

CEOS Disaster Risk Management

CEOS WG Disasters

The Geohazards Lab

CEOS WG Disasters 12th meeting

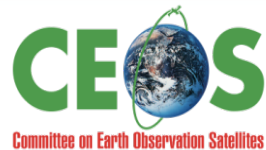


Philippe Bally, ESA

Theodora Papadopoulou, ARGANS c/ ESA

Michael Foumelis, BRGM

Floriane Provost, ESA

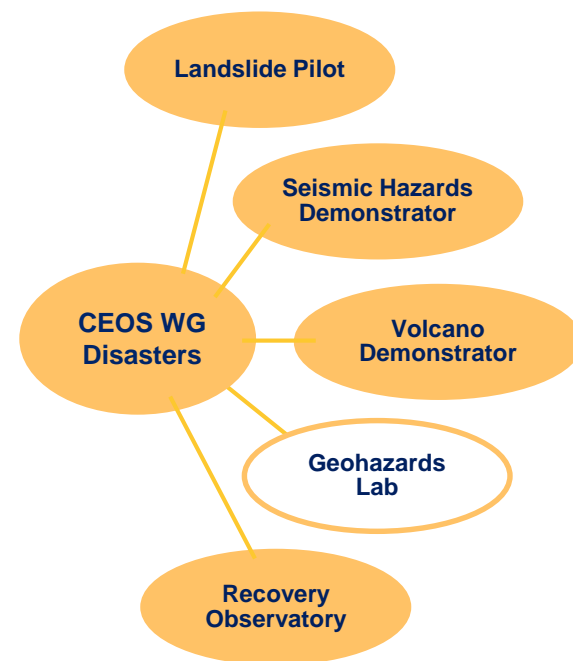




Geohazards Lab:

A platform with federated resources to provide data access and an online processing and e-collaboration environment to exploit EO data to assess geohazards and their impact

- ✓ Supports and complements the **CEOS WG Disasters activities** (on-going pilots, follow-on activities and the RO), **GSNL**, **GEODARMA** and users from the broader geohazards community.
- ✓ Maximize use of EO techniques and cloud processing by the EO expert community
- ✓ Achieve acceptance of EO products by the non-EO scientific community and decision makers





- Access to the **Geohazards Exploitation Platform** including: data storage, processing software (InSAR and stereo-optical processing chains), e-collaboration environment;
- **Man-power (staff & support under consultancy contract)**: scientific animation and promotion of information and results; support to coordination/governance.



- Access to the **PEPS platform & products** (e.g. NSBAS InSAR processing chain);
- Makes available CEOS and **GSNL Pléiades collections** through the GEP
- **Man-power (staff & support contract)**: to support the scientific animation and promotion of EO products and results
- Shall make available CEOS and GSNL Cosmo-SkyMed **collections through the GEP** (already done for the Nepal event supersite). Further details TBD.



- **Higher level science products** derived from Sentinel-1 and TerraSAR-X data
- Access to the **automated Sentinel-1 interferometric chain**



(on a voluntary basis)

Geohazards Community

Geoscience centers with EO expertise **actively involved**

- **BRGM** [FR] provides in-kind contribution (labor) and leads the Geohazards Office
- **CNR-IREA** [IT] (via platform federation activities about InSAR data processing)
- **CNRS EOST** DSM processing and optical image correlation [FR]
- **COMET** [UK]
- **IGME** [ES]
- **INGV** [IT] (via the responsible of the Geohazards Supersites and Natural Laboratories initiatives)
- **ISTerre** / Institut de Recherche pour le Développement (IRD) [FR]
- **NOA** [GR]

Geoscience centres **following closely the GLab activities**:

- **BGR** [DE] (via SNGMS)
- **NGU** [NO]

Concrete objectives



Not on an emergency basis

Support the CEOS activities, the GSNL, GEO-DARMA and the broader geohazards community by
(i) providing data delivery, access to tools and hosted processing for geohazards assessment
and (ii) working on the standardization of EO products

On an emergency basis

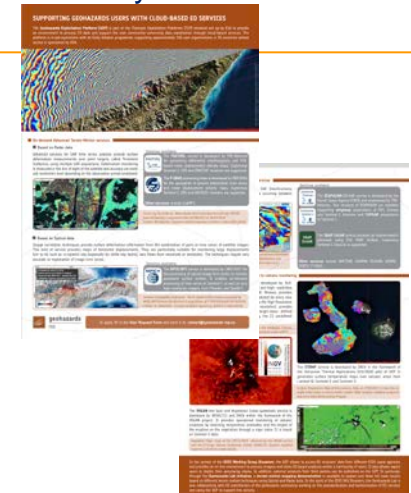
Pursue and support the generation and distribution of advanced science products based on
terrain motion mapping, landslide monitoring, thermal signatures of volcanic eruptions etc.

Geohazards Lab – Reporting on CEOS Work plan Milestones



Objective	Projected Completion Date	Background Information
DIS-19: Promote e-collaboration for broader acceptance and use of EO techniques and products by the geohazards community.	Q3 2019	Promote the concept of e-collaboration so that EO experts (as well as non-EO scientists that are newly introduced to EO) familiarize with EO techniques and products. The following activities have been foreseen: circulate a brochure to promote EO services on GEP to the EPOS user community, develop a Terrain Motion Demonstration on GEP, identify users as part of the GEP Early Adopter programme (intention to reach 100 users) and organize benchmarking activities to address capabilities, drawbacks and complementarities of EO monitoring.
DIS-20: Pursue the standardization of geohazards EO-products	Q1 2020	Identify a framework for standardization of geohazards related EO-products to achieve acceptance by the EO community and decision makers

- Brochure prepared and disseminated on how the Geohazards Exploitation Platform supports users from the geohazards community with cloud-based EO services (DIS-19)
- Terrain Motion Demo made available on GEP https://geohazards-tep.eu/geobrowser/?id=terrainmotion_demo (DIS-19)
- Publication on benchmarking activities for landslide EO techniques and services to be published (DIS-19)
- DIS-20 is on-going, a survey focusing on EO products and formats to be circulated among geoscience centres within Q4 2019.



Brochure



- **Cosmo-SkyMed SNAP DInSAR service** available: first service able to process Cosmo-SkyMed data on GEP
- **Sentinel-1 SNAP-StaMPS PSI service**: integration at final stage
- **Sentinel-1 P-SBAS service** is available on the Geohazards Exploitation Platform

The service was tested over several regions and updates have been implemented to the new version.

Upcoming:

- **Integration of Volcanic Plume Elevation Model (VPEM)** on PEPS to start Q4 2019 (BRGM)



- **Capacity building exercise** for the Central Sulawesi Earthquake-Tsunami Reconstruction Plan, Jakarta, Indonesia to support EO4SD
- GLab and the Geohazards Exploitation platform presented at the IGARSS conference in Japan (July 2019)
- Sentinel-1 SNAP-StaMPS PSI service presented at the Φ -week at ESRIN, Italy (September 2019)
- **Brochure** on how the Geohazards Exploitation Platform supports users from the geohazards community with cloud-based EO services
- **CEOS webpage** updated
- **Paper** (published): Monitoring geohazards using on-demand and systematic services on ESA's Geohazards Exploitation Platform, IGARSS 2019

Upcoming:

- GLab **presentation** at the MDIS Workshop in France (October 2019)
- SNAP-StaMPS PSI **training** to be organised for the participants of the MDIS Workshop in France (October 2019)
- **Paper** (to be published) on benchmarking activities for landslide EO techniques and services



TERRADUE

TRE
ALTAMIRA
A CLS Group Company

irea

DLR

UNIVERSITÉ DE STRASBOURG

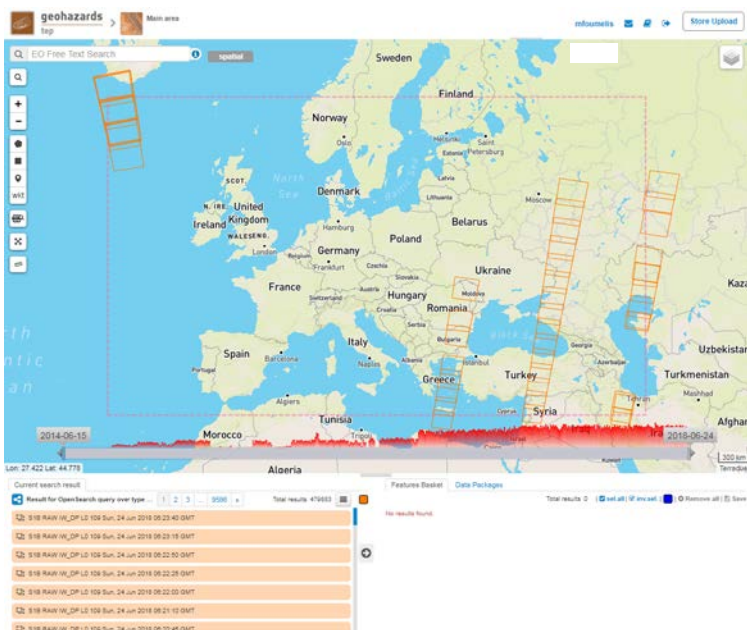
ENS

INGV

Consortium: **Terradue** [lead] (IT), **TRE ALTAMIRA** (ES), **CNR IREA** (IT), **DLR** (DE),
EOST-CNRS (F), **ENS-CNRS** (F), **INGV** (IT)

- Develop a Platform based on **virtualization & federation of satellite EO data and methods**
- Provide innovative responses to the **geohazards** community needs (services & support)
 - **On-demand processing** services to address AOI-specific analysis
 - **Systematic processing** services to address needs for “common information layers”
 - **Massive Cloud Compute** power, managing multi-tenant resources
 - **Access to Copernicus Sentinels-1/2/3 repositories**
 - **Access to 70+ TB of EO data archives (ERS and ENVISAT)**, and specific data collections from EO missions, such as JAXA’s **ALOS-2**, ASI’s **Cosmo-Skymed** and DLR’s **TerraSAR-X**, provided under special arrangements in the framework of the **CEOS WG Disaster** and the **GSNL**

Over 100 Early Adopters worldwide (primarily users from Europe, but also in Asia, Africa and the Americas) from the public (mainly) and private sector.



