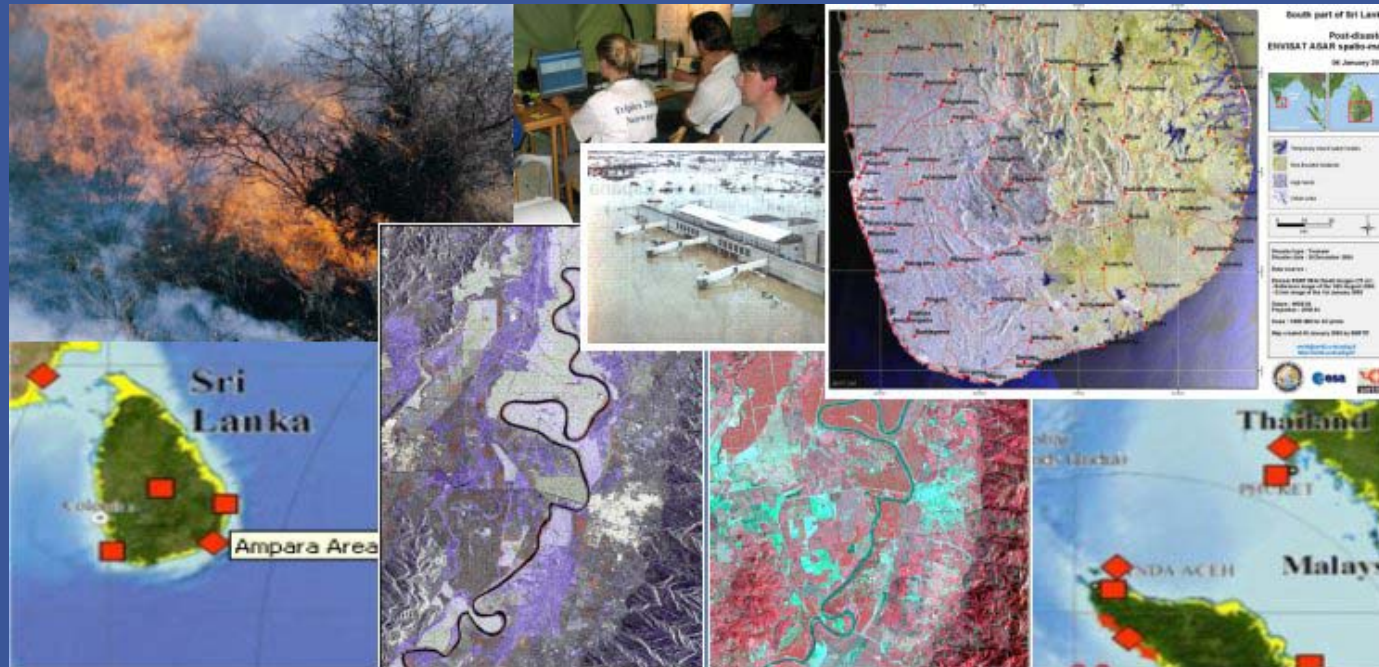


The Contribution of Earth Observation to Disaster Risk Reduction Findings from Current Activities



Philippe Bally, Marc Paganini
European Space Agency (ESA)

European Space Agency (ESA):

- an inter-governmental organisation
- a mission to provide and promote - for exclusively peaceful purposes:

- Space science, research & technology
- Space applications

ESA achieves this through:

- Space activities and programmes
- Long term space policy
- A specific industrial policy
- Coordination with national space programmes from its Member States



Note: Canada takes part in some projects under a cooperation agreement.

In order to develop and provide useful services the starting point has been to **listen to what the actors involved with Humanitarian Aid & Disaster Reduction have to say**

➤ **ESA originated a collaboration with UNITAR** to ensure a permanent dialogue with the broad community of organisations operating & funding Relief & Development activities:

- with **Europe** (e.g. ECHO, Relex & AIDCO)
- within **the UN** : UNOCHA, UNDP BCPR, UN HCR, UN development agencies, etc
- **Governmental organisations** (e.g. THW, Germany)
- **Red Cross / NGOs** / Charities

➤ ESA supporting the **EO User Liaison Office in Geneva (UNITAR)**

Key issues of the Humanitarian Aid & Disaster Reduction sectors:

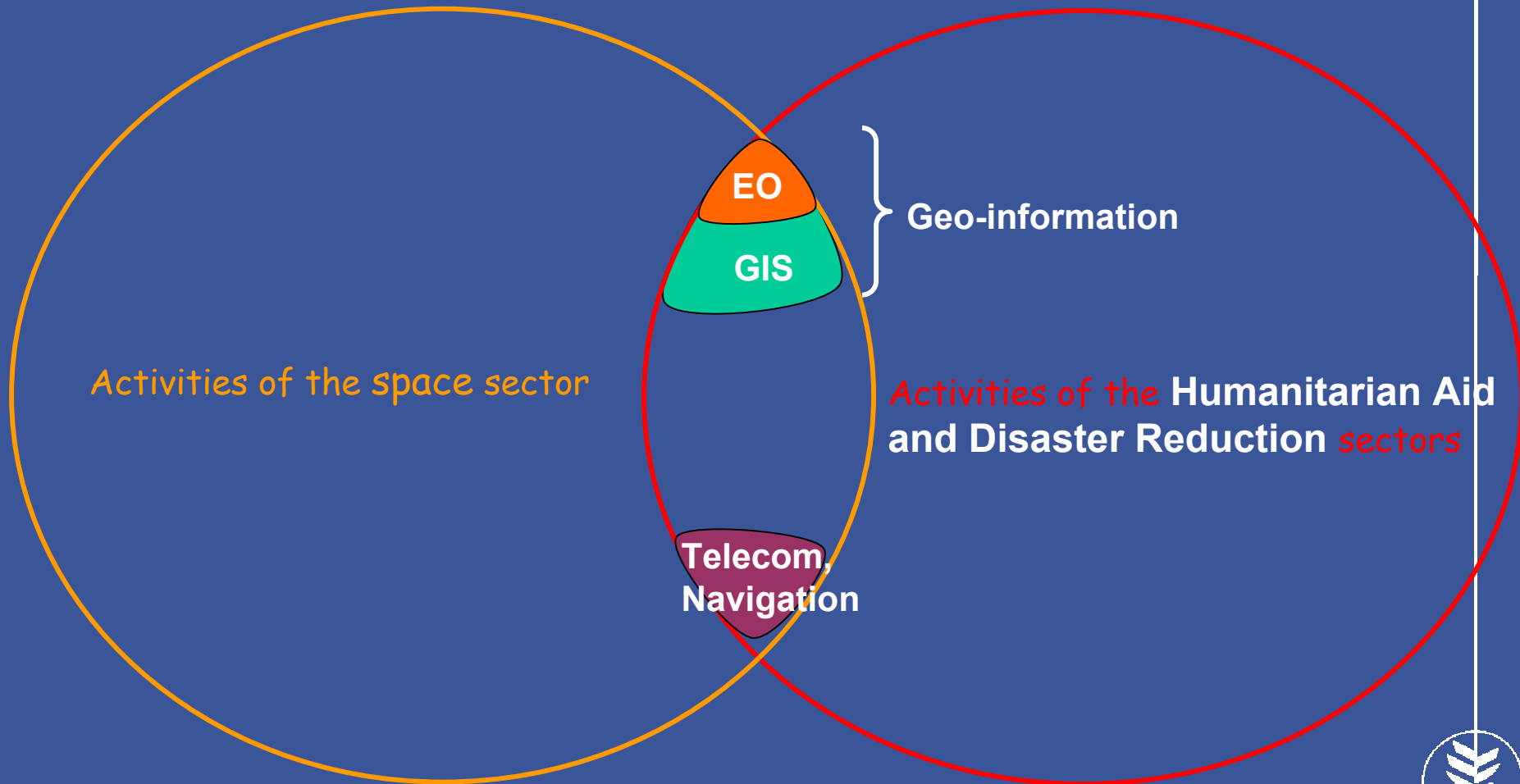
- ✓ Water sanity
- ✓ Habitat
- ✓ Health (Epidemiology)
- ✓ Nutrition (Food aid)
- ✓ Food security
- ✓ Crisis relief (incl. natural disasters)
- ✓ Crisis recovery/ rehabilitation
- ✓ Reconstruction
- ✓ Long term development (*disaster reduction compliant*)

Key activities of the Humanitarian Aid & Disaster Reduction sectors:

- Humanitarian assistance & International development cooperation:
 - ✓ Planning **humanitarian response actions**
 - ✓ Planning within **post-crisis reconstruction** projects
 - ✓ Planning within **natural risk management**
(Preparedness Mitigation Response Recovery)
 - ✓ Planning/management within **development projects**
 - ✓ Assessing the **effectiveness and efficiency of assistance & development actions**

Based on these issue & activities: how can space technology contribute ?

The utilisation of geo-information today only represents a **small fraction** of the activities of the **Humanitarian Aid and Disaster Reduction** sectors:



- what can ESA provide using Earth Observation (EO) technologies ?
- ✓ ESA **operate satellite missions** (ERS, ENVISAT: tools for crisis mapping)
- ✓ participate to the **International Charter Space & Major Disasters**
- **data**
- ✓ has **EO application development programmes** (such as GMES)
- ✓ participate to **international activities to develop EO applications**
- **end-to-end services**



International Charter Space & Major Disasters (**CHARTER**)

Group on Earth
Observations

Global Earth Observing System of Systems (**GEOSS**)



Global Monitoring for Environment & Security (**GMES**)



Integrated Global Observing Strategy (**IGOS**)

The International Charter Space & Major Disaster:

- implemented in 2000 to ensure **immediate access to EO data from participating space agencies** to organisations dealing with major disasters
- main features:
 - An operational mechanism which delivers satellite imagers to **civil protection agencies**, emergency & rescue services and to signatories during emergency situations
 - **UN** is a cooperating body since 1st July 2003 and therefore a certain number of UN specialized agencies (UNOSAT) can request activations of the Charter
- Evolution since 2003:
 - 80% of Charter activations are **outside Europe**
 - 60%+ of all Charter Activations are for **UN bodies**



User driven EO services:

- **EO data** given to relief agencies but ...
- there is a need for operational services to provide **end-to-end services** not only satellite imagery

→ **GMES Services** dedicated to disaster reduction, capable of organising work to provide support with mapping services;

→ Higher-level derived information to be developed and made available by **EO value-adding organisations** (public organisations and European industry).



