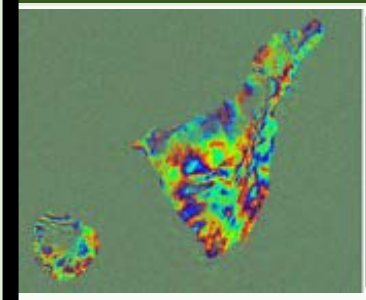
LAYMAN'S REPORT



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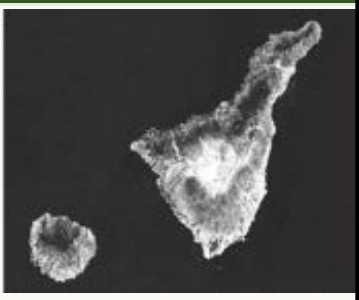

SAFETY: Sentinel-1 for Geohazards regional monitoring and forecasting

The project implemented a procedure based on Sentinel-1 data, to evaluate and periodically update the activity state of geohazards (i.e., volcanic activity and landslides) and their potential impact on urban areas.

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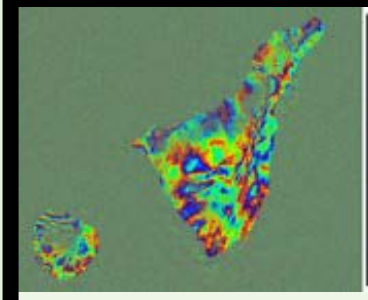

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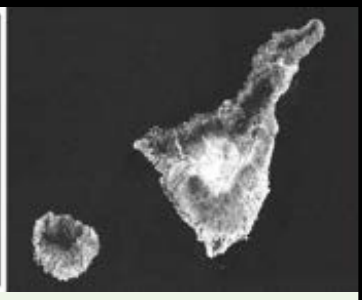

SAFETY: Sentinel-1 for Geohazards regional monitoring and forecasting

Introduction

Safety is a two years project (1 January 2016 – 31 December 2017) with the aim of providing Civil Protection Authorities (CPAs) with the capability of evaluate and periodically update, at a regional scale, the activity state of geohazards (i.e., volcanic activity and landslides) and their potential impact on urban areas. This goal was achieved implementing a procedure and new free accessible tools capable to periodically generate maps, addressed to support the CPA activities for the geohazard management. The main input of the procedure are Sentinel-1 SAR (Synthetic Aperture Radar) data and the Differential Interferometry (DInSAR) analysis.

Why Sentinel-1?

Sentinel-1 (S1) is a constellation of two radar imaging satellites (S1A and S1B). It ensures a regular worldwide acquisition, with a high temporal sampling (acquiring an image every 6 days in Europe), and providing free data available to all users, without limitations. Moreover, the acquisition method (TOPS) delivers images covering wide areas (250x250 km^2). These characteristics allow to accomplish long term monitoring planning, at a regional scale, in any place of the world.

Consortium

GOBIERNO DE ESPAÑA – MINISTERIO DE FOMENTO

INSTITUTO GEOGRÁFICO NACIONAL – Instituto Geológico y Minero de España

UNIVERSITÀ DEGLI STUDI FIRENZE – DST DIPARTIMENTO DI SCIENZE DELLA TERRA

PROTEZIONE CIVILE – Presidenza del Consiglio dei Ministri – Dipartimento della Protezione Civile

Consiglio Nazionale delle Ricerche

Gobierno de Canarias – un solo pueblo

CTTC

DIRECCIÓN GENERAL DE PROTECCIÓN CIVIL Y EMERGENCIAS

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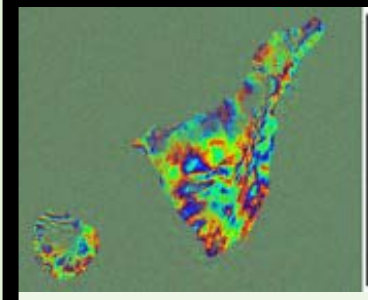