Processing Services

- RASTER
- GMTSAR Sentinel-1
- GMTSAR ENVISAT
- COI
- SNAC
- SNAP InSAR
- COIN
- DIAPASON Sentinel-1
- DIAPASON Stripmap
- HASARD
- FASTVEL
- STAMP L-8
- STAMP S-2
- eGEOS SAR Flood
- STAMP L-8
- STAMP S-2
- eGEOS SAR Flood
- DIAPASON Stripmap
- HASARD
- FASTVEL
- ADORE DORIS
- STAMPS PS
- PSI Post-Proc
- STAMP L-8
- STAMP S-2
- eGEOS SAR Flood
- PF-ERS
- GAMMA Level-0
- GAMMA DinSAR

On-demand processing services
FASTVEL, P-SBAS, MPIC-OPT, DIAPASON, SNAP InSAR, GMTSAR, COIN, SNAC, RASTER etc.

Automatic processing services
Sentinel-1 InSAR Browse (DLR), VEGAN (NOVELTIS & INGV), STEMP (INGV)



What is PEPS?

- PEPS – Satellite data distribution platform for COPERNICUS Sentinel-1, Sentinel-2 et Sentinel-3 missions.
 - Full temporal and geographical coverage(all the globe since the beginning of mission)
- Data volume : **10 Po** (14 millions of products)
- Data download via dedicated interface or automated scripts
- **PEPS online processing** (e.g. S-2 atmospheric correction , S-1 rectification on S-2)
- PEPS also offers a capacity to host processing chains on a high performance 'cluster'

cnes **peps** [HOME](#) [EXPLORE](#) [PEPS-RSS](#) [MORE](#) [SIGN IN](#) [REGISTER](#)

peps
FRENCH ACCESS TO THE SENTINEL PRODUCTS

PEPS : NOUVELLE VERSION

La version 3.1 de PEPS est désormais installée ! Nouvelle interface, amélioration de l'expérience en ligne, vous pouvez dès maintenant télécharger vos produits et lancer vos traitements dans les meilleures conditions ! Retrouvez les dernières infos sur le [flux RSS](#)



GeoHazards Office Goals:

- Full in line with the Geohazards Lab Implementation Plan
- Liaise with the geohazards community to promote their results when using the Geohazards Lab resources
- Develop collaboration with experts to harmonize and improve acceptance of platform based EO techniques
- Demonstrate and showcase hosted processing services for terrain motion mapping


Example of activities:

- Revival of the CIEST «Cellule D'intervention et d'Expertise Scientifique et Technique» collaborative framework between research institutes → Rapid response to earthquake events by e-collaboration within hosted processing platforms (GEP & PEPS)
- Co-Organization with Univ. of Strasbourg (EOST) of next MDIS (Mesure de la Déformation par Imagerie Satellite) conference of the Form@Ter group (Oct 2019)
- Communicate scientific results obtained using hosted processing services



ABOUT THE GEOHAZARD OFFICE INITIATIVE ARCHIVES EVENTS CONTACT

About

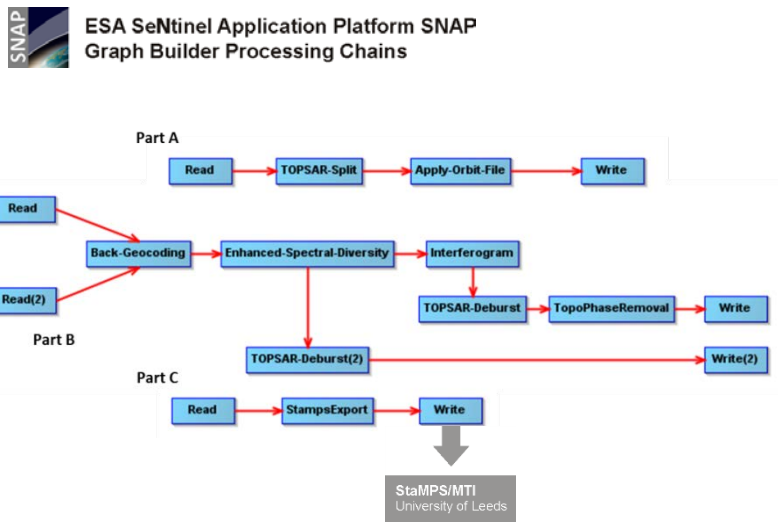


The GeoHazards Office is an activity integrated in the GeoHazards Lab initiative within the Committee on Earth Observation Satellites (CEOS) Working Group on Disasters (WG Disaster) to enable a greater use of Earth Observation (EO) data and derived products to assess geohazards and their impact.

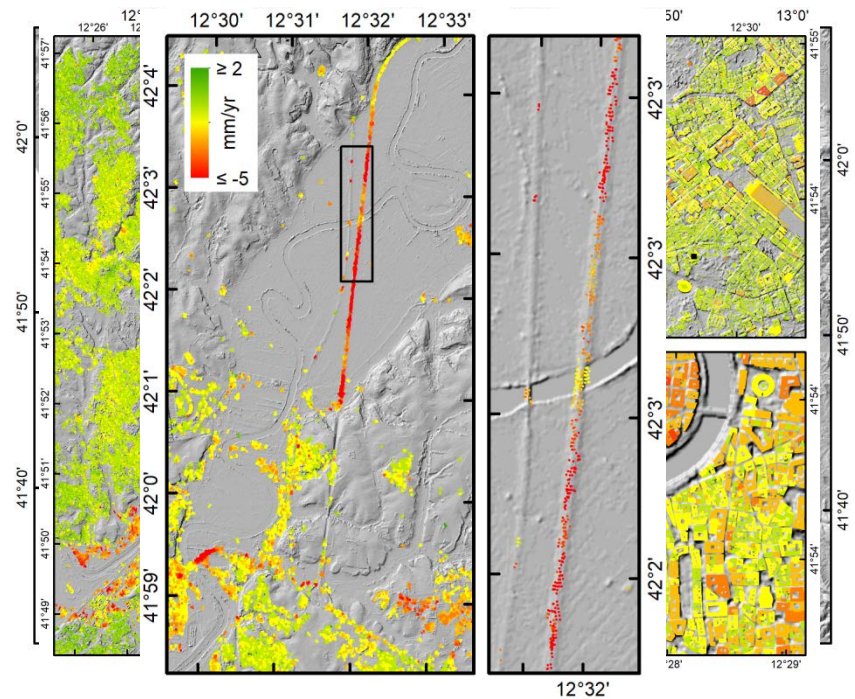
The GeoHazards Lab, an initiative based on a group of inter-operable platforms with federated resources providing EO data access, hosted processing and e-collaboration capabilities, to animate and support the geohazards user community. It is originated by the European Space Agency (ESA), with the support of several other CEOS space agencies, including the Italian Space Agency (ASI), the French Space Agency (CNES) and the German Space Research Centre (DLR).

In this context, the GeoHazards Office, envisaged and supported by ESA in collaboration with CNES is an activity to develop a collaborative framework with expert geoscience centres and users to achieve a greater adoption of EO methods. Its goals are to support the exploitation of hosted processing capabilities with a focus on cloud processing solutions, define consensus methods in liaison with experts to harmonize EO based processing results, establish a methodological approach to support the generation of reference ground deformation measurements in support to historical hazard analysis, and finally, utilize available EO capabilities looking at geohazards. The GeoHazards Office intends to help bridge the gap between the space community and the geohazards community with a strong focus on expert users from geoscience centres who are the priority intermediaries with end users from DGM organisations.

Services: SNAP-StaMPS integrated Sentinel-1 PSI



Sentinel-1 vertical displacement rates





The goal is to create data processing pipelines to:

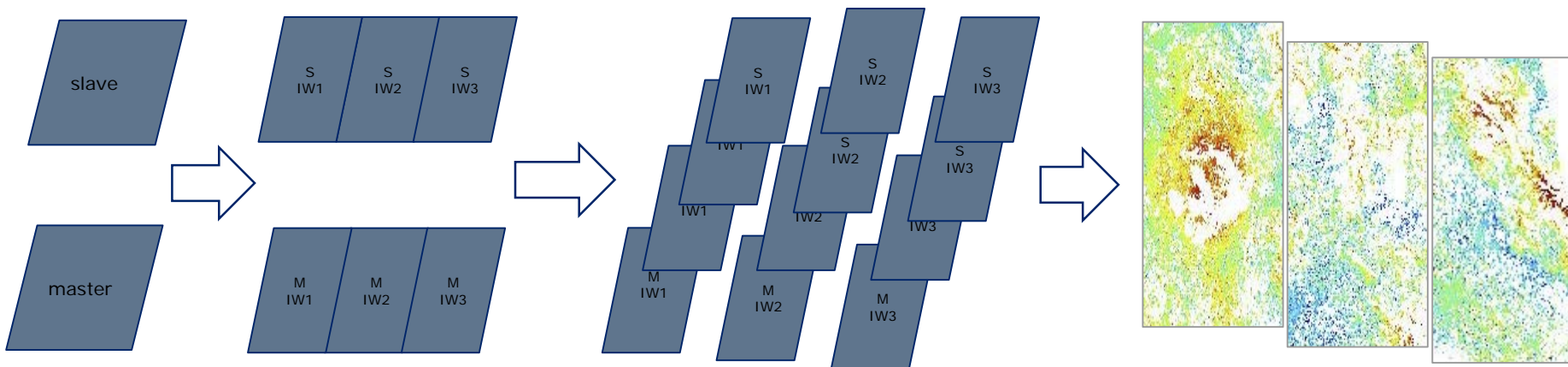
- Generate stacks of interferograms derived from Sentinel-1 SLC data
- Generate PSI time series with StaMPS out of those interferograms stacks

Interferograms stack data processing pipeline

For each slave paired with a defined master, the data processing pipeline generates one processing request per swath.

