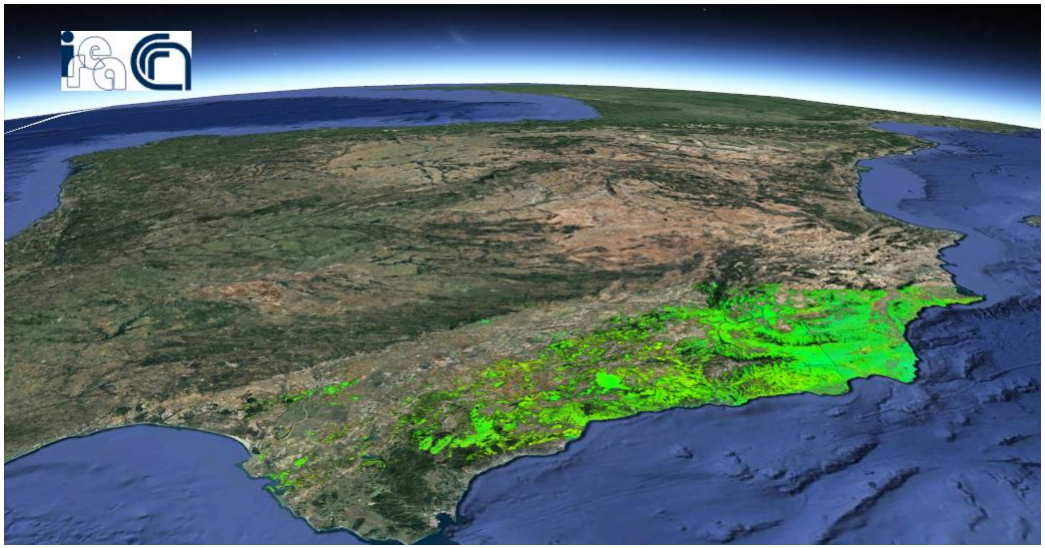
EGU General Assembly 2020

The Sentinel-1 CNR-IREA SBAS service of the European Space Agency's Geohazard Exploitation Platform (GEP) as a powerful tool for landslide activity detection and monitoring



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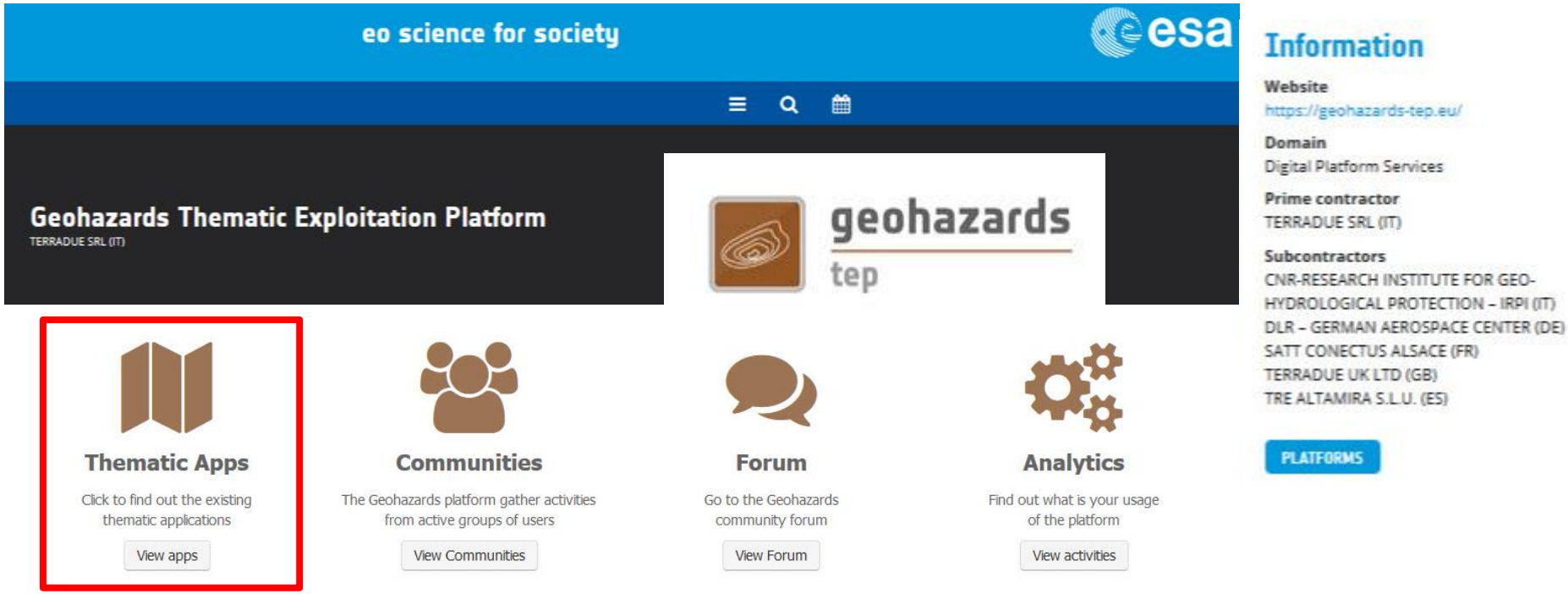
Instituto Geológico y Minero de España

ANÁLISIS DEL RELIEVE Y PROCESOS ACTIVOS

Interreg Sudoe RISKCOAST

The Geohazards Exploitation Platform



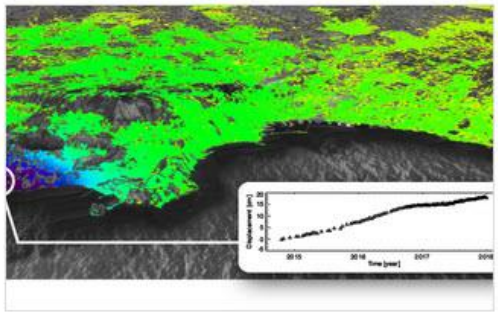
The Geohazards Exploitation Platform (GEP) is a web-based platform, promoted by the European Space Agency (ESA), through users can perform independent analysis by exploiting satellite data for geohazards. This platform hosts several thematic apps that allow to identify, monitor and asses hazard related to geological processes such as volcanism, subsidence or landslides.

The Geohazards Exploitation Platform

SBAS Ground Motion Services

by **CNR IREA**

App | insar | sar | earthquake | fast response | emergency | seismic hazard | disaster risk reduction | disaster management



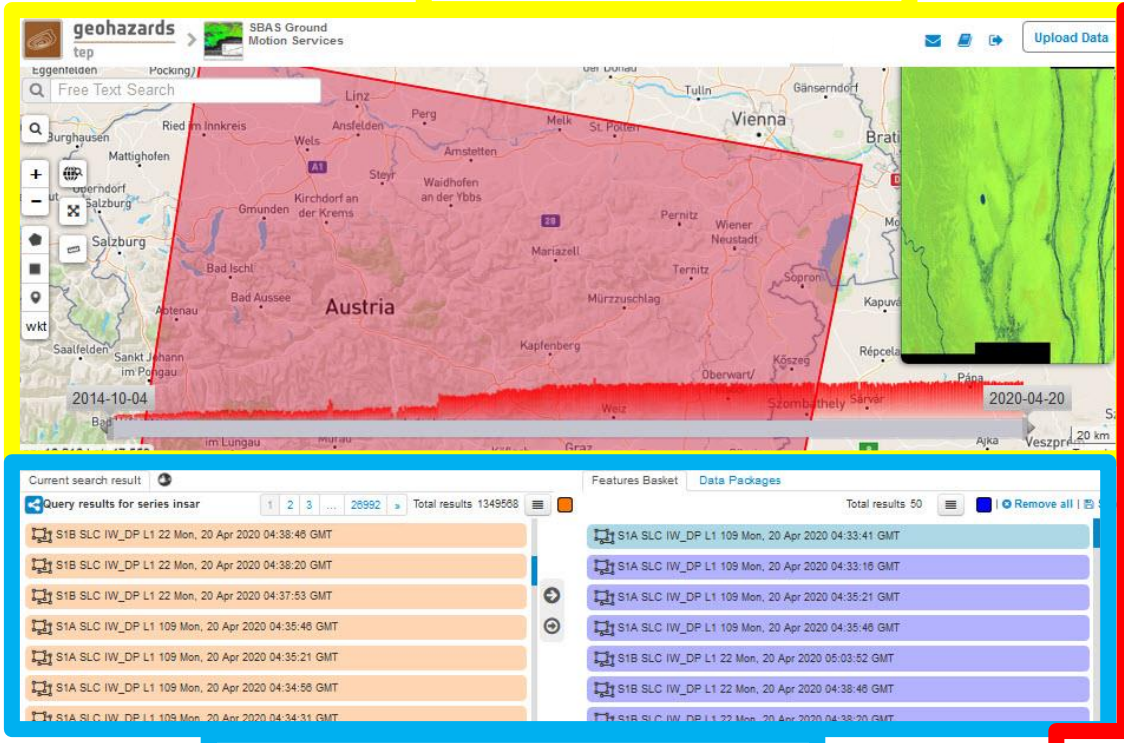
This App provides the CNR-IREA SBAS tools for generating surface displacement time series using Sentinel-1 data. The App provides the possibility to use the Sentinel-1 CNR-IREA SBAS tool to on-demand generate displacement time series of an area identified by the user. Moreover, the collections of SBAS results related to the systematic processing of specific Areas of Interest and updated with the most recent Sentinel-1 acquisitions are also available. SBAS tools provides the following results: LOS Displacement Time Series; Mean LOS Velocity; Temporal Coherence; Location (latitude, longitude, elevation) and LOS Unit Vector for each pixel. For more information on tool usage and provided results see also the on-line tutorial: https://terradue.github.io/doc-tep-geohazards-v2/tutorials/gep-sbas-s1.html

