

# CEOS Disaster Risk Management Flood Pilot Status and Plans

Presented at the CEOS Disasters Working Group Meeting  
#5 in Bonn, Germany

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8-10 March 2016



# Outline

- **Flood Pilot overview**
- **Status of data acquisition and exploitation**
- **Pilot status report:**
  - **Objective A: Global component status**
  - **Objective B: Regional component status**
    - **Caribbean/Central America**
    - **Southern Africa**
    - **Southeast Asia**
    - *Special event: Mississippi River (US)*
  - **Objective C: Capacity Building**
- **Issues and Risk Management**

# CEOS DRM Flood Pilot Overview

- **Goal:** demonstrate effective application of EO to the full cycle of flood management at all scales by:
  - **Objective A:** Integrating information from existing NRT global flood monitoring / modeling systems into a Global Flood Dashboard;
  - **Objective B:** Delivering EO-based flood mitigation, warning, and response products and services through regional end-to-end pilots in:
    - Caribbean/Central America (focus on Haiti)
    - Southern Africa (inc. Namibia, South Africa, Zambia, Zimbabwe, Mozambique, and Malawi);
    - Southeast Asia (focus on lower Mekong Basin and Java)
  - **Objective C:** Encouraging at least base-level in-country capacity to access EO and integrate it into their operational systems and flood management practices

# Data Acquisition Status

- Detailed EO Requirements for each Pilot approved at 2013 Plenary; acquisition allocations approved at 2014 Plenary
- Individual requests from each Pilot coordinated by co-leads and detailed on consolidated request form

Mission / Instrument	Repeat or Revisit	Swath	Resolution	Agency	Image Counts		
					Annual Quota	Since 9/2015 WGDisasters meeting	Total for 2015 + Jan-Feb 2016
<b>Optical - Coarse Resolution (&gt;100 m)</b>							
Terra / MODIS	1 day	2230 km	250, 500, 1000 m	NASA			
Aqua / MODIS	1 day	2230 km	250, 500, 1000 m	NASA			
NPP / VIIRS	1 day	3000 km	375, 750 m	NASA			
<b>Optical - Moderate Resolution (10 to 100 m)</b>							
Sentinel-2A / MSI	10 days	290 km	10, 20 m	ESA	?	N/A	N/A
EO-1 / ALI	204 days	185 km	10, 30 m	NASA	300	28	70
Landsat-8 / OLI	16 days	183 km	15, 30 m	USGS	730	28	70
Terra / ASTER	16 days	60 km	15, 30, 90 m	NASA			
<b>Optical - High Resolution (&lt;10 m)</b>							
SPOT (archive only)	26 days	60 km	1.5 and 6 m	CNES		0	0
Pleiades	26 days	20 km	50 cm and 2 m	CNES	50	0	0
<b>C-Band SAR</b>							
Sentinel-1A / SAR	12 days	80, 250, 400 km	9, 20, 50 m	ESA		15	47
Radarsat-2 / SAR-C	1-6 days	8-500 km	0.8 to 100 m	CSA	500 (3 yr)	116	117
ALOS-2 / PALSAR-2	14 days	25 to 490 km	10 to 100 m	JAXA	100	40	40
<b>X-Band SAR</b>							
Cosmo Sky-Med / SAR-2000	5 days	10-200 km	1 to 100 m	ASI	300	103*	103*

\* 50 of the CSK images were archive images that counted toward the 2014 quota

# Data Acquisition Status

- The International Disaster Charter has granted the CEOS Flood Pilot team access to Charter data:
  - Future events: requests must be submitted within 14 days of the activation notice (i.e., the beginning of the period)
  - Past events: permission has also been granted for five 2015 events: Malawi (Jan); Vietnam (July); Myanmar (August), and India (December); and one in 2016 (Mississippi River in January)
- To date, the Flood Pilot has been able to obtain images from
  - ALOS-2 (JAXA)
  - RISAT-1, ResourceSat-1,2, and Cartosat 1-2 (ISRO)
  - KOMPSAT-2 (KARI)
  - Kanopus-V 1 and Resurs-P (ROSCOSMOS)
  - UK-DMC2 (DMC International Imaging)
- This is a significant step forward and the CEOS DRM Flood Pilot team wishes to thank the International Disaster Charter for their cooperation and Brenda Jones for all her help!

# How Data Are Being Exploited

Geographic Area	Product	Value Added Partner
Haiti	Flood extent maps, flood risk maps, landslide maps, flash flood guidance / threat maps, integrated risk assessment platform	SERTIT, CIMA, INGV, Altamira, CIMH, RASOR FP7, NOAA/HRC
Other Caribbean islands, Central America	Flood damage maps, change detection products, co-registered map overlays	CATHALAC, CIMH, NASA/GSFC
Namibia	Flood extent maps, flood warning products, co-registered map overlays	Namibia Hydrology Dept, Namibian Water Authority, NASA
Zambezi basin	Flood extent maps, flood forecast models, flood hazard maps, flood depth forecasts	Lippmann Institute (PAPARAZZI, HAZARD, WATCHFUL), DELTARES, RSS
Mekong	Flood extent maps, flood risk maps, flash flood guidance / threat maps	Mekong River Commission, NASA, NOAA/HRC, USGS, University of South Carolina, Texas A&M
Java (Bandung, Jakarta, Cilacap)	Flood risk maps, subsidence maps tied to flood risk, tsunami risk maps (Cilacap only), flood extent maps	SERTIT, Deltares, CIMA, Altamira, INGV, RASOR FP7

**Products used by: national end users, civil protection agencies, World Bank, Red Cross, World Food Program, River Commissions (Kavango, Zambezi, Mekong) 6**

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# Objective A: Global Component Status

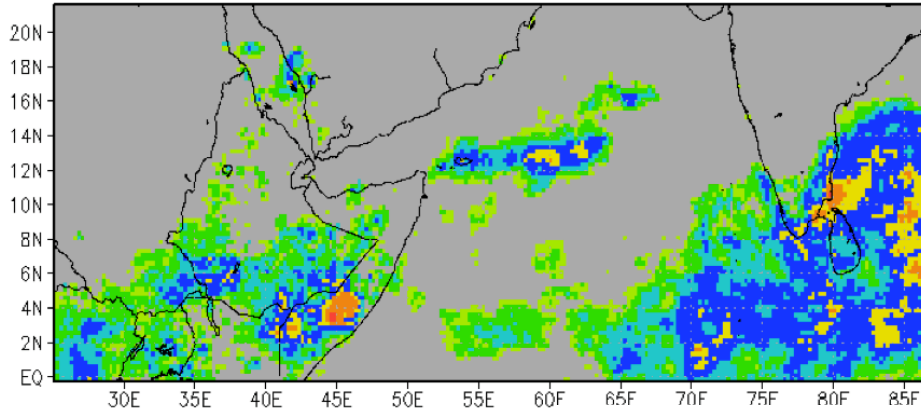
- 2014 Milestone: initial pilot Global Flood Dashboard website with linkages to major global projects and systems and archive flood products
- 2015 Milestone: functional linkages between the Global Flood Dashboard and the three regional flood component areas; indication of regions of interest based on reports of flooding; showcase at WCDRR
- 2016 Milestone: draft a plan for longer-term sustainability; provide functional linkages to additional user-selected polygons of interest beyond the three regional Pilot areas.
- Status: **75% complete**—decided to initially host the site on the Matsu cloud using a copy of the Southern Africa Flood Dashboard as a platform, retrieving data anywhere requested by the user. Completion expected by mid-March 2016. Will share requirements and prototype implementations with ESA afterward.



