Perspectives for Earth Observation in contributing to “Understanding Risk” and disaster preparedness

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UNISDR Technical Workshop on Sendai Monitoring,

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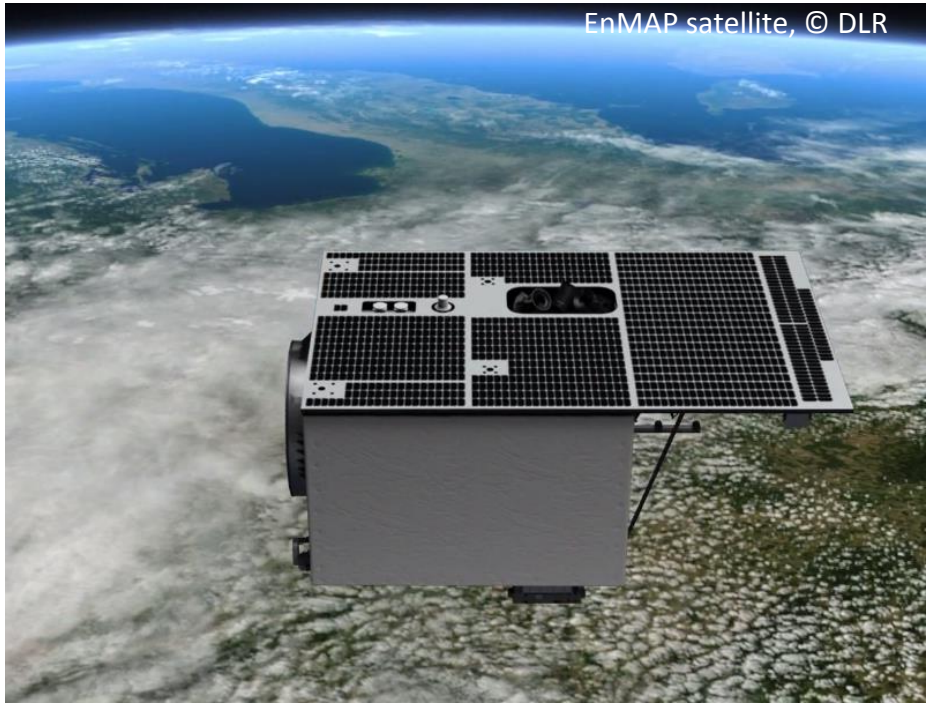
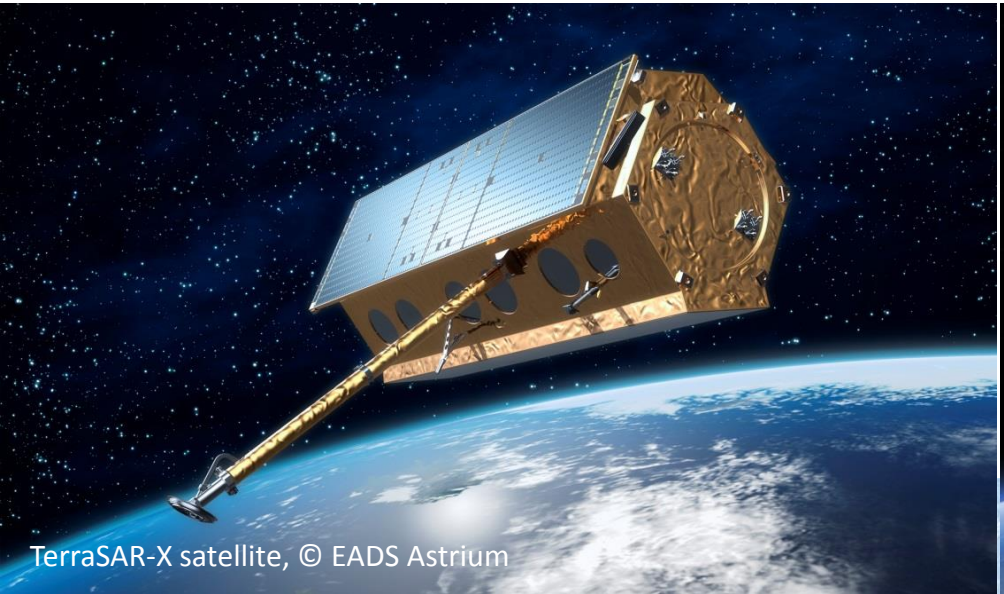
Earth observation satellites

- EO satellite data more and more becomes a widely available source of information
  - free & open data of the European Sentinel satellites and the US Landsat and MODIS missions etc.
  - large private satellite constellations
  - national high-tech / scientific missions
  - etc.