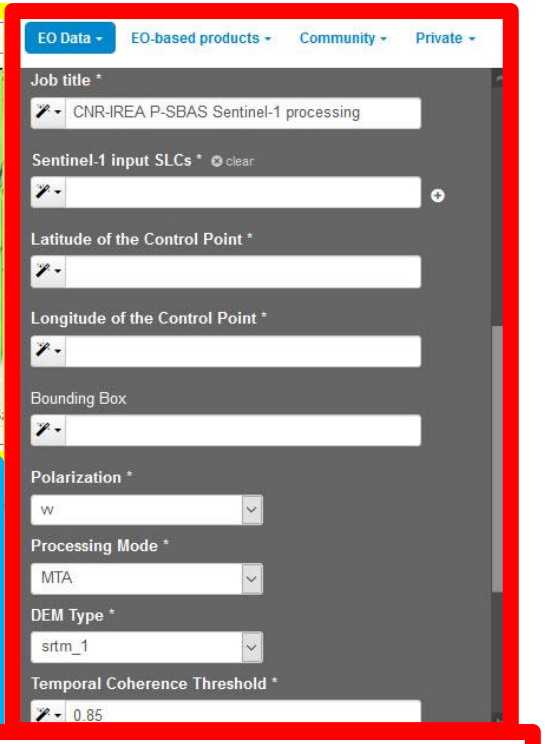
The **CNR-IREA SBAS Ground Motion Services** is one of the GEP thematic apps that consists on a Differential SAR Interferometry (DInSAR) processing chain for the generation of earth deformation time series and mean velocity maps of surface ground displacement. This service exploits **Sentinel-1** satellite images and provides results in just 24 hours.

In this work, we are going to present **an overview or compilation of landslides** that we could detect and monitor by making use of this app.

How to use the CNR-IREA SBAS Ground Motion Services

MAP WINDOW to define the study area





SELECTION WINDOW to select the images for the analysis

SERVICE WINDOW to include the processing parameters

Results

We performed several DInSAR analysis to obtain ground displacement information in Southern Spain. We made use of the **mean LOS velocity** data. Such information is provided in kmz format as well as in csv format, which can be handled in a GIS. Pixel resolution of each measured point is 90 m.

The present work is divided in two parts:

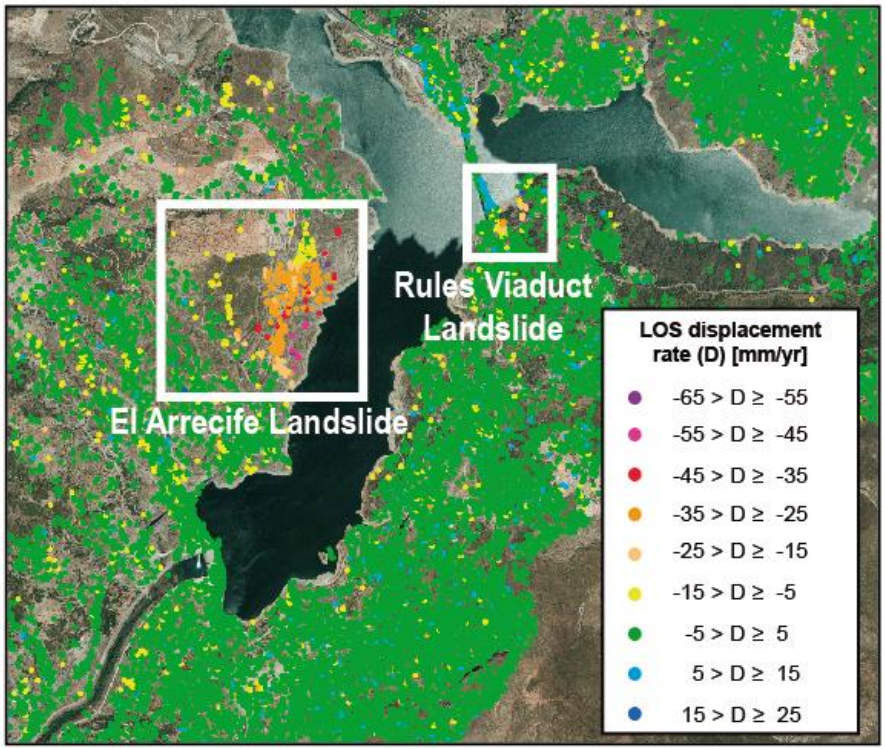
1. Validation. We validated GEP results by comparing them with other DInSAR data already published in scientific literature. For such aim, we selected two well-known cases located in Granada province: the **Rules Reservoir landslides** and the **Albuñuelas Lateral Spreading**.

2. Exploration. We obtained the first DInSAR results in several unexplored areas, where DInSAR techniques have not been applied before. For such aim, we present the case of **Sierra Nevada** -a mountainous range in Southern Spain- where we have detected several active landslides.

Results

1. **Validation**
   - Rules Reservoir
   - Albuñuelas Lateral Spreading
2. **Exploration**
   - Sierra Nevada

Results – Validation: Rules Reservoir landslides

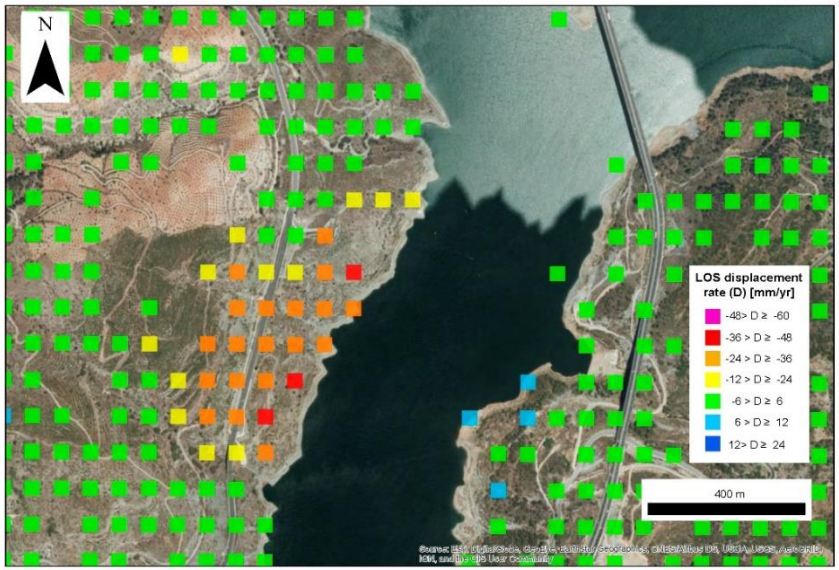


Satellite: Sentinel-1 A and B
Orbit: Ascending
Track: 1
Number of images: 101
Temporal span: March 2015-September 2018
Standard Deviation: 2.5
Stability range: -5 to 5 (mm/yr)

