OGC Standards to Enable SensorWebs for Disaster Management

(Session 10 Working Groups: Data Center Migration for Ground Systems: Geospatial Clouds)

Daniel Mandl - NASA/GSFC 3/3/10
Overview

• Goal: Enable user to cost-effectively find and create customized data products to help manage disasters
  • On-demand
  • Low cost and non-specialized tools such as Google Earth and browsers
  • Access via open network but with sufficient security
• Use standards to interface various sensors and resultant data
  • Wrap sensors in Open Geospatial Consortium (OGC) standards
  • Wrap data processing algorithms and servers with OGC standards
  • Use standardized workflows to orchestrate and script the creation of these data products
• Make use of cloud computing
  • On-demand computing
  • On-demand storage
• Target Web 2.0 mass market
  • Leverage new capabilities and tools that are emerging
  • Improve speed and ease of production
Goal is to visualize available satellite data and possible future satellite data in an area of interest on Google Earth.

Satellite imagery available on Myanmar flooding as a result of Nargis cyclone May 2008.
SensorWeb High Level Architecture

Data Processing Node
- Web Coordinate Transformation Service (WCTS)
- Web Processing Service (WPS)
- Web Coverage Service (WCS)

Capabilities Documents

SensorML

Web Feature Service (WFS)

Observation Service (SOS)

Sensor Alert Service (SAS)

Sensor Planning Service (SPS)

Internet

RSS Feeds

Sensor Data Products

Campaign Manager

In-situ Sensor Data Node

UAV Sensor Data Node

Satellite Data Node

OpenID 2.0

Workflows

floods, fires, volcanoes etc
Use of Cloud Computing

• Migrating components to commercial cloud computing servers (Joyent)
  • Campaign Manager
  • Data processing services
  • Data feeds
• Joyent servers allow surge in demand and will absorb extra need for CPU utilization and extra storage short term
• Can increase CPU and storage capacity instantly for long term by providing credit card for extra capacity
• Experimental since security on open network still has issues
• Speeds up production services via web and OGC enabled services
# Campaign Manager Tasking Request Page

Create a campaign

<table>
<thead>
<tr>
<th>Title</th>
<th>Content</th>
<th>Theme</th>
<th>User</th>
<th>Scenario Requests</th>
<th>Created At</th>
<th>Updated At</th>
<th>Weight</th>
<th>Edit</th>
<th>Delete</th>
<th>Show</th>
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<tbody>
<tr>
<td>Guatemala Zacapa Landslide</td>
<td>Landslide in La Union, Zacapa, Guatemala</td>
<td>flooding</td>
<td>CATHALAC</td>
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<td>10/23/2008 05:23 PM</td>
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<td>World Bank request for coastal coverage</td>
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<td>stufrye</td>
<td>Guyana test case, New Guyana tacking</td>
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<td>01/19/2009 03:54 PM</td>
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<td>Huahua landslide</td>
<td>Landslide and flooding, Cerro el Socorro, Huahua Mexico</td>
<td>flooding</td>
<td>gimnastaverde</td>
<td>Landslide Cerro el Socorro</td>
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<td>Joggins Cliff</td>
<td>UNESCO site on the Bay of Fundy</td>
<td>intel</td>
<td>jallen</td>
<td>Joggins Cliffs</td>
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<td>02/04/2009 08:30 PM</td>
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<td>Karumba</td>
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<td>jallen</td>
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<td>03/12/2009 05:40 PM</td>
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<tr>
<td>Lake Eyre</td>
<td>(anticipated) refilling of Lake Eyre from heavy rains upstream in Queensland</td>
<td>flooding</td>
<td>jallen</td>
<td>Lake Eyre</td>
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<td>Lake Eyre (North)</td>
<td>Floodwaters entering Lake Eyre basin from Queensland floods</td>
<td>flooding</td>
<td>jallen</td>
<td>Lake Eyre (North)</td>
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<td>drought</td>
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<td>Llaima volcano, in Chile [Simmon, Robert B]</td>
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<td>cappelaere</td>
<td>Llaima, Chile</td>
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<td>Flooding in East coast of Madagascar</td>
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<td>rcmrd-dan</td>
<td>-</td>
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<td>Flooding on the Zambezi and Limpopo Rivers</td>
<td>flooding</td>
<td>stufrye</td>
<td>Adler forecast 3-18-09, Adler 3-22-09, GDACS gauge2</td>
<td>01/05/2009 03:31 PM</td>
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<td>Mt. Asama</td>
<td>Volcano in Japan, currently active</td>
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<td>Namibia</td>
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<tr>
<td>Namibia Flooding</td>
<td>Flood campaign test in Namibia</td>
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<td>Lake Liambezi test1</td>
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</table>
Campaign Manager Tasking Request Page
Select Namibian Flooding Campaign and create first scenario—
Lake Liambezi imaging