Towards a Global Earth Observing System of Systems (GEOSS)

- **July 2003:** 1st summit of nations and organisations involved in Earth Observations held in Washington DC, hosted by US Secretary of State Colin Powell
 - a first step in putting in place a global system of systems for improved coordination of observations (satellites or ground-based);
 - launch of the intergovernmental ad-hoc Group on Earth Observations (GEO) to set up a ten-year implementation plan;
- **April 2004:** 2nd EO Summit hosted in Tokyo by Prime Minister Junichiro Koizumi.
- **February 2005:** 3rd EO Summit hosted by the European Commission (EC) in Brussels will adopt the plan and authorise its implementation.

Observing and understanding the Earth system more comprehensively will expand worldwide capacity to achieve sustainable development and will yield advances in many specific areas of socio-economic benefits:

- Reducing loss of life and property from natural and human-induced disasters;
- Understanding environmental factors affecting human health and well being;
- Improving management of energy resources;
- Understanding, assessing, predicting, mitigating, and adapting to climate variability and change;
- Improving water resource management through better understanding of the water cycle;
- Improving weather information, forecasting, and warning;
- Improving the management and protection of terrestrial, coastal, and marine ecosystems;
- Supporting sustainable agriculture and combating desertification;
- Understanding, monitoring, and conserving biodiversity.

GMES:

Global Monitoring for Environment & Security

- ESA believes that important societal benefits could be derived from a successful **implementation of the GEO plan**
- **February 2005**: 3rd EO Summit in Brussels
- GMES is the **European contribution** to the Global Earth Observing System of the Systems (GEOSS)

Jointly led by the **European Commission** and **ESA**

- Establish a **European capacity to produce & disseminate timely & reliable information in support to policy sectors concerning Environment and Security**

The GMES Service Element programme (GSE) of ESA:

- ✓ **operational services** using EO missions available today
- ✓ definition of future EO missions: **service continuity & evolution**

ESA have initiated GMES Actions to deliver operational services: GSE

- Address **different policy sectors**
(e.g. forestry, water, pollution, flood & fires, humanitarian aid, etc)
- **12 different GSE Actions** have started (i.e. 50+ services)

Current status of GMES:

Many elements of the modules of GMES **already exist today**

- ✓ Providing **large scale operational end-to-end services** primarily looking at EU policy sectors
- ✓ There exist services **available today** which are relevant to humanitarian aid and disaster risk reduction:
 - **Humanitarian Aid & Disaster Reduction** (relief, rehabilitation, reconstruction)
 - **Geohazards Risk management** (subsidence, landslides, seismicity)
 - **Meteorological Risk management** (flood & fire)
 - **Food Security** (crop production, calamities)

Europe is the first donor in the world for Humanitarian Aid.

There is a need for a European capacity to deliver geo-information useful to relief operations, re-habilitation, post-crisis reconstruction

- **GMES RESPOND**, an alliance of European & International organisations:
 - **Satellite imagery**
 - **Mapping & Damage Mapping**
 - **Alert services**
 - **Geographic information** for rehabilitation, reconstruction & risk prevention purposes
- **GMES RESPOND** primarily building on the collaboration between ESA and public organisations already providing services to users, for instance:
 - **UNOSAT**, to the United Nations and NGOs
 - **Alertnet**, to 300+ NGOs via Internet
 - **EC/JRC**, to the EC (ECHO, RELEX)

For more information: www.respond.eu.com

Industry:

8 Value Adding Companies elaborate EO components

INFOTERRA

SERTIT

KEYOBS

METRIA

Kayser-Threde

SciSys

SSTL

ESYS

In-Sector Providers:

- provide/integrate mapping solutions
- have established user relationships



Users:

- recipient of products
- UN, EC, NGOs, etc



UN Agencies



UN HCR
UN OCHA
UN DPKO
UN ISDR
UNOPS
UN JLC



NGOs and Organisations
"Unknown Users"



German Users

UN NGOs

NGOs

EC





scisys

The Charter triggered by three agencies:

- **India (ISRO)** for its own territory;
- the **UN Office of Outer Space Affairs (OOSA)** for Indonesia and Thailand
- the **French Civil Protection Agency (DDSC)** for Sri Lanka

EO data acquired from many satellite sources immediately after the event:

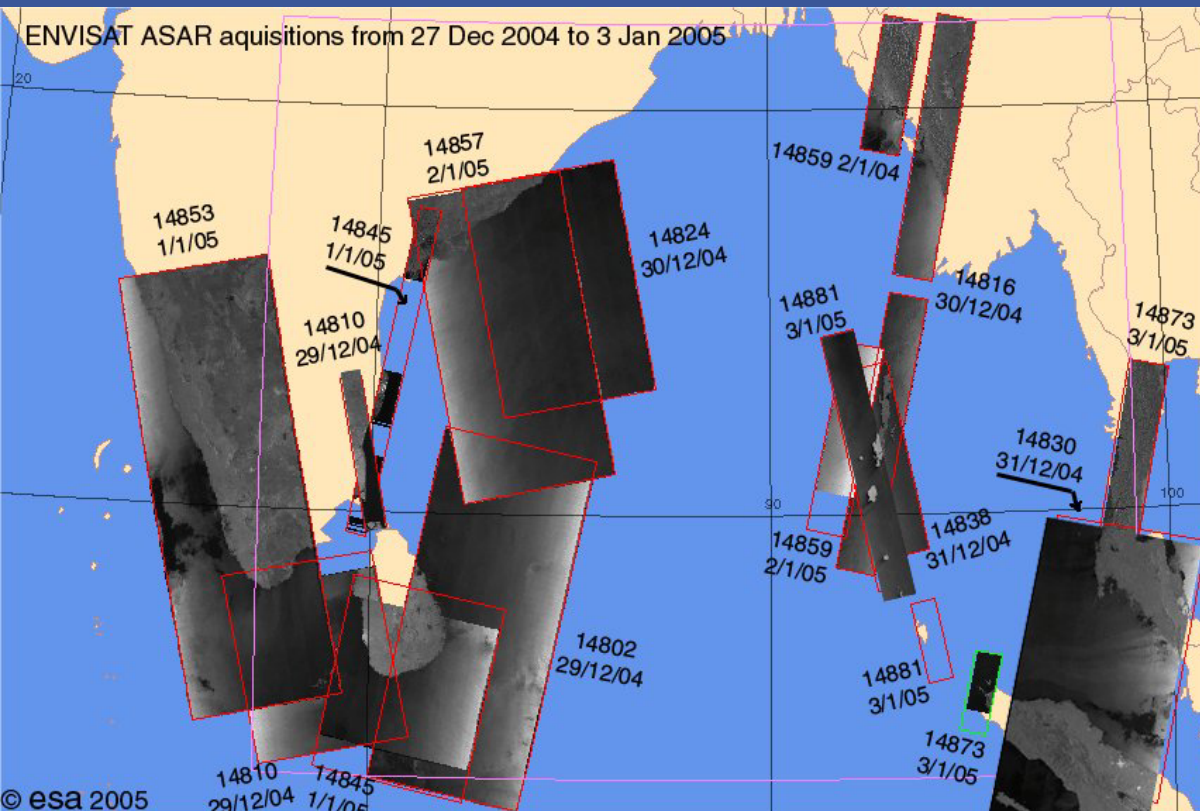
- **ESA:** ENVISAT, ERS & PROBA satellites
- **FRANCE (CNES):** SPOT series, **CANADA (CSA):** RADARSAT,
- **US (USGS):** LANDSAT, **INDIA (ISRO):** IRS series

Hundreds of EO based mapping products have been generated and made available to users, via GMES RESPOND, at all levels:

- **to the EC and the UN & NGOs** for a variety of purposes from decision makers to users in the field (ECHO, UN organisations, THW, German Red Cross, Médecins Sans Frontières, Architectes de l'Urgence, etc)

