Possible contributions of radar-based Earth Observation to Disaster Risk Reduction and Climate adaptation

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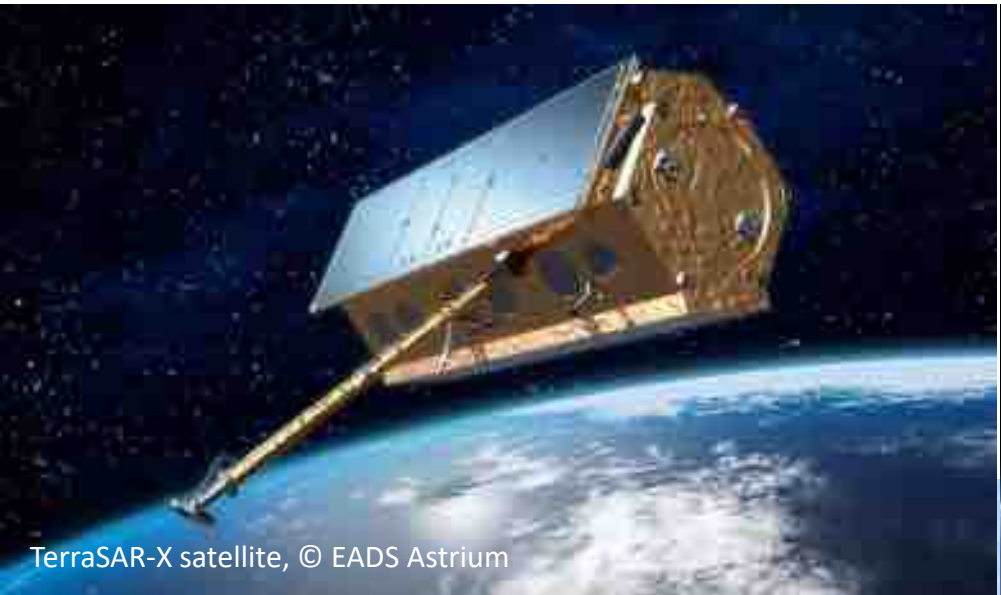
Radar satellites scanning Earth

- Availability of radar satellite data since the 1990s
- Satellites send microwaves down to Earth and receive the “echo”:
  - X-Band (short wavelength), C-Band, L-Band (long wavelength)
- Multiple applications – potential for increased utilisation in DRR
- Ability to generate precise Digital Elevations Models


TerraSAR-X satellite, © EADS Astrium


Sentinel-1 satellite, © ESA / ATG medialab

First TerraSAR-X Image!

