

Satellite Earth Observation & Disaster Risks

ESA's overview of EO capabilities for Disaster Risk Management

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GFDRR
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Cooperative Governance
Traditional Affairs



ISDR





Are satellite data useful for
Disaster Risk Management (DRM)?

What the European Space Agency does in DRM:

- ESA is taking part to international collaborations concerning DRM
- one of the founders of the International Charter Space & Major Disasters (2000)
- it is part since 2011 of the CEOS Ad Hoc team on DRM (with 9 other space agencies) looking at enlarged actions augment/accelerate how EO can contribute to DRM



International Charter Space & Major Disasters (CHARTER)



Global Earth Observing System of Systems (GEOSS)



Global Monitoring for Environment & Security (GMES)



Integrated Global Observing Strategy (IGOS)



Committee for Earth Observation Systems (CEOS)

- Emergency Response,
 - Rapid Crisis Mapping & Damage Assessment,
 - Situation Mapping.

- Prevention, Preparedness, Recovery, Reconstruction
 - Detailed Damage Mapping,
 - Risks Assessment.

(Floods, Fires, Geo-Hazards)

- All phases
 - Reference Mapping,
 - Digital Elevation and Digital Terrain models,
 - LU/LC cover Mapping,
 - Asset Mapping.



EO techniques (in red) both in response phases and other phases of risk management (such as prevention)

Satellite EO can help science & operational users in:

1. Exposure/Asset mapping/Asset modeling

A wealth of information types (many areas)

2. Hazard mapping - *for instance*:

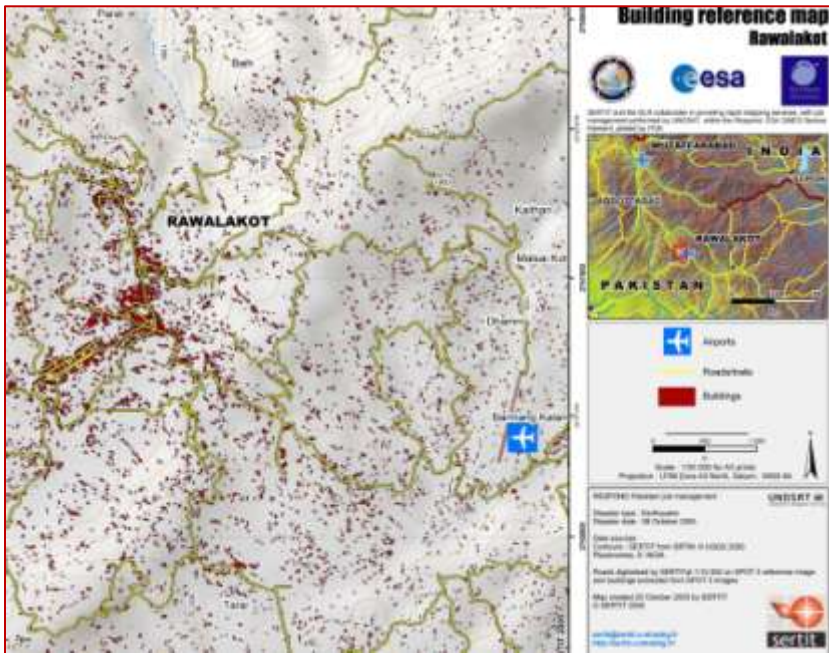
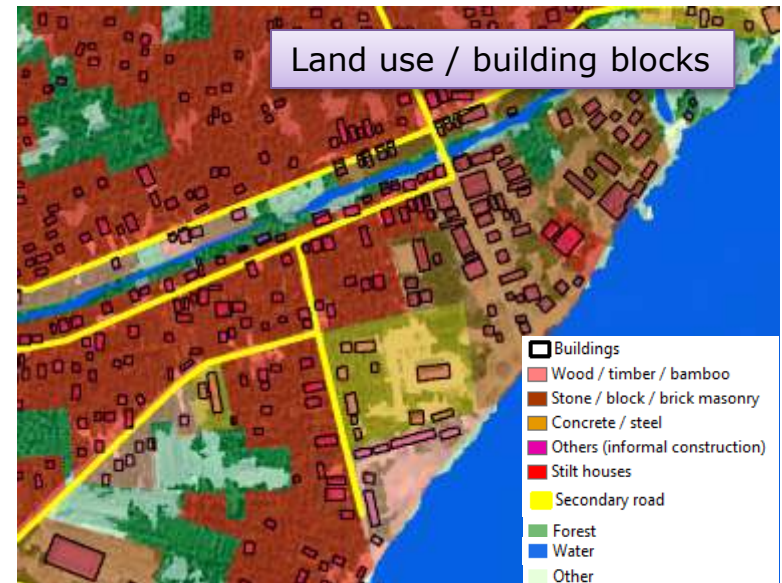
- . scientific data to better characterize/monitor hazards
- . operations: low level of sophistication but rapid information on the hazard impact (and damage zoning)
- . operations: sophisticated information on hazard/risk (e.g. risk inventory)

Urban mapping of buildings & infrastructure

Land use map with building and infrastructure inventory over Cambodia:

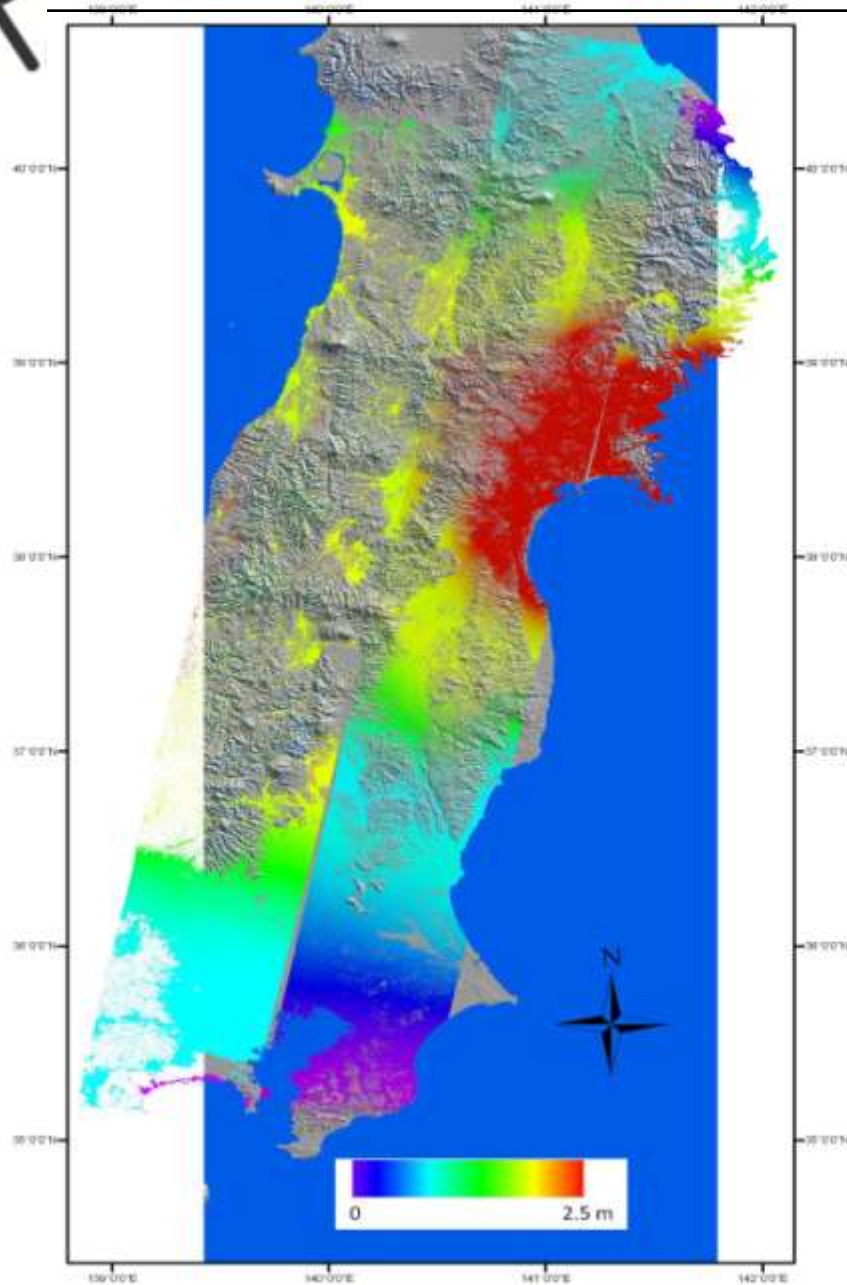
Copyright: GeoVille for ESA / World Bank

