INTEGRATION OF SATELLITE INTERFEROMETRY AND LANDSCAPE ANALYSIS TO DETECT LARGE LANDSLIDES IN MOUNTAINOUS AREAS

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INTRODUCTION

A good-quality landslide inventory map is necessary to assess landslide hazard. However, it remains difficult and time-consuming to produce inventories **in mountainous areas** with high extension and poor accessibility (Bekaert et al. 2020) where large and diffuse landslides can be overlooked. In this context, **new technologies** such as satellite remote sensing or advanced landscape analysis are gaining prominence **to optimise landslide mapping** at regional scale.

OBJECTIVE

The main objective was **to improve the existing landslide database in the Sierra Nevada mountain range** (Province of Granada, Southern Spain). Reaching elevations of 3479 m.a.s.l., this range has one of the **highest topographic gradients** of Europe.

A novel approach was employed, combining data from **Differential Synthetic Aperture Radar Interferometry (DInSAR)** and **Landscape Analysis** based on the morphometry of rivers.

METHODS

The DInSAR data was derived from the **P-SBAS** processing chain (Casu et al. 2014) implemented on the European Space Agency's **Geohazards Exploitation Platform (GEP)**. For the ascending orbit processing, 101 Sentinel-1B images from September 2016 to March 2020 were exploited, while 241 Sentinel-1A and 1B images in descending orbit were used.

The Landscape Analysis was computed through the Python library **landspy** (Pérez-Peña et al. in prep), using a 10-m resolution Digital Elevation Model (DEM). A new geomorphic index was derived to detect changes in river gradient: **the double normalised steepness index (k_{snn})**.

