



Committee on Earth Observation Satellites

WGDisasters Seismic Hazards Demonstrator

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WGDisasters-17 Meeting

Virtual Meeting

15-17 March 2022





Aims to provide satellite data to generate EO based scientific information to be shared with decision makers for seismic hazard assessment

- Pursue **global tectonics mapping** in the long term
- Expand **active fault mapping** from regional to global coverage primarily using VHR **optical data** supporting supporting geomorphological and morpho-tectonics studies
- Exploit EO data to derive **advanced research products for earthquake response**: expand to target of at least 10-12 EQ per year
- **Articulate with EO disaster response capabilities** e.g. the Charter to make sure users are aware of and use it.

Data - Yearly quota available and requests



Agency	ASI Cosmo-SkyMed	CNES Pleiades	DLR TerraSAR-X	ESA Sentinel-1 & 2
Quota <u>per year</u>	650 images	20000 sq. km.	Upon request	Open

Request no.	Request status	Prime Investigator Affiliation	Data requested	AOI	Number of images requested
2019-R01	<i>Rejected</i>	University of Tehran	Cosmo-SkyMed	Kerman province (Iran)	130 images
2019-R02	Approved	University of Leeds	Pleiades	Central Asia	2322 sq. km. in Central Asia
2019-R03	Approved	University of Leeds	Pleiades	Indonesia	316 sq.km. in Indonesia
2019-R04	Approved	University of Leeds	Pleiades	Ecuador	approx. 3000 sq. km. in Ecuador
2019-R05	Approved	University of Leeds	Pleiades	Nepal	approx. 3000 sq. km. in Nepal
2019-R06	Not received	University of Leeds	Pleiades	Turkey	approx. 3000 sq. km. in Turkey
2019-R07	Approved	University of Leeds	Pleiades	Kenya	approx. 3000 sq. km. in Kenya
2019-R08	Not received	HUA	TerraSAR-X, Cosmo-SkyMed, Pleiades	Greece	N/A in Greece
2019-R09	Not received	HUA	TerraSAR-X, Cosmo-SkyMed, Pleiades	Iran	N/A in Iran
2019-R10	Approved	University of Oxford	Pleiades	Turkmenistan	3,648 (tri-stereo total)
2019-R11	Approved	Argans c/ESA	Cosmo-SkyMed	Durres (Albania)	10 images
2020-R12	Approved	University of Leeds	Pleiades	Elazig (Turkey)	Approx, 3320 sq, km
2020-R13	<i>Rejected by DLR</i>	INGV	TanDEM-X	North Zanzan fault (Iran)	9 images



Request no.	Request status	Prime Investigator Affiliation	Data requested	AOI	Number of images requested
2020-R14	Approved	University of Oxford	Pleiades	Dushanbe (Tajikistan)	1,500 sq. km. (tri-stereo total)
2020-R15	Approved	NOA, AUTH, DUTH	Pleiades	Samos island (Greece)	824 sq. km. (tri-stereo total)
2020-R16	Approved	University of Oxford	Pleiades	Dushanbe (Tajikistan)	1,856 sq. km. (stereo total)
2021-R17	Approved	University of Oxford	Pleiades	Almaty (Kazakhstan)	4,227 sq. km. (tri-stereo total)
2021-R18	Approved	University of Tehran	Cosmo-SkyMed	Tehran (Iran)	400 images
2021-R19	Approved	INGV, NOA, AUTH	Cosmo-SkyMed and CSK Second Generation	Tirnavos, Thessaly (Greece)	19 images per satellite per orbit ≈ 190 images
2021-R20	Approved	University of Oxford	Pleiades	Shamakhi (Azerbaijan)	5,836 sq. km. (stereo total)
2021-R21	Approved	COMET-University of Leeds	Pleiades	Qinghai (China)	2,421 sq. km (tri-stereo total)
2021-R22	Approved	COMET-University of Leeds	Pleiades	Tehran (Iran)	3,900 sq km (tri-stereo total)
2021-R23	Approved	University of Oxford	Pleiades	Huaxian (China)	808 sq, km (stereo total) + 189 sq. km

- Updated **Data Requests spreadsheet** available on www.ceos.org under Document Management

Version March 2021



Quito, Ecuador), Nairobi (Kenya) and Kathmandu (Nepal), University of Leeds et al.

