The Geohazards TEP

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ESA, April 2015
Innovation in space...

ESA is operating EO missions providing very large collections of large files

**Sentinel-1: three Terabyte per day** (projection: 10 Tera with S1-A & S1-B)

**One year ~ 1 Petabyte**

ERS & ENVISAT data over **world tectonic regions ~1 month** of S1-A acquisitions
Theoretical(*) volume of data acquired by Sentinel-1
(~465-700 scenes per day i.e. 23-35 000 000 km²)

Volume of production similar to Terrafirma
(~750/yr equivalent to 43 000 000 km²)

173-260 times extent of Greece
[*assuming 17-26% duty cycle]

EO Supply capacity **200 - 300 times** larger than levels of exploitation of current levels of service delivery

ESA has started to apply **innovative approaches: TEPs**
ESA has started **Thematic Exploitation Platforms** initiative covering six thematic areas: hydrology, polar, coastal, forestry, urban & geohazards.

The **Thematic Exploitation Platforms goals** are:

- **Facilitate use** & processing of large datasets (including non-space data) by a large number of users (science and non-science)
- Processing services, software (e.g. toolboxes, etc.) and computing resources
- Provide an **environment for services development**, integration and exploitation
- Federate user communities around common scientific & thematic objectives
- Promote **shared science objectives** & better use of satellite EO
- Collaboration tools (e.g. knowledge base, open publications, social networking)
Objectives of the geohazards community:

A. Support the generation of **globally self-consistent strain rate estimates** and the mapping of **active faults** at the global scale by providing EO InSAR and optical data and processing capacities to existing initiatives, such as the iGSRM

*role of EO: wide extent satellite observations*

B. **Support and continue the GSNL** for seismic hazards and volcanoes

*role of EO: multiple observations focused on supersites*

C. Develop and demonstrate advanced science products for **rapid earthquake response**.

*role of EO: observation of earthquakes with $M > 5.8$*
The “Santorini Conference” organised by ESA and GEO:

- 140+ participants from 20 countries including European countries, the US, Canada, Japan and China.
- 70+ organisations: international organisations, public institutes, space agencies, universities & private sector.
EO Data Exploitation which allows a user to discover/select data and pre-existing processing service and process data; and visualize/analyse or select and apply data manipulation tools to the result.

New EO Service Development which allows a user to discover/select a data sample and software components; engineer (or upload) & validate an application (e.g. a processor) and deploy it on the platform for use also by other users.

New EO Product Development, which allows a user to Authenticate; alternatively upload and deploy a new processor; discover/select data; process data and eventually publish the resulting product.
Overview of the GEP:

- ESA is developing the geohazards platform (GEP) that is based upon the *virtualization & federation of satellite EO methods* to support the geohazards community.

- An enhancement of the precursor SSEP platform (GPOD) designed to support the *Geohazard Supersites* (GSNL) and the *Geohazards community* via the CEOS WG Disasters.

- An ESA funded **R&D activity** to demonstrate the benefits of an exploitation platform for large scale hazard mapping and monitoring and to link with with large science networks.

- A **2 years Contract starting on 22 October**; Team: Terradue (IT), CNR IREA (IT), INGV (IT), DLR (DE), ALTAMIRA Information (ES), University of Strasbourg (F), ENS/CNRS (F).
An Exploitation Platform under development and validation that is sourced with **data and processing** relevant to the GeoHazards theme:

- **EO data storage** concerning wide extent tectonic analysis for which large data stacks are needed (typically 1000+ and 5000+ scenes and larger)
- Access to **advanced processing tools** (e.g. InSAR and Optical based)
- A **collaborative** work environment and scientific animation
- 2015: **22 users** on board; end 2017: **60 users**
- One of the 6 **Thematic Exploitation Platforms** originated by ESA
**Sentinel-1** made available starting with CEOS Pilot targets and with the goal to gradually cover large community targets within 2016.