For more information: www.respond.eu.com

ESA satellite data: ENVISAT, ERS & PROBA



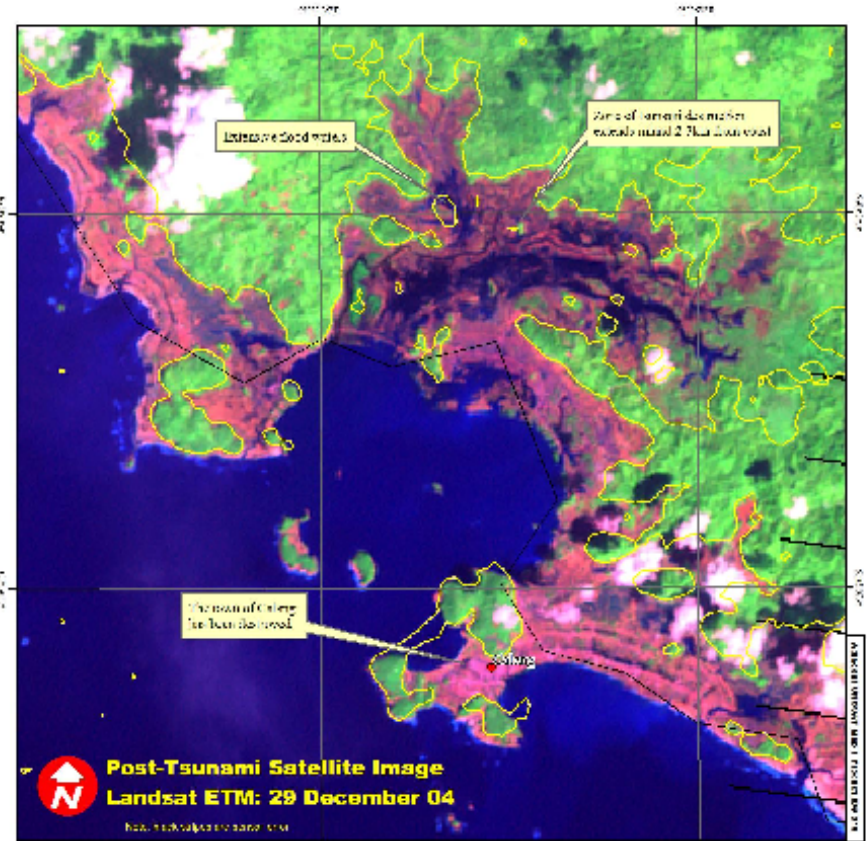
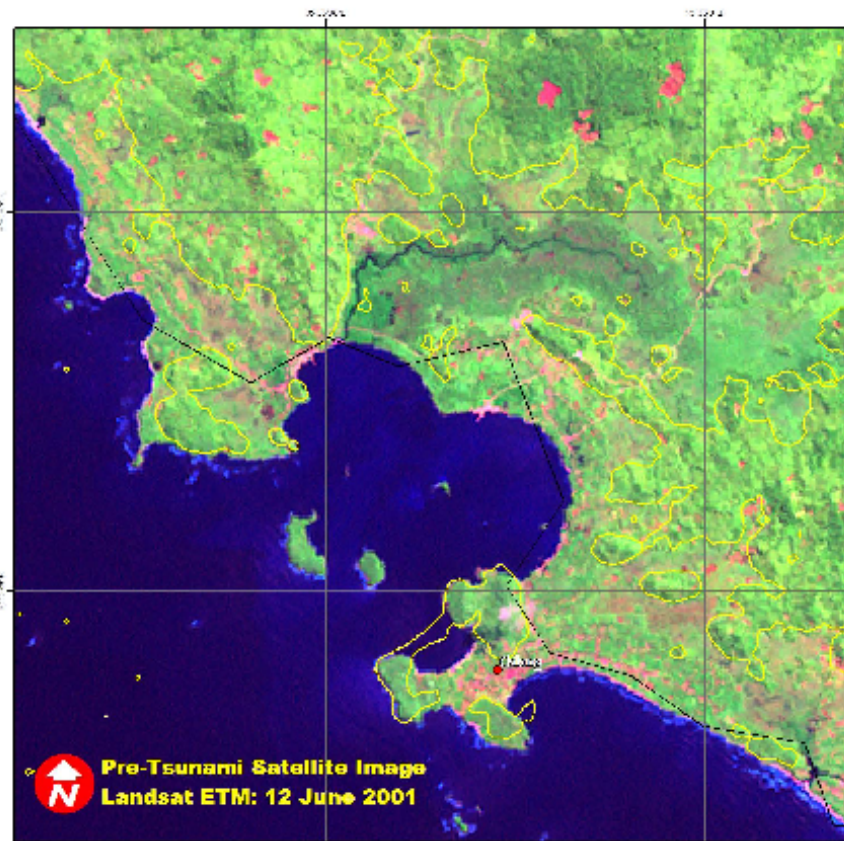
- First Call received by ESA on 26th December 2004
- Programming of ENVISAT and ERS initiated
- Daily reprogramming since
- First data acquired 27th Dec
- Routinely:
2-5 ENVISAT ASAR & MERIS acquisitions per day,
1-2 ERS ASAR acquisitions per day,
PROBA data being acquired

Access to Near Real Time imagery from ENVISAT awarded to UNOSAT, JRC, SERTIT and DLR



This 3 January 2005 Envisat Advanced Synthetic Aperture Radar (ASAR) image of Banda Aceh is shown along with high-resolution pre- and post-disaster optical Quickbird imagery. Located on the northern part of Sumatra, Banda Aceh is the capital of the devastated Indonesian territory of Aceh.

(Credits ESA; ENVISAT data: Copyright ESA 2005; QuickBird data: Copyright DigitalGlobe)



Post-Tsunami Image of Aceh Coast Including Town of Calang

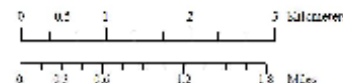
The International Charter on Space and Major Disasters aims at providing a unified system of space data acquisition and delivery in case of natural or man-made disasters through earth-observing satellites. Since 1 July 2003 the Charter is available to support the UN with satellite imagery. The Charter is the UN Office for Outer Space Affairs for further information: space@undesa.org

This map was produced for the UNOSAT project, headed by UNOSAT and executed by UNOSAT. UNOSAT is a UN satellite consortium providing satellite imagery and related geographic information to UN humanitarian and development agencies and their implementing partners. There are now more than 100 additional information:

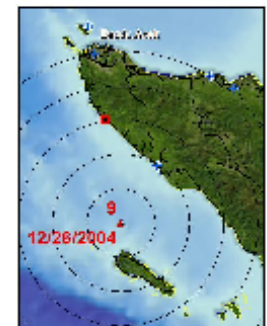
Image type: True color false color
Date/Time: 29 December 2004
Data Source: USGS Landsat-5 TM
Sensor: Landsat-5 TM
Resolution: 30m
Scale: 1:50,000
Projection: UTM
Map Produced: 1 January 2005

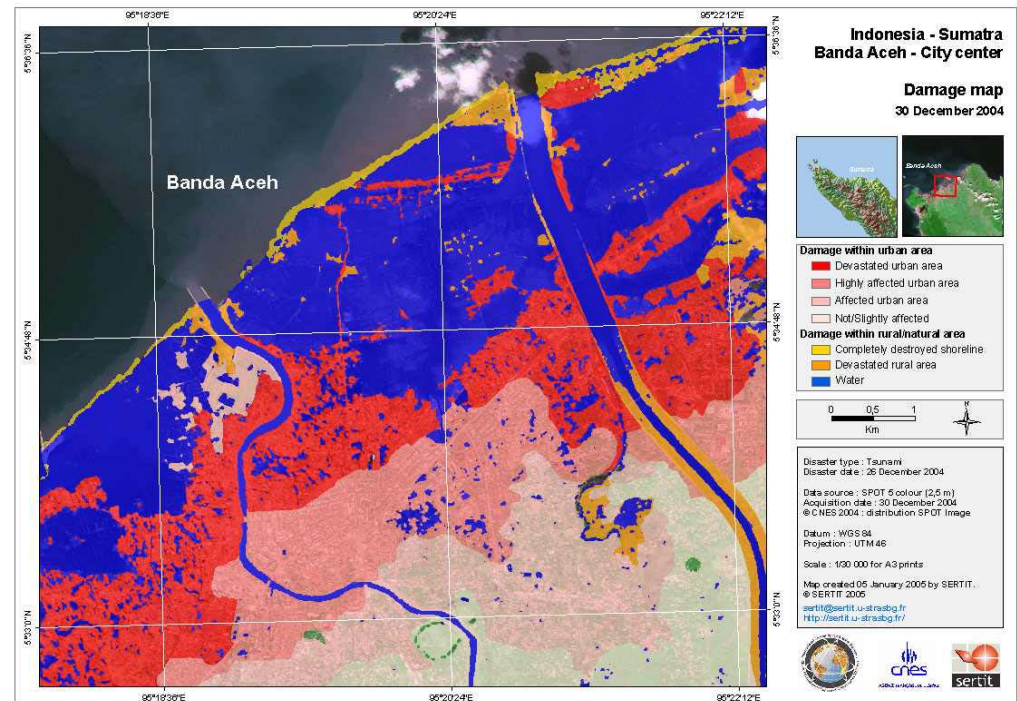
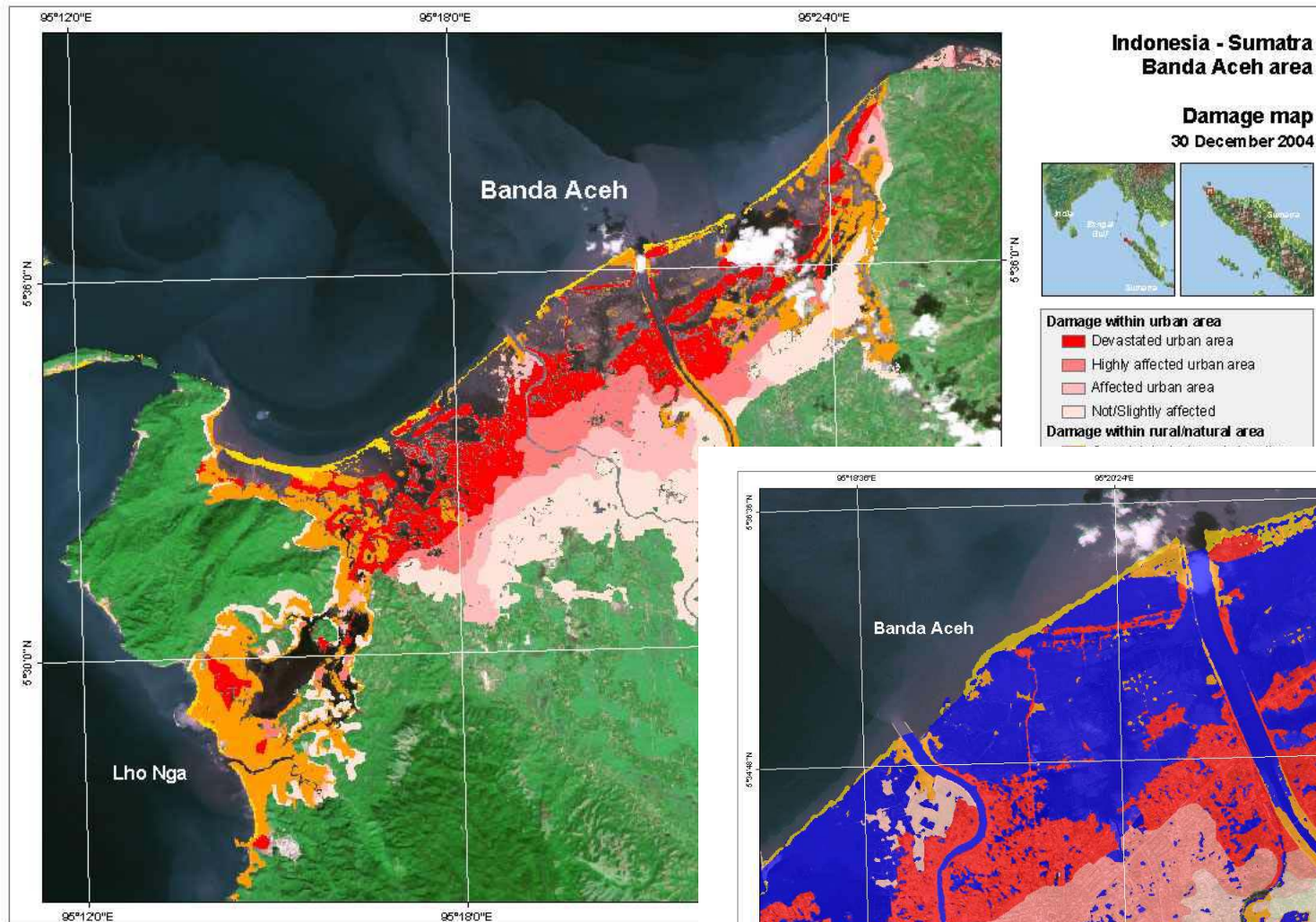
The depiction of land use, geographic names and other data from the zone of war is not intended to be used for any purpose other than to provide information to the United Nations.

