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Landslide event inventory maps from satellite imagery with an automatic, topography-driven algorithm

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We describe an automatic procedure for the classification of satellite imagery into landslide or no landslide categories, aimed at preparing inventory maps for a landslide event. We devised a two-steps procedure, which requires knowledge of the occurrence of a landslide event, availability of a pre- and post- event pseudo-stereo pair and a digital elevation model. The first step consists in the evaluation of a discriminant function, applied to a combination of well-known change detection indices tuned on landslide spectral response. The second step is devoted to discriminant function classification, aimed at distinguishing the only landslide class, through an improvement of the usual 'thresholding' method. The novel feature of the approach is represented by the use of slope units as topographic-aware subsets of the scene within which we apply a multiple thresholding method to classify a landslide class membership tuned on the sole landslide spectral response.

SUs are morphological terrain units, bounded by drainage and divide lines delineated in such a way that terrain homogeneity is maximized within the units, and inhomogeneity is maximized across neighboring units. We obtained SUs for our study area using the r.slopeunits specialized software. The software is adaptive, in that SUs are delineated with varying sizes and shapes in different regions of the study area. SUs are particularly suited in the present context, since they encompass areas with similar slope-facing direction (aspect), accounting for the fact that locations located in regions homogeneously facing the same direction likely provide consistent spectral response in satellite imagery.

The proposed method was tested in an area of about 1000 m^2 in Myanmar, where torrential rainfall triggered extensive landslides in 2015, which made the news due to the occurrence of the massive Tonzang landslide and the large number of fatalities. Results of our automatic mapping were calibrated and validated against a landslide inventory map prepared through photo-interpretation by expert geomorphologists. The numerical results of the comparison of the automatic, multi-threshold mapping procedure with the ground-truth of the inventory map prepared by visual interpretation reveal that the topographic-aware subdivision of the territory allows for a better classification performance both than thresholding applied globally, or within a topographic-blind subdivision. This is particularly true in the validation area, where the grid-based method shows little gain with respect to the global thresholding method.

The method is fully automatic after site-dependent operations, required only once, are performed, and exhibits improved classification performance with limited training requirements. We argue that the improved classification performance and limited training requirements represent a step forward towards an automatic, real-time landslide mapping from satellite imagery.