- Infrastructure and building inventory on building block level
- Database of building parameters & construction classes
- 86% of the buildings are small structures < 100 m²
- 90% of the settlement area are low-density stilt-houses with 2 stories and a distance of < 100 m to a road



Wood / timber / bamboo (1%)	Other (e.g. informal constructions) (1%)
Adobe / mud walls (0%)	Stilt house (concrete stilts) (27%)
Stone / brick / block masonry (0%)	Stilt house (wooden stilts) (56%)
Concrete / steel (1%)	Stilt house (simple / bamboo stilts) (6%)

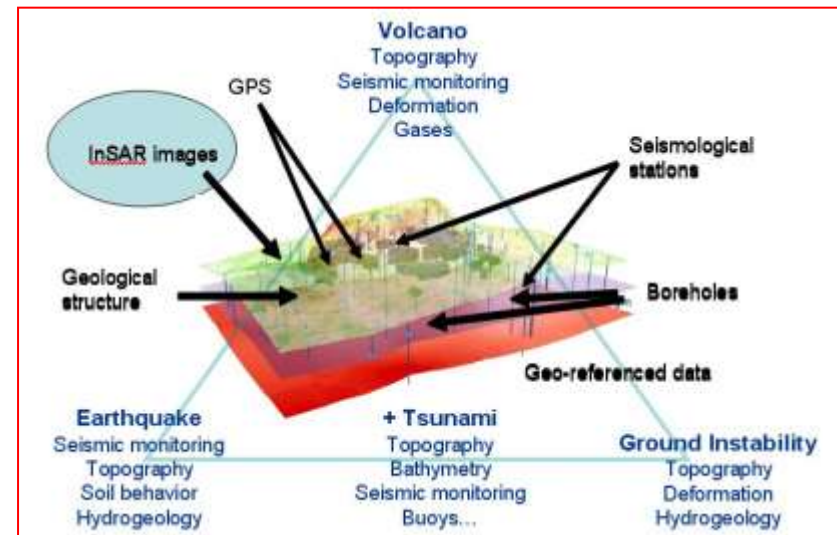
Tohoku Oki EQ: SAR Interferometry for science