EnMAP satellite, © DLR

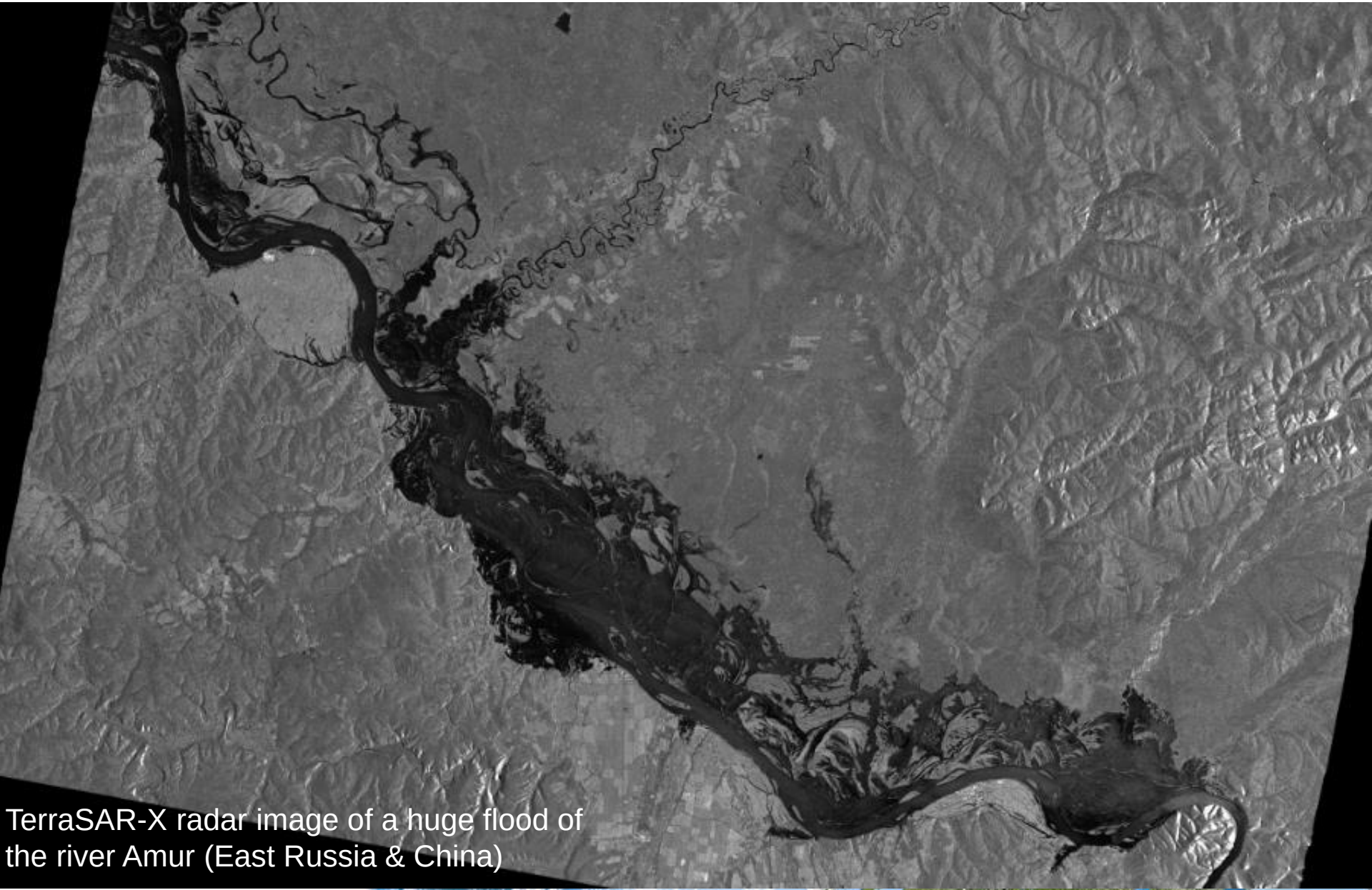

TerraSAR-X satellite, © EADS Astrium


Sentinel-1 satellite, © ESA / ATG medialab

Images/maps help understand situations (1)

Central-eastern Brazil,
Sentinel-2 image (ESA 2017)

Images/maps help understand situations (2)



TerraSAR-X radar image of a huge flood of the river Amur (East Russia & China)

Earth observation of disasters and risks

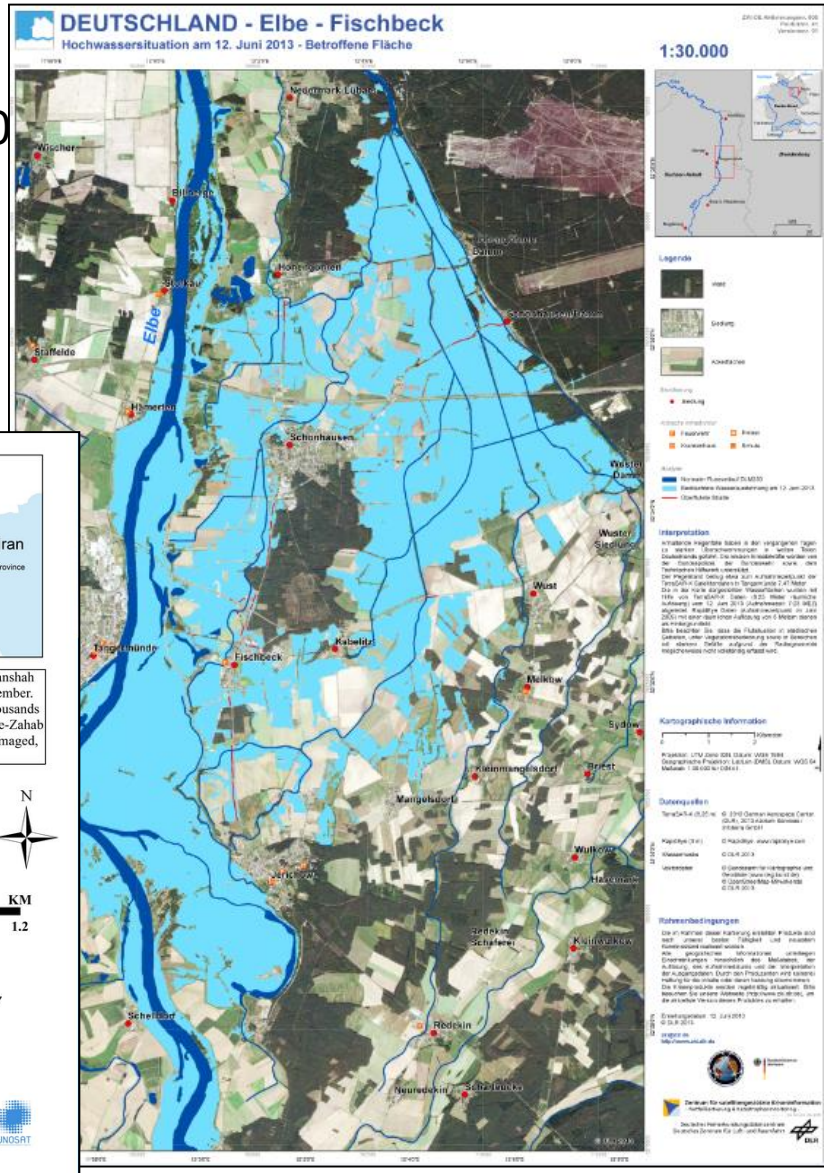
- EO-based analyses are much used in disaster response (e.g. Charter, Copernicus EMS)
- Better understanding / awareness of hazards and risks
- Preparedness: Assessment of hazards, exposure, and risks

