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Combining high-resolution spatial data in landslide mapping: a fuzzy-set-based approach in W Belgium

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Numerous approaches have been developed for mapping landslide hazard at the regional scale and frequently a key issue concerns the relevance of the spatial data combination used in the prediction. The advantage of the statistical approach is that only a few data are generally needed to produce landslide susceptibility maps. However, very often, due to the poor resolution of the available topographic data, some potentially contributing factors are often omitted in the prediction and only a combination of data less sensitive to the resolution is used.

The aim of this research is to analyse the relevance of various data combinations in landslide susceptibility mapping and to discuss the ways in which they can be selected from a larger dataset. We have investigated the scarp reactivation of 15 large landslides in a hilly region of W Belgium. 26 segments of scarp reactivation were identified from the comparison of 2 m-resolution DTMs obtained for the epochs 1952 and 1996. They represent 30% of the total scarp length in the study area. The model used the reactivated scarp segments as the dependent variable and 13 factors related to topography, hydrology, land use and lithology as potential independent variables. Our landslide susceptibility modelling used a fuzzy set approach based on the comparison, for each independent variable, between two empirical distribution functions (EDFs), respectively for the reactivated and non-reactivated areas. It used these EDFs as favourability values to build membership values and combine them by using a fuzzy Gamma operator.

In total, 5 different data combinations were tested and compared by analyzing the

prediction-rate curves obtained by cross-validation and discussing the value of the resulting susceptibility maps. This confirmed that using all the available data yields poor results and that, in this case, the use of expert opinion was not efficient. Moreover, among the three combinations retained on a quantitative basis (Chi-2, PCA , and prediction-rate based selections), only the latter two provided relevant results, both in terms of prediction rate and susceptibility mapping. This research stressed the general need for testing several data combination in a landslide prediction.