Geophysical Research Abstracts
Vol. 14, EGU2012-7437, 2012
EGU General Assembly 2012

Assessing the quality of landslide susceptibility maps for Lower Austria

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Globally there is a recent rise for the demand of landslide susceptibility maps that should be implemented in spatial planning strategies in order to enhance preparedness and damage prevention. In this process the provision of detailed information on the quality of landslide susceptibility maps is of high importance for end-users as for example spatial planners. Major development decisions might be heavily influenced by such maps. Therefore, expressing the quality of the final product is crucial for the decision making process.
Generally statistical validation methods are applied to assess the quality of landslide susceptibility maps, which can also give an empirical estimation on the transferability of a fitted model (the ability to fit a model in one area and apply it to another). This is usually performed by creating independent training and test subsamples and by determining the sensitivity and specificity of the trained model with the test subsample. In literature three possibilities of partitioning the sample are described, which are usually applied only in a single model run: randomly, spatially or temporarily. These single test runs might not give an accurate description of the model quality. Thus, the objective of this study was to perform a k-fold cross-validation with random and/or spatial partitioning of the data samples (in k subsets) to model the (spatial-) transferability of landslide susceptibility. This was modeled with the statistical method of generalized additive models (GAM) within each lithological unit of the province of Lower Austria. The estimation of the (spatial-) transferability results from comparing the range of the area under the receiver operating characteristic curve (AUROC) values derived by the repeated k-fold random and/or spatial cross-validation. Therefore k = 5-fold subsets are used for the random and spatial partitions of the individual lithological units. Subsequently the GAM is trained using k-1 subsets, and the AUROC value is calculated using the remaining subset as a test set. This is performed for each of the k = 5 possible test sets in order to obtain a measure of the (spatial-) transferability of the model in terms of the variation of the resulting AUROC.
Comparing the resulting AUROC values calculated for each lithological unit it can be stated that in general the median AUROC values using random partitioning (0.78-0.97) are higher than the median AUROC values derived by the spatial partitioning (0.68-0.97). This differences in the (spatial-) transferability of the models may be related to differences in landslide density among the lithological units, which may be due to their different general susceptibility as well as contrasting environmental conditions.
This study shows the benefits of k-fold cross validation in contrast to single validation runs. This improved validation technique is important for implementing the resulting susceptibility maps. On the one hand, it can give a better understanding and awareness regarding the uncertainties involved while creating the maps. On the other hand, this can lead to a better knowledge of the acceptable interpretation of the modeling results. Therefore describing the quality of the resulting landslide susceptibility maps should form an essential part of the communication with stakeholders.