This map illustrates the extent of the coastal destruction along the western coast of Sumatra. The shaded area in this map shows the tsunami-affected zone, including most coastal areas under 20 meters in elevation. The roads, bridges and villages in this zone have been devastated.



- Town in 20m zone
- Town above 20m
- ✈ Airport
- Road
- Rail road
- 20 Meter Contour





Courtesy of SERTIT (F)

Courtesy of DLR (D)

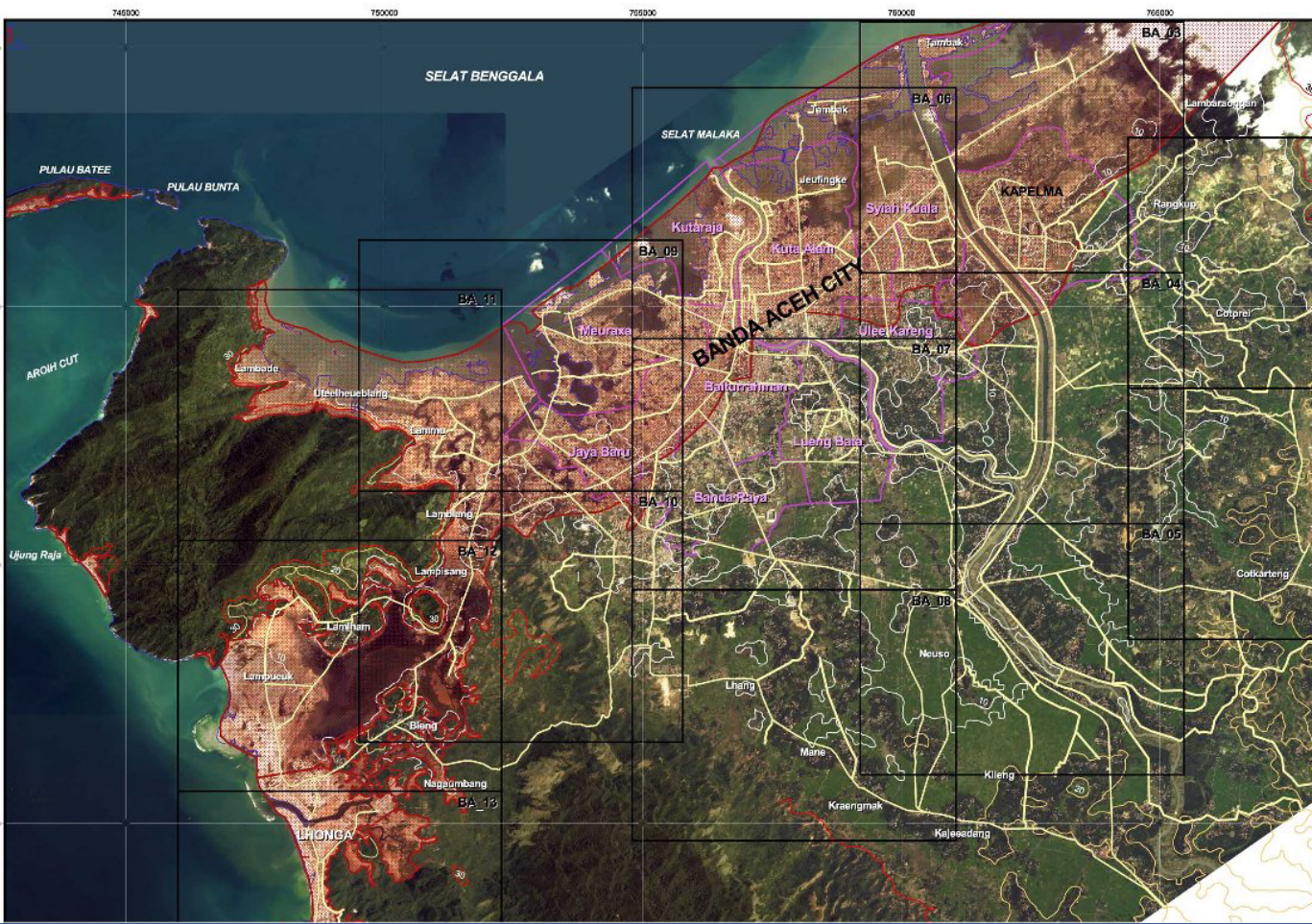
Joint Tsunami relief mapping by DLR and JRC
in the framework of RESPOND



EUROPEAN COMMISSION
DIRECTORATE-GENERAL
Joint Research Centre



INDONESIA/SUMATRA - Banda Aceh Region



Legend



Banda Aceh city, road network and river



Coastline - forest area damaged area in red



Damaged area (red outline) contour and shore line



Airport, agriculture, contour lines (yellow: 20m)

Interpretation

This satellite map displays the area of Banda Aceh, Sumatra / Indonesia at a scale of 1:45.000. It shows an overview of the area struck by the tsunami flood wave of 26th December 2004. The map was derived from high resolution satellite imagery taken on 2nd January, 2005. It indicates that the seafront of the city of Aceh was extremely hit. Detailed analysis of the damage area shows, that 49 km² or 80% of the built-up city area (61 km²) were totally destroyed or extremely damaged. Furthermore the map indicates where the high resolution 1:10.000 map sheets were derived.

GMES RESPOND brings **increased supply capacity** (redundancy of supply chains in 24/7 mode) : 150+ space-maps generated in 2 weeks...

GMES RESPOND links **different user segments of Humanitarian Aid** (EC, UN, NGOs, Media) and, in particular, via the UN network thanks to UNOSAT

Main benefit of the EO services to relief operations:

- to allow an **immediate assessment of the extent of the damage** in those areas where local information is either impossible or difficult to access
- to give a more **general overview** of the affected areas

Further work is on-going:

- elaborate mapping products for **further damage analysis**
- help to provide geo-information services for **longer term (but urgent) reconstruction activities** in countries affected by the disaster