Llaima volcano
Llaima volcano, in Chile [Simmon, Robert B]
volcano

Madagascar
Flooding from Adler’s forecast
flooding
stuirye
Adler 04-07-09, Adler’s forecast 3-12-09, Adler 3-16-09
02/11/2009 06:14 PM
02/11/2009 06:14 PM
0.0

Madagascar Floods
Flooding in East coast of Madagascar
flooding
rcmrd-dan
-
04/08/2009 02:34 PM
04/08/2009 02:34 PM
0.0

Mozambique
Flooding on the Zambezi and Limpopo Rivers
flooding
stuirye
Adler forecast 3-18-09, Adler 3-22-09, GDACS gauge2
01/05/2009 03:31 PM
02/04/2009 08:06 PM
24.0

Mt. Asama
Volcano in Japan, currently active
volcano
jallen
-
02/02/2009 07:49 PM
02/02/2009 07:49 PM
0.0

Namibia
Flooding in Namibia
flooding
rcmrd-dan
Namibia
04/06/2009 12:40 PM
04/06/2009 12:40 PM
0.0

Namibia Floods
Flood campaign test in Namibia
flooding
dmandl
Lake Liambezi test1
04/21/2009 06:10 PM
04/23/2009 12:04 PM
0.0
Perform “Get Feasibility” and Campaign Manager searches available Sensor Planning Services (SPS) for available sensors to image Area of Interest (AOI)
Campaign Manager Tasking Request Page

Visualize request using Google Map

Tasking Request:

Title: Lake Liambezi test!
Description: Namibia flood campaign requested by Guido Van Langenhove
Category: 17.9108028411856
Latitude: 24.313226256876
Longitude: day/night: day
country code: day
Zone Number: 376
Zone Name: Zambia
Region Number: 37
Region Name: Africa
Admin Code: 2009-04-23
Admin Name: 2009-04-23
Nearby:
CreatedAt: Thu, 23 Apr 2009 02:37:14 -0000
UpdatedAt: 2009-04-23

Fasibilities
Potential Feasibility Asset: EC-1, Date: 2009-04-24T00:00:00Z
Potential Feasibility Asset: FORMOSAT-2, Date: 2009-04-25T00:45:28Z
Potential Feasibility Asset: QB-2, Date: 2009-04-25T08:00:21Z
Potential Feasibility Asset: EC-1, Date: 2009-04-27T08:25:00Z
Potential Feasibility Asset: SPOT-5, Date: 2009-04-28T06:24:02Z
Potential Feasibility Asset: QB-2, Date: 2009-04-28T19:10:07Z
Potential Feasibility Asset: ALOS, Date: 2009-04-28T00:35:33Z
Potential Feasibility Asset: EC-1, Date: 2009-04-29T08:04:00Z
Potential Feasibility Asset: ALOS, Date: 2009-04-29T20:38:33Z
Potential Feasibility Asset: FORMOSAT-2, Date: 2009-04-29T23:19:50Z
Potential Feasibility Asset: QB-2, Date: 2009-04-30T02:52:57Z
Potential Feasibility Asset: SPOT-5, Date: 2009-04-30T11:02:33Z
Potential Feasibility Asset: EC-1, Date: 2009-03-02T00:21:00Z
Potential Feasibility Asset: ALOS, Date: 2009-05-02T14:09:28Z
Potential Feasibility Asset: QB-2, Date: 2009-05-02T14:38:16Z
Potential Feasibility Asset: SPOT-5, Date: 2009-05-03T01:43:33Z
Potential Feasibility Asset: FORMOSAT-2, Date: 2009-05-03T09:47:24Z
Campaign Manager Tasking Request Page

Visualize request using Google Earth

<table>
<thead>
<tr>
<th>Tasking Request:</th>
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<tbody>
<tr>
<td>Title:</td>
<td>Lake Liambezi test1</td>
</tr>
<tr>
<td>Description:</td>
<td>Namibia flood campaign requested by Guido Van Langenhove</td>
</tr>
<tr>
<td>Category:</td>
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<td>Latitude:</td>
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<td>Zone Number:</td>
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<td>Zone Name:</td>
<td>Zambia</td>
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<tr>
<td>Region Number:</td>
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<td>Admin Name:</td>
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<tr>
<td>Updated At:</td>
<td>2009-04-23</td>
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Feasibilities