PSI processing pipeline

For each swath stack of interferograms, the data processing pipeline triggers a StaMPS PSI processing request



Services: SNAP COSMO-SkyMED DInSAR service



Develop & Harmonize

Expansion of SNAP services on GEP to support TPM DInSAR processing

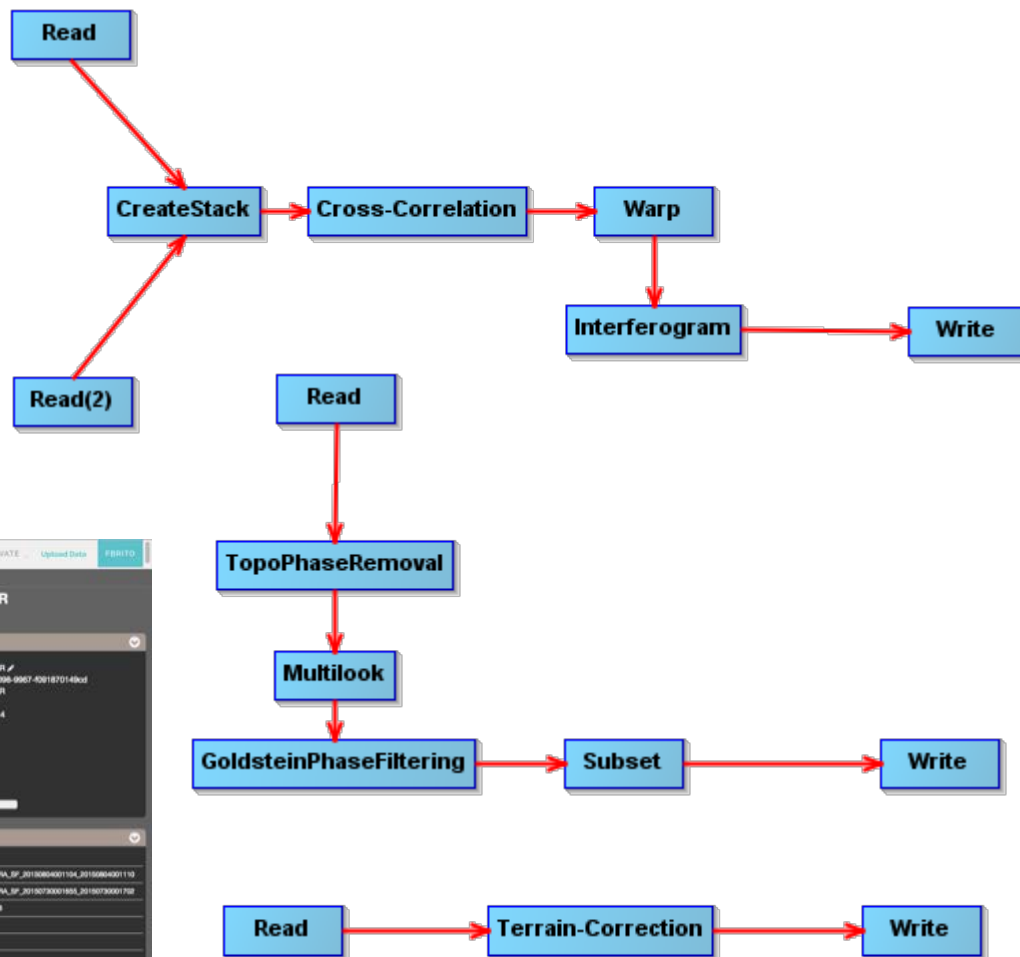
CSK_Stack_CrossCor_Wrap_lfg.xml

CSK_TopoRem_ML_Flt_Sub.xml

CSK_TC.xml

The screenshot shows the SNAP web interface. On the left is a map of Kathmandu with a processing area highlighted. On the right is the 'Processing Services' panel for 'SNAP CSK DInSAR'. The panel includes job information such as Name, ID, Processing service, Service version, Started at, Created by, Status/Result Location, and Visibility. Below this is a 'Parameters' section with a table of input parameters.

Name	Value
1-source	CSK32_SCS_B_H_15_HH_RA_SF_2019081001656_2019081001656
2-source	CSK32_SCS_B_H_15_HH_RA_SF_2019081001656_2019081001656
slr	84.86127772284.861277818
pl_size	30
slr_size	3
slr_spacing	10



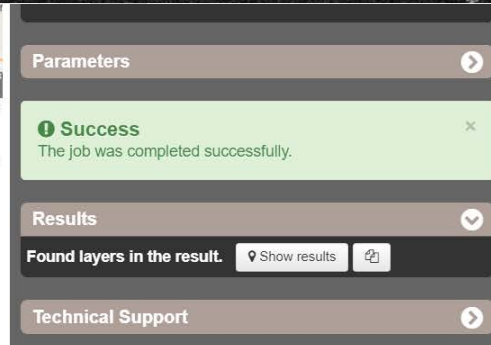
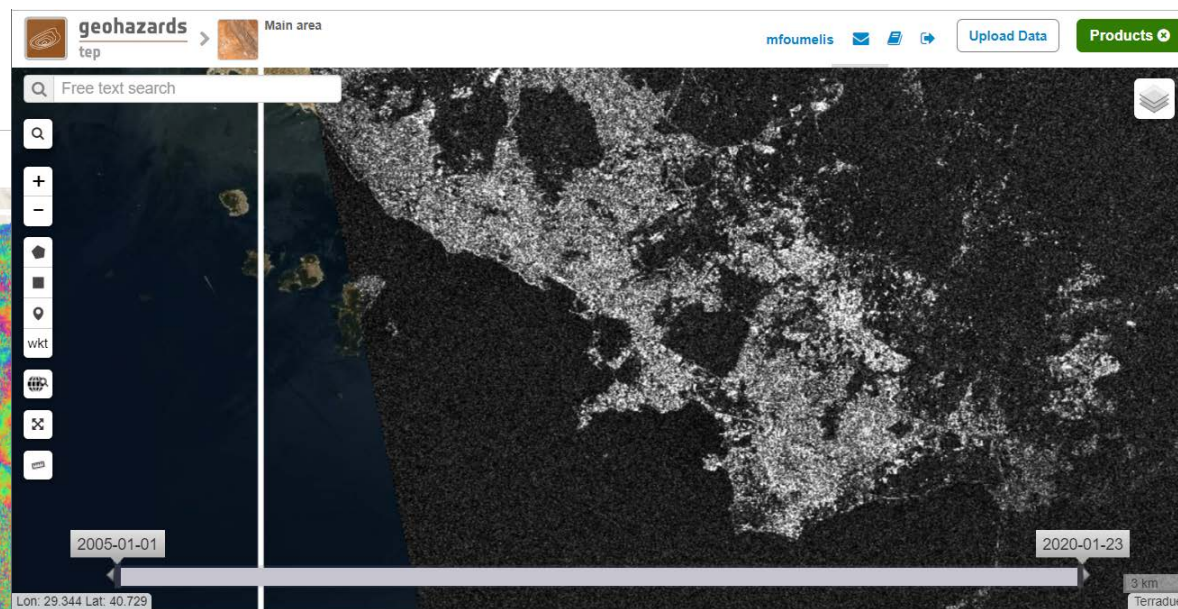
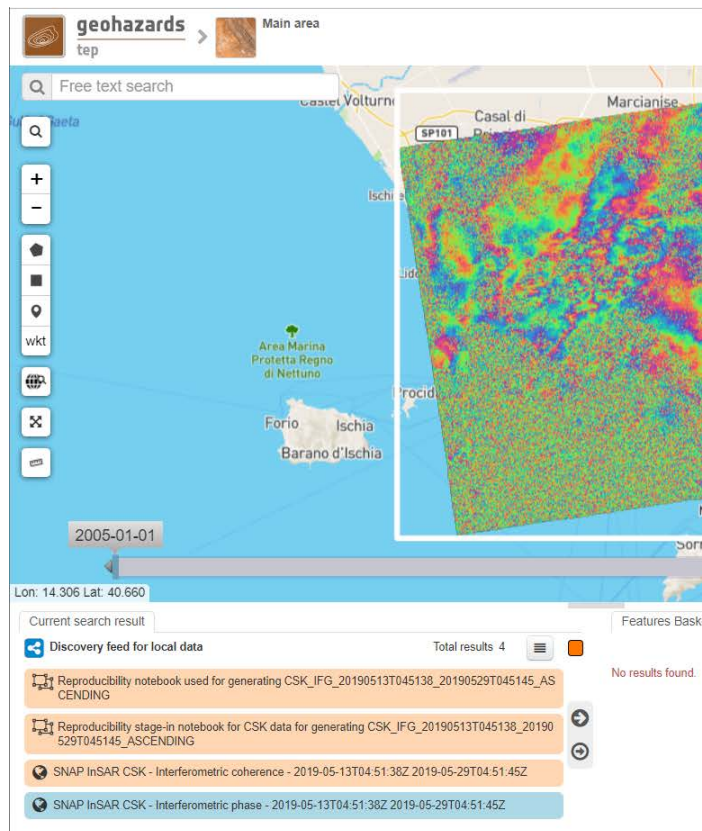
CSK DInSAR results on GEP

Data via GSNL (ASI)



CSK ~7 months coherence
Name: SNAP CSK DInSAR Istanbul 20171023-20180503
Id: [10f67b55-7f4a-4708-a909-f54f1112fe16](#)

CSK 20190513-20190529 (16 days)
Name: SNAP CSK DInSAR Naples
Id: [545bb721-76ce-4e10-9dbb-2b63a8b43d2f](#)





ASI contributes to the Geohazards Lab by making available CEOS and GSNL Cosmo-SkyMed datasets through GEP.

