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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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
- Data distribution co-ordinated by co-leads (the lack of standardized data distribution makes it very labor-intensive)

Mission / Instrument	Repeat or Revisit	Swath Width	Spatial Resolution	Agency	Image Counts		
					Annual Quota	Since 3/2016 WGDisasters Meeting	Cumulative Total
Optical - Coarse Resolution (>100 m)							
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			
Optical - Moderate Resolution (10 to 100 m)							
Sentinel-2A / MSI	10 days	290 km	10, 20, 60 m	ESA		0	0
EO-1 / ALI	204 days	185 km	10, 30 m	NASA	300	11	81
Landsat-8 / OLI	16 days	185 km	15, 30 m	USGS		8	78
Optical - High Resolution (<10 m)							
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	9-12*	9-12*
L-Band SAR							
ALOS-2 / PALSAR-2	14 days	25 to 350 km	10 to 100 m	JAXA	100	0	40
C-Band SAR							
Sentinel-1A / SAR	12 days	80, 250, 400 km	9, 20, 50 m	ESA		5	52
Sentinel-1B / SAR	12 days	80, 250, 400 km	9, 20, 50 m	ESA		0	0
Radarsat-2 / SAR-C	1-6 days	50 to 500 km	8 to 100 m	CSA	500 (3 yr)	6	123
X-Band SAR							
Cosmo Sky-Med / SAR-2000	5 days	10 to 200 km	1 to 100 m	ASI	300	4	107

*includes a set of 4 stripes over Jakarta corresponding to 7-9 individual images

Data Acquisition Status

- The CEOS Flood Pilot team requested International Disaster Charter data for six events since March:
  - Argentina (activation on 7 April)
  - Seychelles (19 April)
  - Sri Lanka (17 May)
  - Bangladesh (25 May)
  - Louisiana (14 August)
  - India (26 August)
- Charter data for the first four events above were already freely available (e.g., NOAA, EUMETSAT, USGS, ESA); Charter data from Louisiana and India is still pending receipt except two images from Venezuela were delivered over Louisiana
  - Wide-swath Multispectral Camera (WMC) onboard the Venezuelan Remote Sensing Satellite-1 (VRSS-1) from 17:19:42 to 17:20:09 UTC (camera 1) and from 17:19:48 to 17:20:15 UTC (camera 2) 28 August 2016 including four spectral bands (red, green, blue, and near-IR)

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, RCCP (Costa Rica)
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 (HAZARD, WATCHFUL), Deltares, RSS
Mekong	Flood extent maps, flood risk maps, flash flood guidance / threat maps	Mekong River Commission, ADPC, NASA, NOAA, HRC, USGS, Univ. of South Carolina, Texas A&M , IMWI
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)

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  - **Objective C: Capacity Building**
- **Issues and Risk Management**

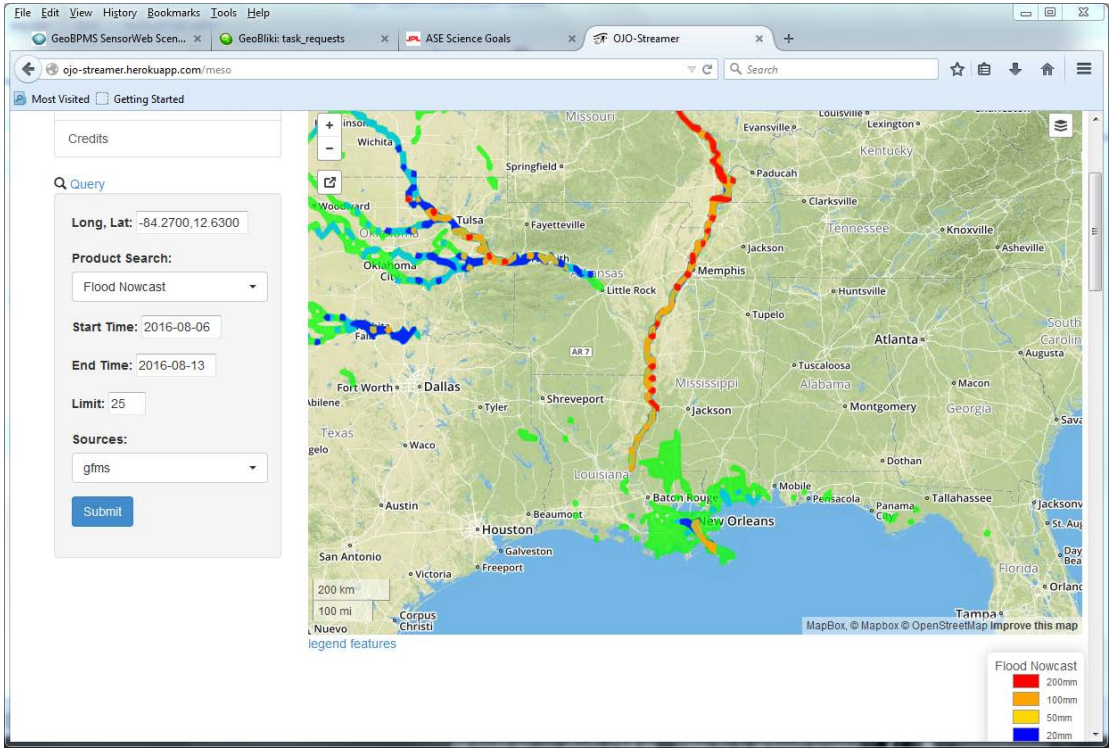
Objective A: Global Component Status

- 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
  - Status: **75% complete—**telecon with B. Koetz (ESA) to discuss concept of using GeoOpenSocial API to allow regional users to post and access products that could be hosted at Hydro-TEP or on Amazon Cloud. ESA is currently considering it and will provide a response in September.