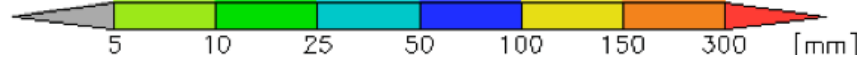
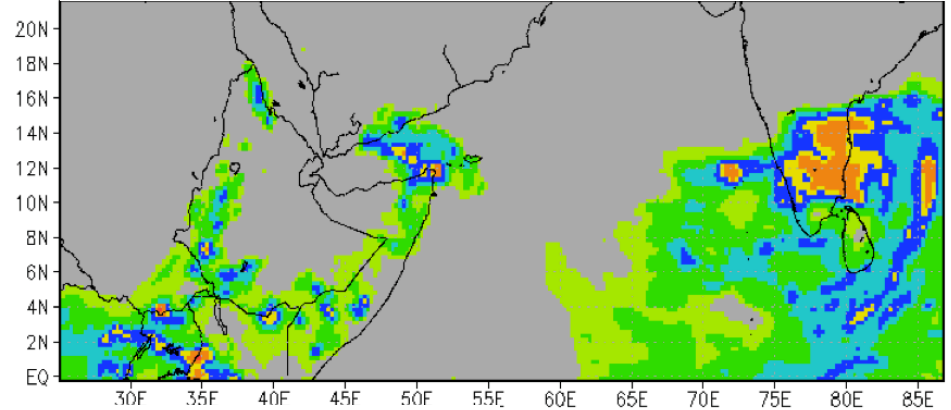
# Global Component Highlight: Somalia Floods

(used by UN Office for the Coordination of Humanitarian Affairs)

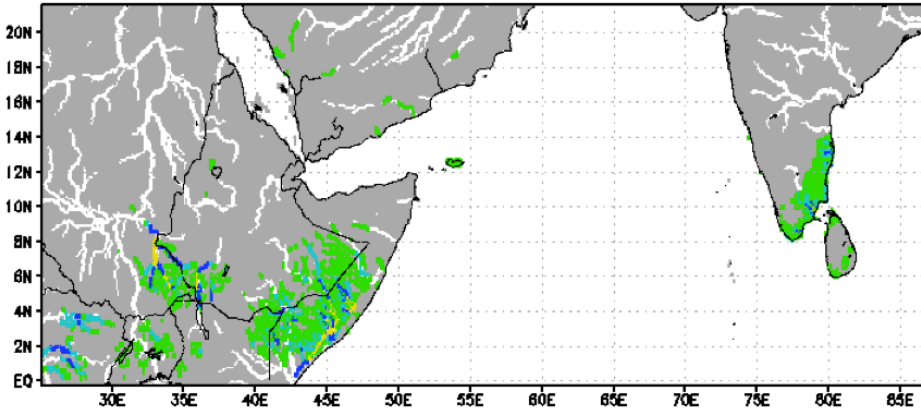
## OBSERVED rainfall 6-8 November



## FORECAST rainfall 9-11 November



## Streamflow above threshold 8 November



## FORECAST Streamflow above threshold 11 November

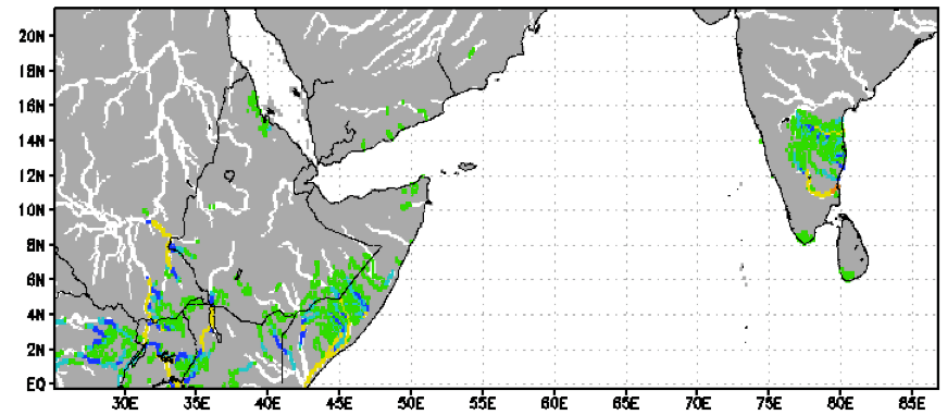


Figure courtesy B. Adler / H. Wu, U. of Maryland

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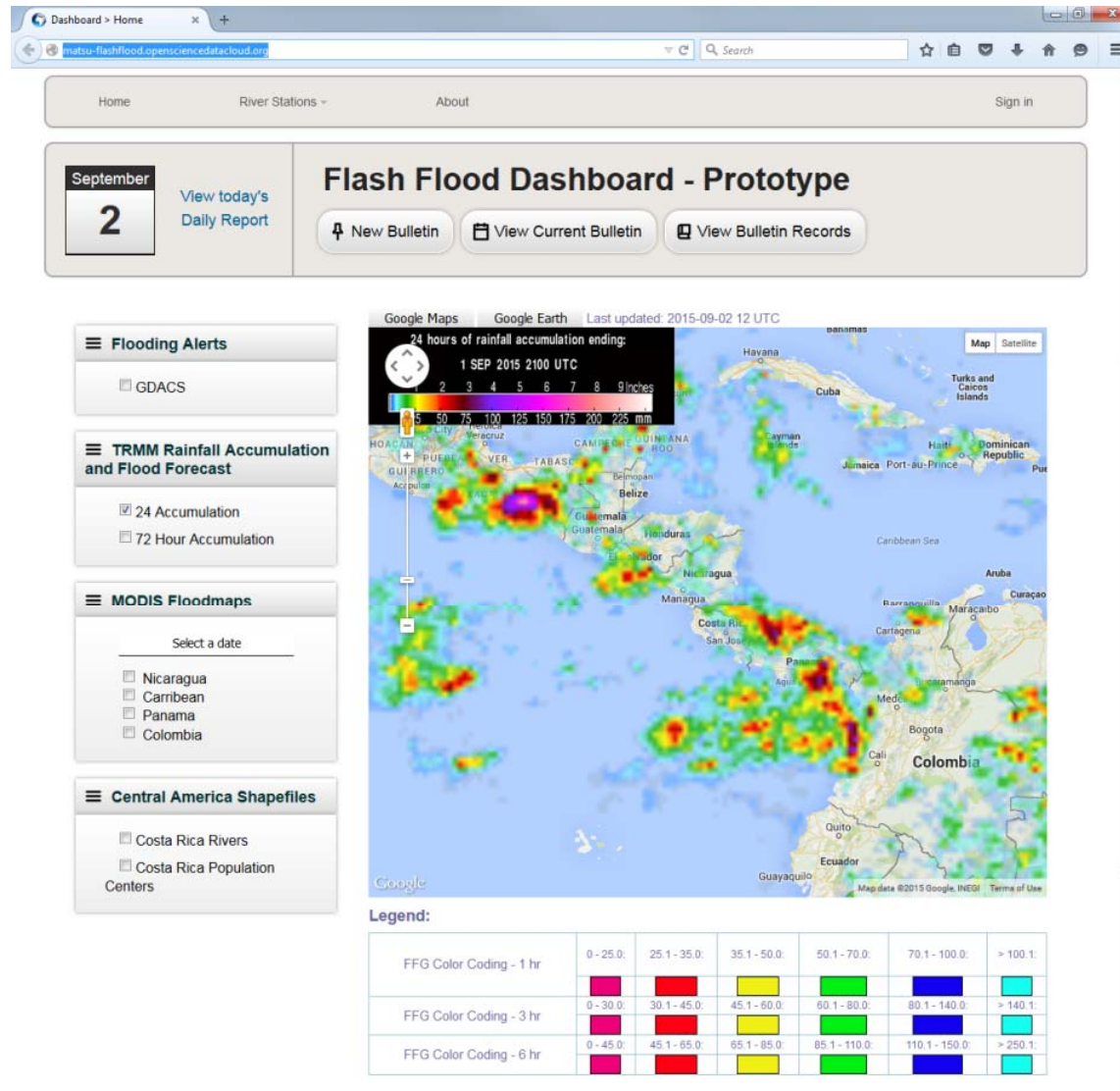
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# Objective B: Caribbean/Central American Component Status (1/6)

