LANDSLIDE DETECTION AND SUSCEPTIBILITY MAPPING USING INNOVATIVE REMOTE SENSING DATA SOURCES

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This study was realised within the EU funded project ASSIST (Alpine Safety, Security & Informational Services and Technologies). One main objective was the design of a geo-service framework based on Earth Observation (EO) Data to support mitigation and emergency measures. Three types of products were generated: base information layers (e.g. land cover maps), dynamic information layers (e.g. snow cover maps) and derived products combining information layers with different models (e.g. landslide susceptibility maps). Some results of the latter are described in the following contribution.

OBJECTIVES

The focus in this work was the identification of parameters and/or indicators for natural hazards with special emphasis on landslides and the derivation of susceptibility maps. Focal points are the usage of new remote sensing tools and the development of (semi-) automatised procedures for the derivation of environmental factors that might affect landslide occurrence.

GEOGRAPHICAL AND GEOLOGICAL SETTING OF THE TEST AREA

The test region in the western part of Tyrol/Austria covers the eastern parts of the Verwall Mountain Group (dominated by metamorphic rocks) and the south-eastern part of the Lechtal Alps (dominated by carbonatic and clastic sedimentary rocks). The main valleys, the 'Stanzer'- and the 'Paznaun Valley' are densely populated and extensively used for transport and touristic purposes. The test area is characterised by a high number of different types of mass movement processes and highly vulnerable to natural hazards, as could be seen during the August 2005 flood which caused damages on infrastructure and settlements.

DATA SOURCES AND METHODS

GIS-based landslide inventories are the key component of any statistical landslide modelling. QuickBird data have been chosen as optical remote sensing data source due to its high spatial resolution of 60 cm in the panchromatic mode and an additional four multi-spectral band range with 2.4 m resolution. The acquisition date of the QuickBird scene was the 5th of September 2005 (12 days after the flood event). The compilation of the landslide inventory was performed mainly by on-screen interpretation of a simulated QuickBird 'pseudo-stereo' image generated from the monoscopic image and the respective Digital Elevation Model (DEM). Fieldwork in selected areas was performed mainly for verification and specification purposes. The inventory is restricted to recently active mass movements which are represented in the field by open scars and sliding surfaces without significant vegetation. Since shallow translational and rotational slides are predominant in the study area, the current investigation is restricted to these types. The determination of specific landslide features can

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be difficult as there are a number of processes active in high mountain environments, creating similar patterns (e.g. erosion and transport of loose material by avalanches, wind erosion). Nevertheless, approximately 1060 landslides were identified and included for this inventory.

In addition to the landslide inventory, information on the main factors controlling slope stability is needed. The use of a DEM in mountainous regions is a prerequisite in the overall processing of the EO Data as well as in the generation of geomorphometric derivates. For deriving geomorphometric factors, two data sets were compared: the standard DEM with a 25 m resolution and a DEM from LIDAR data with a resolution of 2 m. Important parameters deduced from the DEMs were elevation, slope, slope length, aspect, curvature, roughness and distance from drainage lines. In order to obtain land cover and land use parameters with adequate accuracy the VHR (very high resolution) satellite imagery were used, applying supervised classification and visual interpretation, with special emphasis on the development of automatic classification tools. The aim was to segregate land cover classes identified as important for landslide susceptibility. As the test area covers a height difference of almost 2400 m it is evident that there are manifold surface types. Thus, the applied methodology had to be elaborated in a flexible way involving different approaches for the derivation of the required parameters. Geological information including geotechnical and hydrogeological classification was deduced from a digital geological map at a scale of 1:50.000 from the Austrian Geological Survey (GBA 2004).

The above mentioned information layers were integrated as input data to derive landslide susceptibility maps on a catchment- and on a single pixel basis. Two different univariate statistical methods were used to model the landslide susceptibility, namely the so-called 'Susceptibility method' implemented according to the description of Van Westen (1993) and the 'Weights of Evidence (WoE) method' according to Bonham-Carter et al. (1989). The models were implemented and executed within an ArcGIS environment. The calculated values were transferred into five categories in order to compare the results statistically.

RESULTS AND DISCUSSION

The results of this work showed that with respect to the visual interpretation of surface parameters, congruent quality from VHR satellite imagery compared to that of aerial photographs can be obtained. The quality of the land cover classification based on QuickBird imagery was assessed by using an independent test area set for each class. The overall average accuracy is approximately 90% which is sufficient for the envisaged purpose. As the quality of the calculated statistical models is directly dependant on the quality (e.g. spatial resolution and classification accuracy) and quantity of the used data, this can be seen as a conclusive argument for using VHR remote sensing data. Furthermore the QuickBird images have a larger coverage and a better radiometric stability, which has proved to be of high benefit for the development of automatic tools. Comparisons between the resulting landslide susceptibility maps of the 'Susceptibility method' and the 'WoE method' showed the different weighting of the input parameters, which is especially obvious for geological inputs. Generally, it can clearly be seen that both methods show similar tendencies, but that the 'WoE method' is more selective and gives a more realistic impression of the terrain. Further tests show that the transferability of the model is possible only with restrictions, as the specific local situation with regard to input parameters has strong effects on the modelling results.

Keywords: remote sensing, landslides, susceptibility modelling