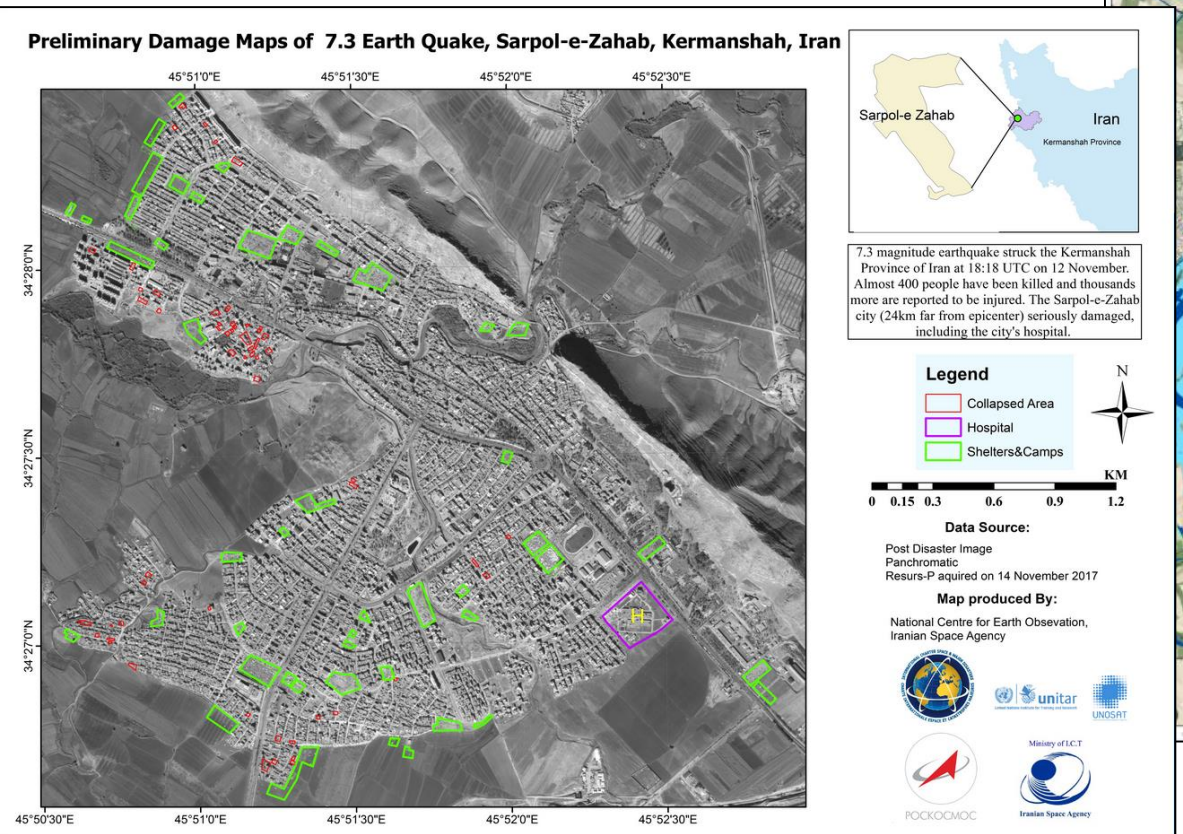
➢ A few examples will be provided in the following slides

EO support to disaster response

- The Int. Charter ‘Space and Major Disasters’ supported more than 550 disasters since 2000

- “Universal Access” (Disaster Management authorities can use the mechanism after registration and training)





Charter Universal Access: Conditions for becoming an Authorized User

1. be a **national disaster management authority** or its delegated agency in that country

2. have the **capacity to download and use maps**

3. be able to **submit and pursue an activation request in English**

Understanding risk: Copernicus EMS Risk & Recovery (1)

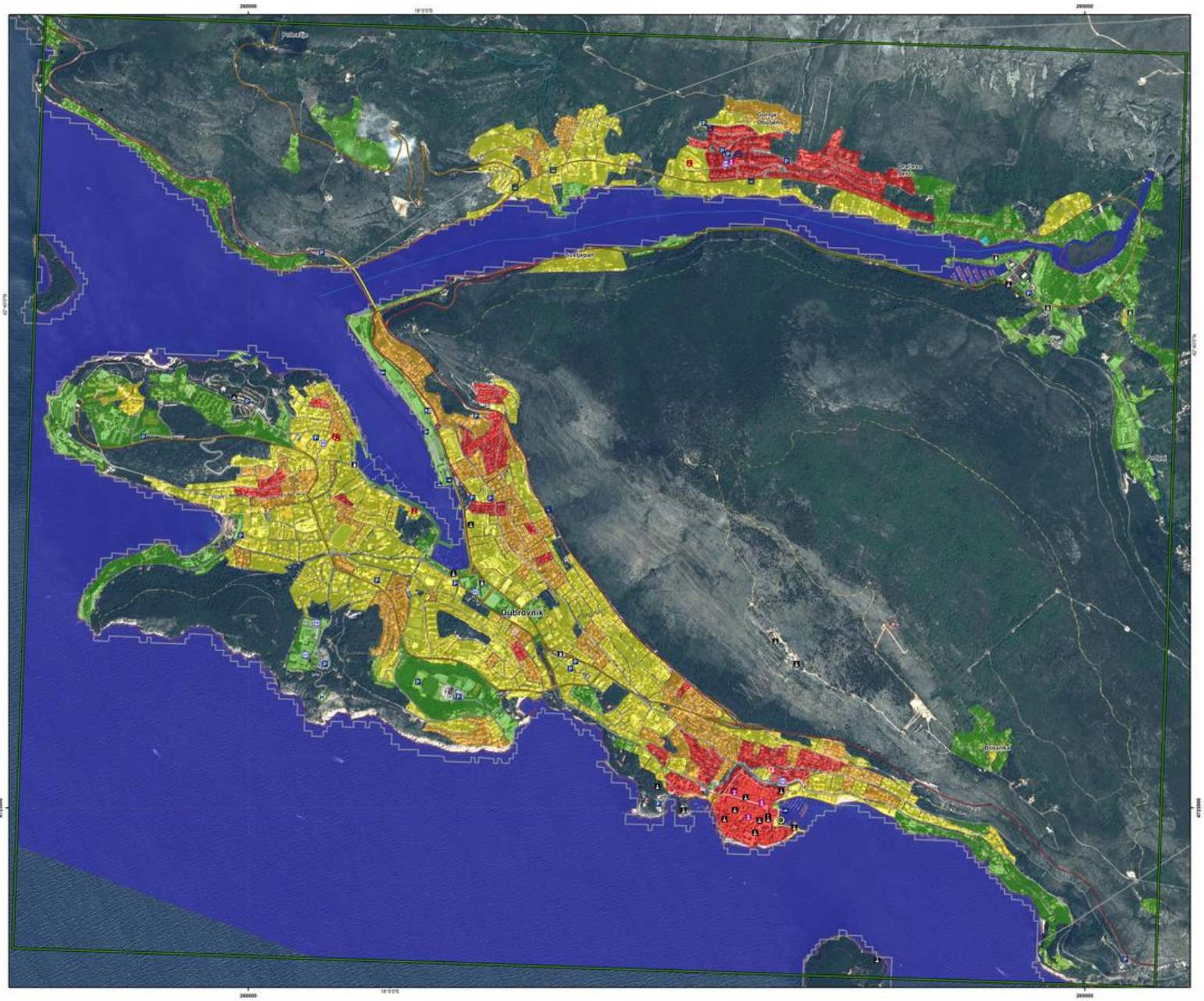
http://emergency.copernicus.eu/mapping/

Understanding risk: Copernicus EMS Risk & Recovery (2)