Other examples of GMES services

Urban Subsidence

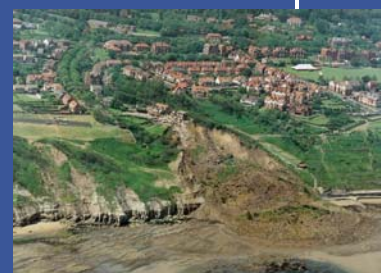
Landslide Hazards

Seismic Hazards

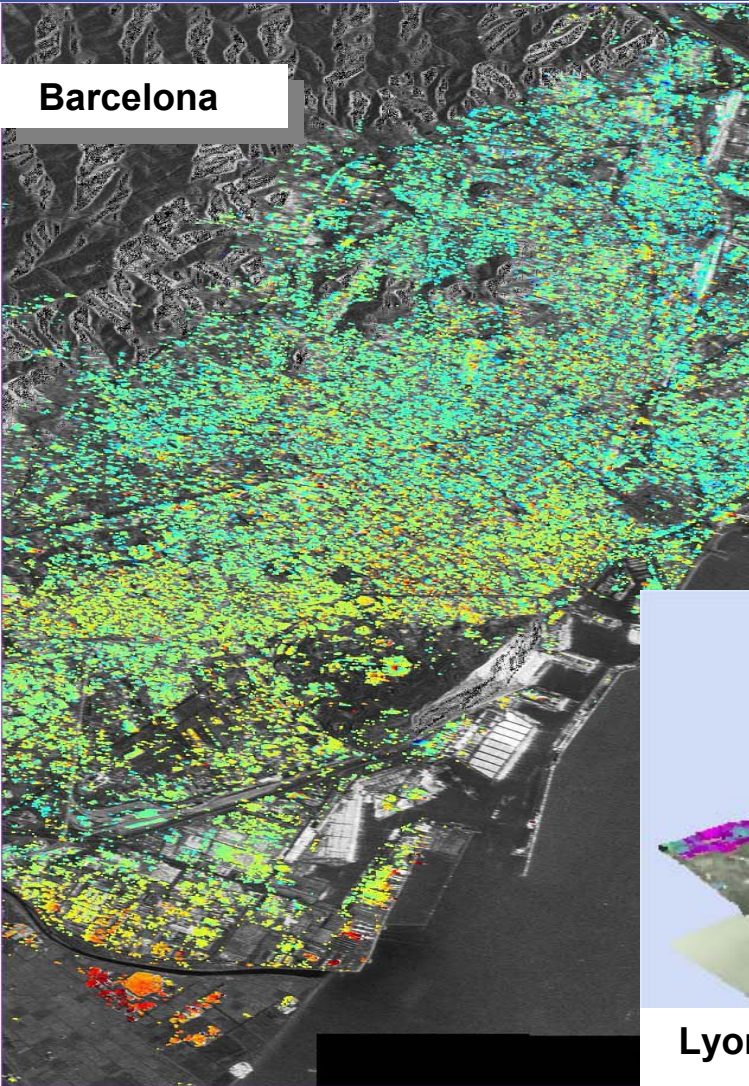
Volcanic Hazards

GMES TERRAFIRMA & SLAM

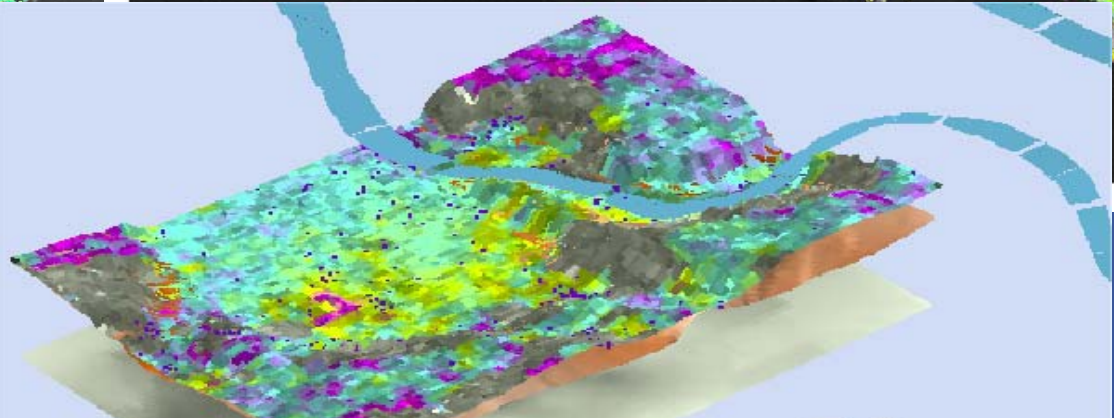
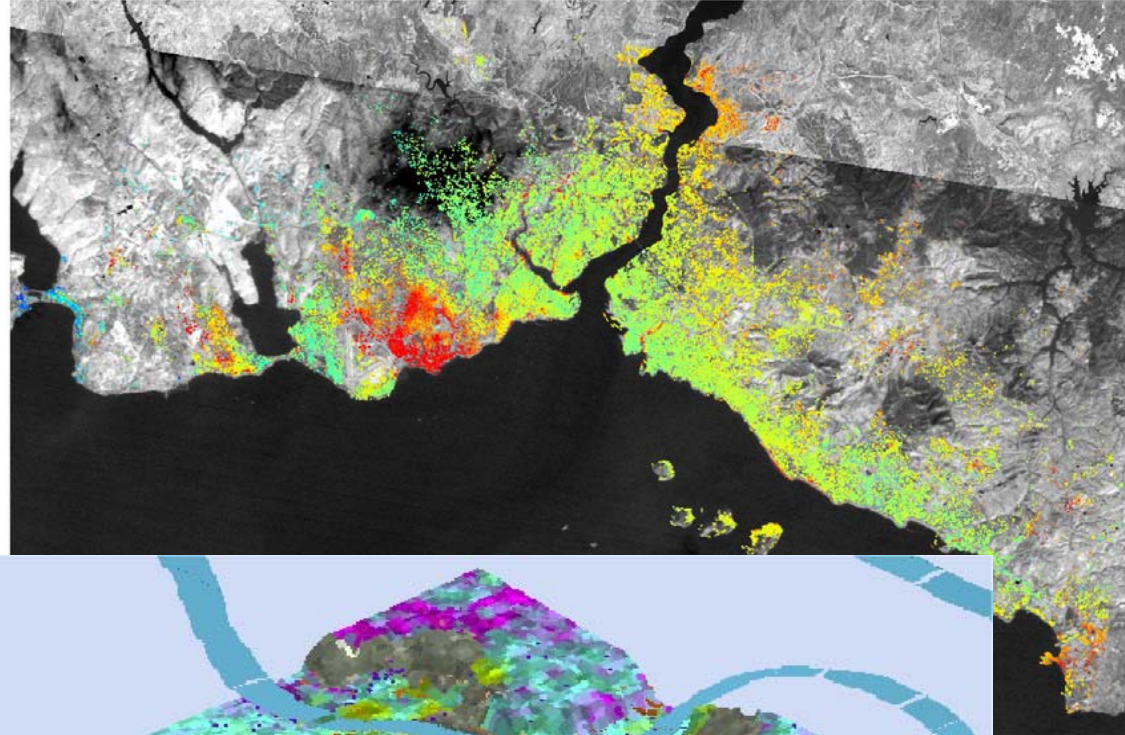
(delivered in Europe today but available world-wide)



Barcelona



Istanbul



Lyon

Also Bangkok, Mexico, etc ...

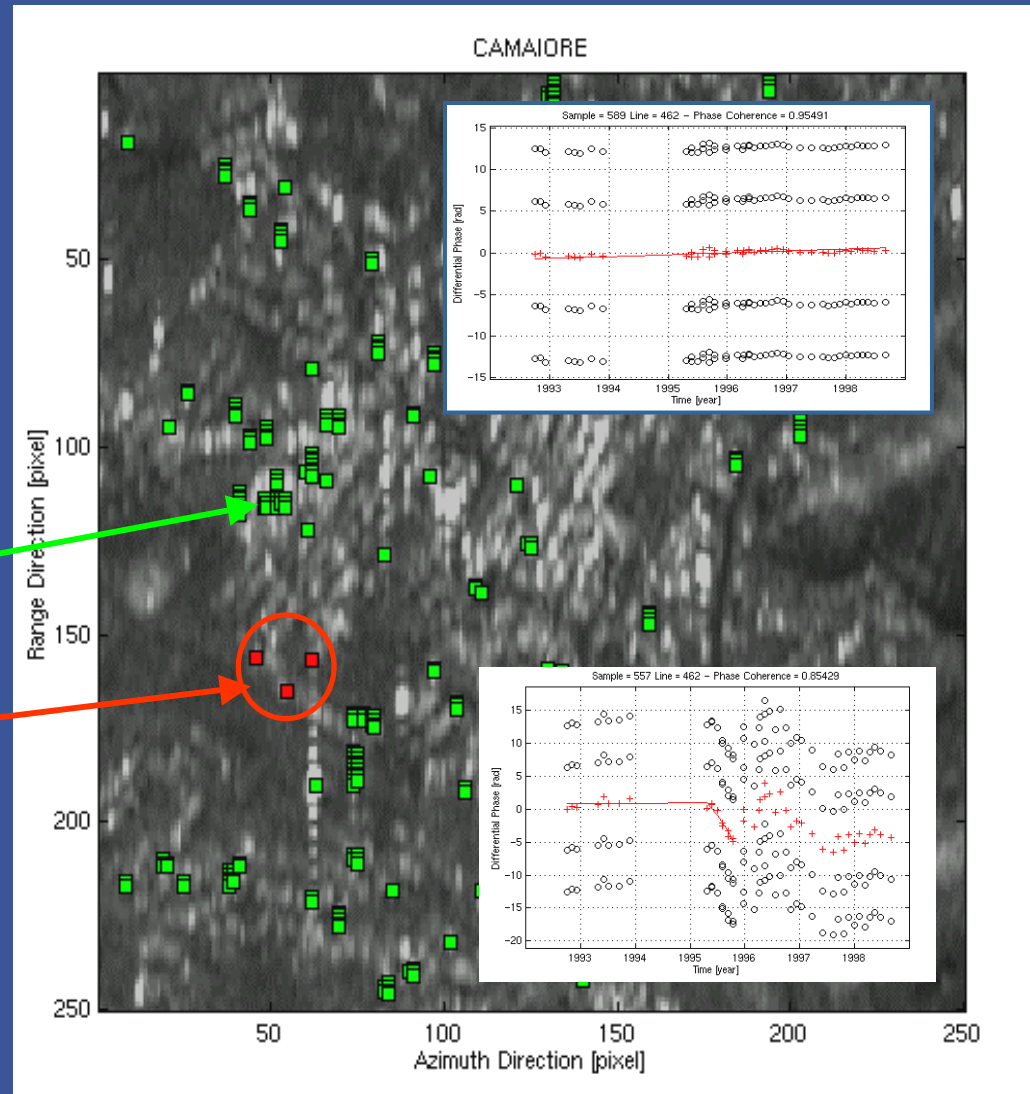
By 2030 the 15 largest cities will be from outside Europe & the US and in majority on a coastline

