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Uncertainty of spatial prediction models for natural hazard events

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This contribution discusses the uncertainty associated with prediction maps for the occurrences of future hazard events such as landslides, floods, avalanches, earthquakes, and subsidence to increase their usefulness to decision makers in land-use planning. A hazard prediction map is generated by dividing the study area into a number of "prediction" classes. Each class represents a level of likelihood of occurrence of future hazardous events and provides a relative level with respect to the other classes. The number of the classes to consider or visualize depends on the quantity and quality of the spatial input data. To obtain the classes, several quantitative models have been developed that reconstruct the typical settings of the hazardous events and use such spatial typicality for predicting. However, without having discussions on the uncertainty/evaluation of the prediction results, a decision maker would indeed wonder what action to take when confronted with a prediction map that he/she cannot fully comprehend or relay upon. Consequently, the usefulness of the prediction remains extremely limited without measures of the validity and reliability of its results. Today, such a situation is hard to accept given the progress made in spatial data managing, processing, and analysis.

The uncertainty of the prediction map has to be assessed and there are several types of uncertainties related to the prediction: on the input data, on the quantitative models and its assumptions, and on the way the results are represented and interpreted. Two types of uncertainties are discussed in this contribution: the spatial uncertainty of a prediction pattern and the one of the estimated hazard levels of the prediction classes. For the uncertainty of the estimated hazard level in each class, a cross-validation procedure is established dividing the past events into two time-periods. To obtain the accompanying spatial uncertainty map of a prediction pattern, at each pixel the un-

certainty/robustness of the predicted level is estimated by changing the conditions of input and model parameters. Although we are still at an initial stage of understanding the uncertainty of the prediction results, the estimates of the two uncertainties already allow the decision maker to reliably interpret the results shown in the hazard prediction maps.