- Potential Feasibility: Asset: EO-1, Date: 2009-04-24T08:09:00Z
- Potential Feasibility: Asset: FORMOSAT-2, Date: 2009-04-25T00:45:38Z
- Potential Feasibility: Asset: QB-2, Date: 2009-04-25T08:00:31Z
- Potential Feasibility: Asset: EO-1, Date: 2009-04-27T08:15:00Z
- Potential Feasibility: Asset: SPOT-5, Date: 2009-04-28T06:24:03Z
- Potential Feasibility: Asset: ALOS, Date: 2009-04-29T00:35:33Z
- Potential Feasibility: Asset: ETR-1, Date: 2009-04-29T08:04:00Z
- Potential Feasibility: Asset: ALOS, Date: 2009-04-29T20:38:33Z
- Potential Feasibility: Asset: QB-2, Date: 2009-04-30T02:52:57Z
Select one of the available satellites and task the asset to make it part of the campaign once the weather forecast for the overflight is checked by pressing forecast button.

### Tasking Opportunity:

<table>
<thead>
<tr>
<th>Campaign</th>
<th>Namibia Flooding</th>
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<tbody>
<tr>
<td>User</td>
<td>dmandl</td>
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<tr>
<td>Organization</td>
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<tr>
<td>Theme</td>
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<td>Request</td>
<td>Lake Liambezi test1</td>
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<td>Latitude</td>
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<td>Longitude</td>
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<tr>
<td>Score</td>
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<tr>
<td>Veto</td>
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### Available Satellites:

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<td>Theme</td>
<td>flooding</td>
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<td>Request</td>
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<tr>
<td>Latitude</td>
<td></td>
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<tr>
<td>Weather</td>
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<td>Score</td>
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<tr>
<td>Veto</td>
<td></td>
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<tr>
<td>Notes</td>
<td></td>
</tr>
</tbody>
</table>
Deliver Level 2 Products via News Feeds to Users Along with Links to GeoTiff, KML and information about Image
Key Implementation Challenges (Open yet secure)

1. Single sign on
2. Secure transactions
3. Delegation

Orchestrating Workflow

Organization
- Sensor Planning Service (SPS)
- Web Processing Service (WPS)
- Web Coverage Service (WCS)
Sample Application: Flood SensorWeb
Top Level Flood SensorWeb Functional Flow

Request for satellite imagery in area of interest

Customized plan of needed satellite images

Campaign Manager

Flood conditions

Compare to history

Improved Flood Prediction Model

*SPS – Sensor Planning Service
Normanton, Queensland, Australian Floods February 2009 Data Simulation

• **Prediction:** TRMM-based Predictive Flood Potential Model
  - Robert Adler/University of Maryland – NASA/GSFC

• **Survey:** MODIS Flood Map
  - Robert Brakenridge/ Dartmouth Flood Observatory

• **Details:**
  - Earth Observing 1 Advanced Land Imager and Hyperion
    - NASA/GSFC – Image acquisition, flood map, automation
      -- Mandl, Frye, Cappelaere
  - Radarsat Flood Image
    - MDA/Canadian Space Agency – Image acquisition
    - Space Research Institute NASU-NSAU, Ukraine – Flood Map Production
      - Serhiy Skakun and Natalia Kussul
  - Landsat Water Mask
    - Space Research Institute NASU-NSAU, Ukraine – Water Mask
      - Serhiy Skakun and Natalia Kussul
  - Formosat Flood Image
    - Taiwan National Program Science Office – Image acquisition
    - National Cheng-Kung University – Data processing
      - Cheng-Chien Liu
Normanton Floods- Google Earth view from before floods (Quickbird image)

