

Namibian Flood Early Warning SensorWeb Pilot

Dan Mandl

NASA/Goddard Space Flight Center



Session Title: IN34A. Sensor Networks:
From Sensors to the Web II

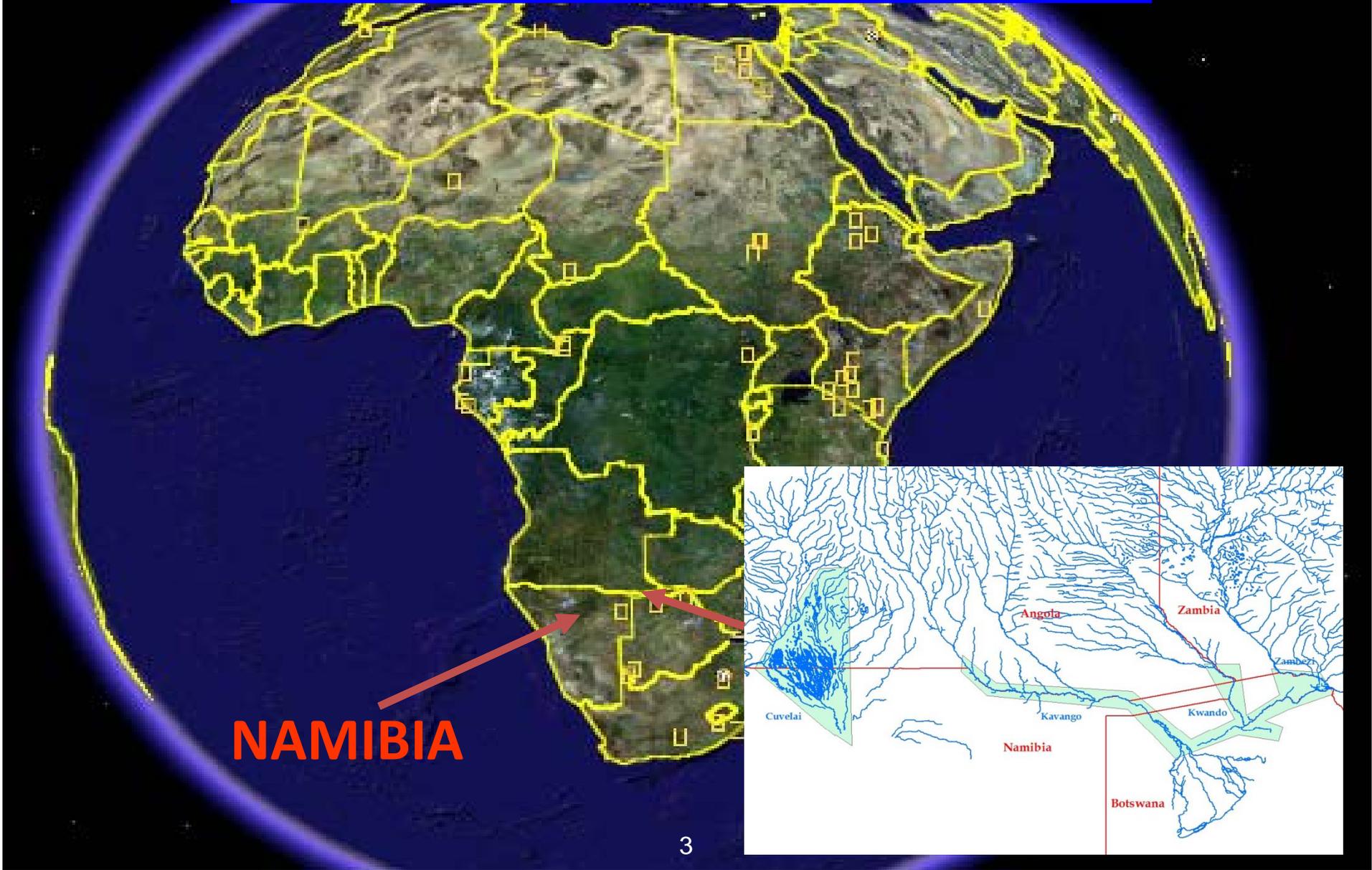
Location: 302 (Moscone South)

Start time: Wed, Dec 15 - 4:00 PM

Team Members

- Guido Van Langenhove and Staff/Namibia Department of Hydrology
- Joerg Szarzynski, Lorant Czarán and staff/ United Nations Platform for Space-based Information for Disaster Management and Disaster Response (UN-SPIDER)
- Natalia Kussul, Serhiy Skakun/ Ukrainian Space Research Institute
- Carl Keuck, Jan Peter Mund, Herald Mehl/DLR
- Tom DeGroeve/Joint Research Centre
- Tom Rientjes/Geo-Information Science and Earth Observation (ITC) of the University of Twente
- Daniel Irwin and SERVIR team/SERVIR
- Lenny Roytman/City College NY
- Felix Kogan/NOAA
- Martha Maiden , Karen Moe &team/Committee on Earth Observing Satellites (CEOS)/Working Group on Information Systems and Services (WGISS)
- Dan Mandl, Stu Frye, Pat Cappelaere, Fritz Policelli and NASA SensorWeb Team- NASA/GSFC

Country of Namibia and Flood Risk Areas in North



2009 Flood Disaster

- *In February and March 2009, torrential rains increased water levels in Zambezi, Okavango, Cunene and Chobe Rivers*
- *This led to a 40-year flood in Caprivi, Kavango and Cuvelai basins, affecting some 750,000 people (37.5% of population of Namibia)*
- *Whole villages were cut off and had to be relocated into camps. Some 50,000 people were displaced*
- *Livestock were stranded and died of hunger*
- *102 people died*



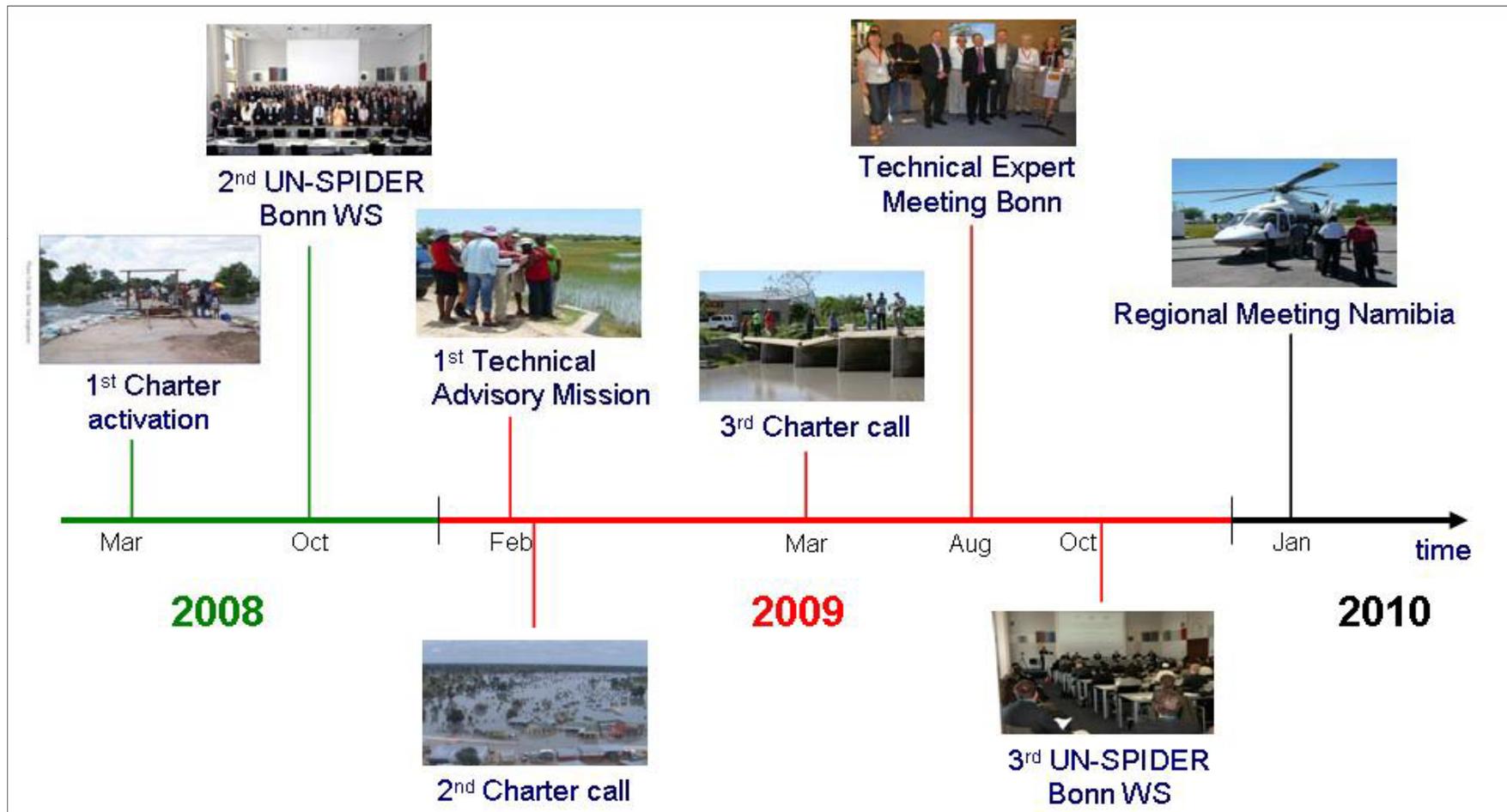
Rescue Operations



Formation of Flood-Disease Early Warning Project

- Against this background, major goal of the Namibia SensorWeb Pilot Project is a scientifically sound, operational trans-boundary flood management decision support system for Southern African region to provide useful flood and waterborne disease forecasting tools for local decision makers.
- Pilot Project established under the auspices of:
 - Namibian Ministry of Agriculture Water and Forestry (MAWF), Department of Water Affairs
 - Committee on Earth Observing Satellites (CEOS) , Working Group on Information Systems and Services (WGISS)
 - And moderated by the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER).
- Effort consists of identifying and prototyping technology which enables the rapid gathering and dissemination of both space-based and ground sensor data and data products for the purpose of flood disaster management and water-borne disease management.

Timeline of Activities Related to Namibia Early Warning Flood Project



Flood SensorWeb Workshop Held in Winhoek, Namibia in January 2010



Front Row: left to right, Gail D. Mathieu, U.S. Ambassador to Namibia, John Mutorwa, Minister of Ministry of Agriculture, Watery and Forestry (MAWF) and Kari Egge, UN Resident Coordinator in Namibia

The following agencies contributed to establish an international expert team and sent representatives to this field mission: European Commission, Joint Research Center (JRC), Italy; German Aerospace Center (DLR), Germany; German Technical Cooperation (GTZ), Windhoek, Namibia; International Institute for Geo-Information Science and Earth Observation (ITC), University of Tuent, The Netherlands; National Aeronautics and Space Administration (NASA), US; NOAA / National Environmental Satellite Data and Information Service (NESDIS), US; Ukraine Space Research Institute (USRI), Ukraine; UNESCO; United Nations Resident Coordinator, Namibia; United Nations Office for Outer Space Affairs (UNOOSA), Austria/Germany; and World Meteorological Organisation (WMO).