- "*Service consists of the on-demand provision of geospatial information. […] This service addresses prevention, preparedness, disaster risk reduction or recovery phases.*"

- Recent examples:
  - Nation-wide Asset mapping (values in EUR/m2)
  - Seismic risk assessment
  - Multiple natural hazards risk assessment
  - Tsunami risks assessment
  - Forest fire damage assessment and post-event landslide risk

Understanding risk: Copernicus EMS Risk & Recovery (3)



Glide Number: (N/A)

Activation ID: EMSN-039
Product N.: Population - Seismic Risk Map, v3, English

Seismic risk assessment - Croatia 2017

Population - Seismic Risk Map

04 Dubrovnik - Overview

Cartographic Information

1:10,383

Full color A1, high resolution (300 dpi)

0 0.2 0.4 0.8 Kilometers

Grid: WGS 1984 Zone 34N map coordinate system
Tick marks: WGS 84 geographical coordinate system

Legend

Population - Seismic Risk
- Negligible
- Acceptable
- Undesirable
- Unacceptable

Hydrography
- BH140 - River Line
- BH140 - River Area
- BH080 - Lake Area
- BA040 - Total Water Area

Population
- AL020 - BUA First Order
- AL020 - BUA Village
- AL020 - Suburb/Neighb.
- AL020 - Hamlet

Transportation
- AP030 - National Motorway
- AP030 - Primary Route
- AP030 - Secondary Route
- AP030 - Local Route
- AP030 - Under Construction Rte
- AP010 - Cart Track
- AP050 - Trail Line
- AP010 - Railway Line
- AQ040 - Bridge Line

Industry and Utilities
- Industry
- Comm. station, Antenna
- Gas station, Fuel
- Wastewater Plant
- Water Tower
- Water Well

Boundaries
- AOI
- Admin. Limits

Points of Interest
- Hospital
- Fire Station
- Police
- Shelter
- Sport Facility
- Place Of Worship
- Cemetery
- Educational Facility
- Embassy
- Public/Social Facility
- Townhall
- School
- Educational Facility
- Library
- Prison
- Camp Site
- Landmark/Monument
- Airport
- Heliport, Heliport
- Bus Station
- Station
- Ferry Terminal
- Parking
- Lighthouse
- Dock
- Yatch Marina

Map Information

Pre-disaster situation analyses for four locations in Croacia: Zagreb, Rijeka, Split and Dubrovnik.
The core user of the map is the National Protection and Rescue Directorate. The potential additional users of the map are any other authorities involved in in-field operations.

The scope of the map production is to generate a pre-event reference content, and analyses including hazard, exposure, vulnerability and risk concerning to Seismic and Flood events. Secondary risk are also considered. Mitigation measures with respect to all evaluated risks are proposed.

EMSN039 - Croacia	
AOI	04 Dubrovnik
Event type	Earthquake and Flood

Data Sources

Pre-Event Image layer: SPOT 7 © CNES (2016), distributed by Airbus DS (acquired on 28/09/2016, 1.5m, 4.7% cloud coverage, 16.6 incidende angle), provided under COPERNICUS by the European Union and ESA, all rights reserved.

Vector layers: Seismic Risk of population elaborated by Indra from spatial analyses of flood hazard overlaid with population distribution. Transportation Network, Populated Places and Points of Interest primary source is OpenStreetMap © OpenStreetMap Contributors duly updated over SPOT 7 pre-event imagery. Hydrographic features source is EU-Hydro. Administrative boundaries source is GADM.

Inset maps: Administrative boundaries source is GADM.

All data sources are complete and with no gaps.

Dissemination/Publication

Map products are available in the Copernicus EMS Portal at the following URL: http://emergency.eu/mapping/list-of-components/EMSN039.
Delivery formats are GeoPDF, GeoJPEG and vectors.
No restrictions on the publication of the mapping apply.
All products are © of the European Union.

Disclaimer

The products elaborated in the framework of current mapping in Risk and Recovery mode activation are realized to the best of our ability, optimizing the available data and information. All geographic information has limitations due to scale, resolution, date and interpretation of the original data sources. The products are compliant with Copernicus EMS Risk and Recovery Product Portfolio specifications.

Map Production

The present map shows the seismic risk of population elaborated using spatial analyses, and classified in four levels: Negligible, Acceptable, Undesirable and Unacceptable. The Croatian Map of Earthquake Areas was classified in levels of probability according to Peak Ground Acceleration (PGA). It was overlaid with the building blocks representing population, and classified into five classes of consequences according to population density. Hazard level and consequences on assets are combined by an equally weighted approach to obtain the Risk.
Results are accompanied by Transportation Network, Hydrography, Populated Places, including Points of Interest, in AOI 4-04 Dubrovnik.
All satellite images have been radiometrically enhanced and georeferenced.
The estimated thematic accuracy of this product is 80% or better, as it is based on visual interpretation of recognizable items on very high resolution optical imagery.
Only the area enclosed by the Area of Interest has been analyzed.

Contact

Map produced on 21/09/2017 by Indra Sistemas S.A. under contract 258611 with the European Commission. All products are © of the European Commission.
Name of the release inspector (quality control): Indra Sistemas S.A.
E-mail: gio-ems-nonrush@ec.europa.eu
http://emergency.copernicus.eu/mapping