Objective A: Global Component Status

- 2016-17 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: In concert with GeoDARMA, reach out to UN World Bank, International Red Cross, and other potential partners to implement the Flood Pilot monitoring capabilities on a more permanent basis, possibly in other regional settings

Global Component Highlight



- GFMS flood products (above from August LA flooding) converted to GIS layers and distributed via ojo-streamer client
  - C. Vaughan of FEMA: “This is absolutely the direction we want to head (API based).”
- Also provided data for a levee break in China (June) and flooding in Sri Lanka (May), Myanmar (June), Mexico (June), WV (July), Louisiana (August) and India (August)

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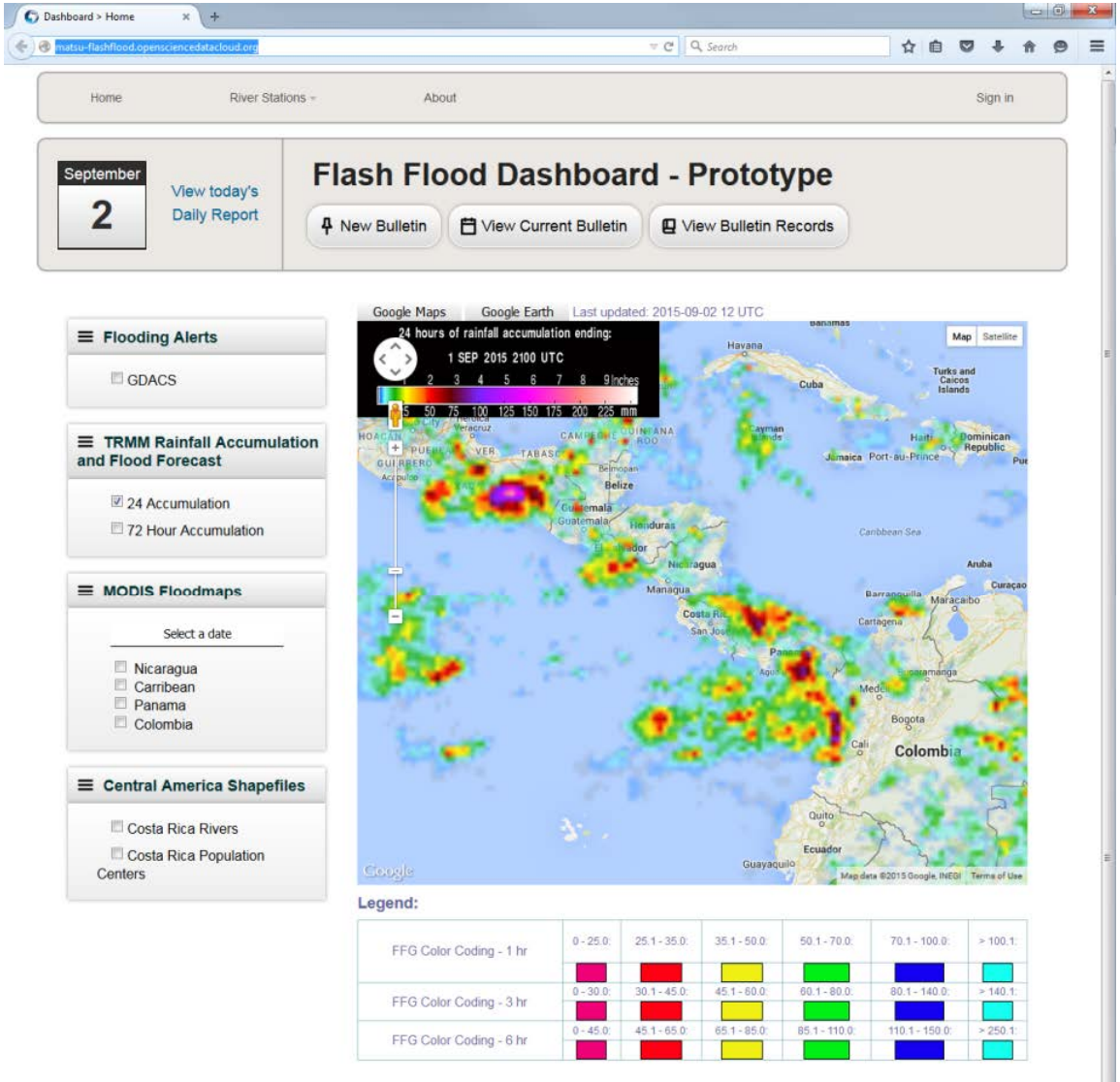
Objective B: Caribbean/Central American Component Status (1/7)

- 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 (2/7)

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



Objective B: Caribbean/Central American Component Status (3/7)

- 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: No significant new work since subsidence mapping reported in March
  - 10-year flood archive based on Deltares Flood Monitoring Programme
    - Status: work is on-hold due to funding constraints.

Objective B: Caribbean/Central American Component Status (4/7)

- 2016-17 Milestones:
  - Flood monitoring during 2016 season
    - Status: Provided optical imagery (EO-1 and MODIS) and GFMS for Mexico (TS Danielle—June) and Belize (H Earl—August)
  - Draft a plan for longer-term sustainability
    - Status: Intent is to transition much of this work into AmeriGEOSS, but details need to be worked out
- Overall Status: **50%** complete.

