

Geomorphic transport from historical shape from motion: Implications for tropical and alpine environments

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Abstract

Mountainous landscape evolution under tropical and alpine environments is mainly dictated by climatic forcing which influences underlying mechanisms of geomorphic transport (e.g., soil formation, river dynamics, slope stability and mass wasting). The time scale over which this influence acts ranges from seasonal to decennial time span. On the seasonal time scale, for accessible locations and when manpower is available, direct observations and field survey are the most useful and standard approaches. While very limited studies have been focused on the the decennial and century scale due to observational constrains. Here, we present an open and reproducible pipeline based on historical aerial images (up to 70yrs time span) that includes sensor calibration, dense matching and elevation reconstruction over two areas of interest that represent pristine examples for tropical and alpine environments: The Rempart Canyon in Reunion Island, and the Bossons glacier in the French Alps share a limited accessibility (in time and space) that can be overcome only from remote-sensing. We reach unprecedented resolution: the aero-triangulation falls at sub-metric scale based on ground truth, which is comparable to the initial images spatial sampling. This provides elevation time series with a better resolution to most recent satellite images such as Pleiades. In the case of the Rempart Canyon, we identified and quantified the results of 2 landslides that occurred in 1965 and 2001, and characterized the landslides dynamics. As for the alpine case, we highlight the effect of the temperature plateau occurred during 1939-1970 in Europe before the well known accelerated retreat during the post-industrial period. In both cases, we emphasize the strong effect of extreme events over multi-decennial to century time-scales.

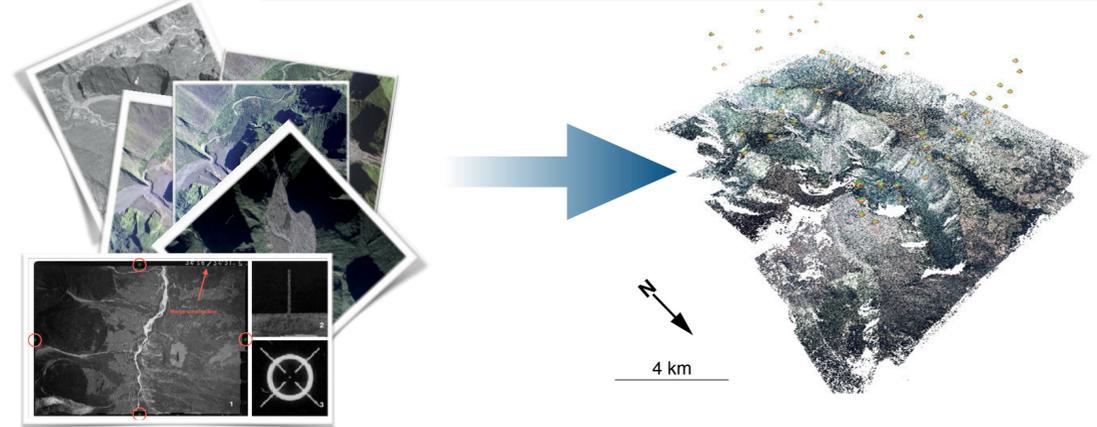
The abstract

We used historical aerial imagery in order to compute multi-decennial time-series of digital elevation models in order to assess geomorphic transport in both alpine and tropical environments. We focused on two pristine examples namely The Rempart Canyon in Reunion Island and the Bossons glacier in the French Alps which share a limited accessibility (in time and space) that can be overcome only from archived remote-sensing. We have developed a calibration method to take into account the old analog photographic plate and the deformations due to the scanning of the archived images. In both cases, we emphasize the strong effect of extreme events over multi-decennial to century time-scales and discuss the implications in terms of landscape dynamics.