Tomorrow's Cities: deriving models of multi-hazard risk (earthquakes, flooding, fire, and volcano) to inform urban development planning for four major capital cities using Pleiades VHR images

- ✓ *In progress (Quito and Kathmandu completed, Nairobi is starting)*
- ✓ *Paper in review*

Qinghai, China (University of Leeds, COMET et al.)

Deriving DEMs of the 2021 May 21st Mw 7.3 Maduo earthquake rupture using Pleiades tri-stereo data to map the fault rupture zone. This will aid field teams in mapping out the rupture in the field, as well as create remotely derived datasets against which to compare this information to improve our understanding of earthquake faulting events.

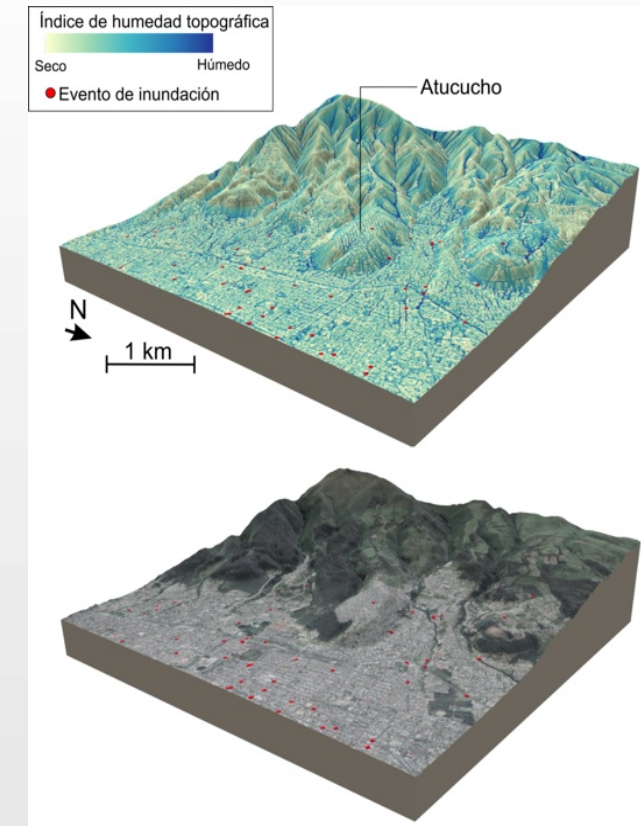
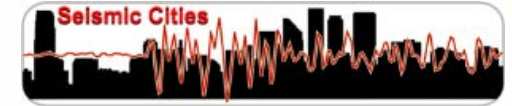
- ✓ *In progress (investigation of artifacts found)*

Shamakhi, Azerbaijan (U. of Oxford & Azerbaijan National Academy of Sciences)

Using Pleiades stereo data to support active fault characterisation and palaeoseismic trenching along the edge of the Caucasus mountains and within the Kura basin, where rapid slip is expected, but evidence of active faulting is subtle.

project co-funded through a UKRI GCRF award

- ✓ *In progress, fieldwork has been postponed for 2022.*



Wetness index used to show movement of water around and into the city of Quito, generated using Pleiades data



Elazig, Turkey (University of Leeds, et al.)

Request of **Pleiades stereo** to characterise the 2020 rupture along the East Anatolian Fault zone

✓ *No successful stereo imagery was acquired in the specified acquisition period*

Dushanbe, Tajikistan (University of Oxford and Institute of Geology and Geophysics, Tajikistan National Academy of Sciences, University of Central Asia, GFZ Potsdam, Germany)

Active faulting and fault behavior study combining geomorphic analysis with InSAR studies of fault slip.

