Analyzing topographic changes through LiDAR and SfM techniques: assessing the deposition-erosion patterns and estimation of debris-flow volume in the eastern Italian Alps

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EGU General Assembly 2020
Online | 4–8 May 2020
https://doi.org/10.5194/egusphere-egu2020-3516

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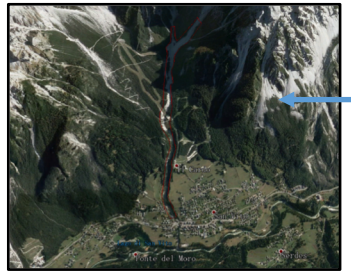
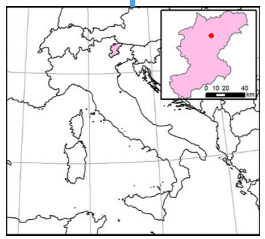
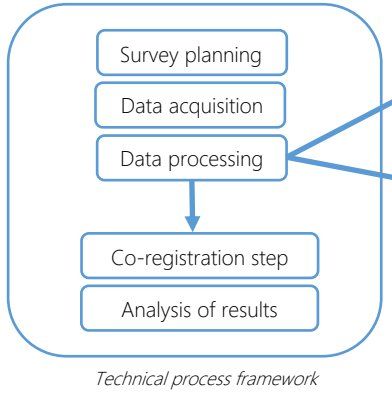
On 4 August 2015, a very high intensity storm, 31.5 mm in 20 min (94.5 mm/h), hit the massif of Mount Antelao on the Venetian Dolomites (eastern Italian Alps) triggering stony debris flow characterized by high magnitude. It routed along the Ru Secco torrent and progressively reached the resort area and the village of San Vito di Cadore, causing fatalities and damages. The aim of the present research is the study of this debris-flow event by means of pre and post-event topographic data derived by LiDAR (Light Detection and Ranging) and Structure-from-Motion (SfM) photogrammetry technique associated to its occurrence. This study analyzes the Digital Terrain Models (DTMs) derived from LiDAR survey carried out in July 2015 and UAV-SfM data obtained in September 2019. The most important step to compare these multi-temporal surveys was the co-registration process, fundamental to guarantee the coherence among the two different surveys. The post-event SfM-DTM of the area routed by debris flow subtracted to the pre-event LiDAR-DTM, provided a DoD (DTM of Difference) that was useful to assess the deposition-erosion patterns and estimate debris-flow volume. Multi-temporal topographical data are important to analyze the phenomenon and its characteristics. This allowed us to more in depth analyzed the debris-flow effects and provide valuable information for the planning of risk prevention measures.



The Ru Secco catchment.



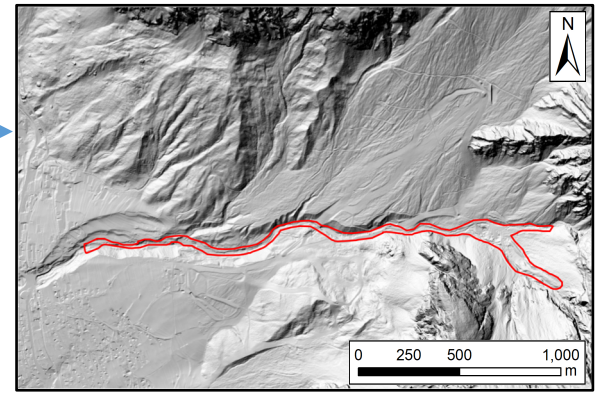


Technical process framework

- **LiDAR data**: the flight was carried out in November 2015. The point density of the survey was about 1.5 pts/m² (*Gregoretti et al 2018*). The LiDAR point cloud was used to realized a DTM at 1 m resolution.
- **SfM data**: Agisoft Photoscan Pro v 1.4 software was used to process the SfM images acquired by UAV and to extract the 3D point clouds of Ru Secco reach. The point cloud was filtered and used to carried out a DTM at 0.10 m resolution.

DTM (LiDAR)

DTM (SfM)

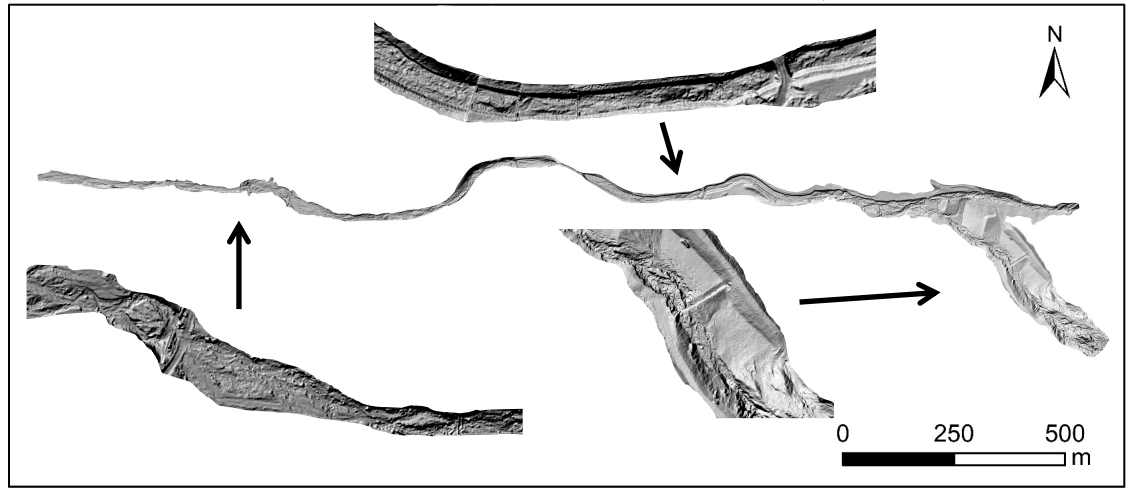


Shaded relief map of the pre-event LiDAR-DTM (1 m)

SfM survey in September 2019

Debris-flow deposits in the upper part of the Ru Secco catchment.

The torrent control works along the Ru Secco torrent.



Shaded relief map of the post-event SFM-DTM (0.25 m)

WORK IN PROGRESS...

The comparison of DTMs through time will allow the estimation of the total volumes of erosion and deposition together with the net changes. Additionally, this analysis can provide important information to characterize the spatial distribution and magnitude of geomorphic processes, leading to a better understanding of the debris-flow dynamics in the Ru Secco catchment.

REFERENCES

- *Gregoretti C, Degetto M, Bernard M and Boreggio M (2018) The Debris Flow Occurred at Ru Secco Creek, Venetian Dolomites, on 4 August 2015: Analysis of the Phenomenon, Its Characteristics and Reproduction by Models. Front. Earth Sci. 6:80.*