# USE OF THE INTERNATIONAL CHARTER SPACE AND MAJOR DISASTERS FOR DAMAGE ASSESSMENT

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**ABSTRACT:**

Operational since November 1, 2000, the activation of the Charter is regularly increasing. As of December 31, 2003 the civil protection agencies requested triggering of the Charter 45 times : seventeen times for flooding in Argentina, Austria, Canada, Czech Republic, Dominican Republic, France, Germany, Indonesia, Morocco, Nepal and Russia, seven times for an earthquake in Afghanistan, India, Iran, San Salvador, Turkey and Algeria, five times for forest fires in Canada, France and Portugal, five times for oil spills near the coast of Denmark, Ecuador, Lebanon, Spain and Yemen, four times for landslide in Italy, Nepal, Philippines and Russia, four times for a volcanic eruption in the Democratic Republic of Congo, Italy and Montserrat island, three times for a storm in Mexico, India and the USA.

The purpose of the International Charter is to provide a unified system of space data acquisition and delivery for users affected by disasters, to promote co-operation between space agencies and space system operators and to allow participation in the organisation of emergency assistance or subsequent operations. Data acquisition using available space resources (ERS-2, ENVISAT, IRS-1C, 1D, RADARSAT, SPOT 2-4-5, NOAA polar satellites and SAC-C) and delivery takes place on an priority basis as well as processing and damage assessment maps production.

All Partner agencies undertake to co-operate on a voluntary basis with no exchange of funds between them in the event of a major natural or technological disaster and to provide free data and information to the end users. This paper will point out some of the best cases of Charter activation for different disasters leading to change detection imagery and to some tentative of damage assessment products in close co-ordination with the end users.

## 1. BACKGROUND

### 1.1 Establishment of the Charter

In July 1999, during the Unispace III Conference, the French Space Agency (CNES), and the European Space Agency (ESA), considering the potential contribution that space can provide in case of major disasters, announced their intention to set a co-ordinated access to space means. The international Charter "Space and Major Disasters" was signed on June 20, 2000 by both agencies followed in October 2000 by the Canadian Space Agency (CSA). In September 2001, the National Oceanic and Atmospheric Administration (NOAA) and the Indian Space Research Organisation (ISRO) became members of the Charter and in March 2003 the Argentina Space Agency (CONAE) also joined the Charter. Japan Space Agency (JAXA) is currently in the process of joining the Charter.

The International Charter aims at providing a unified system of space data acquisition and delivery to those affected by natural or man-made disasters through authorized users. Each member agency commits resources to support the provisions of the Charter and thus is helping to mitigate the effects of disasters on human life and property. Efficient use of space technology in disaster management will only be achieved through a long-term working relationship between the civil protection community and space agencies. This is the objective of the Charter, and even though until now, the Charter has relied on limited capabilities, it is an important step forward in merging user's requirements, like the ones of civil protection authorities, with space technology solutions.

### 1.2 The Charter organization

The Charter is open to space agencies and satellite operators ready to make available significant and relevant satellite resources. The parties develop their co-operation on a voluntary basis and without transfer of funds among them. Data and, possibly, information are provided free of charge to the end user. The administrative, operational and technical co-ordination is provided by a Board and an Executive Secretariat, each with one representative per member and chaired in rotation according to the *Primus inter pares* rule.

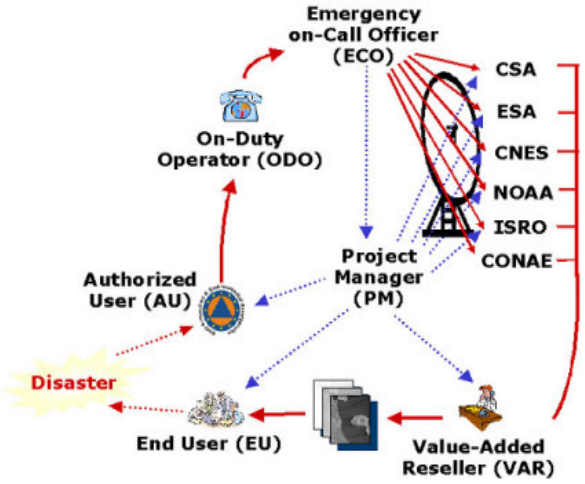
The International Charter was declared formally operational on November 1, 2000. An Authorized User can call a single confidential number to request the mobilisation of the space and associated ground resources of the partner agencies (ERS-2, RADARSAT-1, ENVISAT, SPOT 2-4-5, IRS 1-C, 1D, POES, GOES and SAC-C) to obtain data on a disaster occurrence**.**