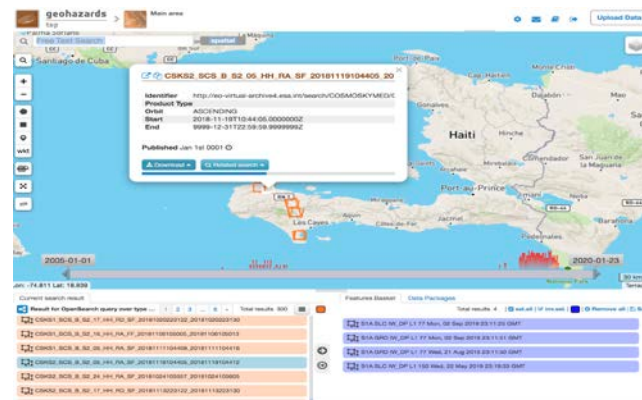
- The **totality of GSNL data are available through GEP** (on-going process to remove any duplicated data)
- CEOS Haiti RO data are available on GEP
- CEOS Seismic and Volcano pilots' data to be integrated (discussion on-going with ASI)

➤ Simplifying data management:

Proposition to store COSMO-SkyMed data for CEOS and GSNL directly on GEP to provide richer metadata, better manage the access rights and avoid unnecessary download (from ESA's VA4) for processing.

➤ Two processing chains available on GEP for processing Cosmo-SkyMed Stripmap data (SNAP CSK and SBAS Stripmap). Discussion to include services able to process Spotlight data on-going.

AOI/Supersite	CSK data on ESA archive	Frame
Ecuador	27	GSNL
Campi Flegrei	524	
Hawaii	1090	
Iceland	1924	
Iran	116	
Marmara	563	
Nepal	657	
San Andreas	446	
South Andes	702	
Taupo	246	
Virunga	885	CEOS
Haiti RO	300	

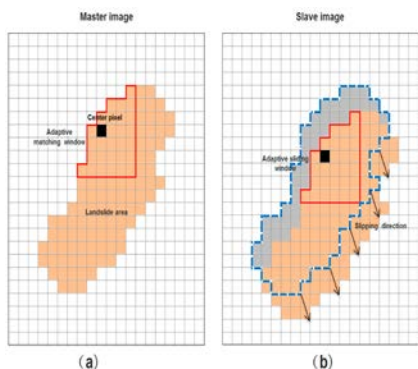




3 main services developed by CNRS-EOST Strasbourg

Developed for **landslide monitoring** but can be applied to other objects (eg. Earthquake, volcano, glacier, etc.)

Pixel-offset tracking



Measurement: **Ground displacement**

Application: local to regional scale
Satellites: Sentinel-2, Pléiades and VHR satellites (coming)

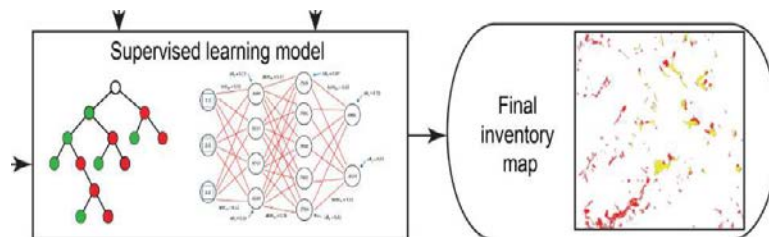


Digital surface Model



Measurement: **surface elevation**
Application: local to regional scale
Satellites: Pléiades and other tri-stereo VHR satellites (coming)

Automatic landslide detection based on Machine Learning (Random Forest)



Measurement: **landslide areas (polygon)**

Application: regional scale
Satellites: Sentinel-2, Pléiades and VHR satellites (coming)

Services: Automatic Alerting System



New GEP functionality under implementation:

Triggering services based on geohazards events polled from external systems

- **Automatic production of deformation maps** and other **VA products** with different GEP processing services
 - **Triggers** are **event-based** components able to start specific data discovery, ingestion, caching and processing workflows (**USGS pager**, **@INGVterremoti** twitter feed, **Copernicus EMS** rapid mapping and risk & recovery feeds and **UNOSAT/GDACS** disaster feed, Smithsonian / USGS **WVAR**)

- **Publication** of generated maps in a specific index in the GEP catalogue linked to the originating event

Services: Automatic Alerting System



➤ **Triggered processing services**

- CNES - DIAPASON InSAR Sentinel-1 TOPSAR(IW,EW)
- DLR - Sentinel-1 High-Resolution InSAR Browse Service
- CNRS-EOST - MPIC-OPT Sentinel-2 (Multiple Pairwise Image Correlation of Optical image Time-series)

➤ **Potential future additions**

- CNR IREA - P-SBAS Sentinel-1 processing on-demand
- ESA - SNAP Sentinel-1 IW SLC Interferogram and Displacements

Services: Automatic Alerting System – USGS Pager

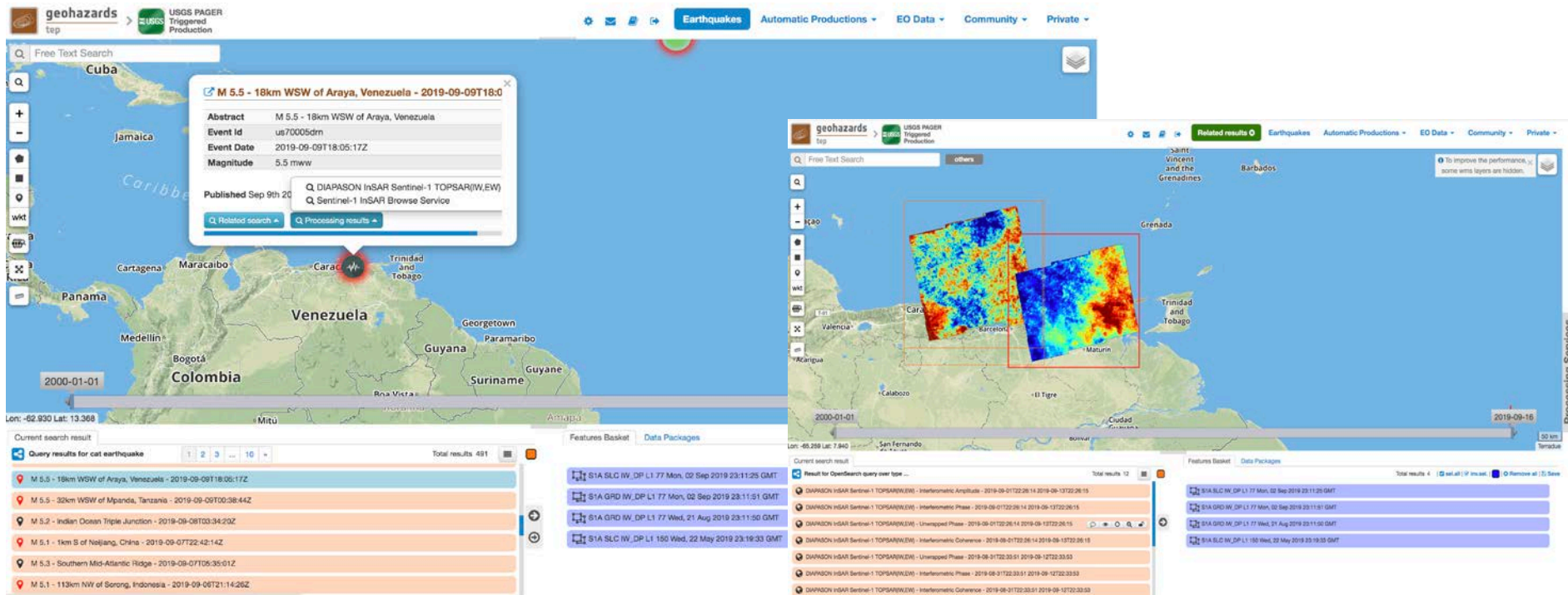


➤ Already in operations since July 2019

- Automatic trigger based on **USGS pager** alerts
- Productions with **Sentinel-1** based **DLR InSAR Browse** and **DIAPASON TOPSAR** services are triggered for each earthquake with a **magnitude > 5** generating **pre-, co- and post-seismic** interferograms
- Production with **Sentinel-2** based **CNRS EOST MPIC-OPT** service will be started in October for **Strike-Slip Fault** Earthquakes

