CEOS Thematic Pilots
Q3-Q4 2015 CEOS Seismic Pilot report

Seismic Pilot/ Objective A, B and C		
August 2015-February 2016	PI or PoC: Philippe Bally (ESA) and Stefano Salvi (INGV).	Collaborating organisations: CEOS partner agencies: ESA, NASA, ASI, CNES, DLR, JAXA Other partners: INGV, NOA, UNAVCO, COMET+, University of Miami, EU Centre, ISTerre/IPGP, BGS, CNR IRPI, CNR IREA
Achievements: • CNR IREA has joined the pilot (within the next days they will send a formal email for their contribution). • Greece earthquake: A number of data were accessed and used (Sentinel-1, TerraSAR-X, COSMO-SkyMed, Radarsat-2) for the Lefkada earthquake in November 2015. A Lefkada fault model was generated. Pleiades data shall be requested (waiting CNES restriction to French users to change). • First COSMO-SkyMed collections for Nepal through the GSNL are available on the GEP (only for users that have signed the ASI license form). • The first results stemming out of pilot work were published on the GEP: SBAS-InSAR processor was used by CNR IREA to generate Sentinel-1 interferograms over Chile.		

Activities over Q3-Q4:
• NOA and INGV worked on the Lefkada earthquake generating a number of products: interferograms, fault models.
• INGV generated azimuth displacement maps for Lefkada using COSMO-SkyMed data.
• InSAR deformation measurements (ground displacement over Tibetan lake) were generated by ISTerre using NSBAS processing with ERS and ENVISAT data. ISTerre will re-generate these results on the GEP after the NSBAS integration.
• NASA JPL generated interferograms (showing surface deformation) constructed from ALOS-2 fine-beam passes.
• Data access for the pilot: Upon to ESA's arrangement with ASI, DLR and JAXA to support data dissemination using the Geohazards Exploitation Platform (GEP).
  1. ALOS-2 data are disseminated through GEP.
  2. TerraSAR-X data are currently catalogued (users shall be re-directed to the DLR portal for downloading and access will be granted after registration).
  3. COSMO-SkyMed data will be catalogued shortly.
• Data access for the GSNL, other pilots and the community: the GEP is under		

Validation Phase:

1. The Volcano pilot is using the platform for data dissemination (11TB for ALOS-2 data).
2. First COSMO-SkyMed collections for Nepal through the GSNL (Obj. B) are available on the GEP (only for users that have signed the ASI license form).
3. Copernicus Sentinel-1 data were made available (in raw as well as SLC format) starting with CEOS Pilot targets and with the goal to gradually provide global coverage.
4. First Copernicus Sentinel-2 data are available on the platform.

- Data processing (on the platform): The GEP is under validation.
  1. Seismic pilot users (NOA, INGV, ISTerre) access and exploit EO data to generate measurements. Users are able to process using applications on the platform or after integrating (themselves) their own processing.
  2. First publication on the platform: Sentinel-1 interferograms over Chile (Obj. C) were generated by CNR IREA using SBAS-InSAR. The processing was run on ESA's Grid Processing On-Demand (G-POD) where the algorithm is currently integrated. The integration of the SBAS-InSAR service on the GEP is still on-going.

- Support to GSNL (Obj. B): The pilot continued to support the Gorkha earthquake Event Supersite. No other Event Supersites have been established in the period.

- A number of publications stemmed out of pilot work (listed in the related section, below).

- Pilot users are promoting their results through: the CEOS website (http://ceos.org/), the GSNL portal (http://www.earthobservations.org/gsnl.php) and the Geohazards Exploitation Platform (https://geohazards-tep.eo.esa.int/). The platform hosts results from the broad geohazards community using satellite EO, not only results from CEOS Pilot users and not necessarily processed on the GEP.

