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Geophysical Research Abstracts
Vol. 19, EGU2017-6260, 2017
EGU General Assembly 2017

Dealing with heterogeneous landslide information for landslide susceptibility assessment: comparing a pixel-based and slope unit-based approach

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In the Rwenzori Mountains, various multi-disciplinary data collection initiatives have resulted in a heterogeneous database counting 247 fully characterized landslides with known size and shape (polygon dataset) and 307 landslides represented as single points taken at an unknown location within the landslide body (point dataset). While the polygon dataset covers only 9% of the inhabited highlands, the point dataset extends the total inventoried area to 18% of the entire inhabited highland region. A regional susceptibility model for the total area should therefore include both information from polygon- as well as point datasets. This involves two distinct methodological challenges with regard to the use of points and polygons respectively. Firstly, the point dataset, where the location of the point within the landslide body is unknown, may not be fully representative for the spatial conditions under which the landslides occurred. Here we aim to identify a robust approach, to limit this uncertainty and maximize the point location representativeness. For this purpose, a pixel-based approach is tested and compared to a slope unit-based approach. To mimic the uncertainty related to the localization of the points, 50 random samplings of single points within each landslide were performed and then fed into a logistic regression model. The model was thus run 50 times using both the slope unit-based and the pixel-based approach. The results show that the slope unit-based alternative has an overall better performance than the pixel-based with comparable stability over the runs. Based on these results, the slope unit seems a more appropriate mapping unit for a susceptibility model based on point-data. A second significant methodological issue, when using polygon-based models, concerns the decision on when a slope unit is considered to be landslide-prone. A threshold representing the fraction of the slope unit affected by landslides above which a slope unit is assigned to be landslide-prone is often used for this purpose. The selection of this threshold is a trade-off: the larger the threshold, the more slope units also containing landslides are considered safe, while a small threshold will give more weight to mapping errors of landslide polygons exceeding slope unit boundaries. Here, five different thresholds ranging from 0.0005 to 0.05 are compared with the repeated random sampling described above. A threshold of 0.001 was found to provide the best model performances, while the random sampling approach performed better than the models based on thresholds larger than 0.001. This shows that a threshold approach can produce the best model performances only if an optimal threshold selection is performed. Based on these findings, a regional slope unit-based model was (i) calibrated using landslide polygon data and performing an optimal threshold selection and (ii) validated using the point-data achieving an AUC_{ROC} of 0.69. This experiment shows that although pixel-based susceptibility mapping is by far the most common statistical approach, slope unit-based modelling can represent a more powerful approach especially when dealing with landslide point-data or a heterogeneous combination of point- and polygon data.