

# Science for disaster risk reduction and response

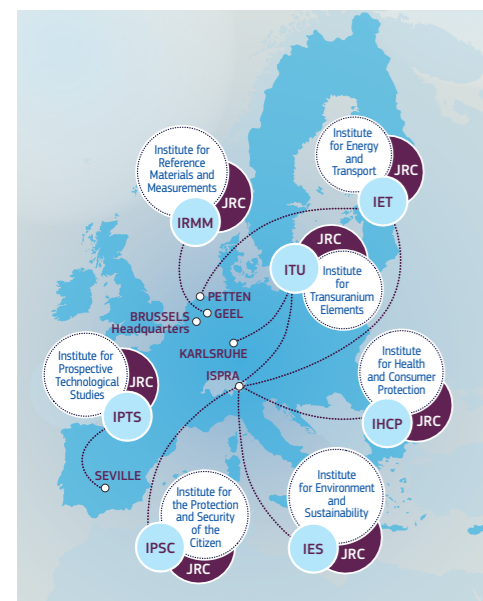
early response capacities, as well as for recovery planning. The JRC contributed to this process with the development of a 'guide to a multi-stakeholder needs assessment recovery framework (PDNA)' for decision-makers to use during the early phases of disaster recovery planning. The guide includes the JRC's approaches for damage assessment from remotely sensed and other data sources, as well as sector specific tools developed by the partners of the joint initiative. In May 2014 heavy rains in Bosnia and Herzegovina (BiH) caused sudden and severe flooding and landslides over one third of the country, affecting more than one million people.

The Bosnia and Herzegovina government, together with the World Bank, the EU and the UN conducted a Post-Disaster Needs Assessment (PDNA) to identify damages, losses and needs, and to estimate recovery costs. The JRC, together with the international partners, contributed to the PDNA by providing flood maps through the Copernicus Emergency Management and by conducting data collection and rapid in-field mapping.



With the Copernicus Emergency Management Service, the JRC produced a damage assessment map after the severe flooding in Bosnia and Herzegovina in May 2014.

## Joint Research Centre The European Commission's in-house science service



Serving society  
Stimulating innovation  
Supporting legislation

### JRC mission

As the Commission's in-house science service, the Joint Research Centre's mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle. Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new methods, tools and standards, and sharing its know-how with the Member States, the scientific community and international partners.

### Facts & figures about the JRC

Established in 1957  
Around 3 000 scientific and technical personnel  
7 scientific institutes  
1 370 publications in 2014

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Natural disasters and crises cause fatalities and considerable economic losses worldwide every year. Floods, forest fires, earthquakes, tsunamis, droughts, industrial accidents and political crises have a significant impact on society, the environment, the economy and the well-being of the population. Disaster data clearly show that most casualties occur in poor countries, whereas the medium and high income countries suffer the highest economic losses. Recorded economic loss from disasters is rising - this higher figure may be due to better reporting, greater exposure to disasters, or a combination of the two.

In 2011, economic damage from natural disasters was the highest ever registered, amounting to some € 280 billion. In Japan, the tsunami triggered by an earthquake killed nearly 20,000 people and was the costliest disaster in history, causing a 3.5% loss of the country's GDP. According to the World Economic and Social Survey (UN, 2011), the number of natural disasters increased five-fold between 1979 and 2010. In 2011, 245 million people were affected worldwide by natural disasters, with a death toll of 31 000.

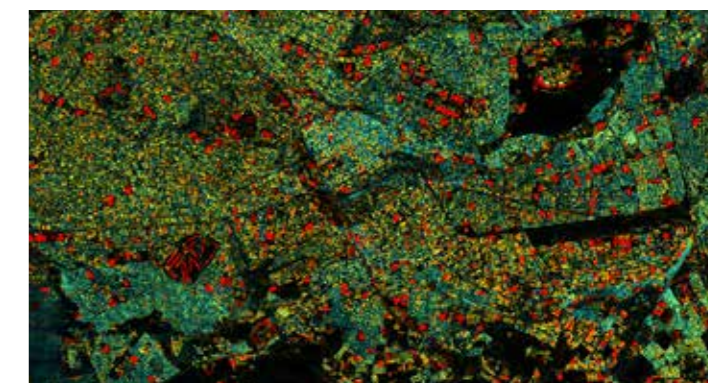
The EU is the world's largest donor for humanitarian aid and development globally. Enhancing the EU's resilience to crises as well as its capacity to prepare and respond to acute threats, especially cross-border threats, is also amongst the objectives of the Europe 2020 strategy, the EU's growth strategy for the coming decade.

