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Sentinel-2 for rapid operational landslide inventory mapping

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Landslide inventory mapping after major triggering events such as heavy rainfalls or earthquakes is crucial for disaster response, the assessment of hazards, and the quantification of sediment budgets and empirical scaling laws. 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. Nevertheless, such semi-automatic methods are rarely used in an operational context after major triggering events; this is partly due to access limitations on the required input datasets (i.e. VHR satellite images) and to the absence of dedicated services (i.e. processing chain) available for the landslide community. Several on-going initiatives allow to overcome 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, this study targets the development of a largely automatic, supervised image processing chain for landslide inventory mapping from bi-temporal (before and after a given event) Sentinel-2 optical images. The processing chain combines change detection methods, image segmentation, higher-level image features (e.g. texture, shape) and topographic variables. Based on a few representative examples provided by a human operator, a machine learning model is trained and subsequently used to distinguish newly triggered landslides from other landscape elements. The final map product is provided along with an uncertainty map that allows identifying areas which might require further considerations.

The processing chain is tested for two recent and contrasted triggering events in New Zealand and Taiwan. 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 homogenous terrain. Based on the obtained results we discuss the potential and limitations of Sentinel-2 bi-temporal images and time-series for operational landslide inventory mapping

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