Joint Research Centre (JRC)

Crisis Management and Natural Disasters
Overview of JRC operational or pre-operational activities
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http://www.jrc.ec.europa.eu/
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• JRC operational activities on Natural Disasters
  – Earthquake and Tsunami monitoring
  – Tropical Cyclones
  – Floods
  – Forest Fires
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Disaster monitoring for earlier response

Global Security and Crisis Management
  Preparedness
  **Response**
  Recovery
  Prevention
  Risk reduction

Alert systems for natural disasters
  Real time systems: GDACS, EFAS, GFDS, EFFIS
  Physical and risk modelling
  Strong practitioners community
  Multidisciplinary scientific community
JRC has developed operational systems to monitor and alert for Natural Disasters:
- Earthquake and Tsunami
- Tropical Cyclones
- Floods
- Forest Fires

JRC role covers the whole cycle of disasters from Preparedness, Alerting, Response, Reconstruction.

Major users of JRC systems:
- Internal EU users (i.e. DG-ENV, DG-ECHO)
- Member states (i.e. Portugal for Tsunami/Forest Fires)
- International Organizations (i.e. UN agencies: OCHA)
JRC, in collaboration with UN-OCHA (United Nations Agency for Humanitarian Affairs) developed the Global Disaster Alerts and Coordination System (GDACS)

- Fully automatic system, available 24/7
- Automatic gathering of natural events data: earthquakes, tsunamis, tropical storms, floods and volcanoes
- Analysis and alert
- Automatic reporting systems

More than 10000 users receive alerts from JRC in case of Natural Disaster

Platform: http://www.gdacs.org
**GDACS: system for international disaster response community**

Information gap in the initial response phase

10000 active users of 184 countries

Secretariat: OCHA

**JRC’s role: alert and monitoring system**

Earthquakes and tsunamis
- 13 scientific partners
- Tsunami modelling
- Impact modelling

Tropical cyclones
- 2 scientific partners
- Wind modelling
- Impact modelling

Volcanic eruptions, Floods
- 4 scientific partners
- No scientific monitoring network
Earthquakes

- impact model based on evaluation of the
  Alert Score = $F_{vulnerability} \times F_{Population\ density} \times F_{Magnitude}$

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**Earthquake Alert Level**

- **Depth < 300 km?**
  - yes
  - no
- **M > 4.5?**
  - yes
  - no
- **Population Density > 2.5 p/km²?**
  - yes
  - no
- **Alert Score $a = f(m, p, v)$**
  - $a > 17$
  - $a > 22$
- **Depth < 100 km?**
  - yes
  - no
- **Lower Alert Score $a = a - 1$**

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**Green Earthquake Alert Bolivia**

- **M 6.7**
- Summary
  - On 11/17/2005 7:28:47 PM UTC an earthquake of magnitude 6.7 has struck the unpopulated region of Chile-Bolivia border region in Bolivia.
  - Whether international humanitarian aid is needed must be decided by an expert. However, the following automatically calculated elements can help. This earthquake has potentially low humanitarian impact and the affected region has low vulnerability to natural disasters.

**Red Earthquake Alert Pakistan**

- **M 6.0**
- Summary
  - On 10/6/2005 3:55:18 AM UTC an earthquake of magnitude 6.0 has struck the very highly populated region of Pakistan.
  - Whether international humanitarian aid is needed must be decided by an expert. However, the following automatically calculated elements can help. This earthquake has potentially high humanitarian impact and the affected area has high vulnerability to natural disasters.
Issue: improvements in time detection

Improvement in the data availability through agreements with data providers
Tsunami models have been included in GDACS after 2004. At the moment we have:

- **Online calculations** initialized by several triggering mechanisms, to have as fast as possible start of the calculations (typical 30-40 min calculation time)

- **Grid calculations**: a worldwide scenario database containing 136000 scenarios that can be requested and included in the web pages (immediately available on request)

- **Tsunami Analysis Tool** software to analyse ongoing events
  - Developed to support Portugal Tsunami Early Warning System
Tsunami calculation grid

10184 possible epicenters in a grid of 0.5 degrees for a total of 136000 scenarios
Tsunami calculation grid

Historical events

Grid points

Mediterranean area
Samoa event, 29 sep 2009
Based on track information provided by the **Pacific Disaster Center**, JRC calculates areas around the track affected by high winds.

- Population and critical infrastructure.

- Depending on the wind speed and the population in the area, alert levels are set as follows:
  - Population < 100000: Green alert
  - Population > 100000 in Cat1: Orange alert
  - Population > 100000 in Cat1, with maximum wind speeds of Cat3 or up: Red alert

- Population potentially affected by storm surge (not yet part of the alert model).

- One important aspect that does influence the alert model is extreme rainfall, but no suitable models have been found and integrated as of now.
## Affected Cities

<table>
<thead>
<tr>
<th>Estimated arrival time (UTC)</th>
<th>Wind speed (km/h)</th>
<th>Distance (km)</th>
<th>Name</th>
<th>Province</th>
<th>Country</th>
<th>City Class (1-3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>09/23 09:30</td>
<td>105</td>
<td>72</td>
<td>Tam Ky</td>
<td>Quang Nam</td>
<td>Vietnam</td>
<td>3</td>
</tr>
<tr>
<td>09/23 09:45</td>
<td>105</td>
<td>93</td>
<td>Quang Ngai</td>
<td>Quang Ngai</td>
<td>Vietnam</td>
<td>3</td>
</tr>
</tbody>
</table>

## Affected Critical Infrastructures

No nuclear plants affected.