Namibian Flood Early Warning Prototype



- Namibian Dept of Hydrology installing various telemetered flood gauges and other ground measurement devices

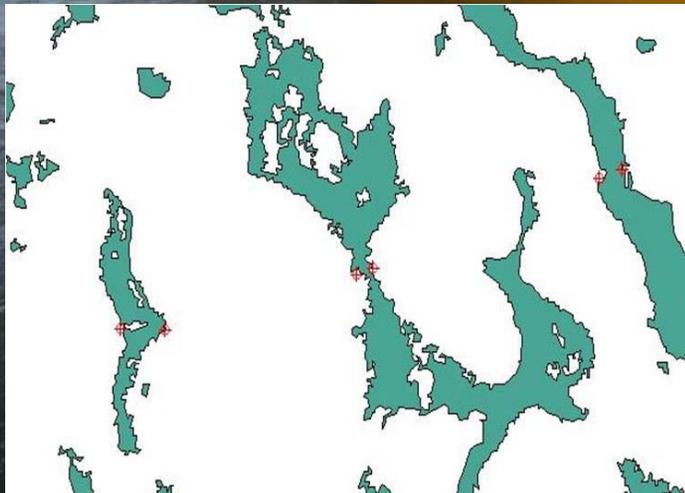
Surveying Flood Damage



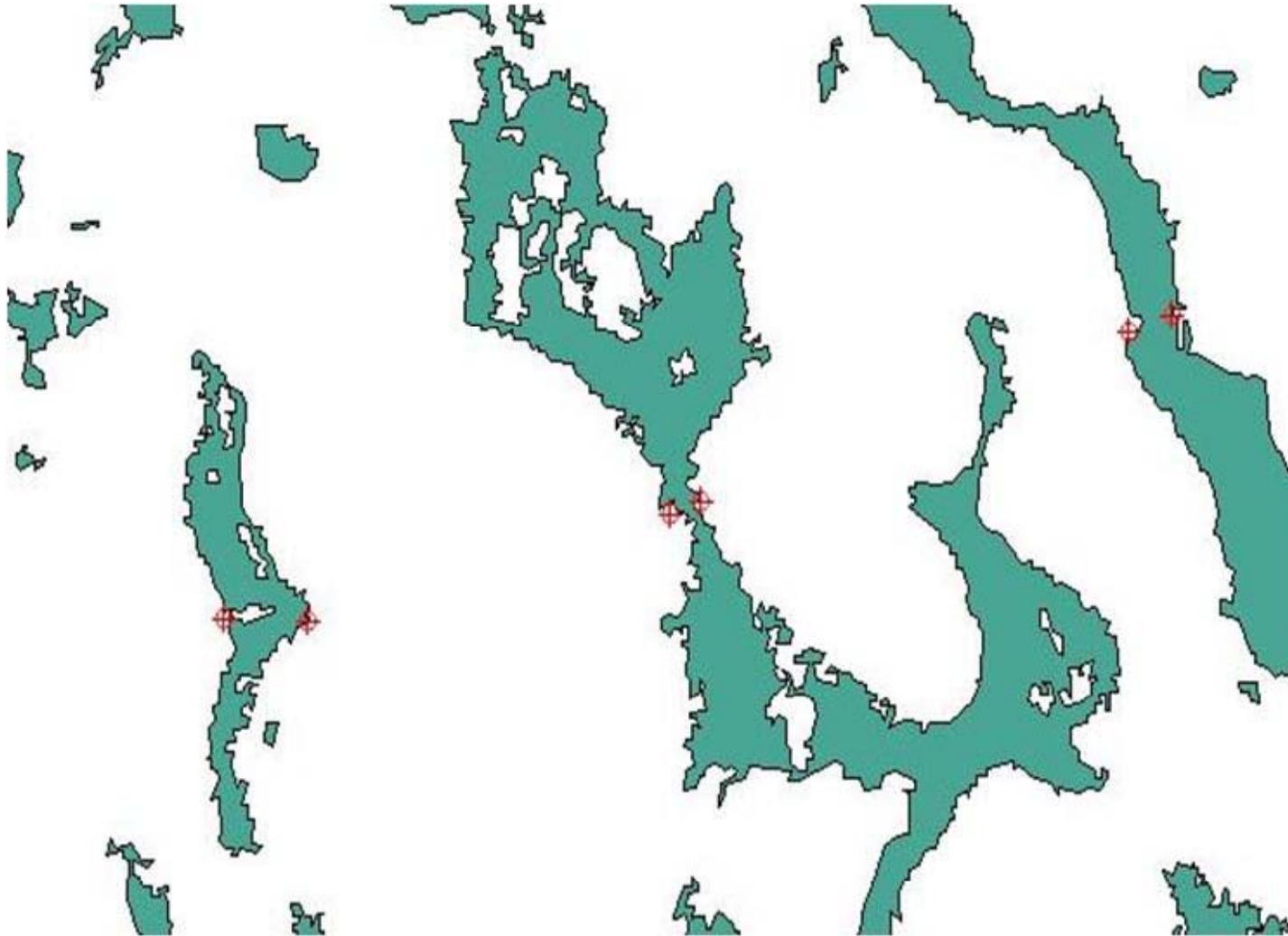
Surveying Flood Damage and Validating Water Locations

Guido Van Langenhove
Head, Department of Hydrology, Namibia

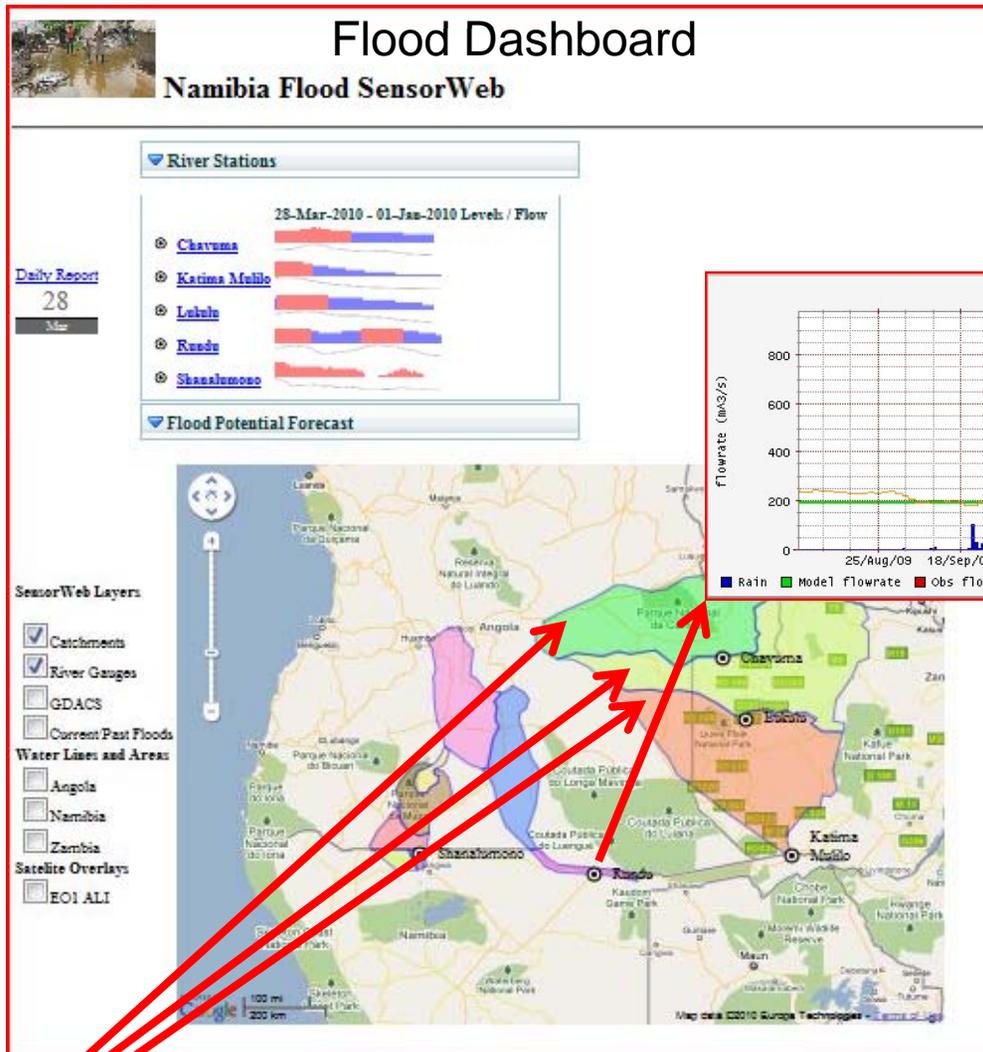
Hango Leonard
Hydrologist & Basin support Officer
Department of Water Affairs and Forestry
Cuvelai-Etoshia Basin, Oshakati



Validating Satellite Data via Ground Observations

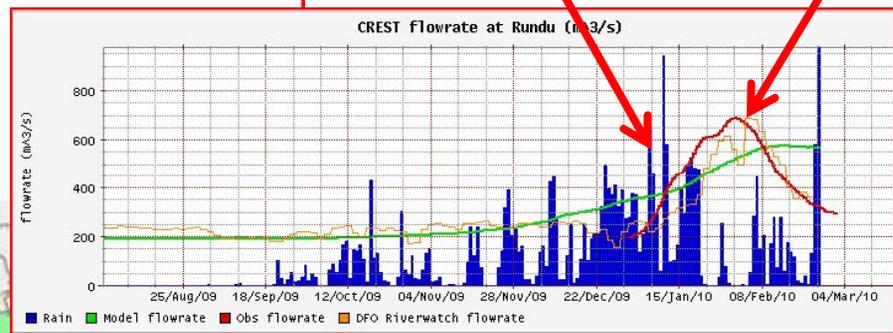


Experimental Namibian Flood SensorWeb Webpage



Note blue bars indicating a surge of rainfall upstream

Then a flood wave appears downstream at Rundu river gauge days later



Namibia Short Term Pilot for 2010

- Colored areas represent catchments where rainfall collects and drains to river basins
- River gauges displayed as small circles
- Detailed measurements are available on the display by clicking on the river gauge stations.
- This display can be viewed and manipulated at:

<http://geobpms.geobliski.com/namibia>
and
<http://geobpms.geobliski.com/namibia2>