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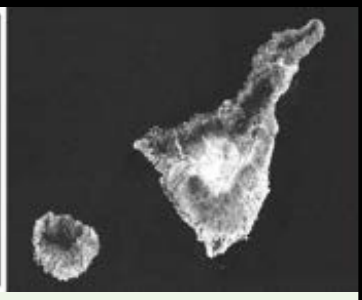
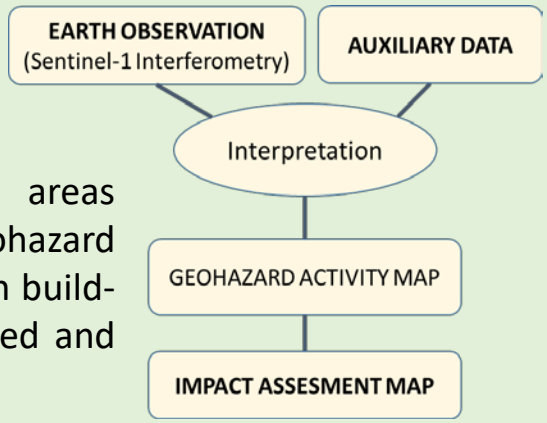


SAFETY: Sentinel-1 for Geohazards regional monitoring and forecasting

What has been done?

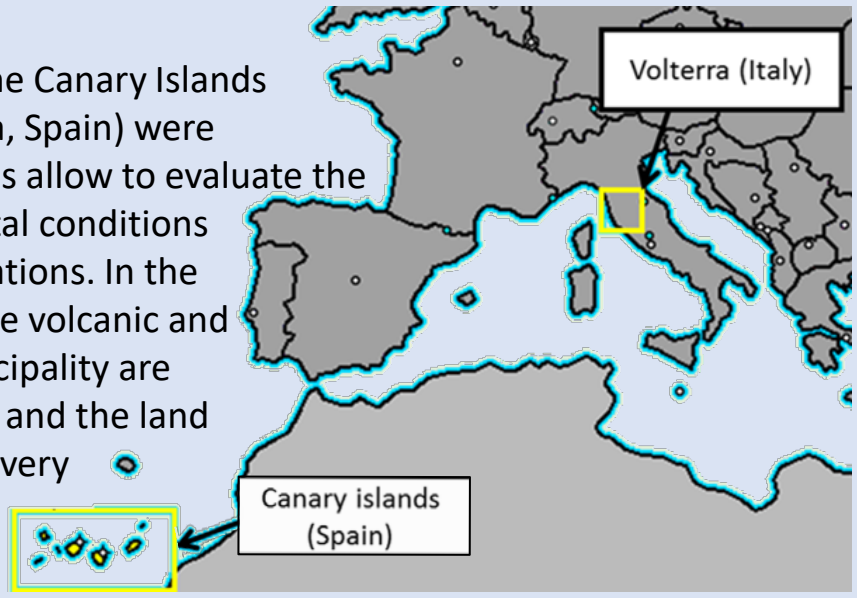
- A **free accessible software** for the Sentinel-1 data processing, suitable to prepare deformation activity maps (DAM). The software is delivered with a manual.
- A **methodology** to semi-automatically detect active areas through Earth Observation, focused to derive the Geohazard Activity Map (GAM) and to assess the potential impact on build-up areas and infrastructures. The methodology was tested and validated in two test sites, in Italy and Spain.



- **Landslide Susceptibility** zonation (i.e., spatial probability occurrence) in the Volterra Municipality.
- **Rockfall Susceptibility** zonation in Gran Canaria. The map will be used to identify areas for the main interventions.
- A sustainable **long term infrastructure** involving Civil Protection Authorities (CPAs) and public organizations responsible for monitoring, alert declaration and geohazard management.
- A **technical training** to provide CPA technicians of different EU countries with a basic knowledge necessary to properly interpret and use the SAFETY products.

Test sites

The Volterra Municipality (Italy) and the Canary Islands (La Gomera, Tenerife and Gran Canaria, Spain) were selected as test sites. The two locations allow to evaluate the methodology in different environmental conditions considering various scenario of applications. In the Canary Islands the main geohazards are volcanic and rock-fall whereas in the Volterra Municipality are landslides. The geo-lithological setting and the land coverage of the two sites determine a very different radar response in terms of coherence.