Data accessed over this period	Total data accessed to date (#images /satellite)
• 9 images/ALOS-2 (a total of 37 images will be downloaded under Obj. C for year 2015, over Nepal). Another 33 images were ordered and currently catalogued on GEP.	• 25 images /ALOS-2(out of a total of 37 images that will be downloaded under Obj. C for year 2015, over Nepal, as JAXA will not provide data through the GSNL) • 65 TerraSAR-X images (Greece, Obj. C) currently acquired (some of them already accessed) • 2 Radarsat-2 images (Greece, Obj. C) • COSMO-SkyMed images over Greece (Obj. C), Iran and China (Obj. A) • A number of Sentinel-1 images

• 65 TerraSAR-X images (Greece, Obj. C) currently acquired. • 93 COSMO-SkyMed images over Greece (Obj. C), Iran and China (Obj. A). • A number of Sentinel-1 images.		
Products: 1. Azimuth displacement measurements with COSMO-SkyMed for the Greece earthquake, under Objective C. 2. Fault models using Sentinel-1, TerraSAR-X, COSMO-SkyMed and Radarsat-2 data. 3. Ground displacement measurements over Tibetan lake using the NSBAS processor, under Objective A. 4. Interferograms over Chile using the SBAS-InSAR processor, under Objective C. 5. Interferograms over Nepal based on ALOS-2 fine-beam passes, under Objective C.	**User (by product)**: • Stefano Salvi, INGV • Harris Kontoes, NOA • Erwan Pathier, ISTerre • Francesco Casu, CNR IREA • Eric Fielding, NASA JPL Overall no end-user received data yet; generally it is challenging to link to local users for earthquake response as location of events is not predictable and end-users relations have to be developed each time. The agreement with the International Charter (to provide earthquake response products in the event of Charter activations concerning earthquakes) should improve the capacity to reach end-users. Current results have been published on the Geohazard Supersite webpages and the GSNL page.	**User or practitioner endorsement/opinion/outcomes** • ALOS-2 interferograms show interesting features [NASA JPL].

List any publications directly stemming from pilot work:
- Grandin et al. (2015), "Rupture process of the Mw=7.9 2015 Gorkha earthquake (Nepal): insights into Himalayan megathrust segmentation" submitted (**IPGP, Obj. C**)
- Doin, M. - P., Twardzik, C., Ducret, G., Lasserre, C., Guillaso, S., & Sun Jianbao. (2015). InSAR measurement of the deformation around Siling Co Lake: Inferences on the lower crust viscosity in central Tibet, *J. Geophys. Res.-Solid Earth*, 120, 5290–5310, doi:10.1002/2014JB011768. (**ISTerre, Obj. A**)
- Papadopoulos et al. (2016), The Mw6,5 earthquake of 17 November 2015 in Lefkada Island and the seismotectonics in the Cephalonia Transform Fault (Ionian Sea, Greece), Geophysical Research Abstracts, Vol. 18, EGU2016-

9041-1, 2016 (accepted, **NOA, Obj. C**)
- Melgar D. et al., Slip segmentation and slow rupture to the trench during the 2015, Mw8,3 Illapel, Chile earthquake, doi: 10.1002/2015GL067369 (**JPL, under Obj. C**)
- Angster et al. (2015), Field Reconnaissance after the 25 April 2015 M 7,8 Gorkha Earthquake, Seismological Research Letters, Vol. 8, No. 6 (**JPL, under Obj. C**)

List objective milestones and state progress to date (%):

Objective A:
- Partial results of validation – Turkey, California, Japan, other selected areas

Objective B:
- The GEP has been successfully used to support the Nepal Event site (first COSMO-SkyMed data available).

Objective C:
- Earthquakes identified in 2015: Nepal, Greece, Chile.
- Comparison of results obtained by different groups/algorithms/approaches (has not started, is a complex activity which requires collaboration and funding)
- Examine the gaps of existing acquisition plans over the major cities of the world in areas of high seismic risk (90% completion). All megacities in areas at high seismic risk are at least partially covered by SAR sensor. The study identified sites with good coverage using nearly global coverage missions as Sentinel-1 and ALOS-2, but for many sites there is not full coverage with ascending and descending acquisitions from Radarsat-2, TerraSAR X, and COSMO-SkyMed.
- Demonstration of the generation of different products for 1-2 earthquakes (75%).
- Product assessment by the final users (0%)

Issues identified and risk management approach
- Most pilot users are EO practitioners from the category of science users (rather than end-users). It is difficult to identify end-users in advance as earthquake location and time are not predictable.
-It is difficult to get detailed user feedback about the value of satellite data.
-Accounting of data accessed can be difficult due to lack of user feedback.
-It takes time to organize data supply to users.