DISASTER RESPONSE IN AFRICA BY THE INTERNATIONAL CHARTER

Ahmed Mahmood*, Canadian Space Agency, Saint-Hubert (Quebec), Canada, J3Y 8Y9, Ahmed.Mahmood@space.gc.ca
Eliane Cubero-Castan, Centre National d'Etudes Spatiales
Jerome Bequignon, European Space Agency
Levin Lauritson, National Oceanic and Atmospheric Administration
P. Soma, Indian Space Research Organization
Gabriel Platzeck, Comision Nacional de Actividades Espaciales

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ABSTRACT:

The International Charter 'Space and Major Disasters' is an initiative on the part of its member European, French, Canadian, Indian, U.S. and Argentinean space agencies to pool together their satellite resources to provide data in the event of a natural or technological disaster. In the first four years of its operation, the Charter was in fact activated six times to help the disaster stricken communities in Africa with space-based data and information. The disasters ranged from volcanic eruption in Congo, and floods in Morocco and Namibia, to earthquakes in Algeria and Morocco. The latest Charter activation took place for floods in the Darfur region, western Sudan.
The Charter can be activated by an Authorized User on whose request the various Charter functional units work in conjunction with the individual space agency staff responsible for data acquisition planning. After a brief description of the Charter history and operational system, the above-referred activations are described in terms of data acquisition, value-adding and data delivery to the users.

HISTORY AND BACKGROUND

Initially signed by the European (ESA), French (CNES) and Canadian (CSA) space agencies, the International Charter 'Space and Major Disasters' currently has three more members from the Argentinean (CONAE), Indian (ISRO) and U.S. (NOAA) space organizations. The Japanese space agency (JAXA) has already applied for the Charter membership, and its application has been accepted pending JAXA's full operational integration.

The Charter administration is the responsibility of a Charter Executive Secretariat, where each member that has assumed the full Charter operational function is represented. The Executive Secretariat works under the overall responsibility of a Charter Board formed of all the members.

The purpose of the Charter is to promote cooperation among space agencies and space system operators in the use of their space resources for making a contribution towards the management of crises arising from natural or technological disasters. The Charter members' contribution is essentially in the form of space data, and no funds are exchanged.

The Charter can be activated for obtaining data covering a disaster event by a group of predefined users, called 'Authorized Users' (AU). These are primarily institutions or services responsible for rescue and civil protection, defense and security under the authority of a State whose jurisdiction covers an agency or a space operator that is a member of the Charter. As described below, each of the Charter activations being reported in this article was requested by one of these AUs on behalf of their counterparts in the affected African country, who themselves were not Charter members. In fact, many of the worldwide charter activations to date have taken place in countries other than those represented in the Charter.

The Charter membership is open to space agencies and national or international space operators (Bessis, et al., 2002). Any such organization intending to seek the Charter membership is encouraged to make a request with the Head of anyone of the current signatories to the Charter. The request is in the form of a letter of commitment to contribute by providing data and the necessary human resource for participating in the Charter operations. The Charter Board examines the request and formulates its response within the stipulated period of time. The acceptance of the request requires the unanimous approval of the Charter Parties.

CHARTER OPERATIONS

The Charter has been fully operational since the 1st November 2000; it is in fact the first multi-satellite joint operational enterprise. The operational system, illustrated in Figure 1, is activated following a request from an AU for data and information (Mahmood, et al., 2002). The AU's request is received by a centralized 24 hours/day call-receiving unit manned by an 'On-Duty Operator' (ODO). This function is presently furnished by ESA at ESRIN in Frascati (Italy). After initial application of the request acceptance criteria, the ODO refers the request to the next functional unit staff named 'Emergency on-Call Officer' (ECO), who is accessible 24 hours a day. The ECO function is assumed on a weekly rotation by the member agencies. An important prerequisite for total operational integration of a member agency is its ability to deliver the ECO function, and as a consequence of which its participation in all the activities and responsibilities of the Executive Secretariat. The ECO carries out in-depth verification of the request by interaction with the AU and by using the ECO's own means of information on the reported disaster event, before the request is finally accepted for acquisition planning. The ECO prepares an elaborate record of the request, and determines the data source (archive or new acquisition) and space sensor(s) most appropriate to cover the disaster. The