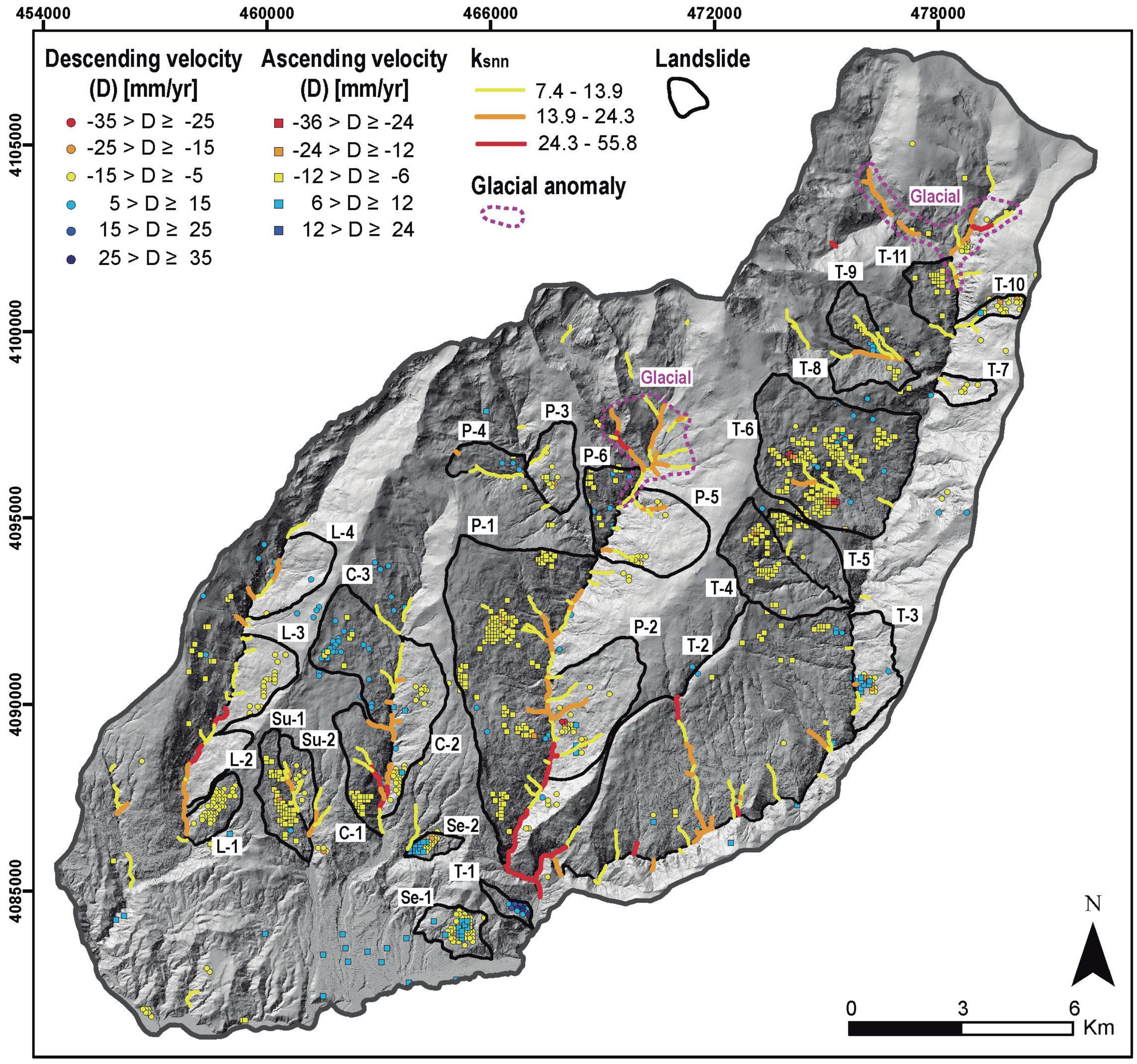
DISCUSSION AND CONCLUSIONS

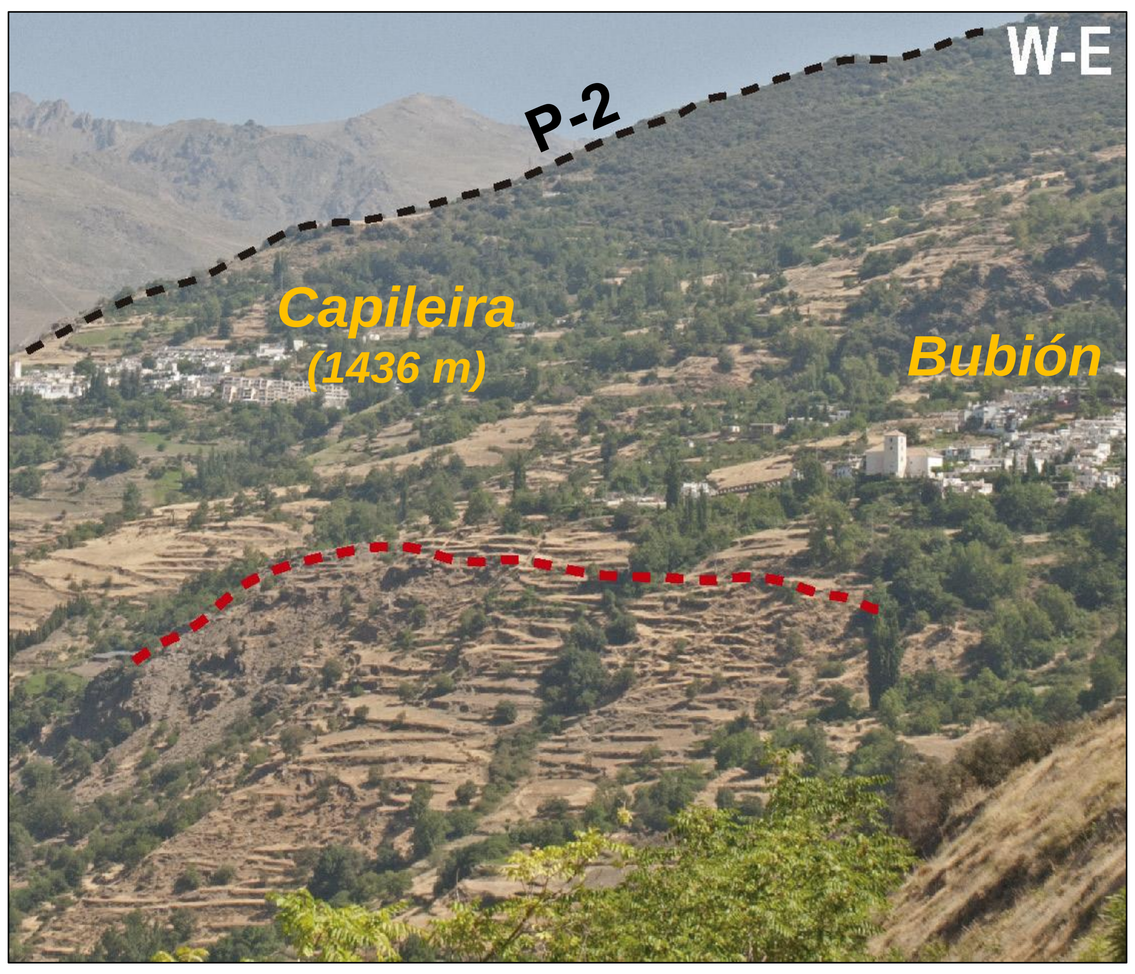
- **The new inventory demonstrates a successful technique integration**, doubling the affected landslide area (33.5%) compared to the previous inventory's coverage (14.5%).
- The data can be **well-complemented**: short-term activity up 5 years (DInSAR) vs. long-term influence at millennia scale (k_{snn} anomalies).
- Some **limitations of each methods can be overcome**: active small sectors (DInSAR) vs. larger dimensions (k_{snn} anomalies) of landslides.
- **DGSDs are discovered for the first time in Sierra Nevada.** Their identification was possible thanks to **techniques that rapidity highlighted** the slopes of interest.
- Despite their slow movement (cm/yr), DGSDs can **damage infrastructures** and evolve into faster and more hazardous secondary slides.