Precursors to building collapse

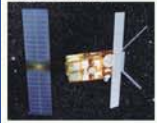


Stable buildings

Collapse precursors



ERS-1 & ERS-2



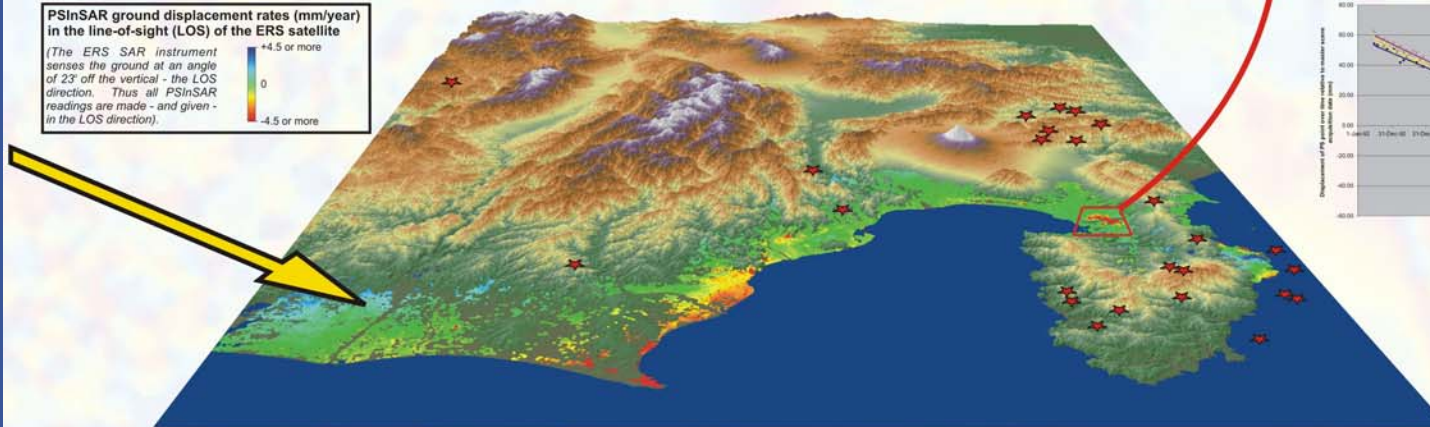
INPA
SATELLITE MAPPI

3D graphic:
Landsat ETM image
draped over Digital
Elevation Model

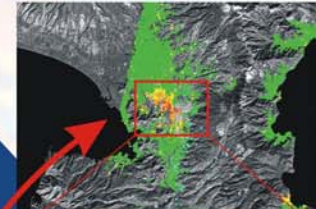
Earthquake hazard assessment

Southern Japan: Multiple radar images acquired over the last 10 years can be used to measure the millimetric crustal deformations associated with earthquakes and that are used to derive forecasting models. The technique of PSInSAR thus offers a cost-effective supplement to expensive GPS networks.

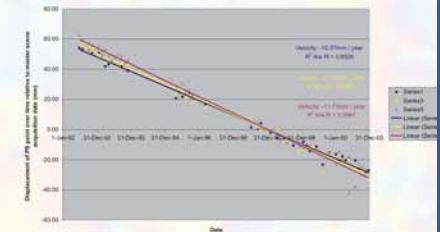
PSInSAR ground displacement rates (mm/year) in the line-of-sight (LOS) of the ERS satellite
(The ERS SAR instrument senses the ground at an angle of 23° off the vertical - the LOS direction. Thus all PSInSAR readings are made - and given - in the LOS direction).



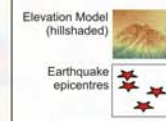
Displacement histories in
Mishima region - derived
from PSInSAR analysis



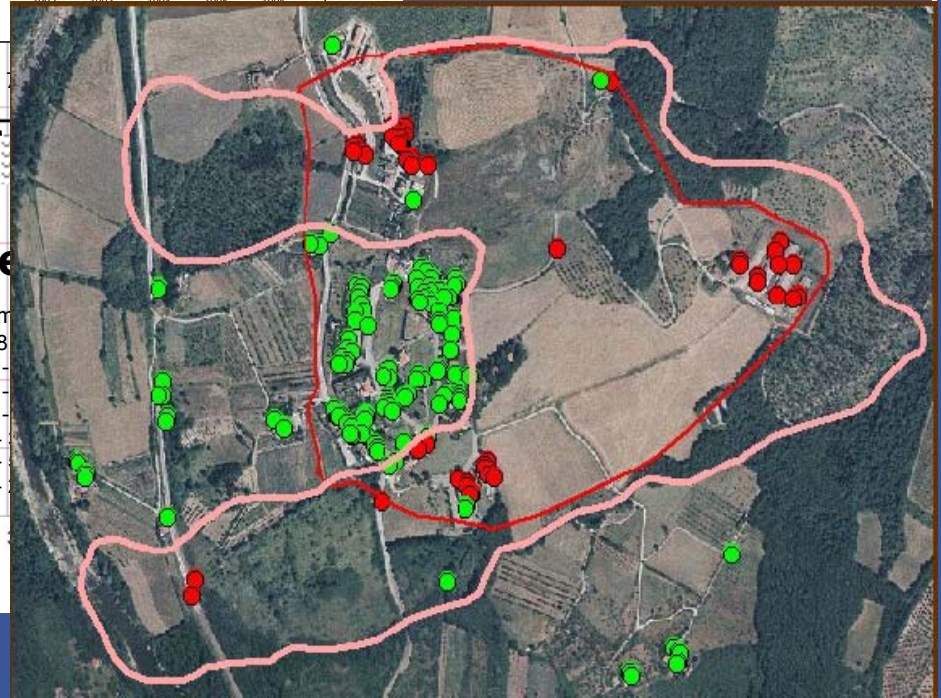
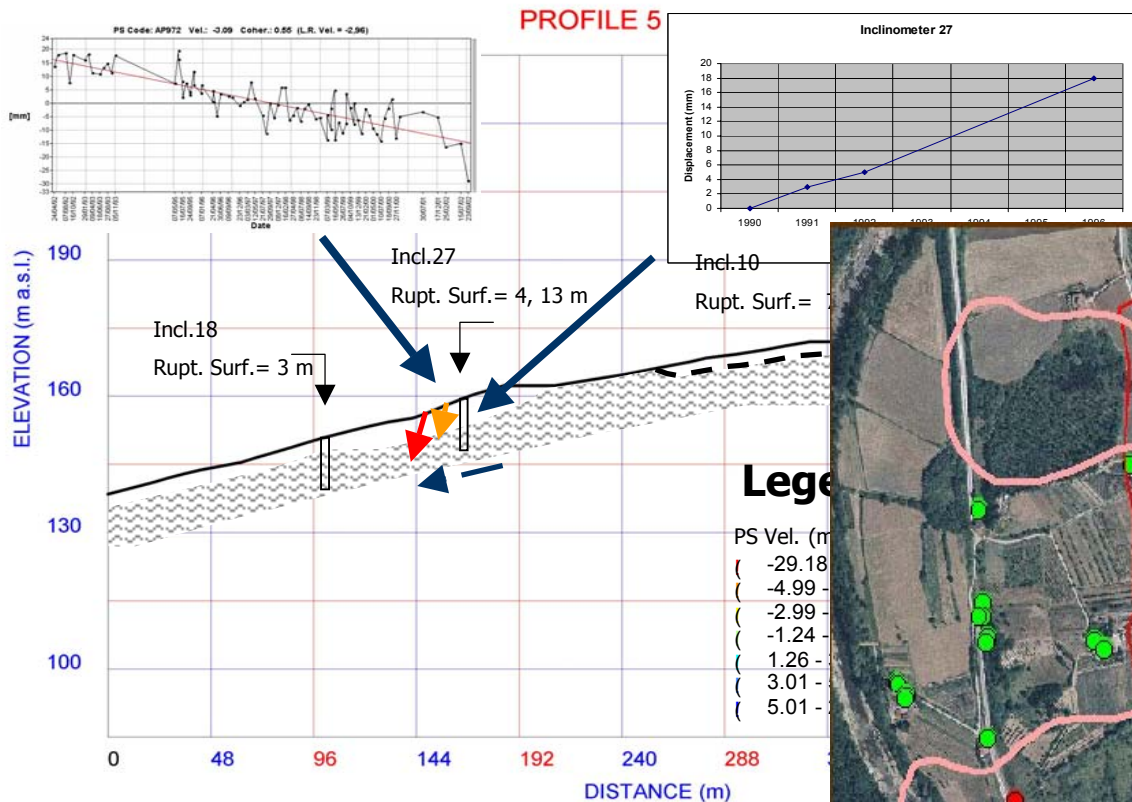
Displacement histories of 3 "red-velocity" PS points in Mishima



Additional image layers



Landslide Displacement Monitoring

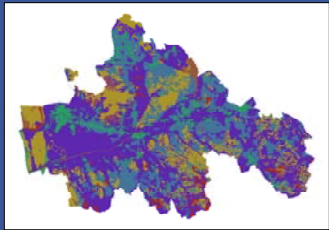


Left: Example of integration of geologic information with ground measurements (inclinometric readings) and PS-derived information, to define or refine a model of an existing landslide.