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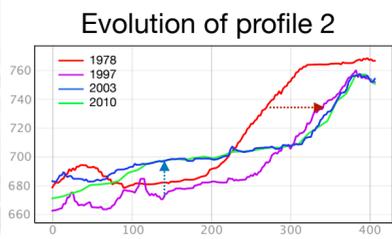
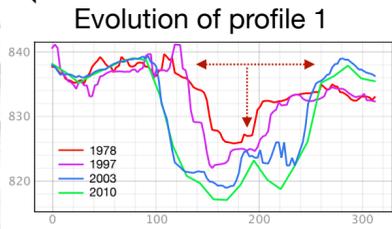
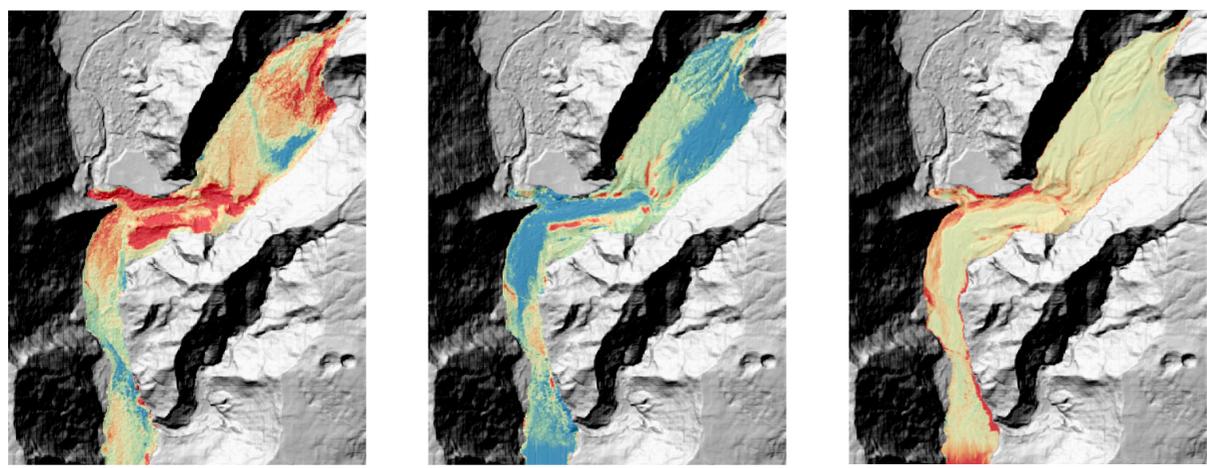
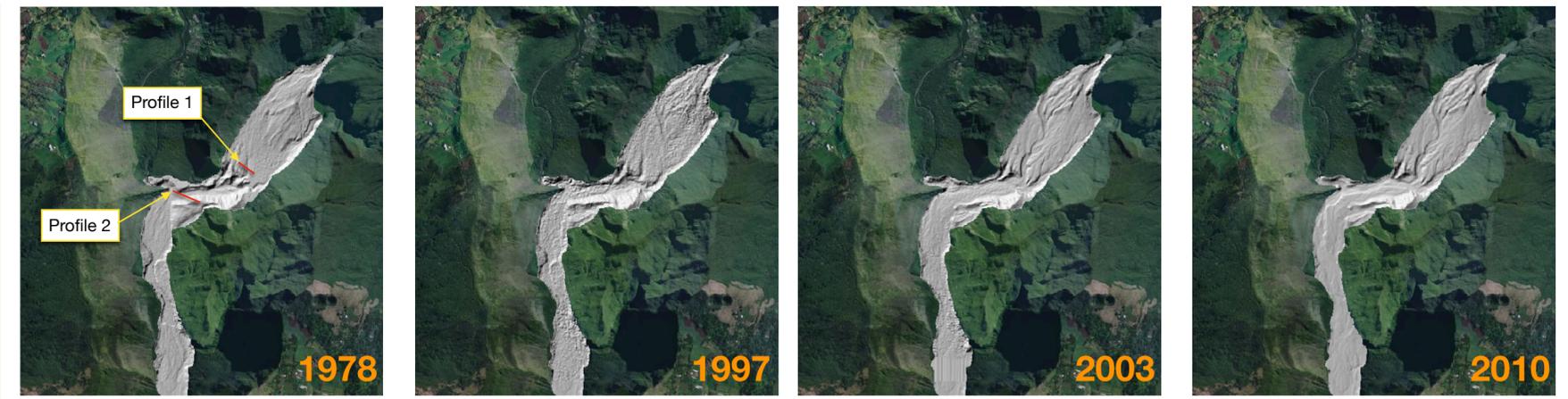
We reach unprecedented resolution: the aero-triangulation falls at sub-metric scale based on ground truth, which is comparable to the initial images spatial sampling. This provides elevation time series with a better resolution to most recent satellite images such as Pleiades. We emphasize the potential of assessing the effect of extreme events over multi-decennial to century time-scales.

The method → From scanned archived image to 3D cloud model



We integrated into the Open-Source MicMac [1] workflow new tools for automatic calibration and orientation of large archive of aerial scanned images

The tropical case → Highlight on mass transfer from hillslopes to the Remparts river (La Réunion)



The alpine case → Highlight on fast Bossons glacier reaction (Chamonix Mont-Blanc)

