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High predictor dimensionality in slope-unit-based landslide susceptibility models through LASSO-penalized Generalized Linear Model

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Grid-based landslide susceptibility models at regional scales are computationally demanding when using a fine grid resolution. Conversely, Slope-Unit (SU) based susceptibility models allows to investigate the same areas offering two main advantages: 1) a smaller computational burden and 2) a more geomorphologically-oriented output.
In this contribution, we generate a SU-based landslide susceptibility for the Sado Island in Japan. This island is characterized by deep-seated landslides which we assume can only limitedly be explained by the first two statistical moments (mean and variance) of a set of predictors within each slope unit. As a consequence, in a nested experiment, we first analyze the distributions of a set of continuous predictors within each slope unit computing the standard deviation and quantiles from 0.05 to 0.95 with a step of 0.05 which were then used as predictors for landslide susceptibility. In addition, we combined shape indices for polygon features and the normalized extent of each class belonging to the outcropping lithology in a given SU. This procedure significantly enlarges the size of the predictor hyperspace, thus producing a high level of slope-unit characterization. In a second step, we adopt a LASSO-penalized Generalized Linear Model to reduce the predictor set to a sensible and interpretable number, carrying only the most significant covariates in the models. As a result, we are able to identify the geomorphic features that primarily control the SU-based susceptibility within the test area while producing high predictive performances. Level 4 validation procedures were implemented to assess uncertainty and quality of the models through a set of 500 randomly generated replicates.