➤ Available to GEP Early Adopters in a dedicated thematic app

- <https://geohazards-tep.eu/geobrowser/?id=usgs-pager-trigprod-app#!&context=Earthquakes>



The screenshot displays the 'geohazards tep' web application interface. The main map shows a search result for an earthquake: **M 5.5 - 18km WSW of Araya, Venezuela - 2019-09-09T18:02**. A pop-up window provides details:

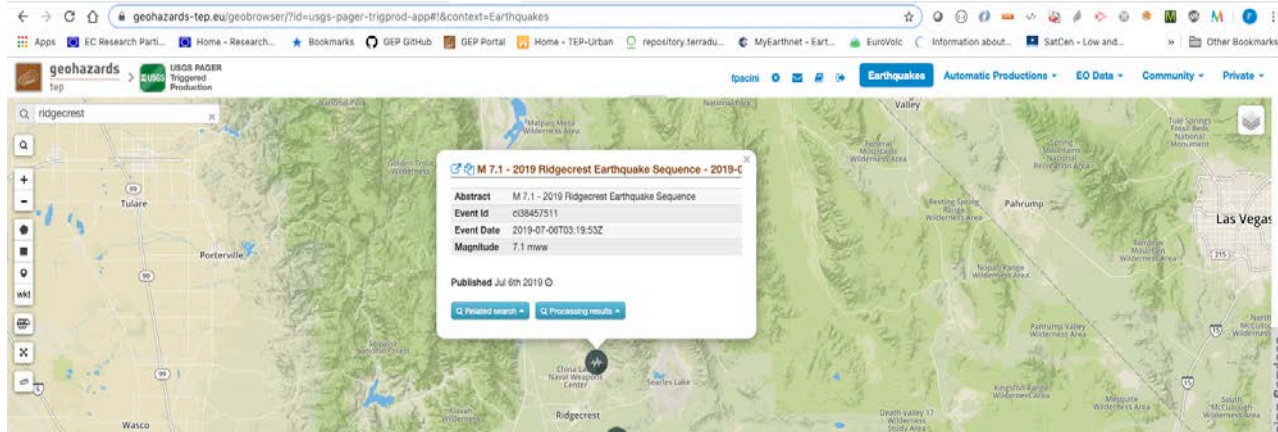
- Abstract:** M 5.5 - 18km WSW of Araya, Venezuela
- Event Id:** us70005dm
- Event Date:** 2019-09-09T18:05:17Z
- Magnitude:** 5.5 mww
- Published:** Sep 9th 2019
- Related services:**
 - Q DIAPASON InSAR Sentinel-1 TOPSAR(W,EV)
 - Q Sentinel-1 InSAR Browse Service

The interface includes a search bar, navigation tools, and a list of search results. The results list shows several entries, including the primary earthquake and related InSAR and TOPSAR products. The map also displays a heatmap overlay on the earthquake location, with labels for nearby cities like Caracas and Maturin.

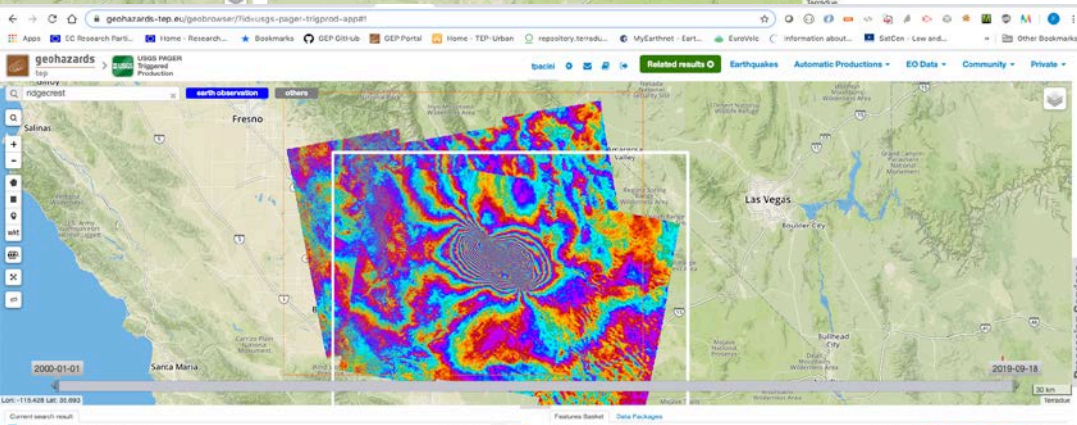
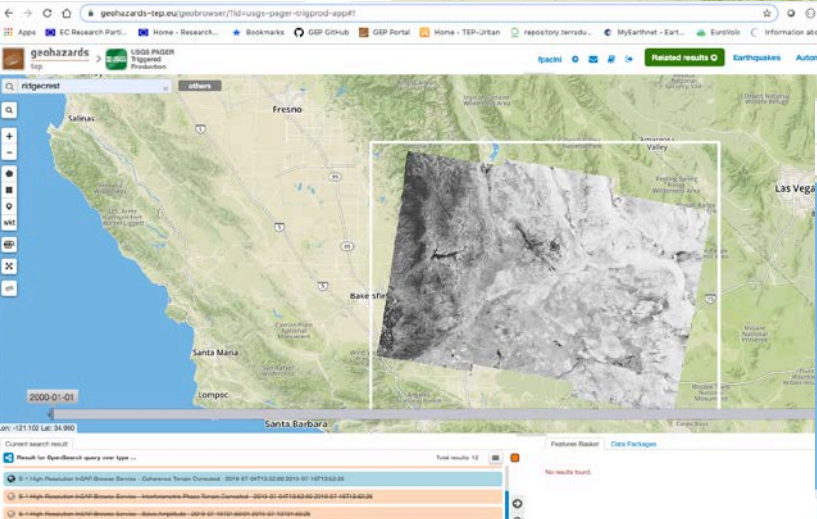
Services: Automatic Alerting System – USGS PAGER



➤ Example: The July 6th, 2019, 03:19 UTC Mw 7.1 earthquake in eastern California, southwest of Searles Valley



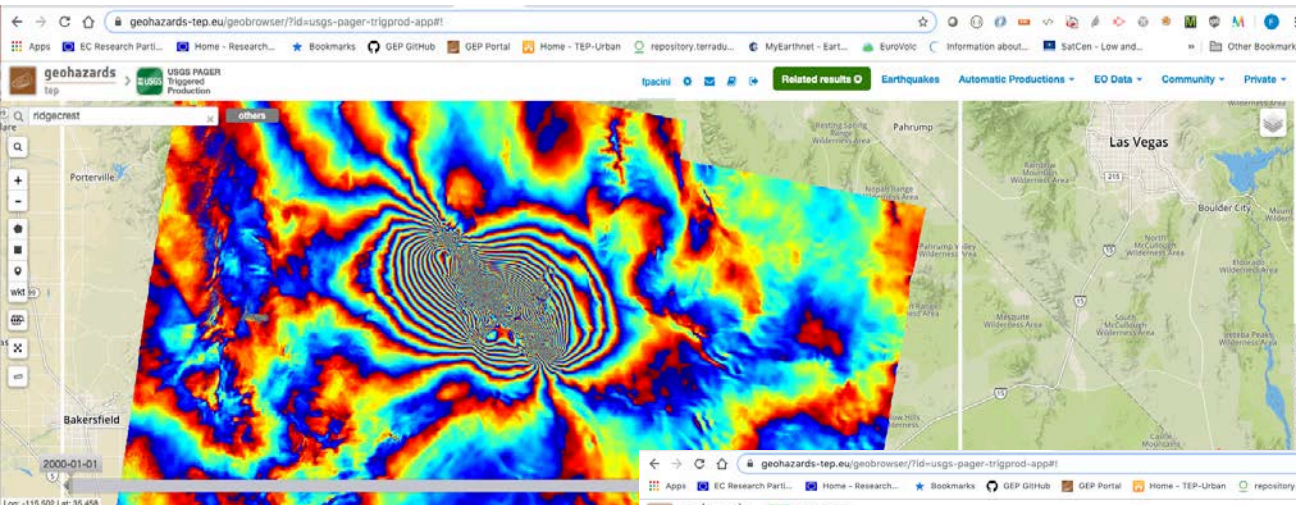
Coherence Terrain Corrected -
2019-07-04T13:52:00 2019-
07-16T13:52:26



Services: Automatic Alerting System – USGS Pager



➤ **Example: The July 6th, 2019, 03:19 UTC Mw 7.1 earthquake in eastern California, southwest of Searles Valley**



DIAPASON InSAR Sentinel-1 TOPSAR(IW,EW)

