Progress in landslide susceptibility mapping over Europe using Tier-based approaches

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The European Thematic Strategy for Soil Protection aims, among other objectives, to ensure a sustainable use of soil. The legal instrument of the strategy, the proposed Framework Directive, suggests identifying priority areas of several soil threats including landslides using a coherent and compatible approach based on the use of common thematic data. In a first stage, this can be achieved through landslide susceptibility mapping using geographically nested, multi-step tiered approaches, where areas identified as of high susceptibility by a first, synoptic-scale Tier ("Tier 1") can then be further assessed and mapped at larger scale by successive Tiers.

In order to identify areas prone to landslides at European scale ("Tier 1"), a number of thematic terrain and environmental data sets already available for the whole of Europe can be used as input for a continental scale susceptibility model. However, since no coherent landslide inventory data is available at the moment over the whole continent, qualitative heuristic zonation approaches are proposed.

For "Tier 1" a preliminary, simplified model has been developed. It consists of an equally weighting combination of a reduced, continent-wide common dataset of landslide conditioning factors including soil parent material, slope angle and land cover, to derive a landslide susceptibility index using raster mapping units consisting of 1 x 1 km pixels. A preliminary European-wide susceptibility map has thus been produced at 1:1 Million scale, since this is compatible with that of the datasets used. The map has been validated by means of a ratio of effectiveness using samples from landslide inventories in Italy, Austria, Hungary and United Kingdom. Although not differentiated for specific geomorphological environments or specific landslide types, the experimental model reveals a relatively good performance in many European regions at a 1:1 Million scale.

An additional "Tier 1" susceptibility map at the same scale and using the same or equivalent thematic data as for the one above has been generated for six French departments using a heuristic, weighting-based multi-criteria evaluation model applied also to raster-cell mapping units. In this experiment, thematic data class weights have been differentiated for two stratification areas, namely mountains and plains, and four main landslide types. Separate susceptibility maps for each landslide type and a combined map for all types have been produced. Results have been validated using BRGM's BDMvT landslide inventory.

Unlike "Tier 1", "Tier 2" assessment requires landslide inventory data and additional thematic data on conditioning factors which may not be available for all European countries. For the "Tier 2", a nation-wide quantitative landslide susceptibility assessment has been performed for Italy by applying a statistical model. In this assessment, multivariate analysis was applied using bedrock, soil and climate data together with a number of derivatives from SRTM90 DEM. In addition, separate datasets from a historical landslide inventory were used for model training and validation respectively. The mapping units selected were based on administrative boundaries (municipalities). The performance of this nation-wide, quantitative susceptibility assessment has been evaluated using multi-temporal landslide inventory data.

Finally, model limitations for "Tier 1" are discussed, and recommendations for enhanced Tier 1 and Tier 2 models including additional thematic data for conditioning factors are drawn.

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