An Authorized User is a civil protection, rescue, and defence or security body from the country of a Charter member - at present France and other ESA member states, Argentina, European Commission, Canada, India and the USA. Relief agencies in countries not represented by Charter members are able to activate the Charter by requesting assistance from civil

protection bodies in those countries or by requesting international aid to member countries. In addition since July 2003, the UN Office of Outer Space Affairs (UN OOSA) has become a co-operative body to the Charter, allowing also the UN organizations to activate the Charter.

The process is triggered by the call of an Authorized User to a 24-hour On-Duty Operator (ODO) who is located at ESA/ESRIN in Italy. This operator checks the identity of the requester, verifies that the User Request Form sent by the user, is correctly filled up (preliminary information on type, location and scope of the disaster); then, he forwards this information, within the hour, to the Emergency On-Call Officer (ECO). This officer is an engineer on the staff of one of the Charter members, which share the task in turn, week by week.

The next step for the Emergency On-Call Officer is (1) to analyse the request and the scope of the disaster with the user, (2) to identify the most quickly available and appropriate satellite resources, and (3) to inform the requester of the contemplated action plan for rapid acquisition of satellite imagery of the disaster zone. This request of satellite tasking and archive retrieval is sent to partner satellite operators to obtain immediate action. By this time the activation procedure is up and running. The Emergency On-Call Officer hands over to a Project Manager (PM), appointed by the partners, who supervises the process through to its conclusion, namely rapid delivery of the relevant documents (archive imagery, land use map, change detection leading to possible damage identification, etc.) to the end-user.
The Charter operation loop is described hereafter:



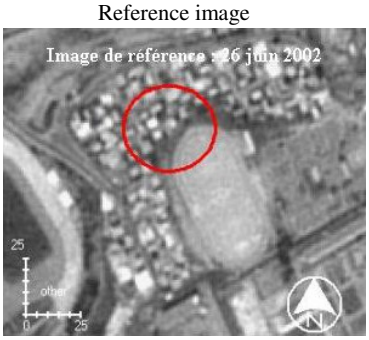

Since its implementation, the Charter has been activated 52 times in 42 months (as of May 15, 2004) on almost all the continents and for various kinds of events such as landslide, earthquake, oil spill, flood, volcanic eruption, forest fires.
Fourteen different organisations from Argentina, Austria, Belgium, Canada, European Union, France, Germany, India, Italy, Portugal, Switzerland, UK, United Nations and the USA were involved. Each operation was analysed with the relevant end-users and the Project Manager in order to improve the efficiency of the service provided to the civil protection community particularly in terms of response time and of delivered products. Some of the best cases of Charter activation leading to change detection imagery and to some tentative of damage assessment products in close co-ordination with the end users are described hereafter.

## 2. SOME CHARTER ACTIVITIES

### 2.1 Earthquakes

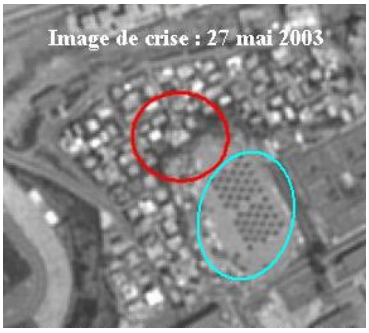
A major **earthquake struck Algeria in May 2003**, the French Civil Protection Authority (CPA) initiated the Charter at the request of the Algerian CPA. The only useful satellite information were Spot 4 (May 23) and Spot 5 (May 27).
Spot 4 imagery could not be successfully compared with Spot 5 available archive due to viewing angle differences, although the products were available 40 hours after activation. However the good accuracy of the Spot 5 (2.5 m) archive was useful, as no local maps at that scale were available.
The new Spot 5 acquisition and the resulting value-added products were delivered on May 28 and were finally appreciated by the Algerian CPA and the central government. They were integrated in the local GIS with other existing data and provided a good overview of the situation with clear identification of the refugees' camps.