Zambezi basin consisting of upper, middle and lower catchments

Experimental Namibian Flood SensorWeb Webpage View of Available Envisat & EO-1 Overlay Images

Flood Dashboard
Namibia Flood SensorWeb

Experimental TRMM-based Flood Forecast Products

Envisat SAR and EO-1 Optical Image Overlays

Daily Report
25
Apr

River Stations

Flood Potential Forecast

[1-Day Flood Potential Forecast](#)
[5-Day Flood Potential Forecast](#)
[Severe Flood Report](#)

SensorWeb Layers

- Catchments
- River Gauges
- GDACS
- Current/Past Floods

Water Lines and Areas

- Angola
- Namibia
- Zambia

Dwelling Density

- Northern Namibia

Satellite Overlays

- EO1 ALI
- SAR (SRI/Ukraine)

2010-01-30 Flood Water Area
Flood/water mask derived from SAR imagery
Image credit: Copyright ESA 2009, 2010
Image processing, map created by:
Space Research Institute,
National Academy of Sciences of Ukraine,
National Space Agency of Ukraine.
2010-03-28 (07:58 UTC)
[Download KML file](#)

Map Satellite Terrain

Map showing various geographical features and overlays in Namibia, including national parks (Parque Nacional da Quipama, Parque Nacional da Camero, Parque Nacional de Etosha, Hwange National Park, Skeleton Coast Park), reserves (Reserva Natural Integral do Luando, Khaudum Game Reserve), and administrative boundaries. The map displays a flood water area mask in blue, overlaid on a satellite image. A legend on the left side of the map lists various layers and overlays, including Catchments, River Gauges, GDACS, Current/Past Floods, Water Lines and Areas (Angola, Namibia, Zambia), Dwelling Density (Northern Namibia), and Satellite Overlays (EO1 ALI, SAR (SRI/Ukraine)). A pop-up window provides details about the 2010-01-30 Flood Water Area, stating it is derived from SAR imagery and processed by the Space Research Institute, National Academy of Sciences of Ukraine, and National Space Agency of Ukraine. The pop-up also includes the date and time (2010-03-28 (07:58 UTC)) and a link to download the KML file.

Sample of Planned Addition of Flood Product Overlay

EO-1 Land Cover Land Use Change

ALI Imagery of Australian Flood (Mar. 2009)



March 12, 2009
True-Color Image
EO-1 ALI Image

In this true-color image, note how the water color is so muddy that it makes discerning the extent of the flooding difficult



March 12, 2009
False-Color Image
EO-1 ALI Flood Product

This false-color image combines infrared and visible light, which makes the extent of the flooding far more obvious. Water is dark blue, while plant-covered land is green, and bare earth is rosy tan.



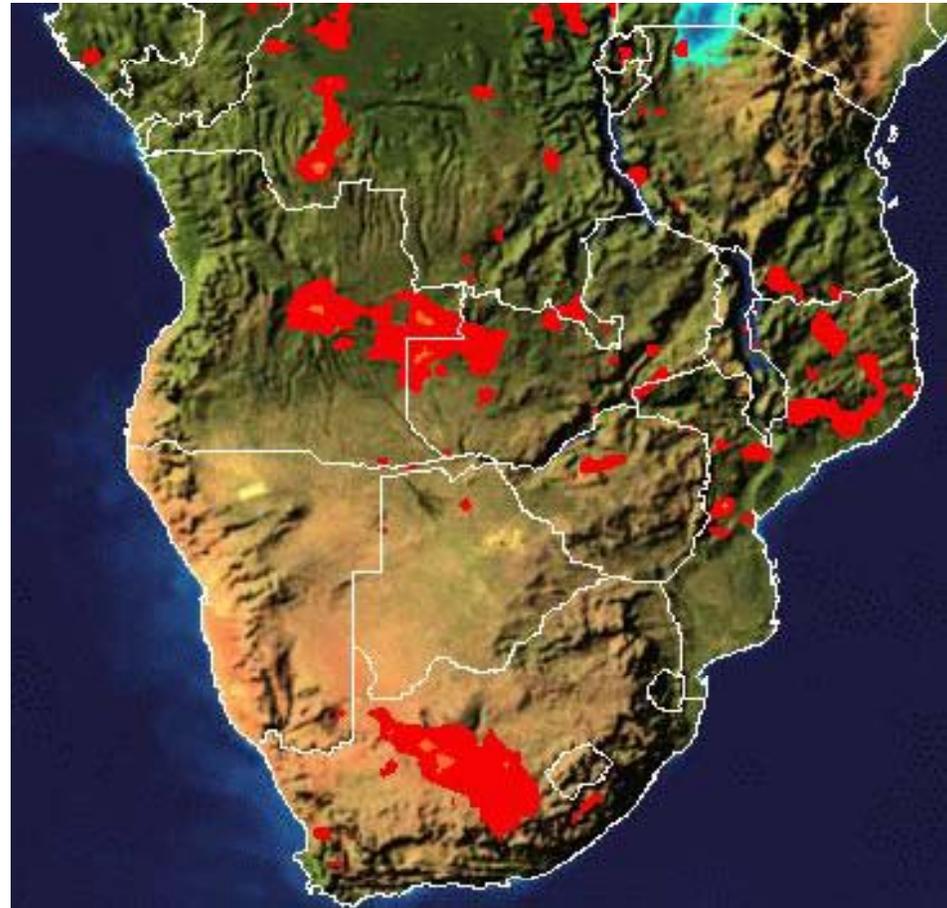
March 25, 2009
False-Color Image
EO-1 ALI Flood Product

Two weeks later, the flood waters have receded even more, which the EO-1 Flood Product makes evident.

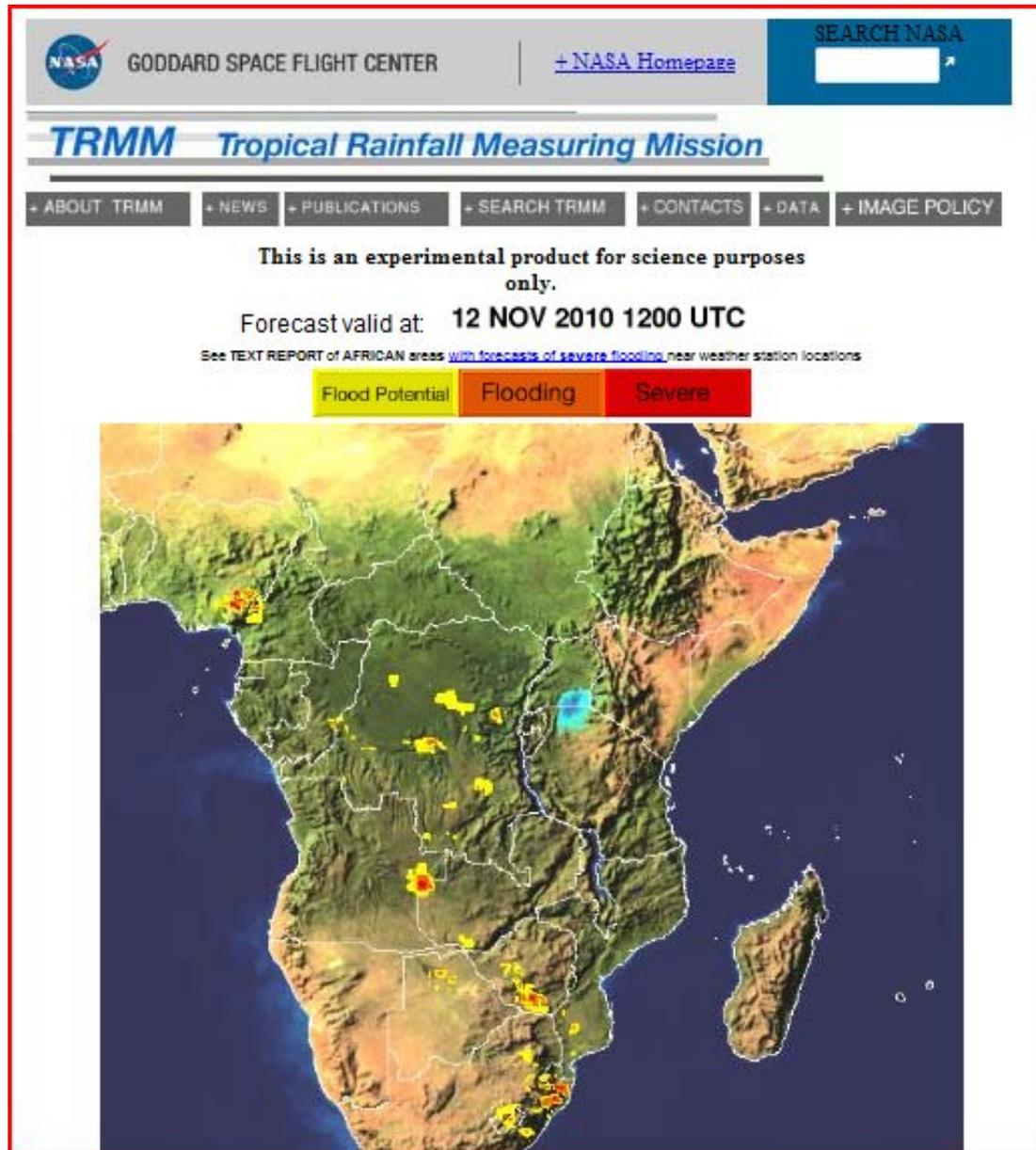
Images are from NASA's Earth Observatory
web site (<http://earthobservatory.nasa.gov/>)