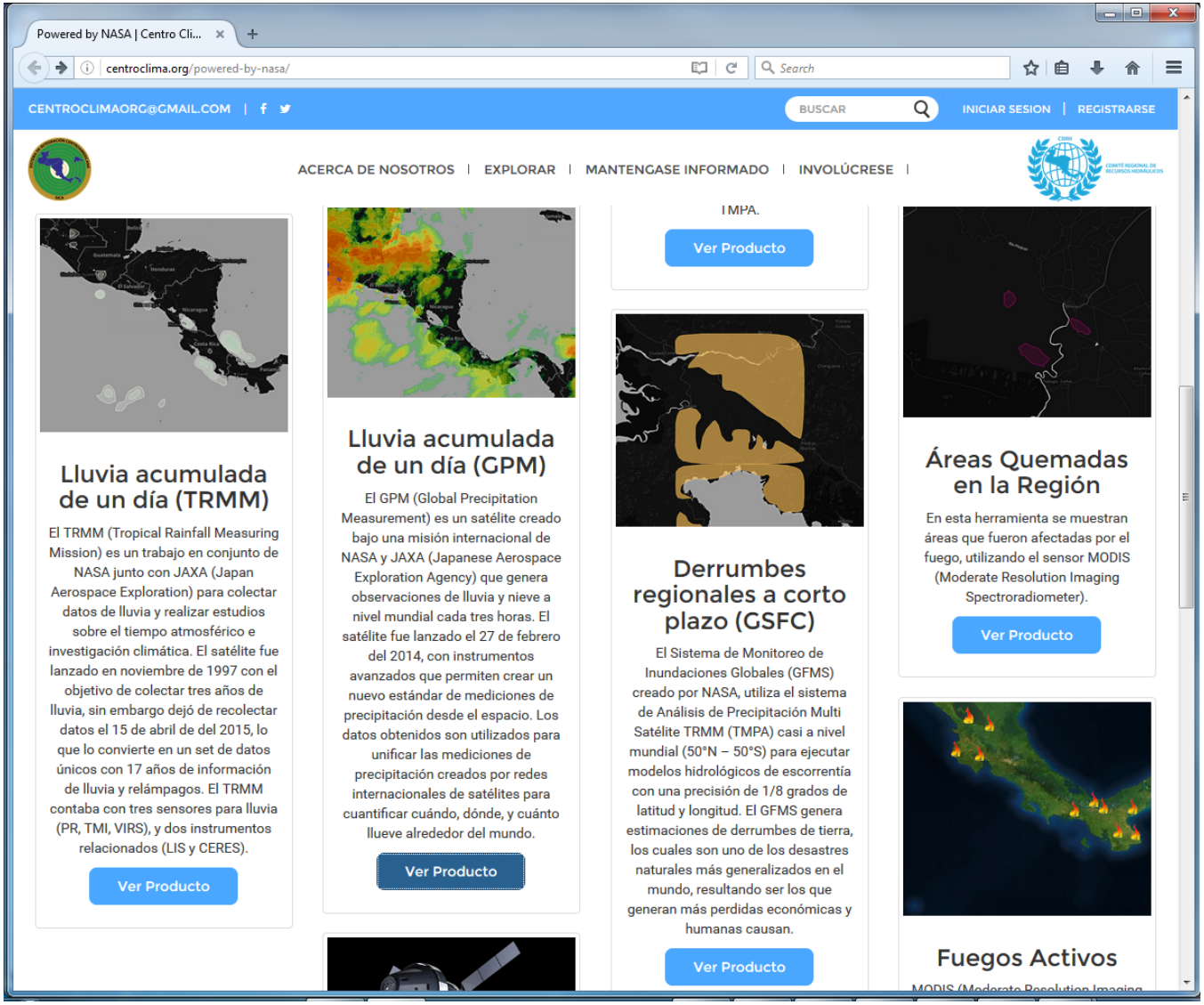
Objective B: Caribbean/Central American Component Status (5/7)

- Other Planned Activities / Accomplishments
  - Collection of background Radarsat-2 pre-event imagery at known look angles and modes for the entire region (CSA-Giguere)
    - Status: Completed; 8 complete sets of background images collected over all of Central America and the Caribbean
      - Working with the Landslide Pilot to identify opportunities for them to use these datasets
  - Damage assessment studies to analyze satellite-derived inputs as compared to ground-based manual techniques (CIMH-Farrell)
    - Status: Analysis in Saint Vincent and the Grenadines (using Radarsat and EO-1), and in Dominica (using Radarsat and COSMO-SkyMed) has been hampered by lack of pre-event Radarsat and COSMO-SkyMed imagery with same characteristics as post-event imagery. Currently looking at the effects of Hurricane Earl in Belize using pre- and post-event Radarsat-2 data.

Objective B: Caribbean/Central American Component Status (6/7)

- Other Planned Activites / Accomplishments (cont.)
  - Open GeoSocial API for publishing / visualizing flood modeling and monitoring products installed at DAI in Costa Rica
    - 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; software installation supported by a grant from SICA/CEPREDENAC.
    - Training workshop conducted in early May in Costa Rica
    - System operational since May: http://centroclima.org/powered-by-nasa/ (example on next slide)

Objective B: Caribbean/Central American Component Status (7/7)



