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An algorithm for rapid operational landslide inventory mapping based on pair of multi-spectral images

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Mapping landslides after major triggering events such as earthquakes and large rainfalls is crucial for disaster response, hazard assessment, as well as for having benchmark inventories on which empirical and physical models can be tested. Numerous studies have already demonstrated the utility of very-high resolution satellite and aerial images for the elaboration of inventories based on semi-automatic methods or visual image interpretation. However, while manual methods are very time consuming, faster semi-automatic methods are rarely used in an operational context after major triggering events, partly caused by data access restrictions on the required input (i.e. VHR satellite images) and by the absence of dedicated services (i.e. processing chain) available for the landslide community. Several on-going initiatives should help to go beyond these limitations.

First, from a data perspective, the launch of the Sentinel-2 mission offers opportunities for the design of an operational service that can be deployed for landslide inventory mapping at any time and everywhere on the globe. Second, from an implementation perspective, the Geohazards Exploitation Platform (GEP) of the European Space Agency (ESA) allows the integration and diffusion of on-line processing algorithms in a high computing performance environment. Third, from a community perspective, the recently launched Landslide Pilot of the Committee on Earth Observation Satellites (CEOS), has targeted the take-off of such service as a main objective for the landslide community.

Within this context, we present a largely automatic, supervised image processing chain for landslide inventory mapping from bi-temporal (before and after a given event) multi-spectral images. The processing chain combines change detection methods, image segmentation, higher-level image features (e.g. texture, shape) and topographic variables. Taking as input a sample of manually mapped landslide polygon, a random-forest classifier is trained and subsequently used to distinguish newly triggered landslides from other landscape elements.

The processing chain is tested with medium resolution, freely available image (typically Sentinel 2), to demonstrate its utility within an operational context. Two recent and contrasted triggering events in New Zealand, and Taiwan are taken as prime examples. A Mw 7.8 earthquake in New Zealand in November 2016 triggered tens of thousands of landslides in a complex environment, with important textural variations with elevations, due to vegetation change and snow cover. In contrast a large but unexceptional typhoon in July 2016 in Taiwan triggered a moderate amount of relatively small landslides in a lushly vegetated, more homogeneous terrain. The final map product is provided along with an uncertainty map that allows identifying areas which might require further considerations. For example, the question of individual landslide delineation remain problematic. Therefore, we discuss the range of operational application and additional post-processing required for various application. We also present and discuss the results of the algorithm chain for other bi-temporal pairs of image at higher or lower resolution (SPOT, Landsat).

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