Copernicus
Europe's eyes on Earth

Understanding risk: radar-based ground motion measurements

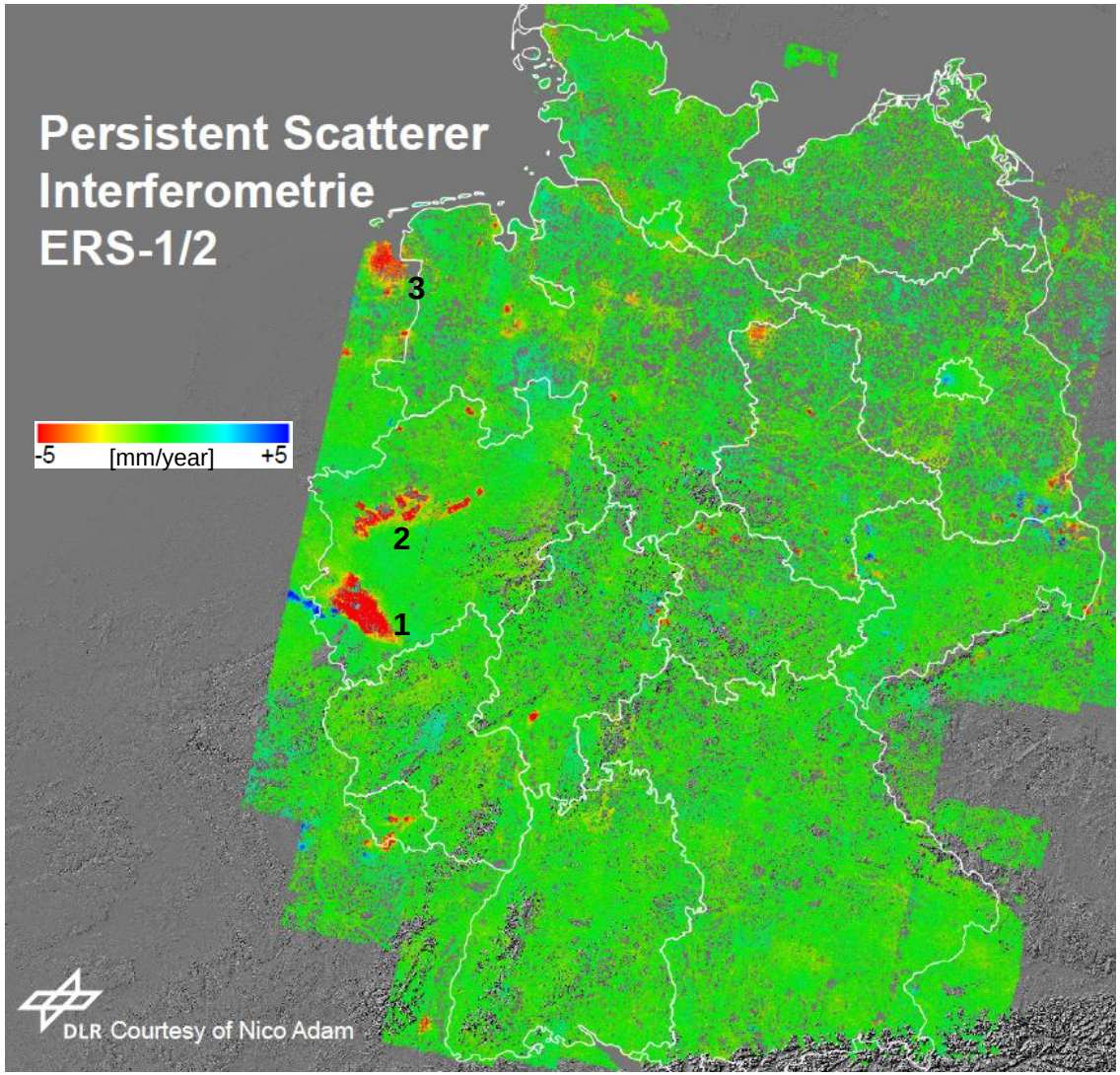
- Radar time series (ESA satellite data 1992-2001) allow precise measurement of ground movements

- Ground subsidence takes place for many reasons and is sometimes associated with disaster risk (e.g. flooding)

Most prominent features:

1+2: subsidence due to coal mining activities and lowered groundwater tables

3: gas exploitation in the Groningen area (Netherlands)



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Operational Ground Motion Service Germany

- Sentinel-1 based nationwide wide-area product in preparation
  - will reveal a lot of small/slow motion features which could cause damage to buildings and infrastructure

- Inception of a European Copernicus Ground Motion Service under discussion

The national Ground Motion Service is run by the German Federal Institute for Geosciences and Natural Resources (BGR) in order to support operational utilization of radar-based motion detection in authorities for the purpose of hazard prevention.

BodenBewegungsdienst Deutschland
BBD

BGR

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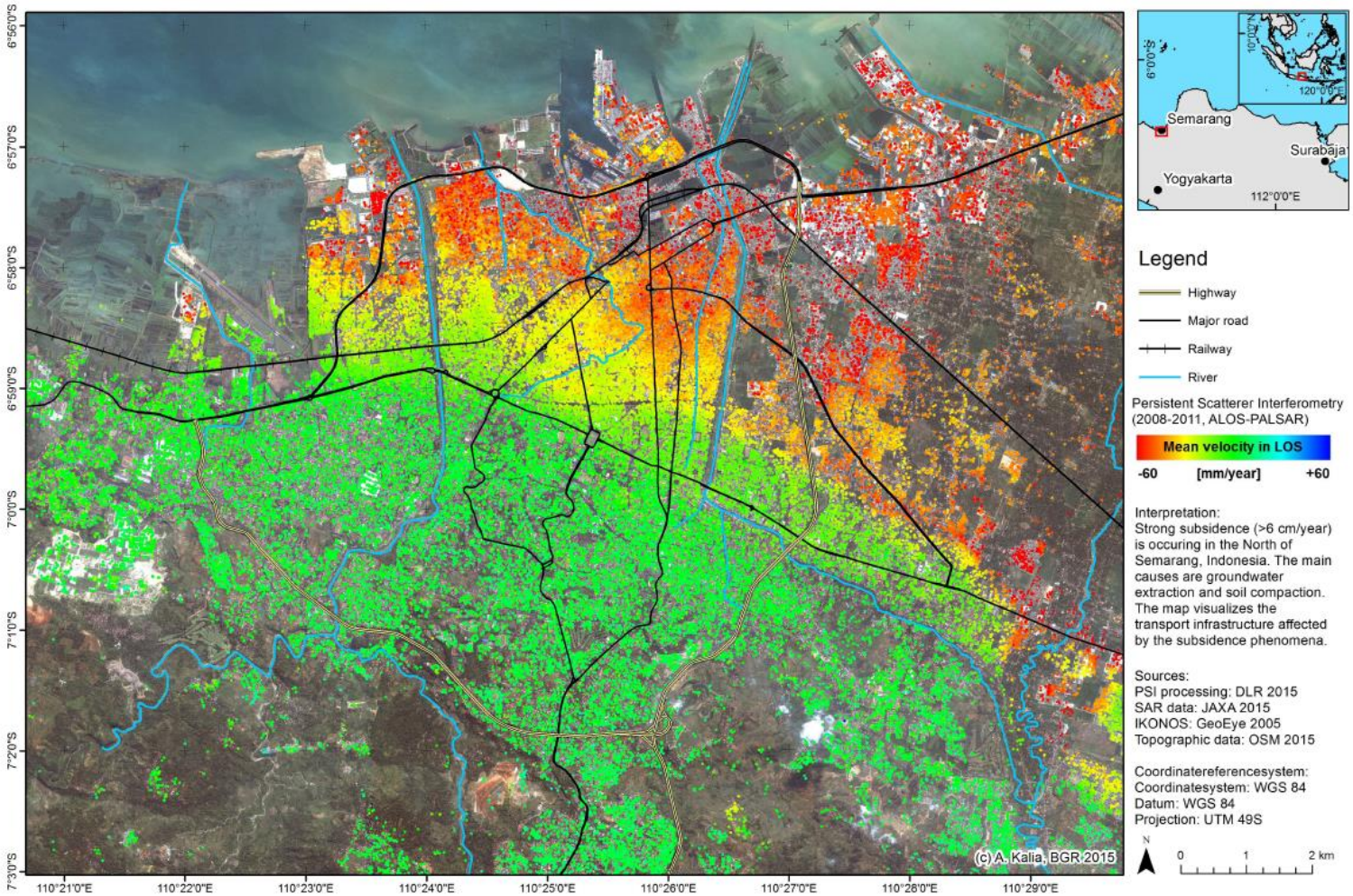
Subsidence in Cities increasing flood risks