Science and technology offer key solutions to improve disaster risk reduction, as well as anticipation and response to natural and man-made disasters. The European Commission's in-house science service, the Joint Research Centre (JRC), carries out research in crisis management technologies, analysis and application of remotely sensed data, natural hazard modelling, information mining/analysis, vulnerability and risk analysis, and civil engineering to support resilience against disasters.

### Being prepared for disasters

In the long run, prevention measures combined with preparedness can save money by reducing spending on recovery and reconstruction and, more importantly, increase resilience against future disasters. The JRC's research activities in this field cover:

**Monitoring populations in disaster hot spots** Crisis management operations require a clear understanding of exposure and vulnerability of both physical assets and populations. Being able to detect the urban areas with high population concentrations, those that are rapidly growing, those more vulnerable (such as in poorer districts or slums), and the types of buildings present in these areas are fundamental inputs for disaster risk assessments. The JRC's Global Human Settlement Analysis system can detect, characterise and map human settlement in both urban and rural settings. It also allows the monitoring and characterisation of urban growth, an important factor in disaster risk.



Information from the Global Human Settlements Layer (GHSL) over London: black areas are classified as not built-up, while different colours point to automatically detected built-up structures with different morphological characteristics.



**Detecting emerging threats** Regularly monitoring the internet has shown to be very useful in detecting emerging threats, such as public health outbreaks and various forms of socio-political instability. The JRC has developed and continually refines open source intelligence systems that can automatically harvest and analyse a vast amount of multi-lingual information from internet-based sources. The Europe Media Monitor (EMM) automatically identifies people and organisations, geo-locating each article and sensing positive or negative tonality. The Medical Information System (Medisys), built around EMM, helps to rapidly identify potential threats to public health.

**Measuring the risk of humanitarian crises and disasters** Risk analysis is used to identify the people and places most at risk in the case of a disaster and, therefore, reduce and manage the threat. The Index for Risk Management (INFORM), developed by the JRC together with the Inter-Agency Standing Committee Task Team for Preparedness and Resilience, is a way to understand and measure the risk of humanitarian crises and disasters. INFORM is a composite index which aims to provide an open, transparent, consensus-based methodology for analysing crisis risk at global, regional or national level.

**Recording disaster losses** It is widely recognised that risk assessment requires accurate recording of previous disasters and in particular, the associated losses in terms of human casualties, property and environment damage as well as economic loss. Loss data are used to infer vulnerabilities and to identify sectorial areas for disaster risk reduction and mitigation measures. The JRC is working to improve approaches and standards for recording loss data. The aim is to have consistent databases that can be aggregated up to a global level in support of the post-2015 global framework for disaster risk reduction.

**Easy access to transparent data** The EU is committed to ensuring that information about how and where aid funds have been used is widely available. The EU Aid Explorer, developed by the JRC together with the Directorates-General for Development and Cooperation - EuropeAid and Humanitarian Aid and Civil Protection - ECHO, is a unique web tool that provides easy access to clear, complete and accurate data on development and humanitarian aid around the world, covering activities of different donors.

By making data easily accessible, countries, beneficiaries and EU citizens can examine the use of donor funds and donors themselves can improve co-ordination and effectiveness.



The JRC's European Laboratory for Structural Assessment (ELSA) is equipped with one of the three largest reaction walls in the world to test the vulnerability of buildings against earthquakes.

**Safer buildings and resilient infrastructure** Prediction of the location and intensity of future earthquakes is unfortunately not possible, but much can be done to enhance the safety of structures, as most of the human casualties are due to the collapse of inadequate constructions. In its European Laboratory for Structural Assessment (ELSA), the JRC assesses the vulnerability of buildings and other civil infrastructures and develops appropriate methodologies to make them more resistant to earthquakes, as well as to explosions and other accidents or terrorist attacks. This research contributes to the development of the EUROCODES, the new set of European standards for the construction sector.