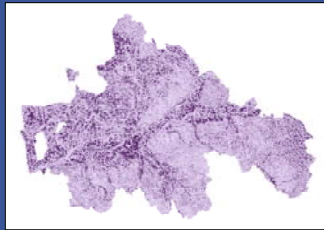
Right: This product has been used by the Arno AdB to refine the limits of the Risk-zones for which it is legally responsible (Carbonile: Red: previous R3/4 area, Pink: revised R3/4 area)



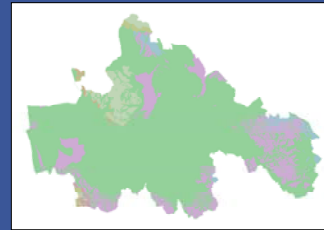
Slope gradient



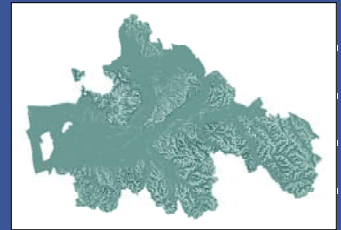
Land cover



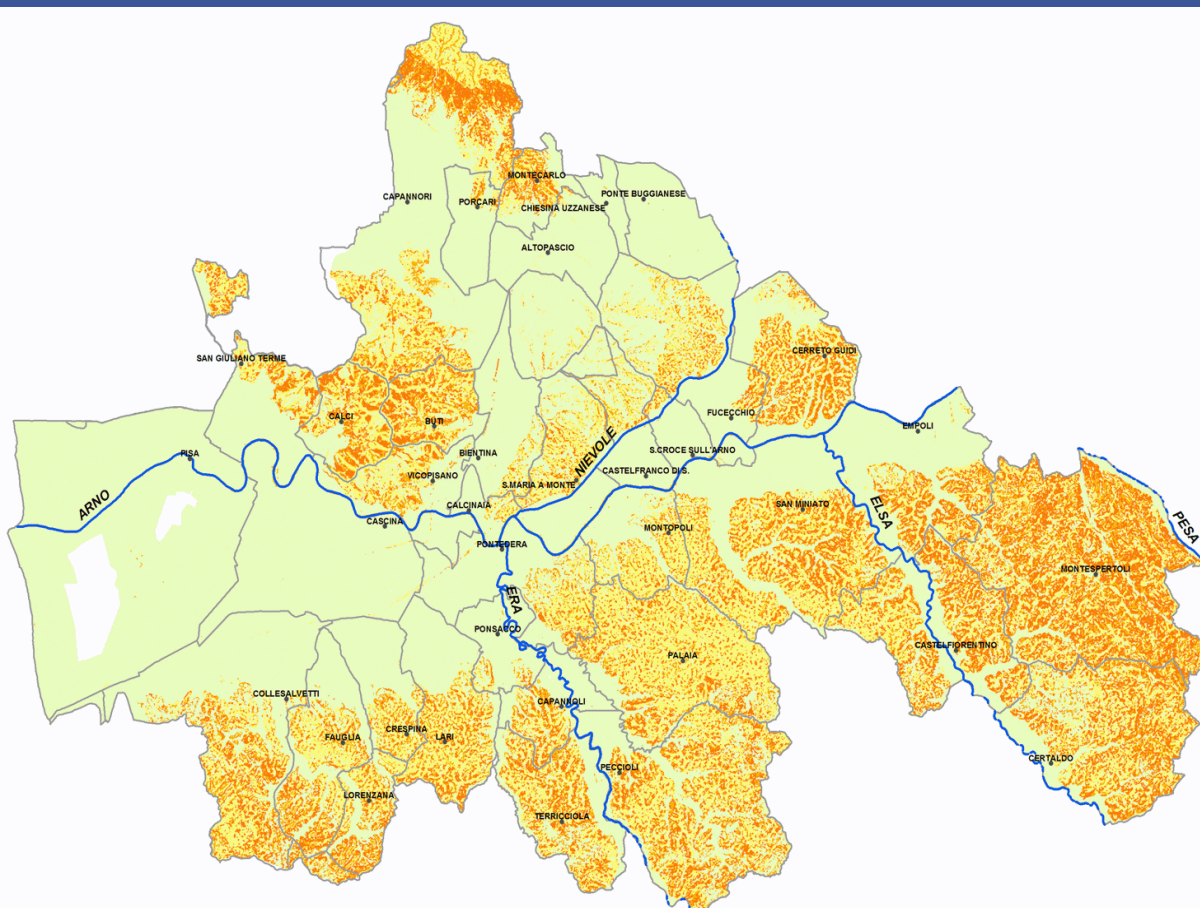
Lithology



Upslope area



Slope aspect



Landslide susceptibility classification with respect to different classes of landslide hazards, through the integration of ground displacements observations from Space with thematic maps (e.g. land use, slope, geomorphology, lithology).

Other examples of GMES services

Plain Floods
Flash Floods
Forest Fires

GMES RISK-EOS



*European Space Agency
Agence spatiale européenne*



	FIRES	COMMON	FLOODS
PREVENTION	Structural Fire Risk Mapping	Assets Mapping	Flood Risk Analysis
ANTICIPATION	Dynamic Fire Risk Monitoring		Flash Flood Awareness
RESPONSE	Active Fires Monitoring (Medium Resolution)		
	Fire Rapid Mapping	Flood Rapid Mapping	
POST CRISIS	Burn Scars Mapping		Flood Memory Atlas

Historical flood Extent Map

Flood extent from historical events superimposed upon Land Cover Map derived from Landsat imagery. The figure puts in evidence the flooded areas (in red) outside the 100year flood boundary.



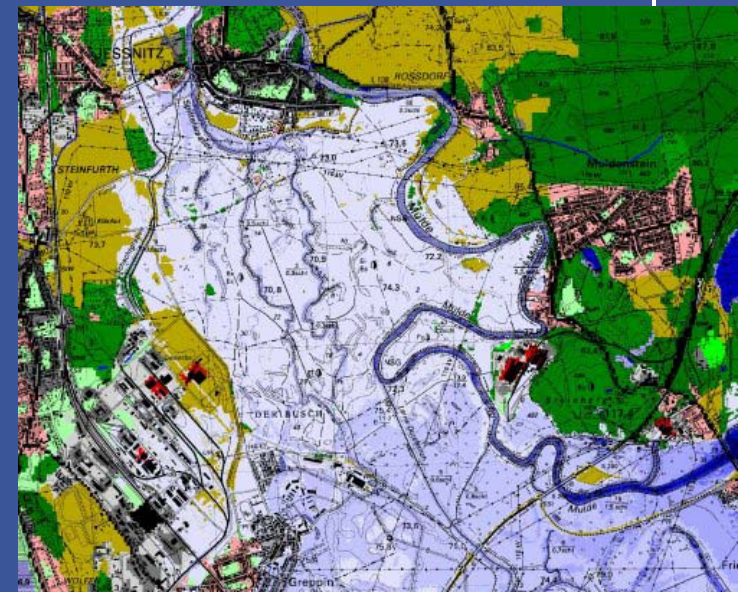
Simulated Flood Extent Map

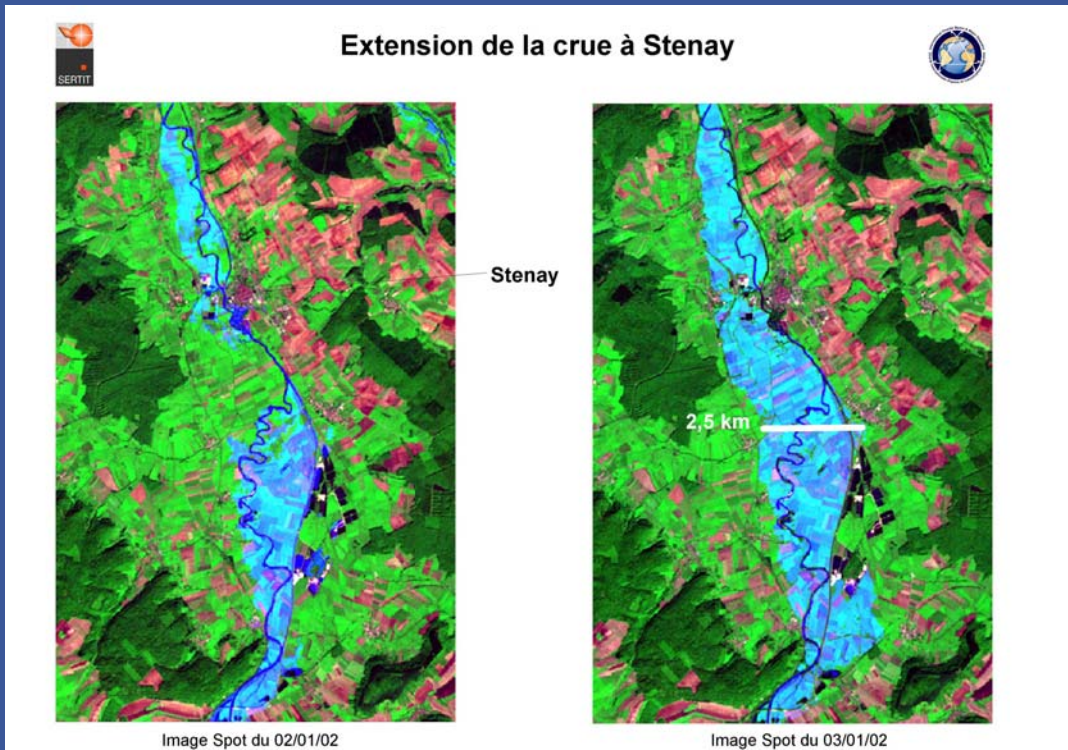
Flood extent determined by hydraulic simulation, overlaid on a Land Cover Map obtained with Landsat imagery.