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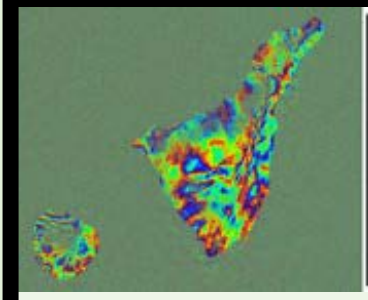

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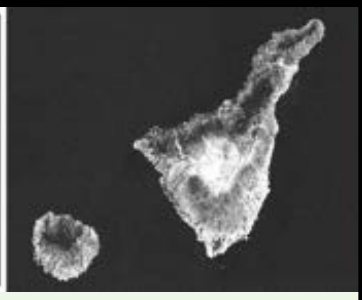


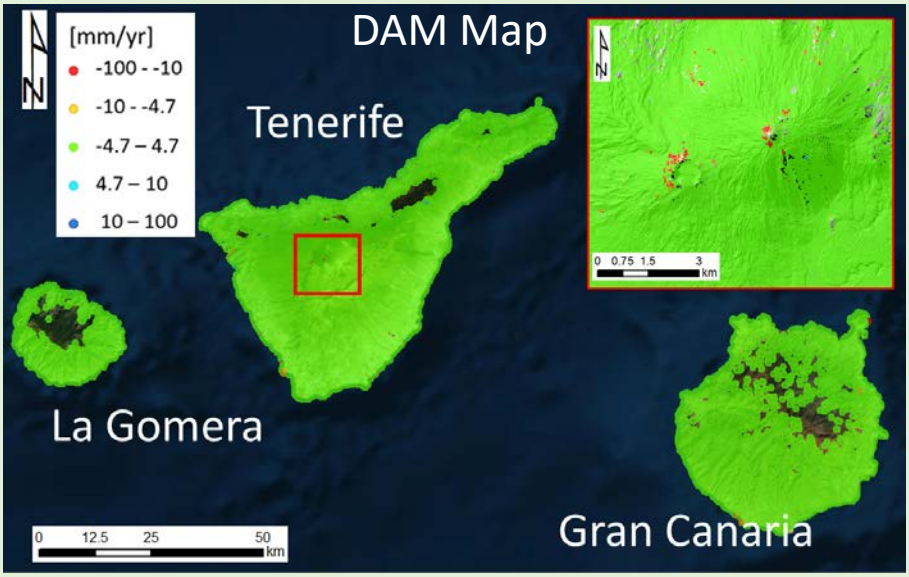
SAFETY: Sentinel-1 for Geohazards regional monitoring and forecasting

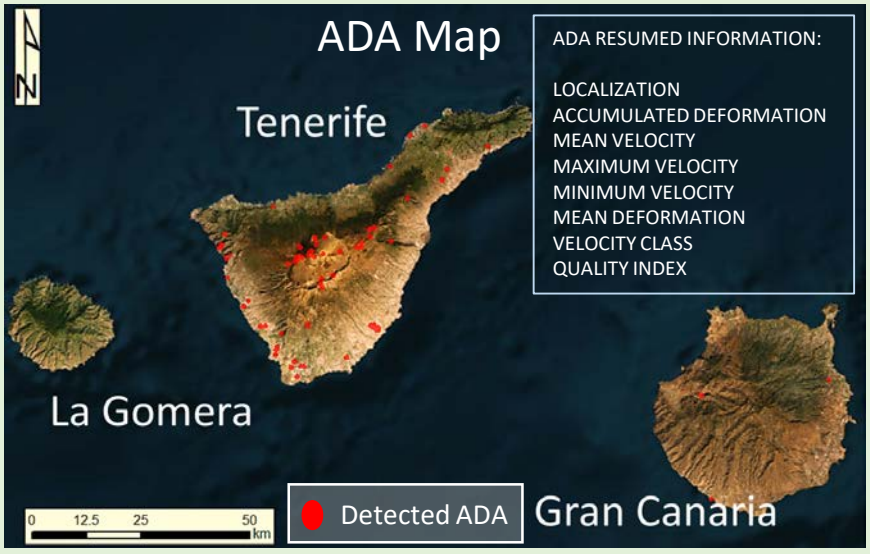
State of the art: what was the main challenging problem?