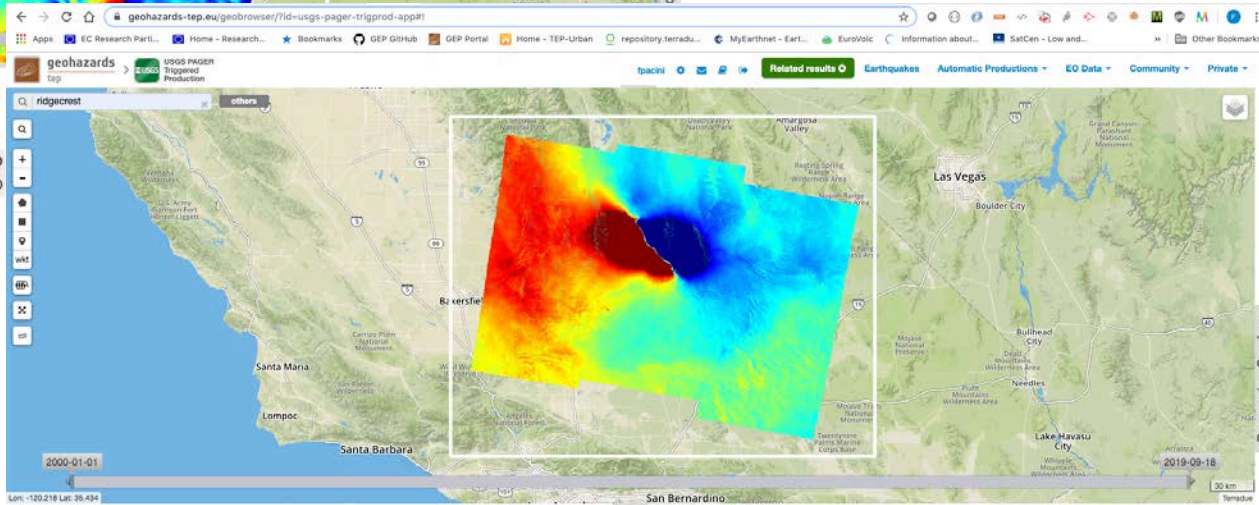
Unwrapped Phase - 2019-06-28T01:49:58
2019-07-10T01:50:01

Current search result

Result for OpenSearch query over type ... Total results 10

DIAPASON InSAR Sentinel-1 TOPSAR(IW,EW) - Interferometric Phase - 2019-07-04T13:51:58-2019-07-16T13:52:00	
DIAPASON InSAR Sentinel-1 TOPSAR(IW,EW) - Interferometric Phase - 2019-06-28T01:49:58-2019-07-10T01:50:01	
DIAPASON InSAR Sentinel-1 TOPSAR(IW,EW) - Interferometric Phase - 2019-07-04T01:40:49-2019-07-16T13:52:00	
DIAPASON InSAR Sentinel-1 TOPSAR(IW,EW) - Interferometric Phase - 2019-06-20T18:51:57-2019-07-16T13:52:00	
DIAPASON InSAR Sentinel-1 TOPSAR(IW,EW) - Interferometric Phase - 2019-06-28T01:49:58-2019-07-10T01:50:01	

Interferometric Phase - 2019-07-04T13:51:58
2019-07-16T13:52:00



Current search result

Result for OpenSearch query over type ... Total results 10

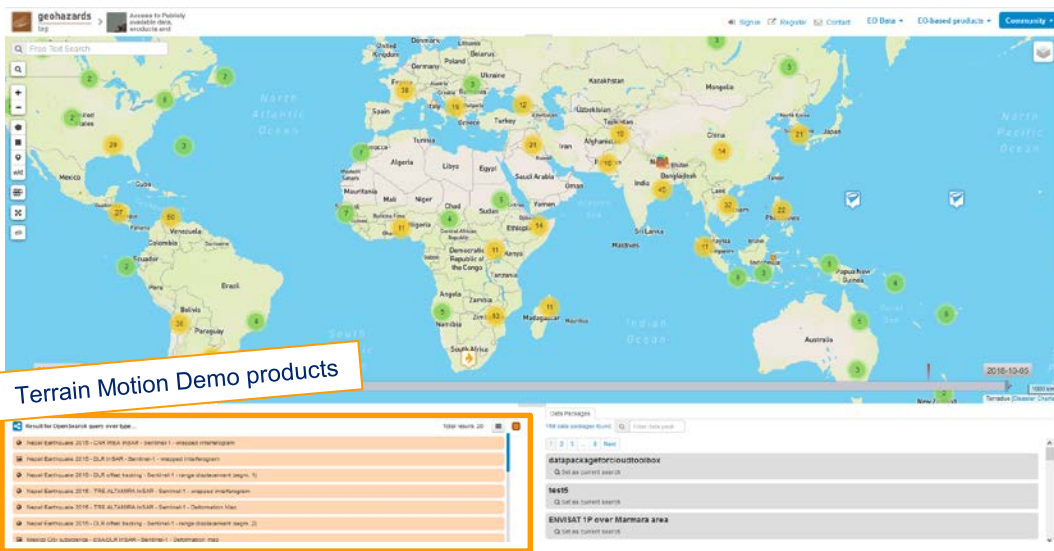
DIAPASON InSAR Sentinel-1 TOPSAR(IW,EW) - Unwrapped Phase - 2019-07-04T13:51:58-2019-07-16T13:52:00	
DIAPASON InSAR Sentinel-1 TOPSAR(IW,EW) - Interferometric Phase - 2019-07-04T01:40:49-2019-07-16T13:52:00	
DIAPASON InSAR Sentinel-1 TOPSAR(IW,EW) - Interferometric Phase - 2019-06-28T01:49:58-2019-07-10T01:50:01	

DIS-19: Terrain Motion Demo



Promote use of EO for Geohazard applications

Demonstration of Ground Motion Services' products on different sites based on different terrain motion techniques using Optical and Radar data and publication on GEP.



Terrain Motion Demo products

DISCUSS Log In

Providers of the EO sector are sharing their products on GEP in the framework of the Geohazards Lab Initiative: visit the Terrain Motion Demo in the Community area

In a CEOS initiative to promote and harmonize EO techniques for geohazards, service providers such as PLANETEK, TRE ALTIMIRA, GEOMATIC VENTURES, GAMMA REMOTE SENSING, CURSUS-ECST and BRGM are providing access to terrain motion products on the GEP. Earth Observation techniques to monitor Terrain Motion provide key information to better understand hazards such as for instance earthquakes, volcanoes, landslides and ground subsidence. To raise interest and promote the use of these techniques the Terrain Motion Demo is a new exercise designed in the framework of the Geohazards Lab initiative of the CEOS Working Group Disasters. The Geohazards Lab aims to establish an inclusive and comprehensive process to optimize the use of EO techniques with a primary focus on Cloud based hosted tools and services. This includes publishing and providing permanent access to Third Party products via the GEP that is ESA's contribution to CEOS. The Terrain Motion Demo provides measurements based on different terrain motion techniques using Optical and Radar data from various missions (e.g. Sentinel-2, Pleiades and Sentinel-1). Some of the products presented were processed using GEP hosted services, while others were processed externally and then uploaded on the platform. Interested EO service providers are invited to contact the GEP to contribute to the Demo.

You can now start navigating and have a look at the different products via the Public Area on the GEP.

Geohazards-Tep @esa_gep Follow

On the blog: Providers of EO sector sharing their Terrain Motion demo products on GEP - @CEOSdotORG Geohazards Lab initiative

Providers of the EO sector are sharing their products on G...

In a CEOS initiative to promote and harmonize EO techniques for geohazards, service providers such as PLANETEK, TRE ALTIMIRA, GEOMATIC VENTURES, GAMMA REMOTE SENSING... discuss.terradue.com

10:49 AM - 8 May 2019

Source: Earthquake 2010 - USK WAKA WAKA - Sentinel-1 - InSAR (Interferogram), Credits: B. Vallianatos, Contents modified Copernicus Sentinel-1 data (2018)

DIS-19: Terrain Motion Demo



Geohazards

Earthquakes, Volcanoes,
Ground subsidence &
landslides

EO satellites

Sentinel-1 & 2, Envisat,
ERS-1&2, TSX, CSM,
Pléiades...

Providers

DLR, INGV, EOST, TRE-
ALTAMIRA, GAMMA,
CNR-IREA, Planetek,
BRGM...

Ground Motion Processing

Diapason, SNAP, MicMac,
P-SBAS, MPIC-OPT,
GAMMA, PSinSAR®,
SqueeSAR®

The screenshot displays the 'geohazards' web application interface. It features a search bar at the top left with the text 'Free Text Search'. Below the search bar is a map of the world with several green circular markers. The main content area is divided into several panels:

- Sulawesi Earthquake 2018:** A large map showing the island of Sulawesi with a color-coded displacement field. A legend below the map indicates 'Velocity (mm/yr)' with a scale from -0.8 to 0.8. A text box overlay reads 'Sulawesi Earthquake 2018 Sentinel-2 | CNRS-EOST'.
- Landslides, Italy:** A map showing a detailed view of a landslide area in Italy. A legend indicates 'Velocity (mm/yr)' with a scale from -68.3 to 79.8. A text box overlay reads 'Landslides, Italy Sentinel-1 | TRE Altamira'.
- Map Navigation:** A vertical toolbar on the left side of the main map area includes zoom in (+), zoom out (-), and other navigation controls.
- Search Results:** A list of search results is visible at the bottom of the interface, including 'Hazard Earthquake 2018', 'Hazard Earthquake 2015 - DLR offset tracking - Sentinel-1 - range displacement (degm, 1)', and 'Mexico City subsidence - ESA/DIR INSAAR - Sentinel-1 - Deformation map'.
- Processing Services:** A vertical sidebar on the right side of the interface is labeled 'Processing Services'.