* Corresponding Author

ECO then checks the availability of the sensor(s), and suggests, whenever possible after discussions with the relevant space agency or its designate, a draft plan to the concerned agency(ies) for execution. Next the ECO transfers the entire file on the disaster occurrence, called a 'dossier', to a 'Project Manager' (PM), who is appointed by the Executive Secretariat, following nomination by one of the agencies and by taking into account such factors as the geographical location of the disaster occurrence, its type, and the expertise required. The PM ensures the management of the project related to the coverage of the disaster and with regard to data processing and delivery. The PM through interaction with the AU complements the information needs of the requester and initiates, as the case may be, any special data product generation and value-adding on behalf of the concerned agency and beyond the agency's obligations under the Charter. The PM also provides a project closeout report to the Charter Executive Secretariat. In addition to the technical details, the report contains the PM's experience with the activation and the user feedback.

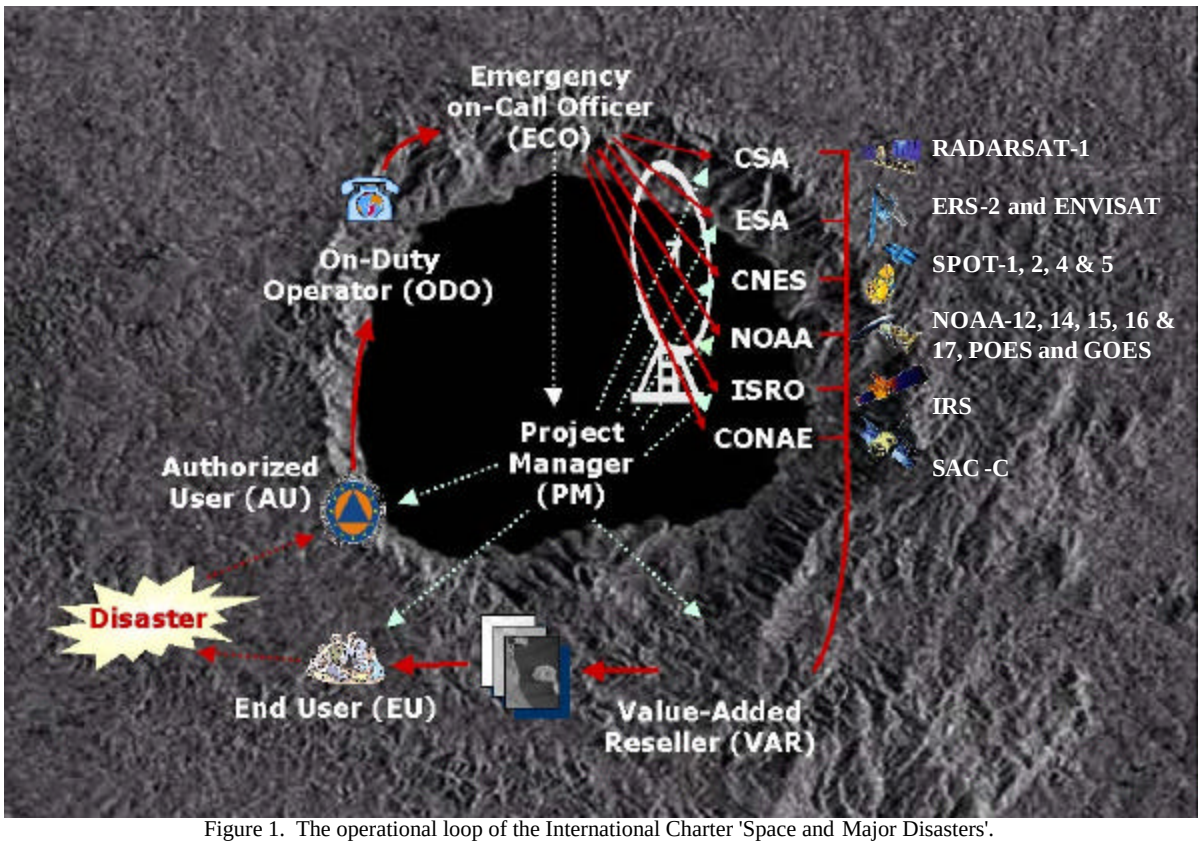

Figure 1. The operational loop of the International Charter 'Space and Major Disasters'.