- 2014 Milestones:
  - Flood dashboard based on Namibia pilot adapted to Caribbean and Central American users
    - Status: Prototype Flood Dashboard completed: <http://matsu-flashflood.opensciencedatacloud.org/>
  - Flood monitoring (i.e., targeted EO data acquisitions)
    - Status: Targeted EO acquisitions in 2014 for Guatemala, Panama, Trinidad, Haiti, and Belize
  - Contributions of data to KAL Haiti data base
    - Status: Completed

# Objective B: Caribbean/Central American Component Status (2/6)

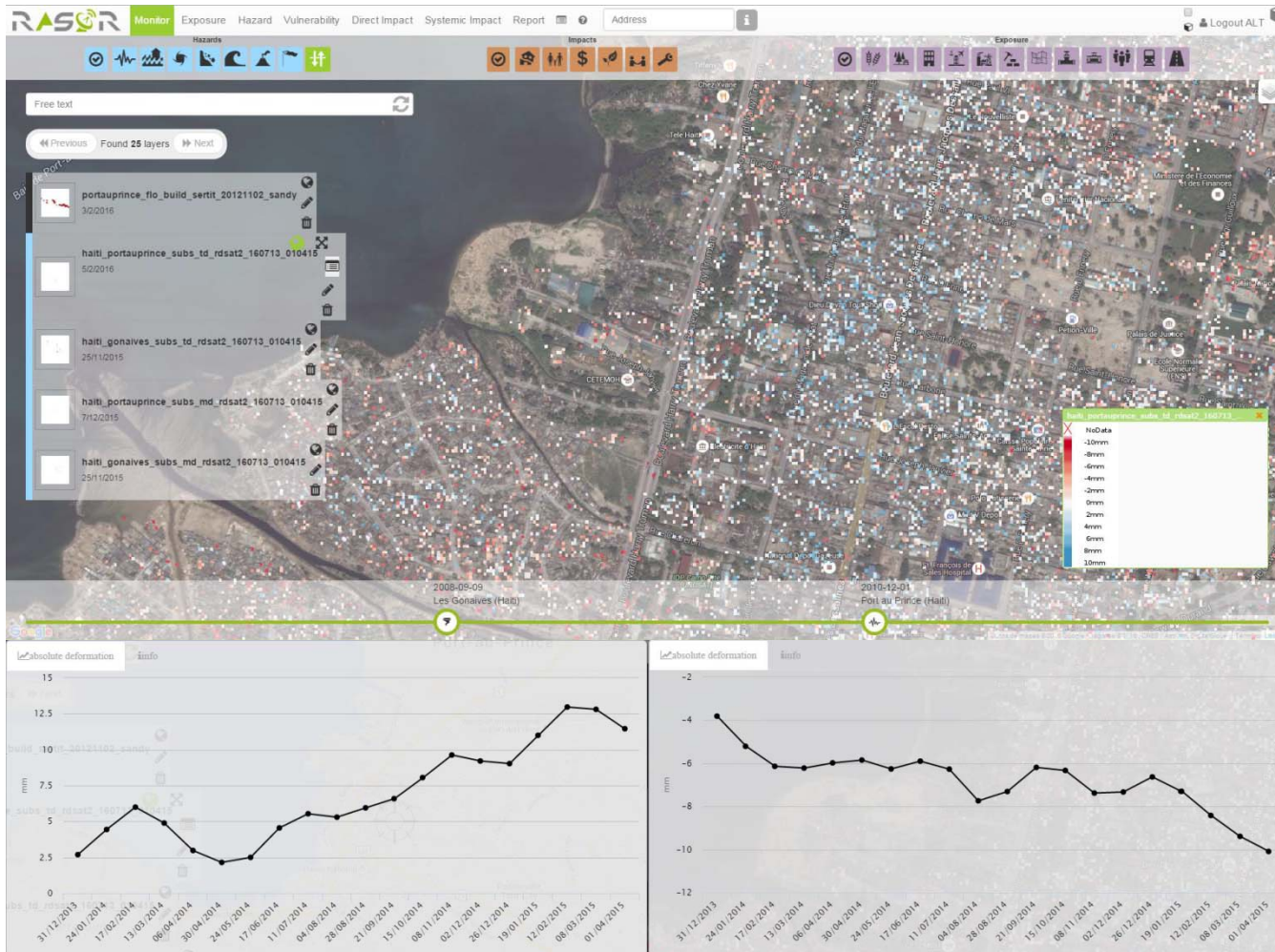
<http://matsu-flashflood.opensciencedatacloud.org/>



# Objective B: Caribbean/Central American Component Status (3/6)

- 2015 Milestones:
  - Flood monitoring during 2015 season
    - Status:
      - Panama (June); EO-1 / MODIS / Landsat flood maps for CATHLAC
      - Dominica (August—TS Erika): COSMO-Sky-Med, Radarsat-2, and EO-1 data
      - Bahamas (October—H Joaquin); EO-1 images, GPM rainfall, GFMS flood predictions, flood maps from multiple sensors
  - RASOR risk management platform operational for flood risk and landslide risk analysis in Haiti
    - Status: Subsidence analysis for 2014 has been performed using RADARSAT-2 imagery (see next slide)
  - 10-year flood archive based on Deltares Flood Monitoring Programme
    - Status: Deltares has ceased collaboration with this Pilot region as per Hessen Winsemius.

# Objective B: Caribbean/Central American Component Highlight



Map of Port-au-Prince with elevation changes determined by RASOR team (red=decrease; blue=increase) based on ~1 year of RADARSAT-2 images. This can in turn be related to changes in flood risk. (Credit: F. Kuodogbo, Altamira)



# Objective B: Caribbean/Central American Component Status (4/6)

- 2016 Milestones:
  - Flood monitoring during 2016 season
  - Draft a plan for longer-term sustainability
- Overall Status: **50%** complete.

# Objective B: Caribbean/Central American Component Status (5/6)

- Other Planned Activities
  - Collection of background Radarsat-2 pre-event imagery at known look angles and modes for the entire region (CSA-Giguere)
    - Status: 5 complete sets of background images collected over all of Central America and the Caribbean
    - Attempts to use these images for the October 2015 Guatemala landslide with varying degrees of success
  - Damage assessment studies to analyze satellite-derived inputs as compared to ground-based manual techniques (CIMH-Farrell)
    - Status: Case studies performed in Saint Vincent and the Grenadines using Radarsat and EO-1, and in Dominica using Radarsat and COSMO-SkyMed. Collaboration with MDA Corporation to highlight regions of change that were then compared to ground surveys. Lack of pre-event COSMO - SkyMed data made comparisons over Dominica more difficult. CIMH has limited (skill) capacity to process the SAR data but are working to improve their knowledge base.



# Objective B: Caribbean/Central American Component Status (6/6)

- Other Planned Activities (cont.)
  - Open GeoSocial API for publishing / visualizing flood modeling and monitoring products installed Feb 2016 as part of the disasters component of the Climatic Information Platform for Central America and the Dominican Republic under the Regional Climate Change Program (RCCP) funded by USAID. The software suite is being hosted by DAI in Costa Rica under a grant from SICA/CEPRENAC. Training workshop planned in March / early April in Costa Rica.