- In river flood plains or coastal zones, an integrated view on ground subsidence and effects of Climate Change is necessary!

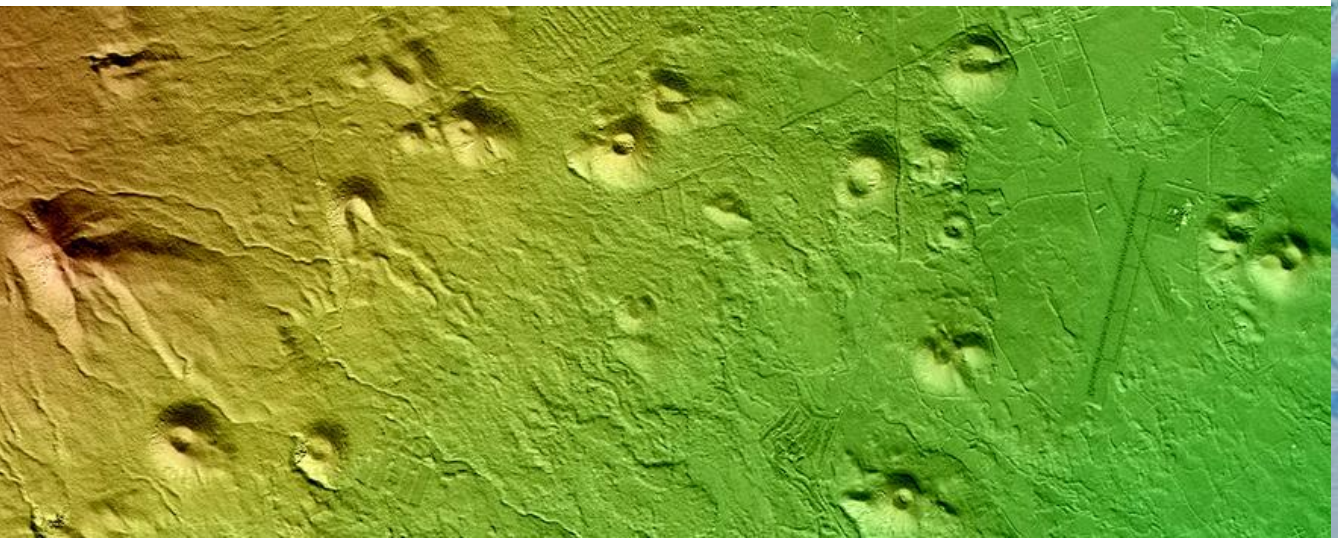
The Indonesian city of Semarang shows subsidence of more than 6cm p.a. due to groundwater extraction and soil compaction. (Analysis of ALOS-PalSAR data 2008-2011)

Many cities are sinking: Bangkok, Jacarta, Shanghai, New Orleans, St. Petersburg, Lissabon etc.



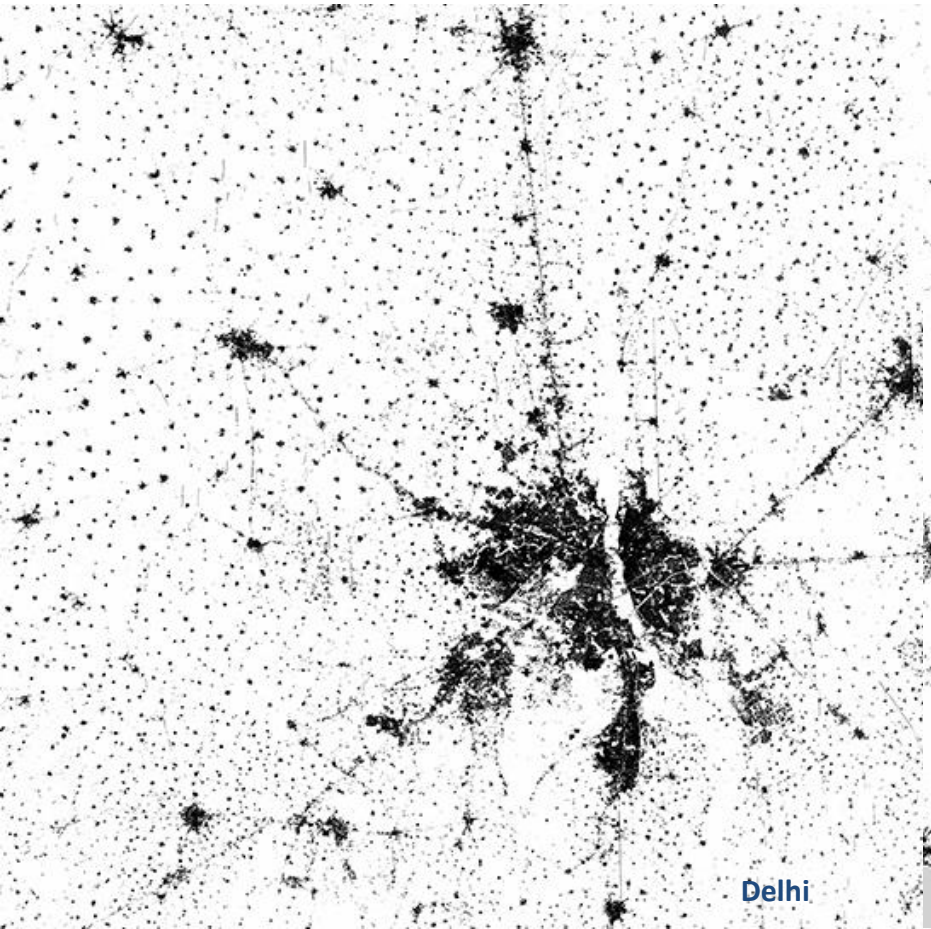
Digital Elevation Model (derived from the German TanDEM-X Mission)

