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Automated object-based landslide and debris flow identification – a case study for supporting disaster management in Taiwan

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Landslides and debris flows are a major hazard in almost all mountainous regions of the world and claim the lives of many people every year. Taiwan is one of the countries, which is heavily affected by landslides and debris flows, especially latter are extremely dangerous as they often affect settlements and cause enormous damages to infrastructure. These hardly predictable mass movements are mainly triggered by typhoons, which hit the island several times a year. A lot of efforts are made in landslide research in Taiwan towards effective and sustainable disaster management. The rapid assessment after landslide events is as well a major issue as the continuous and reliable update of existing databases and landslide inventory maps. So far, this information is usually retrieved by visual image interpretation; only little research has been done in automated analysis to identify landslides and debris flows. With traditional pixel-based image analysis methods it is hard to distinguish landslides and debris flows from bare land, e.g. due to the missing ability of considering context information, but this knowledge is very useful for disaster mitigation and recovery issues. Therefore it is necessary to establish reliable, fast and accurate methods for detecting and classifying landslides and debris flows by making use of the nowadays available amount of Earth Observation (EO) data, which implies the need to implement semi- or even fully automated methods. Object-based image analysis (OBIA) constitutes a powerful framework for fulfilling these needs and seems to be suitable for the identification and characterization of such complex natural features.

The automated landslide and debris flow detection was performed for a study site of approximately 30 km^2 in Southern Taiwan using eCognition software. By applying a semi-automated approach using OBIA and integrating optical data (SPOT-5 with 2.5 m GSD), digital elevation data with 5 m GSD as well as derivates from the DEM (e.g. slope, aspect, curvature, flow accumulation) during class modeling it was possible to identify landslides and debris flows. As in Taiwan no database exists that shows debris flows, a focus was put on the classification of this mass movement type and to differentiate them from landslides. Through combining the most suitable spectral, geometrical and spatial features from both data sets we were able to accomplish the landslide and debris flow identification and to come up with results, which were assessed to be useful in disaster management by local stakeholders. The approach was then transferred to two other study sites in Taiwan, whereby only minor adaptions in the ruleset had to be done and so analyzing time could be significantly decreased. We therefore claim that such automated approaches can complement traditional time- and cost-intensive visual interpretation. Nevertheless, there is more research needed in terms of increasing the transferability of such methods to different sites and conditions in order to become fully operational.