Russia, West of Wolgograd,
19th June 2007

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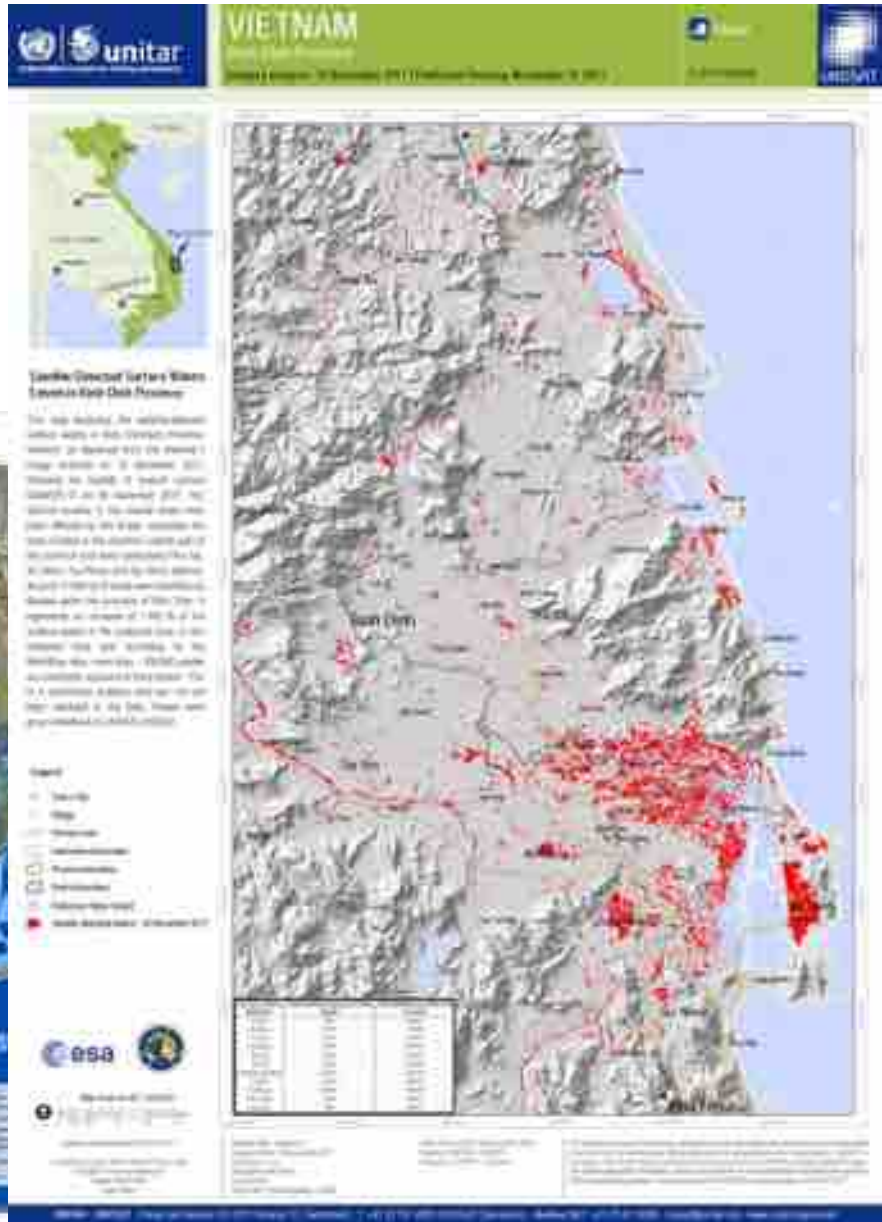
Flood mapping using radar satellite images

- Flood mapping capabilities operationally used by the Int. Charter, Copernicus, Sentinel Asia and others
- Disasters response phase



Support for other phases of the disaster management cycle

- Mitigation and Preparedness:
  - Better understanding / awareness of hazards
  - Assessment of hazards, exposure, and risks

- Early Warning

➢ A few examples will be provided in the following slides

Radar-based ground motion measurements

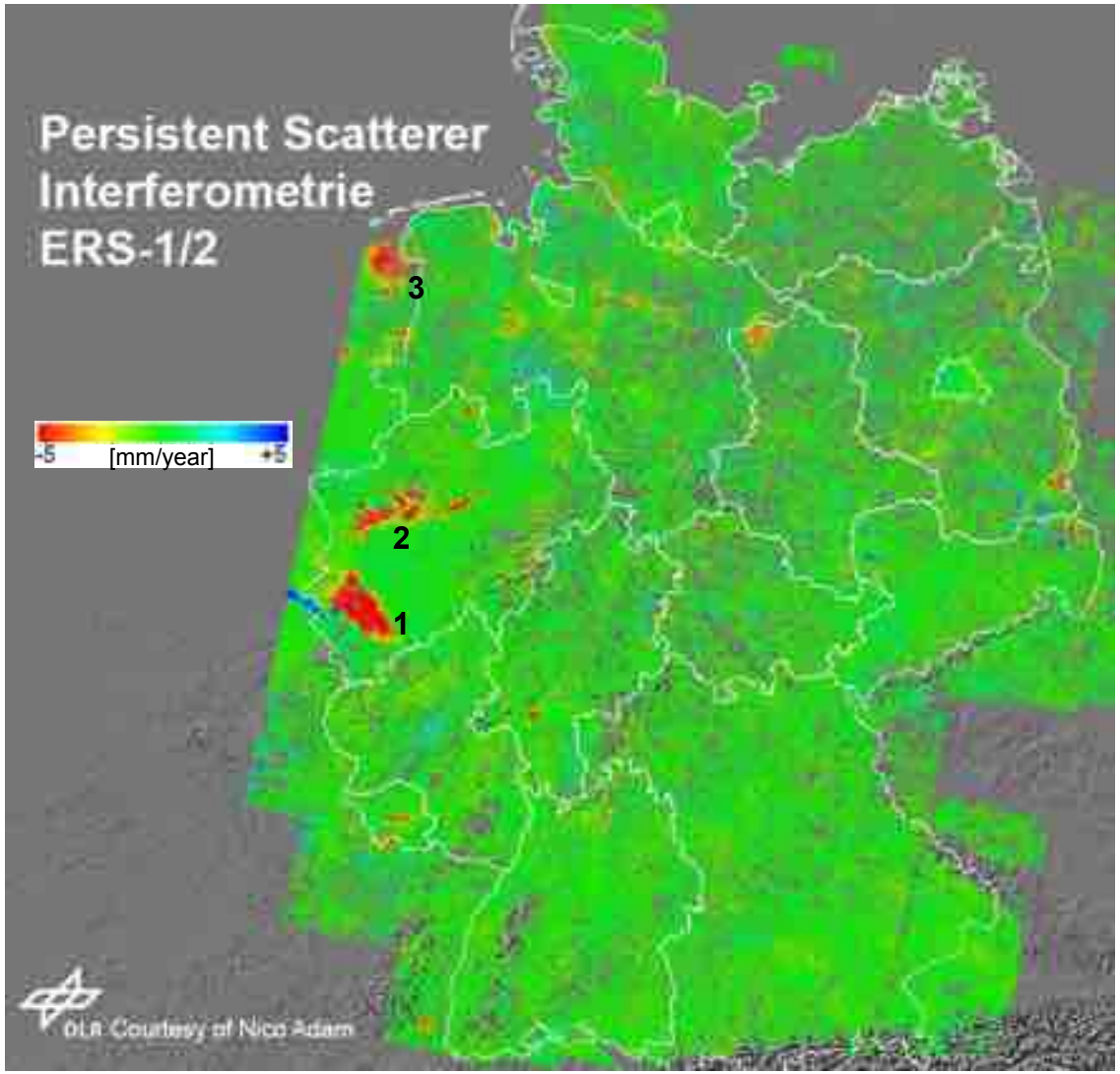
- Radar time series (ESA satellite data 1992-2001) allow precise measurement of ground movements

