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A Spatial Strategy for Representing Risk from Landslide Hazard Predictions

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This contribution targets the spatial representation of risk due to natural hazardous processes by reconsidering the common usage and definitions of risk to provide an operational solution to risk mapping. A common general definition of risk with the Society of Risk Analysis is the following (consult the Society's site www.sra.org/resources_glossary.php/): The potential for realization of unwanted, adverse consequences to human life, health, property, or the environment; estimation of risk is usually based on the expected value of the conditional probability of the event occurring times the consequences of the event given that it has occurred. An alternative definition is also provided of risk in the context of uncertainty. Furthermore, in the realm of natural hazards the term hazard, H, refers to the probability of occurrence of a damaging natural process at a given location within a given time frame, and when the process is likely to affect human activities, the concept of risk, R, is used that associates hazard intensity of the natural process with the exposure of vulnerable assets and socioeconomic activities. The vulnerability, V, then is the probability that the element at risk, E, will be damaged when the natural process that occurs affects it.

The construction of maps for modeling such concepts and the corresponding natural processes requires the decomposition of the risk problem into: (i) operational interpretation of the expression R = H*V*E; (ii) procedures with successive levels of detail; (iii) strategic hierarchy of processing steps; (iv) mathematical models for spatial prediction; (v) parameters expressing H, V and E; (vi) significant databases in space and in time; (vii) operational assumptions and socioeconomic scenarios.

An operational solution to risk mapping is provided by the isolation of the analytical process from mathematical models and its implementation as GIS-independent software. A spatial strategy is provided by the SPA/SRA System as a set of integrated software tools and its generality in spatial data analysis and modeling of negative and positive risks, i.e., potential hazard occurrence and potential resource discovery mapping. The three-stage strategy developed consists of: (i) construction of a hazard prediction map using spatial databases for time-partitioned distributions of "future" hazardous events, such as landslides, avalanches, subsidence or floods, and supporting data layers such as DEMs, and land use, surficial deposit, geology, geomorphology and other thematic maps; (ii) validation/reliability of prediction results and estimation of the probability of occurrence for each predicted hazard level; and (iii) generation of risk maps with the introduction of socio-economic factors representing assumed or established vulnerability levels by combining the prediction map in the first stage and the estimated probabilities in the second stage with socio-economic data. The approach is PC-based, interactive, and it provides several mathematical prediction models (fuzzy sets, empirical likelihood ratios, multivariate statistical models such as logistic and linear models) and a variety of procedural flows for risk analysis to provide a fundamental tool for decision making.

Keywords: risk, prediction, software system, cross-validation, mathematical models, analytical strategy landslide hazard.