Town of Normanton, Australia population approx 1100

Normanton Airport
TRMM-based flood potential forecast for February 6, 2009

**Prediction**
Specific Water Level and Lat/Long Projected for Normanton Area

Use this lat/long to trigger other assets

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>WATER LEVEL &amp; Latitude/Longitude</th>
<th>NEARBY LOCATION</th>
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</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>134mm -32.63 -60.88</td>
<td>~35.96km from ROSARIO AIRPORT -32.92 -60.78</td>
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<td>Argentina</td>
<td>151mm -32.88 -61.13</td>
<td>~32.39km from ROSARIO AIRPORT -32.92 -60.78</td>
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<td>Argentina</td>
<td>163mm -22.12 -80.98</td>
<td>~22.41km from ROSARIO AIRPORT -22.92 -80.78</td>
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<tr>
<td>Australia</td>
<td>126mm -16.88 143.63</td>
<td>~107.79km from PALMERVILLE QU-16.00 144.07</td>
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<tr>
<td>Australia</td>
<td>127mm -16.88 141.13</td>
<td>~89.09km from NORMANTON QU-17.67 141.08</td>
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<tr>
<td>Australia</td>
<td>129mm -14.88 129.88</td>
<td>~84.91km from PORT KEATS AWS (AUT) NT-14.23 129.45</td>
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<tr>
<td>Australia</td>
<td>129mm -18.38 143.13</td>
<td>~109.00km from PALMERVILLE QU-16.00 144.07</td>
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<tr>
<td>Australia</td>
<td>131mm -15.63 141.63</td>
<td>~20.25km from KOWANYAMA QU-15.47 141.73</td>
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<tr>
<td>Australia</td>
<td>137mm -16.38 141.38</td>
<td>~107.91km from KOWANYAMA QU-15.47 141.73</td>
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<tr>
<td>Australia</td>
<td>138mm -16.38 143.38</td>
<td>~84.60km from PALMERVILLE QU-16.00 144.07</td>
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<tr>
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<td>139mm -16.38 143.63</td>
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<td>~116.07km from NORMANTON QU-17.67 141.08</td>
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<tr>
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<td>Australia</td>
<td>201mm -16.38 141.13</td>
<td>~119.57km from KOWANYAMA QU-15.47 141.73</td>
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<tr>
<td>Australia</td>
<td>216mm -17.63 146.13</td>
<td>~15.56km from INNISFAIL QU-17.52 146.02</td>
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<tr>
<td>Indonesia</td>
<td>170mm -8.13 120.38</td>
<td>~154.43km from ENDEH/IPI -8.80 121.60</td>
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<td>174mm -5.13 105.63</td>
<td>~51.55km from TELUKBETUNG/BRANTI -5.27 105.18</td>
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<tr>
<td>Indonesia</td>
<td>179mm -5.38 105.63</td>
<td>~50.22km from TELUKBETUNG/BRANTI -5.27 105.18</td>
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<tr>
<td>Indonesia</td>
<td>224mm -5.13 105.88</td>
<td>~78.64km from TELUKBETUNG/BRANTI -5.27 105.18</td>
</tr>
<tr>
<td>Mozambique</td>
<td>169mm -25.88 32.63</td>
<td>~7.07km from MAPUTO/MAVALANE -25.92 32.57</td>
</tr>
<tr>
<td>Country</td>
<td>WATER LEVEL &amp; Latitude/Longitude</td>
<td>NEARBY LOCATION</td>
</tr>
<tr>
<td>-----------</td>
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<td>---------------------</td>
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<td>Country</td>
<td>WATER LEVEL &amp; Latitude/Longitude</td>
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<tr>
<td>Country</td>
<td>WATER LEVEL &amp; Latitude/Longitude</td>
<td>NEARBY LOCATION</td>
</tr>
</tbody>
</table>
MODIS Flood Extent on Google Earth as KML File February 18, 2009

**Survey**

Robert Brakenridge – Dartmouth Flood Observatory
MODIS Flood Extent on Google Earth as KML File February 18, 2009

**Survey - Zoom**

Robert Brakenridge – Dartmouth Flood Observatory
OVERFLOWING sewerage, crocodiles and mosquito-borne diseases were among the possible hazards Queensland Emergency Services Minister Neil Roberts faced when he arrived in the Gulf yesterday. Mr Roberts visited Karumba and Normanton to gauge the impact the floodwaters were having on the region.

And according to a statement released by Carpentaria Shire Council yesterday, there were quite a few issues making an impact on the isolated communities.

A spokesperson for Carpentaria Shire Council said the council was anticipating possible sewage overflows in the towns due to the inundation of pump stations.

The spokesperson also said there had been increased sightings of large crocodiles in the floodwaters surrounding Normanton and that Queensland Health had recommended the public avoid wading and playing in floodwaters due to mosquito-borne diseases.

