# Risk Assessment and Zoning of Forest Snow Disasters in Inner Mongolia (Postprint)

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## Abstract

Based on natural disaster risk theory, meteorological, forestry, basic geographic information, and socioeconomic data related to forest snow disasters were selected to comprehensively evaluate regional differences in forest snow disaster risk levels in Inner Mongolia from four aspects: hazard of disaster-causing factors, vulnerability of disaster-bearing bodies, sensitivity of disaster-formative environments, and disaster prevention and mitigation capacity. Using the weighted comprehensive scoring method and the Analytic Hierarchy Process (AHP), the comprehensive forest snow disaster risk assessment indicator system and index were established and calculated, and a forest snow disaster risk zoning model for Inner Mongolia was constructed. High-risk and sub-high-risk areas for forest snow disasters in Inner Mongolia account for 77.18% and 0.05% of all forest snow disaster risk areas, respectively, and are both located in Hulunbuir City in northeastern Inner Mongolia. Moderate-risk areas account for 6.01% of all forest snow disaster risk areas, mainly located in Xilingol League, Hulunbuir City, Chifeng City, and Hinggan League, accounting for 0.61%, 36.50%, 9.11%, and 5.99% of the total moderate-risk area, respectively; sub-low-risk and low-risk areas account for 16.76% of all forest snow disaster risk areas, mainly located in Alxa League, Ordos City, Hinggan League, and other regions. Forest snow disaster risk in Inner Mongolia exhibits a gradual decreasing trend from northeast to southwest, which is basically consistent with the spatial distribution patterns of forests and snow cover.

# Full Text

## 2 Data and Methods

### 2.1 Data Sources

Meteorological and forestry data, basic geographic information, and socioeconomic data related to forest snow disasters were selected to comprehensively assess the regional differences in snowstorm risk in Inner Mongolia. This included disastrous factors and vulnerability, environmental sensitivity to snow disasters, and snow disaster prevention and mitigation capabilities based on natural disaster risk theory.

The Forest Disaster Risk Index (FDRI) was established using the weighted comprehensive scoring method and analytic hierarchy process (AHP):

$$FDRI = V_H W_H + V_S W_S + V_V W_V + V_R W_R$$

where $V_H$, $V_S$, $V_V$, and $V_R$ represent the evaluation indices for hazard factors, vulnerability, sensitivity, and prevention/mitigation capability, respectively; $W_H$, $W_S$, $W_V$, and $W_R$ are their corresponding weights. The weights were determined through the analytic hierarchy process based on expert scoring, with values of 0.5125, 0.3565, 0.0850, and 0.0459, respectively (Table 1). Kriging interpolation was used to generate 1 km × 1 km grid maps of forest snow disaster risk indices across Inner Mongolia.

### 2.2 Methods

Snow depth data from 2001–2016 were obtained from MODIS/Terra 8-day composite snow products (MOD10A2, MOD). For 2001–2007, snow depth data came from SSM/I, while 2008–2016 data were derived from SSMIS, both processed to EASE-Grid format.

## 3 Results

### 3.1 Hazard Factor Assessment

Forest snow disasters are closely related to forest stock volume, stand age structure, and other factors. The spatial distribution of hazard factors shows clear regional patterns [Figure 2: see original paper]. High-value areas are concentrated in regions with dense forest distribution and heavy snow accumulation.

### 3.2 Vulnerability Assessment

The vulnerability zoning map reveals that high-vulnerability areas are primarily located in the forest regions of the Greater Khingan Range [Figure 3: see original paper]. These areas are characterized by high forest stock volume and concentrated distribution of mature and over-mature stands.

### 3.3 Sensitivity Assessment

Sensitivity evaluation indicates that high-sensitivity areas are mainly distributed in the northern forest zones, where both forest resources and snow depth are substantial [Figure 4: see original paper].

### 3.4 Prevention and Mitigation Capability Assessment

Areas with strong prevention and mitigation capabilities are concentrated in regions with well-developed forestry management infrastructure and active disaster prevention measures [Figure 5: see original paper].

### 3.5 Comprehensive Risk Assessment

The comprehensive forest snow disaster risk zoning map shows that high-risk areas account for 77.18% of the total forest snow disaster risk area, primarily distributed in Hulun Buir City. Sub-high-risk areas constitute 0.05%, also mainly in Hulun Buir. Medium-risk areas represent 6.01% of the total area, distributed across Xilingol League (0.61%), Hulun Buir City (36.50%), Chifeng City (9.11%), and Xing'an League (5.99%). Sub-low and low-risk areas together account for 16.76%, mainly in Alxa League, Ordos City, Xing' an League, and other regions [Figure 6: see original paper].

The forest snow disaster risk in Inner Mongolia decreases gradually from northeast to southwest, which is basically consistent with the spatial distribution of forest resources and snow cover.

## 4 Discussion

The assessment results demonstrate that the northeastern forest region of Inner Mongolia faces the highest snow disaster risk. The Greater Khingan Range area, with its concentrated forest resources and heavy snowfall, exhibits particularly high vulnerability. The prevention and mitigation capability evaluation shows that areas with better infrastructure and management have enhanced resilience.

Previous studies [21, 22] have established that risk assessment should integrate hazard factors, vulnerability, and response capacity. Our findings align with this theoretical framework and provide a scientific basis for targeted forest snow disaster prevention strategies in Inner Mongolia. The spatial patterns identified can inform regional forestry management and disaster preparedness planning.

The weighted comprehensive scoring method combined with AHP provides a robust approach for multi-factor risk assessment. However, continuous refinement of evaluation indicators and weights through validation with historical disaster data would further improve the accuracy of the risk model.

*Note: Figure translations are in progress. See original paper for figures.*