Reference image




"Building" changes

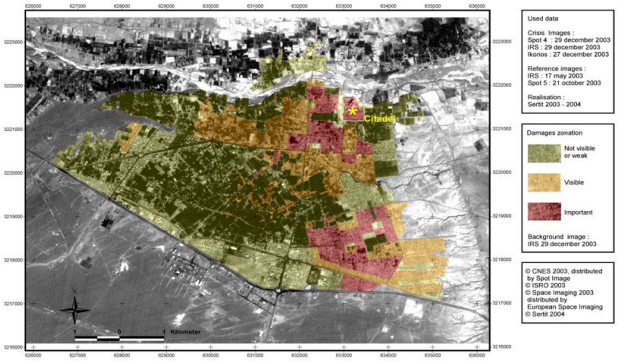
Structural anomalies




After the earthquake

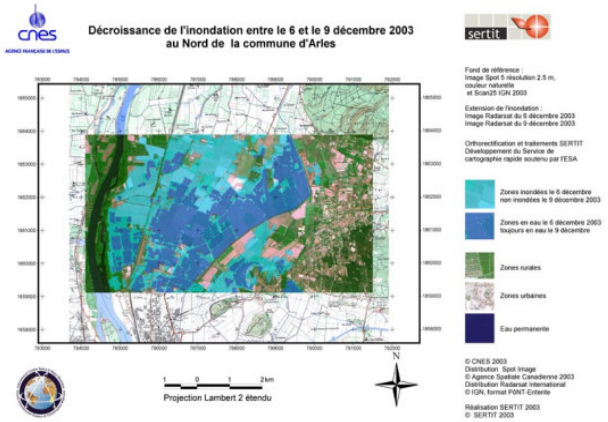
Another **major earthquake in Iran (city of Bam), December 26, 2003**, killed over 35,000 inhabitants according to UN information leaving several hundred thousands homeless.
Both the German and French CPAs activated the Charter.
A number of products were delivered by the French value added company SERTIT (under an arrangement with ESA), as of December 29 using a number of data sources: Spot 4, IRS and Ikonos for crisis images acquired December 27 and 29 and IRS and Spot 5 images for reference acquired before the earthquake. Although not a party to the Charter, Space Imaging in co-

operation with the German Aerospace Centre (DLR) have made available damage analysis maps based on Ikonos satellite imagery (1 m resolution).
The products (SERTIT processing) delivered to the Iranian authorities consist of estimated damages zonation maps (in fact change detection) over the Bam city from satellites data and also damages zonation maps correlated with land use:



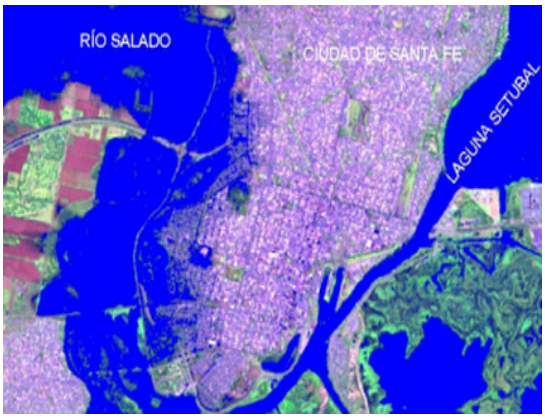

## 2.2 Floods

A **major flood** occurred **over the south of France December 4, 2003** (Rhône river), as an example the town of Arles (northbound) was over flooded for a number of days and rescue teams from France and Germany had to pump out the water for several weeks. Six people were killed and over 15,000 were forced to leave their homes.
Satellite imagery was again useful for the CPAs and once more Ikonos data were provided by European Space Imaging to help the rescue operation in addition of Spot 4 and 5 and Radarsat.
Value added products (CNES and SERTIT processing) included flood extension maps, impact maps on a very large area (130 x 160 Km) and also local maps on a number of small towns affected by this disaster. For this purpose administrative boundaries were merged together with land use. The example hereunder clearly demonstrates the flood recess between two dates: December 6 and 9, 2003 using two Radarsat images and the detailed land use from a Spot 5 recent archive.