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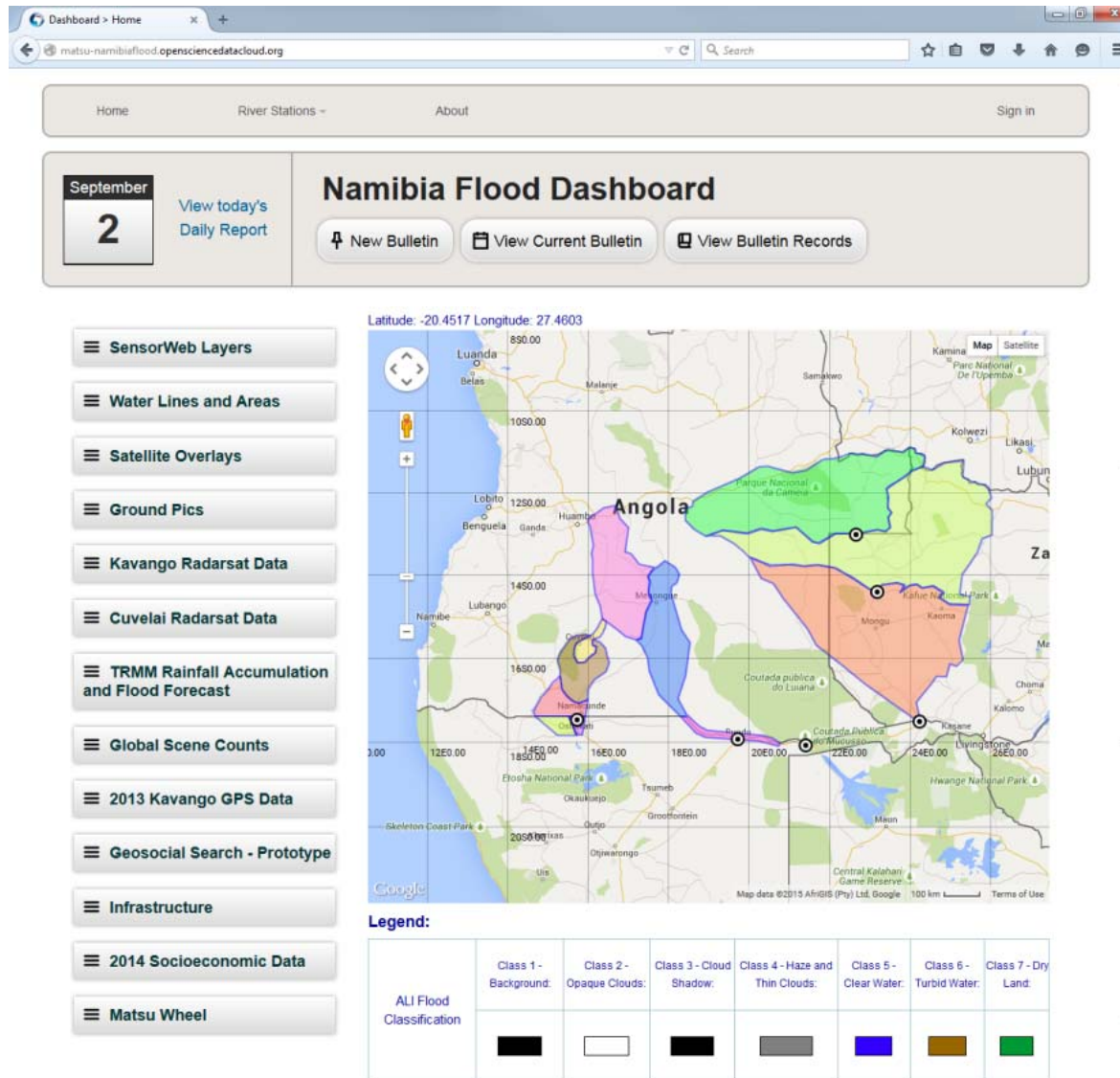
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## Objective B: S. Africa Component Status (1/5)

- 2014 Milestones:
  - Flood monitoring during early 2014
    - Status: Acquisitions from NASA and CSA under previous agreement within GEO task
  - Updates to flood dashboard
    - Status: Upgraded Flood Dashboard completed: <http://matsunamibiaflood.opensciencedatacloud.org/>
- 2015 Milestones:
  - Flood monitoring during early 2015
    - Status: Radarsat-2 images provided for Namibia during flooding on 24 Feb; three Archive Radarsat-2 images of Malawi (early January—ordered in March) provided to LIST for Flood Hazard Mapping that were Disaster Charter acquisitions
  - 10-year flood archive over region based on Deltares Flood Monitoring Programme
    - Status: DELTARES ceased collaboration with this Pilot region.
- Status: **75%** complete.

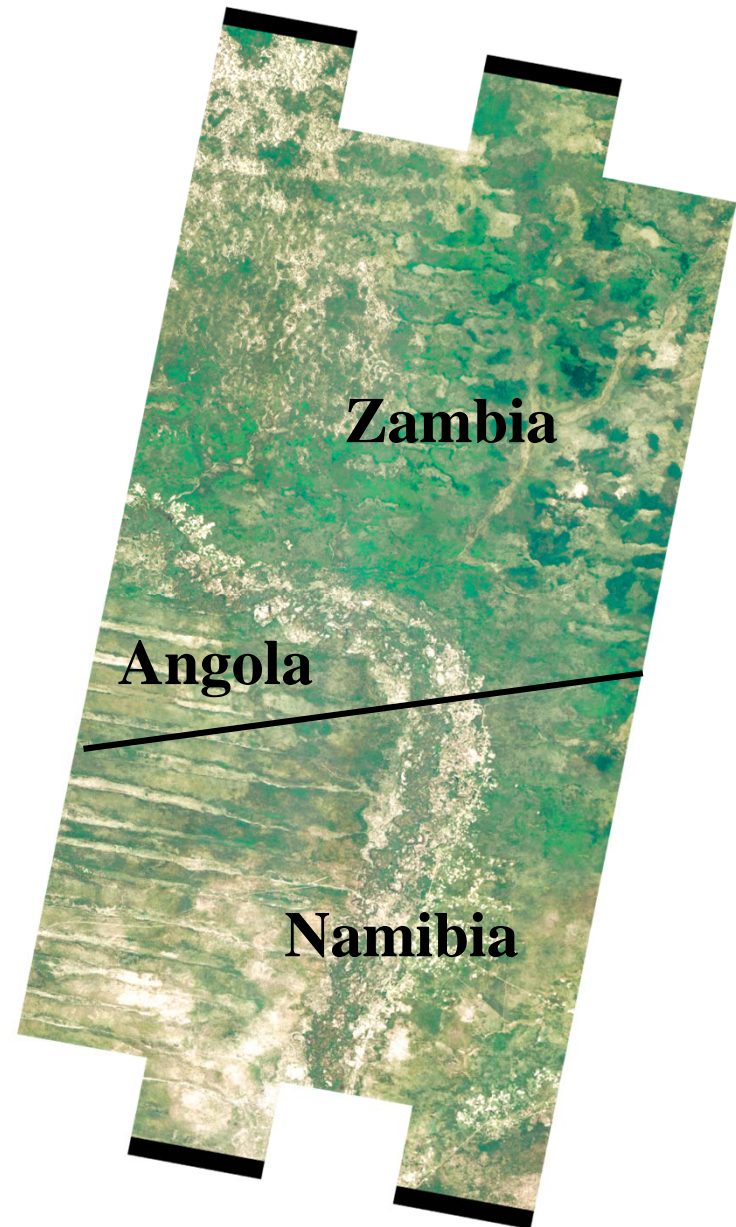
# Objective B: S Africa Component Status (2/5)

<http://matsu-namibiaflood.opensciencedatacloud.org/>



# Objective B: S. Africa Component Status (3/5)

- 2016 Milestones:
  - Flood monitoring during 2016 season
    - Not strictly flood monitoring, but provided EO-1 and Radarsat-2 images to the Namibia Ministry of Agriculture, Water, and Forestry to identify possible diversion of water from the Kwando River in Namibia (not confirmed by available imagery at this point)
  - Draft a plan for longer-term sustainability
- Status: **75%** complete.