The interpretation of the products derived by the PSI (e.g., the Deformation Activity Maps) can be complex and misleading, for users not familiar with the SAR technology. This is the main reason, why PSI derived products are not fully integrated, as a continuous and periodical complementary input, in the existing risk management and monitoring activities. In this contest, one of the main objective of the project was the production of readable and reliable products easy to be exploited by the CPAs in their prevention activities.

How did we solve it?

To simplify the use of the PSI derived Deformation Activity Map (DAM), we implemented a semi-automatically procedure to extract the most significant detected Active Deformation Areas (ADA). The ADA map allows; i) a rapid regional scale overview, for the visualization and localization of the detected active areas; and ii) resumes the most relevant information (e.g., the mean annual velocity, the accumulated deformation and the Quality Index that estimate the reliability level of the ADA information). The ADA map can be used as input of the activity information for the generation of other products of the procedure.





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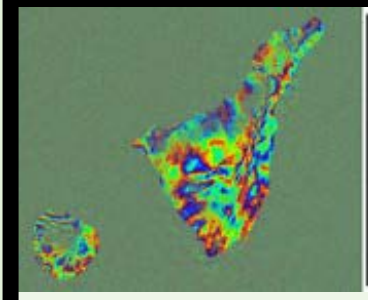

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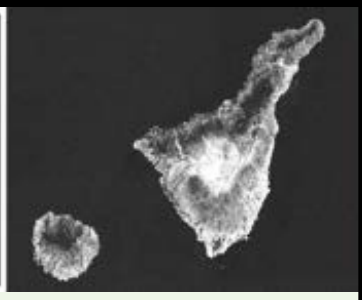
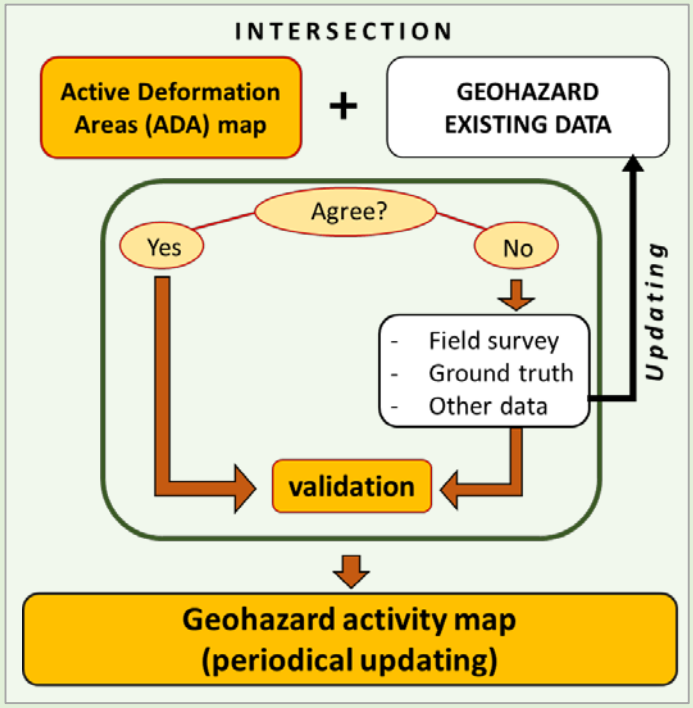
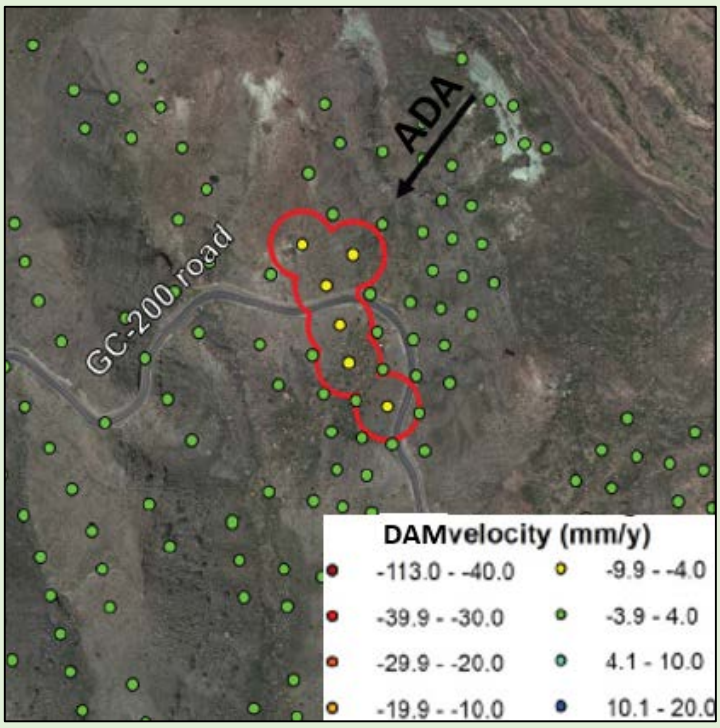