### Airports

<table>
<thead>
<tr>
<th>Estimated arrival time (UTC)</th>
<th>Wind speed (km/h)</th>
<th>Distance (km)</th>
<th>Name</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>09/23 09:30</td>
<td>105</td>
<td>79</td>
<td>No Duc</td>
<td>Vietnam Local et privée</td>
</tr>
<tr>
<td>09/23 09:45</td>
<td>105</td>
<td>69</td>
<td>Minh Long</td>
<td>Vietnam Local et privée</td>
</tr>
<tr>
<td>09/23 10:00</td>
<td>105</td>
<td>72</td>
<td>Doc Pho</td>
<td>Vietnam Local et privée</td>
</tr>
<tr>
<td>09/23 10:30</td>
<td>105</td>
<td>66</td>
<td>Dai Ly</td>
<td>Vietnam Local et privée</td>
</tr>
<tr>
<td>09/23 11:00</td>
<td>105</td>
<td>72</td>
<td>Tam Ky</td>
<td>Vietnam Local et privée</td>
</tr>
<tr>
<td>09/23 11:30</td>
<td>105</td>
<td>68</td>
<td>Thua Thien</td>
<td>Vietnam Local et privée</td>
</tr>
<tr>
<td>09/23 12:00</td>
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<td>72</td>
<td>Can Lai</td>
<td>Vietnam Local et privée</td>
</tr>
<tr>
<td>09/23 12:30</td>
<td>105</td>
<td>68</td>
<td>Hoi An</td>
<td>Vietnam Local et privée</td>
</tr>
<tr>
<td>09/23 13:00</td>
<td>105</td>
<td>72</td>
<td>Hai Phong</td>
<td>Vietnam Local et privée</td>
</tr>
</tbody>
</table>

### Ports

No dams affected.

## Event time line

### Population in cyclone Category (thousands)

<table>
<thead>
<tr>
<th>Category</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
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</tr>
</tbody>
</table>

### Population in tropical storm (millions)

<table>
<thead>
<tr>
<th>Storm</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
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</table>

### Risk of wind damage

- Category 1: Low
- Category 2: Moderate
- Category 3: High
- Category 4: Very high

## Impact details - Affected cities and critical infrastructure (advisory number: 19)

For each track point of the cyclone, a list of cities and critical infrastructure hit by high winds with speed bigger than hurricane strength is shown below. Click on the button "Impact" to see the data. (*) Data obtained from official tropical storm advisories.

<table>
<thead>
<tr>
<th>Track</th>
<th>City</th>
<th>Population in</th>
<th>Population in</th>
<th>Population vulnerable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Category 1</td>
<td>Category 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(*)</td>
<td>(*)</td>
<td></td>
</tr>
</tbody>
</table>

(*) Data obtained from official tropical storm advisories.
Affected Population

Up to 3.95 million people can be affected by wind speeds of hurricanes strength or above. In addition, 8.29 million people are living in coastal areas below 5m and can therefore be affected by storm surge.

Affected Country (provinces) (population)

Vietnam (Kien Tu), (291,165), Vietnam (Giang Nhon-Ca Nang) (185,762), Vietnam (Giang Nghi) (159,425).

Affected Cities

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<tr>
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<th>Name</th>
<th>Province</th>
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</tr>
</thead>
<tbody>
<tr>
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<td>187</td>
<td>68</td>
<td>Quang Nghi</td>
<td>Vietnam</td>
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<tr>
<td>01:45</td>
<td>187</td>
<td>68</td>
<td>Quang Nghi</td>
<td>Vietnam</td>
<td></td>
</tr>
</tbody>
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Affected Critical Infrastructures

No nuclear plants affected

Airports

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<th>Name</th>
<th>IATA Code</th>
<th>Country Type</th>
<th>Runway</th>
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<tr>
<td>04:15</td>
<td>167</td>
<td>68</td>
<td>Chu Lai</td>
<td>Vietnam</td>
<td>Local or private</td>
<td></td>
</tr>
<tr>
<td>04:15</td>
<td>167</td>
<td>68</td>
<td>Cu Lu Re</td>
<td>Vietnam</td>
<td>Local or private</td>
<td></td>
</tr>
<tr>
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<td>Ha Thanh</td>
<td>Vietnam</td>
<td>Local or private</td>
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Floods

Flood event

Currently Europe only

Detection, confirmation, assessment

News Reporting

Forecast

EMM

GFDS

EFAS

Time

>2

+1

-10
days
Monitoring floods: state of the art

Global flood forecasting?
Modelling and forecasting:
no global coverage
National / regional systems:
EFAS, see later

Media monitoring?
Dartmouth Flood Observatory, EM-DAT
Automatic media monitoring
Reporting is not systematic: language dependent; qualitative, biased

