Project REPORT

NoR Sponsorship

Project ID 2221e9

Evaluation of various geological risks using GEP tools: Pilot case studies of the Geological Survey of Spain

Marta Béjar Pizarro (1)

Pablo Ezquerro (1)

Guadalupe Bru (1)

Juan López Vinielles (1)

(1) Geohazards InSAR Laboratory and Modelling Group (InSARlab),Geological Survey of Spain (IGME-CSIC), Ríos Rosas 23, 28003 Madrid, Spain

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GEOHAZARDS InSAR LAB & MODELING GROUP

Instituto Geológico y Minero de España

MINISTERIO DE CIENCIA E INNOVACIÓN

CSIC Consejo Superior de Investigaciones Científicas

➢ Objectives of the project

The project will address a set of various use cases for the evaluation of various geological risks:

1. Ground deformation in the Canary islands;

2. Automatic identification and classification of deformation signals;

3. Ground deformation associated to Green Hydrogen injection;

4. Ground deformation for cross-border risk assessment at European level;

5. Ground deformation caused by groundwater extraction;

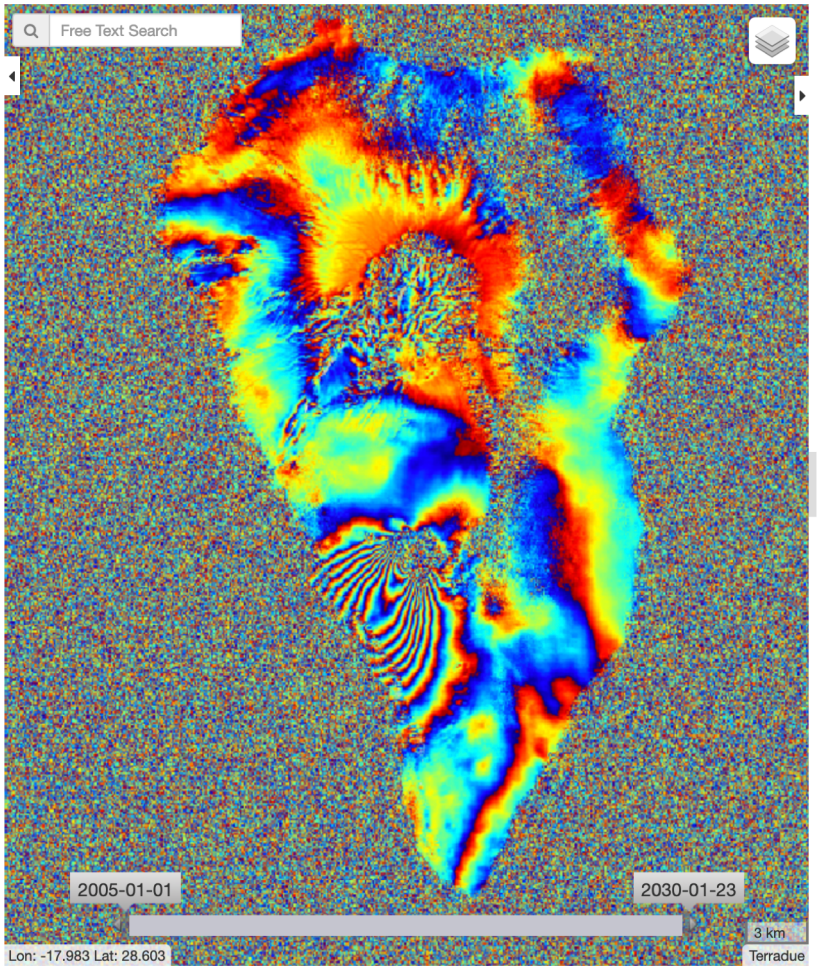
6. Volcanic deformation in El Salvador;