Estimated Rainfall Webpage Based on TRMM Data

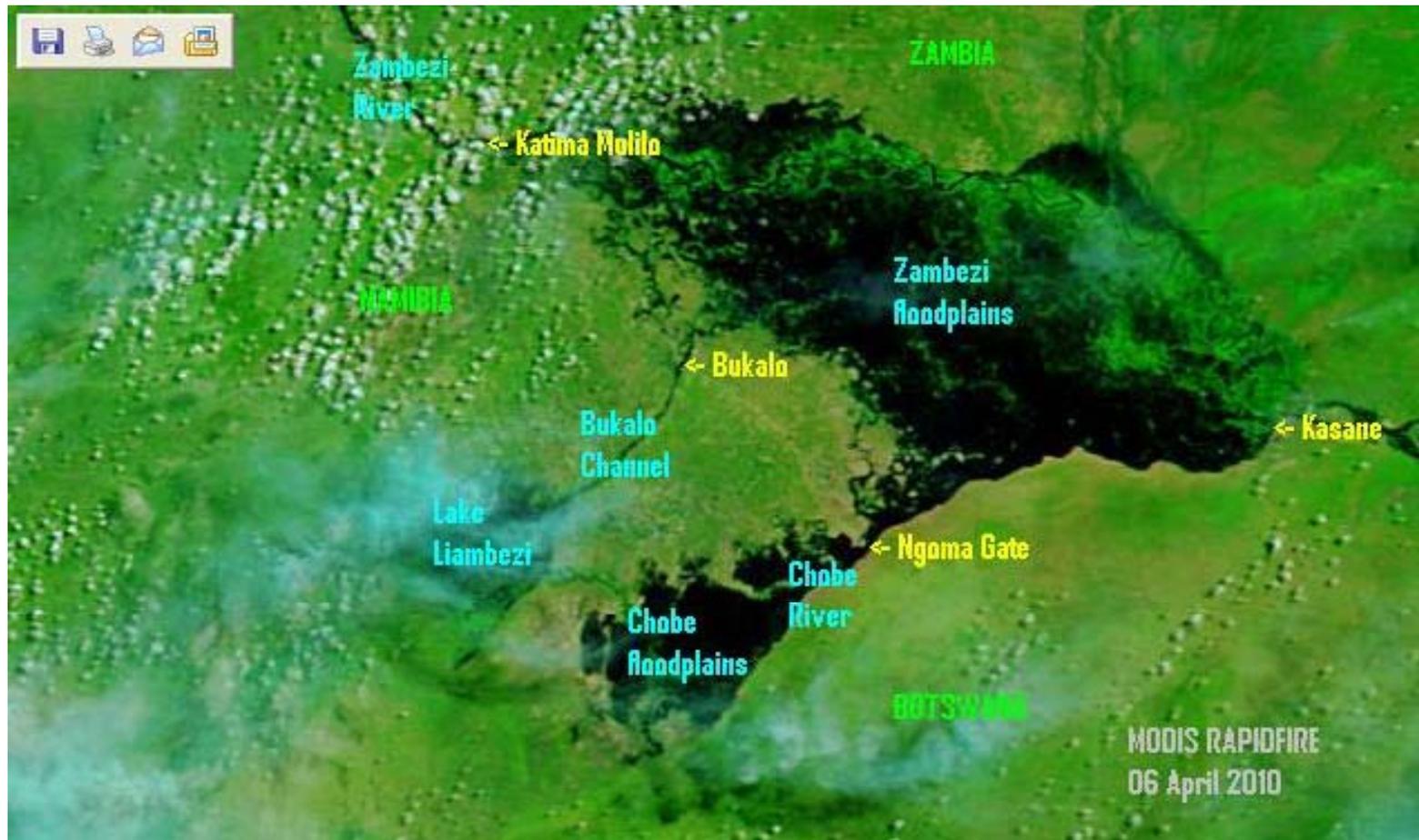
- Experimented with various hydrometeorological information for flood forecasting models
 - remote sensing
 - rainfall estimates
 - 24 February 2010
 - NASA Servir Africa
 - red is > 35 mm



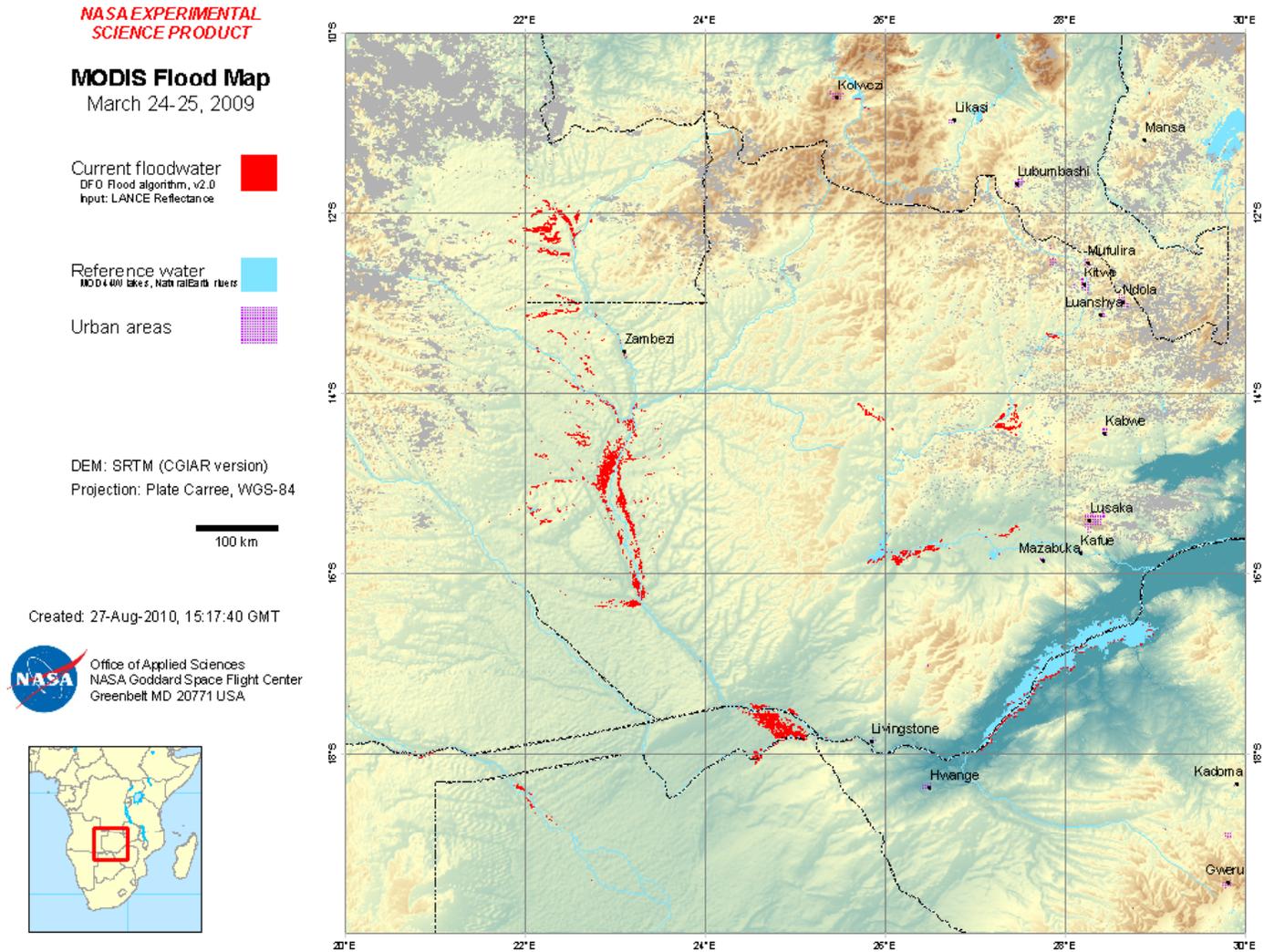
Experimental TRMM Based Flood Forecast



MODIS Image of Flood

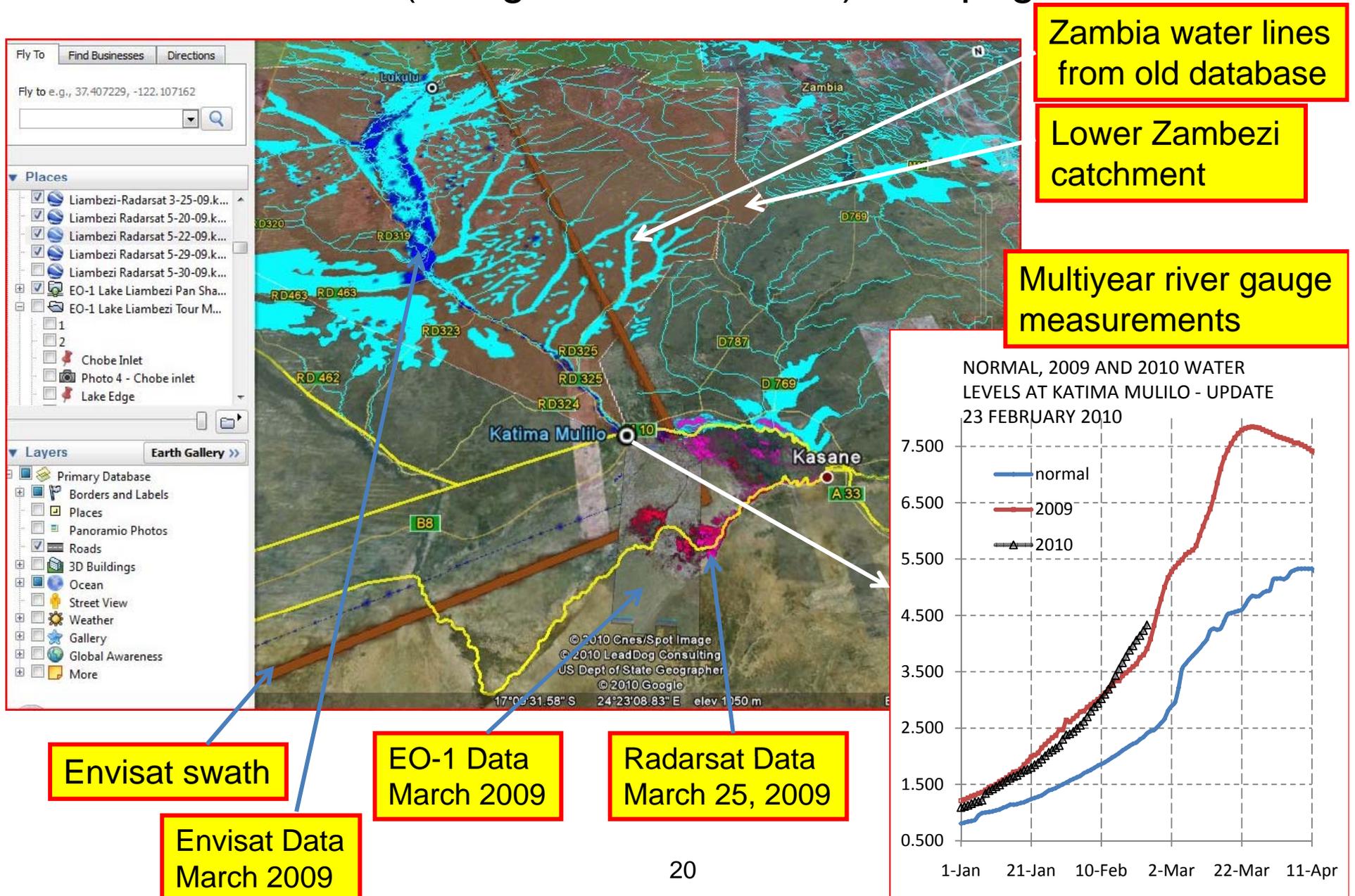


Experimental Flood Extent Data Product Derived from MODIS



First product out of automated MODIS flood extent map pipeline prototype. Used data from March 2009 to test.