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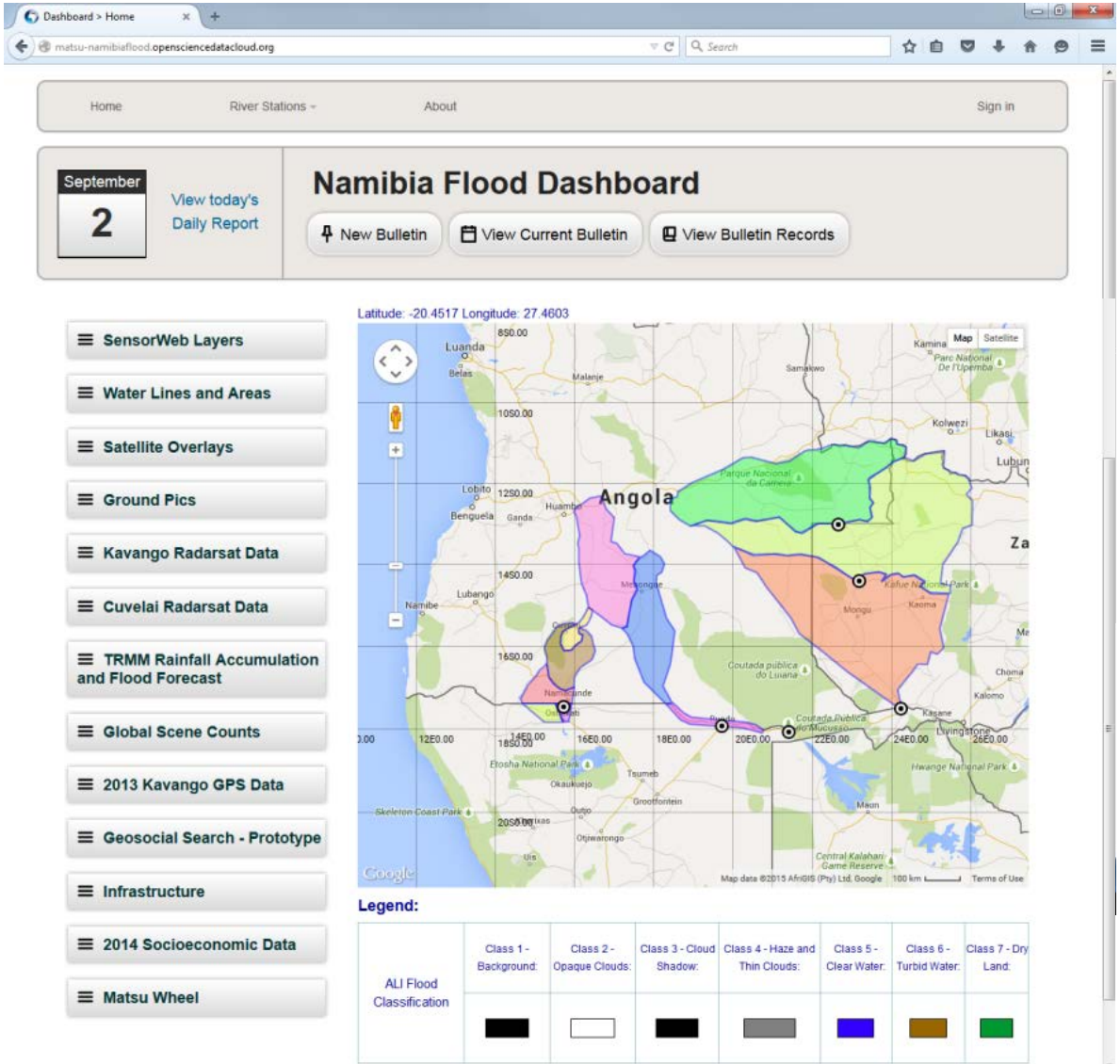
Objective B: S. Africa Component Status (1/6)

- 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://matsu-namibiaflood.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: on hold due to funding constraints
- Status: **75%** complete.

Objective B: S Africa Component Status (2/6)

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



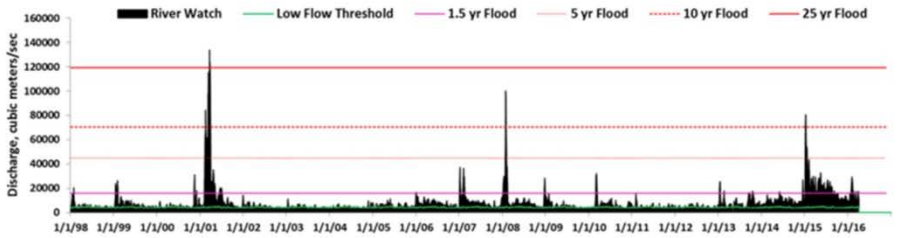
Objective B: S. Africa Component Status (3/6)

- 2016-17 Milestones:
  - Flood monitoring during 2016 season
    - Status: Quiet flood season thus far, so no support provided
  - Draft a plan for longer-term sustainability
    - Status: Intent is to transition much of this work into AfriGEOSS but details need to be worked out
- Status: **75%** complete.

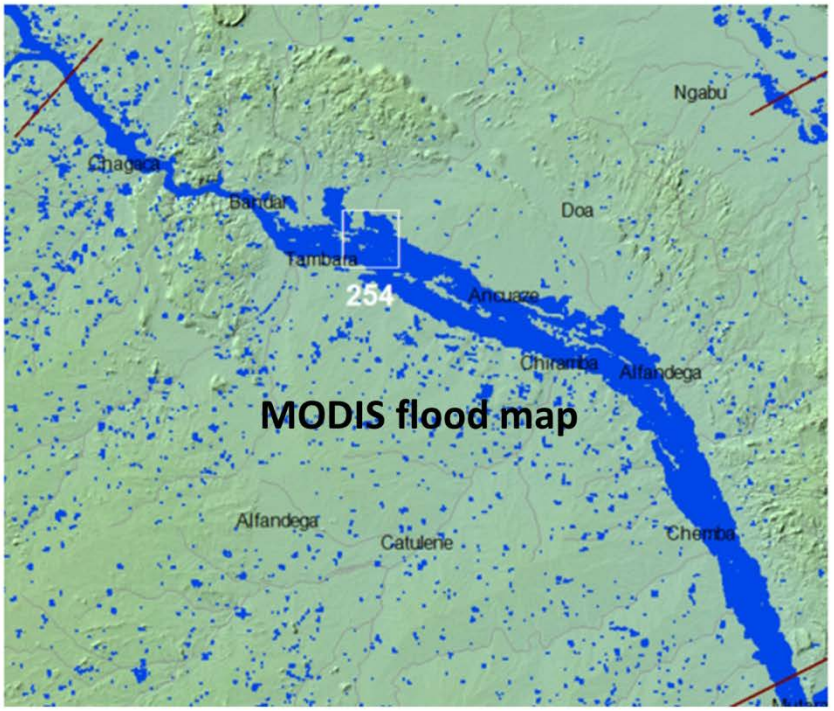
Objective B: S Africa Component Status (4/6)