7. Geological risks in urban areas;

8. Ground deformation induced by underground mining in active mining areas.

➢ Ground deformation in the Canary islands

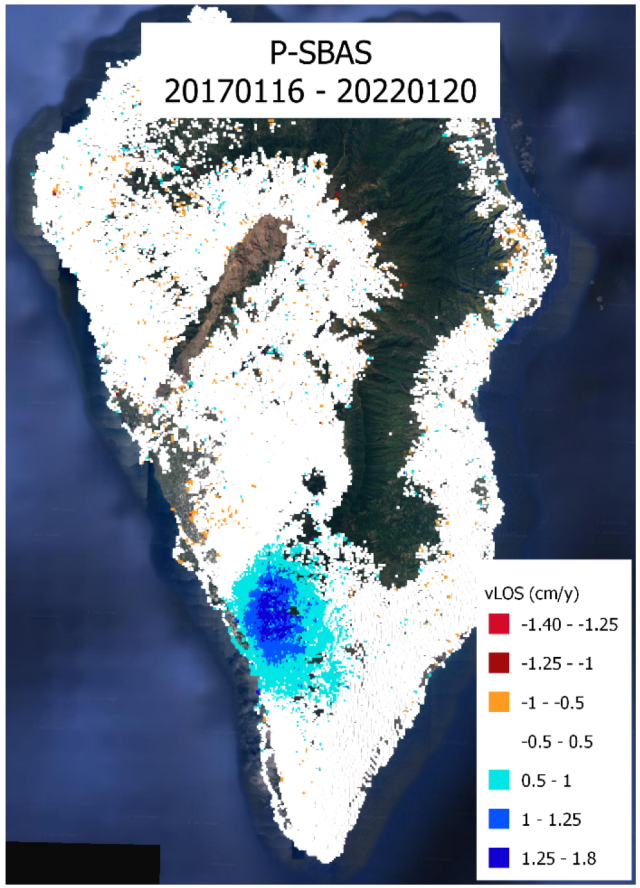
Different GEP tools (Diapason, P-SBAS) were used to generate differential interferograms, deformation time series and mean velocity maps over La Palma island. We identied and characterized ground deformation associated to the volcanic eruption that began on 19th September 2021. Some of these results were published in Ezquerro et al. (2023).



Wrapped interferogram showing surface displacement associated with the Cumbre Vieja volcano eruption (September 2021, La Palma Island, Spain). The interferogram was build using ***Diapason*** *to combine two Sentinel-1 images acquired on 14th and 20th September 2021 in ascending track 60.*

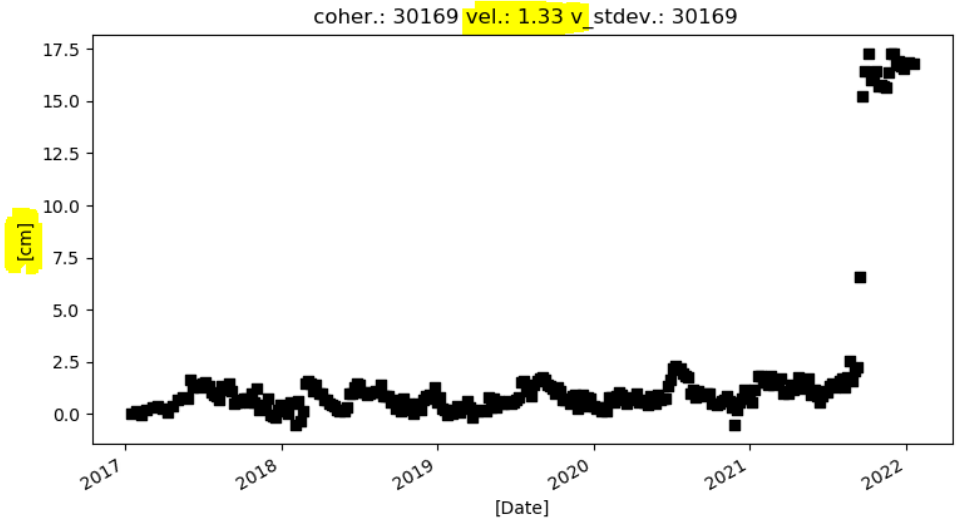
Ezquerro et al. (2023). Analysis of SAR-derived products to support emergency management during volcanic crisis: La Palma case study, Remote Sensing of Environment, Volume 295, 2023, 113668, ISSN 0034-4257, https://doi.org/10.1016/j.rse.2023.113668.

