Determining an appropriate integrated assessment model of tourism safety risk within the Changbai Mountain Scenic Area

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Abstract. Tourism safety is gradually gaining more attention due to the rapid development of the tourism industry in China. Changbai Mountain is one of the most famous mountainous scenic areas in Northeast Asia. Assessment on Changbai Mountain scenic area’s tourism safety risk could do a favor in detecting influence factor of tourism safety risk and classifying tourism safety risk rank, thereby reducing and preventing associated tourism safety risks. This paper uses the Changbai Mountain scenic area as the study subject. By the means of experts scoring and analytic hierarchy process on quantified relevant evaluation indicator, the grid GIS method is used to vectorize the relevant data within a 1000m grid. It respectively analyzes main indicators associated tourism safety risk in Changbai Mountain scenic area, including hazard, exposure, vulnerability and ability to prevent and mitigate disasters. The integrated tourism safety risk model is used to comprehensively evaluate tourism safety risk in Changbai Mountain scenic area.

1. Introduction
Tourism safety is gradually gaining more attention due to the rapid development of the tourism industry in China. Understanding the influence factors and conducting risk assessments are the key topics of tourism safety risk management. Faulkner (2001)\textsuperscript{[1]}, Ritchie (2004)\textsuperscript{[2]} constructed a framework for tourism disaster management. Prideaux (2003)\textsuperscript{[3]} explored the limits to formal tourism trends forecasting methods. Peter (2010)\textsuperscript{[4]}, (2014)\textsuperscript{[5]} presented a model that used the principles of risk assessment to evaluate the environmental sustainability in the tourism and recreation sectors, and applied this model in Ireland. The tourism safety risk studies are very popular in Mountainous areas, because these areas are the common destinations of tourists gathering while the terrain is complex and accident-prone. Hu Wenhai (2000)\textsuperscript{[6]} studied the forms of and preventive measures against disasters in mountain tourism; Li Xinjuan (2010)\textsuperscript{[7]} explored the tourism safety evaluation method of mountain scenic; while Cen Qiao (2011)\textsuperscript{[8]} conducted systematic studies on the perception, alerts, and rescues in mountain tourism safety. In general, the studies in mountain tourism safety are relatively fragmented and preliminary, with few quantitative examinations, as most focused only on the qualitative level.

Taking Changbai Mountain as the study area, based on the integrated tourism safety risk model, the authors identify the influence factors of tourism safety risk, quantify the relevant assessment indicators through expert scoring method, and gain the evaluation value. Then discuss the results of tourism safety risk assessment in the Changbai Mountain scenic area.

2. Research methods
2.1 Integrated tourism safety risk model
Tourism safety risk refers to the probability of accidents occurring within the tourism system. The magnitude of tourism safety risk is dependent on the combined effect of the hazard of risk source (H), the exposure (E) and vulnerability (V) of the hazard-bearing body, and the ability of disaster prevention and reduction (R). The relation can be expressed by the following equation:

\[ \text{Tourism safety risk indicator (TSRI)} = \frac{H \times E \times V}{1 + R} \]  

In Equations (2) through (5), \( X_i \) is the weight of \( i \) after quantification and \( W_i \) is the weight of the indicator \( i \), which represents the relative importance of various factors to tourism risk formation.

2.2 Grid GIS technology
Grid GIS is the application of geographic information system technology in the network environment. The authors vectorize the relevant data within a 1000m × 1000m grid and obtain the tourism safety risk value of every grid, which is then further classified.

3. Determining an indicator system and a model of tourism safety risk assessment for the Changbai Mountain scenic area
Changbai Mountain is one of the most famous mountain destinations in Northeast Asia. Changbai Mountain started receiving visitors in the 1980s. At present, the tourism routes within China’s boundary (as it separates the country from North Korea) are developed along the northern slope, western slope, and southern slope.