Seismological and geomorphic study of active faulting, and the source of the destructive 1949 Khait earthquake.

✓ *In progress (Papers from both projects are expected in 2022)*

Ashgabat, Turkmenistan (University of Oxford & Turkmenistan National Academy of Sciences):

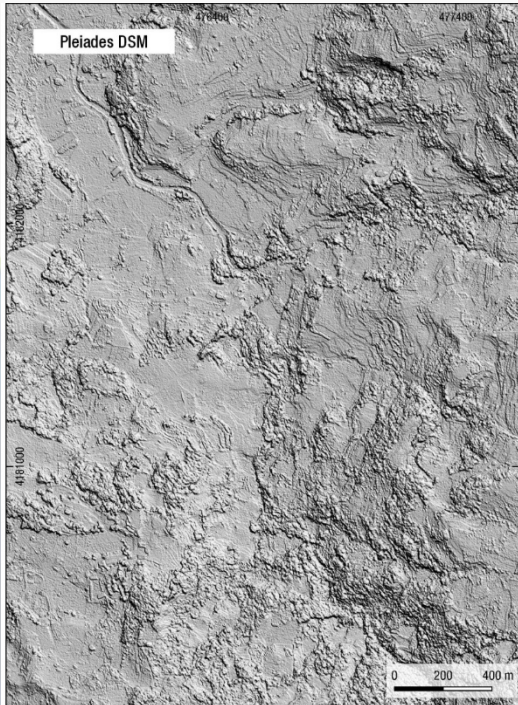
Examine the landscape for signs of **faulting within urban Ashgabat associated with the destructive 1948 earthquake**, and to undertake reconnaissance in support of further palaeo-seismic trenching studies.

✓ *Ongoing with the analysis, completion of the 1948 study foreseen in summer 2022. Fieldwork in Turkmenistan is postponed until 2023. (planned paper for end 2022)*



Samos (University of Oxford, NOA, AUTH)

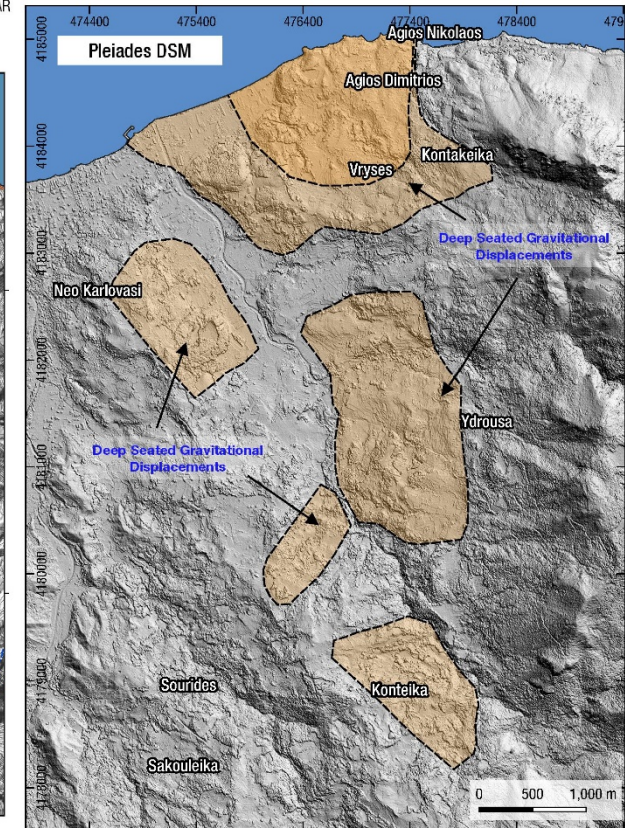
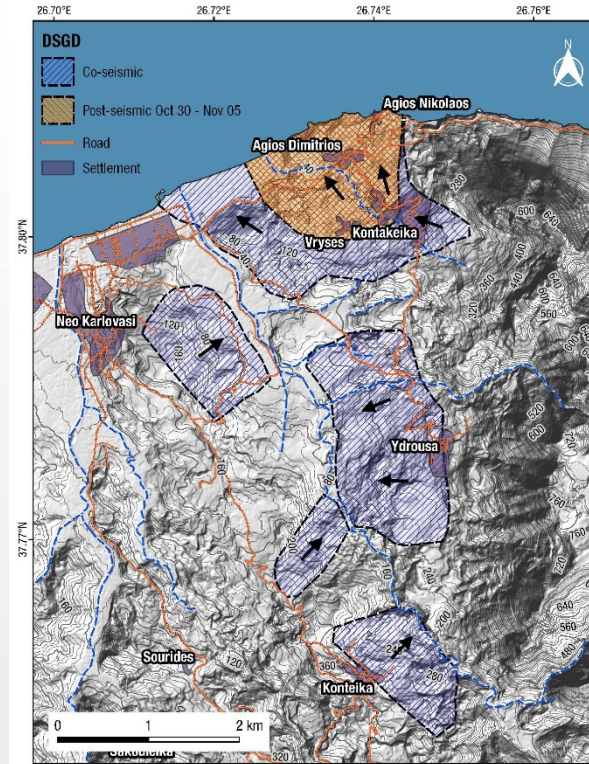
Detection of co-seismic horizontal displacement and identification and mapping of the extensive landslides (active and inactive), after the earthquake occurring on 30th October 2020, in the broader area of Karlovasi, Samos island using Pleiades tri-stereo.