➢ Ground deformation in the Canary islands



P-SBAS vLOS map in cm/y.

Time series showing the ground uplift (magma emplacement) in September 2021



Displacement TS in cm of a pixel located by the arrow

Ezquerro P. et al. (2023). An integrated approach of SAR derived products to support emergency management during volcanic crisis: La Palma case study, Remote Sensing of Environment, Volume 295, 2023, 113668, ISSN 0034-4257, https://doi.org/10.1016/j.rse.2023.113668.

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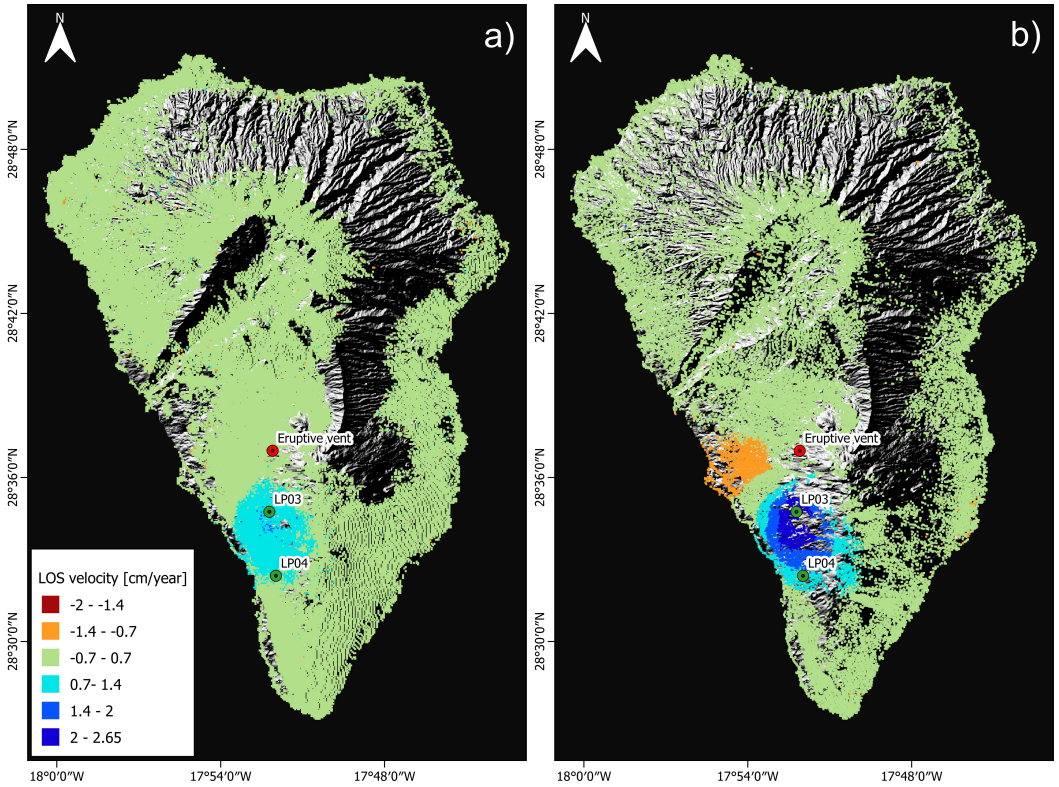
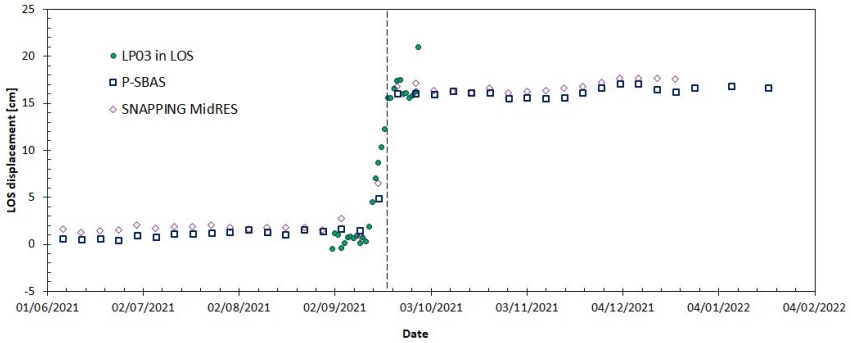


a) P-SBAS and b) SNAPPING vLOS map in cm/y.

