

A Cascading Storm-Flood-Landslide Guidance System: Development and Application in China

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Flash floods and landslides, triggered by storms, often interact and cause cascading effects on human lives and property. Satellite remote sensing data has significant potential use in analysis of these natural hazards. As one of the regions continuously affected by severe flash floods and landslides, Yunnan Province, located in Southwest China, has a complex mountainous hydrometeorology and suffers from frequent heavy rainfalls from May through to late September. Taking Yunnan as a test-bed, this study proposed a Cascading Storm-Flood-Landslide Guidance System to progressively analysis and evaluate the risk of the multi-hazards based on multisource satellite remote sensing data.

First, three standardized rainfall amounts (average daily amount in flood seasons, maximum 1h and maximum 6h amount) from the products of Topical Rainfall Measuring Mission (TRMM) Multi-satellite Precipitation Analysis (TMPA) were used as rainfall indicators to derive the StorM Hazard Index (SMHI). In this process, an integrated approach of the Analytic Hierarchy Process (AHP) and the Information-Entropy theory was adopted to determine the weight of each indicator. Then, land cover and vegetation cover data from the Moderate Resolution Imaging Spectroradiometer (MODIS) products, soil type from the Harmonized World Soil Database (HWSD) soil map, and slope from the Shuttle Radar Topography Mission (SRTM) data were add as semi-static geo-topographical indicators to derive the Flash Flood Hazard Index (FFHI). Furthermore, three more relevant landslide-controlling indicators, including elevation, slope angle and soil text were involved to derive the LandSlide Hazard Index (LSHI). Further inclusion of GDP, population and prevention measures as vulnerability indicators enabled to consecutively predict the risk of storm to flash flood and landslide, respectively.

Consequently, the spatial patterns of the hazard indices show that the southeast of Yunnan has more possibility to encounter with storms than other parts, while the northeast of Yunnan are most susceptible to floods and landslides, which agrees with the distribution of observed flood and landslide events. Moreover, risks for the multi-hazards were classified into four categories. Results show a strong correlation between the distributions of flash flood prone and landslide-prone regions and also highlight the counties with high risk of storms (e.g., Funing and Malipo), flash floods (e.g., Gongshan and Yanjing) and landslides (e.g., Zhaotong and Luxi). Compared to other approaches, the Cascading Storm-Flood-Landslide Guidance System uses a straightforward yet useful indicator-based weighted linear combination method and could be a useful prototype in mapping characteristics of storm-triggered hazards for users at different administrative levels (e.g., catchment, town, county, province and even nation) in China.