Global discharge monitoring?
Global Runoff Data Centre:
no global / timely coverage
Costly: 1 million km of river globally
(89M$/year for US)
Local systems: not interoperable
FLOOD FORECASTING (EFAS)

Currently Europe only

Forecast

News Reporting

Flood event

Detection, confirmation, assessment

EMM

GFDS

Time

>2

+1

-10
days
Adaptation: early warning systems
the European Flood Alert System (EFAS)

- EU Flood GIS
  - Realtime H-Q data
  - Historical Data
  - Static Data
  - Europ. Data Layers
  - Meteo -Data
  - Expert Knowledge of Member States

120 forecasts daily

24/365 Web-Interface

Impact: earlier crisis preparedness actions by national civil protection (e.g. HU, RO)

Support to EU Flood Directive, river basin Action Plans for floods (Danube, Elbe), and EU Civil Protection (MIC)
Po flood 2009 (28-29 April)
Challenge: From European to African and Global forecasting systems

Two pilot studies:
- Juba & Shabelle river basins (Somalia/Ethiopia)
- Zambesi river basin (Southern Africa)

Collaboration exist between JRC and Dartmouth Flood Observatory, Princeton University, Washington State University
FLOOD DETECTION (GFDS)

Currently Europe only

News Reporting

EMM

GFDS

Detection, confirmation, assessment

Flood event

Forecast

EFAS

>2

+1

-10

Time

days
Passive microwave remote sensing

Specifications for monitoring
- Global revisit time: daily
- Atmospheric attenuation: low

AMSR-E
- Resolution: 10km
- Swath width: ~3000km
- Launch: 2002

36.5GHz
Novel normalization methodology: flood signal

Influence of clouds is eliminated by comparing dry and wet signal.

Water has a lower brightness temperature than land.
Global flood detection system

Flood signal for the site 262 in the year 2009

Burkina Faso, 6 Sept

Burkina Faso, 15 Sept

http://www.gdacs.org/floods
Flood signal

Brightness temperature (K)  Flood signal (M/C ratio)
Rapid flood mapping

Flooded area mapped by the Dartmouth Flood Observatory based on MODIS optical imagery

Flooded area mapped by JRC based on AMSR-E microwave data

Executive Summary
On 2 May 2008, a tropical cyclone of category IV made landfall in Myanmar, affecting the provinces of Rakhine, Tanintharyi, Kayin, and Mon State. According to the latest figures reported in the media (5 May 2008), over 19,000 people were killed while another 40,000 people are reportedly missing. The scope of the U.N. High Commissioner for Refugees (UNHCR) operation, was estimated at 60,000 people, with a peak of 2.2 million. The affected area is still under assessment, with the scale of the disaster still under evaluation. International community is still assessing the scale of the disaster, but response has started with, among others, a $2 million contribution in fast-track humanitarian aid by UNHCR.

Discussion
In the aftermath of Tropical Cyclone NARGIS in Myanmar, an analysis of the AMSR-E passive microwave sensing was done to determine if this sensor could see flooded areas using the methodology of the Global Flood Detection System (GFDS).

The flooded area detected using AMSR-E is consistent with MODIS optical remote sensing.

Conclusions
(1) AMSR-E flood maps can provide an alternative to optical flood maps for large floods. The resolution is lower, but the extent is similar.
Map and observation site

First media reports

10 days time gain for first response
The European Forest Fire Information System (EFFIS) supports the services in charge of the protection of forests against fires in the EU and neighbour countries and provides the European Commission services and the European Parliament with updated and reliable information on wildland fires in Europe.

The most up to date information on the current fire season in Europe and in the Mediterranean area. This includes today meteorological fire danger maps and forecast up to 6 days, daily updated maps of burnt areas and damage assessment derived from satellite imagery of the last 7 days, maps of the latest hot spots and fire perimeters also updated daily.
Situation assessment (danger forecast, damage analysis)
GIS Tool for Forest Fires
Future plans

Earthquakes:
• Improve the vulnerability factor, including local effects and regional or municipal values, if available

Tsunami
• Completion of the vers. 2.0 of the scenario database, currently available in the Gulf of Cadiz

Tropical Cyclones
• Include inundation model for storm surge

Floods
• Forecasting: extend to worldwide coverage
• Detection: include additional sensors

Fires
• Fire risk assessment (including danger forecasting): EU and foreseen worldwide coverage.
• New modules on “socio-economic impact of fires” and “emissions and dispersion modeling” under development.
Conclusions

- JRC has developed and is currently run several operational systems for Early Warning Systems
  - GDACS system is used by more than 10000 users worldwide for earthquakes, tsunamis, volcanoes, tropical cyclones and flood detection
  - EFAS system is serving European Member States authorities with 10 days flood forecasting. Currently plans to extend to other world areas
  - Global Flood Detection System can already be used on a large scale
  - EFFIS system is currently forecasting Forest Fire Danger and assessing forest damages for European and neighbour countries
- Plans are ongoing to improve the tools in several areas
- Data, methodologies and products exchange with other organizations would be highly beneficial