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Examples of Earth Observation applications to Natural Hazards in the Euro-Mediterranean Region

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Through its Earth Observation (EO) Programme, ESA undertakes a wide variety of projects related to the application of EO for the monitoring of natural hazards. These include operational services for rapid mapping and post disaster relief, as well as research and demonstration projects on the use of EO techniques for natural hazard monitoring.

Since the creation, in 1999, of the International Charter "Space and Major Disasters", initiated by ESA and the French Space Agency CNES (plus many other space agencies who became members afterwards), a variety of different disasters have been mapped and analysed from space, including many that took place in the Euro-Mediterranean Region. These include earthquakes, volcanoes, floods, landslides. Just in Turkey, the Charter provided satellite-based products of three earthquakes (in 2003, 2010, 2011), one flood (2009) and one landslide (2011).

Some of these examples of catastrophic events (such as the Izmit/Turkey earthquake of 1999 or the Thessaloniki/Greece floods of 2006), mapped and analysed using satellite data, have been used in order to create computer exercises for secondary schools, using a free educational software developed and distributed by ESA in the frame of its multilingual web project Eduspace (http://www.esa.int/SPECIALS/Eduspace_EN/).

The International Charter aims to provide a unified system of space data acquisition and delivery to those affected by natural or man-made disasters worldwide. To date, 15 organisations are Charter members. The member agencies put at the disposal of the Charter their satellite resources. The Charter therefore benefits from a growing number of satellites that increase the revisit frequency and the choice of sensor for spectral and spatial resolution. Data from these sensors are processed, merged and interpreted in a variety of ways to extract the best possible information on the effects of a given disaster. One of the advantages of using Earth Observation satellites for disaster mapping is that ground-based information in the region affected is often difficult to generate otherwise because the infrastructure on ground, needed to generate the information might be destroyed or damaged by the disaster.

Furthermore, satellites are the most effective means for synoptic viewing for disaster response on an emergency and priority basis. The Charter products are delivered to users on the ground with fast turnaround and at no cost. Valueadding and extraction of information from satellite data is generously sponsored by the individual Charter members. However, the Charter covers only the response phase of a disaster, on a best effort basis, whereas the later recovery and rehabilitation efforts are excluded by this mechanism.

Floods have been the most commonly covered disaster, representing roughly 50% of the Charter requests received. Typically, the main feature of the products is based on deriving flooded surfaces, either from the nature of the spectral response of these surfaces, and/or by comparison with the reference imagery predating the disaster. Typically, the flood vectors are presented as final products in GIS layers. More recently, with the advent of high resolution SARs (metric resolution), new products showing changing water depths of inundated areas have been created.

In the case of volcanic eruptions, volcanic plumes and ash clouds can easily be detected using optical sensors from space. However, the volcanic cloud often hampers observation of the crater and the surface topography during the eruption - therefore radar backscattering properties of the ground features can be exploited to delineate the different types of volcanic deposits. A good example of the use of SAR imagery for this disaster type comes from the Charter coverage of the Iceland volcanic eruption that halted air traffic over much of Europe in

April–May 2010.

For fires, thermal and optical sensors from space constitute the core Charter capability for monitoring this disaster type. Large scale burnt area mapping of the 2009 Greek fires was carried out with satellite sensors.

Very similar to the Charter is the Emergency Management Service, one of the services of Copernicus (former GMES: Global Monitoring for Environment and Security). Copernicus develops services dedicated to a systematic monitoring and forecasting of the state of the Earth's subsystems. It collects data from multiple sources (earth observation satellites and in situ sensors such as ground stations, airborne and sea-borne sensors), processes these data and provides users (mainly policymakers and public authorities) with reliable and up-to-date information through services. Six thematic areas are developed: marine, land, atmosphere, emergency, security and climate change. The pre-operational Copernicus emergency management service reinforces the European capacity to respond to emergency situations such as fires, floods, earthquakes, volcanic eruptions, landslides or humanitarian crisis. It functions very much like the Charter, in that EO data is processed to produce disaster mapping products, which are delivered to users.

While the Charter and Copernicus Emergency Management Service are predominantly for immediate disaster mapping, the Copernicus "Respond" service provides EO data in support to recovery, rehabilitation and reconstruction activities. The objective of Respond is to reinforce Europe's capacity to respond to emergency situations caused by the weather such as storms, fire and floods, geophysical hazards such as earthquakes, tsunamis, volcanic eruptions, landslides and subsidence, and environmental disasters resulting from human activity such as oil spills, and humanitarian disasters.

Another activity of ESA in the application of EO for natural hazards is in the development of a service for landslide monitoring. Ground Instabilities are among the most widespread geological hazards on Earth. Thousands of deaths and injuries, and enormous economic loss are regrettable evidences of worldwide slope instabilities. The necessity to identify and monitor slope movement is of paramount importance to reduce the socio-economic toll that every year is paid in developing as well as in developed countries. Several projects funded by ESA have investigated the feasibility and the operational applicability of spaceborne imagery to respond to the needs of governmental institutions that have a mandate in landslide prevention. These include the SLAM projects (Service for Landslide Monitoring), which are aimed at developing an end-to-end service chain for the provision of Slope Instability products.

The 1997 Kyoto Convention revealed to the general public that industrial and agricultural emissions of carbon dioxide, methane and other Greenhouse gases threaten to change the climate rapidly. The Baveno Manifesto reflected the European concerns for Global Environment Monitoring by space as a component of the Kyoto Convention implementation. In response to these, ESA developed the first ever multi-year Global Fire Atlas.

Remote sensing data from the ERS-2 ATSR-2 (Along Track Scanning Radiometer) allows to monitor agricultural fires and wildfires distribution at global scale and in Near Real Time. All Hot Spots (including gas flares) with a temperature higher than 312 k at night are precisely localised (better that 1km).

Through its activities in Earth Observation, ESA contributes to the monitoring of a wide range of disasters worldwide at all phases of the event cycle, including risk analysis and forecasting (e.g. in the case of SLAM), immediate disaster mapping (in the case of the International Charter and Copernicus Emergency Management Service), and post disaster recovery, rehabilitation and reconstruction (in the case of Respond). Continued availability of Earth Observation data is a prerequisite for the continuity of crisis mapping and disaster mitigation services in the long term. The upcoming Sentinel missions will provide essential rapid multisensor coverage over potential disaster-stricken areas.