Time series showing the ground uplift (magma emplacement) in September 2021

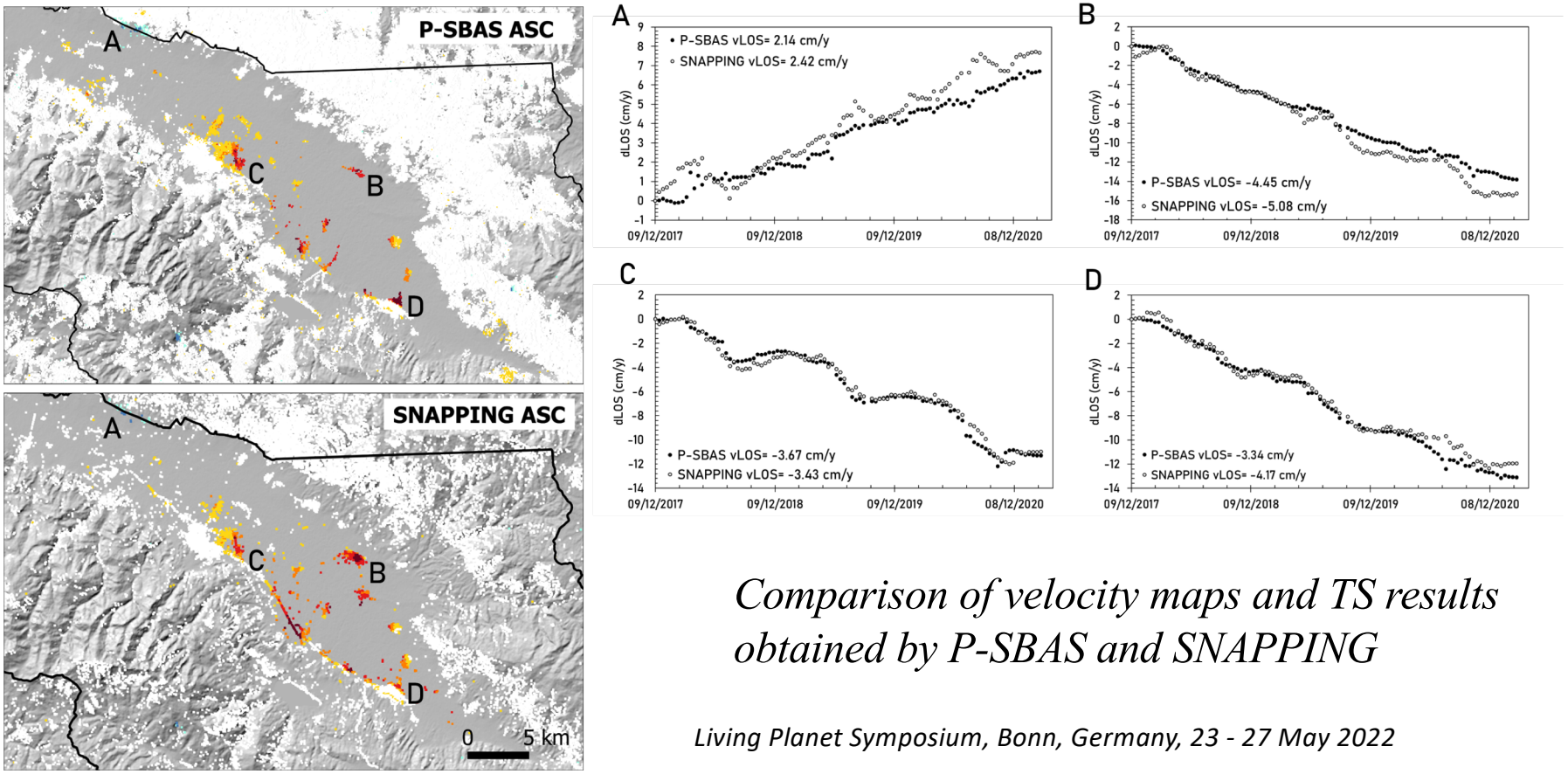


Displacement TS in cm of the averaged pixels within a 200m buffer area around LP03 GNSS station

Ezquerro et al. (2023). Analysis of SAR-derived products to support emergency management during volcanic crisis: La Palma case study, Remote Sensing of Environment, Volume 295, 2023, 113668, ISSN 0034-4257, https://doi.org/10.1016/j.rse.2023.113668.