3.1 Determining an indicator system of tourism safety risk assessment
According to the integrated tourism safety risk model described above and based on the principles of representation and operability, the authors have further broken down the four factors—hazard, exposure, vulnerability, and the ability of disaster prevention and reduction—in an effort to select more specific assessment indicators for constructing an appropriate tourism safety risk assessment indicator system. This paper selected 18 performance indicators for the tourism safety risk assessment applicable to the Changbai mountain scenic area. The specific indicators are shown in Table 1.

| Factor     | Indicator                                | Weight |
|------------|------------------------------------------|--------|
| Hazard     | Slope level                              | 0.1742 |
|            | Altitude level                           | 0.1334 |
|            | Precipitation level                      | 0.1248 |
|            | Type of surface vegetation cover         | 0.1475 |
|            | Management standard indicator            | 0.2275 |
|            | Visitor behavior variability indicator   | 0.1925 |
| Exposure   | Visitor ratio                            | 0.3021 |
|            | Facility ratio                           | 0.2025 |
|            | Tourism income ratio                     | 0.2353 |
|            | Tourism resource amount                  | 0.2600 |
| Vulnerability | Visitor vulnerability indicator         | 0.4484 |
|            | Tourism capacity                         | 0.3213 |
|            | Tourism resource level                   | 0.2302 |
| Ability of | Visitor safety awareness                 | 0.2711 |
| Disaster   | Safety management ability                | 0.1612 |
3.2 Weighted calculation of the tourism safety risk assessment indicators

The authors applied the Analytic Hierarchy Process (AHP) method to the tourism safety risk assessment indicators. During this process, experts in fields such as tourism management, natural disasters, and tourism geography were invited to score on the importance of various indicators to their corresponding hierarchy level, before final weights were derived.

3.3 Classification and scoring of the various indicators

After determining the weights of the various indicators using the above AHP method, we then used a five-level scoring method to assign values (i.e., 1 through 5) to each basic-level factor, and divided each indicator into five classes. The classification was done based on the actual status of the assessment indicators, followed by the assignment of different values.

4. Results of total tourism safety risk assessment for Changbai Mountain scenic area

4.1 Hazard assessment for Changbai Mountain scenic area

Based on the weights and scores of Changbai Mountain scenic area’s tourism safety risk hazard indicators, the authors then calculated by the integrated tourism safety risk model. The result is spread in the GIS to obtain the hazard assessment map of the area (Figure 1).

Figure 1 shows that the hazards in the entire scenic area generally form a semi-circle around Tianchi Lake (reflected in red), indicating that the area has the highest degree of hazard, with its distribution range widest in the northern slope, followed by the southern slope, and the western slope. Grids with a moderate level of hazard are mainly distributed in the western and southern slopes, the northern slope having a slightly lower level than the others. Areas marked in yellow depict relatively low hazard areas, and their distribution is more fragmented, concentrated mostly along the edges of the southern and western scenic areas. Most of these areas are distanced away from tourism routes. Areas marked in green are located at the center of the volcanic cone and indicate a weak hazard level. The rest are areas with only minor hazards.

4.2 Safety exposure assessment for Changbai Mountain scenic area

Based on the weights and scoring of the exposure indicators for the Changbai Mountain scenic area’s disaster occurrence, we then used the integrated tourism safety risk computation model to obtain the calculations shown in Figure 2. Two units—the car station and hot spring at the northern slope—are under extremely high exposures. These are also the areas with the highest tourist concentrations. Areas
under severe exposure, as a result of high tourism volume or concentration of resources, include the great canyon at the western slope, falls at the northern slope, Tianchi Lake, and entrances. Other destinations along tourism routes are under moderate exposure, while areas with slight exposure are largely tourism channels in the scenic area.

4.3 Safety vulnerability assessment for Changbai Mountain scenic area
Based on the weights and scoring of the vulnerability indicators for the Changbai Mountain scenic area, the authors then used the integrated tourism safety risk model for the calculations shown in Figure 3. In general, areas near the great canyon and mountain trails at the western slope are deemed extremely vulnerable; other areas along the northern slope and western slope routes are largely severe and moderate vulnerable areas. The southern slope routes, excluding Tianchi and the Camel Peak, are largely areas of slight vulnerability.