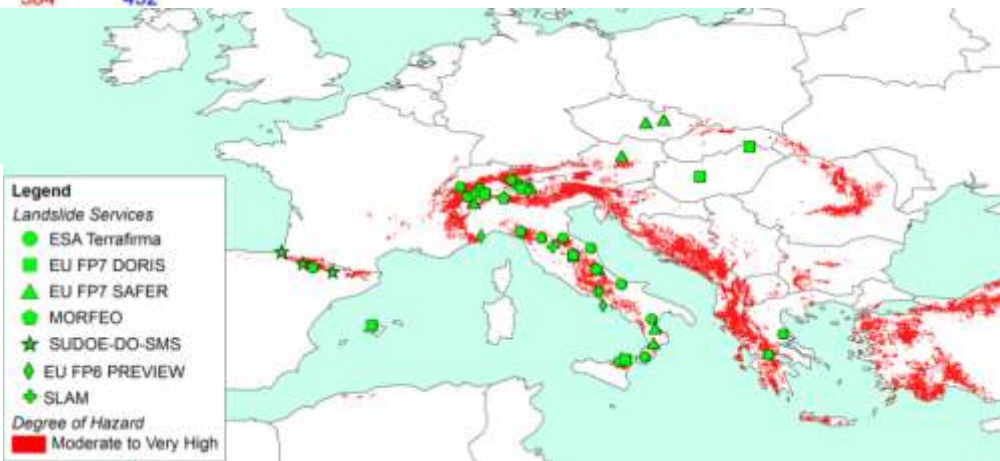
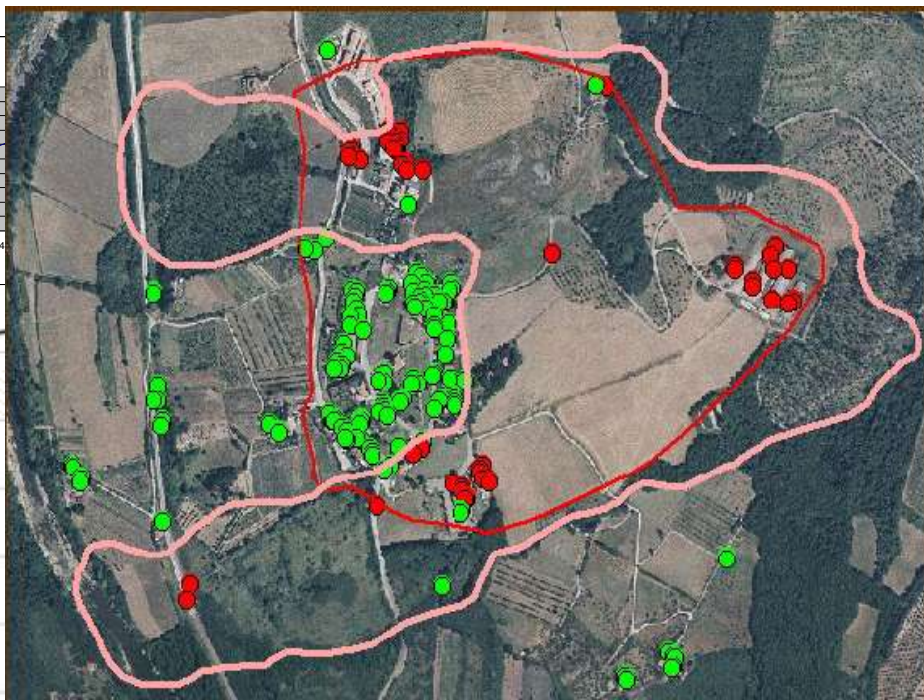
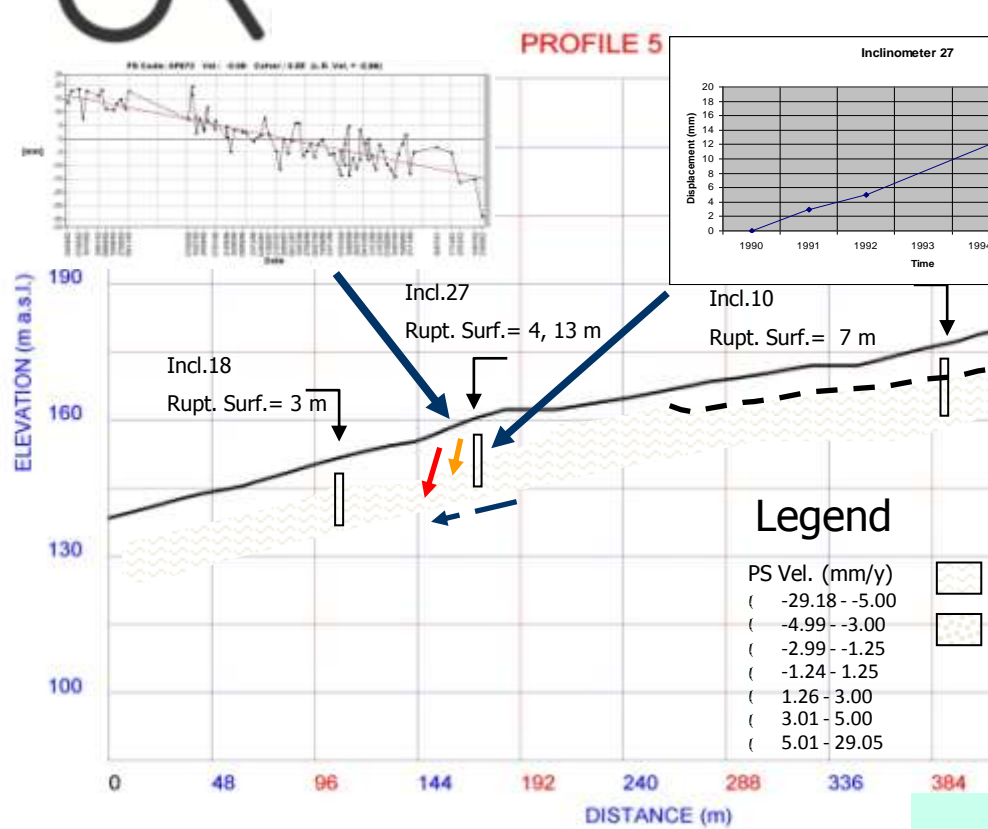
Interferogram processed by INGV using 3 post-Earthquake acquisitions from ENVISAT ASAR & reference data (800+km segment, tracks from E to W: 74, 347 & 189)

Displacement map (scale: 0-2.5m, line-of-sight measurement)

Credits: INGV, ENVISAT Data: copyright ESA; INGV is the Tectonics Theme Leader of ESA's project TerraFirma.

