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Remote sensing techniques for landslide detection, and their efficiency according to different pre-processing levels of high-resolution satellite data

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Remote sensing methods are the privileged tool for natural hazard monitoring in remote mountainous regions, as detecting and mapping natural hazard occurrences over extensive areas cannot be accomplished by time consuming methods like point-based field measurements or aerial photographs analysis. Satellite data offer an inexpensive means of deriving complete spatial coverage of land use and environmental data in a consistent manner that may be updated regularly. Despite its well-established attractions and potentials, remote sensing techniques have been relatively underused for regional landslide inventories in mountain environments as their applicability is still largely constrained by methodological challenges due to topographical and shadowing effects.

In this study, we evaluate the efficiency of high spatial resolution satellite sensors with relatively high spectral and temporal resolution to create regional scale landslide inventories. Various methodological challenges that are related to the practical uses of remote sensing data in mountainous regions such as the development of specific preprocessing and interpretation techniques suited to steep terrain are addressed. The Ecuadorian Andes are selected as a preliminary test site, as this region is facing intense land use changes and harsh biophysical constraints characterized among others by heavy rainfall and steep topography, causing major environmental threats.

Landslide inventories are created based on different high resolution remote sensing datasets and ancillary topographic data for detection of specific morphometric landscape characteristics. Multi-spectral images appear to be particularly effective for mass movement mapping, as they allow improving the 2D shape recognition of features, particularly with processing techniques such as color composites, vegetation indexes, pan-sharpening, band arithmetic or principal component analysis. Our results indicate that the spectral characteristics of the remotely sensed data play a major role in the detection of the landslides, along with their spatial resolution. For instance, the ASTER sensor appears to be particularly suited for landslide mapping as it covers a part of the electromagnetic spectrum that enables to highlight more efficiently geological features in comparison to other data of similar spatial resolution such as a pan-sharpened LANDSAT ETM+ image. Along with these image processing techniques, we focus at the effect of applying three different preprocessing algorithms to correct for topographic distortion on landslide detection accuracy. The results of the semi-automated landslide detection procedures that are applied on ASTER and LANDSAT ETM+ data for three levels of data preprocessing are validated with the help of very-high resolution remote sensing imagery and focused field campaigns for ground-truthing.