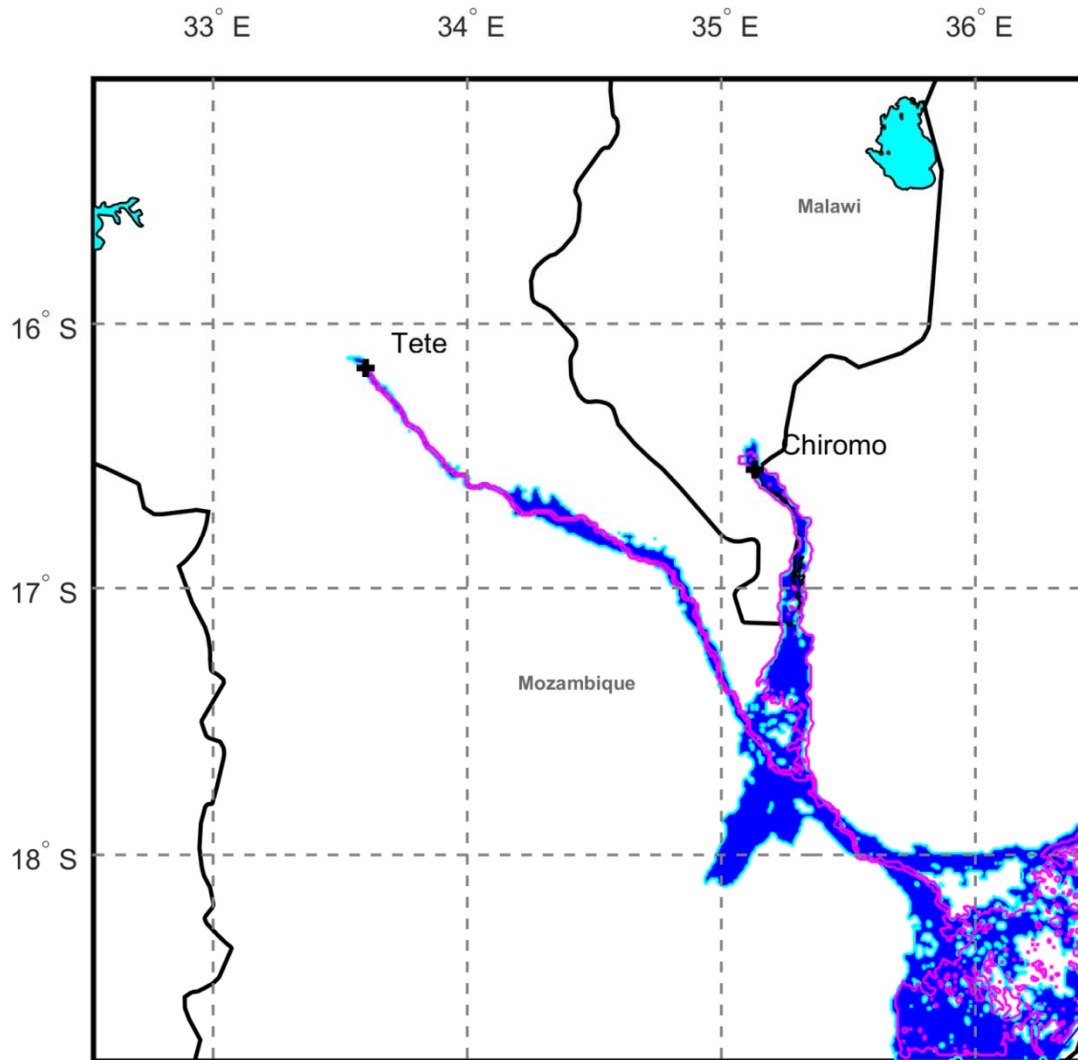


# Objective B: S Africa Component Status (4/5)

- Other Planned Activities

- Improvements to flood model by computing river width and deriving more realistic and complete stream networks derived from Landsat-8 (RSS-Schumann)
  - Status: In progress; results on next slide show that differences in flood extent can be large (flood depth differences still need to be assessed).
- Using a flood modeling study of the Lower Zambezi to define areas for high-resolution LiDAR acquisitions over the floodplains to construct higher-resolution DEMs for flood modeling / forecasting (RSS-Schumann; results in slide after next slide)
  - Status: LiDAR image acquisition is targeted for funding by the World Bank this year
- Implementation of regional CREST flood model in Namibia, Kenya, and South Africa (U of Oklahoma-Hong/Flaming)
  - Status: Proposal for Step-2 SERVIR ROSES call in preparation to enhance flood image processing and flood / landslide monitoring at ADPC in Bangkok (SERVIR hub). ADPC will be listed as self-funded Co-Is.

# Southern Africa Component Highlight



Difference in flooded area using a 2-D flood model LISFLOOD-FP, conditioned on the gauged flow of the 2007 event.

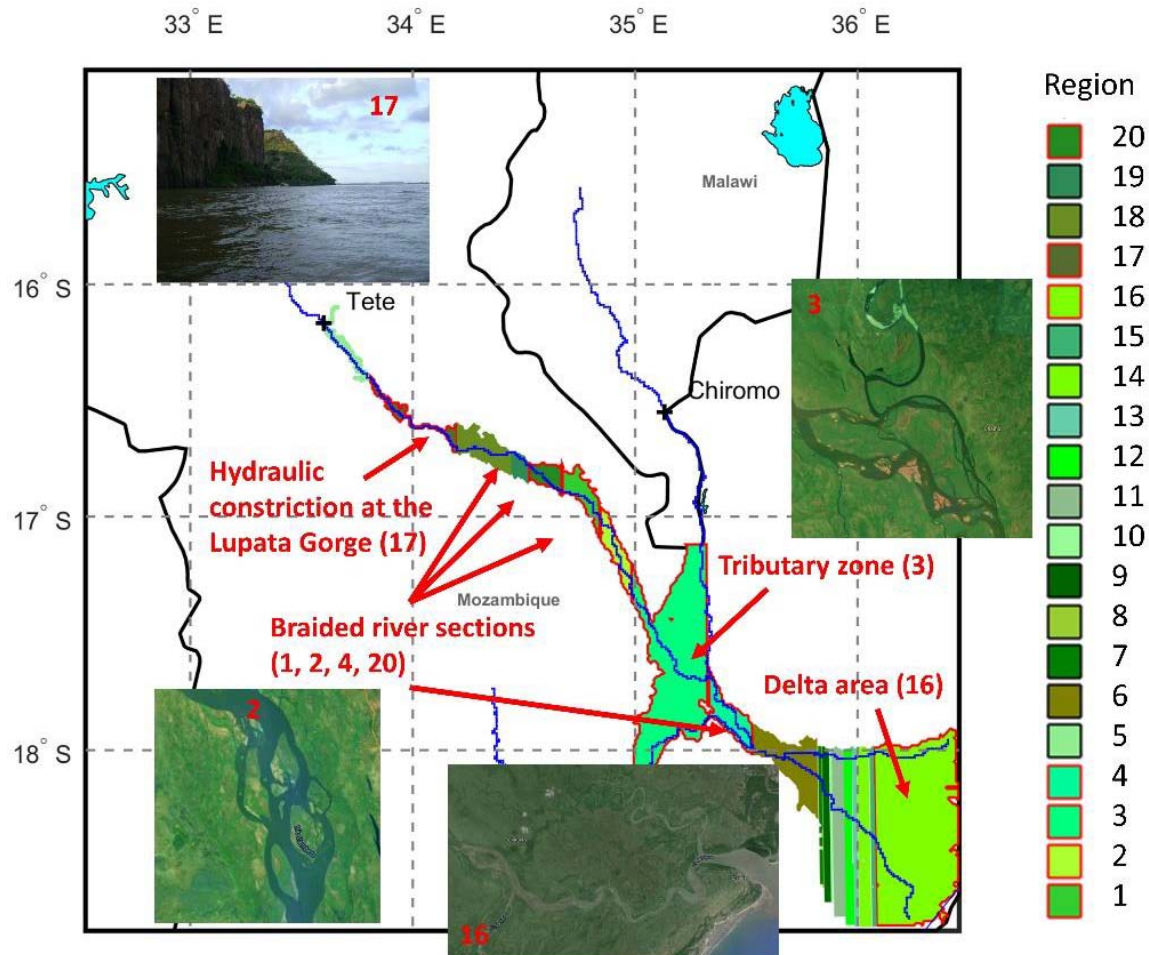
**Pink outline:** Simulation based on HydroSHEDS stream network & river widths.