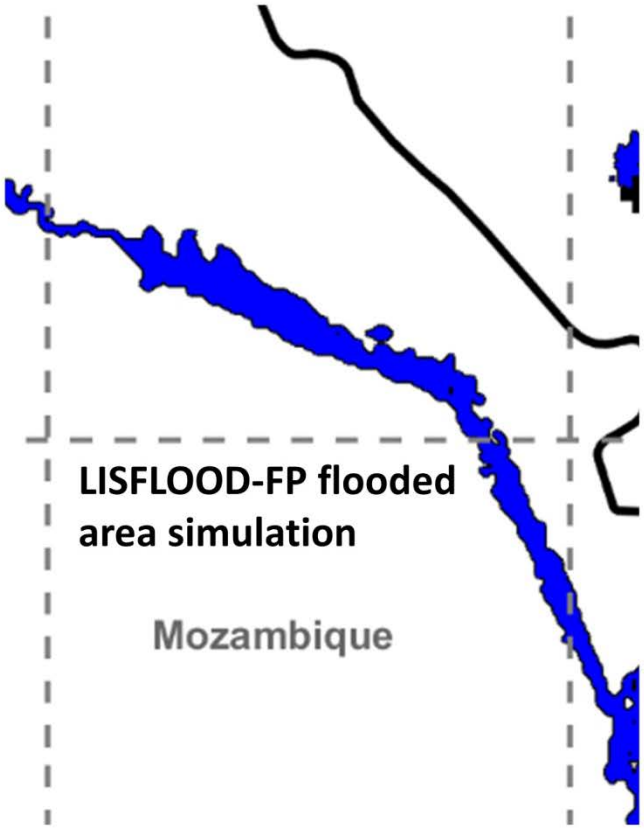
- Other Planned Activities
  - Improvements to flood model by computing river width and deriving more realistic and complete stream networks derived from Landsat-8 (UCLA-Schumann; results in next slide)
    - Status: Validating the improved flood model outputs with MODIS flood maps from the Dartmouth Flood Observatory
  - 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 (UCLA-Schumann)
    - 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: SERVIR grant secured and set to begin September 2016 to transition from CREST to EF5 flood model.

Southern Africa Component Status (5/6)



Flooded area for "4", Major Flooding, r = 18 yr (observed 2008)





Validation of Africa-wide flood model by comparing simulations to Dartmouth Flood Observatory MODIS flood maps (Credit: G. Schumann, UCLA)

Objective B: S Africa Component Status (6/6)

- 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

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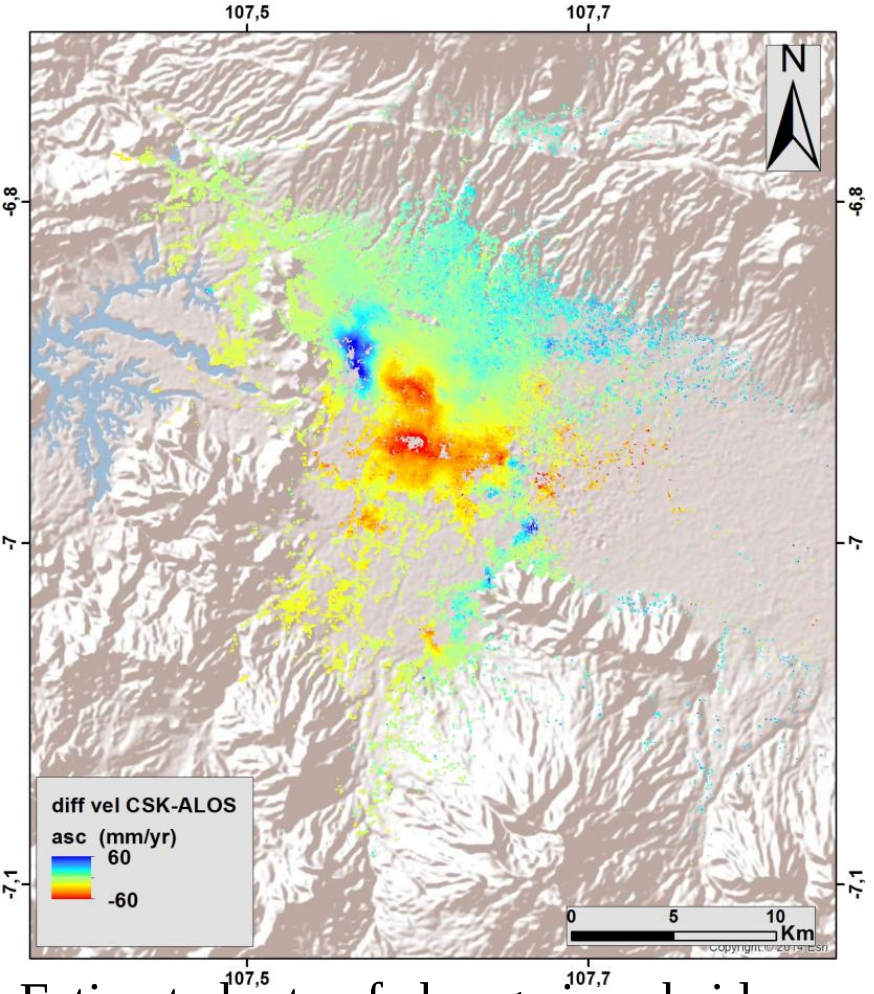
Objective B: SE Asia Component Status (1/9)

- 2014 Milestones:
  - User consultations on new pilot products
    - Status: Open GeoSocial API flood forecasting and event mapping software installed at ICIMOD in 2015.
      - New SERVIR funding secured to install new flood products at ADPC (e.g., J. Bolten's NDVI differential product for the Mekong)
      - SERVIR grant for OpenGeoSocial API installation was not funded but hoping to leverage the above work
  - 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. SERVIR project may provide a way forward.
  - Flood Dashboard development based on Namibia pilot example adapted to SE Asia users;
    - Status: Completed http://matsu-seasia.opensciencedatacloud.org/; may be replaced by OpenSocial API hosted by ADPC