CHARTER ACTIVATIONS

Since the start of its operations, the Charter was activated six times for disasters in Africa. These six activations are described in terms of the involvement of the various functional units, the satellites tasked, the type of data acquired and the information processed, and the effectiveness of such information in meeting the user needs.

Nyiragongo 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 with significant loss of human life, property and infrastructure. The Charter activation request to cover the disaster emanated on January 21, 2002, from the Belgian civil protection authorities. The French space agency CNES had the ECO responsibility during the week of the disaster, and also provided the PM services. All the Charter satellites available at that time were tasked, including ERS, SPOT and RADARSAT-1. However, SPOT data could not be exploited for lava flow monitoring because of excessive cloud cover.

The user requested information about damage in and around the city of Goma and about possible sites for setting up shelters. The user was provided with three types of value-added products (Bessis et al., 2004), including land-use maps with identification of the zones of lava occupation, network of roads, sites for refugee camps, and urban damage assessment localities. Land-use maps were extracted by means of SPOT panchromatic and multi-spectral archive images and the lava flows were identified on pre- and post-disaster RADARSAT-1 Fine beam mode images (Figure 2). The first map products were delivered to the user only three days after the Charter activation. The user found the map information very useful for rehabilitation purposes. The lava flow mapping with satellite data was correct with the exception of a few areas of false alarm. This pointed to the need in future of higher resolution radar data than the currently available 10 m RADARSAT-1 data. Some limited use of data from outside sources (SRTM, ASTER) was found to be helpful for this disaster type.

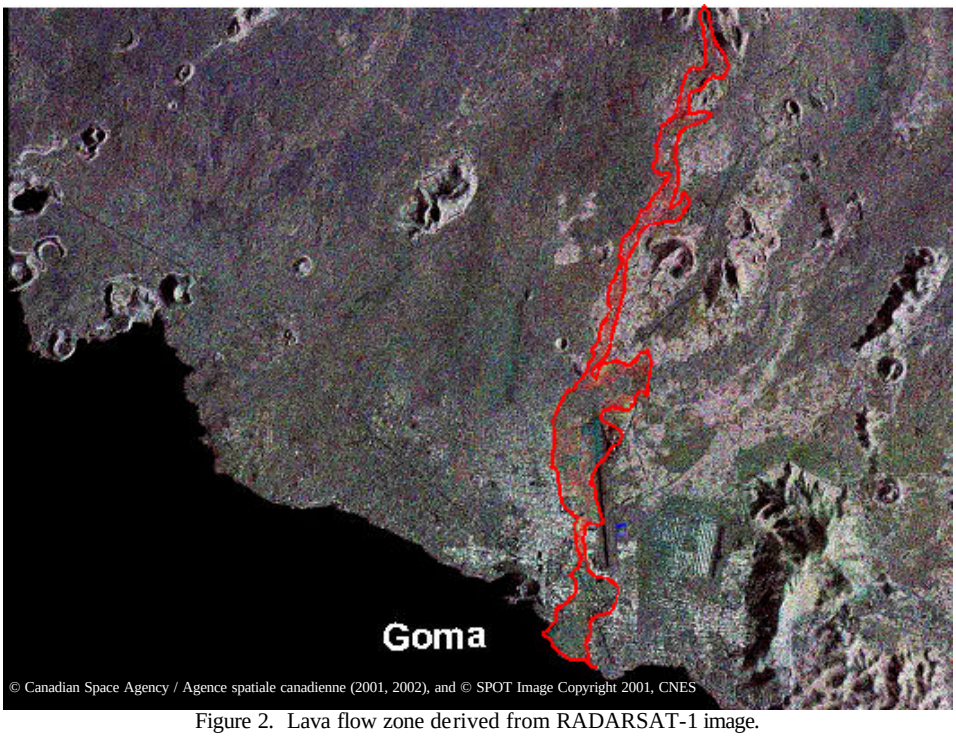

Figure 2. Lava flow zone derived from RADARSAT-1 image.