➢ Ground deformation caused by groundwater extraction

Different GEP tools were used to estimate ground deformation over the Gediz river basin (Turkey) and the Guadalentin basin (Spain). These results are part of the RESERVOIR PRIMA project and will be disseminated in a scientific paper (in preparation).



Comparison of velocity maps and TS results obtained by P-SBAS and SNAPPING

Living Planet Symposium, Bonn, Germany, 23 - 27 May 2022

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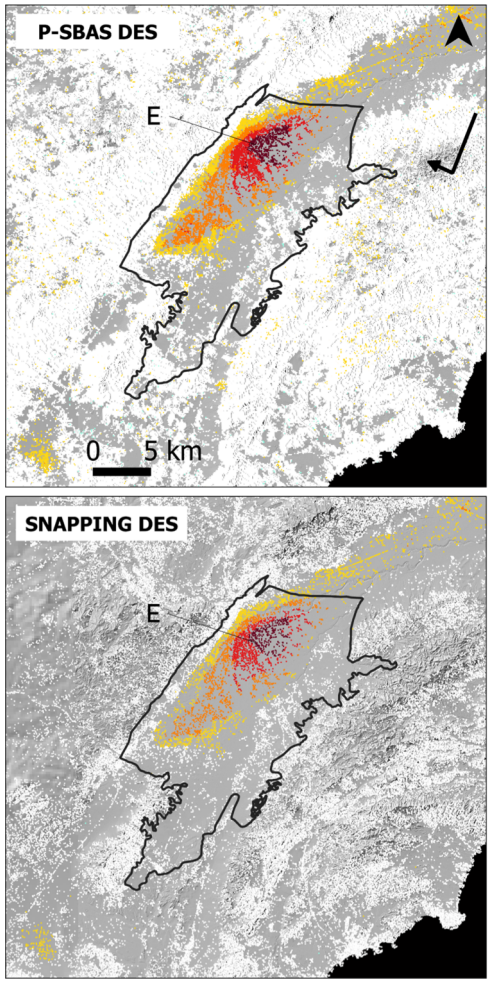
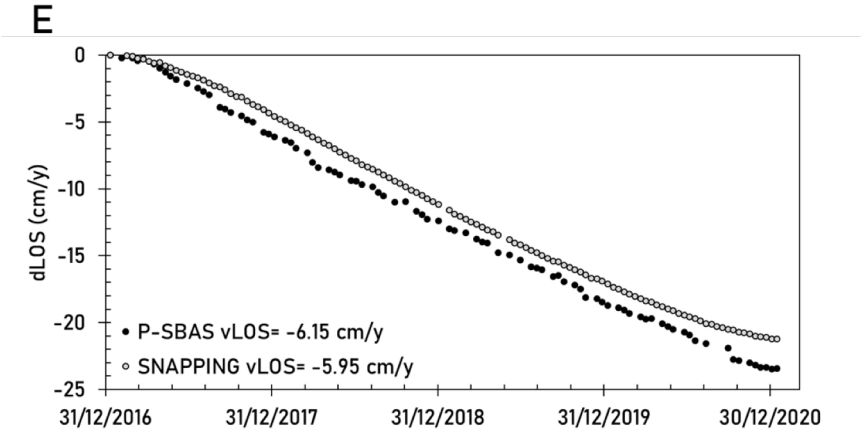
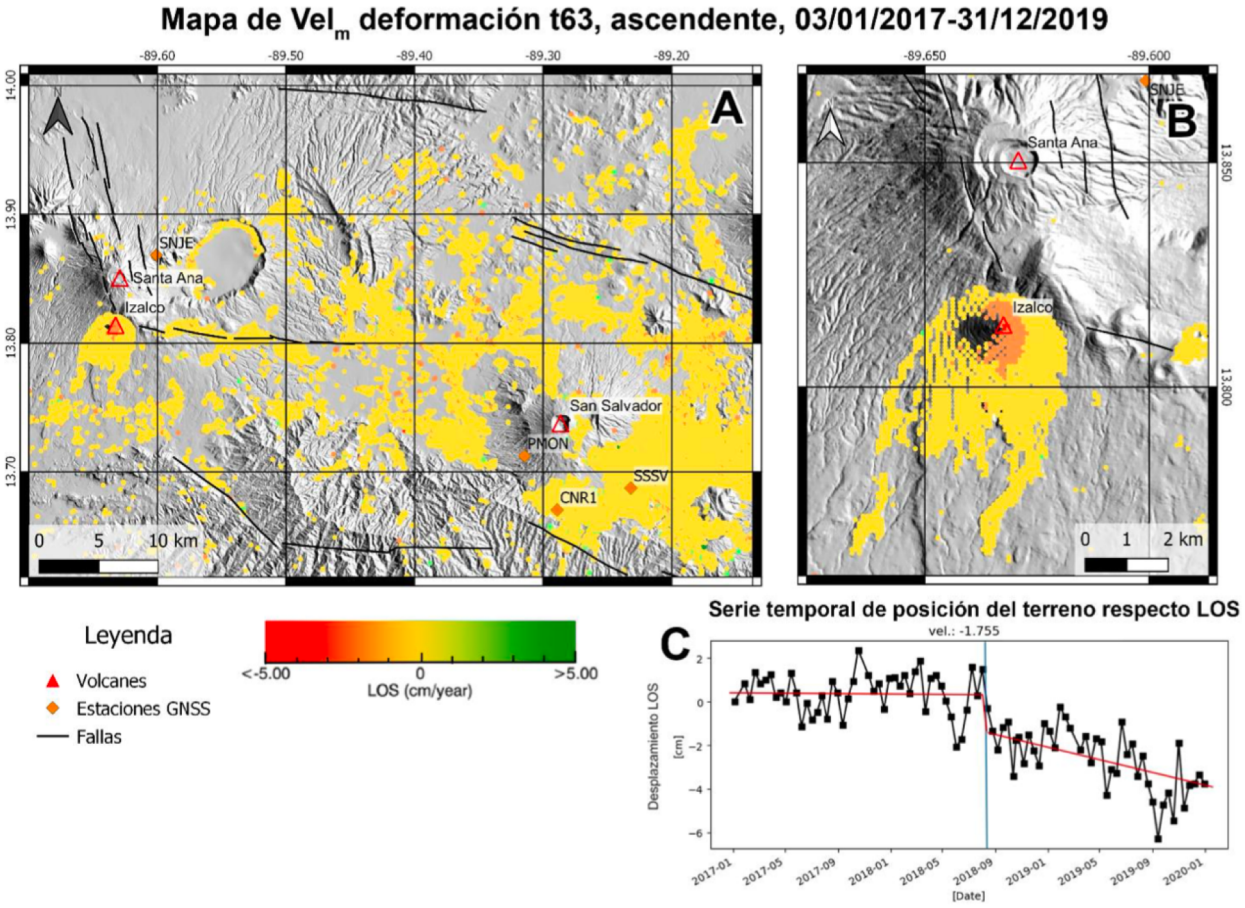