**Blue area:** Simulation based on Landsat-derived stream networks & river widths.

Especially in the delta region, differences in flood extent are significant and more realistic using the Landsat river dimensions. Flood depths are also very different but these still need to be assessed.  
(Credit: G. Schumann)



# Southern Africa Component Highlight



Map of individual sub-reaches and their floodplains (colors are random). Sub-reaches of hydraulic complexity are depicted with a red outline and annotated. Note that the flooded area shown for each sub-reach is based on a 1:10,000 year flow return flood simulation. Photos are taken from Google Earth. (Credit: G. Schumann)



# Objective B: S Africa Component Status (5/5)

- Other Planned Activities
  - Framework for evaluating flood model forecasts in the Zambezi basin using satellite-derived flood extent maps (LIST-Matgen)
    - Status: In progress; results can also be used to evaluate and modify model calibration parameters and thus improve accuracy

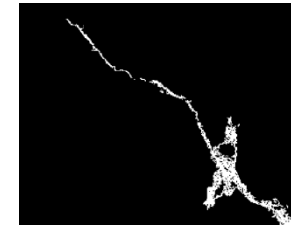
# Southern Africa Component Highlight

Improving flood model predictions using collections of SAR-derived flood extent maps

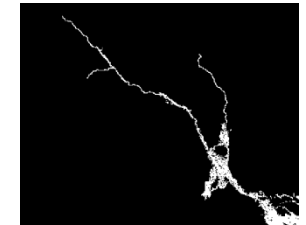
## Objectives:

- ❑ New methodology using a repository of **satellite flood images** to make improvements to the estimation of hydraulic model parameters.
- ❑ Correct parameterisation ensures a more robust model that can make better predictions of flooding.
- ❑ Regular calibration is essential to the future performance of these flood models.

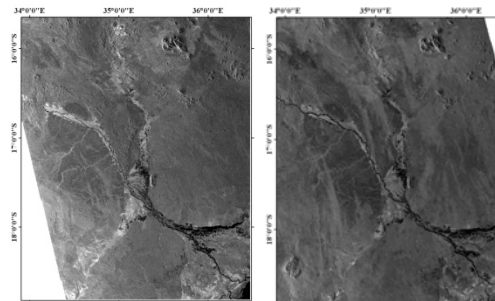
The methodology compares many model simulations of the Zambezi and Shire rivers in flood ...



LISFLOOD February 5 2008



LISFLOOD February 8 2008



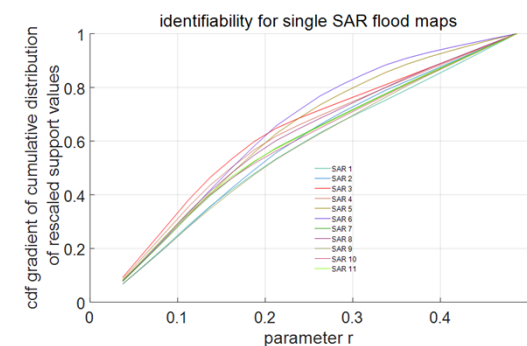
ENVISAT February 5 2008

ENVISAT February 8 2008



... against the SAR satellite observations & makes a judgement which model is best at reproducing the observations

If there are multiple satellite data available, the methodology uses 'identifiability' to find the satellite images with the best information for calibration



(Credit: P. Matzgen)

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## Objective B: SE Asia Component Status (1/5)

- 2014 Milestones:
  - User consultations on new pilot products
    - Status: Flood forecasting and event mapping software installed at ICOMOD in 2015. Currently working out the details on defining and installing software at ADPC for a combination of Flood Pilot products and theirs.
  - Test TRMM/GPM-based Global Flood Modeling System (GFMS) 1km resolution flood modeling product over the Lower Mekong Basin (contingent on river gauge data being obtained)
    - Status: On hold—unable to obtain gauge data for this application
  - Flood Dashboard development based on Namibia pilot example adapted to SE Asia users;
    - Status: Completed <http://matsu-seasia.opensciencedatacloud.org/>

# Objective B: SE Asia Component Status (2/5)

- 2015 Milestones:
  - Operational test bed for RASOR risk management system for test sites in Java
    - Status: Phase 2 proposal being prepared by RASOR team to fund extensions of 2007-11 / 2013-15 risk mapping work
  - Integration of flood dashboard
    - Status: Funding to automate updates to <http://matsu-seasia.opensciencedatacloud.org/> ceased so not all data being served are current; if SERVIR Step-2 proposal is awarded, data will be served through OpenGeoSocial API, including ADPC's own products.
  - Initial services for Mekong River Commission
    - Status: ADPC to host Open GeoSocial API Flood Monitoring software suite; full proposal for Step-2 SERVIR grant funding is being developed

## Objective B: SE Asia Component Status (3/5)

- 2015 Milestones (cont.):
  - 10-year flood archive over region based on Deltares Flood Monitoring Programme
    - Status: DELTARES has recently re-engaged with the Pilot to produce products with Charter data and in collaborating with the ADPC flood record (access via OpenSocial API pending SERVIR grant funding).
  - 1<sup>st</sup> new TRMM/GPM and other flood monitoring products
    - Status: iMERG products now served under Open GeoSocial API
    - GFMS flood products being served from another API instance (<http://ojo-streamer.herokuapp.com/>)
- 2016 Milestones:
  - Flood monitoring during 2016 season
  - Draft a plan for longer-term sustainability
- Status: **80%** complete.

# Objective B: SE Asia Component Status (4/5)

<http://matsu-seasia.opensciencedatacloud.org/>

The screenshot shows a web browser displaying the 'Southeast Asia Flood Dashboard'. The browser's address bar shows the URL 'matsu-seasia.opensciencedatacloud.org'. The page has a navigation bar with 'Home', 'River Stations', 'About', and 'Sign in'. Below this, a date selector shows 'September 2' with a 'View today's Daily Report' link. The main heading is 'Southeast Asia Flood Dashboard' with three buttons: 'New Bulletin', 'View Current Bulletin', and 'View Bulletin Records'. A red notice states 'NOTE: THIS SITE IS UNDER CONSTRUCTION!!!'. On the left, there are several menu sections: 'Infrastructure' (Mekong Dams, River Gauges), 'TRMM Rainfall Accumulation and Flood Forecast' (Flood Potential, 24 Hour GFS Forecast Accumulation, 48 Hour GFS Forecast Accumulation, 3 Hour Accumulation, 24 Hour Accumulation, 72 Hour Accumulation), 'MODIS Floodmaps' (Lower Mekong Basin, South Myanmar, Peninsular Malaysia, East Malaysia, Sumatra, Borneo and Java), 'Geosocial Search - Prototype', 'Flood Impact (Mekong)', and 'Hydro-Estimator'. The main content area features a map of Southeast Asia with a coordinate display (Latitude: 21.4778 Longitude: 103.9911) and a Google map logo. The map shows Myanmar, Laos, Thailand, Vietnam, and Cambodia with various geographical features and labels.