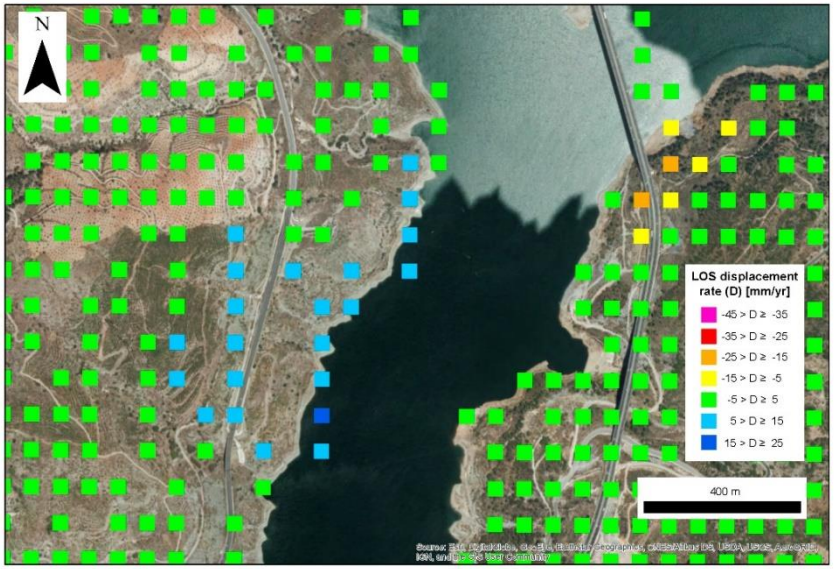
Surface velocity map of the Rules Reservoir area, modified from Reyes-Carmona et al. 2020. This map was derived by applying the PSI chain of the Geomatics Division of the Centre Tecnològic de Telecomunicacions de Catalunya (CTTC). Pixel resolution of each measured point is 14x4 m. Two active landslides were detected: the **El Arrecife Landslide** (translational) and the **Rules Viaduct Landslide** (rotational).

Results – Validation: Rules Reservoir landslides

GEP RESULTS

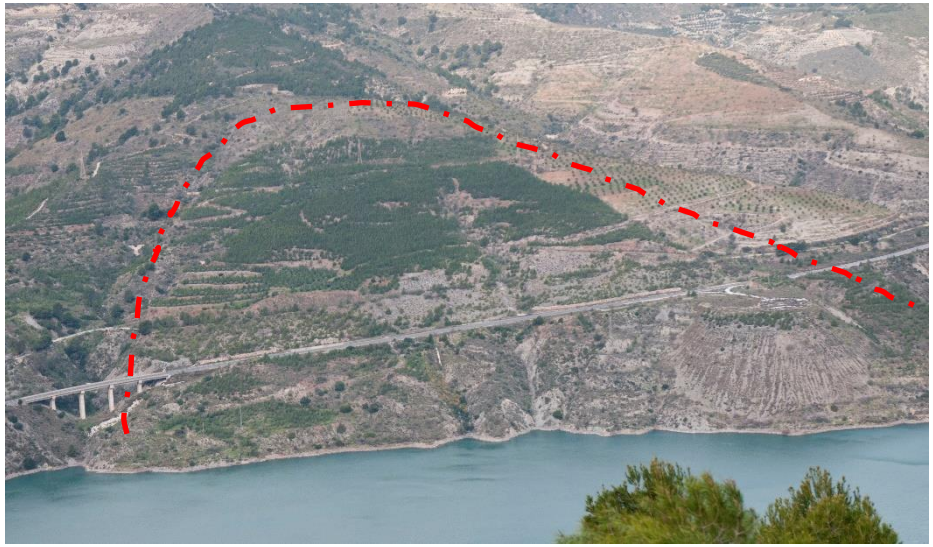


Satellite: Sentinel-1B
Orbit: Ascending
Track: 1
Number of images: 101
Temporal span: September 2016- March 2020
Standard Deviation: 3
Stability range: -6 to 6 (mm/yr)

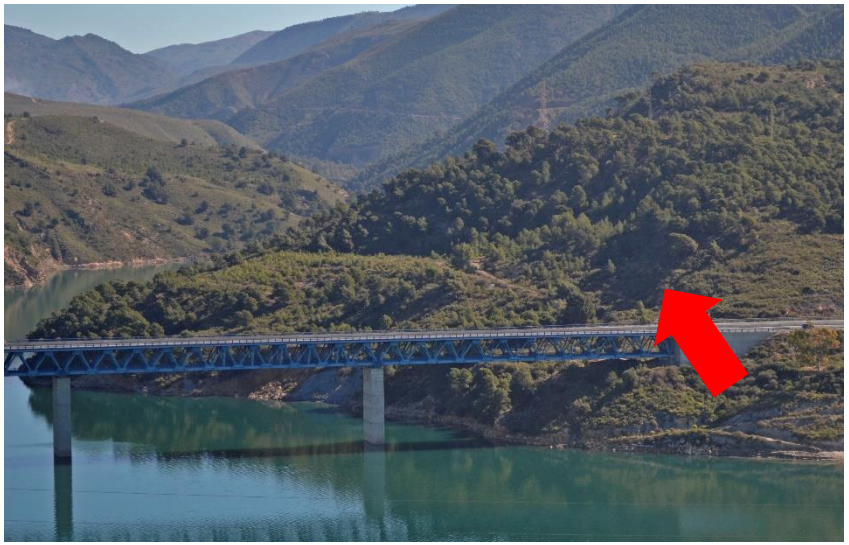


Satellite: Sentinel-1 A and B
Orbit: Descending
Track: 81
Number of images: 241
Temporal span: December 2014-March 2020
Standard Deviation: 2.5
Stability range: -5 to 5 (mm/yr)