P-SBAS and SNAPPING vLOS map in cm/y over the Alto Guadalentin basin



Displacement TS in mm of a pixel located in the area of maximum vLOS

➢ Volcanic deformation in El Salvador

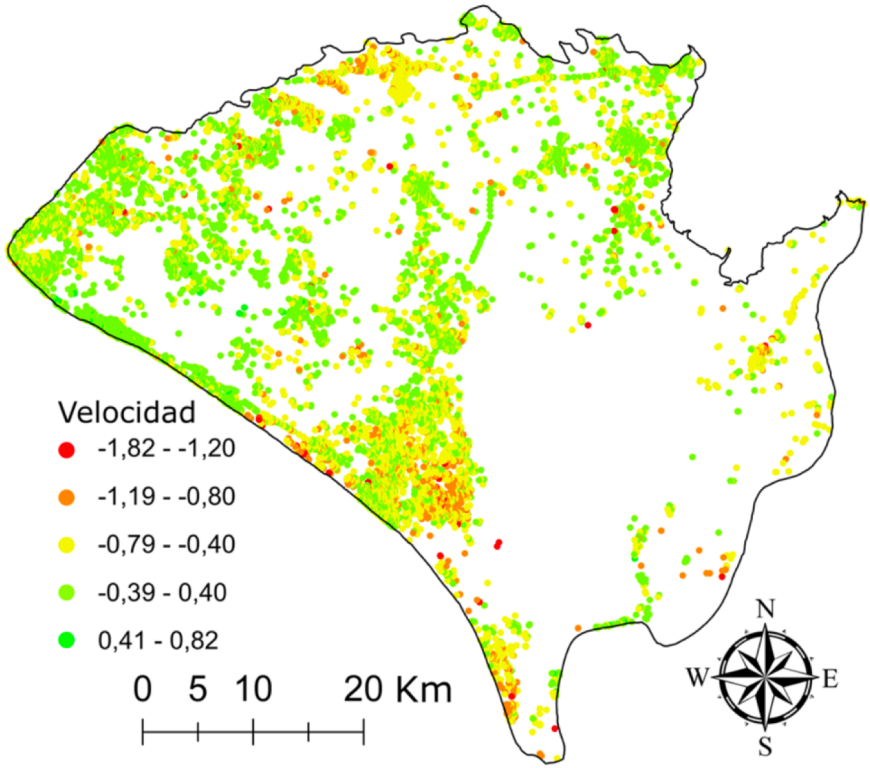


Diapason and P-SBAS were used to estimate ground deformation over active volcanoes in El Salvador. This was analyzed in a Master thesis (Carvajal De Lago, A.M. 2021) and is part of an ongoing PhD thesis.

Ground deformation in the Izalco volcano (Salvador). LOS velocity results were the obtained with ASCENDING orbit between January 2017 and December 2019, processed with ***P-SBAS*** *(from* Carvajal De Lago, A.M. 2021).

➢ Geological risks in urban areas

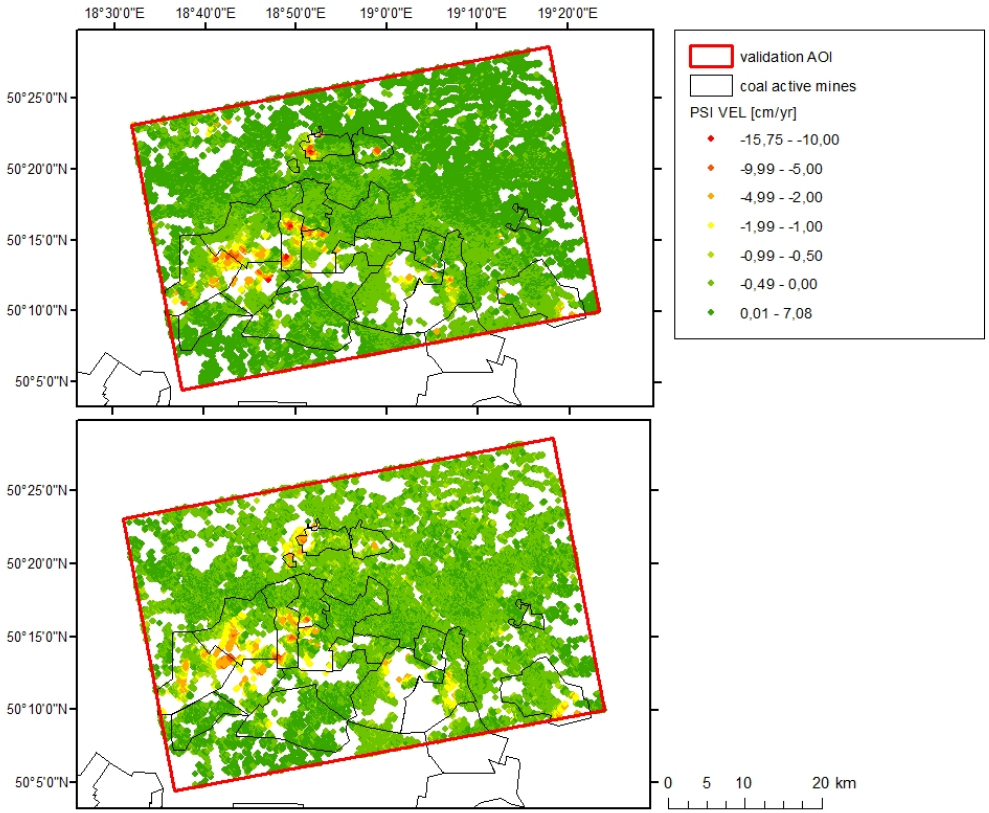
In the framework of the H2020 project e-Shape, IGME has studied surface displacements over different areas to monitor different geological risks. Ground deformation was detected in the Doñana National Park (Spain) .



