Rapid and Detailed RADARSAT-2 Data Collection for the Caribbean Satellite Disaster Pilot (CSDP)

Practical Experience Gained During the Hurricane Season in 2010, 2011 and 2012

By

Dirk Werle (Ærde, Halifax, Canada)
Guy Aubé, Guy Séguin (CSA)
Stuart Frye (NASA/GSFC/SGT)

Presented at the NOAA Satellite Conference, College Park, MD, USA, April 11, 2012
Context, Goal and Objectives

- Caribbean Satellite Disaster Pilot is a CEOS / GEO activity, regional end-to-end pilot, led by NASA, with CSA support
- Demonstration of RADARSAT-2 and other EO capabilities to assist disaster management; CDEMA, CIMH, UWI
- Rapid and detailed assessment of hurricanes and extreme rainfall events; geospatial information for damage analysis
- Timeliness is a critical issue: How well can RADARSAT-2 prepare and respond, especially to transient events?
Diverse CSDP Target Areas within the Caribbean
Large Urban-Coastal Plains, Small Mountainous Island States

Map courtesy NGS

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Hurricane Track Maps and Location of CSDP Sites

Maps courtesy of NOAA's National Hurricane Center
RADARSAT-2 and other EO Data Collection

Considerations for SAR data planning

- Pre-emptive preparatory SAR data acquisition (small areas)
- High-resolution RADARSAT-2 SAR data for small islands at different radar look directions
- Coordination with RADARSAT Hurricane Watch (large areas)

Time-lines for SAR data acquisition and processing

- Data collection requests to be placed 24-48 hours in advance
- SAR data product delivery within hours of down-link
- Similar timelines for EO-1 ALI (via scheduling tool)
- Image maps in 1-5 days
Pre-emptive RADARSAT-2 Data Acquisition

Before Event for Post-Event Change Detection

Grenada

Conceptual Design

Actual Plan and Execution

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1 & 2 Situational awareness: nascent Hurricane “Maria” approaching the Caribbean

3 5 PM Tuesday

3 Plan Option for R-2 data

4 5 PM Wednesday

4 Action Request R-2 data for BVI

Expected BVI R-2 Acquisition: Sept. 11, 6 AM, ~ 6 hours after “Maria”
~25 Rapid Response RADARSAT Products Procured by CSA, with Canadian Industry, for CSDP Partners

Examples:

[Images of map overlays and satellite images related to CSDP and RADARSAT products]

(detail to follow)

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Sample CSDP Rapid Response Product: Cancun
(Courtesy of CSA and Effigis GeoSolutions, RADARSAT data © MDA 2011)

Carribean Satellite Disaster Pilot
CSDP Rapid Response Product

Cancun, MEXICO
Event: Tropical Storm Rina
Location: Cancun, Mexico
Sensor: RADARSAT-2 SAR
Resolution: 4 meters
Image date / before storm: 08.06.2011 (W3)
Image date / after storm: 30.10.2011 (U17 W2)

Scale 1:20000

Note:
This is a small sample of a high resolution satellite change detection map product provided by the Canadian Space Agency (CSA).

Initial processing and analysis conducted by VIASAT Geotechnologies (Montreal, Canada) and CSA indicate some flooded areas following the passage of tropical storm Rina which left more than 1300 mm of rain in the Cancun area on October 27th.

For more information on the rapid response RADARSAT-2 products and detailed image products contact Mr. Guy Aubé directly at CSA: guy-aube@asc-csa.gc.ca

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RADARSAT-2 data and products copyright by MacDonald Dettwiler and Associates Ltd. (2011) RADARSAT is an official trademark of the CSA.
Summary of CSDP Results 2010/11/12

High-res. RADARSAT-2 data collection
- More than 300 scenes collected
- Minor conflicts (resolved)
- SAR data collection successful; timely data product delivery
- “Before” and “after” SAR data for fast change detection

Generation of rapid EO-based image map products
- Covered impact areas of 15 hurricanes, storms, severe rain
- Used hi-res optical (EO-1) as well as FNMOC satellite info
- CSA and partners generated more than 20 rapid response change detection image maps