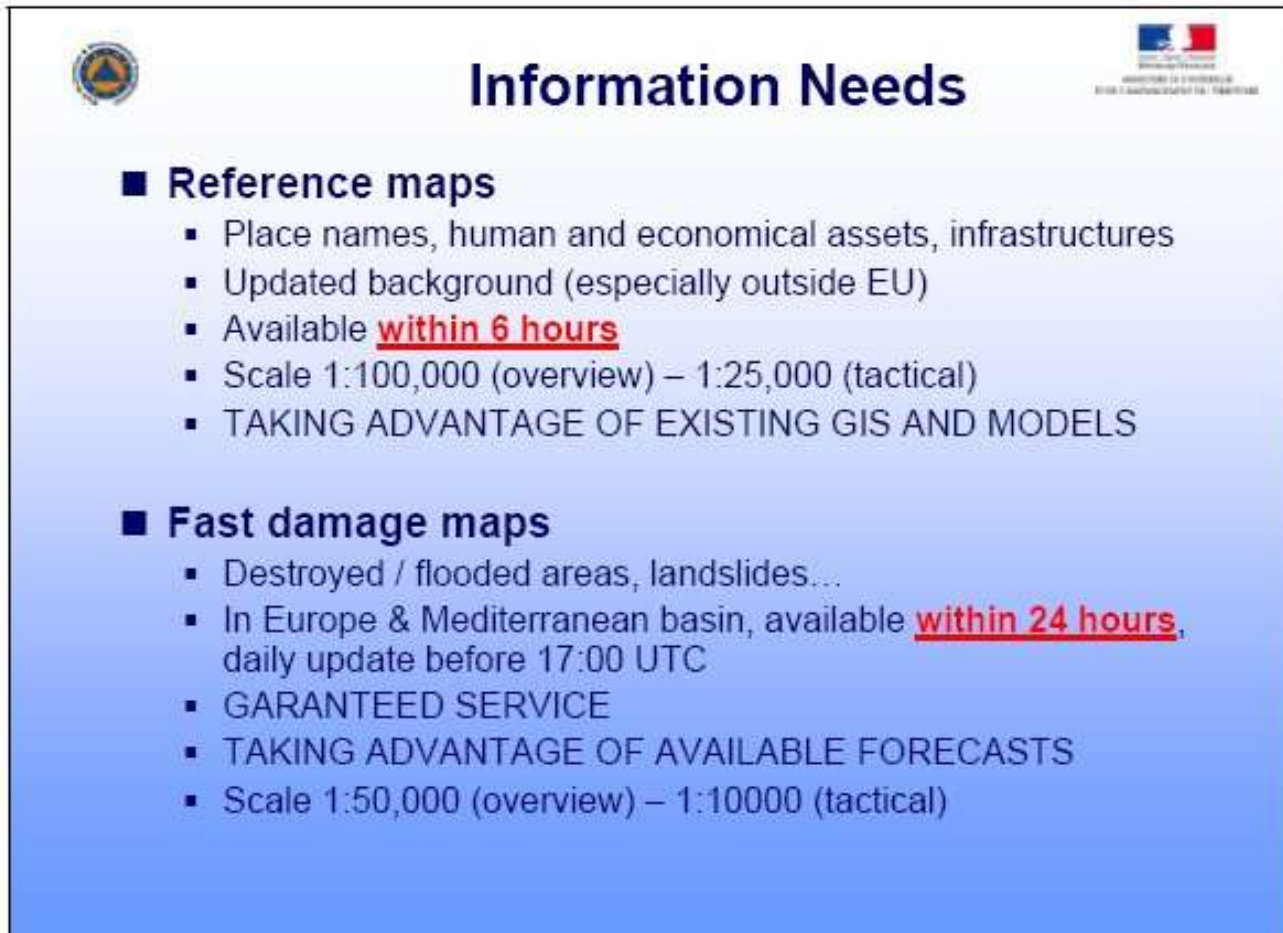


Landslide Displacement Monitoring



Left: geologic information integrated with ground measurements (inclinometer readings) and PS-derived information, to define or refine a model of an existing landslide. Right: This product has been used by the Arno AdB to refine the limits of the Risk-zones for which it is legally responsible (Carbonile: Red: previous R3/4 area, Pink: revised R3/4 area). Credits: TRE Europa, UNIFI.

- An International agreement among Space Agencies to support with space-based data and information relief efforts in the event of emergencies caused by major disasters.
 - **Disaster response**
 - **Multi-satellite data acquisition planning**
 - Fast data turn-around – priority acquisition
 - **Archive retrievals and spacecraft tasking**
 - **Data processing at pre-determined level**
 - **Space Agency contribution in image/data**
 - **Space Agency initiative for value-added-data fusion**



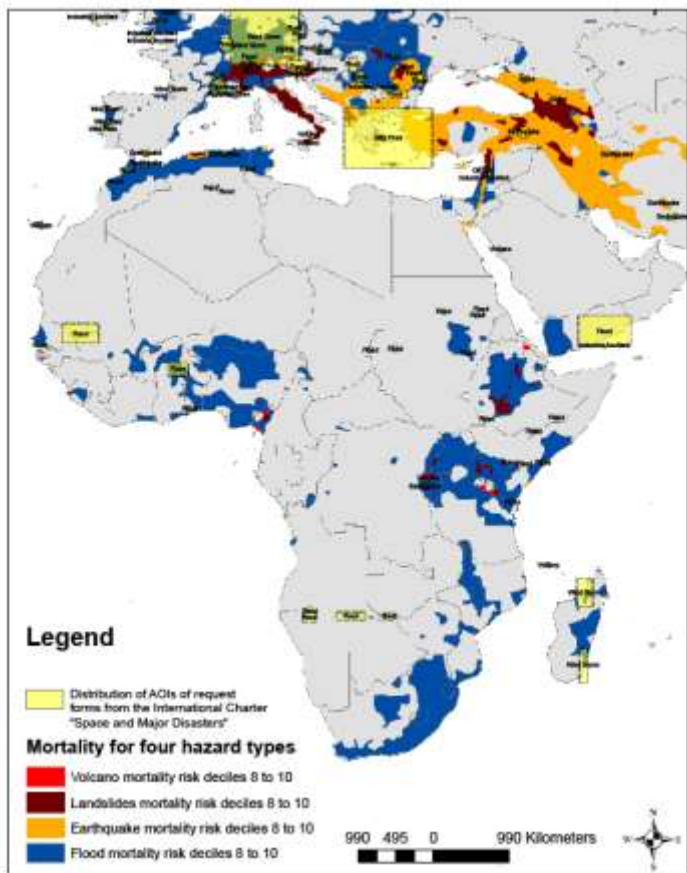
The slide is titled "Information Needs" and features a blue gradient background. It includes logos for the University of Regensburg (UR) and the French Republic. The content is organized into two main sections: "Reference maps" and "Fast damage maps", each with a list of bullet points. The text is in a sans-serif font, with key timeframes highlighted in red.

Information Needs

- **Reference maps**
 - Place names, human and economical assets, infrastructures
 - Updated background (especially outside EU)
 - Available **within 6 hours**
 - Scale 1:100,000 (overview) – 1:25,000 (tactical)
 - TAKING ADVANTAGE OF EXISTING GIS AND MODELS
- **Fast damage maps**
 - Destroyed / flooded areas, landslides...
 - In Europe & Mediterranean basin, available **within 24 hours**, daily update before 17:00 UTC
 - GARANTEED SERVICE
 - TAKING ADVANTAGE OF AVAILABLE FORECASTS
 - Scale 1:50,000 (overview) – 1:10000 (tactical)

- **weather-related** hazards such as Floods, Forest Fires, Ice Jams, Landslides, Storms (e.g. hurricanes, cyclones, typhoons, tornados)
- **geo-hazards** such as Earthquakes (and landslides), Tsunamis (provoked by submarine earthquakes), Volcanic eruptions.
- **technological disasters** such as Oil Spills due to platforms or ships accidents.

Distribution of disaster risks in Africa



Weather-related hazards

Floods
(average annual frequency)

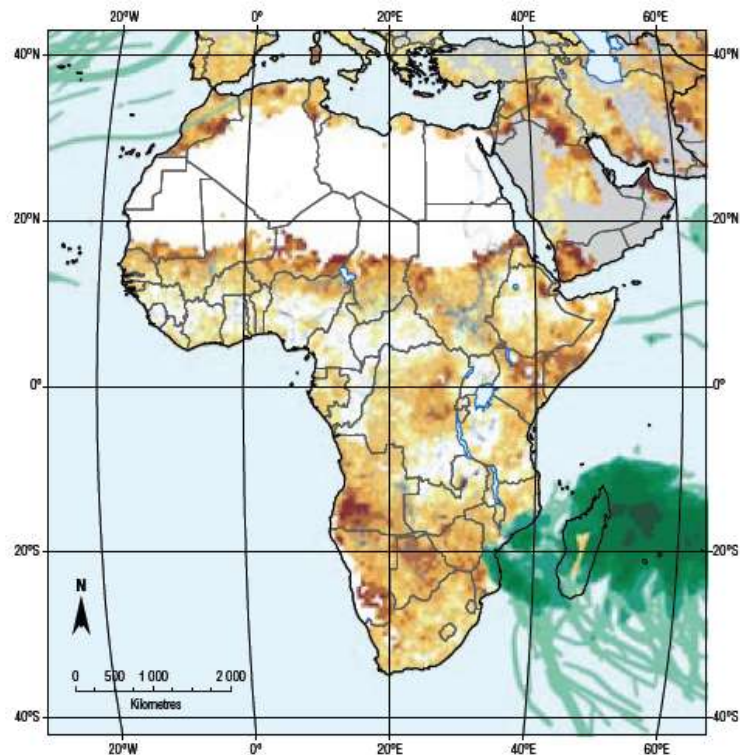
- Dark blue: >50
- Medium blue: 20-50
- Light blue: <20

Tropical cyclones
(sum of winds in km/year)