However, despite the possible dangers, the Minister pressed on with his trip undeterred. “I’m here to be shown around the district and to talk to locals about the impact of the flooding,” Mr Roberts said. “I really need to take advice from local governments and emergency services personnel on the ground. So I’ll be waiting for their advice about what other measures need to be taken.”

The Carpentaria Shire Council spokesperson said another issue they planned to discuss with the minister was the upgrade of the Einasleigh and Gilbert crossings. They said this would enable road access for the essential re-supply of goods. The isolated communities were currently reliant on food drops via aircraft and a fortnightly barge service from Cairns to Karumba to supply food, fuel and essential items to residents in the area.

With the Norman River continuing to rise, the communities could be cut off for a further six weeks. Carpentaria Shire Council and Emergency Management Queensland met with local retailers and suppliers to discuss re-supply sustainability.
Retailers were encouraged to monitor stocks and liaise with the Council to ensure all residents had adequate food and other essential items.

A business advisor from the Department of Tourism, Regional Development and Industry was flown into Normanton at the weekend to help the businesses manage the effects of ongoing flooding on their bottom line.

His feet firmly on dry ground, Mr Roberts took time during his brief stopover in Mount Isa to thank local emergency services leaders for their hard work.

“I’ve received very good feedback from the Mayors in the local communities about the work and support the emergency service crews are doing,” he said.
Normanton Airport View 2 2-15-09

Radarsat-2 Water regions 14 Feb 2009)
Formosat-2 image 18 Feb 2009

Dr. Cheng-Chien Liu
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National Cheng-Kung University
Radarsat/Landsat Flood Map

Radarsat Image 2-14-09 (red), 3 meter resolution
Landsat Image pre-flood 5-6-02 (blue), 30 meter resolution
Flood maps produced by the Space Research Institute NASU-NSAU, Ukraine

Red – flood waters
Blue – Existing waters

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Normanton with Landsat 7 5-7-02, Radarsat 2 Flood Extent Overlay February 14, 2009 and February 17, 2009 3m resolution
Namibian Floods 2009

Year 3 Accomplishments
Namibian Flood-Disease SensorWeb Emergency Response Pilot Project

- Extensive flooding in Namibia in 2009
- Worked with Guido Van Langenhove, head of Hydrological Services in Namibia, to identify flood sensorweb pilot scenario
- Collected satellite imagery for months in the Lake Liambezi area
- Collected the following:
  - Ground measurements (Guido Langenhove)
  - Rainfall estimates, and predictions for first three months of 2009 (Policelli)
  - Flood predictions for 1st three months of year (TRMM – Policelli)
  - Assets:
    - EO-1 30 meter/10 meter 1-2 times per week (Frye)
    - Formosat 2 meter data, once per week for 4-6 weeks (requested from Cheng-Chien Liu)
    - MODIS flood map, once per week 4-6 weeks (Requested from Bob Brakenridge)
    - Radarsat about once per week

Year 3 Accomplishments
Namibian Flood-Disease SensorWeb Emergency Response Pilot Project

- Namibian Dept of Hydrology installing flood gauges and rain gauges
- Will correlate ground measurements with satellite imagery to calibrate imagery and thus improve flood forecast models
- NASA will improve our flood forecast model and assist in improving Riverwatch system (Dartmouth Flood Observatory)
Campaign Manager (GeoBPMS 1.0) Triggering EO-1 Flood Image and Possible Other Satellites to Use

Year 3 Accomplishments
EO-1, Radarsat, River Watch Example

Goal is to calibrate River Watch measurements which use AMSR-E to calculate river flows and thus provide early warning for flooding downstream
Another Sample Application:
Disease SensorWeb
Top Level Malaria Early Warning SensorWeb Functional Flow

Flood Predictions

- Flood alerts
- Campaign Manager
  - Flood conditions
  - Climate & vegetation conditions
  - Request for satellite imagery in area of interest

Statistical disease risk alerts

- Historical epidemiological data
  - EFTB
  - Compare to history
  - SPS – Sensor Planning Service
  - Statistical disease risk alerts
  - Flood alerts
  - SPS

Customized plan of needed satellite images
Malaria risk map identifies priority areas and additional resources needed to fight epidemics effectively.
Predicting Malaria in KENYA

VH provides up to 4 months advance malaria warning
Conclusion

• Sensorwebs, OCG standards and cloud computing
  • Lower cost to provide data products to disaster management personnel
    • Easier implementation
    • User provided with tools to “do-it-yourself”
• Ease of use increases via the use of this approach
  • Leverages internet approach to user applications