- 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)



Operational Ground Motion Service Germany

- Sentinel-1 based nationwide wide-area product in preparation
  - wide-area analysis will reveal a lot of small/slow motion features which could cause damage to buildings and infrastructure
- Small-scale features may require more focussed analysis using X-Band SAR
- 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.

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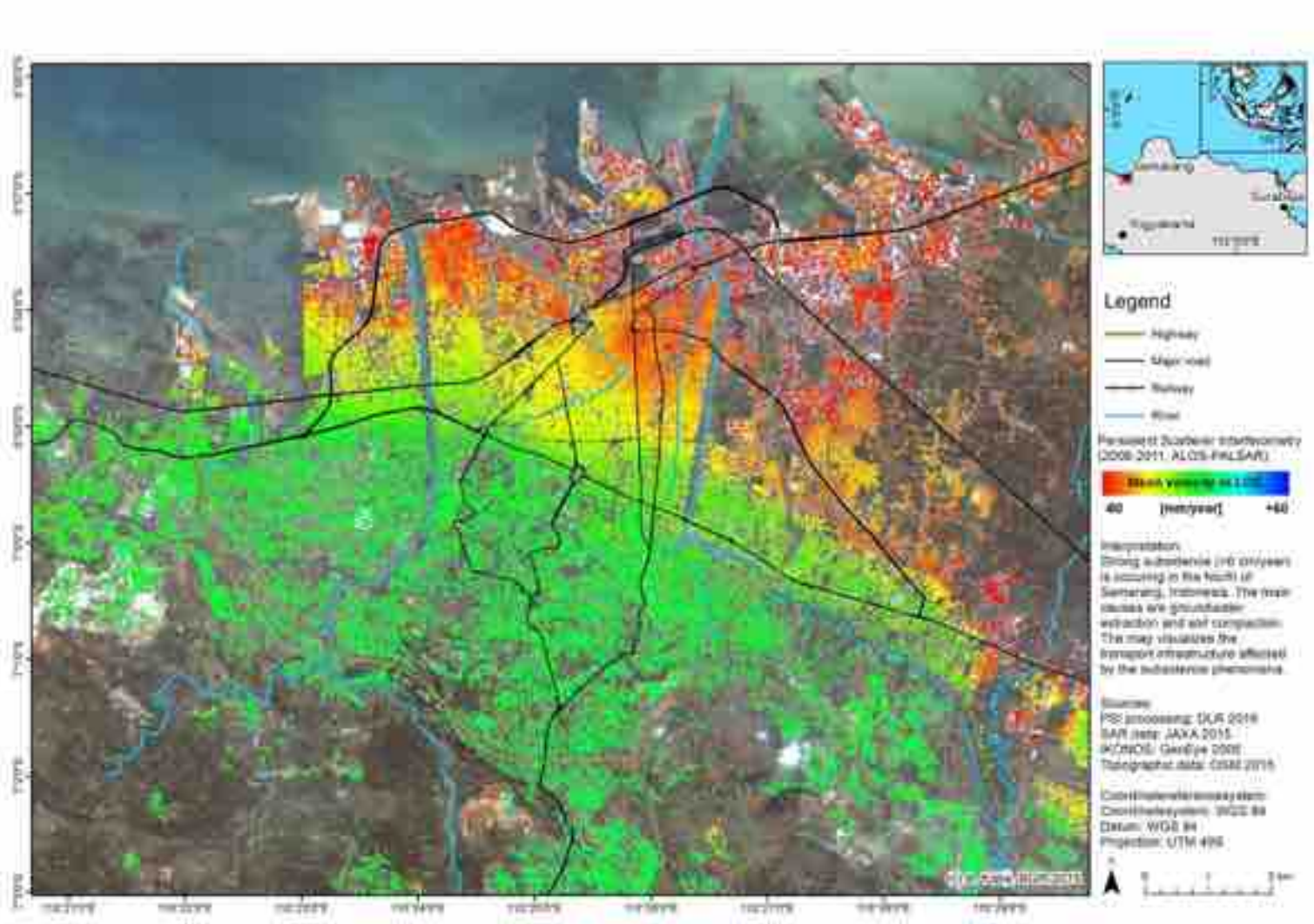
Subsidence in Cities increasing flood risks