- Dark green: 100 000-426 510
- Green: 30 000-100 000
- Light green: 10 000-30 000
- Very light green: 3 000-10 000
- White: <3 000

Droughts index
(frequency and intensity)

- Dark brown: Very high
- Brown: High
- Orange-brown: Moderate high
- Light orange: Moderate low
- Yellow: Low
- Light blue: Lakes and oceans
- White: Regional extent
- Grey: Other regions

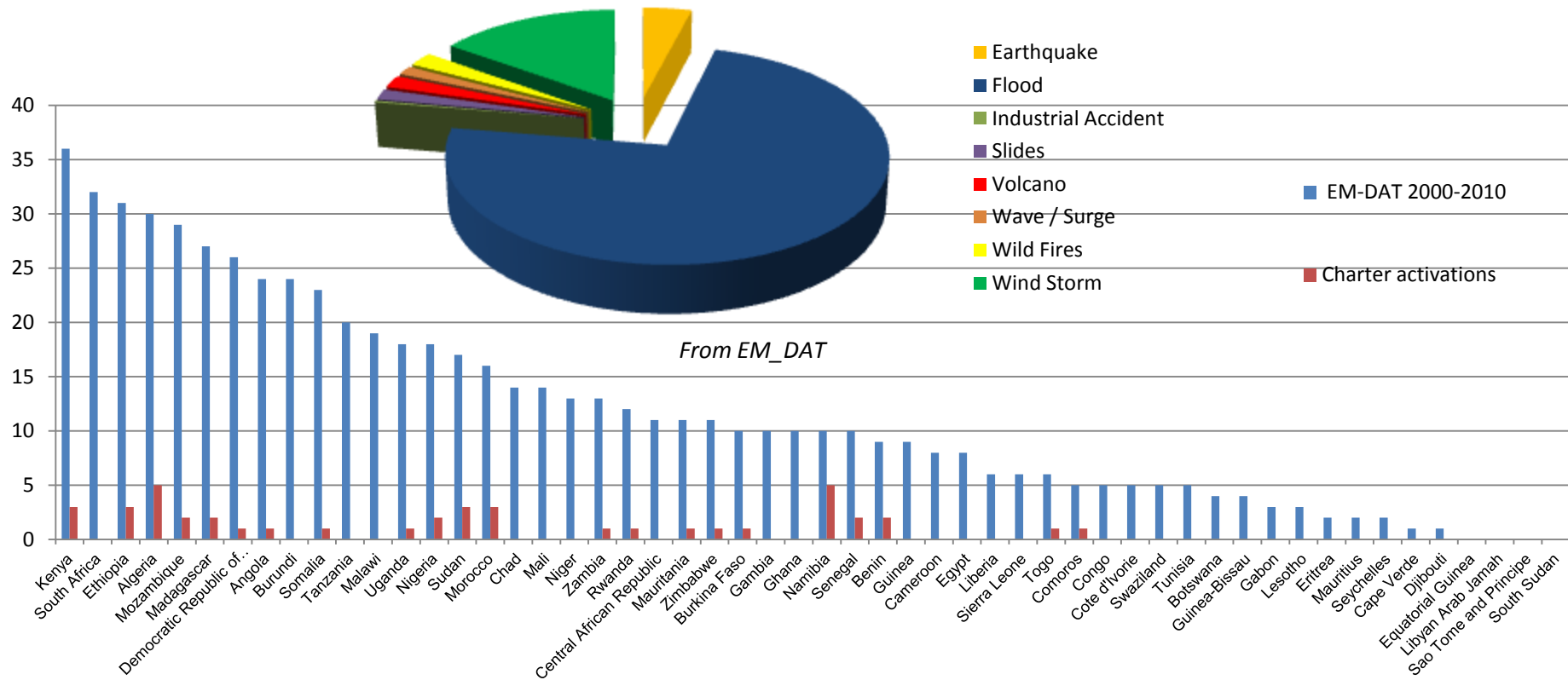


ISDR/GAR 2009 – Chapter 2 : Multiple hazard maps of Africa.
From various data sources. Cartography P. Peduzzi, ISDR, UNEP/GRID – Europe, 2009.

- ✓ **Hydro-meteorological hazards** (drought, flood, tropical cyclone) are much more present & frequent than geo-hazards (earthquakes, volcanoes, landslide).
- ✓ **epidemics and insect infestations** (in particular in the Sahel region) are other causes of disasters with high impact on population.

Africa: Charter activations (2000-2011)

41 Charter activations in Africa, 22* of 54 countries have benefited from the Charter.



* Kenya, Algeria, Ethiopia, Mozambique, Madagascar, DRC, Angola, Somalia, Uganda, Nigeria, Sudan, Morocco, Zambia, Rwanda, Mauritania, Zimbabwe, Burkina Faso, Namibia, Senegal, Benin, Togo, Comoros.

- Disaster Management Authorities from countries of Charter member agencies (40 countries today).
- for emergencies in their own country, in another country with which they cooperate for disaster relief.
- UN relief agencies can also activate the Charter via UNOOSA and UNITAR/UNOSAT

- ✓ Charter members, conscious of the need to improve Charter access globally, have adopted the principle of Universal Access, extending direct access to new countries :
 - ❑ **any national disaster management authority** is able to request emergency response, **provided conditions and procedures are met**
 - ❑ **Conditions** :
 - The entity must be a national disaster management authority or its delegated agency in that country
 - The entity must have the capacity to download and utilize maps *
 - The entity must be able to submit and pursue its activation requests in English.
- * either remotely sensed imagery or derived products or VA products (e.g. crisis or damage assessment maps).

List of National Authorities met (2009 – 2012)

Country	National Disaster Management Authority (DMA)	Other organisations
Ethiopia	Early Warning and Response Directorate	–
Uganda	Department of Disaster Management, Office of the Prime Minister	–
South Africa	National Disaster Management Center (NDMC)	4 nat. Org (among them CSIR/SAC)
Mozambique	Istituto Nacional de Gestão de Calamidades INGC (National operational Centre for Emergency)	8 nat. org; 7 intern/humanitarian org.
Mali	Department of Civil Protection – Min. Sécurité Intérieure et de la Prot, Civile	2 nat.org
Niger	Prime Minister Office/ Early Warning System	4 nat. org.
Namibia	Office of the Prime Minister/ Directorate Disaster Risk Management (OPM/ DDRM)	12 nat. org 2 Intern/humanitarian org
Zambia	Disaster Management and Mitigation Office of the Vice President	4 nat. org
Senegal	Senegal Forum for DRR / Ministry of Interior/ Fire Brigade	11 nat. org. 1 Intern/humanitarian org
Burkina Faso	CONASUR (Conseil National de Secours d’Urgence et de Réhabilitation)	20 nat.org, 4 international /humanitarian org
Democratic Republic of Congo	Civil Protection Department	8 nat.org, 1 international /humanitarian org
Kenya	National (Disaster) Operation Centre (NDOC) - Office of the President	4 nat.org, 1 regional org., 2 international /humanitarian org
Tanzania	Disaster Management Department, Prime Minister' s office	9 nat.org, 1 international /humanitarian org
Madagascar	Bureau National de Gestion des Risques et Catastrophes - BNGRC	7 nat.org, 4 international /humanitarian org
Botswana	National Disaster Management Office - NDMO	11 nat. org, 1 reg org (SADC)

