. Normal curve histograms of residuals

Figure 4. Regression standardized residual normal probability graph

The normal curve distribution of residual values is ideal from Figure 3 and Figure 4, and the scattered points are distributed near the straight line, indicating that the variables are linearly distributed, while the variables are roughly linear, and the regression equation meets the linear conclusion.

Therefore, the regression equation is of practical significance. The regression coefficient is integrated into the equation, and the multi-nonlinear regression equation of the degree of prone of the region's collapse-slip is derived:

\[ Y = 5.024 + 8.249x_1 - 0.072x_2 + 3.651x_3 + 1.030x_4 + 9.717x_5 - 12.864x_6 - 2.519x_8 \]

This nonlinear regression equation can better reflect the development of the slippery body in this area, and the evaluation results are reasonable.
5. Collapse Range Prediction Integration System Construction

![Figure 5. Database data entry](image5.png)  ![Figure 6. Collapses and irrelevant filtering data](image6.png)

A database is a repository of data. It has a lot of storage space, can store millions, tens of millions of pieces, hundreds of millions of pieces of data. But the database is not random to store data, there are certain rules, otherwise the efficiency of the query will be very low. And it is a repository of computer storage devices that organize, store, and manage data according to the data structure. Simply put, it can be regarded as an electronic file cabinet - the place where electronic files are stored, and users can add, intercept, update, delete and so on the data in the file. The data 5-7 of the database input, query and prediction interface of the study area.

![Figure 7. Query interface](image7.png)

6. Conclusion

In this project, we first organize and analyze the existing data, then the Changbai Mountain volcano seismic intensity analysis, study the relationship between the influence factor and the collapse, and then determine the characteristics of the typical collapse, to obtain the parameters of UDEC numerical simulation. Determine the uDEC program simulation damping, time step, grid size, seismic load, etc. of the value, determine the site conditions, establish the UDEC discrete element model, and then use SPSS software, with the collapse of the slope, slope height, rock, earthquake and UDEC numerical simulation of the destruction range for the regression equation evaluation index X and range prediction value Y, into the regression equation for the overall analysis of the data, so as to obtain the collapse range prediction model of the Long Baishan area. According to these Access data integration systems, which establish the range prediction of Changbai Mountain collapse, the data is entered, stored, queried, modified and predicted the collapse range value based on regression analysis.

The establishment of the integrated system of prediction and prediction of the collapse range of Changbai Mountain provides a unified and standardized data resource platform for the prevention and control of the collapse disaster, risk evaluation and forecast warning of the research area, and the prediction of the impact of the completion of the collapse can be completed to evacuate the population to the safe area in advance and transfer the valuable assets to the non-impact area, so as to greatly reduce the collapse disaster induced by the changbai mountain volcanic eruption, the
suddenness, destructiveness, and the difficulty of seeking help for the ecological environment, water conservancy and water conservancy in the region. Tourism and personal safety cause great damage and loss.

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