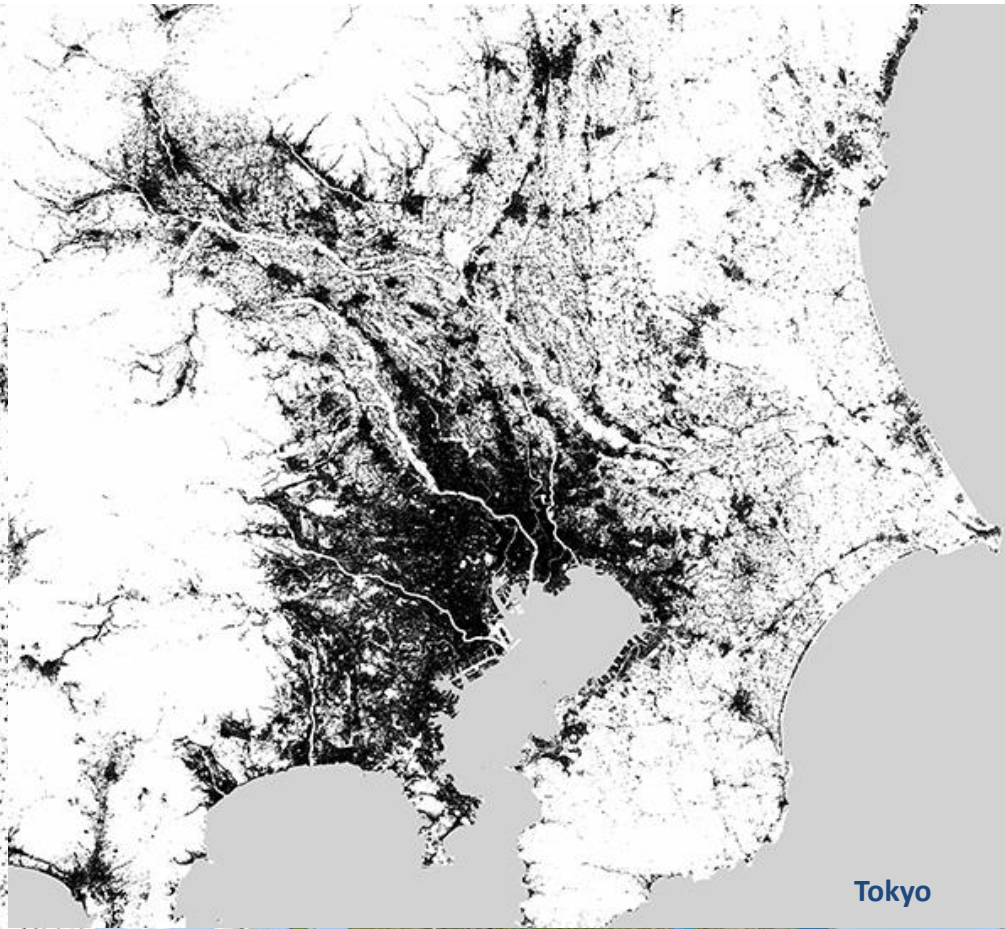
- global high-quality DEM (12m spatial resolution)
- DLR supports >500 scientific projects with DEM tiles
- Commercial access via Airbus (http://www.intelligence-airbusds.com/en/5689-worlddem-data-request-form) + long-term agreement between Airbus and UNPD
- reduced-resolution global DEM version freely available within the coming months (spatial resolution: 90m around the equator, better towards the poles)



Global Urban Footprint (www.dlr.de/guf)

- Precise Map of Human Settlements Location, derived from TanDEM-X acquisitions (12m resolution)
- Future versions will be based on Sentinel-1 data
- ~250 users (institutions) in >40 countries, e.g. Worldbank etc.





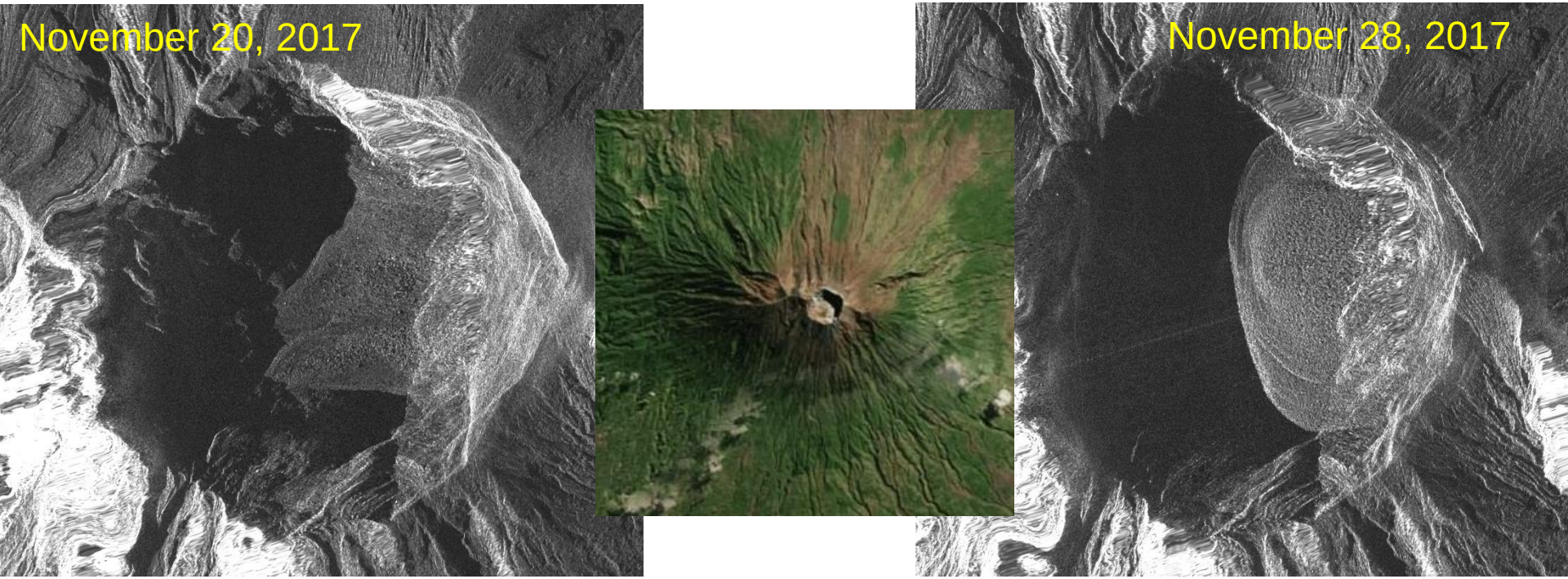
Understanding risk: Monitoring of volcanoes (1)

- 1500 potentially dangerous volcanoes on Earth, many of which are not well monitored.
- Local observatories can benefit from satellite-based observations, such as interferometric analyses of ground deformations based on radar-satellite data.

