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Object-based landslide mapping on satellite images from different sensors

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Several studies have proven that object-based image analysis (OBIA) is a suitable approach for landslide mapping using remote sensing data. Mostly, optical satellite images are utilized in combination with digital elevation models (DEMs) for semi-automated mapping. The ability of considering spectral, spatial, morphometric and contextual features in OBIA constitutes a significant advantage over pixel-based methods, especially when analysing non-uniform natural phenomena such as landslides. However, many of the existing knowledge-based OBIA approaches for landslide mapping are rather complex and are tailored to specific data sets. These restraints lead to a lack of transferability of OBIA mapping routines. The objective of this study is to develop an object-based approach for landslide mapping that is robust against changing input data with different resolutions, i.e. optical satellite imagery from various sensors.

Two study sites in Taiwan were selected for developing and testing the landslide mapping approach. One site is located around the Baolai village in the Huaguoshan catchment in the southern-central part of the island, the other one is a sub-area of the Taimali watershed in Taitung County near the south-eastern Pacific coast. Both areas are regularly affected by severe landslides and debris flows. A range of very high resolution (VHR) optical satellite images was used for the object-based mapping of landslides and for testing the transferability across different sensors and resolutions: (I) SPOT-5, (II) Formosat-2, (III) QuickBird, and (IV) WorldView-2. Additionally, a digital elevation model (DEM) with 5 m spatial resolution and its derived products (e.g. slope, plan curvature) were used for supporting the semi-automated mapping, particularly for differentiating source areas and accumulation areas according to their morphometric characteristics.

A focus was put on the identification of comparatively stable parameters (e.g. relative indices), which could be transferred to the different satellite images. The presence of bare ground was assumed to be an evidence for the occurrence of landslides. For separating vegetated from non-vegetated areas the Normalized Difference Vegetation Index (NDVI) was primarily used. Each image was divided into two respective parts based on an automatically calculated NDVI threshold value in eCognition (Trimble) software by combining the homogeneity criterion of multiresolution segmentation and histogram-based methods, so that heterogeneity is increased to a maximum. Expert knowledge models, which depict features and thresholds that are usually used by experts for digital landslide mapping, were considered for refining the classification. The results were compared to the respective results from visual image interpretation (i.e. manually digitized reference polygons for each image), which were produced by an independent local expert. By that, the spatial overlaps as well as under- and over-estimated areas were identified and the performance of the approach in relation to each sensor was evaluated. The presented method can complement traditional manual mapping efforts. Moreover, it contributes to current developments for increasing the transferability of semi-automated OBIA approaches and for improving the efficiency of change detection approaches across multi-sensor imagery.