Results – Validation: Rules Reservoir landslides



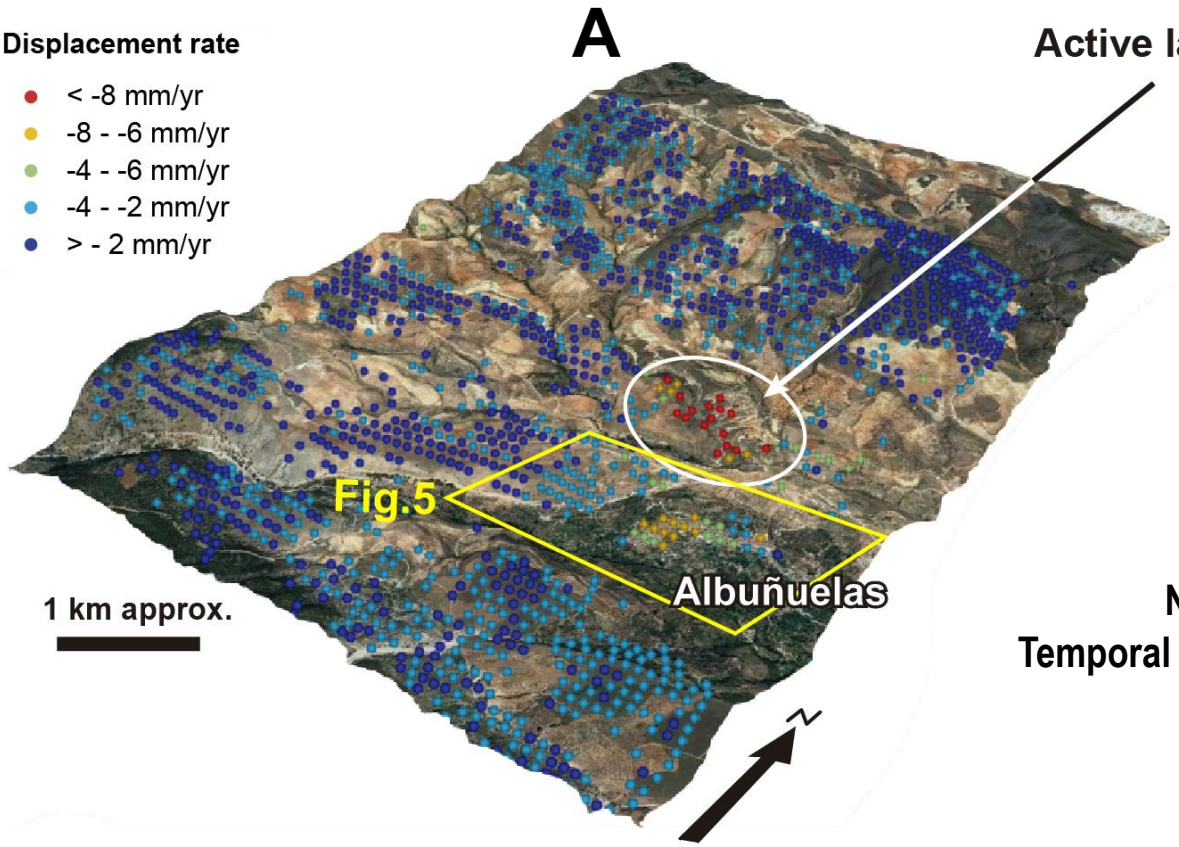
El Arrecife Landslide



Rules Viaduct Landslide

The El Arrecife Landslide activity was detected by both ascending and descending GEP processings while the Rules Viaduct Lansdlide activity was detected just by the descending processing.

Results – Validation: Albuñuelas Lateral Spreading

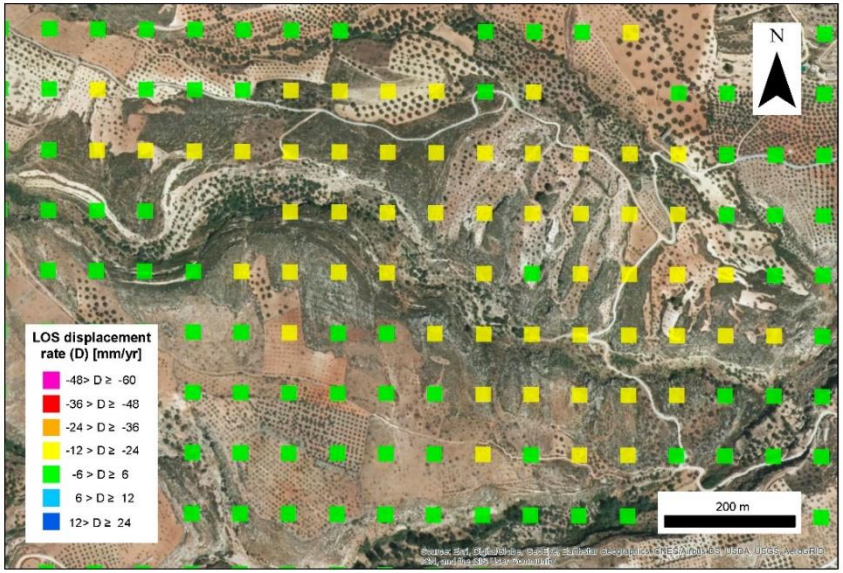


Satellite: Envisat
Orbit: Ascending
Track: 549
Number of images: 25
Temporal span: March 2003-August 2008

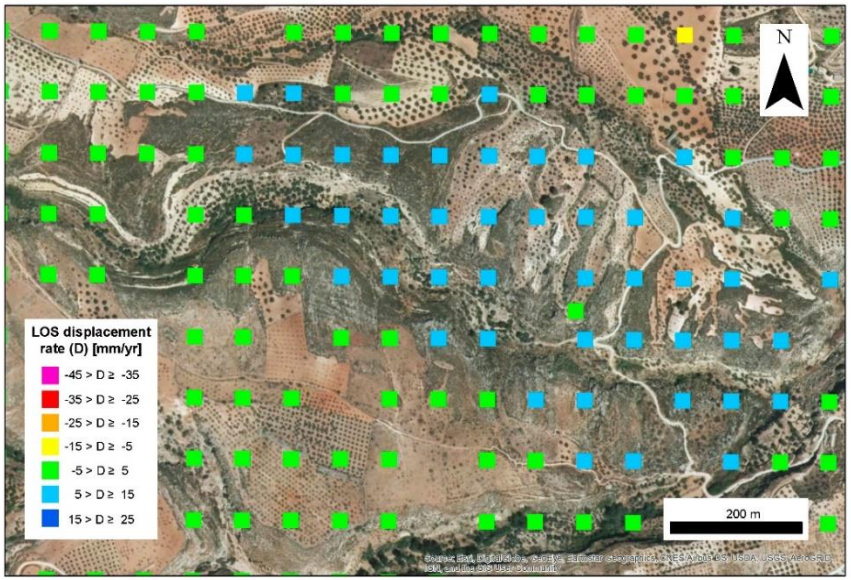
Surface velocity map of the Albuñuelas Lateral Spreading, from Galve et al. 2017. This map was derived by exploiting the SBAS InSAR service of the Geohazards Exploitation Platform (GEP). Pixel resolution of each measured point is 80 m..

Results – Validation: Albuñuelas Lateral Spreading

GEP RESULTS



Satellite: Sentinel-1B
Orbit: Ascending
Track: 1
Number of images: 101
Temporal span: September 2016- March 2020
Standard Deviation: 3
Stability range: -6 to 6 (mm/yr)

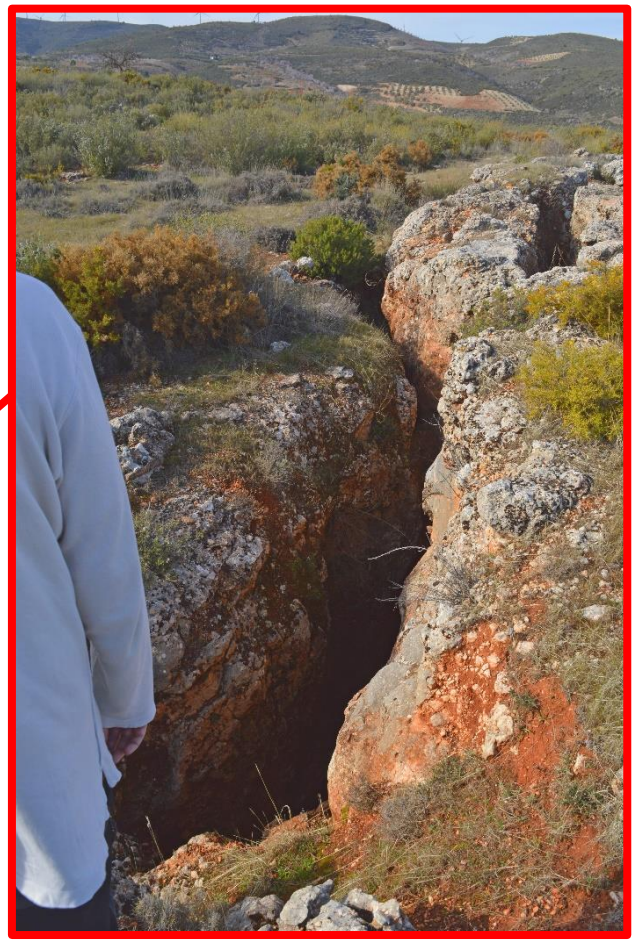


Satellite: Sentinel-1 A and B
Orbit: Descending
Track: 81
Number of images: 241
Temporal span: December 2014-March 2020
Standard Deviation: 2.5
Stability range: -5 to 5 (mm/yr)

