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A tailored machine learning method for inventorying landslides from satellite optical imagery

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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 landslide 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.
Within this context, we present an 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 small sample of manually mapped landslide polygons, machine learning models are trained to classify the landslides from other landscape elements. The machine learning model operates both for pixel and super-pixels (e.g. segments) classification. Active learning loops are integrated in the processing to progressively increase the performance of the machine learning model. Further, uncertainty maps that allow identifying areas which might require further considerations are created. The processing chain is optimized for image analysis on high computing performance environments.
The processing chain is presented using high-resolution (Spot-7) images available over Haiti which has been severaly impacted by Hurricane Matthews triggering thousands of landslides. The effects of the size, quality and diversity of the training sample, and of the super-pixel properties on the performance of the model are discussed.
The research is carried out in the framework of the Landslide Pilot and of the Recovery Observatory of the Committee on Earth Observation Satellites (CEOS).