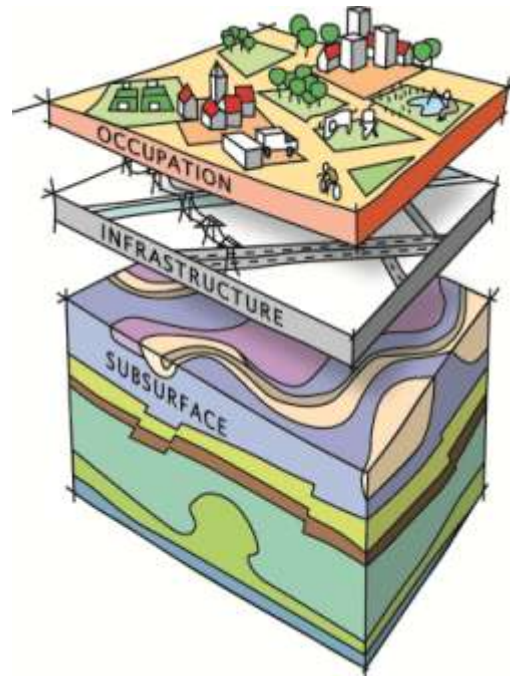
.....A few illustrations of how Satellite data can contribute to different phases of risk management.....

Terrain deformation maps to support mitigation:

Case Study: Analysis of Land Subsidence in Jakarta



Extensometer at old Geology Office Jalan Tongkol

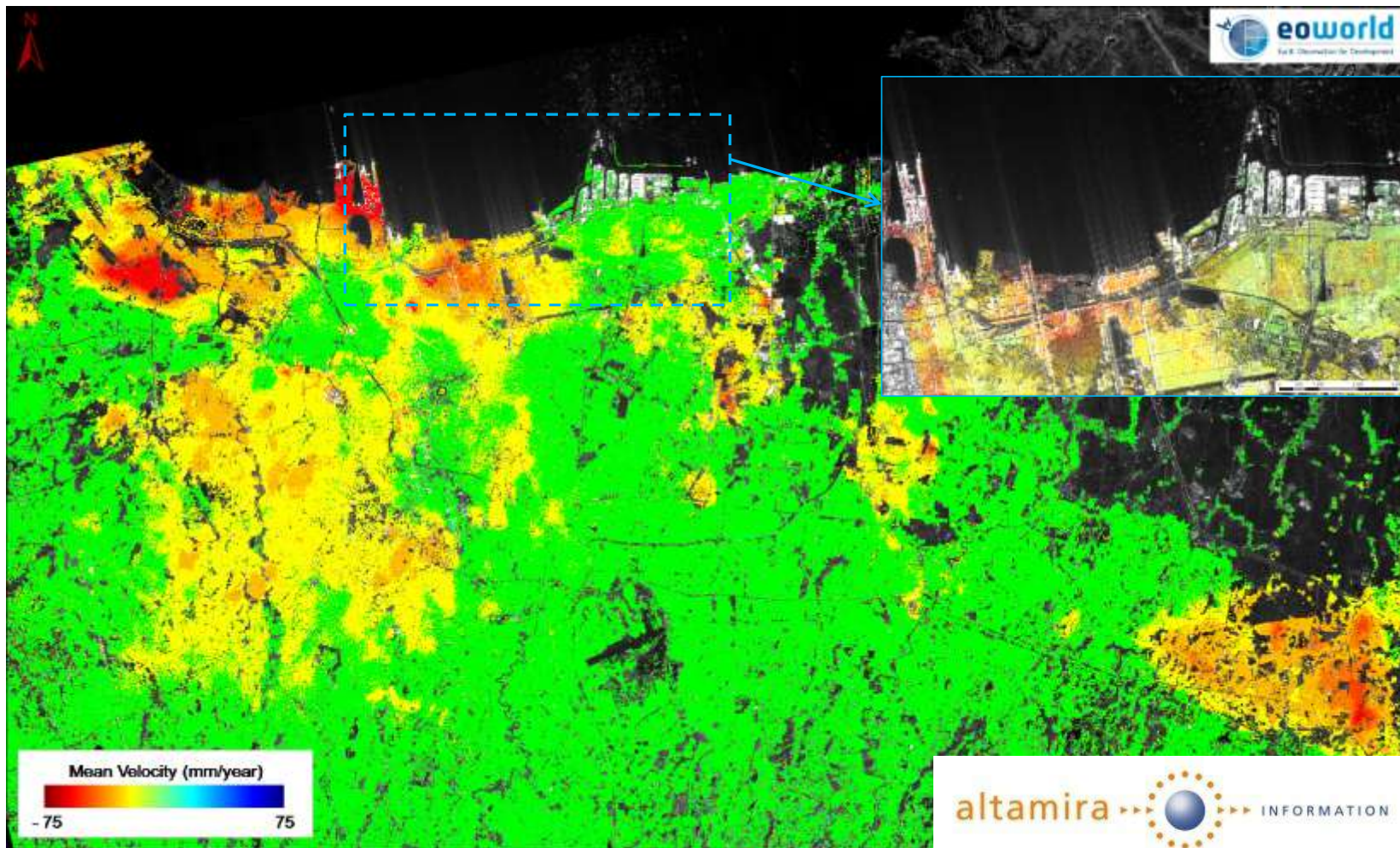


Layer model (adapted from: <http://ruimtexmilieu.nl/?nID=920>)