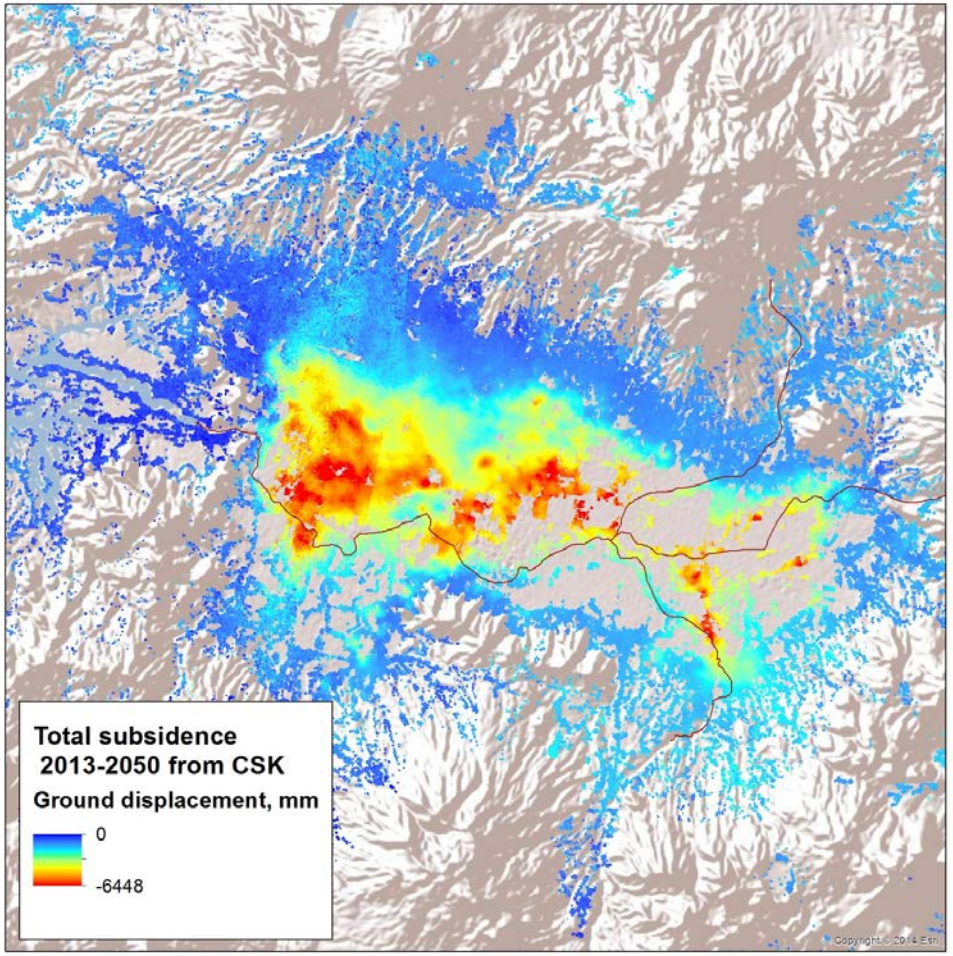
Objective B: SE Asia Component Status (2/9)

- 2015 Milestones:
  - Operational test bed for RASOR risk management system for test sites in Java
    - Status: RASOR team analyzed future flood risk in Bandung based on subsidence mapping from comparing ALOS and CSK data (next two slides). Phase 2 proposal by RASOR team to fund extensions of 2007-11 / 2013-15 risk mapping work is currently under review by the EC. RASOR also used Pleaides data to generate more accurate maps of urban landscape for damage potential assessment (third slide after)
  - Integration of flood dashboard
    - Status: Current Dashboard may be replaced by OpenSocial API hosted by ADPC
  - Initial services for Mekong River Commission
    - Status: See above

Objective B: SE Asia Component Status (3/9)



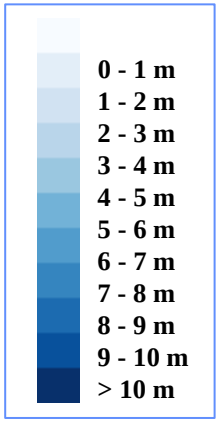
Estimated rate of change in subsidence in Bandung from comparing subsidence rates computed from ALOS in 2007-11 and CSK in 2013-15.

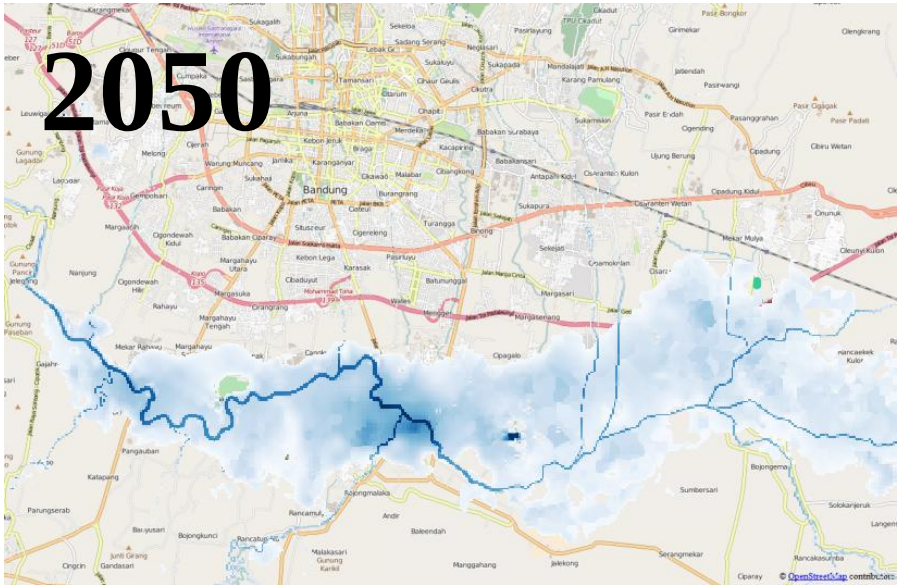


Predicted total subsidence by 2015 based on extrapolation of the changes in subsidence rates