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Change Detection: Flooded terrain, Saint Lucia

ISS photography, before Hurricane Tomas

RADARSAT-2 SAR Ultra-fine, 6 days before Hurricane Tomas

Ground-based rain radar, during Hurricane Tomas

Ground photograph, flooding in progress

RADARSAT-2 SAR Ultra-fine, 2 days after Hurricane Tomas

SAR change detection image before / after Hurricane Tomas

ISS Photo courtesy NASA; SAR processing courtesy of ViaSat/Effigis; RADARSAT-2 data © MDA; Ground photo courtesy NEMO, St. Lucia
Legend of Matrix Table

Event # / Location / Date

Impact

RADARSAT-2 data acquisition

Latency of event

*Outcome in terms of RADARSAT-2 response:
  + + + highly effective, timely (5)
  + + still timely (5)
  + somewhat timely (5)

Information on satellite data acquisitions courtesy of the Caribbean Satellite Disaster Pilot (CSDP).

Potential 6 AM / 6 PM RADARSAT-2 windows

High-res. optical data acquisition
Matrix of Sample Locations, Event Latency, EO Time Windows, Actual EO Data Acquisitions, and Outcome

"THE WEEK AFTER"

Rapid RADARSAT-2 SAR and optical data acquisitions relating to hurricane landfalls, flash floods and severe rain

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15 hurricane, storm, rain-related events 8 acquisitions 3 acquisitions 5 acquisitions 4 acquisitions 6 acquisitions 6 acquisitions Total: 32, mostly Ultra-fine mode
One-third of all event-related RADARSAT-2 data collection occurred within ~ 48 hours.
Matrix of Sample Locations, Event Latency, EO Time Windows, Actual EO Data Acquisitions, and Outcome

**“THE WEEK AFTER“**

Rapid RADARSAT-2 SAR and optical data acquisitions relating to hurricane landfalls, flash floods and severe rain

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One-third of all event-related RADARSAT-2 data collection Occurred within < 48 hours.

.. but in three cases just hours before the storm hit the island.

15 hurricane, storm, rain-related events  8 acquisitions  3 acquisitions  5 acquisitions  4 acquisitions  6 acquisitions  6 acquisitions  Total: 32, mostly Ultra-fine mode
Nine out of 15 events were comparatively transient, as impact eased within ~48 hrs.
Matrix of Sample Locations, Event Latency, EO Time Windows, Actual EO Data Acquisitions, and Outcome

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Latency of event and timeliness of satellite data collection are critical factors for success.

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Hurricane *Leslie* Impact in Newfoundland, Canada: Timely RADARSAT-2 SAR and EO-1 ALI Response

Sept. 11, 8 AM
Sept. 12, 6 AM
Sept. 12, 10 AM
EO-1 ALI pan

RADARSAT-2 wide swath planned by DND, EC
RADARSAT-2 high-resolution swath planned by CSA / RIPS
Conflicting plans
EO-1 ALI data acquisition planned by NASA

(Courtesy FNMOC)
Summary of CSDP ‘Time-line’ Analysis

**RADARSAT-2 Response**
- Nearly conflict-free planning for 32 SAR acquisition events
- 9 of 15 events (60%) covered during first 48 hours of impact
- 20% during Day 2 and Day 3 after impact
- 20% during Day 4 and Day 5

**Event Latency**
- Most hurricane impacts are transient and difficult to ‘capture’ with hi-res sat data
- Severe hurricanes and rainfall events leave more lasting impact detectable from space
- First 48 hours seem most critical for effective and helpful EO response
Conclusions

CSDP results are case-specific, but offer helpful insights

- Pre-emptive planning essential for collecting SAR data close to event impact
- Transient nature, e.g. flash floods, poses challenges for effective EO data collection
- Timely RADARSAT-2 data
- Events of short-duration are presently a challenge
- Coordinated EO data planning and collection highly desirable
- Timely coverage (e.g. first 48 hours) is critical for most events and for EO success.
- Canadian Outlook: RADARSAT Constellation Mission (2016>) with daily coverage, 24 hour notice; 1 hour delivery.
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Practical Experience During the Hurricane Season in 2010, 2011 and 2012

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