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Landslide hotspot mapping and susceptibility assessment in Pahiatua, New Zealand

Daniel Hölbling (1), Raphael Spiekermann (2), Harley Betts (2), and Chris Phillips (3)

(1) Department of Geoinformatics - Z_GIS, University of Salzburg, Salzburg, Austria (daniel.hoelbling@sbg.ac.at), (2) Landcare Research, Palmerston North, New Zealand (SpiekermannR@landcareresearch.co.nz; BettsH@landcareresearch.co.nz), (3) Landcare Research, Lincoln, New Zealand (PhillipsC@landcareresearch.co.nz)

Detailed landslide inventories are essential for understanding the distribution of landslides and their causal factors, and form the basis for landslide susceptibility mapping. Remote sensing data is well suited for detecting landslides and for deriving information on the spatial distribution of landslides. Manually or semi-automatically mapped landslides from optical images can be used as input for creating landslide hotspot maps, which constitute an easy-to-grasp visual representation of the worst landslide-affected areas following a storm event.

For landslide hotspot mapping and the susceptibility assessment we used historical and recent aerial photography from five different dates, ranging from 1944 to 2011, for a study site near the town of Pahiatua, New Zealand. Landslide hotspots were identified from the distribution of semi-automatically detected landslides using object-based image analysis (OBIA), and compared to hotspots derived from manually mapped landslides. The comparison of the landslide hotspot maps shows that the distribution of the manually identified landslides and those detected with OBIA is very similar for all periods. However, differences can be observed in the proportion of landslides that cover an affected area. One explanation is that the total area of landslides identified by manual interpretation is greater than that detected by OBIA since the detection of landslide tails is more challenging with a semi-automated approach. This is due to the fact that tails revegetate faster and had often grassed over prior to aerial photography acquisition. Consequently, distinct (spectral) characteristics are not present anymore.

A landslide susceptibility map was produced using the manually mapped landslide scars from four different periods (1944 - 2005) as input data, and the 2011 inventory to validate the resulting map. A probabilistic approach was used to characterise land according to its likelihood to erode further - in which the past is the key to the future. The Pahiatua study area lies within lithological terrains of moderately indurated Tertiary sandstone and mudstone. Slope angle is the primary determinant of landsliding, and a preference for east and northeast aspects was shown, which may be influenced by storm direction or previous erosion events. A landslide connectivity model was also incorporated to assess the potential delivery of sediment to streams. The validation results showed that 77% of the scars from 2011 (1612 from 2099 scars) were mapped in susceptibility classes “moderate” to “very high”.

Findings from the analysis of recent and historical images can help characterize individual landslide-triggering storm events (hotspot maps) and identify land susceptible to soil erosion (susceptibility map). Such products can provide valuable direction to improve land management and facilitate erosion mitigation planning.