Mount Sinabung (Sumatra) was dormant for 400 years. Since August 2010 there have been many eruptions, claiming lives and displacing thousands of people.

Understanding risk: Mon. of volcanoes (2)

- Space agencies organised in the CEOS WG on Disasters intend to:
  - support volcanologists and local observatories in their work on volcano monitoring
  - pave the way towards more systematic / operational utilization of satellite-based observations



Cosmo Skymed radar amplitude images of the “Agung” volcano, shared by M. Poland/USGS

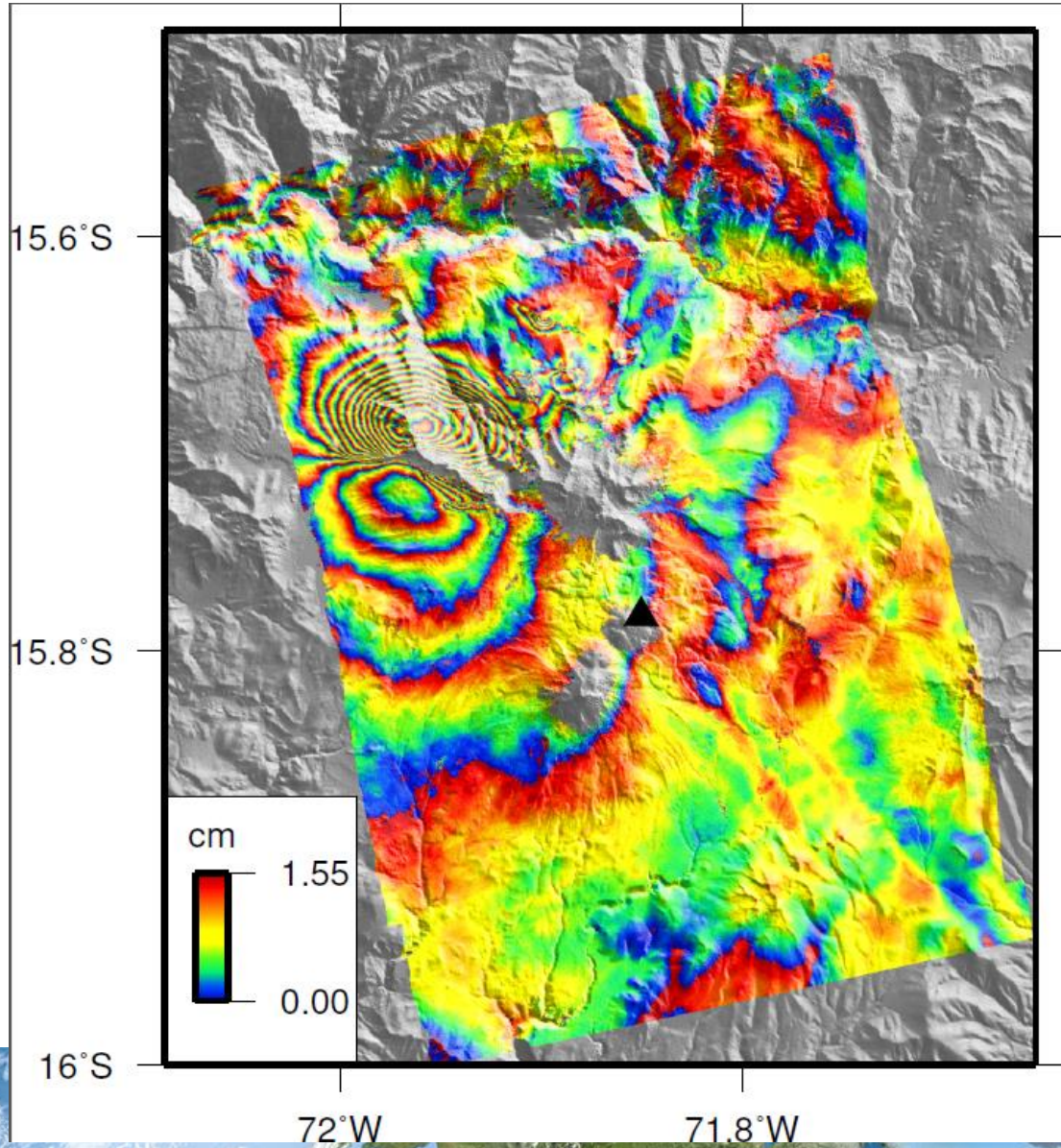
Understanding risk: Mon. of volcanoes (3)

- In February, 2013, earthquake activity increased at Sabancaya volcano in Peru. The CEOS volcano pilot provided satellite thermal and Interferometric SAR observations to the local observatory to help them assess what was happening.

- This interferogram from TerraSAR-X data spans 12 May to 17 July 2013 and includes a shallow earthquake (magnitude 5.9) that caused over 25 cm of ground displacement but did not show accumulation of a large, shallow body of magma near the volcano (black triangle).

- This data, along with satellite observations of increased temperature and ground observations, allowed locals to make informed decisions about the potential eruptive hazard - small eruptions occurred in 2014, 2015, and a continued threat further exist.

(Image credit: Jay et al. 2015)



Understanding risk: Monitoring of volcanoes (4)

Example of a user statement (Luis Lara, Director, Observatorio Volcanológico de los Andes del Sur (OVDAS, Chile) about radar satellite based results on Cordon Caulle which revealed that the volcano was reinflating after the cessation of an eruptive period in 2011-12):

“These [InSAR] results surprised OVDAS, as the volcano does not have geodetic instrumentation, and will lead to the deployment of the first c[ontinuous] GPS stations over the volcano.”

Conclusions and general remarks

- Satellite-based support to emergency response is operational

- Becoming an Authorized User of the Charter can help national Disaster Management Centres getting fast access to satellite-based information in the case of a major disaster

- Several applications with high potential for better understanding of risks are ready for more operational and widespread utilization
    - ➢ new partnerships, frameworks, ways of funding might be needed

- An integrated analysis of flood hazards related to Climate Change / Sea Level Rise and ground subsidence is needed

Many thanks for your attention!

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