Cellule d'Intervention et d'Expertise
Scientifique et Technique



“Cellule d’Intervention et d’Expertise Scientifique et Technique (Ciest)”

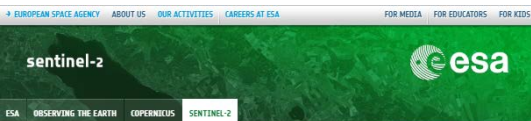
***From satellite platforms to geophysical knowledge:
rapid response to geohazards in seismotectonics***

Collaborative framework between research institutes of ForM@Ter group

Community building at the French level:

**CNES, BRGM, IPGP, CEA, CNRS (ENS Paris), EOST, Uni Grenoble ,
Uni Clermont Ferrand (other)**

For generating geophysical knowledge using EO processing platforms
(but not limited to, e.g. modelling & value added maps)



SENTINEL-2 MAPS INDONESIA EARTHQUAKE

5 October 2018 A 7.5-magnitude earthquake and tsunami hit Indonesia on 28 September, destroying homes and hundreds of lives. As the death toll continues to rise, the effects of this natural disaster are far-reaching, with hundreds of thousands of people seeking access to food, water and shelter in the aftermath of this tragedy.

The European Union activated its Emergency Copernicus satellite mapping service a couple of hours after the earthquake to assist authorities. Copernicus has also produced grading maps showing the impact of the damage covering ten areas of interest. The tailor-made service continues to closely monitor the situation and provide assistance in the aftermath of the disaster.

The Copernicus Emergency Management Service is a key tool providing understanding of the situation on the ground, thus assisting the European Union's Civil Protection Mechanism, activated following a request for assistance from the government of Indonesia. The Emergency Response Coordination Centre is working 24/7 to coordinate offers of assistance to the affected areas.

One of the ways in which ESA is contributing to this area is through leading a range of activities in the framework of the Committee on Earth Observation Satellites (CEOS) Working Group on Disasters.

The Geohazards Office, led by the French Geological Survey (BRGM) takes with practitioners on the exploitation of Earth observation processing services to support hazard mapping and risk assessment. This is in the spirit of the International Forum on Satellite Earth Observation and Geohazards.

BRGM experts have generated displacement maps using Copernicus Sentinel-2 acquisitions from 17 September and 2 October.

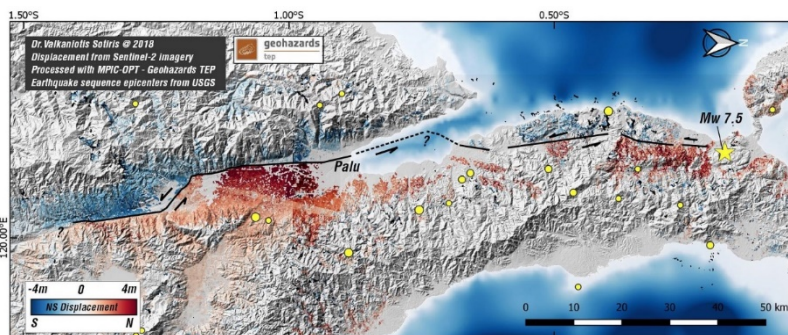
Thematic experts from the Carinthia RIR Laboratory in Greece have generated similar results using the Cloud processing platform GEP, which has been designed to rapidly provide automated measurements.

As shown in the images, the earthquake triggered deformations of several metres and a tsunami. Around 2100 people are reported to have lost their lives, hundreds have been hospitalized and many more thousands are thought to have been displaced. It has been estimated that up to 1.5 million people will be affected by these events.

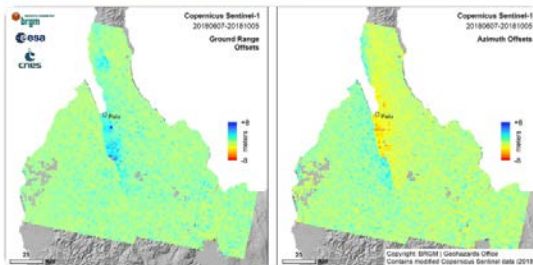
The Vice-President of the country, Jusuf Kalla, has said that the final death toll could reach the thousands. The International Charter Space and Major Disasters was triggered by the Asian Disaster Reduction Centre on 28 September for this event. International collaboration is in place to organise Earth observation-based disaster response activities.

Scientific products such as the map created by BRGM are helping us to better understand hazards. Beyond this example it is foreseen that Earth

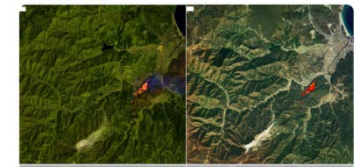
Sulawesi Earthquake (Indonesia)



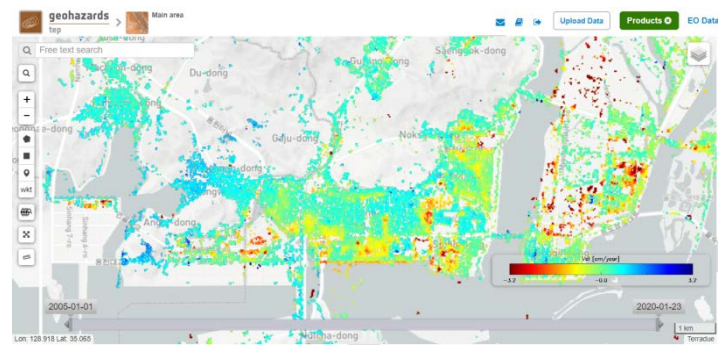
BRGM @BRGM_fr - Oct 12
 #PaluEarthquake Mw 7.5: #Sentinel1 from @CopernicusEU allowed the #BRGM scientists to produce a second map of the displacement field generated by the #earthquake in #Palu (#Indonesia, 2018-09-28) within the frame of the #Geohazard Office with @ESA and @CNES



EO OPEN SCIENCE
 Monitoring #wildfires in #SouthKorea @DisastersChart with Sentinel-2 data from the @CopernicusEU programme. A fire spot could be captured near Okgye-myeon on Apr 5, 2019 using GEP services COMBI and STEM-P-S2 developed by the providers of ESA's GEP platform @esa_gep. #EO4society



12:09 AM - 8 Apr 2019





A scientific advisory Working Group (WG) is set up

Purpose: ***Work on the definition and harmonization of EO products for geohazards applications (terrain motion mapping, landslide monitoring etc.)***

- Maximize use of EO techniques and cloud processing by the EO expert community
- Achieve acceptance of EO products by the non-EO scientific community and decision makers
- Facilitate interpretation and improve understanding of EO products (and derived information) by end-users



✓ **2nd meeting of the WG** held in May 2019 at Milan, Italy (during the LPS 2019)

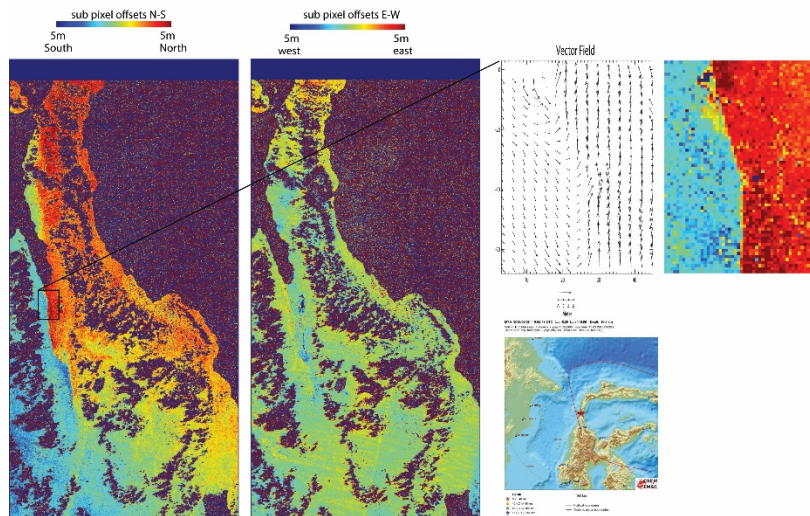


Standardization of EO results & formats → Earthquakes & Landslides

- A family of techniques (Image Matching/Correlation or Offset Tracking) not yet properly addressed in terms of standardization

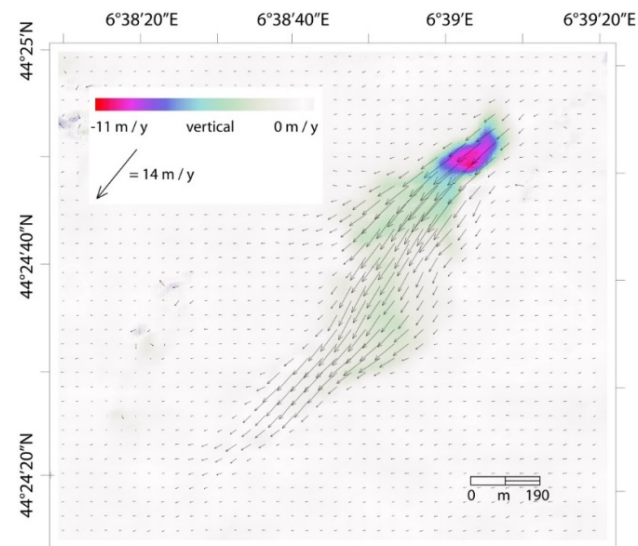
Optical

Sentinel-2 derived displacement field of the 2018-09-28 Mw 7.5 MINAHASA, SULAWESI, INDONESIA earthquake



Copyright : BRGM 2018 M. de Michele
Contains modified Copernicus Sentinel data (2018)

SAR





Proposition of collaboration between GLab and EPOS sent to EPOS TCS Satellite data:

- Inviting the EPOS community to discover and use EO processing services available on-line through the GEP platform. A Terrain Motion Demo and a brochure describing the GEP services is available (see image) to help users familiarize with cloud-based processing services.
- Sharing with the EPOS TCS Satellite Data, guidelines about the standards associated to EO based terrain motion measurements and take on board their views.