**Unprecedented floods** "the worst since the foundation of the town of Santa Fe in 1573" affected the whole province and nearby areas **in central Argentina**, **April 30, 2003**, causing evacuation of 60,000 inhabitants. The Water Institute fears that the situation would last for weeks due to high phreatic levels and abnormal precipitation.

The Charter was therefore triggered by the Argentinean Federal Emergency System, Radarsat and Spot satellites were tasked and the hereunder flood map of the town of Santa Fe was produced together with CONAE and the National Water Institute, in order to help the local civil protection authority:

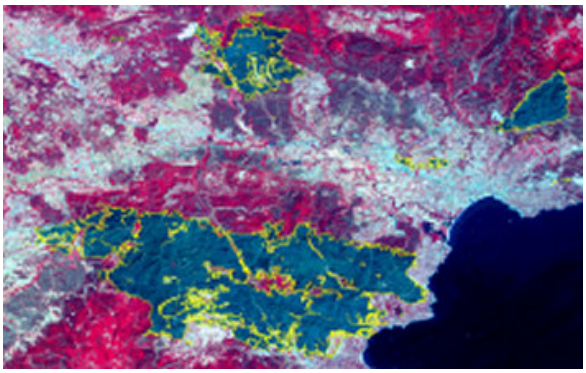



## 2.3 Forest fires

The extent of the **burned area** and the potential danger for the nearby population justified triggering of the Charter **July 19 and 25, 2003** (**Var district in France**).
The local French CPA required as soon as possible a map of the burned area with a maximum resolution due to threatened houses close to the fire. They were expected new fires in the vicinity. The Spot tasking was concentrated to Spot 5 because of its high resolution (2.5 m) and the information reached the fire fighters only 76 h after the request. However as the threat was continuing, the next request was timely with Spot 5 track over the area and CNES processed **imagery was provided** 21h after the request and **only 5 h after the Spot 5 satellite pass.**
User feedback for this type of disaster allows us to indicate:

- the need of high resolution (2.5 m is acceptable),
- the need of quick delivery of even raw data as the identification of burned areas is easy,
- the need of high resolution archives allowing identification of recent constructions.

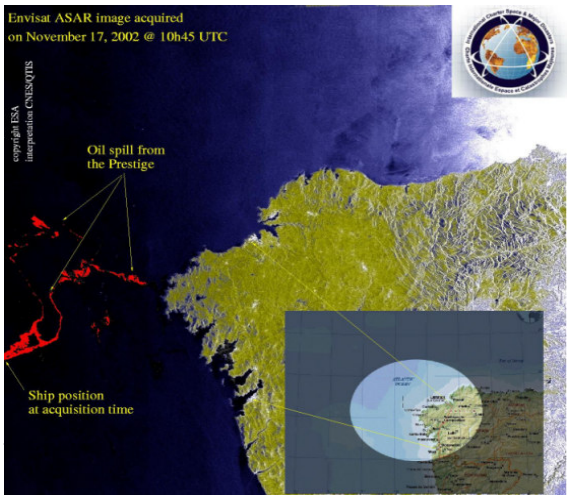
The extent of the burned area in the Maures region (over 20,000 ha were destroyed) from Sainte Maxime (along the coast) to Vidauban (north west on the image) is clearly visible:



## 2.4 Oil spill

When the **« Prestige » tanker oil spill** occurred close to the Galicia coast (Spain), **mid November 2002**, the Charter was activated by both the European Commission, civil protection and environmental accidents unit and the French CPA. The