# Objective B: SE Asia Component Status (5/5)

- Other Planned Activities

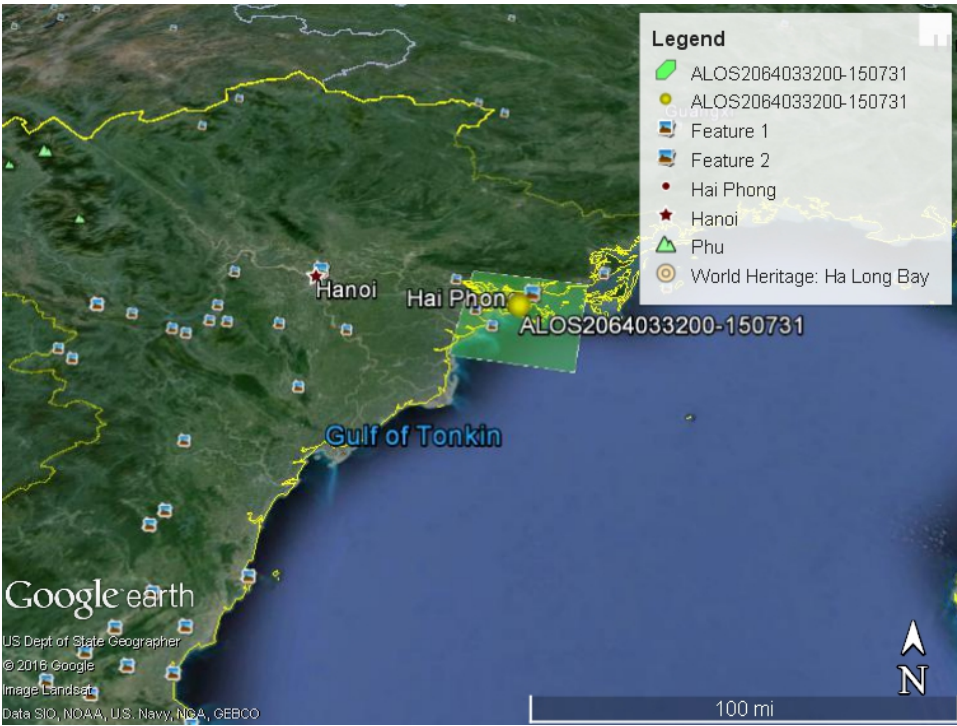
- Indonesia and Java risk assessments and subsidence calculations (Deltares-Villars)

- Status: DELTARES has recently re-engaged with the Pilot and are part of the RASOR team working in Indonesia / Java.

- Other Activities:

- Interaction with the World Bank in December 2015 as part of the RO meeting revealed types of flood products that would be useful to their needs assessments and ongoing recovery support.

# Objective B: SE Asia Component Highlight



**HV-polarized ALOS-2 Charter image from Vietnam flooding, 0445 UTC 31 July 2015**

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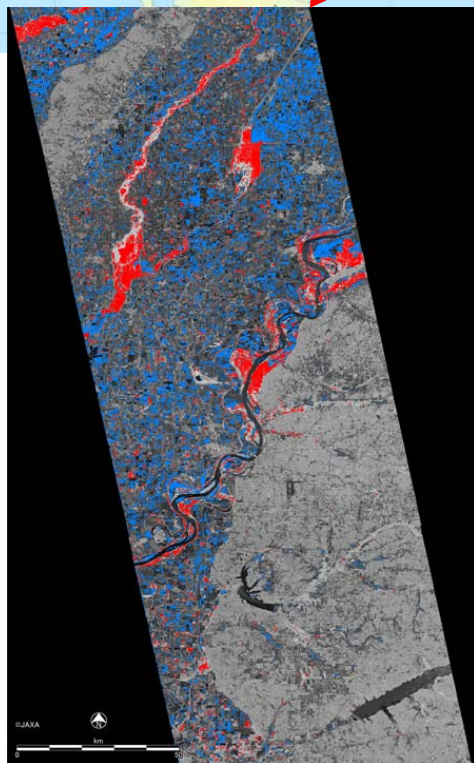
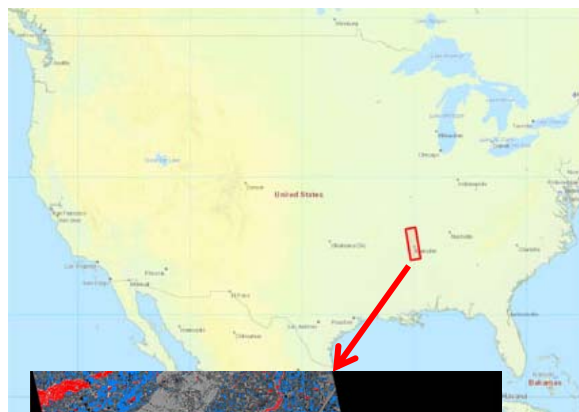
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## Mississippi River Special Event (1/3)

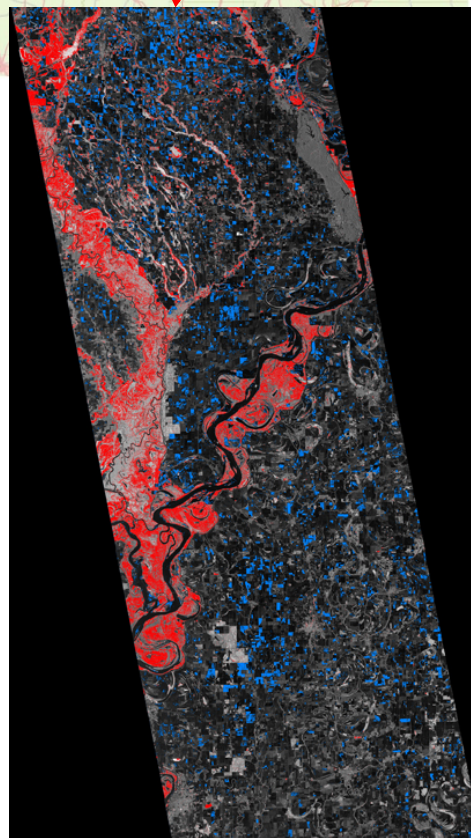
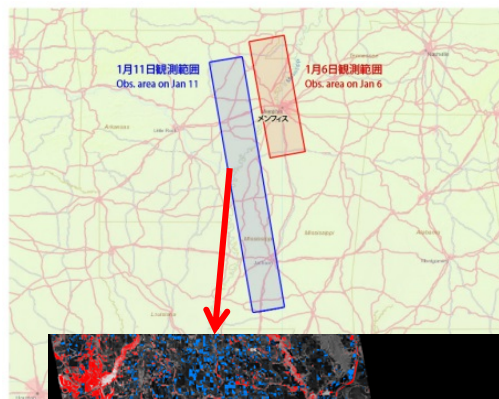
- Data provided: In addition to flood forecast products accessed via data pull from e.g., the U. of Maryland Global Flood Monitoring System and Dartmouth Flood Observatory, NASA provided ALOS-2 flood maps provided to FEMA for the Mississippi River. Feedback from FEMA was very positive.