Assets Map

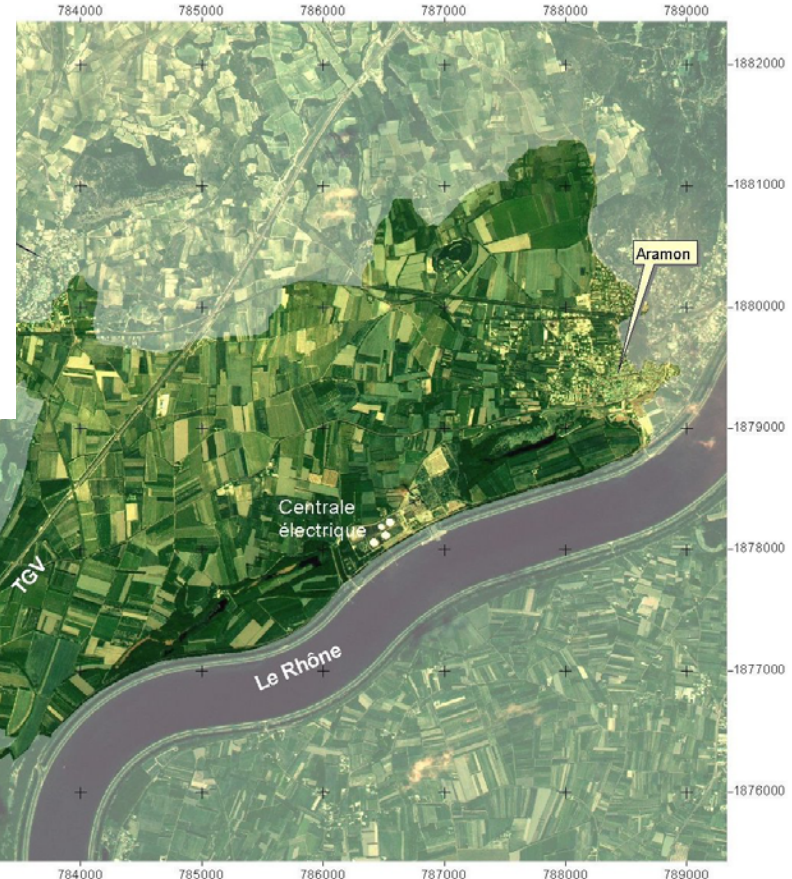
Very high resolution maps of human settlements changes within areas prone to flood risk.





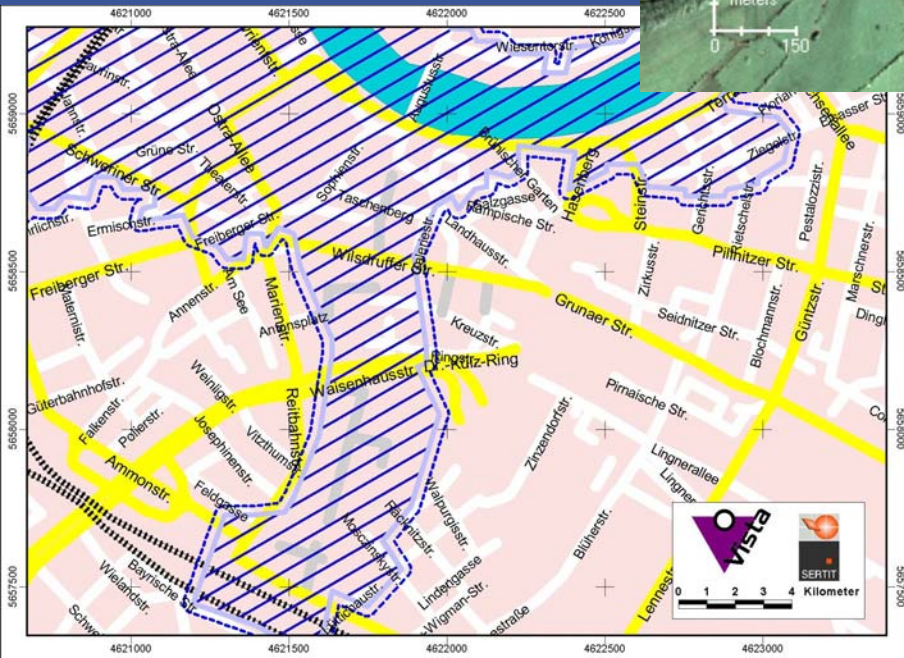
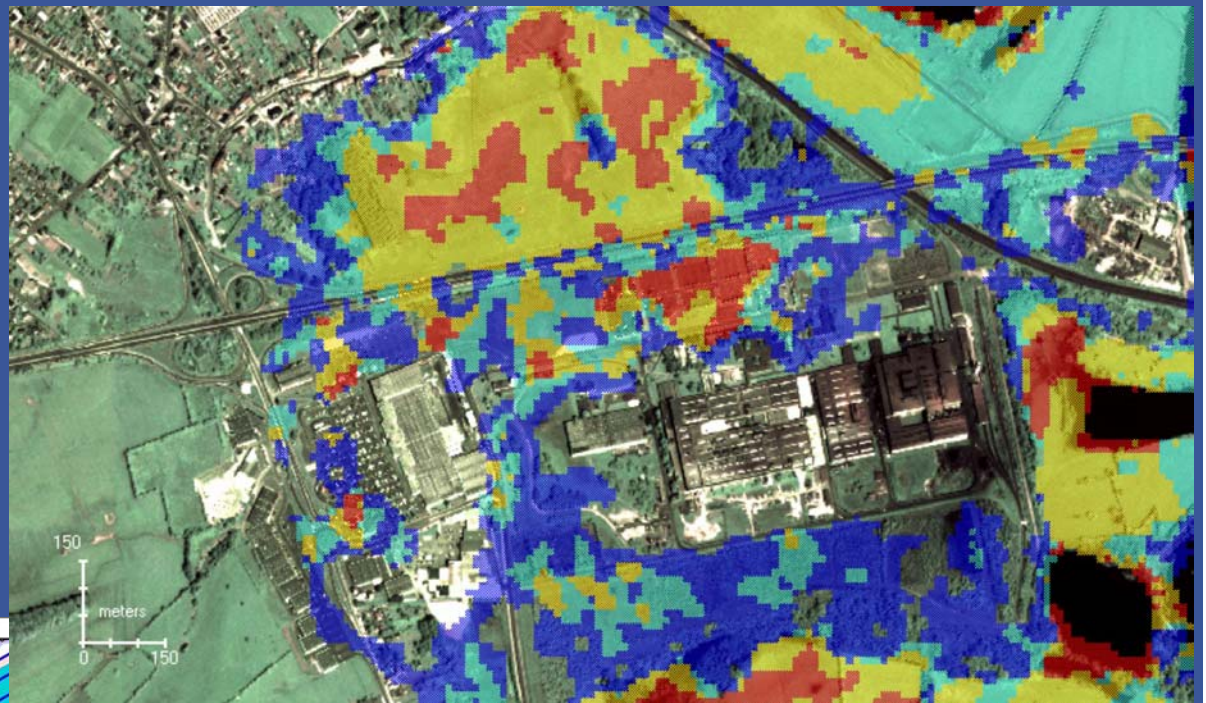
Flood Event Maps

Flood Extent maps are derived from ENVISAT C-band ASAR and overlaid on SPOT 5 in images.



Flood Damage Assessment

Flood Extent interested with cartographic maps to estimate damage to infrastructures.



Flood Events Archive

Flood duration - from 16 days (RED) to 4 days (BLUE) overlaid over VHR optical data (IKONOS). The flooded periods are computed from multi-temporal ERS C-band SAR-derived Flood Extent Maps.

✓ **user-driven activities performed on the basis of collaboration between all stakeholders:**

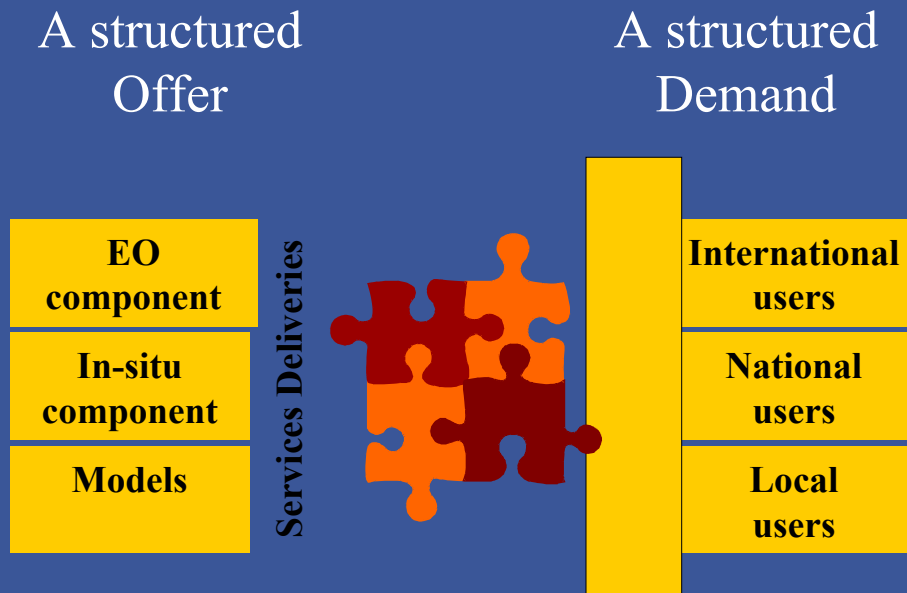
- engaging user organisations with a mandate to provide monitoring or surveillance in relevant policy sectors

✓ **looking at operational solutions building upon the inherent capabilities of EO:**

- synoptic view (spatial measurements)
- frequent measurements (night & day and years of archives)
- objective information
- reliable information (when combined with other information)

✓ **considering end-to-end systems** (space segment, ground segment, value adding, user segment) within which the **user is included**:

- **EO** but not only
- **In-situ / airborne**
- **Socio-Economic**
- **Models / Assimilation**
- **Monitoring -> Assessment -> Forecasting**



- ✓ taking into account **methods coming from both the operational and the research communities** with a view to deliver operational solutions
- ✓ **providing information that concerns not only short term issues** (crisis / emergency) **but also longer term issues** (rehabilitation, reconstruction, prevention, international development)
- ✓ developing sustainable services requires to **take stock of what exists today** (not building isolated systems)
- ✓ **based on the complementary skills of National, European and International organisations**, at institutional level (users, providers) and with the European service industry (value adding service providers)

Thank you...

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Email: philippe.bally@esa.int
marc.paganini@esa.int

The IGOS Geohazards theme report

GEOHAZARDS t h e m e R E P O R T



For the Monitoring of our Environment from Space and from Earth



April 2004

An international partnership for
cooperation in Earth observations

- Context, scope and strategic objectives
- Beneficiaires, stakeholders and user needs
- Required observations and key systems
- Integration issues
- Filling the gaps
- Implementation plan and commitments to act