Structural control of landslides. A regional approach based on a developed ArcGIS tool

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The relationship between bedding planes and topographic slopes plays a major role in controlling landslide mechanisms. The catastrophic nature of many landslides around the Globe was proved to have a relevant structural background. This paper aims at analyzing the relationship between the spatial distribution of landslides and geological structure and lithology at a regional scale (1:50,000). Moreover, by automatizing a well known method to assess the influence of bedding planes on landslide occurence, this study further provides a GIS-based tool useful to speed up regional analyses, when study areas extend over hundreds or thousands of square kilometers.

Three areas with different geological and geomorphological features and extents ranging from 70 to 179 km^2 were selected as case-studies. The sites are located in the Southern Carpathians, the Curvature and the Getic Subcarpathians of Romania. Computation of the topography - bedding plane relation required the following three phases: i) data acquisition, ii) developing a tool for an easy data processing and analysis and iii) testing the tool on the few selected sites having different geological and geomorphological settings. Three categories of spatial data were acquired: i) landslide inventory data; ii) detailed lithological data and iii) data related to geological structure (dip angle and dip direction point data). The landslide database was built based on interpretation of aerial images and field mapping during a more than 8 years long period. Lithology was extracted from geological maps at a 1:50,000 scale, while dip angle and dip direction data were obtained both from geological maps and direct measurements in the field meant to increase the level of detail.

In order to rapidly identify the type of slope in relation to the geological structure (anaclinal, cataclinal and orthoclinal), a tool was developed which integrates a well-known index called TOBIA. This custom created GIS tool was developed using Python programming language and Numpy library and is available both as an ArcGIS Toolbox and as a standalone python script. Both are available at http://www.github.com/sandricionut/tobia.

Preliminary results for the three analysed areas stress the influence of the geological structure on landslide occurence. In monoclinal areas the relationship between the geological structure and spatial distribution of landslide is very obvious. In slightly folded areas the relationship does not appear to be so evident, nevertheless the influence of the structure can be seen on the flanks of some anticline and syncline structures. In faulted areas, landslides occurence do not seem to be influenced by structure and the majority of the landslides occur in a diversity of directions. Even if landslides are a common process in all of these areas, their occurrence is strictly depending on the presence of lithological formations in a clayey or a marly facies.

The new ArcGIS-tool is a useful instrument, facilitating the work involved in the TOBIA computation by reducing the investigation time. The resulted classiffied slopes can be rapidly incorporated as a favorability factor in landslide susceptibility prediction.