**Protecting critical infrastructures** Damage or destruction of critical infrastructures, such as power grid or communication systems, by natural disasters or criminal activities may have a severe impact on the security of the EU and the well-being of its citizens. The JRC carries out different research activities to identify vulnerabilities and protect critical infrastructures. In this context, the JRC has started to analyse the impact of solar storms, both directly on infrastructures and through their effects on global navigation satellite systems (GNSS), the key for precise timing and synchronisation in many infrastructures, such as telecommunication, financial and transport systems. The JRC also coordinates the European Reference Network for Critical Infrastructure Protection (ERNICIP) which provides a framework for experimental facilities and laboratories to share knowledge in order to better align test protocols throughout Europe.

**Preventing industrial accidents** Chemical installations, petrochemical and oil refineries are hazardous installations which need to be safe and secure from technical failure, human error, natural hazard, and terrorist attack. Accurate and detailed information on past accidents provides essential information for learning lessons and improving safety. The JRC manages the official online reporting system eMARS (Major Accident Reporting System), which contains events on chemical accidents and near misses reported by EU Member States since 1982, and which now receives voluntary reports from non-EU countries. The JRC also studies how natural events can damage chemical plant or oil and gas pipelines, causing the release of hazardous material, and has developed a web-based risk analysis and mapping tool, RAPID-N, that estimates the overall risk of natural-hazard damage to chemical industrial installations and its possible consequences.

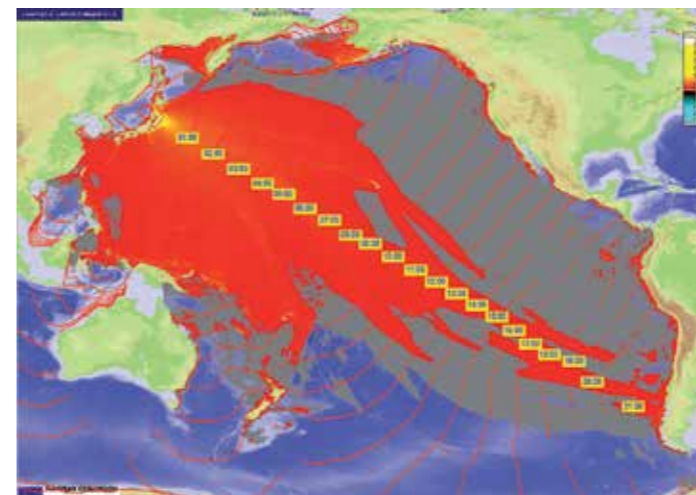
**Global Human Settlement Layer:** <http://ghslsys.jrc.ec.europa.eu/>  
**EMM and Medisys:** <http://emm.newsbrief.eu/overview.html>  
**INFORM:** <http://www.inform-index.org/>  
**EU Aid Explorer:** <https://euaidexplorer.jrc.ec.europa.eu/>  
**Eurocodes:** <http://eurocodes.jrc.ec.europa.eu/>  
**e-Mars:** <https://emars.jrc.ec.europa.eu/>  
**Rapid-N:** <http://rapidn.jrc.ec.europa.eu/>  
**eNatech:** <http://enatech.jrc.ec.europa.eu>

## Monitoring, forecasting and alerting disasters

Science-based forecasting and early warning systems are essential components of informed decision making to provide the relevant authorities and the emergency response community with sufficient lead time to take effective preparatory measures and to quickly decide and co-ordinate the course of actions during the response phase. As part of its research activities, the JRC has developed a range of tools and systems that can help to improve preparedness and response to natural and man-made disasters.

**Disaster early warning at a global scale** Jointly developed by the JRC and the United Nations, the Global Disaster Alert and Coordina-

tion System (GDACS) is a web-based platform that provides global multi-hazard disaster monitoring and alerting for earthquakes, tsunamis, floods, volcanoes and tropical cyclones. In the event of major disasters, GDACS automatically sends alerts via e-mail, fax or SMS to the international first responders community. GDACS combines information on the event, the population in the affected area and their vulnerability to estimate an alert level that indicates the potential for a catastrophic situation needing international humanitarian intervention. GDACS also includes the JRC's Tsunami Assessment Modelling System, which can quickly estimate wave height and travel time of tsunamis based on its global historical tsunami scenario database, helping to provide a rapid assessment of the potential for a tsunami.