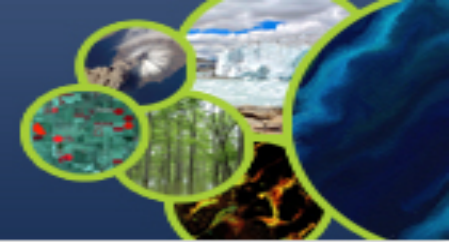
- ✓ *In progress work is focused on creating a new detailed inventory of large gravitational features using Pleiades data, in the north-central area of Samos island, around Neo Karlovassi.*

Pleiades stereo and triple-stereo digital surface model (1.0 m) compared to the available DEM from airborne photogrammetry (Hellenic Cadastre – 5.0 m pixel size). Imaged area: Fourniotikos valley, western Samos island

Deep-seated gravitational displacements (DSGD) in central Samos, observed in co-seismic InSAR
From Ganas et al. 2021 <https://doi.org/10.1007/s11600-021-00599-1>



Deep seated gravitational displacements (DSGD; shaded polygons) identified using InSAR (left; Ganas et al. 2021) and the provisional Pleiades digital surface model (right).



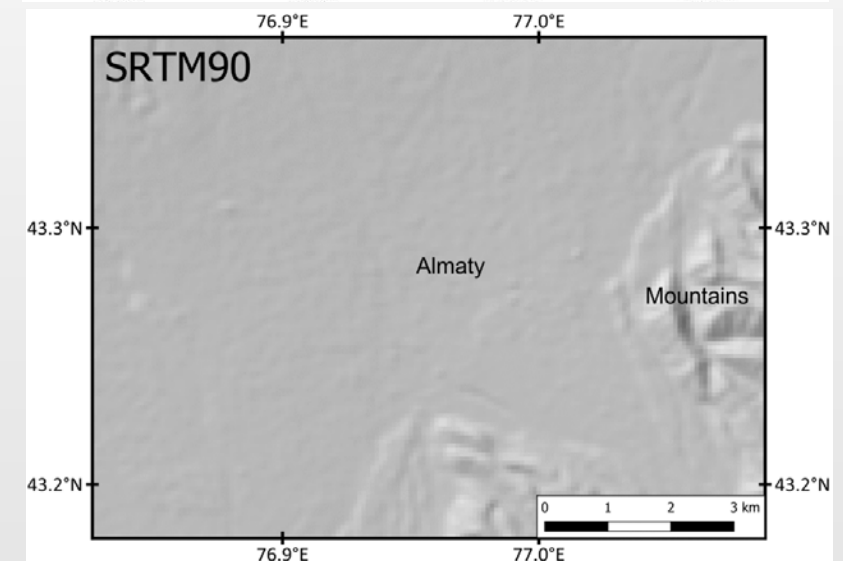
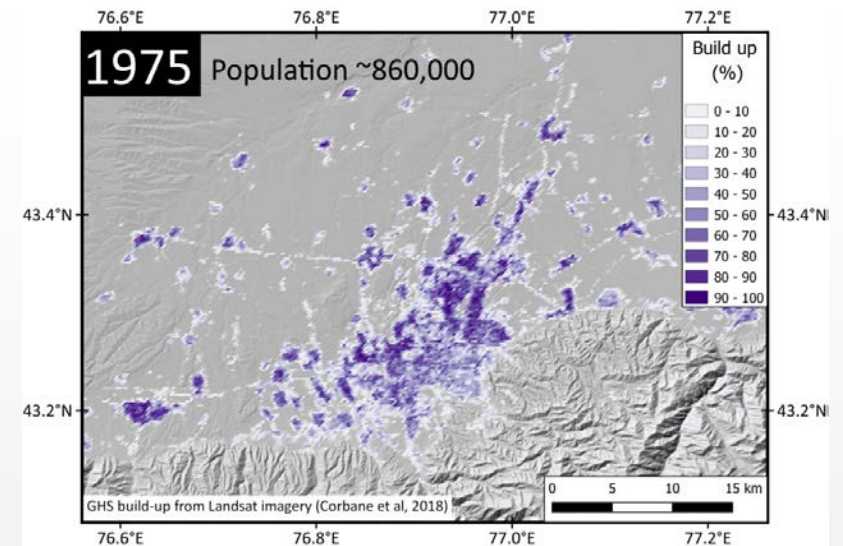
Central Asia - Almaty (Kazakhstan), Bishkek (Kyrgyzstan) (University of Oxford, University of Leeds, COMET, BGS, GEM Foundation et al.)

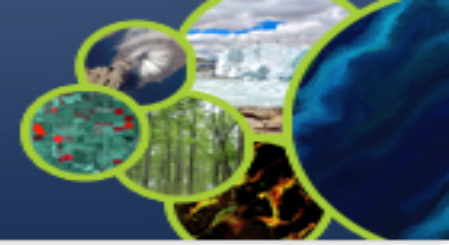
Derive digital elevation models using **Pleiades stereo** data to identify and characterise active fault scarps in urban regions along the Zailisky range front in Kazakhstan, including the city of Almaty (2M population) and various other large towns (including Bishkek, Kyrgyzstan).

Identifying earthquake hazards (earthquake histories and fault locations) in the Tien Shan region

Building Classification for updating Exposure data.

- ✓ **Almaty: Article published**
- ✓ **Bishkek: Article in preprint**
- ✓ **On going activities (paper in preparation)**





Thessaly, Greece (INGV and AUTH)

INGV and AUTH started collaboration on joint analysis processing **Sentinel-1** and **CosmoSkyMed** for the **Thessaly M6.3** in **March 2021** for post seismic relaxation of the area. GEP services are also used.

✓ *In progress (See the Geohazards Lab activities presentation)*

Tehran, Iran (University of Tehran)

Mapping interseismic strain accumulation over the urban area of Tehran using **Cosmo-SkyMed** and Comparison with Sentinel-1 and ICESAT-2 data.