RESULTS

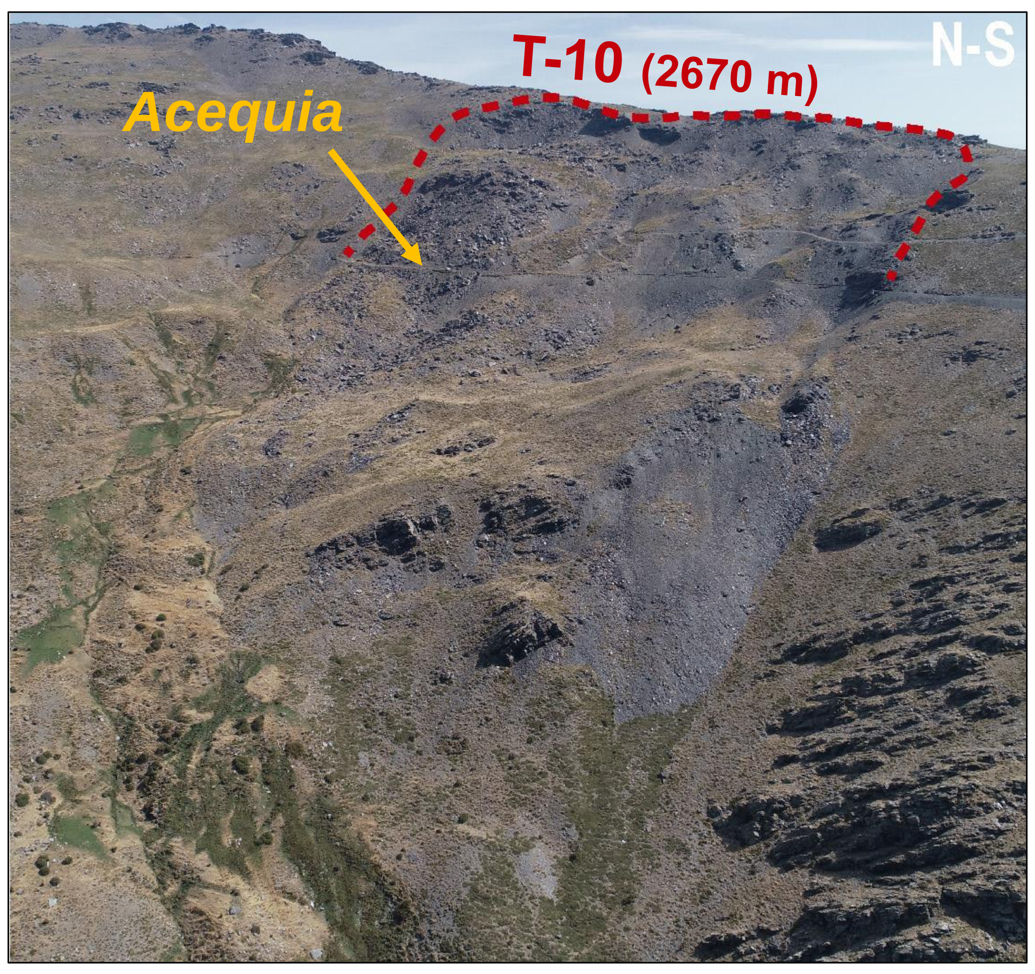
Landslide inventory of the SW sector of Sierra Nevada. The **k_{snn} anomalous values** of the trunk rivers and tributaries channels and the **unstable points from both DInSAR geometries** (ascending and descending) are also shown. Labels indicate the name of each landslide.

28 new landslides were mapped and most of them are large **Deep-seated Gravitational Slope Deformations (DGSDs)**.





Landslide P-2 affecting the villages of Capileira and Bubión, with an active secondary slide beneath Bubión.



Landslide T-10 currently impacting a water ditch (*acequia de careo*) that runs across the slope.

MAJOR REFERENCES

Bekaert et al. (2020) InSAR-based detection method for mapping and monitoring slow-moving landslides in remote regions with steep and mountainous terrain: an application to Nepal. *Remote Sens Environ* 249:111983.

Casu et al. (2014) SBAS-DInSAR parallel processing for deformation time series computation. *IEEE J Sel Top Appl Earth Obs Remote Sen* 7:3285–3296.

Pérez-Peña et al. (in prep) Lansdpy, a open-source library for landscape analysis in Python and QGIS. https://github.com/geolovic/landspy

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