# EARTH OBSERVATION DATA AND NATURAL DISASTER MANAGEMENT CASE OF THE RMS PROJECT: CYCLONE EVENT OVER THE ANTILLES

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## 1- INTRODUCTION

Following the subsequent intervention of the French Civil Defence Agency (DDSC), and the work carried out by PRIVATEERS N.V. and Spot Image concerning the catastrophic damage caused by the hurricane Mitch in Central America, ESA (supported by CNES and CSA) and DDSC had agreed to co-operate during the 1999 cyclone season. In this context, the RMS project (Rapid Mapping System) have been initiated in order to assess the capacity of Earth Observation Systems to provide civil security services with cartographic products of damage estimation in very short delays during climatic events. The project was coordinated by Spot Image. Data processing and analysis were realised by SERTIT and PRIVATEERS N.V.

The experiment focused on inter-tropical regions, and more particularly on the French departments of Guadeloupe and Martinique. The products elaborated for the RMS project are mapping documents produced in a very short delay during a crisis. They are useful as Decision Aid for weighing up intervention logistics, and allowing an easier localisation of affected areas for emergency units.

## 2- CONTEXT : HURRICANE LENNY' CASE STUDY

On the 16th of November 1999, the Hurricane Lenny brewed in The Antilles and started the procedure of realisation of a rapid mapping service. During this event, archive data from ERS, Radarsat & SPOT were processed and new acquisitions planned in order to permit comparisons between images taken before and after event. On the 18th of November, the hurricane reached and damaged Guadeloupe (fig. 1).

*Fig. 1 : Lenny's damages*

## 3- DDSC NEEDS :

The critical factor is the time delay for delivery of the cyclone related information layers :

Within 12 h : summarised rapid reaction mapping for aiding decision making and logistical management (summary for ministerial cabinet, decision aid relating to the scale and disposition of resources for intervention purposes…).

Within 24 h : high resolution mapping of affected areas. This information can be sent by DDSC via the prefecture and/or representatives of intervention ground units (support for politic discussions, strategy and positioning of Civil Defence resources…). The sending of this more detailed information is carried out during the manoeuvres of Civil Defence forces.

## 5- RMS PRODUCTS

To produce this information, access to pre-established pre-crisis databases allows a comparison between post-cyclone and pre-cyclone cartographic references. The products described hereafter constitute this database.

### 5.1 Based-mapping product : "B Product"

These products are used by the photo-interpreter for recognition of planimetric elements on the ground and can be useful for ground units equipped with Global Positioning System (GPS).

*Fig. 2 : B product (extract of IGN Scan25®)*

Specifications :

IGN scanned product (1:25 000 to 1:100 000 scale) (fig.2), available at DDSC for French territories or SpotView®, with SPOT satellite based images (10/20 m resolution, 60x60 km cover).

Digital format (TIFF) and paper

Delivery: 3 days for SpotView® Network.

SPOT or SAR (ERS or RADARSAT).

### 5.2 Reference mapping product ("INIT product")

These products are optical (fig. 3) or radar satellite images, acquired just before an event, that can provide geographical information and be produced in a few hours with existing data (i.e. from archives).

Specifications :

SPOT or radar (ERS, Radarsat) images (archive or programmed)

Resolution : 10/20 m for SPOT; 10/30 m for Radarsat; 25 m for ERS

Cover : 60x60 km for SPOT; 100x100 km for ERS and Radarsat

Optionally encrusted data: place names, hydrographic & road network

Digital format (TIFF) and hard copy restitution scale from 1: 50 000 to 1: 250 000

Geometric correction level : 1B, 2A

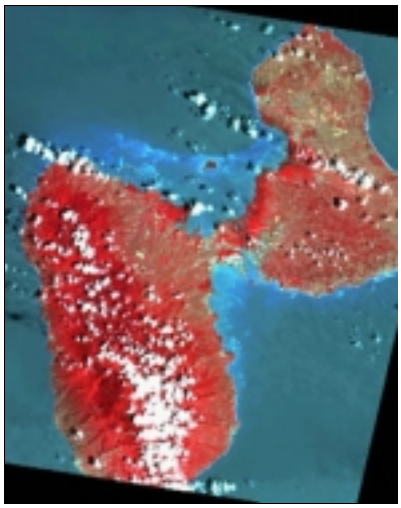

*Fig. 3 : Product INIT (SPOT XS image of 22/03/98 of Guadeloupe)*

### 5.3 Emergency mapping product ("I product")

These are satellite image acquisitions, just after an event (fig.4). These images contain potential damage caused by the hurricane. They permit by comparison with "INIT" products (before event) to elaborate Change Detection products : CD products.