Morocco Floods

On 25 November 2002, the northern part of Morocco was hit by heavy rains that affected urban and agricultural areas in regions around Casablanca. One of the most affected areas was that of Berrechid. The French AU from the Ministry of Interior placed the call for the Charter data to work with the local Royal Remote Sensing Centre for preparing flood maps. The European Space Agency had the ECO duties for the week, and provided also the PM services. SPOT 2 and SPOT 5 as well ERS archive and newly acquired images were provided. Only the preexisting dam lake water surfaces could be recognized on the SAR images, however, SPOT images pre- and postdating the flood proved useful to delineate areas flooded due to rains.

Algeria Earthquake

A major earthquake struck in May 2003 the region east of Algiers. The Mediterranean city of Rouiba was among the hardest hit. The French civil security authorities initiated the Charter call on May 22, 2003. The French space agency CNES was performing the ECO duty for the week the disaster occurred, and it also provided the PM services. The only useful Charter data were obtained from SPOT satellites (Bessis, 2004). A SPOT 4 acquisition of May 23 and a SPOT 5 acquisition of May 27 were planned along with the retrieval of archive imagery. SPOT 4 imagery could not be compared with SPOT 5 archive data due to viewing angle differences. However, the good accuracy of SPOT 5 data of 2.5 m resolution from the archives was found to be very useful in the absence of accurate maps. The new SPOT 5 acquisition data and the value-added products based on these data were delivered to the end user on May 28 to the satisfaction of the Algerian authorities. The space data products were integrated in the GIS and other available data. Together these provided a good overview of the damage spots and the sites for relief camps (Figure 3).

Figure 3. Change detection with SPOT-5 pre- and post-earthquake images of Algeria.

Morocco Earthquake

Another earthquake event in Africa was covered by the Charter starting February 24, 2004. The city of Al Hoceima on the Mediterranean coast of Morocco was hit by 6.5 magnitude earthquake on February 24 at 06:28 GMT with significant

human casualties and property damage. The Charter was activated by the United Nations Office for Project Services (UNOPS) on behalf of the United Nations Office for Outer Space Affairs (OOSA), which is a Charter Co-operating Body authorized to request data. The French space agency CNES performed the ECO function, and the PM responsibility was assumed by the UNOPS staff. The event was covered primarily with SPOT-5 archive and new acquisitions. Value-added work carried out by means of pre-disaster archive data to create a natural colour image worked well, however, automatic change detection analysis could not be done because of the lack of a Digital Elevation Model (DEM). The poor internal image geometry also hampered damage analysis based solely on the space data. Therefore, the damage assessment had to be completed in conjunction with photo-interpretation. The end-user was able to retrieve damage assessment maps through PM's web link. The space maps (Figure 4) proved to be the only detailed information available to the field workers at that time.

Namibia Floods

The Charter was triggered on 31st March 2004 by the United Nations Office for Project Services (UNOPS) and the UNOSAT project on behalf of the United Nations Office for Coordination of Humanitarian Affairs (UN OCHA) in Geneva to respond to severe floods in Namibia. CNES was the ECO for the week and the offer for PM services was received from UNOSAT, which was accepted by the Charter Executive Secretariat. RADARSAT-1 images were used to delineate flood extent using LANDSA T TM as the base landcover map. The pre- and post-flood SAR images were found to be adequate to recognize the flooded areas, without the need for any special value-added work.

Darfur (Sudan) Floods

The latest Charter activation in Africa was requested on August 11, 2004, by the German Foreign Ministry as the Charter AU to cover floods in the Darfur region of the Sudan. The floods were caused by torrential rains in the region, where the humanitarian relief efforts were under way. The European Space Agency (ESA) was the ECO for the week, and the PM services were provided by the German Space Centre (DLR) staff. The results of the value-added work and the type of products supplied to the local authorities by the AU are not known yet. Both optical as well as radar data acquisitions were planned.