LOS velocity over the Doñana National Park (south Spain) using P-SBAS Descending in GEP. Period 2014-2020.

- **Ground deformation induced by underground mining in active mining areas.**

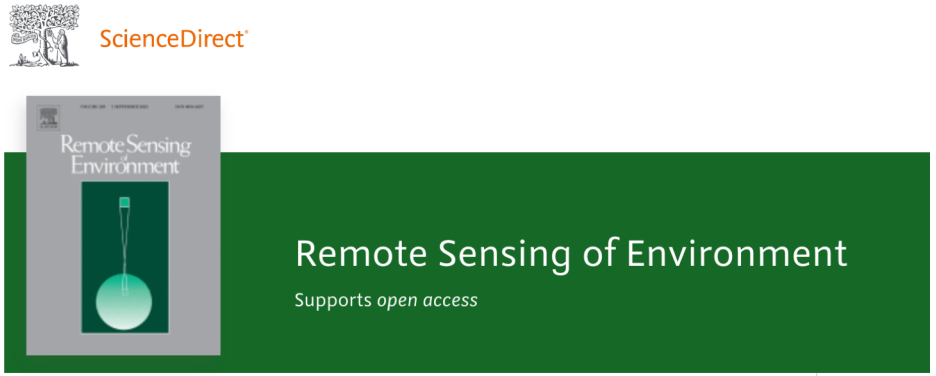
In the framework of GEODRON and E-SHAPE projects, IGME studied subsidence over the Upper Silesian Coal Basin, Poland.



*LOS velocity over the Upper Silesian Coal Basin using **FASTVEL** (upper panel) and P-SBAS (lower panel). The subsidence values correspond to active mining areas.*

➢ List of publications:

- P. Ezquerro, G. Bru, I. Galindo, O. Monserrat, J.C. García-Davalillo, N. Sánchez, I. Montoya, R. Palamà, R.M. Mateos, R. Pérez-López, E. González-Alonso, R. Grandin, C. Guardiola-Albert, J. López-Vinielles, J.A. Fernández-Merodo, G. Herrera, M. Béjar-Pizarro (2023). Analysis of SAR-derived products to support emergency management during volcanic crisis: La Palma case study, Remote Sensing of Environment, Volume 295, 2023, 113668, ISSN 0034-4257, https://doi.org/10.1016/j.rse.2023.113668.



- Juan J. Portela, Marta Béjar-Pizarro, Alejandra Staller, Oriol Monserrat, Anna Barra, José Antonio Álvarez-Gómez, Douglas Hernández (2022). Rapid identification of surface deformation processes in El Salvador using satellite Interferometric Synthetic-Aperture Radar. European Space Agency's 2022 Living Planet Symposium. 23–27 May 2022, Bonn, Alemania. Organised with the support of the German Aerospace Center (DLR).
- Carvajal De Lago, A.M. (2021). Analysis of volcanic deformation in the central sector of El Salvador using geodetic techniques (InSAR and GNSS). Máster Universitario En Geología Ambiental, Universidad Complutense de Madrid.