LANDSLIDE SUSCEPTIBILITY ASSESSMENT IN FLYSCH AREAS OF THE VIENNA FOREST, AUSTRIA

GIS-BASED DISPOSITION MODELLING

Bettina Neuhäuser[1], Bodo Damm[2] and Birgit Terhorst[3]

INTRODUCTION

The study area in the Vienna Forest (Lower Austria) represents a low mountain region at the N-E edge of the Eastern Alps. Due to the altering of permeable and impermeable strata, the local Flysch regions are predestined to landslides. Mass movements are increasingly affecting settlement areas in the study area, which are expanding progressively into landslide prone areas. Current studies (Damm et al. 2008, Terhorst et al. 2009, Damm and Terhorst 2010) aim to identify controlling and triggering factors for landslides and describe the evolution and temporal sequence of sliding processes on local scale. However, mapping and delineation of areas susceptible to landslides are lacking on regional scale. From there, the objective of the present study is the regional assessment of the landslide susceptibility and the identification of geofactors, mainly contributing to the landslide processes in the region.

METHOD AND DATA

A statistical/probabilistic method, referred to as Weights-of-Evidence (WofE) (Bonham-Carter et al. 1989), is applied in GIS-based spatial modelling. WofE is based on a statistical Bayesian bivariate approach. The method allows determining the probability of landslide occurrence on the base of controlling geofactors and the distribution of past and present-day landslides. For this purpose a landslide inventory is compiled including about 600 landslides, recording about 80-years period of landslide activity. The data are derived from landslide maps and documentations of authorities and agencies, which are concerned with natural hazards in Austria. However, general information only exists to comprehend the geological and pedological situation in Lower Austria. Our dataset includes topography derived from ASTER Global Digital Elevation Model, geological and tectonical information from digital map (1:200,000), drainage lines from the federal digital topographic map and remotely sensed CORINE Land Cover data. On the base of these data the following controlling geofactors were derived by GIS-based analysis: (1) geological properties, (2) proximity to tectonic structures (nappe boundaries, thrust faults), (3) proximity to drainage lines (streams and creeks), (4) vegetation cover (5) morphometric parameters (slope, plan curvature, profile curvature), (6) slope aspect (7) slope position and landform category (derived by the Topographic Position Index method).

RESULTS

The resulting susceptibility map shows that the northern transition of the Flysch Zone (the so called Northern Zone) to the adjacent imbricated Molasse areas (i.e. Waschbergzone) has the highest susceptibility to landslides. The weighting in the model indicates that geological properties and vegetation cover are the factors that control the susceptibility the most. Considering the lithological properties of the geological formations that revealed high positive association to the known landslides it can be identified, that clay content and structural unstable bedrock like shales, marls and weathered sandstones control mass movements in the study area. Beside the geological conditions, there is a

[1] Dipl. Ing. Bettina Neuhäuser. Recipient of a DOC-fFORTE-fellowship of the Austrian Academy of Science, Vienna (e-mail: bettina.neuhaeuser@uni-wuerzburg.de)
[2] Prof. Bodo Damm. ISPA, University of Vechta, Germany (e-mail: bdamm@uni-vechta.de)
[3] Prof. Birgit Terhorst. Institute of Geography, Julius-Maximilians-Universität Würzburg, 97074 Würzburg (e-mail: birgit.terhorst@uni-wuerzburg.de)

strong association between the known landslides frequency and woodless areas within the Vienna Forest area.

It is found that the distribution of landslides follows closely the tectonic lines and the drainage lines. A considerable amount of landslides (63%) is within a distance of 400m to the nearest nappe boundaries and/or thrust faults. 70% of the events are situated within a distance of 150m to the nearest stream or creek. A significant positive statistical relation between landslide distribution and the latter geofactors is given, increasing with growing proximity to the tectonic lines and drainage lines.

Concerning the geofactors connected with morphology, a conspicuous relationship to the distribution of landslides is given at slopes with gradient between 3° and 26°. Landslides predominantly occur in W and N-W facing slopes. The slope shape (profile and plan curvature) is found to have only slight predictive value. The weighting of slope position and landform supports the fact that the occurrence of landslides is related to streams and creeks.

CONCLUSIONS

The study highlights the relevance of the properties of bedrock (in particular the clay content) on the occurrence of landslides. The study also emphasizes the role of tectonic structures for the occurrence of landslides in the Vienna Forest, which is tectonically highly stressed. Beyond that, the occurrence and position of stream channels, which are characterised by torrential conditions after long periods of rainfall, is evident in the study. The morphology of the Vienna Forest is determined by soft hills and deeply incised valleys and gorges. The model suggests that landslides occur predominantly on the moderate to steep slopes of the valleys close to the streams.

The main usefulness of the WofE method is the possible application on regional scale, if substratum properties are varying across the study area and in areas, where crucial but general information are available. Deterministic methods are not applicable for problems like this, because detailed physical parameters are required for the modelling. Besides, they are only applicable if substrate parameters are fairly uniform across the study area. In contrast to heuristic methods the analysis can be considered as an objective system that can discriminate between the various geofactors, in order to identify the most important parameters in the evolution of landslide phenomena. Key information in the model is accurate and reliable data on past and present day landslides, because these data are the core of the prediction. Despite its multiple advantages, it is advisable to apply the method (as other data-driven methods) only in regions where the response variables (e.g. the landslides) are fairly well known.

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