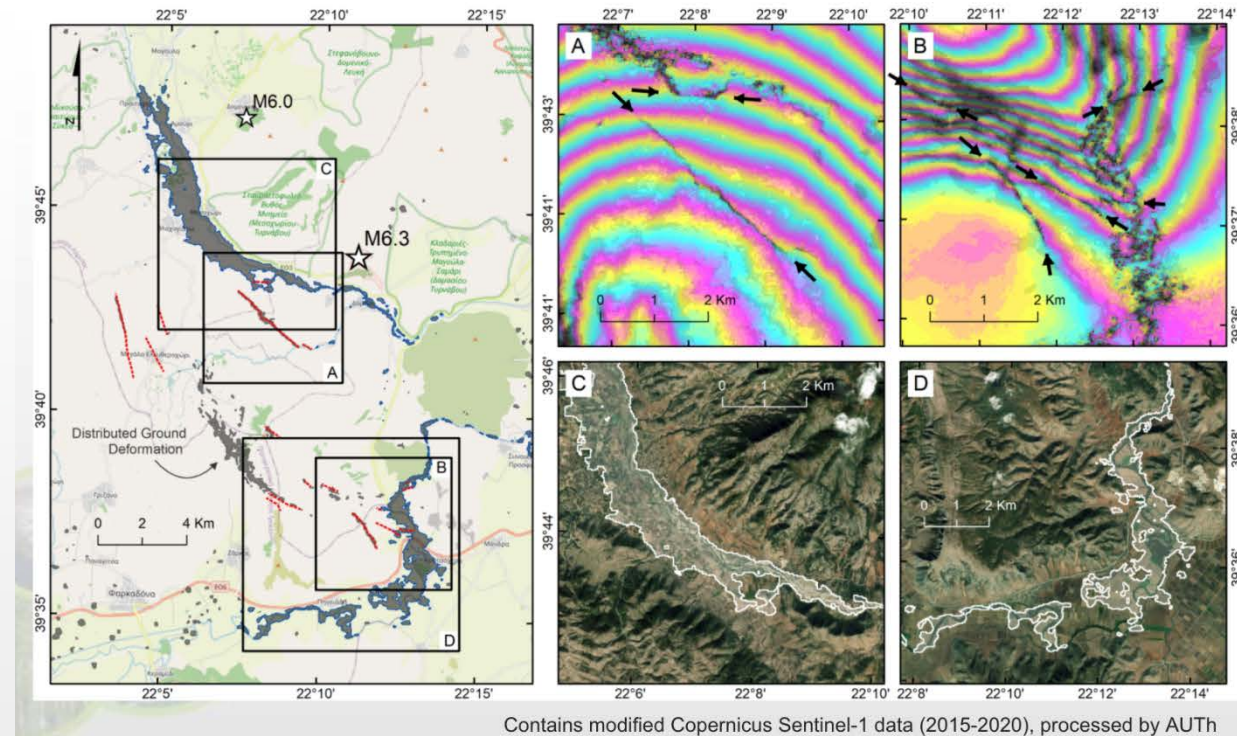
Monitoring the basins long term subsidence.

✓ *In progress (data received in January 2022)*

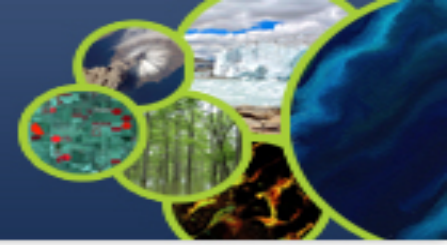
Tyrnavos (Greece) and Durres (Albania) (INGV)

Retrieval of ground displacement and/or the phase using Cosmo-SkyMed.

✓ *Few results due to coherence loss but the Coseismic fringes were retrieved. A new approach is ongoing.*



Composite map of decorrelated areas. Regions suffered extended liquefactions collocate with riverbeds. Contains Copernicus Sentinel-1 modified data.



