Monitoring snow-caused disasters using remote sensing and GIS technologies in pastoral areas

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Introduction

To date, the emphasis in snow-caused disasters that occur in pastoral areas in China has been in monitoring the change in the distribution of snow and in assessing livestock loss in post-disaster. The lack of an operational model and information system for real-time warning of snow disasters has made it difficult to make risk assessments and provide early snow disaster warnings (Liu *et al*. 2008). The aim of this study is to establish an indicator system for the early warning of snow-caused livestock disasters based on data collected from 2001 to 2010 on the Tibetan Plateau, China.

Methods

The statistical analysis of critical factors

We used the following factors: annual probability of snow disaster (X1), snow-covered days (X4), livestock stocking rate (X6), continual days of daily temperature below -10°C (X2) , grassland burial index (X5), rate of snow-covered grassland (X3), and per livestock GDP (X7) as the PC components 1, 2, 3, 4, 5, 6, and 7.

Construction of the early warning model of snow disaster grades

$$Z_{ij} = \frac{57.850 \times a_{ij} + 64.891 \times b_{ij} + 8496 \times \prod_{k=1}^{n} (c_{k,ij})}{d_{ij}}$$

where: Z_{ij} is number of livestock death per county for a warning period; i is the number of counties, i=1, 2, 3, …, 201; j is the number of warning periods, j=1, 2, 3, …, 18, total warning periods in each snow season from October 1 to March 31 (10 days per warning period); a is X1; b is X2; c_k (where k=1 to 4) are respectively the rate of X3, X4, X5, and X6; and d is X7.

Accuracy assessment of snow disaster warning model

The data collected from 411 cases that occurred between 2008 and 2010 were used to validate the early warning snow disaster model. The model had an overall accuracy of 85.64% in predicting the occurrence of a snow disaster suggesting that the model was sufficiently accurate for operational use (Table 1). The detailed procedure is showed in Figure 1.

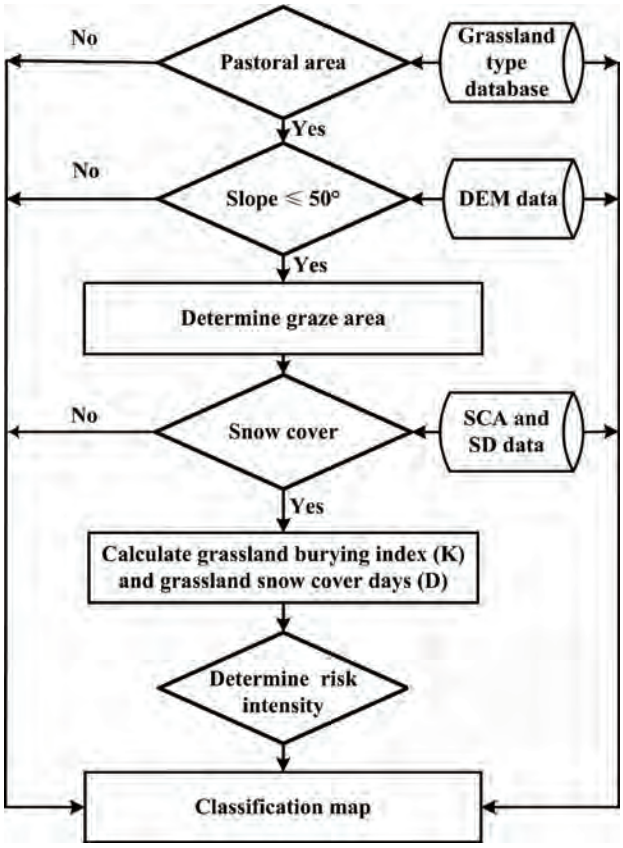

Figure 1. Workflow for risk intensity classification of snow disasters

Results

Figure 2 shows the early warning risk assessment on the Tibetan plateau in terms of 5 grades of snow disasters for the periods (J=12) in the 2008 snow season. This suggests that the early warning approach developed in the study has operational potential for predicting snow disasters on the Plateau.