- 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)

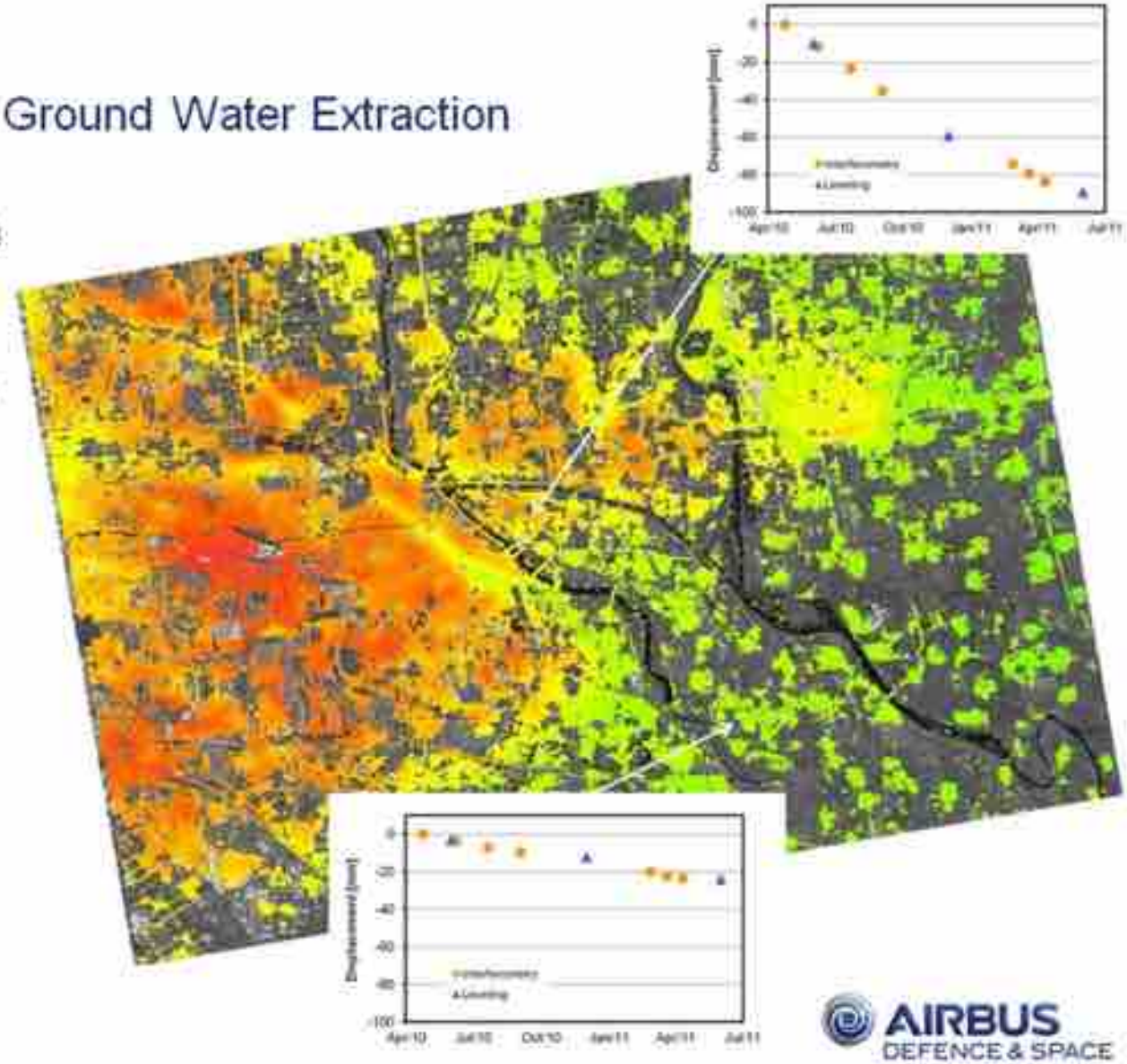
Many cities are sinking: Bangkok, Jacarta, Shanghai, New Orleans, St. Petersburg, Lissabon etc.



