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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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 assess hazard related to geological processes such as volcanism, subsidence or landslides.
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

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).

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

**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
**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

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.

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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