**ERS & Envisat SAR data:**
- Current ENVISAT ASAR IM Level-0 Data: > 60200 products (~35TB)
- Current ERS SAR IM Level-0 Data: > 56500 products (~25TB)

*Top:* Current coverage of ERS & ENVISAT L0 data available
*Top Right:* priority areas of the geohazards community (CEOS WG Disasters, Seismic Pilot)
*Right:* Operations plan of Sentinel-1 (green: once every two cycles in ascending and descending, light green: all cycles)
Since end Q2: 100% of acquisitions also available in SLC format
Since end Q2: 100% of acquisitions also available in SLC format
Sentinel-1 data *(same coverage as SciHub)* is directly available in GEP for launching **EO processing** services (no dissemination)

Portal: https://geohazards-tep.eo.esa.int, contact: geohazards-tep@esa.int
Visualization of collections from CEOS members
Exploitation Platform Overview

EO data Collections (GNSL etc.)

Level-0 Raw

Level-1 SLCs (FIXED FRAMES)

TPM EO Data (Optical, SAR & Auxiliary)

G-POD, CERN, CEMS

Cloud Storage

Processing Platforms

Geographic interface for EO data

InSAR Tools
  NEST, ROI-Pac, DORIS, GAMMA, etc.

TS Analysis
  StaMPS, pirate, GIANT, IPTA, SBAS, etc.

User Segment

Perform queries and browse data

User Customized Processing

Inspect Intermediate Products &

Access Final Processing Results

Initiate Automatic Processing

Geo-browsing data and results

Graphical Interface for Data Analysis

Post-processing of Results
At this stage the Geohazard Exploitation Platform:

- Provides a **geobrowser** able to search & map data collections from platform repository and from repositories of CEOS partners contributing data from outside the platform
- Allows using **Cloud appliances** (on demand processing) and have the test data available (as if on an external drive)
- Allows use of a **Developer Sandbox** to develop and integrate new scientific applications and subsequently exploit them against larger sets of data & computing resources
- Allows the users to **consume** via the geobrowser **Web Processing Services** exposed by the user’s processing appliance as a Platform as a Service (PaaS) model.
- Exploits third party Web Processing Services such as **G-POD services**.
- Exposes appliances with **SBAS**, **Gamma Toolbox**, **ROI-PAC**, **StaMPS**, **Doris**, **GMTSAR**, **PF-ASAR**, **Basic SSEP Toolbox**, **MATLAB** and **IDL**.
- Processors currently under integration: **Sentinel-1 Toolbox**, **DIAPASON**, **NSBAS**, **S-1 INSAR QL Processor** (DLR).
Roadmap of the Geohazards TEP:

- **GEP V1 validation with early adopters**
  - Limited to early adopters (under invitation), evolution of the service on-going
  - 22 platform users integrating application or exploiting on demand processing

- **GEP V2 engineering**
- **GEP V2 pre-operations**
- **GEP V2 operations**
  - Total 50 platform users
    - 28 new users
  - Total 60 platform users
    - 10 new users

- November 2015
  - Open under invitations/approval
  - Consolidation and evolution of service
  - Access to EPOS IP users (within available slots)

- November 2017
  - Open, consolidated and stable service
  - Total 60 platform users
    - 10 new users

Want to apply as early adopters of the GEP (limited slots)? geohazards-tep@esa.int
GEP Validation started March 3rd:

Sentinel-1A based change image of Villarrica eruption (Chile) using pre-event (20/02/2015) and post-event (04/03/2015) acquisitions.

International Charter Space & Major Dissaters activated on 3 April by ONEMI (Chile).

**Blue:** increase of the radar backscatter (melting of snow and ice)

**Cyan:** surface roughness increase (melting of snow and the accumulation of volcanic material (volcanic ash, lava flows and tephra)

Work performed by DLR on 5 March in the framework of the ASAPTERRA project originated by ESA (R&D action).
## Examples of Early Adopters