Specifications :

SPOT or RADAR (ERS, Radarsat) satellite images to be programmed

Resolution : 10/20 m for SPOT; 10/30 m for Radarsat; 25 m for ERS

Cover : 60x60 km for SPOT; 100x100 km for ERS and Radarsat data

Optionally encrusted data: place names, hydrographic & road network

Digital format (TIFF) and hard copy restitution scale from 1: 50 000 to 1: 250 000

Geometric correction level : 1B, 2A

*Fig. 4 : Product I (Radarsat image of 22/10/99 of Guadeloupe)*

### 5.4 Change Detection products ("CD product")

These products correspond to INIT and I data crossing, after data processing, which enable the production of colour products, coded in 3 channels that contain the change information. CD-SPOT (fig.5) and CD-RADAR (fig.6) products differ only by their reference cartographic background : respectively optical and radar

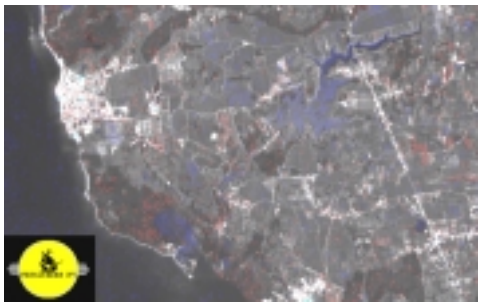

*Fig. 5 : Extract of product CD-Spot over Grde Terre after Lenny event*

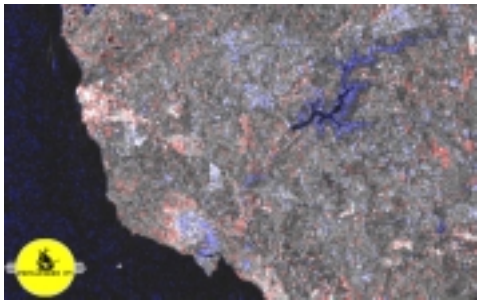

*Fig. 6 : Extract of product CD-Radar over Grde Terre after Lenny event*

Specifications :

3 band color image (RGB) :

- Radar (ERS, Radarsat) or optical (SPOT) image (in grey level)
- Mask of positive changes (in red)
- Mask of negative changes (in blue)

Resolution : 10 m with SPOT and Radarsat SGX, 20 m with ERS or RADARSAT Standard

Cover : 60 x 60 km for CD-SPOT, 100 x 100 km for CD-RADAR

Digital format (TIFF) and hard copy restitution scale at 1:50 000

Geometric correction level : 1B, 2A, 2B, Ortho

### 5.5 Crisis mapping products : "RMS1 and RMS2 products"

These are mapping products generated by the interpretation of CD products which provide change density information indicating the probably affected areas. These products are delivered to DDSC in two formats:

- RMS1 product : comprehensive map of potential damages to be delivered 12 hours after acquisition of satellite images (damage mapping overlaid on a low scale location map with 2 classes of changes)
- RMS2 product : high resolution map of affected areas to be delivered 24 hours after acquisition of satellite images. These products detail areas affected by the hurricane with 4 levels of potential damage

On "RMS1" (fig. 7) and "RMS2" (fig.8) products it could be identified that the most affected area was Northern Guadeloupe (North of Grande-Terre). North-West & South coasts of Basse-Terre also seemed to be affected.

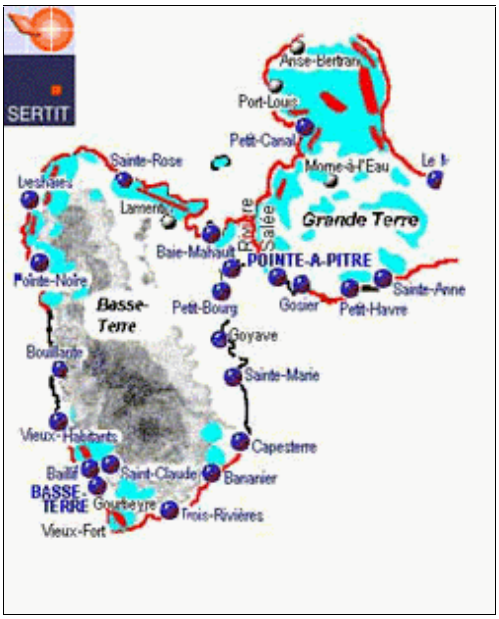


Fig. 7 *: RMS1 product (Summary Map of potentiel damages over Guadeloupe*)

