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Considering geological structures in landslide susceptibility assessment: A case study in Yen Bai Province, Vietnam

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Geological structures play an important role in forming landscapes as well as determining the degree of landslide susceptibility and hazard. One large area (about thousands of km^2) is often composed of several units of geological structures (so-called structural units), in which each unit is characterized by specific tectonic activity, deformation, lithologies, geomorphology and topography. In many studies, controlling factors of landslides have been assessed through factor maps, in which each map is compiled for the whole study area. However, these do account for different structural units, which reduce the degree of prediction accuracy in the landslide susceptibility assessment.

This study aims to assess the importance of considering geological structures in landslide susceptibility assessment for a large area. The study focuses on the Yen Bai Province, which includes three structural units: Tay Viet Bac, Nui Con Voi and Phan Si Pan. The methodology is composed of the following steps: (1) Applying Spatial Multi-Criteria Evaluation (SMCE) approach for the landslide susceptibility assessment; (2) Using eight controlling factor maps related to slope, drainage, deep cleavage, lineament, water bearing capacity, shear strength, weathering crust and vegetation cover as input data, in which each controlling factor map was separately compiled in three sub-maps that correspond to three above-mentioned structural units; (3) Using expert knowledge with pairwise comparison based on the AHP method for weighting of sub-factor maps and sub-factor map classes related to landslide susceptibility in every structural unit; (4) Using the landslide inventory maps and the receiver operating characteristic (ROC) analysis to validate and evaluate the accuracy of the result map for the Yen Bai Province.

The comparison with the landslide inventory maps shows that approximately 86% landslides distribute in the Very High, High and Moderate Susceptibility zones, occupying 69% of the total area of the province. The ROC analysis generates a value of 0.881 for the area under the curve (AUC), which indicates a high degree of accuracy, especially in comparison with the AUC value of 0.731 when assessing the landslide susceptibility without dividing the whole study area into three structural units.

It is concluded that incorporating the divisions of geological structures into landslide susceptibility assessment can increase the prediction accuracy. The finding also confirms the influence of the geological structures in the landslide susceptibility. The limitation of this approach is that it takes much more time to run and assess all sub-maps of the controlling factors and there is a need for a deep understanding of the geology of the study area.