Mashup of Satellite Data and River Gauge Data Using Namibia2 (Google Earth Version) Webpage Tool



Sample Display of Multi-year Satellite Measurements (in month of March) of Katima Mulilo Linked to JRC Via Namibia Flood Mashup Based on AMSR-E Microwave Instrument



GDACS Global Flood Detection System - Version 2
An experimental system to detect and map in near-real time major river floods based on daily passive microwave satellite observations. The purpose is to identify and measure floods with potential humanitarian consequences after they occur.



JRC
EUROPEAN COMMISSION
GLOBESEC

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Create a customize graph by parameter

You can create a custom graph combining up to 4 time series. In a given time period, you can compare different sites (e.g. upstream, midstream, downstream for flood propagation) and/or different years (e.g. comparison with last year's floods). Available parameters are: flood signal (ratio of brightness temperature of observation and nearby dry pixel), flood magnitude (signal anomaly expressed as standard deviation removed from the mean) and estimated flooded area (in km²).

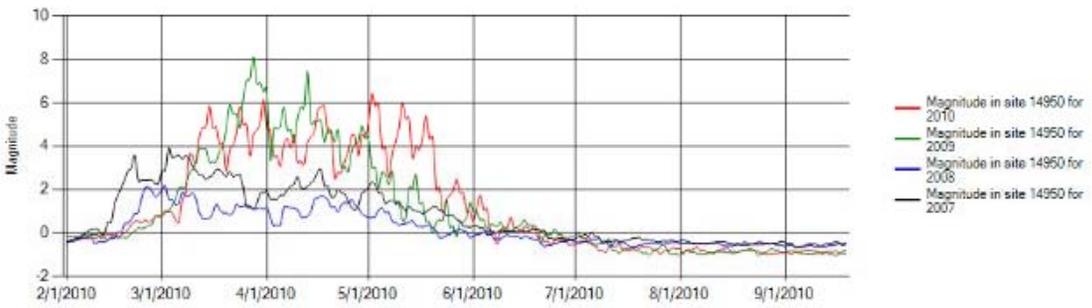
Area Id	<input type="text" value="14950"/>	Colour	<input type="text" value="Red"/>	Legend	<input type="text"/>
Period	From <input type="text" value="2010-02-01"/> To <input type="text" value="2010-09-19"/>				
Series	AreaId	Year	Colour	Legend	
1.	<input type="text" value="14950"/>	<input type="text" value="2009"/>	<input type="text" value="Green"/>	<input type="text"/>	
2.	<input type="text" value="14950"/>	<input type="text" value="2008"/>	<input type="text" value="Blue"/>	<input type="text"/>	
3.	<input type="text" value="14950"/>	<input type="text" value="2007"/>	<input type="text" value="Black"/>	<input type="text"/>	

Parameter

Title:



Katima Mulilo (DWAF) (14950) from 2010-02-01 to 2010-09-19



[Download data](#)

Please note that the information provided on this website has no official status and does not replace local flood warnings. Please refer to the competent local hydrographic authorities for official information on the flood status in each country.

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in collaboration with:



Sample Alert During Pilot

Namibia daily flood bulletin 03 March 2010:

There have again been heavy rains in parts of the Zambezi catchment. See attached NASA map. The waterlevels at Chavuma started rising again. See attached graph. Our forecast remains that the Katima Mulilo waterlevels are heading for 7 m by mid-March 2010. For perspective, the flood would be:

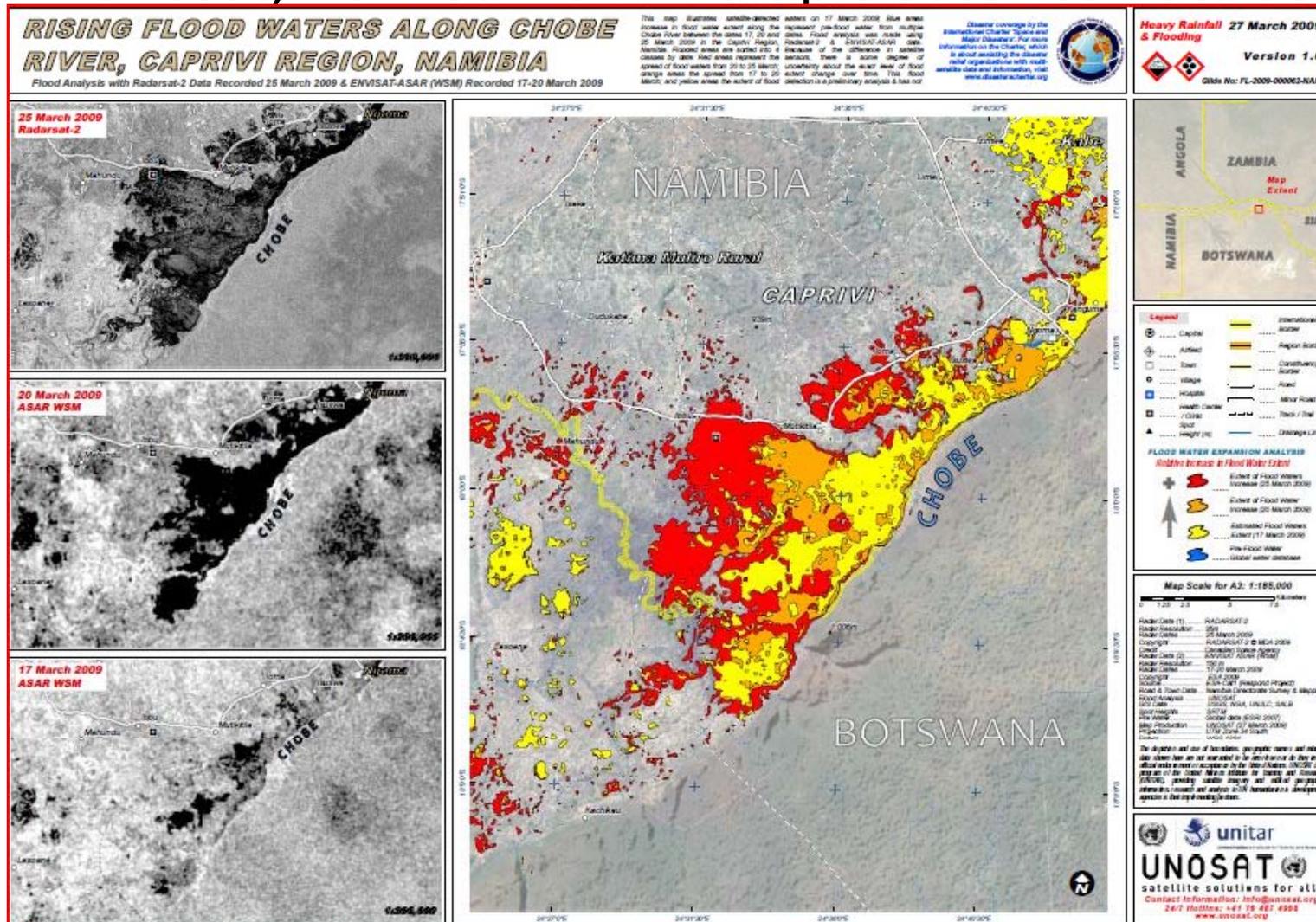
similar to 2007

higher than 2008

lower than 2009

But much will depend on the rains and the catchment response in the coming weeks.

Sample Time Sequence Flood Map Generated by Unosat, Derived from Multiple Satellite Data Sets



Vision is to generate similar product automatically when floods predicted and pair them with river gauge measurements

Capabilities Chart

Capability	Comment
Global low resolution flood predictive model	TRMM based pilot done
High resolution, basin specific hydrological models	NASA completed experimental high resolution model of Lake Victoria basin, would like to do Okavango basin next
Flood gauge data made available on line	Pilot done (Namibia Dept of Hydrology
Auto-generation of MODIS Flood Maps	Almost Done
Auto-generation of EO-1 flood Map	Near future
Auto-generation of Radarsat flood map	Future
Auto-generation of Envisat flood map	Ukraine Space Research Institute
Validation of satellite data and flood location	Namibian Dept of Hydrology, ongoing
Auto-Integration and auto-generation of multiple satellite images info flood differential map	Future
High resolution soil moisture satellite measurements	Future, needed to improve hydrological models

Capabilities Chart

Capability	Comment
Building structure location database	Done, government of Namibia
Auto-generation of flood risk map upon prediction of future floods, auto-notification of people in high risk (red) zones	Future
Correlation of past floods to river gauge measurements to build rudimentary case-based flood forecast model for selected areas	Ongoing
Auto-generation of flood extent maps from TerraSAR	Desirable
High resolution airplane LIDAR generated Digit Elevation Models (DEM)	Desirable to improve hydrological models
Joint Research Centre (JRC) Riverwatch measurements based on Advanced Microwave Scanning Radiometer - Terra (AMSR-E)	Done

Validating Rudimentary Forecast Model and Satellite Imagery for Flood Assessment

- Department of Hydrology validating various flood forecast tools and satellite imagery for flood extent
- Ran flood sensorweb system in spring of 2010 to see how good forecast model performs
- Successfully able to project flood wave downstream up to 10 days in advance
- Experimenting with dwelling unit database to overlay on risk map for future flood
 - Alerts can be sent to warn people to prepare or evacuate

Planned Flood Pilot Effort for Spring 2011

- Use Global Flood Detection System (created and managed by Joint Research Center of European Commission in Italy, Tom De Groeve) to detect flooding levels in the upper regions of the Cuvelai and Zambezi basins
- Using known flood wave delays, trigger automated imaging of the downstream locations to produce flood extent maps as a time series using the EO-1 satellite and other satellites as available
- Make use of Flood Dashboard to store links to satellite related data products and in-situ rain and river gauge data
- Provide a text box alert area to inform viewers the status of flooding in key areas
- Show river water levels as comparative overlays to average and previous years
- Create a case-based history of flooding in relationship to rainfall levels, river levels and other pertinent data
- Create a rudimentary forecast capability via script and show areas at risk by taking a subset of Dwelling Unit database and showing specific dwelling locations at risk in a specified time frame base on flood forecast