4.4 Disaster prevention and reduction ability assessment for Changbai Mountain scenic area
Based on the weights and scoring of the Changbai Mountain scenic area’s ability of disaster prevention and reduction, we then used the integrated tourism safety risk computation model for the calculations shown in Figure 4. The northern slope has a greater ability of disaster prevention and reduction, which is largely attributable to its more advanced development and more comprehensive management organization and facilities. However, there are several areas with lower ability in the northern slope those are mainly inaccessible, as they are distanced from roads. The western slope’s ability to prevent and reduce disasters is generally good, which have moderate ability in preventing and reducing disasters. The southern slope is furthest from the rescue center and has the weakest ability in the scenic area.

4.5 Results of total risk assessment for Changbai Mountain scenic area
Using the above studies on hazard, exposure, vulnerability, and the ability to prevent and reduce disasters, and the integrated tourism safety risk assessment equation, we obtained the total assessment value of Changbai Mountain scenic area’s tourism safety, as illustrated in the following figure: Figure 5 shows that the main tourism routes of individual slopes have relatively large differences in terms of their risk levels. Areas near Tianchi and the falls at the northern slope have the highest risk; some spots, such as Tianwen Peak, little Tianchi, hot springs, and the slope’s entrance have high risks; the rest of the areas are moderate risk areas. As for the western slope, its highest risk level is lower than that of the northern slope, with destinations along the tourism route having relatively high risk levels. For the southern slope, areas with relatively high risks include the entrance, Yuehua Falls, Camel Peak, while the rest are moderate risk areas.
5. Conclusions
This paper used the 100m × 100m scale standard grid as the basic unit for assessing tourism safety risks of the Changbai Mountain scenic area. With comprehensive considerations of the hazard, vulnerability, exposure, and the ability of disaster prevention and reduction for tourism safety accidents, using the integrated tourism safety risk indicator method and GIS techniques, we were able to derive a tourism safety risk assessment map for the area. Results show that areas with the greatest total risks are located around Tianchi Lake and the falls at the northern slope. Areas with relatively high risks include Tianwen Peak, little Tianchi, hot springs, car station, and the entrance at the northern slope, as well as the great canyon and major tourism routes at the western slope and its entrance, the Yuehua falls, Camel Peak, and the upstream tourism routes leading to the Tian at the southern slope. The rest of the areas show only moderate risk.

References
[1] Faulkner, B. Towards a framework for tourism disaster management[J]. Tourism Management. 2001, (22): 135-147.
[2] Ritchie B W.Chaos, Crises and Disasters: A Strategic Approach to Crisis Management in the Tourism Industry[J].Tourism Management. 2004, (25):669-683.
[3] Prideauxa B, Lawsb E, Faulkner B. Events in Indonesia:Exploring the limits to Formal Tourism Trends Forecasting Methods in Complex Crisis Situations[J].Tourism Management, 2003, (24):475-487.
[4] Peter Roe. A Risk Assessment Based Model for Assessing the Environmental Sustainability of Tourism and Recreation Areas. Dublin Institute of Technology .2010, (25):669-683
[5] Peter Roe , Victor Hrymak, Frederic Dimanche. Assessing Environmental Sustainability in Tourism and Recreation Areas: a Risk-assessment-based Model. Journal of Sustainable Tourism,2014,22(2):319-338.
[6] Wenhai Hu, Lailin Hu. Calamities in Tourism Mountain and their Prevention Strategy. Journal of Mountain Science.2000, 18 (6): 576-579.
[7] Xinjuan Li. Tourism Crisis Evaluation and Prevention for Mountainous Scenic Areas. Journal of Henan Polytechnic University. 2010,11(4): 158-162.
[8] Qiao Cen, Ying Huang. Research on Perception and Attitude toward Tourism Safety of Mountain Scenic Areas——Based on Investigation on Tourists and Staffs of Mountain Scenic Areas. Technology and Market.2011,18(6):347-350.