<table>
<thead>
<tr>
<th>User organisation</th>
<th>Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecole Normale Supérieure de Paris (France)</td>
<td>Etna, Italy and Corinth Rift, Greece</td>
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<tr>
<td>DLR IMF (Germany)</td>
<td>European tectonic mask</td>
</tr>
<tr>
<td>Altamira Information (Spain)</td>
<td>Test sites on landslides and earthquakes</td>
</tr>
<tr>
<td>ISTerre / Institut de Physique du Globe de Paris (France)</td>
<td>Subduction zones of Latin America, the NAFZ and Tibet.</td>
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<tr>
<td>INGV Roma (Italy)</td>
<td>Alto Tiberina Fault and Fogo Cape Verde</td>
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<tr>
<td>INGV Roma (Italy)</td>
<td>Marmara, East sector of NAFS</td>
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<tr>
<td>ETH (Switzerland)</td>
<td>Haiti and West Java</td>
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<tr>
<td>ETH (Switzerland)</td>
<td>Large surface deformations caused by landslides in BHutan Himalaya</td>
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<tr>
<td>NOA (Greece)</td>
<td>Geohazard sites in Greece</td>
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<tr>
<td>SATIM (Poland)</td>
<td>Silesia &amp; Warsaw (Poland)</td>
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<tr>
<td>Obs. Physique du Globe de Clermont-Ferrand Univ. Blaise Pascal (France)</td>
<td>Piton de la Fournaise in La Réunion, Cordon del Azufre / Lastarria in Chile–Argentina</td>
</tr>
<tr>
<td>INGV Catania (Italy)</td>
<td>Etna &amp; Campi Flegrei / Vesuvius</td>
</tr>
<tr>
<td>British Geological Survey (UK)</td>
<td>Urban areas of Great Britain</td>
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<tr>
<td>University of Leeds (UK)</td>
<td>Active deformation in the Alpine-Himalayan belt</td>
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<td>ESA</td>
<td>Over calibration sites: Rain forest, Germany (DLR targets), Australia</td>
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<td></td>
<td>Milan, Chicago, Sao Paulo</td>
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<td>ESA(Progressive Systems SLR)</td>
<td>Greater Cairo, South Rayan dune field, Middle Egypt province and Aswan province</td>
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<tr>
<td>CNR IREA (Italy)</td>
<td>Tests on Italian volcanoes and Hawaiian and Japanese volcanic and seismic areas</td>
</tr>
<tr>
<td>Universita De L’ Aquila (Italy)</td>
<td>Abruzzo region: L’ Aquila and Teramo for post-seismic ground dislocations</td>
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<tr>
<td>University College of London (UK)</td>
<td>UK landslides</td>
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<tr>
<td>ICTP (Italy)</td>
<td>Morocco seismic activity</td>
</tr>
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**PoC for applications:** geohazards-tep@esa.int
Since March 2015 the GEP already registered 21 projects

GEP inherits from the precursor TEP-QuickWin Validation phase, 21 User Registration Forms (projects) where:

- **14 projects focused on processing using applications already integrated:**
  - SBAS
  - ROI_PAC
  - GAMMA
  - DORIS
  - DIAPASON

- **4 projects integrate processors or new services:**
  - New services based on SBAS (CNR-IREA)
  - NSBAS (ISTERRE)
  - New services based on DIAPASON (Altamira Information)
  - Sentinel-1 InSAR-QuickLook (DLR)

- **3 projects will concentrate on large scale or systematic production**
  - Country wide measurements using SBAS
  - Systematic processing InSAR-QuickLook

This corresponds to 22 users from 19 organisations and 9 countries
Over 2016-2017 the GEP will have 10-20 new projects

Since October 2015 the GEP includes six new partnerships that bring new applications and new end-users:

- ALTAMIRA Information with SPN processing services (free and commercial products)
- CNR-IREA with SBAS based Sentinel-1 Surveillance service
- DLR with InSAR-QuickLook products generation
- UNI. STRASBOURG with MICMAC based optical data processing
- ENS/CNRS with the validation of the platform services to serve the CRL
- INGV for optical data pre-processing for volcanoes monitoring

Each will bring 1 user and the GEP will identify 25 new users during the project execution.

Two ESA GSP projects on Innovation in the area of Disaster Risk Reduction will bring 7 additional users: Altamira Information, CNR IRPI, INGV, IGME, NKUA, e-geos, Deimos Space and NOA.

- **This will make 60 users in end 2017**
Exploitation platforms within **EO Innovation Europe** → linked with large science networks and ecosystems

**European EO data asset**

- **ESA missions data**
- **Copernicus missions data**
- **Meteo missions data**
- **National missions data**
- **Commercial missions data**
- **Heritage missions data**
- **Airborne & in-situ data**

**EO Innovation Europe**

- **EO enabling element** = Technical & economical interoperability
- **EO stimulating element** = Remote sensing expertise
- **EO outreach element** = Thematic expertise

**European Plate Observing System (EPOS) [H2020]**

**Science network #1**

**Science network #2**
Thank you