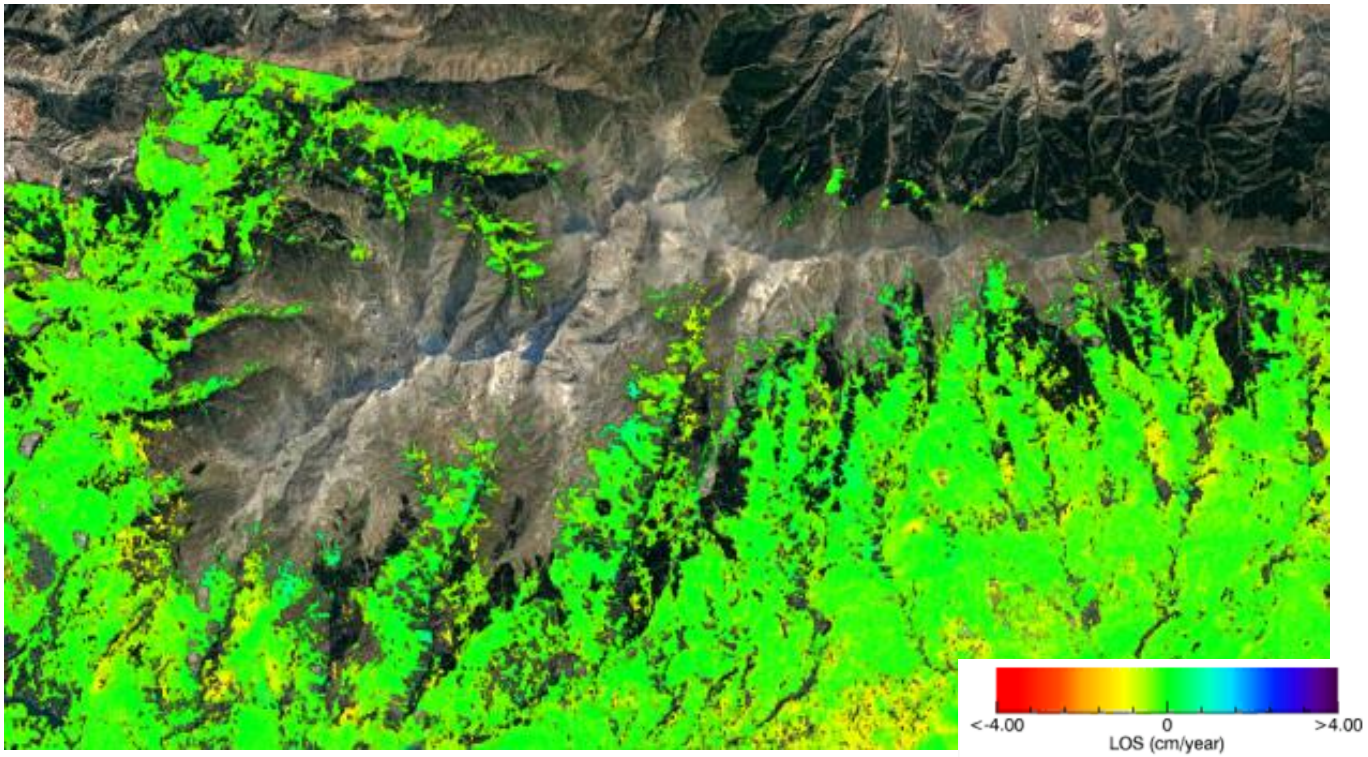
Results – Validation: Albuñuelas Lateral Spreading

The Albuñuelas Lateral Spreading activity has been detected by both descending and ascending GEP processings. It has remained active (at least) since 2003.

Results – Validation: Albuñuelas Lateral Spreading

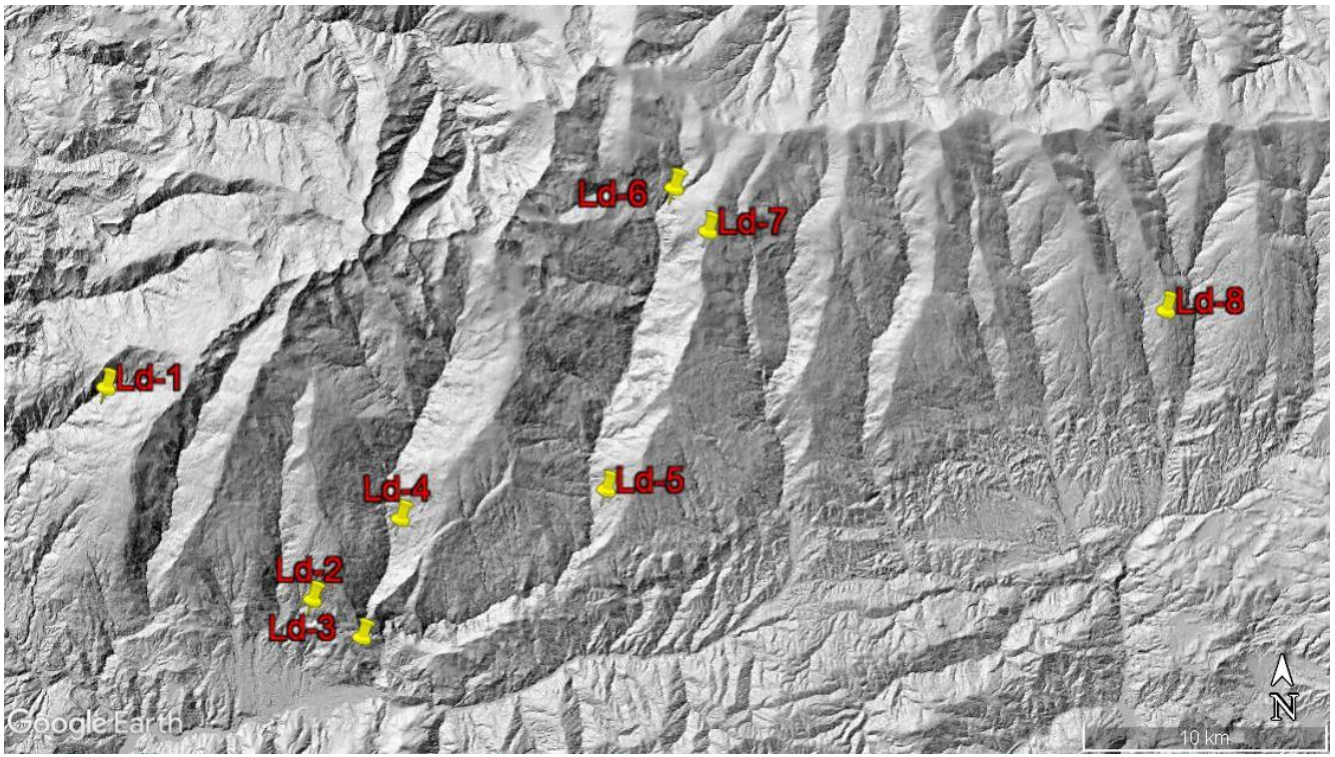


Results – Exploration: Sierra Nevada



Sierra Nevada is a mountainous range that reaches 3400 meters in elevation. Slope instability processes are abundant in this area due to the high topographic gradients. Despite or this, any DInSAR analysis have been done up to date to monitor such instability (i.e. landslides). Thus, GEP provided us the first results of several active landslides in Sierra Nevada.