← Legend of RMS1 Product :

- Cartographic background (Encarta type)
- Mask with potential damages
  - Affected areas
  - Highly affected areas

Legend of RMS2 → Product

IGN Cartographic background (1:100.000), SpotView® or SPOT or RADAR imagemap)

Limit of potentially damaged area :

- Less affected areas
- Affected areas
- Highly affected areas
- Most affected areas

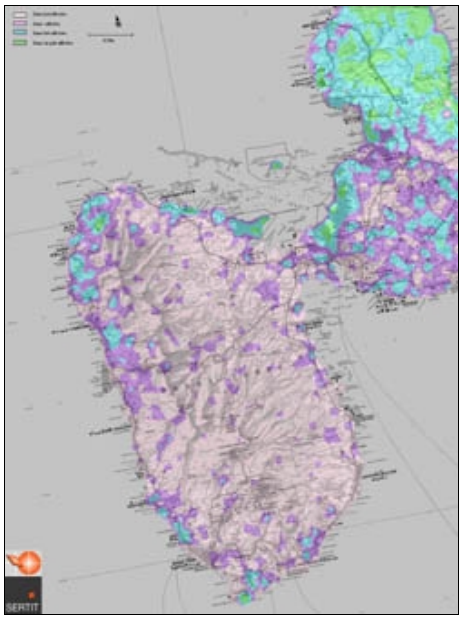

*Fig. 8 : RMS2 product (High Resolution Map of affected areas over Guadeloupe)*

## 5- RMS SERVICE

The service developed in the frame of the RMS project includes 3 phases :

1) Preparedness phase to Set up basemap production & prepare the crisis. This phase is launched when the RMS service is initiated. It includes : the organisation of the service, location of the areas to be surveyed, the available cartographic information inventory over these areas, basemap production ("B" product) and archive and programming analysis for next phases.
2) Anticipation phase to activate satellite resource for “INIT” acquisition. This phase is launched when DDSC receives a BRAM from METEO FRANCE indicating that a cyclone has reached 50°W Longitude. It includes : the mobilisation of the RMS Service team, cartographic database preparation, and "INIT" product realisation.
3) Crisis phase to activate satellite resource for “I” acquisition and “RMS1/2” processing. This phase is launched when DDSC receives a BRAM from METEO FRANCE indicating that the cyclone has reached 55°W Longitude. It includes : "I" product realisation and image processing by the RMS Service Team ("CD", "RMS1" & "RMS2” products realisation), as well as the rapid delivery of the products to DDSC (image server, internet, fax).
4) Post-Crisis Phase to assess lessons learned once crisis is over. It includes database update, evaluation of the service, and an expert’s report on the crisis.

## CONCLUSION AND PERSPECTIVE

The Lenny's operation has lead to the production of summary and detailed damage assessment mapping products, which have both been satisfactorily evaluated by DDSC. It appeared that the immediate need of DDSC was the summary mapping of potential affected areas. As time delays are the users' foremost critical parameter, RMS service could operationally work only if it is integrated into the International Chart " Space and Major Disasters". The Lenny test case has proved that saving of time should be obtained upstream of the data supply chain (from satellite management and data acquisition to their provision to the expertise services).

Presently, RADARSAT data are the best adapted to RMS requirements. Within a crisis management system, it is imperative to have an image acquisition programming capacity, with a high revisit capability. The future ENVISAT satellite will also meet these criteria ; together with ERS and RADARSAT satellites, it will considerably increase rapid reaction image acquisition possibilities. Other planned systems will have better acquisition and resolution capacities and should allow a better revisit interval and more precise mapping of damage areas caused by natural disasters.

The proven operation nature of the rapid mapping service will respond to the Civil Defence's needs for other natural disaster events. A similar operation is actually in discussion for the 2001 cyclone season.

## AKNOWLEDGEMENTS

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