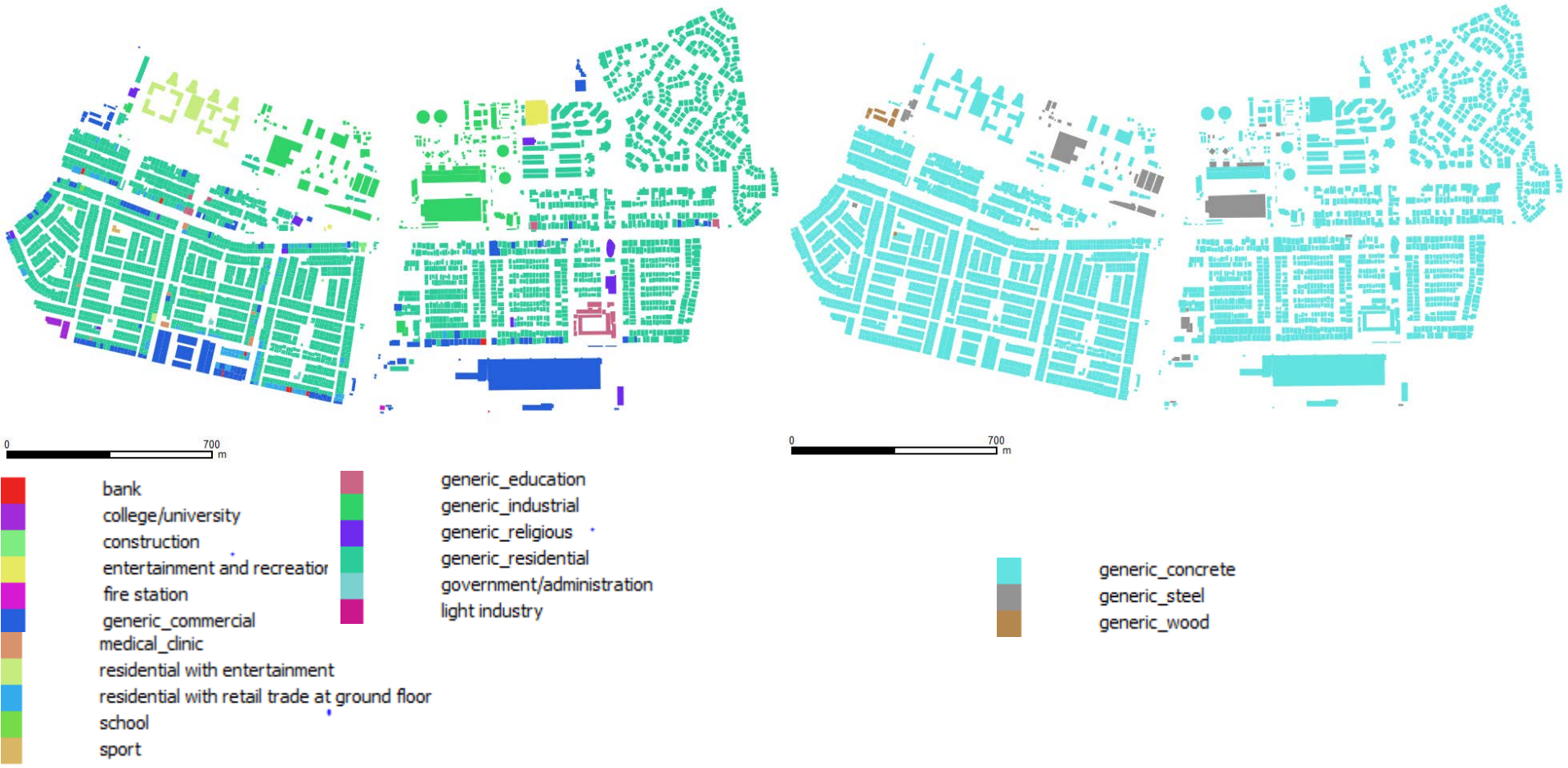
Objective B: SE Asia Component Status (4/9)

Inundation depths calculated for subsidence scenarios in 2014, 2020 and 2050 based on rainfall from the Dec 2014 flood





Objective B: SE Asia Component Status (5/9)