Conclusions

In general, the early warning model developed was very good in predicting whether a snow disaster would occur. However, a lack of available data means the disaster grades cannot be validated. In practice, the model has been

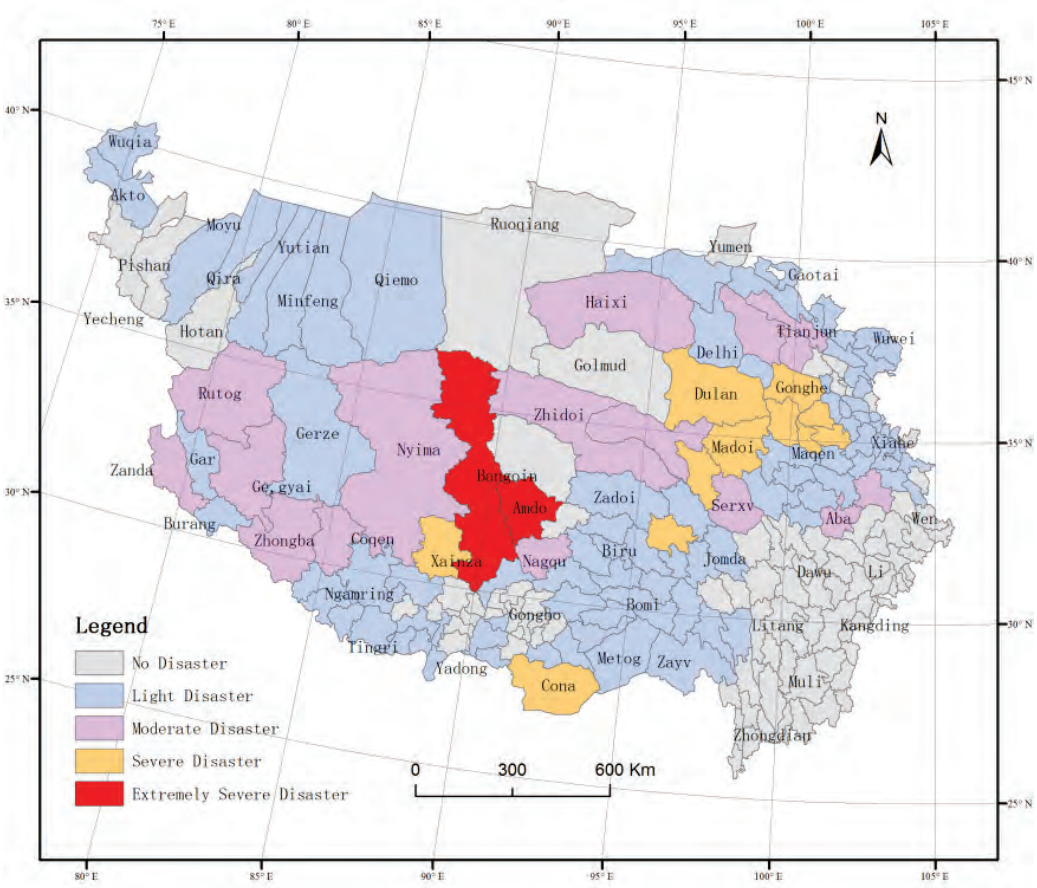

Figure 2. Snow disaster warning simulation result for counties on the Tibetan Plateau in late January 2008 (J=12)

Table 1. Accuracy of the snow disaster warning model from 2008 to 2010 on the Tibetan Plateau

Year	Agreement		Disagreement		Snow disaster Accuracy (%)	No disaster Accuracy (%)	Overall Accuracy (%)
	Snow disaster	No disaster	Only actual records result	Only simulation results			
2008	169	58	19	18	89.89	76.32	85.98
2009	35	62	0	21	100.00	74.70	82.20
2010	19	9	1	0	95.00	100.00	96.55
Overall	223	129	20	39	91.77	76.79	85.64

successful in accurately predicting snow disaster for pastoral areas on Tibetan Plateau, where harsh weather, high altitude and access is difficult for rescue and communication is poor under heavy snow conditions. Therefore, our early warning model of snow disasters has a great potential for operational use. In the future, we need to improve the data collection process and obtain more cases with accurate information about livestock losses and other related information, which can be used to validate the disaster grades predicted by our early warning model.

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References

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