Papers, Presentations, Posters:

- Paper **submitted** (preprint)

Ruth M.J. Amey, John R. Elliott, C. Scott Watson, Richard Walker, Marco Pagani, Vitor Silva, Ekbal Hussain, Kanatbek E. Abdrakhmatov, Sultan Baikulov, Gulkaiyr tilek Kyzy, **Improving urban risk estimates for Bishkek, Kyrgyzstan incorporating recent geological knowledge of hazards**, Nat. Hazards, EarthArXiv <https://doi.org/10.31223/X5KG9X>

- Paper **submitted** (preprint)

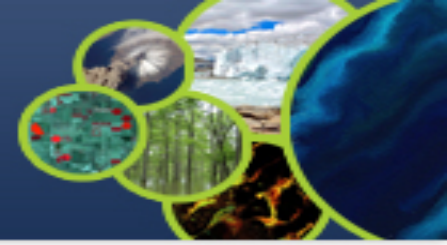
Watson, C. S., Elliott, J. R., Ebmeier, S. K., Vásquez, M. A., Zapata, C., Bonilla-Bedoya, S., Cubillo, P., Orbe, D. F., Córdova, M., Menoscal, J., and Sevilla, E.: **Enhancing disaster risk resilience using greenspace in urbanising Quito, Ecuador**, Nat. Hazards Earth Syst. Sci. Discuss. [preprint], <https://doi.org/10.5194/nhess-2022-20> , in review, 2022.

- Paper **published** (American Geophysical Journal)

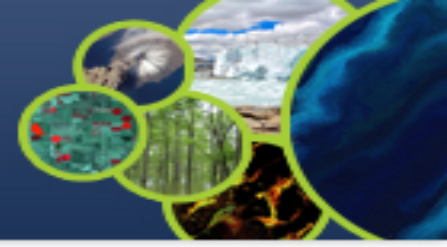
Amey, R. M. J., Elliott, J. R., Hussain, E., Walker, R., Pagani, M., Silva, V., et al. (2021). **Significant seismic risk potential from buried faults beneath Almaty city, Kazakhstan, revealed from high-resolution satellite DEMs**. Earth and Space Science, 8, e2021EA001664. <https://doi.org/10.1029/2021EA001664>

Web page, articles and Twitter:

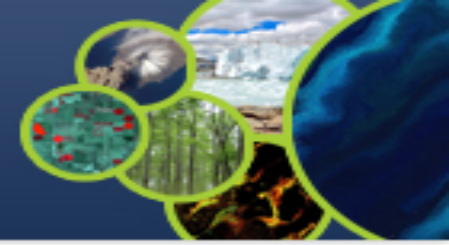
- Seismic Demonstrator web page updated
- Several tweets published



- ✓ The Demonstrator has made important contributions to **publications** on seismic hazard and risk
- ✓ Without this opportunity, the case studies wouldn't have been as **numerous**, and such large areas couldn't have been analysed, as is required for big scale tectonic and seismic hazard studies.
- ✓ Increasing the amount of case studies increases **international collaboration between Research Institutes**
- ✓ These datasets have provided substantial **material to train PhD students and remote sensing specialists** in the field of earth observation and natural hazard analysis
- ✓ Predominant use of the data is for the derivation of DEMs and the **improvement of existing DEMs**
- ✓ The tri-stereo imagery from Pleiades has proven to be more successful for extracting buildings than from normal stereo which is a large advantage over other systems
- ✓ *“With Data support through the WG Disasters Seismic Demonstrator ... we have been able to uncover evidence of previously unknown large earthquakes in the vicinity of major population centres. These kinds of data are extremely important for assessing the hazards and risks to local populations, and continue to be of great help to our partner organisations in improving official hazard assessment and mitigation.” U. of Oxford*



- **Major delay** in the data exploitation due to COVID-19: numerous field surveys have been postponed
- **Extend the activity** until the end of 2022 (most of studies should be completed by then) and plan a user satisfaction survey.
- A discussion on the future of the Seismic Demonstrator is scheduled for next week:
 - What next is needed **beyond the Demonstrator**:
 - > *What type of activities is needed (focus on operationally mandated users & address sustainability)*
 - How to **reshape the strategy** to better address the user/community needs



Thank you

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