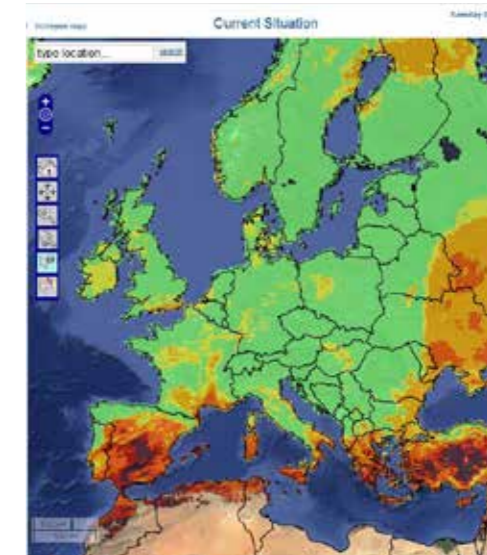
Maximum estimated height and travel time of the Tohoku Tsunami as calculated by the JRC. The wave extended from the Japanese coast to South America in about 24 hours.

**From drought to floods** Drought is recognised as one of the most costly and widespread natural disasters with important impacts on the economy, society and the environment of affected regions. The JRC's work on droughts focuses on the monitoring, assessment and forecasting of drought events in Europe and globally as well as on the societal preparedness for and resilience to droughts. The JRC has developed the European Drought Observatory (EDO) providing up-to-date information on droughts across the European continent at a variety of scales. Similar systems are being developed for Africa (African Drought Observatory - ADO) and Latin America (South and Central America Drought Observatory - SCADO) and the JRC is contributing to the development of a Global Drought Information System (GDIS) as well as to the Integrated Drought Management Programme (IDMP) together with international partners from all continents.

The JRC's research on floods focuses on improving preparedness and support during a flood crisis. The European Flood Awareness System (EFAS) is a flood early warning system that complements the national forecasting systems of EU Member States by predicting the potential for floods in Europe up to ten days in advance. Since 2012, EFAS has become a fully operational system as part of the Copernicus Emergency Management Services. Based on the experience of EFAS, the JRC has also developed the Global Flood Awareness System (GloFAS), which is able to predict large-scale floods with more than 15 days of lead time at a global scale. GloFAS, in combination with the Global Flood Detection System (GFDS) are key instruments for the co-ordination of international aid. GFDS provides up-to-date information on the impact and extent of floods occurring across borders using real-time satellite observations.

**Monitoring forest fires** About 70 000 forest fires occur yearly in the European Union and it is very likely that the damage they cause will

increase in the future according to climate change scenarios. Currently, annual losses in the EU are estimated at nearly € 3 billion. The JRC has developed the European Forest Fire Information System (EFFIS), which monitors forest fires in Europe and covers the full cycle of forest fire events. It supports prevention and preparedness fire related activities by delivering fire danger predictions up to 10 days in advance and helps in the management of crisis situation and post-fire operations with the provision near-real time information on active fires and fire damage in Europe. Currently, in the context of GEO (Group on Earth Observation) activities and in collaboration with international organizations (e.g. FAO, UNECE) and initiatives (e.g. GOFI Fire IT - Global Observation of Forest Cover - Fire Implementation Team) the system is being expanded to a Global Wildfire Information System (GWIS).



The JRC's European Forest Fire Information System (EFFIS) shows risk of fires (from low - green to high - dark red) across Europe.

**GDACS:** <http://www.gdacs.org/>  
**EFAS portal:** [www.efas.eu](http://www.efas.eu)  
**GloFAS portal:** [www.globalfloods.eu](http://www.globalfloods.eu)  
**European Forest Fire Information:** <http://effis.jrc.ec.europa.eu/>  
**Copernicus EMS:** <http://emergency.copernicus.eu/>

## Responding to disasters

Another important aspect of informed decision-making when major disasters and crises strike is to have rapid and reliable access to relevant information depicting the overall picture of what has happened where and the characteristics, extent and severity of the damage.

**Emergency mapping** Over several years, the JRC's research has addressed the rapid identification of the location and extent of post-disaster damage by analysing remotely sensed data such as satellite imagery, helping Commission services to plan relief and assistance measures. Today, the JRC is responsible for the technical coordination of the 'emergency management service' (EMS) of the Copernicus programme (previously known as the Global Monitoring of Environment and Security (GMES) programme). This service provides all actors engaged in civil protection and emergency response with timely and accurate geo-spatial information and maps on disasters based on remotely sensed data complemented by in-situ data when available.

**Recovering after a disaster** The EU is committed to improving its capacity to respond to disasters and supports international co-operation in assessing recovery needs and in planning recovery measures in post-disaster situations. As a result, in 2008 the European Commission, the United Nations Development Group and the World Bank established a platform for partnership to strengthen coordination for