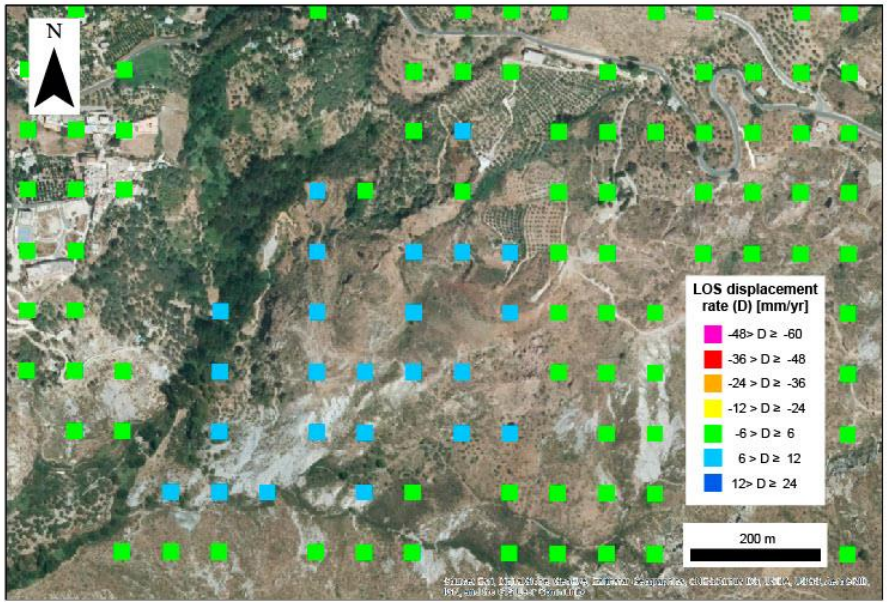
Results – Exploration: Sierra Nevada



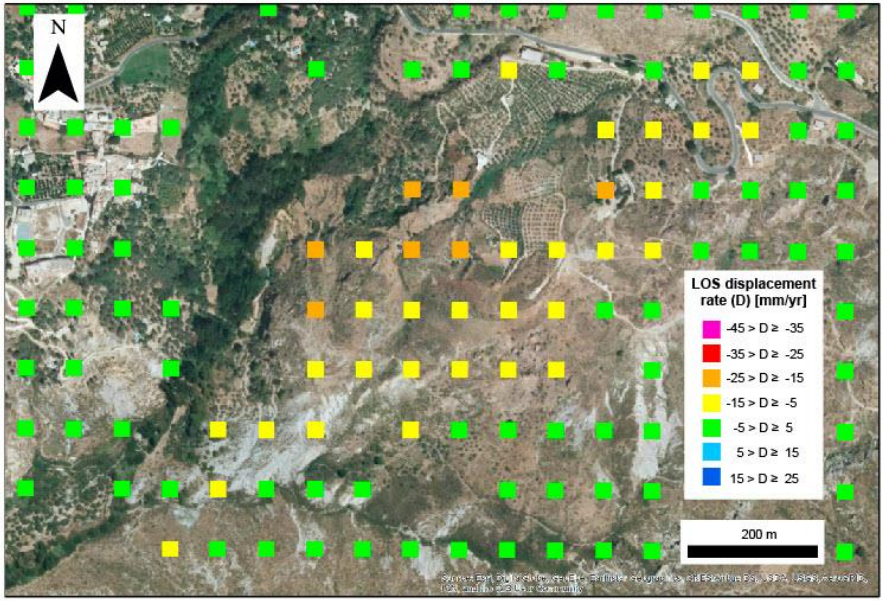
Hillshade map of Sierra Nevada. The **active landslides** are identified as Ld-*n*, being *n* a number from 1 to 8. On the following slides, we show the GEP velocity maps of some of these landslides.

Results – Exploration: Sierra Nevada - some examples

Ld-2



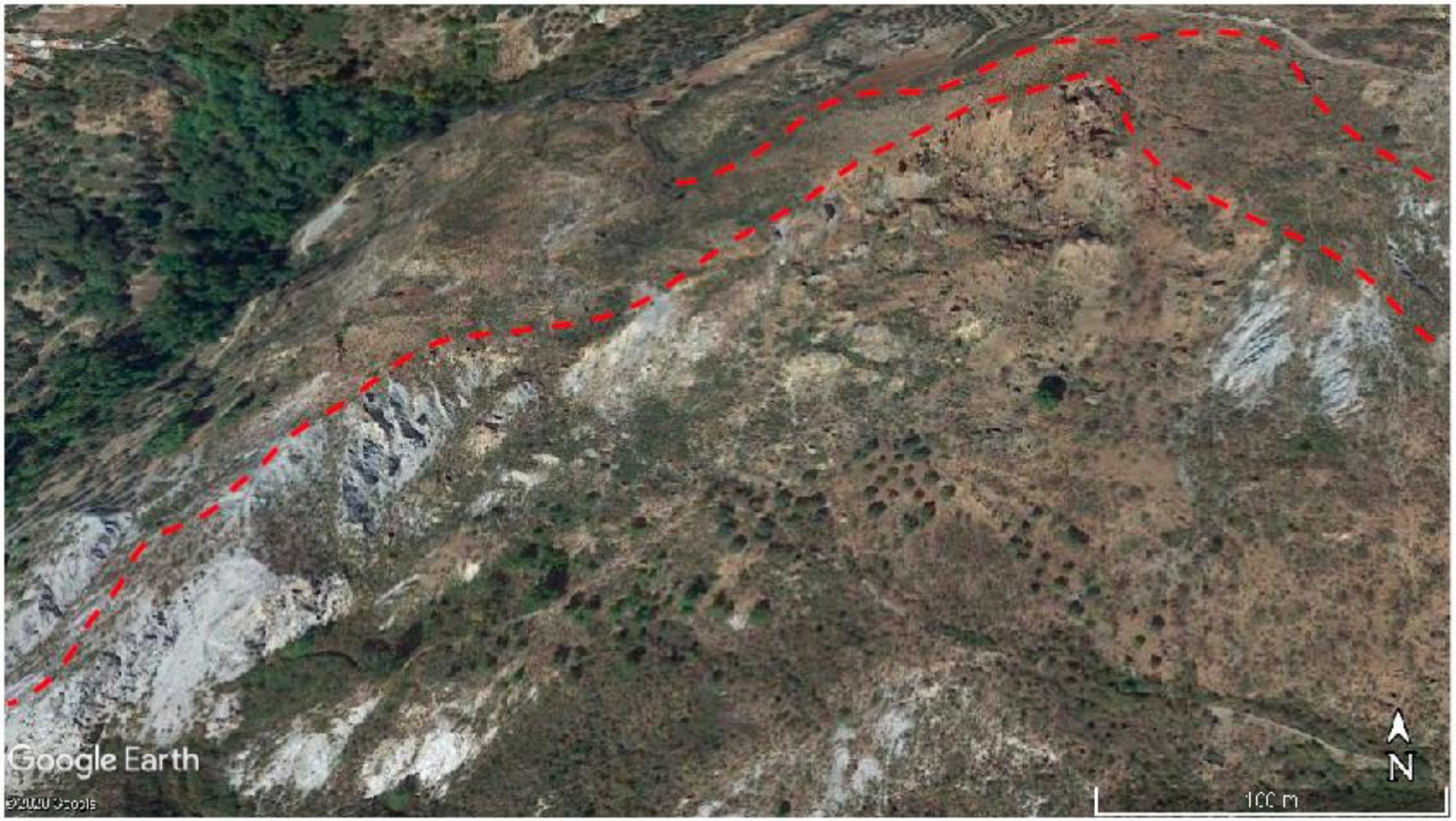
Satellite: Sentinel-1B
Orbit: Ascending
Track: 1
Number of images: 101
Temporal span: September 2016- March 2020
Standard Deviation: 3
Stability range: -6 to 6 (mm/yr)



Satellite: Sentinel-1 A and B
Orbit: Descending
Track: 81
Number of images: 241
Temporal span: December 2014-March 2020
Standard Deviation: 2.5
Stability range: -5 to 5 (mm/yr)

