ESA’s overview of EO capabilities for Disaster Risk Management

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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 Observation 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:

- 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
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

Incl.27
Rupt. Surf. = 4, 13 m

Incl.18
Rupt. Surf. = 3 m

Legend
PS Vel. (mm/y)
( -29.18 - 5.00
( -4.99 - 3.00
( -2.99 - 1.25
( -1.24 - 1.25
( 1.26 - 3.00
( 3.01 - 5.00
( 5.01 - 29.05

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**
Information needs for crisis/damage mapping:

- **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.
Hazard types in Africa:

- **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.

References:

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

Who can trigger the International Charter?

- 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)

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

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)
EO Missions Span:

Example of all weather SARs

- L-band SAR
- C-band SAR
- X-band SAR

- Radarsat-1
- ERS-2
- ERS-1
- ALOS
- SAOCOM-1B
- SAOCOM-1A
- ALOS-2
- RCM-3
- RCM-2
- RCM-1
- Sentinel-1B
- Sentinel-1A
- TerraSAR-X2
- TanDEM-X
- COSMO-SkyMed (4)
- COSMO-SkyMed (3)
- COSMO-SkyMed (2)
- COSMO-SkyMed (1)

+ COSMO SG to be launched 2014
## GMES dedicated missions: Sentinels

<table>
<thead>
<tr>
<th>Sentinel</th>
<th>Type</th>
<th>Description</th>
<th>Launch Dates</th>
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<tbody>
<tr>
<td>Sentinel 1</td>
<td>SAR imaging</td>
<td>All weather, day/night applications, interferometry</td>
<td>2012, 2014+</td>
</tr>
<tr>
<td>Sentinel 2</td>
<td>Multispectral imaging</td>
<td>Land applications: urban, forest, agriculture,.. Continuity of Landsat, SPOT</td>
<td>2013, 2014+</td>
</tr>
<tr>
<td>Sentinel 3</td>
<td>Ocean and global land monitoring</td>
<td>Wide-swath ocean colour, vegetation, sea/land surface temperature, altimetry</td>
<td>2013, 2014+</td>
</tr>
<tr>
<td>Sentinel 4</td>
<td>Geostationary atmospheric</td>
<td>Atmospheric composition monitoring, trans-boundary pollution</td>
<td>2018+</td>
</tr>
<tr>
<td>Sentinel 5 and Precursor</td>
<td>Low-orbit atmospheric</td>
<td>Atmospheric composition monitoring</td>
<td>2015, 2020</td>
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Take-Home Messages:

• 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.
The ESA Earth Observation programmes

... understanding our planet
... securing our environment
... benefiting our economy

Thank You!

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## EO vs airbone concerning DRM

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