Subsidence in Cities – radar based analysis as a service

SBAS Example: Ground Water Extraction

- Beijing East, China
- Monitoring of surface movement induced by groundwater extraction



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Monitoring of volcanic activities

- 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.

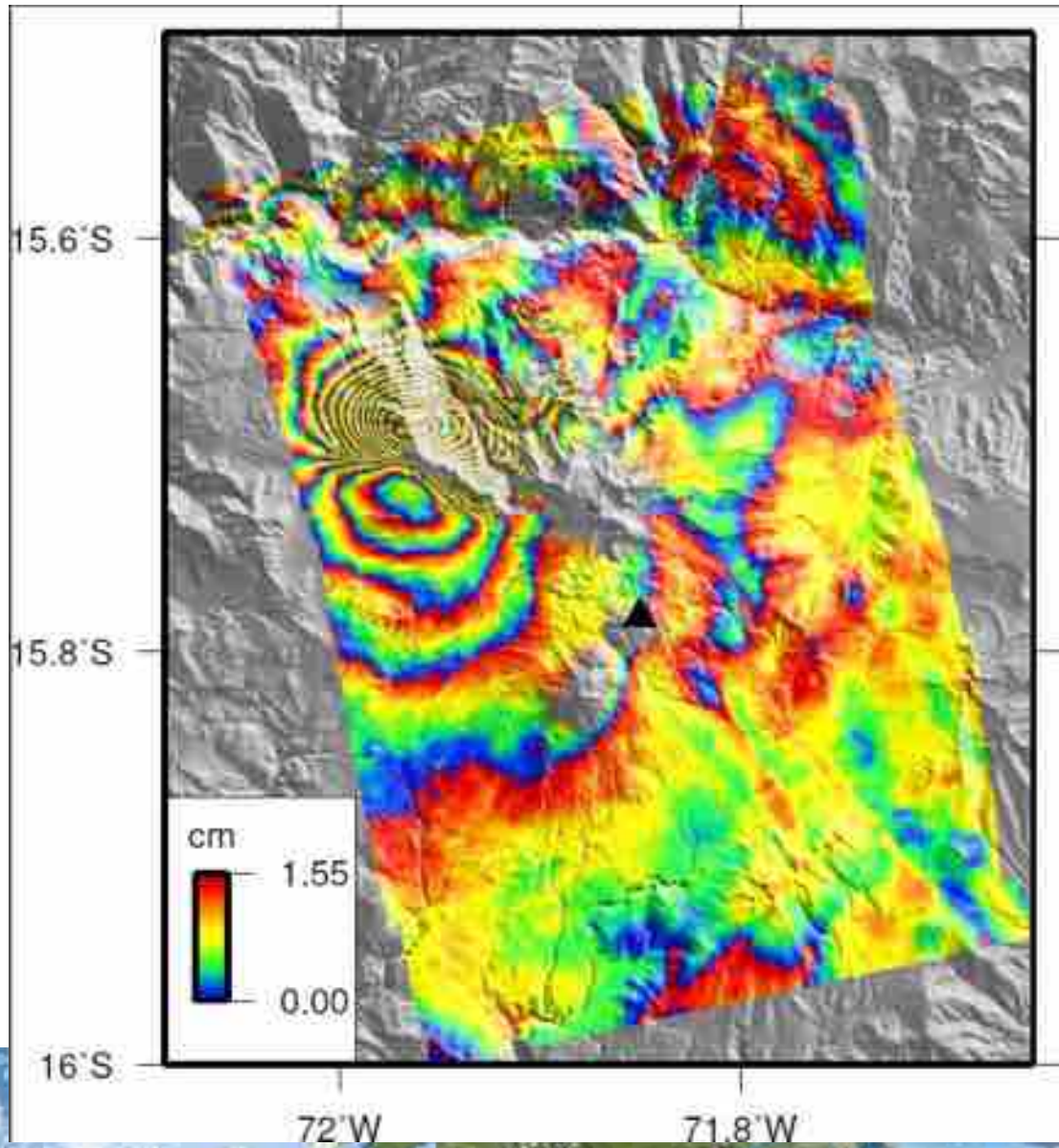
Monitoring of volcanic activities - example