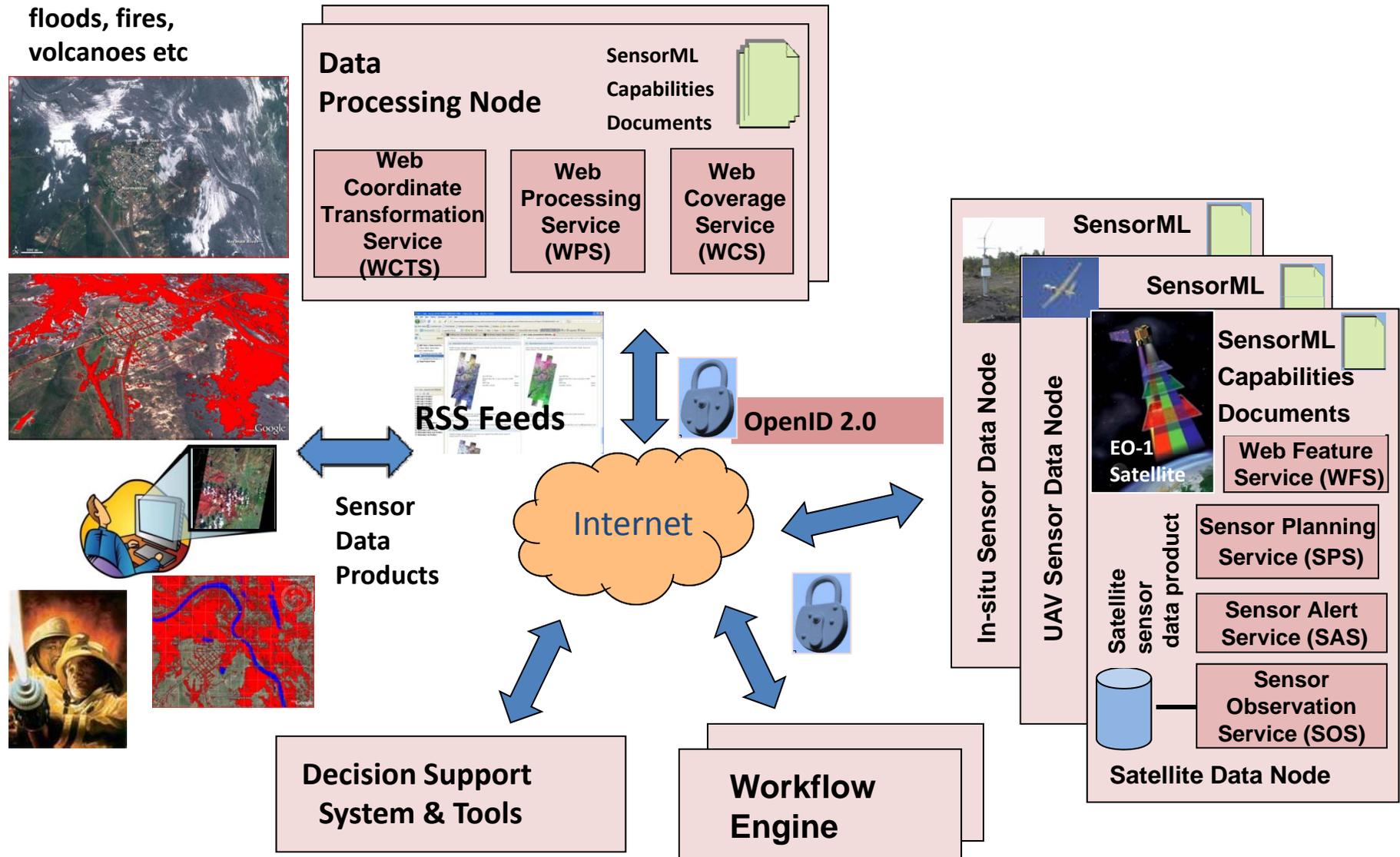
Success of Prototyping Effort as Viewed by Namibian, Department of Hydrology

We (Dept of Hydrology, Namibia) see our success as the openings we made with all the assistance offered and given. Some components:

- The use of radar images for flood mapping
- The access to the space charter
- The tremendous access to satellite images
- The actual use of these images
- The customized rainfall estimates
- The RS estimates (Dartmouth Flood Observatory/European Commission Joint Research Centre)
- How this all augments the conventional hydrological approach which is based on time series in points.
- And last but not least the capacity building and access to new techniques for our young professionals.

Backup

Basic Components Used in Flood-Disease SensorWeb



Campaign Manager Tasking Request Page

Visualize request using Google Map

Tasking Request:

Title: Lake Liambezi test1
Description: Namibia flood campaign requested by Guido Van Langenhove
Category:
Latitude: -17.9108028411865
Longitude: 24.21120262146
Day/Night: day time
Country Code:
Country Name:
Zone Number: 576
Zone Name: Zambia
Region Number: 37
Region Name: Africa
Admin Code:
Admin Name:
Nearby:
Created At: Thu, 23 Apr 2009 02:37:14 -0000
Updated At: 2009-04-23

[Show Map](#)

Feasibilities

Potential Feasibility Asset: EO-1, Date: 2009-04-24T08:09:00Z
Potential Feasibility Asset: ALOS, Date: 2009-04-24T23:24:50Z
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: SPOT-5, Date: 2009-04-25T21:15:14Z
Potential Feasibility Asset: EO-1, Date: 2009-04-27T08:25:00Z
Potential Feasibility Asset: FORMOSAT-2, Date: 2009-04-27T12:24:02Z
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: 2009-04-29T00:35:33Z
Potential Feasibility Asset: EO-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
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Potential Feasibility Asset: EO-1, Date: 2009-05-02T08:21:00Z
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



Deliver Level 2 Products via News Feeds to Users Along with Links to GeoTiff, KML and information about Image

EO-1 Task, Scene:EO1A1700592008326110KF, Theme:fire - Sage - Mozilla Firefox

File Edit View History Bookmarks Tools Help

chrome://sage/content/feedssummary.html?uri=http%3A%2F%2Fgeobpms.geobliki.com%2Fdata%2Fproducts%2Ffeeds%2F83083080-B829-11DC

Most Visited Customize Links Free Hotmail Windows Marketplace Windows Media Windows EO-1 Task, Scene:EO...

FreeRecorder st augustine florida Record Stop Pause Play Settings Record ANY Video & Audio WFLU... st augustine florida

Sage

Options*

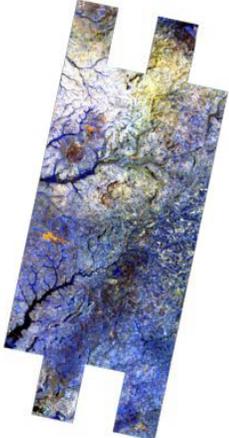
BBC News | News Front Pa...
Yahoo! News: Sports News
EO-1 Data Products
LA Freeway Fires Nov 2008
Uganda/Kenya Floods 11-1...
Uganda/Kenya Floods 11-1...
Sage Project News

EO-1 Task, Scene:EO1A170059200...

1. Ali tcapt 6 Product
2. Ali tcapt 5 Product
3. Ali tcapt 4 Product
4. Ali tcapt 3 Product
5. Ali tcapt 2 Product
6. Ali tcapt 1 Product
7. Ali br 1 Product
8. Ali rdi Product
9. Ali rvi Product
10. Ali gndvi Product
11. Ali ndvi Product
12. Ali cloud mask Product
13. Ali smoke Product
14. Ali active fires Product
15. Ali product swir Product
16. Ali product burn scar Product
17. Ali product vis Product

15. Ali product swir Product

SWIR Image using EO1 ALI Level1G and Vigtel Classifier (Red: band 10, Green:band 9 and Blue:band 8).



GeoTiff File [here](#)
[Note:Data file is also include in KMZ file]
KMZ File [here](#)
GeoBliki Article [here](#)

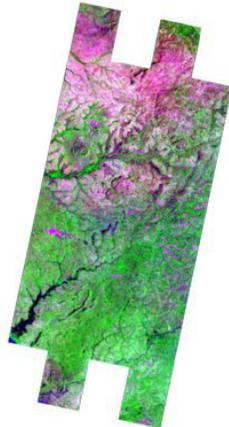
[Disclaimer: This product has not been validated by the Science team]
Provided by GeoBliki and GeoBPMS

Friday, November 21, 2008 2:04 PM

Patrice G. Cappelaere <http://cappelaere.pip.verisignlabs.com/> pat@cappelaere.com

16. Ali product burn scar Product

Burn Scar Image using EO1 ALI Level1G and Vigtel Classifier (Red: band 10, Green:band 7 and Blue:band 5).



GeoTiff File [here](#)
[Note:Data file is also include in KMZ file]
KMZ File [here](#)
GeoBliki Article [here](#)

[Disclaimer: This product has not been validated by the Science team]
Provided by GeoBliki and GeoBPMS

Friday, November 21, 2008 2:04 PM

Patrice G. Cappelaere <http://cappelaere.pip.verisignlabs.com/> pat@cappelaere.com

17. Ali product vis Product

Visible Image using EO1 ALI Level1G and Vigtel Classifier (Red: band 5, Green:band 4 and Blue:band 3).