This proposition aims to foster:

- federation of EO cloud-based processing resources
- broader use of EO hosted processing services based on common standards
- interoperability of results obtained by different services and data providers

SUPPORTING GEOHAZARDS USERS WITH CLOUD-BASED EO SERVICES

The Geohazards Exploitation Platform (GEP) is part of the Thematic Exploitation Platforms (TEP) initiative set up by ESA to provide an environment to process EO data and support the user community requesting data exploitation through cloud-based services. The platform is in pre-operation with an Early Adopter programme, supporting approximately 200 user experiments to 30 countries whose access is sponsored by ESA.

On-demand Advanced Terrain Motion services

- Based on Radar data
 - Advanced services for SAR time series analysis provide surface deformation measurements over target targets, called Persistent Scatterers, using multiple SAR acquisitions. Deformation monitoring is measured in the line of sight of the satellite and accuracy can reach sub-centimetre level depending on the observation period considered.
 - FASTVEL** service is developed by TRF-Arcam for generating differential interferograms and PSI-based time displacement velocity maps. Copernicus Sentinel-1, ERS and ENVISAT receivers are supported.
 - P-SBAS** processing chain is developed by DLR DLRG for the generation of ground deformation time series and linear displacement velocity maps. Copernicus Sentinel-1, ERS and ENVISAT measure are supported.
 - Other services include DMSPs.
- Based on Optical data
 - Image correlation techniques provide surface deformation information from the combination of pairs or time series of satellite images. This kind of service provides maps of horizontal displacements. They are particularly suitable for monitoring large displacements (up to 100 km) such as on seismic slip (especially for strike-slip faults), lava flows from volcanoes or landslides. The techniques require very accurate co-registration of image time series.
 - IMPCO** service is developed by ENVI-GIST for the processing of optical image time series to monitor persistent scatterer motion. It enables an operational processing of time series of Sentinel-2 as well as very high resolution imagery from Pleiades and Spot7.

geohazards
To apply fill in the User Request Form and send it to: contact@geohazards.esa.eu

On-demand Conventional Terrain Motion services

These services are based on Differential SAR Interferometry (DSAR) to measure surface displacements occurring between two SARs.

- DSARMAP** service is developed by the French Space Agency (CNES) and coordinated by TRF-Arcam. Two missions of DSARMAP are available supporting an ongoing acquisition of ERS, Envisat and Sentinel-1 receivers and TOPSAR acquisitions of Sentinel-1.
- SNAP InSAR** service provides an interferometric processor using ESA SNAP toolbox. Copernicus Sentinel-1 mission is supported.
- Other services include GMTSAR, SARMA, EO-SAR, ADRS, DORIS, P-SBAS.

Systemic Services – application example to volcano monitoring

The Sentinel-1 InSAR Browse service is developed by DLR, Medium-EDM spacing and 100m resolution and High resolution, 50m spacing and 50m resolution InSAR Browse products (interferometric products since 2015 and is updated for every new Copernicus Sentinel-1 acquisition. In particular, the High-Resolution InSAR Browse (50m spacing and 50m resolution) provides interferometric products on request over target areas defined by the user through the GEP operator (e.g. the 22 protected volcanoes of the Volcano's TCS Data).

Disruptions generated by the Sentinel-1 InSAR Browse over the Subarctic Islands (Landsat-8, Sentinel-2, Sentinel-3, Sentinel-6, Sentinel-7, Sentinel-8, Sentinel-9, Sentinel-10, Sentinel-11, Sentinel-12, Sentinel-13, Sentinel-14, Sentinel-15, Sentinel-16, Sentinel-17, Sentinel-18, Sentinel-19, Sentinel-20, Sentinel-21, Sentinel-22, Sentinel-23, Sentinel-24, Sentinel-25, Sentinel-26, Sentinel-27, Sentinel-28, Sentinel-29, Sentinel-30, Sentinel-31, Sentinel-32, Sentinel-33, Sentinel-34, Sentinel-35, Sentinel-36, Sentinel-37, Sentinel-38, Sentinel-39, Sentinel-40, Sentinel-41, Sentinel-42, Sentinel-43, Sentinel-44, Sentinel-45, Sentinel-46, Sentinel-47, Sentinel-48, Sentinel-49, Sentinel-50, Sentinel-51, Sentinel-52, Sentinel-53, Sentinel-54, Sentinel-55, Sentinel-56, Sentinel-57, Sentinel-58, Sentinel-59, Sentinel-60, Sentinel-61, Sentinel-62, Sentinel-63, Sentinel-64, Sentinel-65, Sentinel-66, Sentinel-67, Sentinel-68, Sentinel-69, Sentinel-70, Sentinel-71, Sentinel-72, Sentinel-73, Sentinel-74, Sentinel-75, Sentinel-76, Sentinel-77, Sentinel-78, Sentinel-79, Sentinel-80, Sentinel-81, Sentinel-82, Sentinel-83, Sentinel-84, Sentinel-85, Sentinel-86, Sentinel-87, Sentinel-88, Sentinel-89, Sentinel-90, Sentinel-91, Sentinel-92, Sentinel-93, Sentinel-94, Sentinel-95, Sentinel-96, Sentinel-97, Sentinel-98, Sentinel-99, Sentinel-100).

The **STEMP** service is developed by INGV in the framework of the Volcanoes Thermal Applications (VOLTAG) pilot of GEP. It generates surface temperature maps over volcanic areas from Landsat-8, Sentinel-2 and Sentinel-3.

Surface Temperature Map of Elaeo volcano, Italy, on 17/08/2017. A low flow of light lava is visible in the valley. Credits: INGV (Copernicus modified Sentinel-3 data from 2015/10/24) and Sentinel-2.

The **VEGAN** Hot Spot and Vegetation Index systematic service is developed by INGV/ISIS and INGV within the framework of the VEGAN project. It provides operational monitoring of volcanic eruptions by detecting temperature anomalies and the impact of the eruption on the vegetation through a vigor index. It is based on Sentinel-2 data.

Vegetation vigor maps of Mt. Vesuvius (Italy) derived by the VEGAN service over the 22 protected volcanoes. Credits: INGV/ISIS (Copernicus modified Sentinel-2 data from 2015/10/24) and Sentinel-2.

In the context of the CEOS Working Group Disaster, the GEP offers to access EO mission's data from different EO user agencies and provides an on-line environment to process imagery and share EO based products within a community of users. It also allows expert users to deploy their processing chains. In addition, external products from third parties can be published on the GEP. In particular, through the Geohazards Lab initiative, a terrain motion mapping demonstration is available to explore and show EO user results based on different terrain motion techniques using Optical and Radar data. In the spirit of the CEOS WG Disaster, the Geohazards Lab is also collaborating with EO providers of the geohazards community working on the standardization and harmonization of EO services and using the GEP to support this activity.



- **Tools and services:** chain able to process **Cosmo-SkyMed** data available (currently being tested); USGS Pager **triggering automatic production of deformation maps** available; **Terrain Motion Demo** available (regularly updated)
- The totality of GSNL and CEOS RO **Cosmo-SkyMed datasets available through GEP**
- **Promotion and capacity building:** Brochure, presentations in International conferences and workshops; training sessions organized in Europe and Asia; CEOS webpage updated; a number of presentations and trainings are foreseen for October 2019 and 2 papers to be published within 2019-2020
- **2nd Geohazards Lab meeting** held in May 2019
- Survey to support the standardization and broader acceptance of EO products under preparation



Single access point for:

- **Resource tier** providers (ICT Providers hosting collocated EO data)
- **Platform service** providers (built on top of a resource tier provider)

Addressing:

- **Self-funded user:** Any user world wide requiring for any reason Resource Tier or Platform Services (e.g. Science, Development, Pre-commercial and Commercial) who funds the consumption themselves;
- **User sponsored:** (Science, Development, Pre-commercial) by ESA and other entities via Announcement of Opportunity

Sponsorship Application Pre-requisites



- User proposals for research, development or pre-commercial which are of a scientific or value adding nature or which contribute to the goals of the 'EO Science for Society';
- Users must be independent of the Resource Tier or Platform Tier providers from which they ask resources;
- Users algorithms or platform services architecture should ideally show efficient use of resources (e.g. dynamic allocation of resources);
- Users intent to publish a paper / poster acknowledging the 'sponsoring' that was provided by ESA or the external cost waiving entities, promoting both the 'Network of Resources' as well as the used resource/platform providers.
- Users should have a nationality or be appointed at universities from ESA Member States contributing to EOEP5. Exceptions can be made for valuable international cooperation activities

Application Evaluation Criteria



- **The following criteria will be used to assess the proposals:**
- **The merit of the project from a scientific viewpoint**
- **The merit of the project from an engineering viewpoint:**
 - the technical feasibility of hosting the proposed project within the available
 - resources and support framework
 - readiness of the PI core application for integration within the system
 - maturity of the proposed experiment (linkages to already ongoing projects)
- **The adequacy and practicability of the schedule presented in the proposal to complete the project and achieve positive results before the end of the call**



Schedule:

- NoR Portal to be put online by Q4 2019 for Resource tiers
- NoR Portal to onboard Platform services on Q1 of 2020

Sponsoring application form already available via Open Science Earth Observation (OSEO) call:

<https://eo4society.esa.int/2019/06/07/network-of-resources/>



Thank you

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