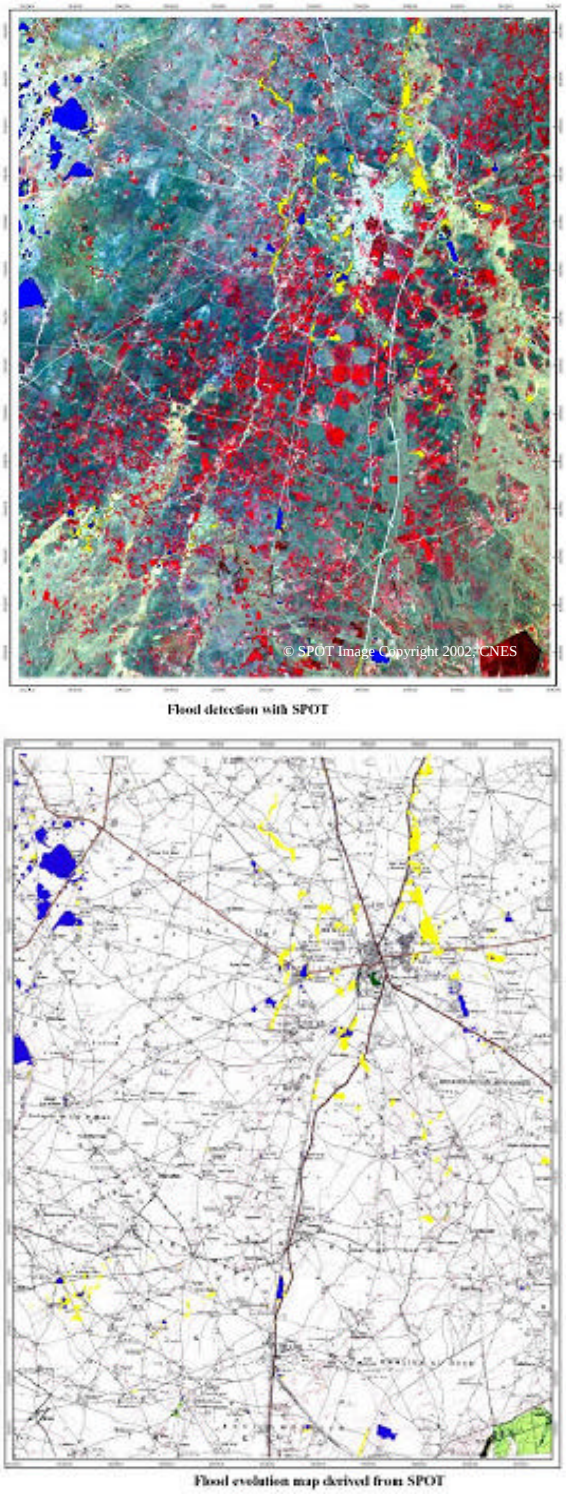

Figure 4. Flood map of Berrechid area (Morocco) derived from space data.

CONCLUSIONS

Although African countries are not the Charter members, disasters in Africa have been amply covered as a result of close cooperation between the Charter Authorized Users, which are the national civil protection authorities of the member states, and the UN agencies represented by the United Nations Office for Outer Space Affairs (OOSA) in its capacity as a Charter Cooperating Body. The Charter data were delivered for the earthquake in Algeria by virtue of a bilateral agreement between the French Civil protection, a Charter Authorized User, and the Algerian authorities. In fact, it is likely that African countries like Algeria and Nigeria, which are now part of the Disaster Monitoring Constellation (DMC) with their own satellites (AlSAT-1 and NigeriaSAT-1), may become Charter members and thus be able to activate the Charter directly. Until such time, it is hoped that cooperative arrangements with the Charter Authorized Users would be maintained and that the African communities would continue to benefit from the space data and information for disaster relief channeled through the International Charter.

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