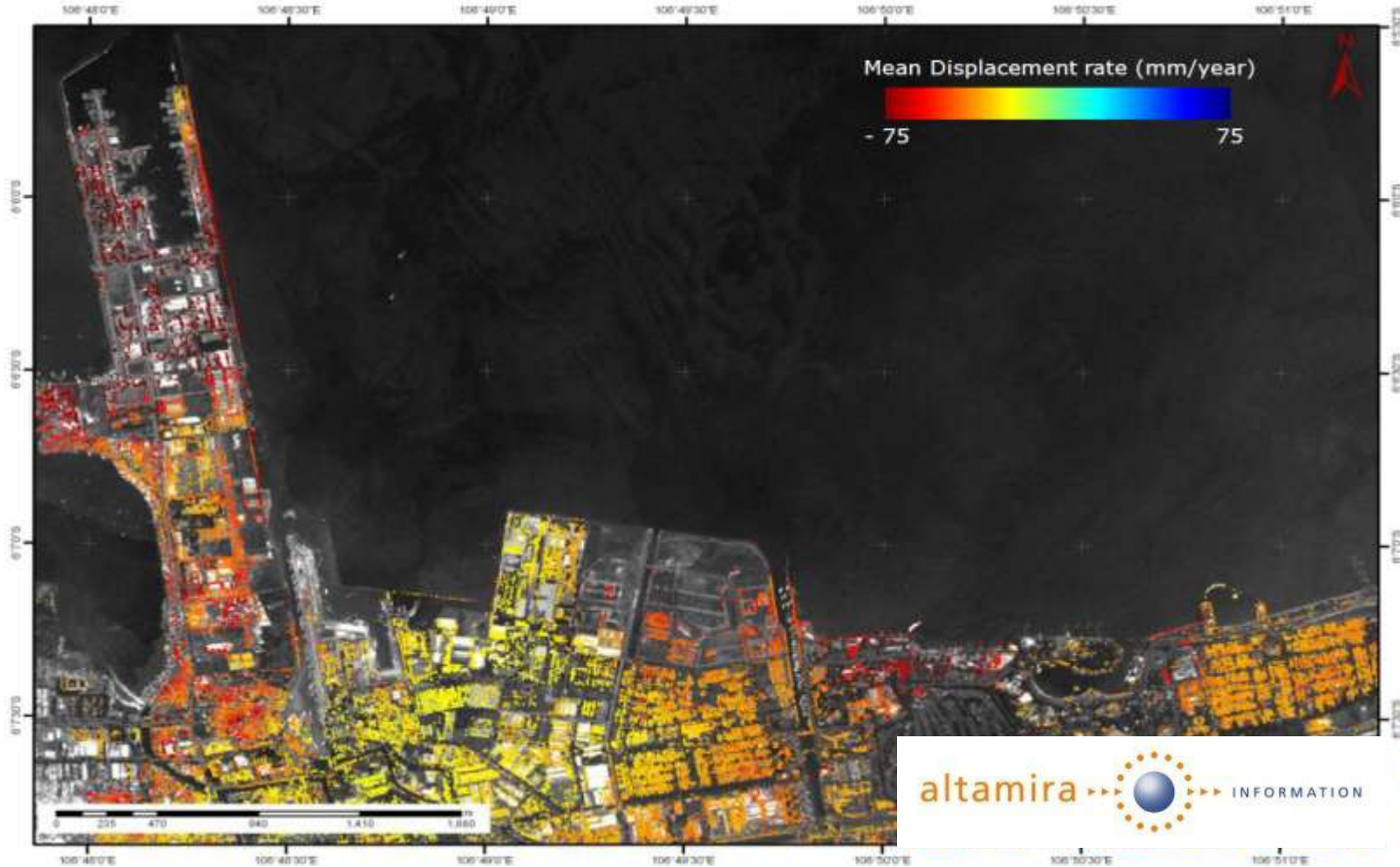
Understanding hazards to support mitigation:

Case Study: **Analysis of Land Subsidence in Jakarta**

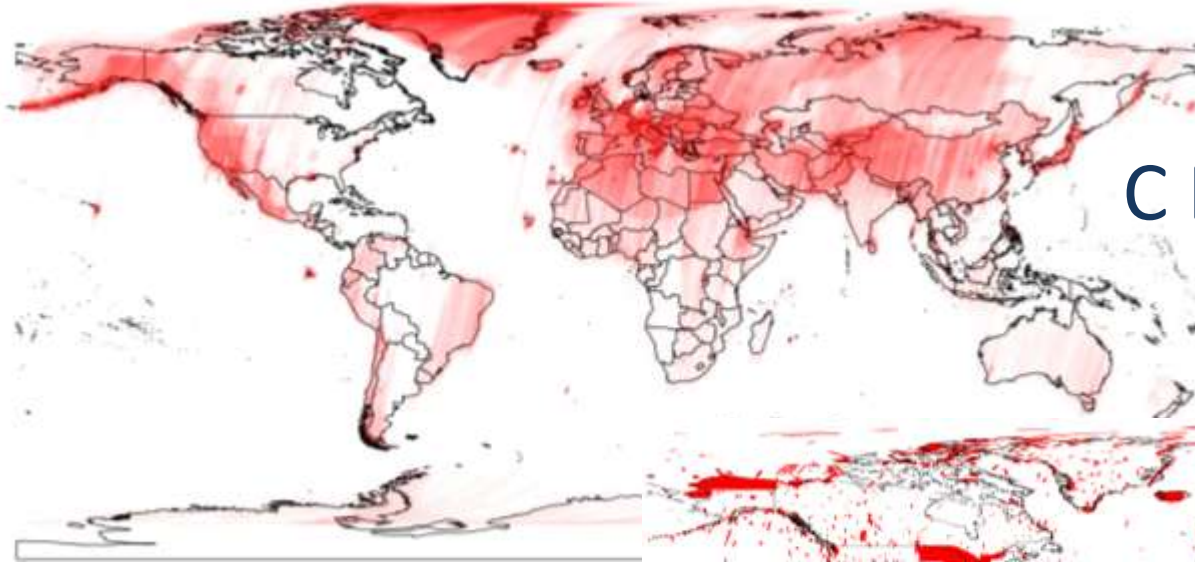


Understanding hazards to support mitigation:

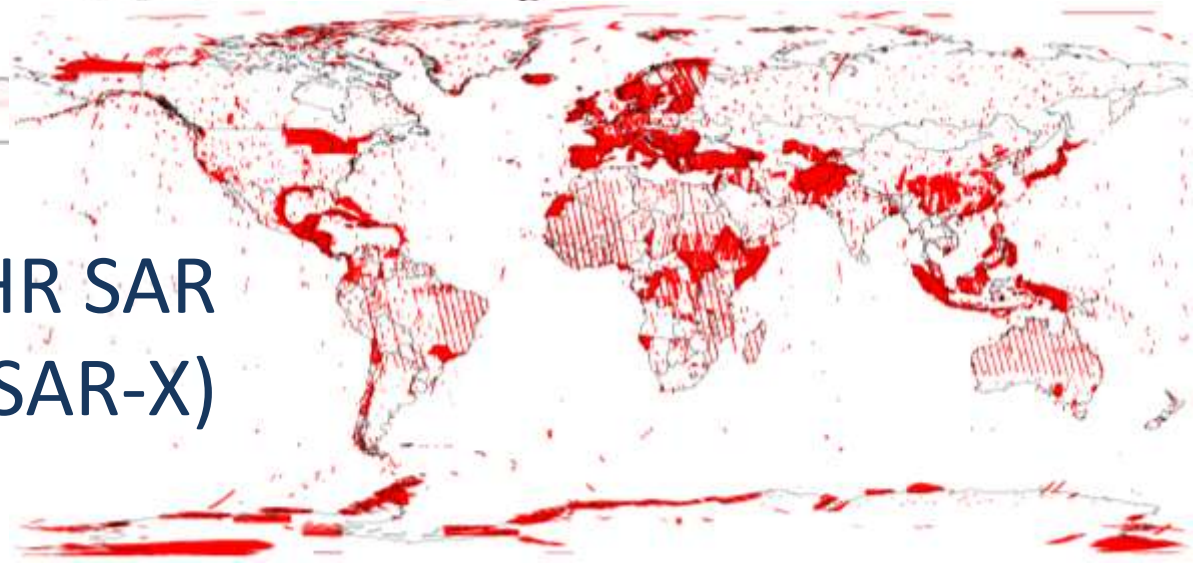
Case Study: Analysis of Land Subsidence in Jakarta