Lake Liambezi Flood in Namibia

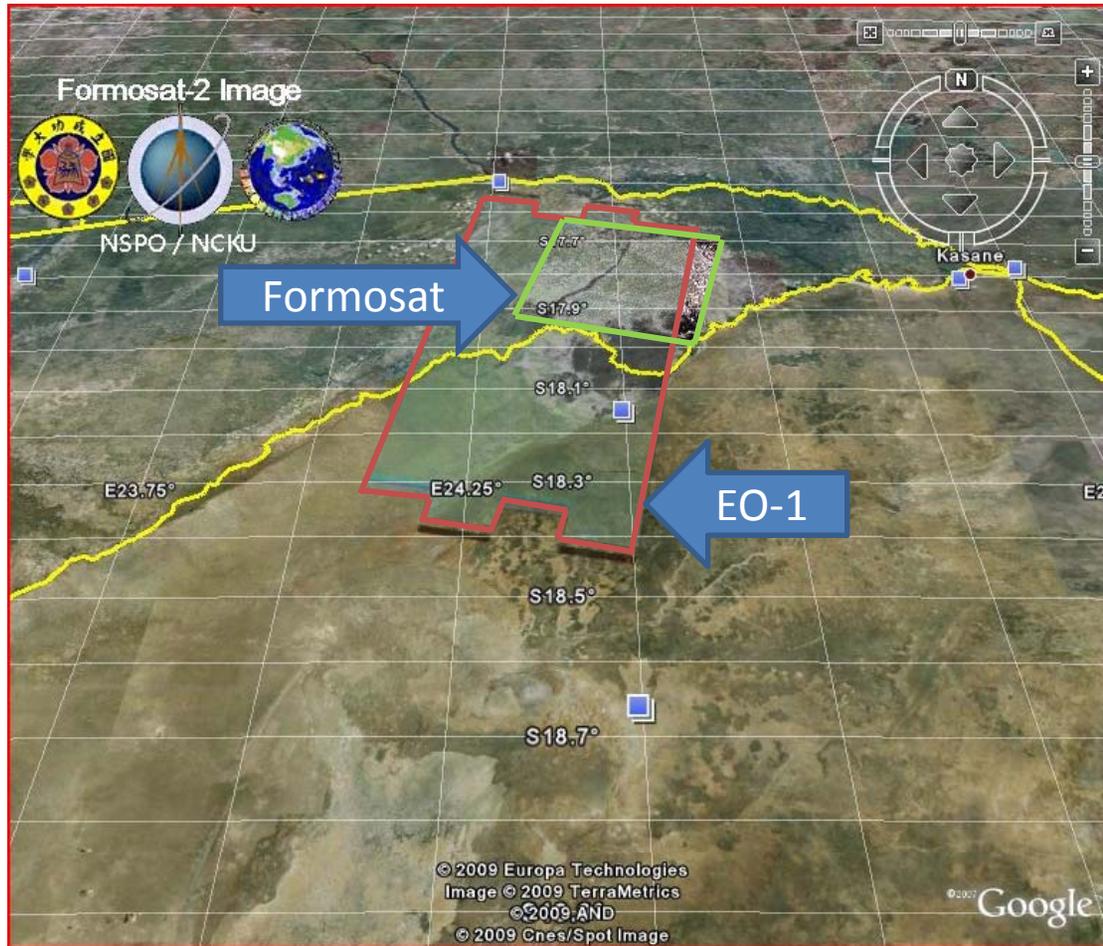


Landsat Image Oct 18, 2002



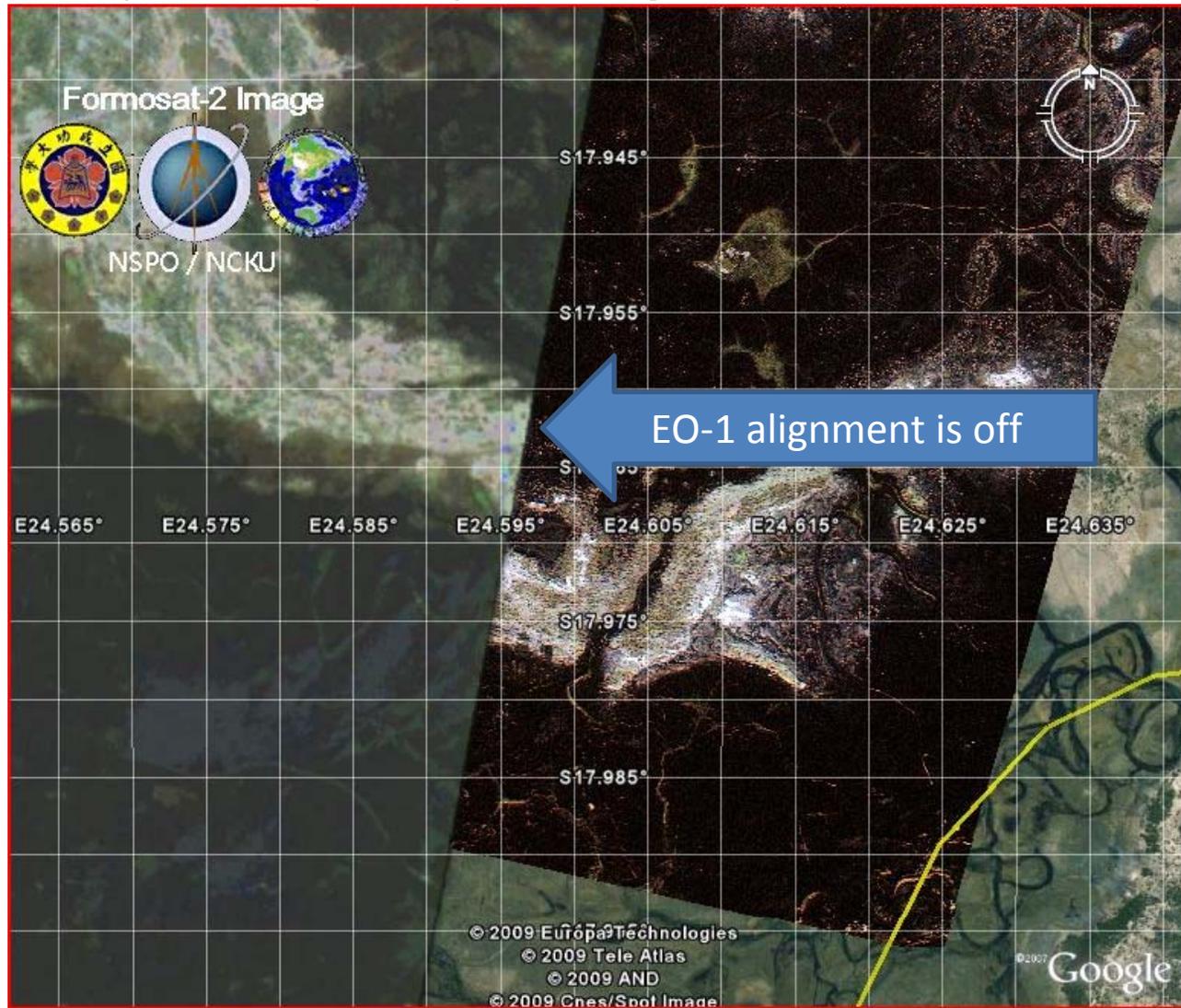
EO-1 Image March 27, 2009

Lake Liambezi: EO-1 ALI Image 4-9-09 (30 m resolution) Overlaid on Formosat Image 4-5-09 (2 m resolution) on Google Earth
Both images Geo-tiled

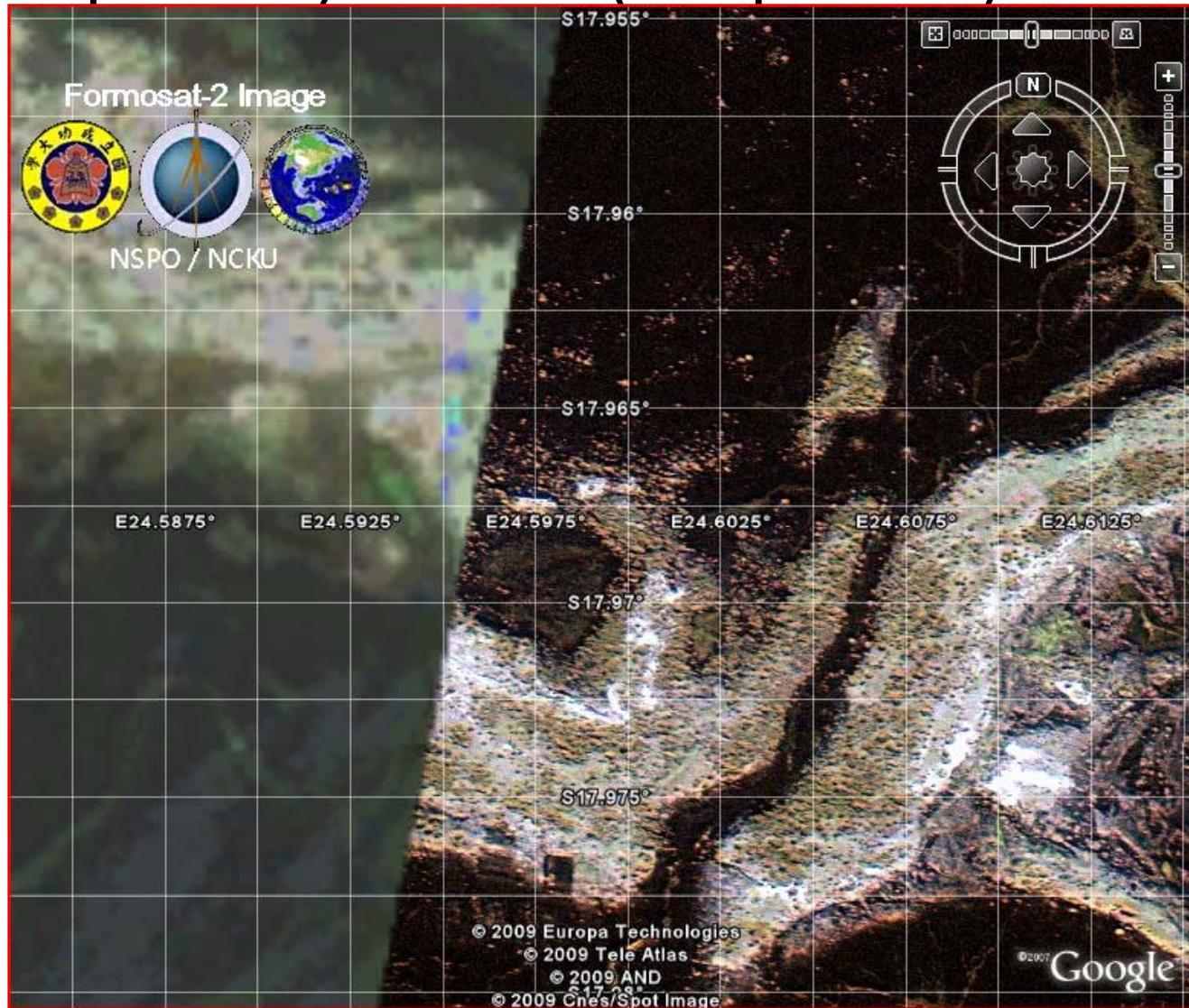


Zoom 1 – Note Misalignment Problem

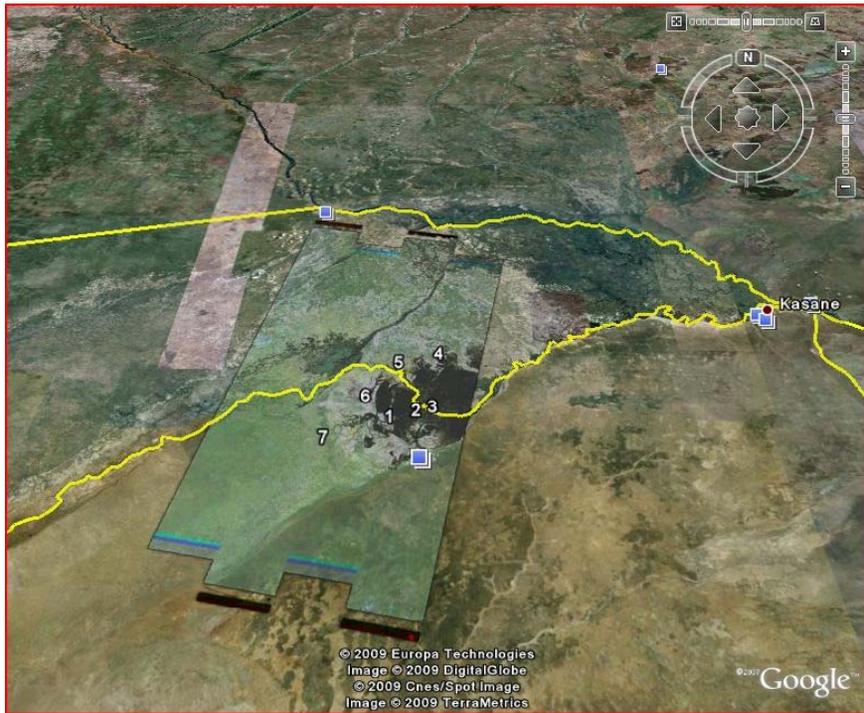
Example of Capability Needing Fix to Get to TRL 7