- 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)



Monitoring of volcanic activities – User statements

- Patricia Mothes, Geophysicist, Instituto Geofísico (Ecuador) about results on the volcanoes Chiles and Cerro Negro that underwent a period of seismic unrest in 2013-14, coupled with uplift of a nearby GPS station:
  "The interferograms that no longer showed significant displacements, as well as the descending GPS data values, along with a lowering of the energy levels of the overall seismic events, were fundamental in helping us arrive to the decision to lower the alert level from orange to yellow."

- 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."

Monitoring of volcanic activities – the way forward

- Space agencies organised in CEOS and the CEOS WG on Disasters intend to:
  - further support volcanologists in their work on volcano monitoring
  - pave the way towards more systematic / operational utilization of satellite-based observations
    (however, a “big solution” would require considerable funding)

- GEO/CEOS Geohazard Supersites and Natural Laboratories (GSNL):
  - new Supersites just agreed for supporting research of the Southern Andes volcanoes and the Eastern African Virunga volcanoes
    (for more info see http://www.earthobservations.org/gsnl.php)

GEO GROUP ON EARTH OBSERVATIONS

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Radar-based Digital Elevation Model

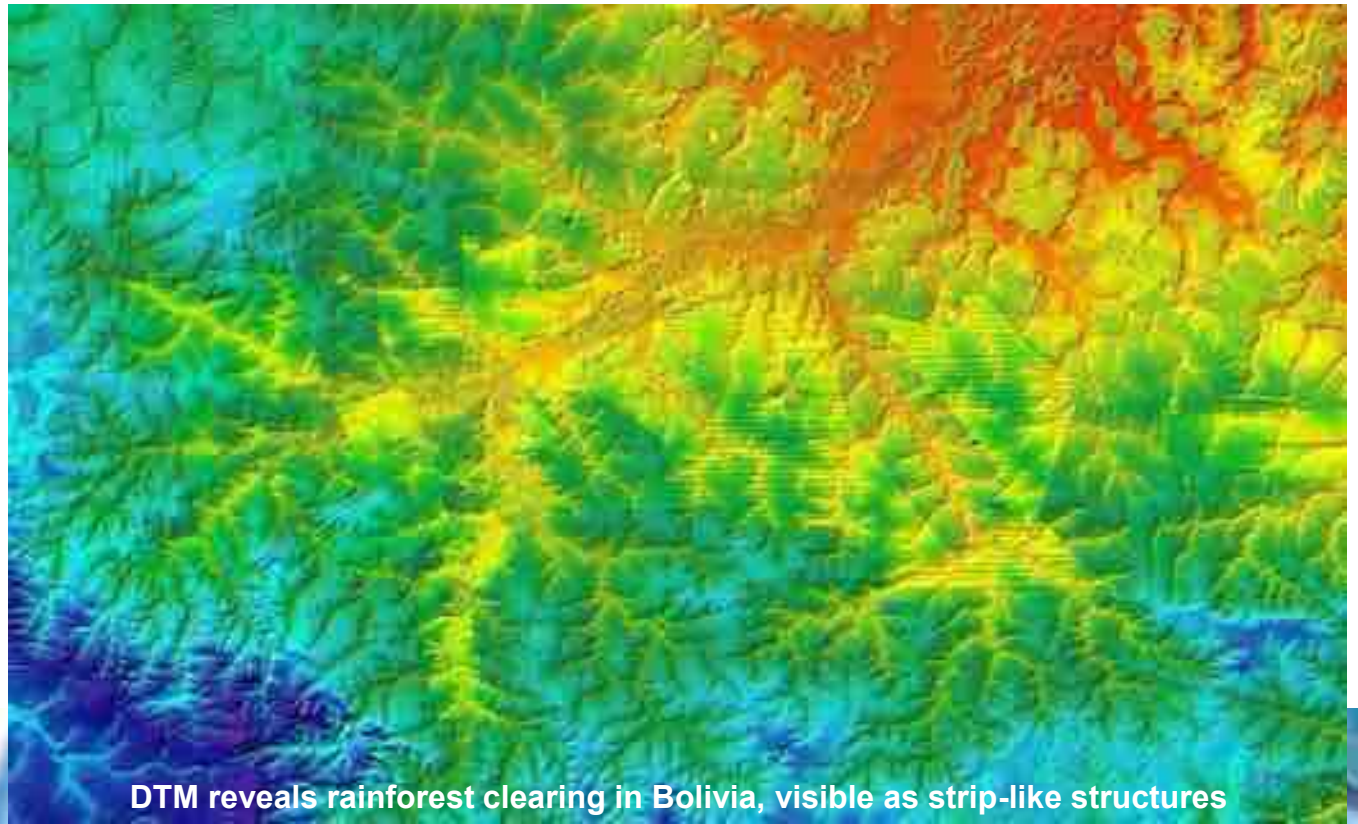
- TanDEM-X mission resulted in a global high-quality DEM (12m spatial resolution)
- Researcher's access: https://tandemx-science.dlr.de (research proposal required)
  - More than 500 scientific proposals are supported (with DEM tiles)
- Commercial access: http://www.intelligence-airbusds.com/en/5689-worlddem-data-request-form

Jeju volcanic island (South Korea)

Radar-based Digital Elevation Model

- Access for UN organisations: long-term agreement between Airbus with UN Procurement Department (UNPD) on commercial provision of Geo Information, including the World DEM.

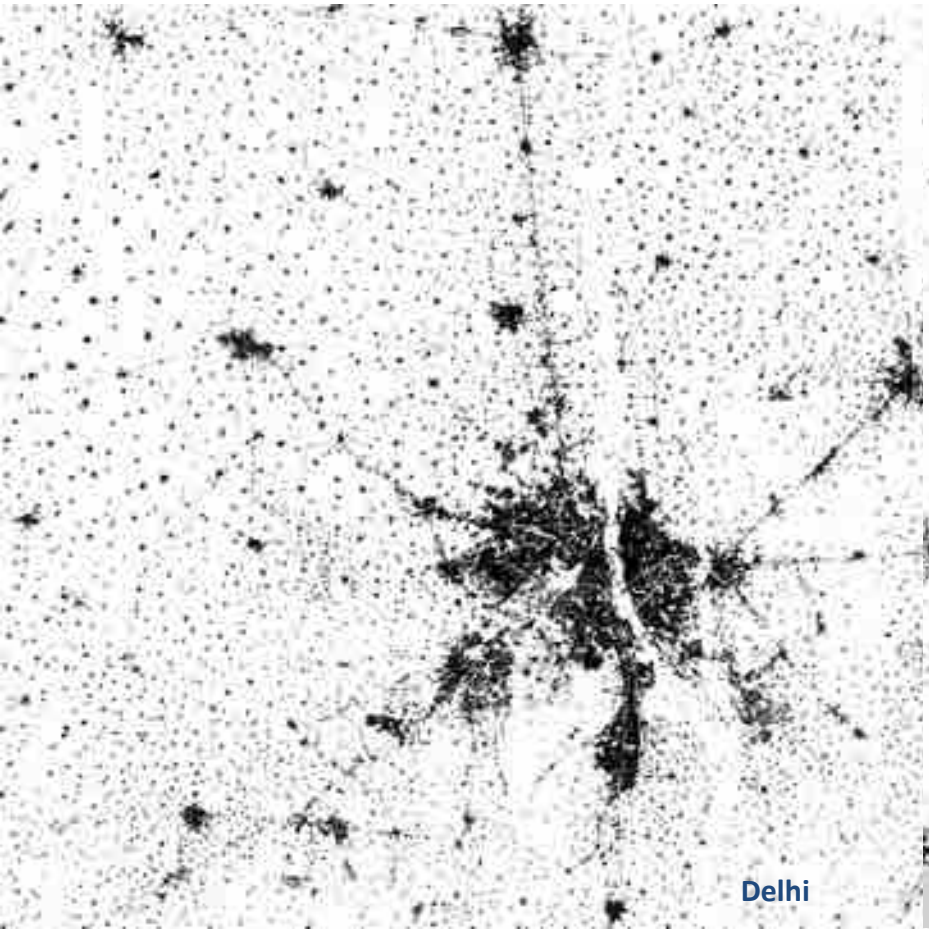
- Plan to make a reduced-resolution global DEM version freely available within the coming months (spatial resolution: 90m around the equator, better towards the poles)