Ability of satellite EO to create global datasets:

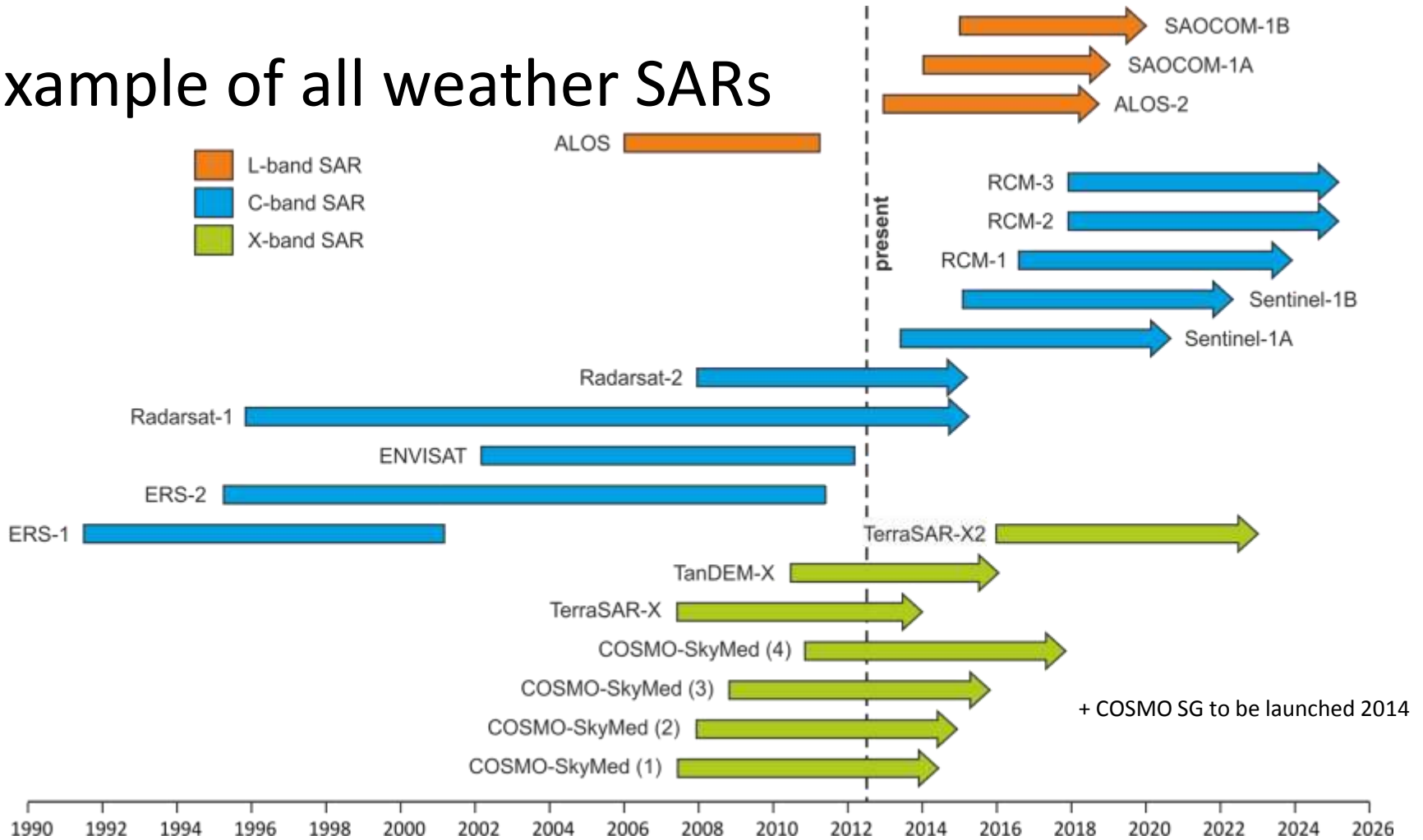


C Band HR SAR
(ENVISAT)



X Band VHR SAR
(TerraSAR-X)

Example of all weather SARs



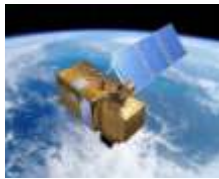
GMES dedicated missions: Sentinels



Sentinel 1 – SAR imaging

All weather, day/night applications, interferometry

2012, 2014+



Sentinel 2 – Multispectral imaging

Land applications: urban, forest, agriculture,..
Continuity of Landsat, SPOT

2013, 2014+



Sentinel 3 – Ocean and global land monitoring

Wide-swath ocean colour, vegetation, sea/land
surface temperature, altimetry

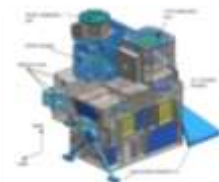
2013, 2014+



Sentinel 4 – Geostationary atmospheric

Atmospheric composition monitoring, trans-
boundary pollution

2018+



Sentinel 5 and Precursor – Low-orbit atmospheric

Atmospheric composition monitoring

2015, 2020



- Crisis Response: the International Charter is growing
→ more users (CPAs & Humanitarian community), increased performance, Rapid mapping being adopted by CPAs
 - Access for users should be improved – in particular in Africa (Universal Access to the International Charter).
 - Risk prevention/mitigation: capacities devoted to DRM users are established or being developed (e.g. GMES EMS, 50+ Geological Surveys are engaged via SLAs); quite embryonic in Africa (varies from country to country).
 - To deliver Data & VA services requires to address various challenges: cost, data processing capacity, thematic knowledge, raising awareness & capacity building.
-



Thank You !

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The ESA Earth
Observation
programmes

... understanding our planet

... securing our environment

... benefiting our economy

EO vs airborne concerning DRM

	Satellite data	Aerial data
Availability	24/7 world-wide with a rush production capacity Access to imagery globally (independent from politics)	Depending on the authorisations to fly
Spatial Res.	60-250cm at best using VHR Optical imagery	Up to better than 10cm
Coverage & Revisit	Revisit :Generally high with up to several acquisitions/day Coverage: from 15km to 150km swath (east-west) for a single scene	Revisit: One off / possibly several times a day
Timeliness	Between 1 and 3 days after an event	36h after acquisition
Cost	Access to data at no cost (systematic in the framework of the Int. Charter) not counting data analysis	N/A