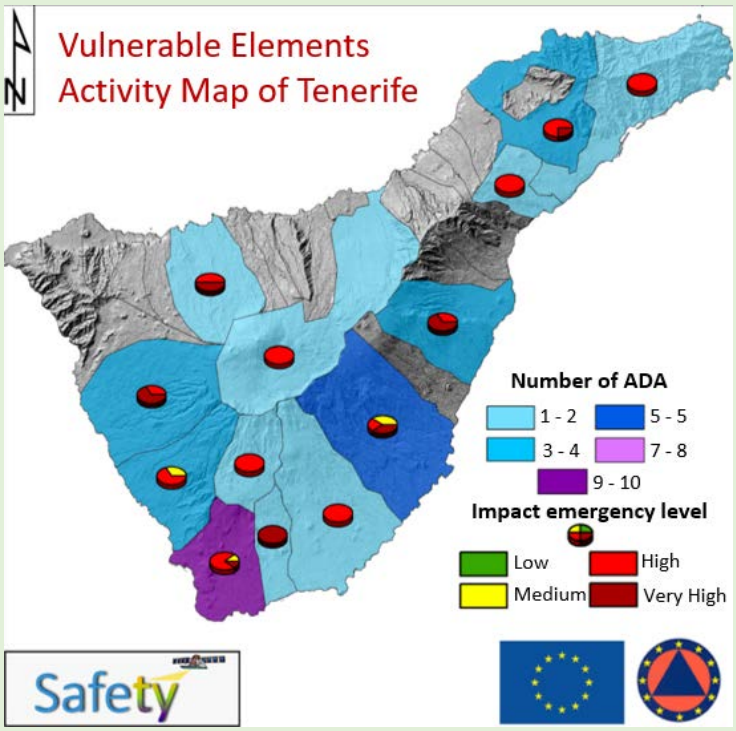
SAFETY: Sentinel-1 for Geohazards regional monitoring and forecasting

Developed Methodology

The main products are obtained from the DInSAR analysis of Sentinel-1 data and the obtained Deformation Activity Map (DAM). The **Active Deformation Areas (ADA) map**, allows the periodical update of the activity information. The intersection of the ADA map with existing geohazard information (e.g., inventory map or susceptibility map), results in the **Geohazard Activity Map (GAM)**. The GAM allows: i) to validate and update the existing data (inventory or susceptibility models) and ii) to define the type of the detected deformation. Moreover, the intersection of the GAM with the exposed elements (e.g., infrastructures, streets, houses, hospitals) provides the **Vulnerable Element Activity Map (VEAM)**. The VEAM shows only the ADA affecting elements at risk and summarizes, in a visual and direct way, for each portion of the territory (e.g., municipalities, regions, basins), the number of impacting ADA and the emergency level related to the affected elements.