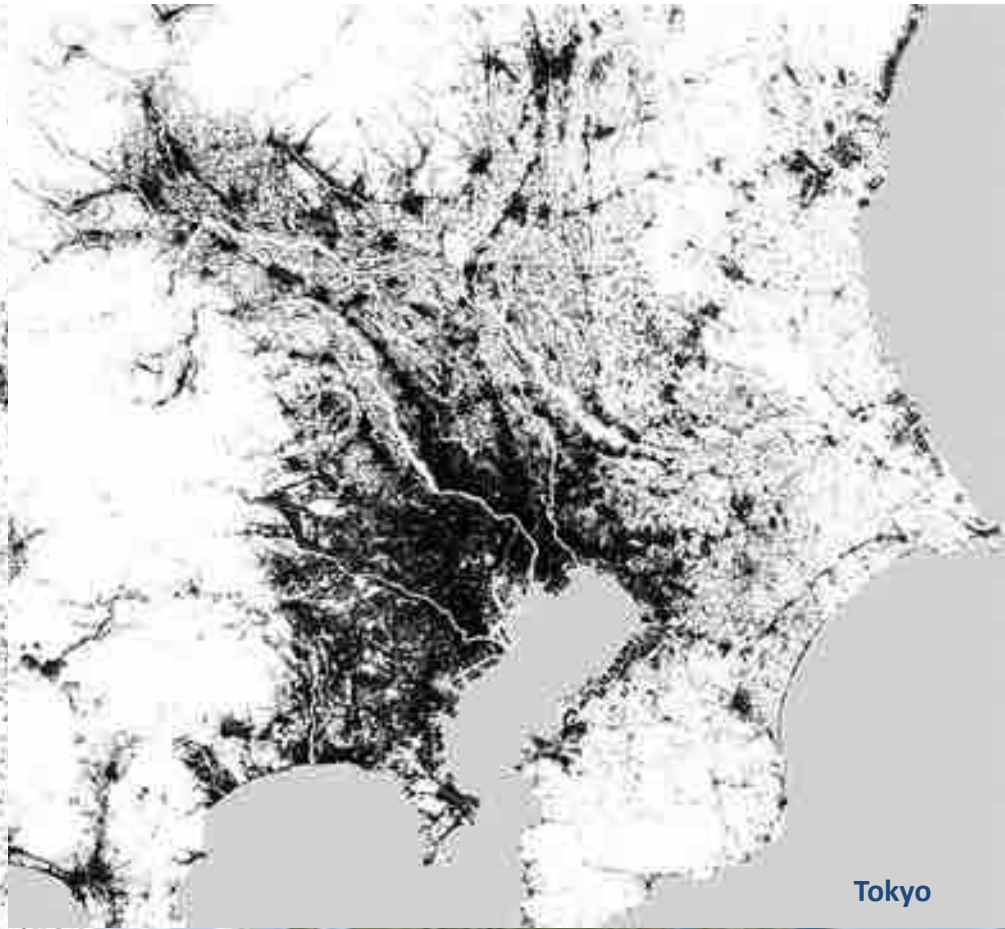


DTM reveals rainforest clearing in Bolivia, visible as strip-like structures

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.





Conclusions: Radar-based Earth observation for DRR and Climate adaption

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

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

- Radar satellites deliver DEMs which support risk assessment (e.g. loss & damage related to SLR or more extreme river floods)

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Many thanks for your attention!

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