Prestige started leaking fuel, then the tanker was pulled out far from the shore and finally sunk after splitting in half.
Spot satellites were initially tasked but the requests were cancelled since optical data are not appropriate for oil spill detection, this led to a modification of the ECO scenarios advising tasking of only the radar satellites.
Therefore Radarsat and ERS-2 satellites were tasked and ESA provided Envisat ASAR images though the satellite was still on its commissioning phase. The only useful information according to recent feedback from CEDRE, French centre in charge of operational aspects in case of major oil spill accident, was the Envisat data clearly showing the oil slick following the movement of the tanker before she sunk:



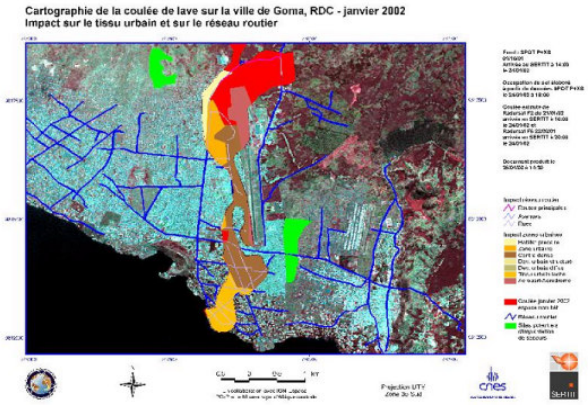

### 2.5 Volcanic eruption

The **Nyiragongo volcano** in the Democratic Republic of Congo **erupted on January 17, 2002**, and subsequently sent streams of lava into the city of Goma on the north shore of Lake Kivu. More than 100 people were killed, more than 12,000 homes were destroyed, hundreds of thousands people were forced to flee from the city. However, during the weekend, most of the inhabitants of Goma started to come back to their homes, even if the volcano still threatened the city. At this time, the problem was to host all the people coming back to the city and whose homes were damaged.
The Belgian Civil Protection authorities asked for the activation of the Charter on January 21, 2002. Again all available satellites from the Charter members (ERS-2, Spot, and Radarsat) were tasked but the Spot acquisitions were unusable due to cloud cover. The user requested for two kinds of information:
- damages caused by the lava flow over the city of Goma,
- possible areas for setting up of the refugees' camps.

Three types of product were delivered to the user:
- land-use map with identification of the lava,
- lava flow location (updated with automatic change detection), road network extraction and location of refugees' camps,
- damages of the lava flow to the urban areas.

Land use was extracted from a fusion of panchromatic and multi-spectral Spot archive images; lava flow was extracted by comparison of Radarsat fine mode images acquired before and after the event. The first map was provided to the user three days after the activation of the Charter. The user provided very useful feedback for the validation of the products: the rehabilitation tasks, but an image viewer software should be available on site which was not the case at that time.

Most of the lava flow was well detected, but there were two areas of false alarm and the western lava flow was not detected. This shows that, for this kind of event, even 10 m resolution may not be enough. Also, had other type of sensors been available together with SAR, more precise detection could have been done.




## 3. CONCLUSION

Despite the relatively limited number of the space systems involved in the Charter, encouraging results were obtained and significant improvements were performed thanks to the well-established relationship with the civil protection authorities. Additional satellites from ISRO, from the Disaster Monitoring Constellation (DMC) and from the future Japanese satellite (ALOS) will soon improve the global, systematic and more and more accurate coverage of our planet. Although the service does not yet come up to the end users' expectations, it has become compatible with some of their operations and they now regard the Charter as a credible instrument. We still have to speed up the Charter process from its activation to the information delivery in order to improve the overall response time.
In terms of data processing, we need to improve the algorithms between all sensors available and automation of the software to provide accurate damage assessment maps and not only change detection maps. These future final products must be immediately usable on the disaster site with a minimum training by the CPAs and also by the local authorities.

Do not hesitate to use our web-site for additional information, suggestions and comments and to access to the full text of the Charter.

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