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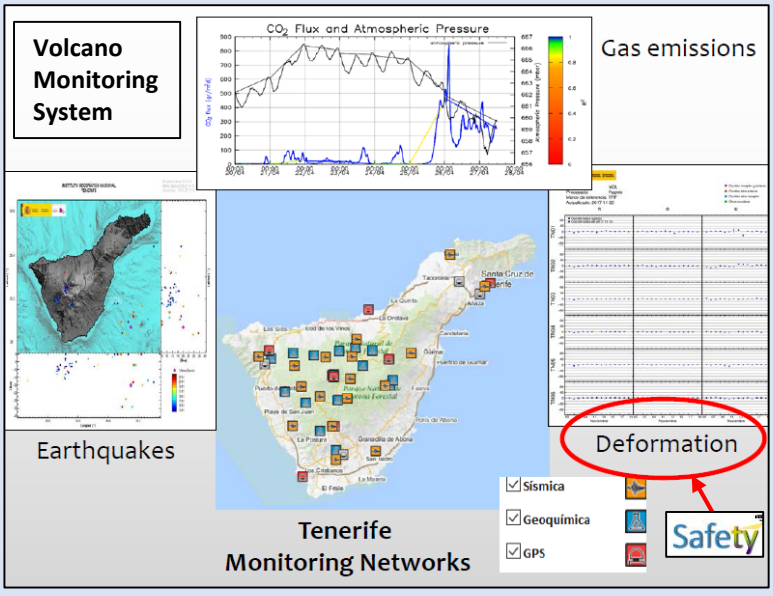
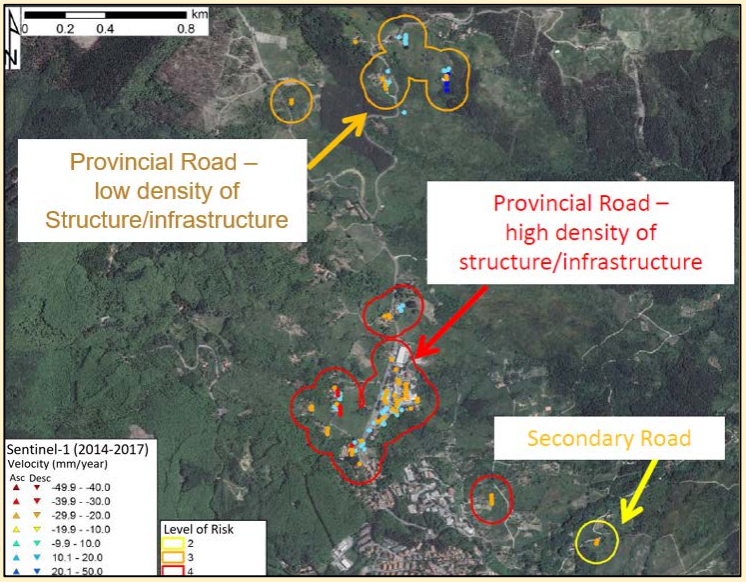
SAFETY: Sentinel-1 for Geohazards regional monitoring and forecasting

How the SAFETY results will be used in the future?

SAFETY in the Spanish National Geographic Institute (IGN) Volcano Monitoring System (VMS) and Alert.

The SAFETY products and tools (modified and automated according to the specific user needs and requirements) are integrated into the VMS procedures to provide useful information to CP authorities. Products derived from SAR interferometry processing facilitate the interpretation of the field deformations provided by VMS, and support the CPA in the delivery of alert messages.





SAFETY in UNIFI "PS continuous streaming for landslide monitoring and mapping in the Tuscany Region (Italy)".

In the framework of an agreement established between UNIFI, the Italian Civil Protection and the Regional Authority of the Tuscany region, UNIFI is applying and testing the procedure developed in SAFETY. After this agreement, the SAFETY procedure will be potentially implemented by Civil Protection agencies and local authorities to be applied in other regions of Italy.

SAFETY for Spanish Geological Survey and the Canary Island Civil Protection.

An operable methodology (i.e., a protocol) integrated into the Civil Protection activities of prevention has been implemented in SAFETY. It provides the capability of evaluating and assessing rock fall hazard. A new data form has been designed in the frame of the project and will be used by the CPA to collect and organize information and data of future rock fall events.

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