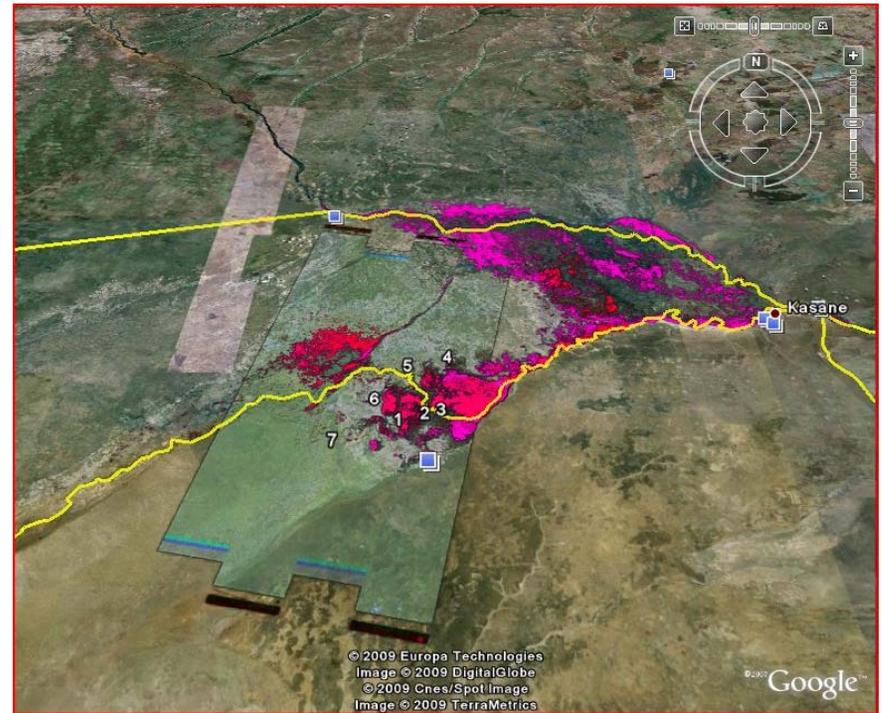
Zoom – Note increased detail of Formosat(right portion) vs EO-1 (left portion)



EO-1 & Radarsat 2 Flood Image



EO-1 Image 5-11-09 on Google Earth



EO-1 Image 5-11-09 overlaid with Radarsat 2 data from 3/25/09, 5/20/09, 5/22/09 and 5/29/09 on Google Earth

SERVIR Experimental/Standard Flood Products Page – Policelli/GSFC (password protected)

File Edit View History Bookmarks Tools Help

http://aspires.gsfc.nasa.gov/SERVIR_Africa/test.html

Freeecorder Record Stop Pause Play Settings Amazing MP3 Song Recorder

Directory
Collaborators
Site Map
Reference Material
SERVIR Internal
Contact Us

NASA
USAID
CATALANAC

NATURAL HAZARDS
[Earthquakes](#)
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[Fires](#)

Low Level Flood Potential
(150mm-250mm)

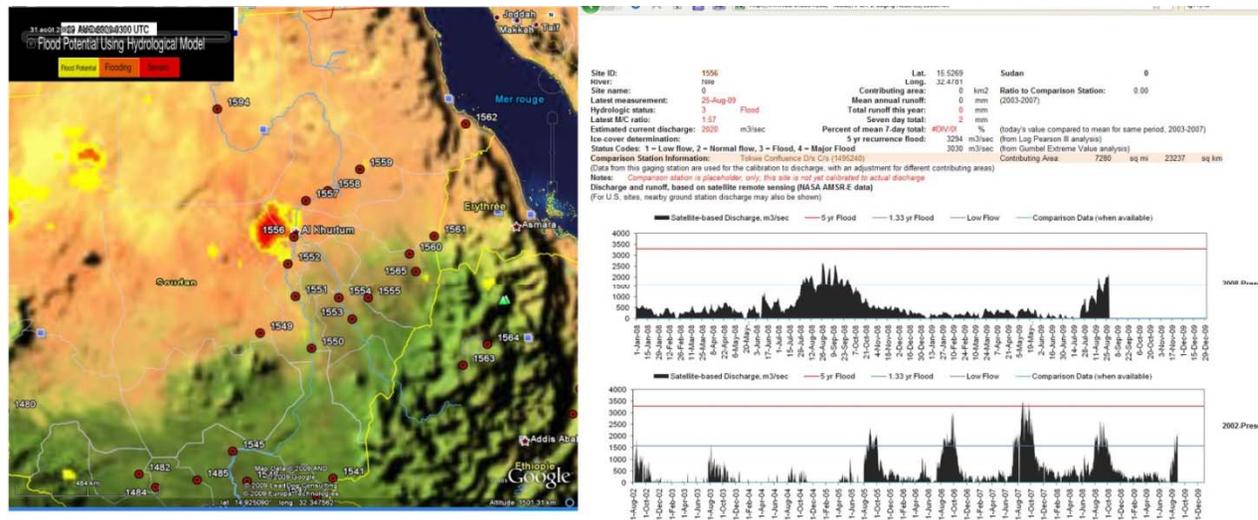
Moderate Flood Potential
(250mm-1250mm)

Severe Flood Potential
(1250mm+)

Imagery ©2009 TerraMetrics, NASA - Terms of Use

Clouds/Rain Meteosat Clouds Rain Accumulation Forecast Precip	Current Flood Potential Flood Potential 7Day Animation Severe Flood Report River Discharge	Forecast Flood Potential Flood Forecast 5Day Animation Severe Flood Report	Field Reports/Flood Maps Field Reports Quick Look Flood Maps
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Red Cross Used Flood Potential Model and Relevant Info to Launch Appeal



From: Frederic Zanetta [mailto:Frederic.Zanetta@ifrc.org]
Sent: Monday, August 31, 2009 11:05 AM
To: Policelli, Frederick S. (GSFC-6104)
Subject: Use of NASA product

Hi Fritz,

How are you ?

I just want to let you know that we have been using today the TRMM product (see attached) to confirm information from the field about floods near Kartoum and we will probably be launching an Emergency Appeal.

Have a nice day

Frederic

Frédéric Zanetta

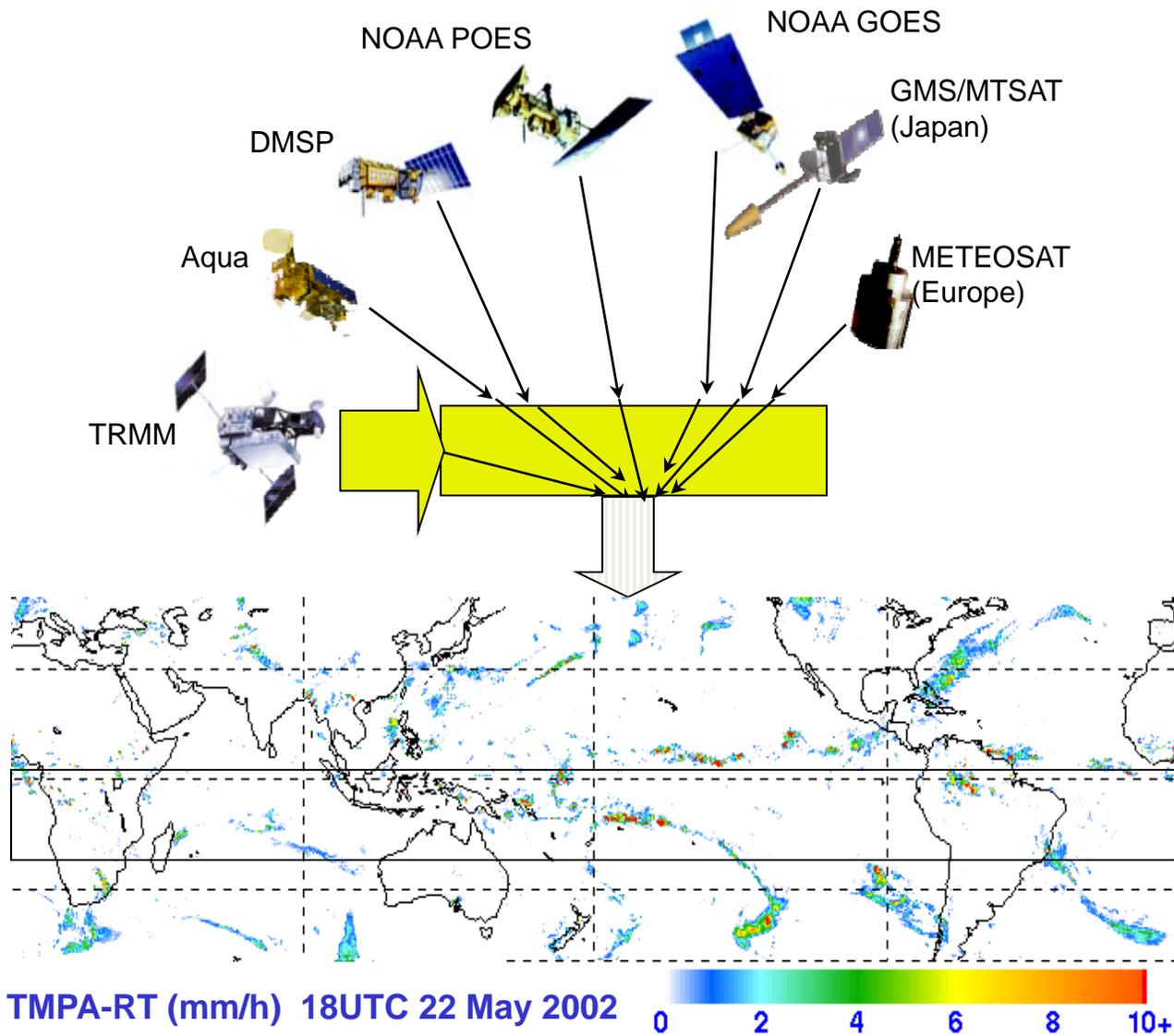
Operations Support Department
Disaster information senior officer

Chemin des Crêts 17 | Petit-Saconnex | P.O. Box 372 | 1211 Geneva 19 | Switzerland

Phone: +41 22 730 4291 | Fax: +41 22 730 4480

E-mail: frederic.zanetta@ifrc.org | Skype: fzanetta

Near Real Time Rainfall Measurements



1. TRMM used to calibrated all other satellites
2. 25-km grid precipitation, every 3 hours, 1998-present;
3. <http://trmm.gsfc.nasa.gov>

From: Hong, Adler