Results – Exploration: Sierra Nevada - some examples

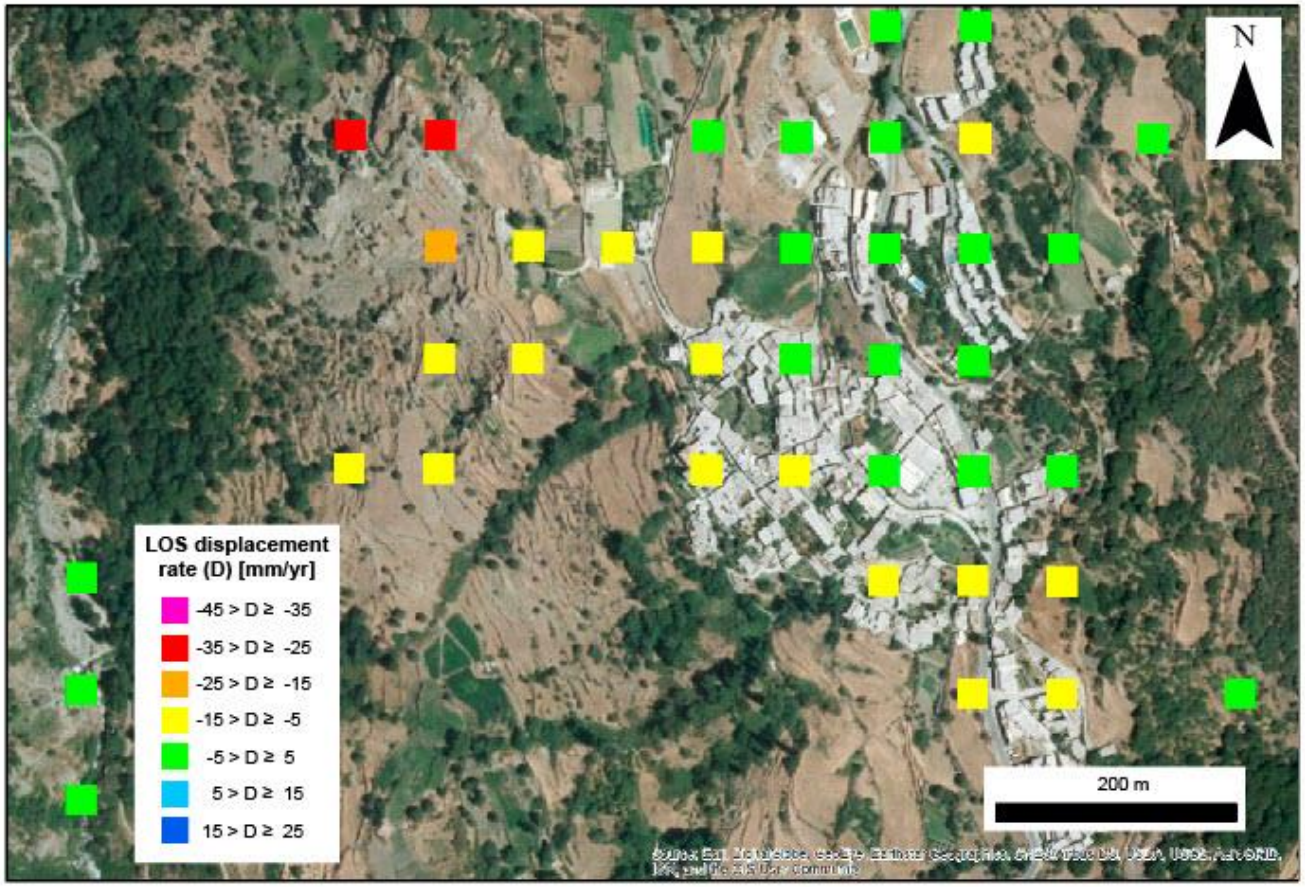
Ld-2



Results – Exploration: Sierra Nevada - some examples

Ld-4

Satellite: Sentinel-1 A and B
Orbit: Descending
Track: 81
Number of images: 241
Temporal span: December 2014-March 2020
Standard Deviation: 2.5
Stability range: -5 to 5 (mm/yr)



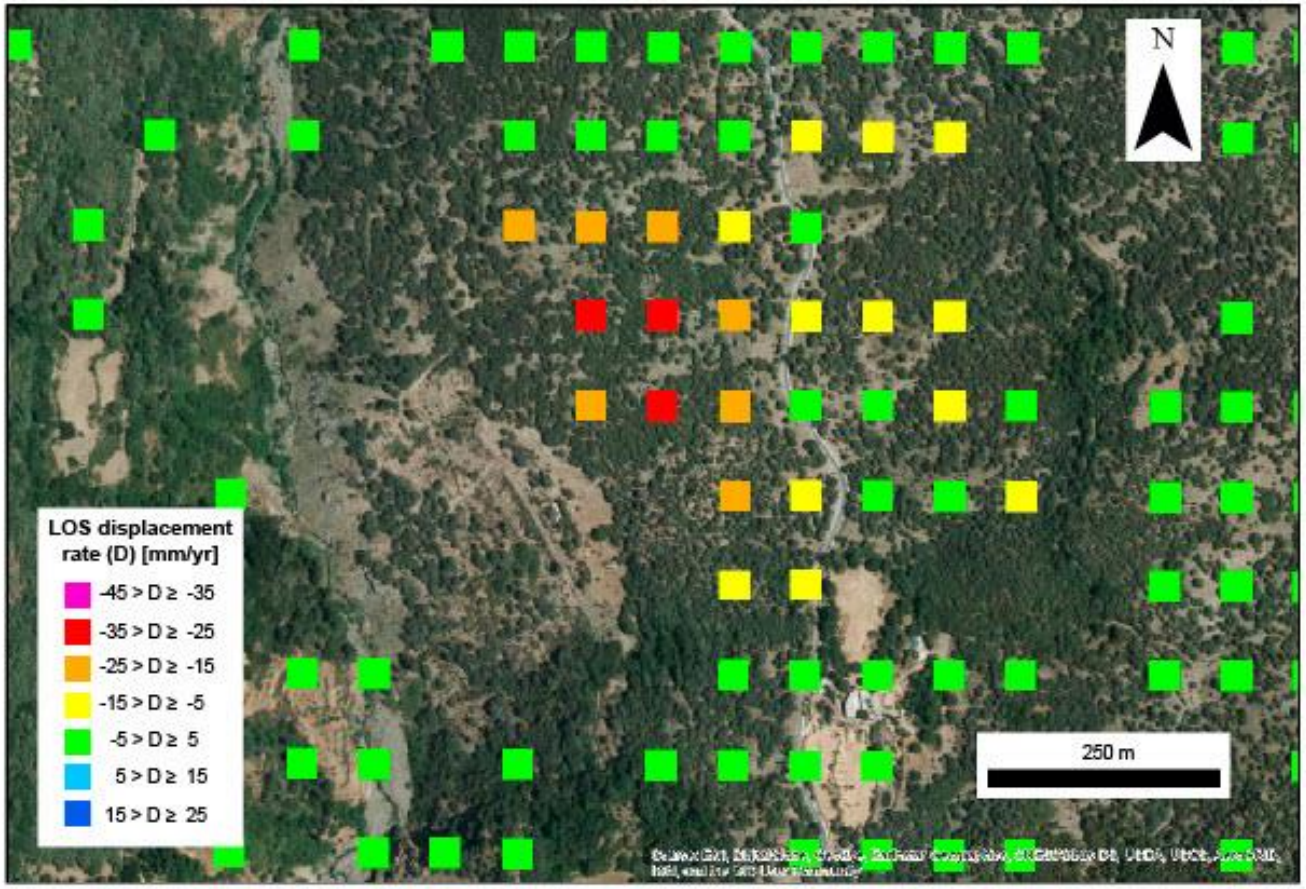
Results – Exploration: Sierra Nevada - some examples

Ld-4

Results – Exploration: Sierra Nevada - some examples

Ld-5

Satellite: Sentinel-1 A and B
Orbit: Descending
Track: 81
Number of images: 241
Temporal span: December 2014-March 2020
Standard Deviation: 2.5
Stability range: -5 to 5 (mm/yr)



