A multi-sensor satellite method to spatial and temporal detection of landslides and flash floods in cloud-covered tropical environments: the western branch of the East African Rift

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Geomorphic hazards such as landslides and flash floods (hereafter called GH) often result from a combination of complex interacting physical and anthropogenic processes across multiple spatial and temporal scales. In many instances, landslides and flash floods occur very quickly, sometimes in a matter of a few hours occasionally leading to catastrophic impact on human lives. Given that they are mostly related to common meteorological events, landslides and flash floods frequently co-occur and interact, leading to more severe impacts. The tropics are environments where GH are under-researched while, in the meantime, GH disproportionately impact these regions. In addition, GH frequency and/or risks in the tropics are expected to increase in the future in response to increasing demographic pressure, climate change and land use/cover changes. To understand the role of climate and landscape (topographic and land use/cover) in controlling the spatio-temporal distribution of GH in the context of environmental changes, establishing a regional-scale inventory of GH events that are localised accurately in space and time is essential. Since the tropics are frequently cloud covered, an accurate characterization of the timing of GH at a regional scale can only be achieved through the combined use of optical and Synthetic Aperture Radar (SAR) remote sensing. Here, the objective is to present the first phase of the ongoing development of a remote sensing methodology that aims to identify accurately in space and time the GH events in the western branch of the East African Rift using a multi-temporal change analysis approach combining optical and SAR amplitude and phase coherence data. Copernicus Sentinel 1 (SAR imagery) and Sentinel 2 (optical imagery) are the key satellite products used. Next to being open access, they offer a very good trade-off between frequency of acquisition and spatial resolution. The detection methodology is calibrated and validated using information from three citizen observer networks and higher spatial resolution imagery. Preliminary results show clear changes in SAR amplitude and phase coherence time-series at the time of GH event occurrence. Various change detection approaches (difference, log-ratio, normalized difference, correlation) are
explored and provide ideas for detection of GH timing within the time-series. We present the ongoing method development with a specific focus on recent extreme GH events in the region.