Investigating Causal Factors of Shallow Landslides in Grassland Regions of Switzerland

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Mountainous grassland slopes can be severely affected by soil erosion, among which shallow landslides are a crucial process, indicating instability of slopes. We determine the locations of shallow landslides across different sites to better understand regional differences and to identify their triggering causal factors. Ten sites across Switzerland located in the Alps (eight sites), in foothill regions (one site) and the Jura Mountains (one site) were selected for statistical evaluations. For the shallow-landslide inventory, we used aerial images (0.25 m) with a deep learning approach (U-Net) to map the locations of eroded sites. We used logistic regression with a group lasso variable selection method to identify important explanatory variables for predicting the mapped shallow landslides. The set of variables consists of traditional susceptibility modelling factors and climate-related factors to represent local as well as cross-regional conditions. This set of explanatory variables (predictors) are used to develop individual-site models (local evaluation) as well as an all-in-one model (cross-regional evaluation) using all shallow-landslide points simultaneously. While the local conditions of the 10 sites lead to different variable selections, consistently slope and aspect were selected as the essential explanatory variables of shallow-landslide susceptibility. Accuracy scores range between 70.2% and 79.8% for individual site models. The all-in-one model confirms these findings by selecting slope, aspect and roughness as the most important explanatory variables (accuracy=72.3 %). Our findings suggest that traditional susceptibility variables describing geomorphological and geological conditions yield satisfactory results for all tested regions. However, for two sites with lower model accuracy, important processes may be under-represented with the available explanatory variables. The regression models for sites with an east-west-oriented valley axis performed slightly better than models for north- south-oriented valleys, which may be due to the influence of exposition-related processes. Additionally, model performance is higher for alpine sites, suggesting that core explanatory variables are understood for these areas.
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