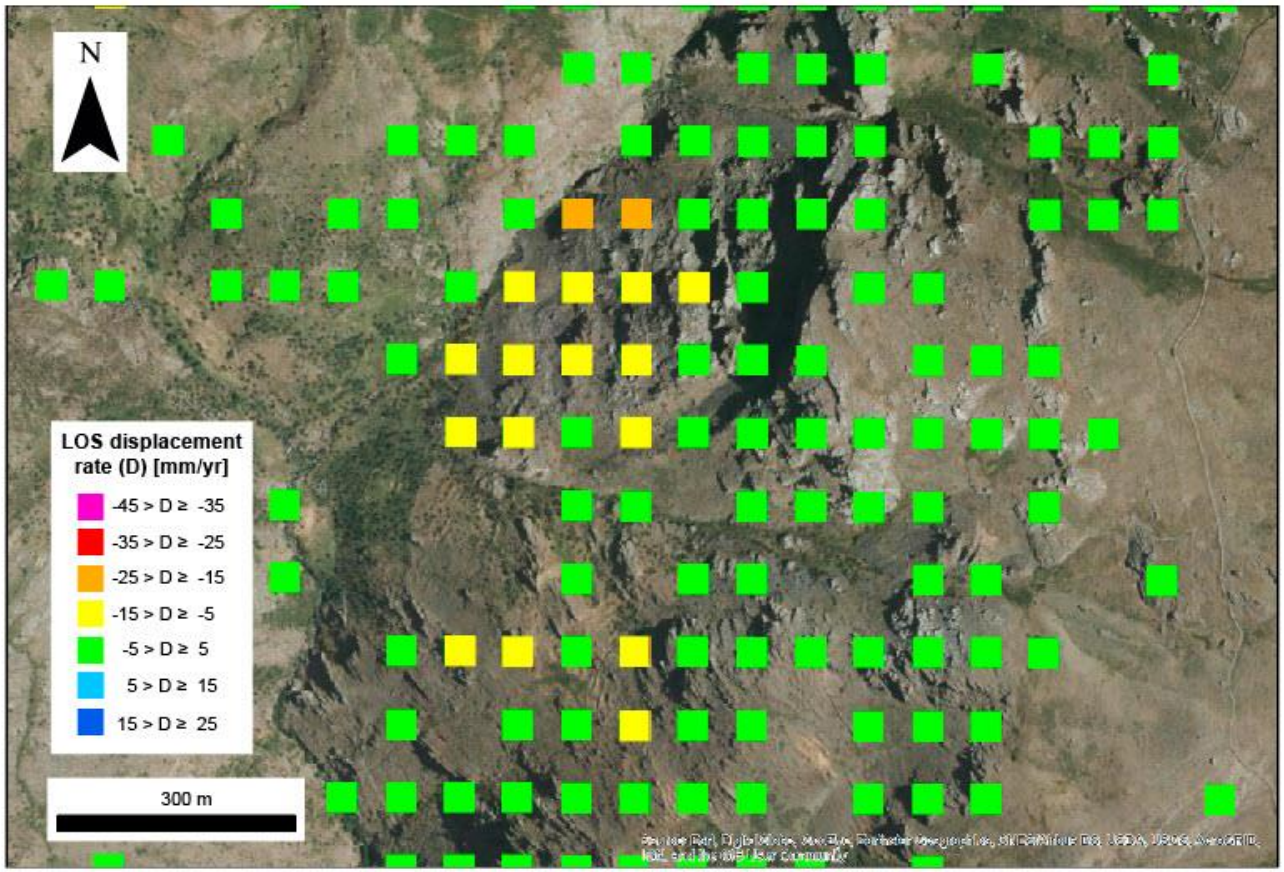
Results – Exploration: Sierra Nevada - some examples

Ld-5

Results – Exploration: Sierra Nevada - some examples

Ld-6

Satellite: Sentinel-1 A and B
Orbit: Descending
Track: 81
Number of images: 241
Temporal span: December 2014-March 2020
Standard Deviation: 2.5
Stability range: -5 to 5 (mm/yr)



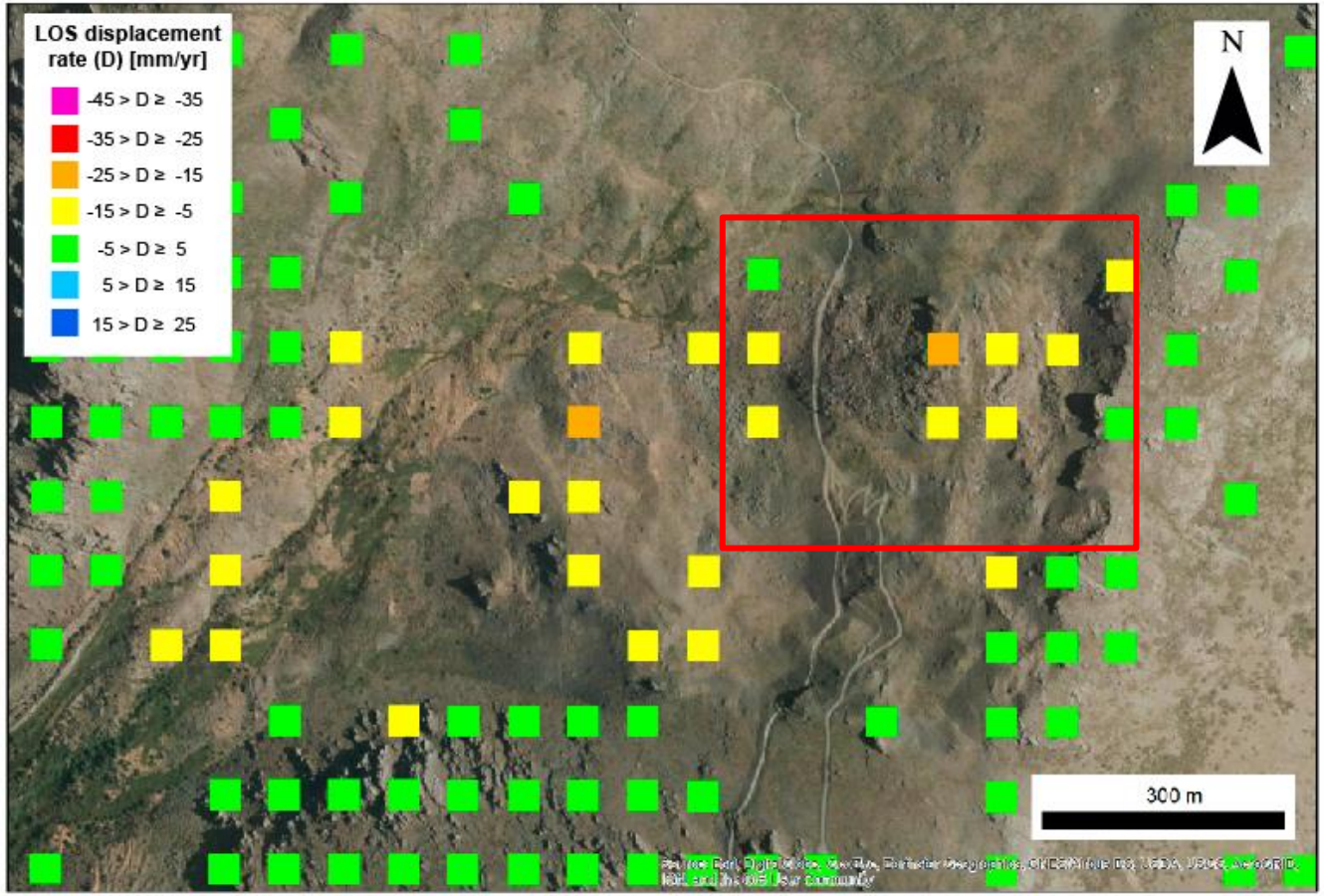
Results – Exploration: Sierra Nevada - some examples

Ld-6

Results – Exploration: Sierra Nevada - some examples

Ld-7

Satellite: Sentinel-1 A and B
Orbit: Descending
Track: 81
Number of images: 241
Temporal span: December 2014-March 2020
Standard Deviation: 2.5
Stability range: -5 to 5 (mm/yr)



Results – Exploration: Sierra Nevada - some examples

Ld-7

Final remarks

1. We have **validated** the **Sentinel-1 CNR-IREA SBAS Services** by comparing the obtained results with previously published data.

2. The Sentinel-1 CNR-IREA SBAS Service is also **useful to obtain preliminary DInSAR data** in unexplored areas and thus, we are able to evaluate whether it is worth doing further research using DInSAR techniques.

3. This service provides **results in just 24 hours**, what makes possible to perform quick analysis.

4. The main **disadvantage** of this GEP service is that the **user cannot control all the processing parameters**.

5. Overall, we consider that the Sentinel-1 CNR-IREA SBAS GEP service has satisfactory proven its **effectiveness and reliability for preliminary DInSAR analysis related to landslide detection and monitoring**.

References

Galve, J.P.; Pérez-Peña, J.V.; Azañón, J.M.; Closson, D.; Caló, F.; Reyes-Carmona, C.; Jabaloy, A.; Ruano, P.; Mateos, R.M.; Notti, D.; Herrera, G.; Béjar-Pizarro, M.; Monserrat, O.; Bally, P. Evaluation of the SBAS InSAR Service of the European Space Agency's Geohazard Exploitation Platform (GEP). Remote Sens. **2017**, 9, 1291.

Reyes-Carmona, C.; Barra, A.; Galve, J.P.; Monserrat, O.; Pérez-Peña, J.V.; Mateos, R.M.; Notti, D.; Ruano, P.; Millares, A.; López-Vinielles, J.; Azañón, J.M. Sentinel-1 DInSAR for Monitoring Active Landslides in Critical Infrastructures: The Case of the Rules Reservoir (Southern Spain). Remote Sens. **2020**, 12, 809.

Thank you so much for reading.

Please, feel free to contact us to share your experience of using any service of the Geohazards Exploitation Platform.

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