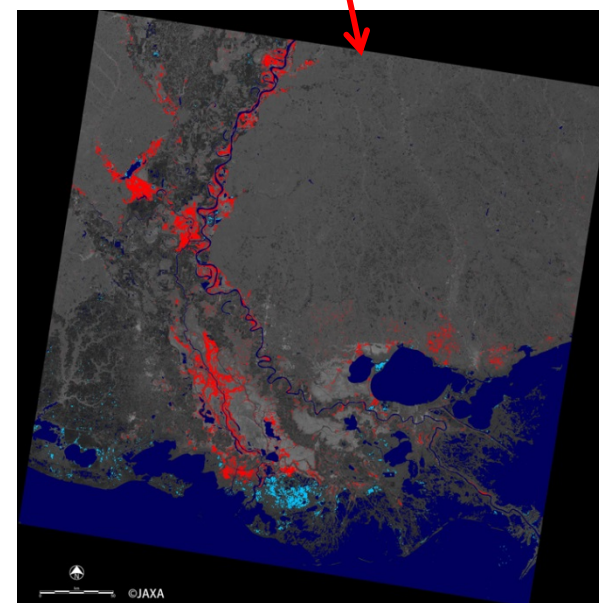
# Mississippi River Special Event (2/3)



ALOS-2, 1 Jan 2016



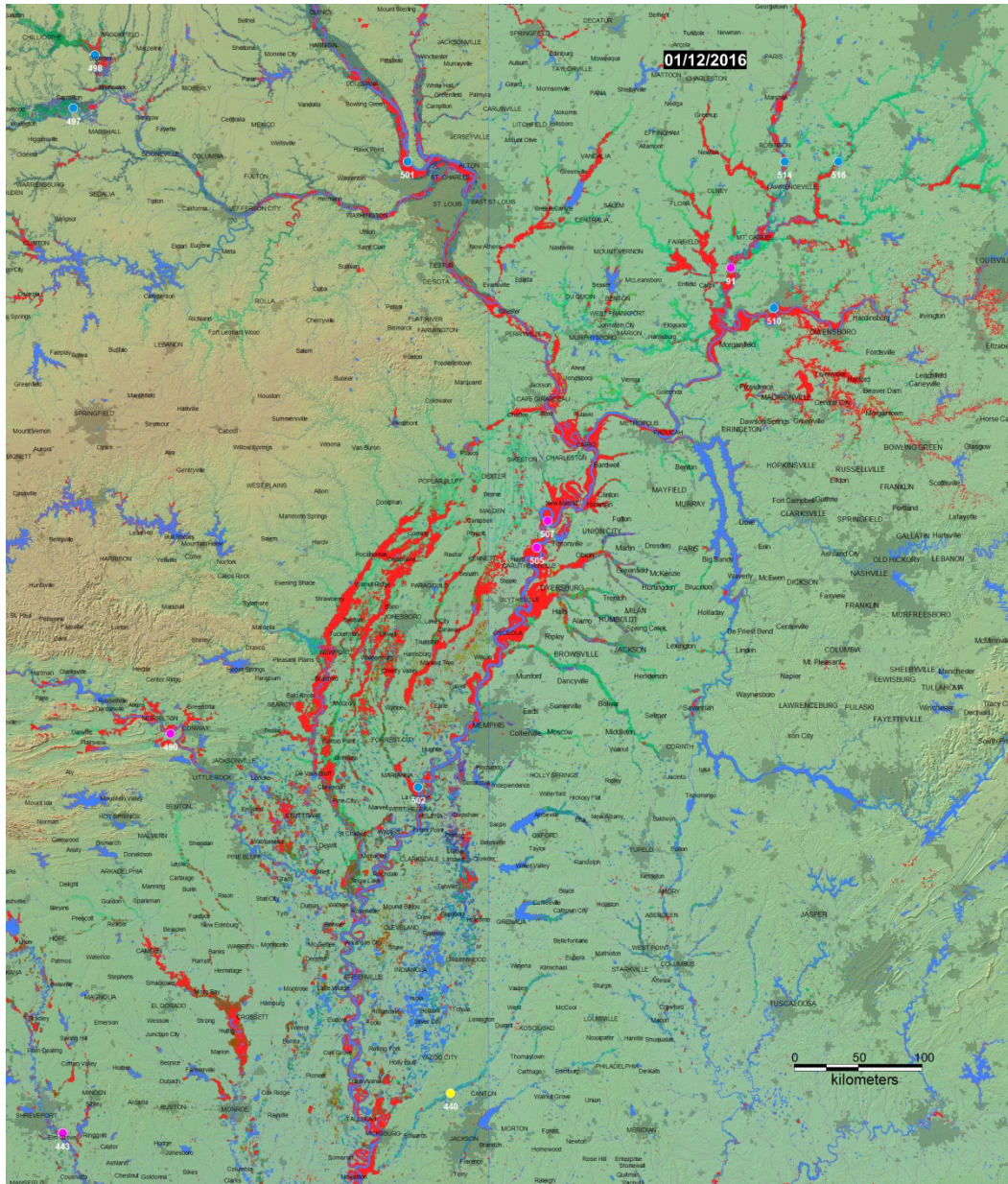
ALOS-2, 11 Jan 2016



ALOS-2, 16 Jan 2016



# Mississippi River Special Event (3/3)



Dartmouth Flood Observatory map comparing the flood extent on 12 January 2016 (red) with previous floods (other colors) based on MODIS data

(Credit: Bob Brakenridge)

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# Objective C: Capacity Building Status (1/2)

- Caribbean/Central American Component:
  - Coordinated inclusion of Open GeoSocial API Flood Monitoring software suite as disasters component within the Climatic Information Platform for Central America and the Dominican Republic as part of the USAID Regional Climate Change Program (RCCP)
    - Training workshop by NASA GSFC personnel (supported by SERVIR and USAID) in Costa Rica
    - Awaiting Step 1 Go-Ahead for SEVIR grant funding.
  - Approval of AmeriGEOSS initiative by GEO; working on Terms of Reference for a Disasters group within the Americas (Chile, Colombia, Costa Rica, and Mexico) that would need to interact with the CEOS Regional component in the Caribbean and Central America. Splinter session at Latin American Remote Sensing (LARS) Conference 30 March-1 April in Santiago, Chile.
- Southern Africa Component:
  - TIGER workshop in Addis Abbaba 1-2 February; 100 participants and 72 h of training on EO for water resources management
  - New TIGER training kit is being used in “Training of Trainers” with Cap-Net UNDP (119 experts trained so far)



## **Objective C: Capacity Building Status (2/2)**

- Southeast Asia Component:
  - ADPC installation of API pending SERVIR grant funding.

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    - *Special Event: Mississippi River (US)*
  - Objective C: Capacity Building
- **Issues and Risk Management**

# Issues and Risk Management Approach

- Data access:
  - Update: previously discussed agreement with the International Charter has greatly alleviated the previously raised data access issues. Thanks again to the International Charter for their cooperation and to Brenda Jones for all her help!

# Data Use: Recent Publications / Conference Presentations

Frye S., Wells G., Adler R., Brakenridge R., Bolten J., Murray J., Slayback D., Green D., Wu, H., Kirschbaum D., Howard T., Flamig Z., Clark R., Chini M., Matgen.P., Stough T., “User-Driven Workflow for Modeling, Monitoring, Product Development, and Flood Map Delivery Using Satellites for Daily Coverage Over Texas May-June 2015”, Poster presentation at the American Geophysical Union 2015 annual meeting, December 2015 San Francisco, CA

Schumann G. J-P., Frye S., Wells G., Adler R., Brakenridge R., Bolten J., Murray J., Slayback D., Green D., Wu H., Kirschbaum D., Howard T., Flamig Z., Clark R., Chini M., Matgen.P., Stough T., B. Jones, “Unlocking the Full Potential of Earth Observation during the 2016 Texas Flood Disaster”, *Water Resources Research*, in review.

Schumann, G. J-P and K. M. Andreadis (2016). A method to assess localized impact of better floodplain topography on flood risk prediction, *Advances in Meteorology*, in review.

Wu, H. and Adler, R., “Evaluation of Quantitative Precipitation Estimations (QPE) and Hydrological Modeling at the Iowa Flood Studies Focal Basins.”, 2016 *Journal of Hydrometeorology*, in review.

Presentation by Chu Ishida on the Flood Pilot at Asian Water Cycle Symposium last week

Special Issue in *Remote Sensing* on “Earth Observation for Water Resource Management in Africa”

# **Questions / Discussion**