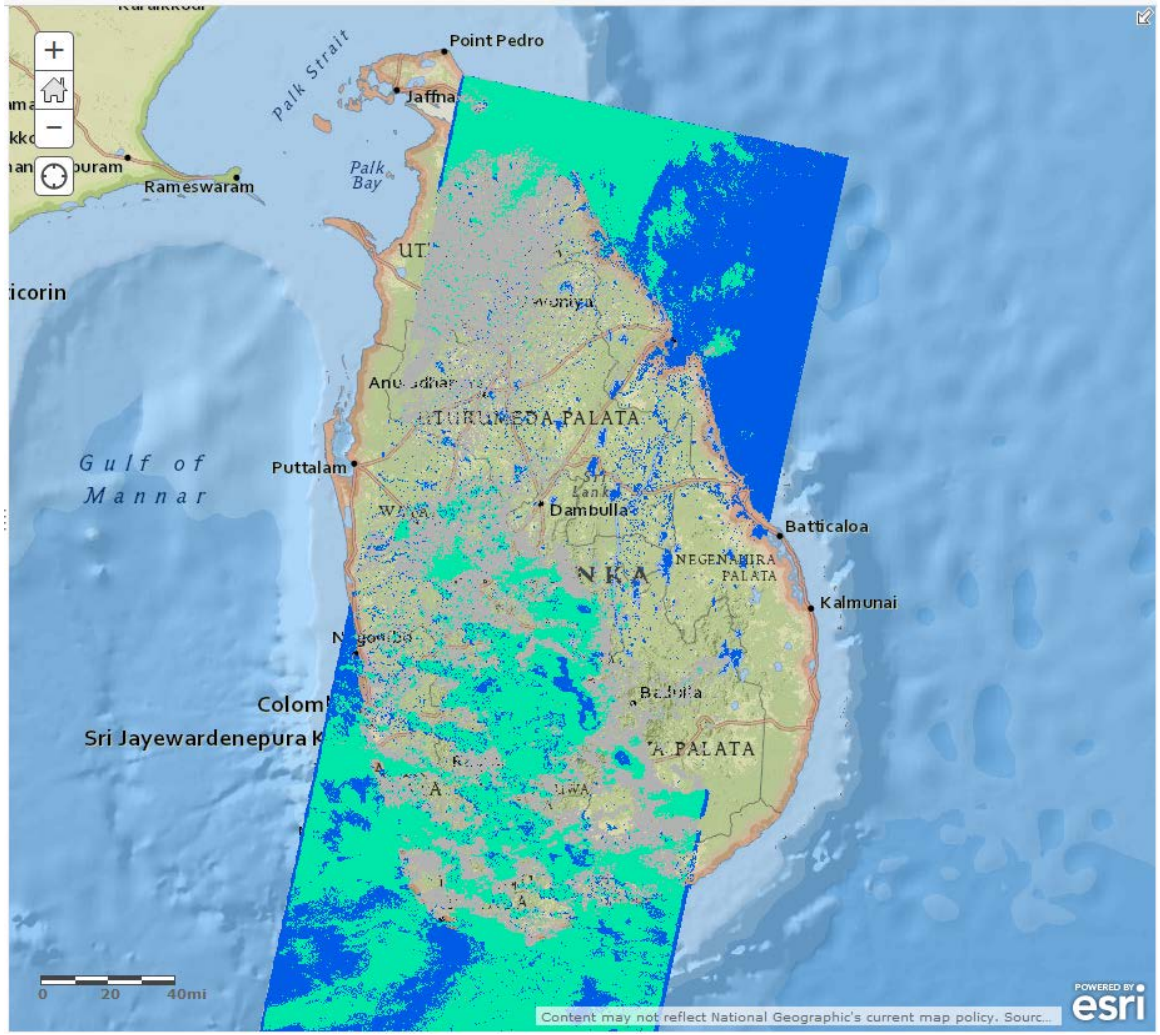


Comparison of land overlay of buildings and usage in Jakarta from Pleiades (left) with Open Street Map (right) (Courtesy H. Yesou, SERTIT)

Objective B: SE Asia Component Status (6/9)

- 2015 Milestones (cont.):
  - 10-year flood archive over region based on Deltares Flood Monitoring Programme
    - Status: Deltares has ceased collaboration with this Pilot region.
  - 1st 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/)
- 2016-17 Milestones:
  - Flood monitoring during 2016 season
    - Status: Provided optical imagery for flooding in Sri Lanka (May) and Myanmar (June) and India (August)
  - Draft a plan for longer-term sustainability
    - Status: Intent is to build this capacity into ADPC via the SERVIR Applied Science Grant but details need to be worked out
- Status: **80%** complete.

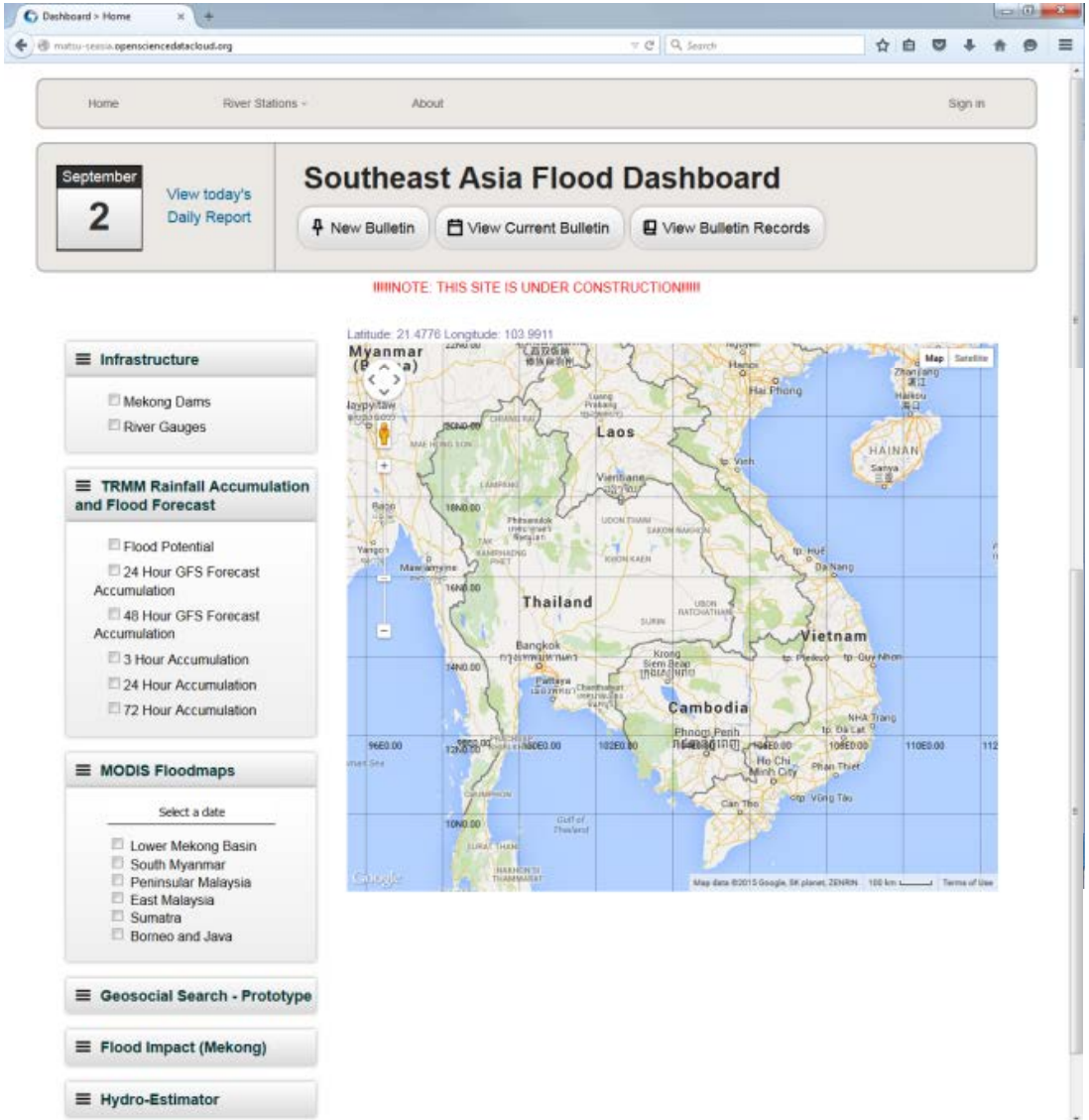
Objective B: SE Asia Component Status (7/9)



Flood coverage map for Sri Lanka on 18 May 2016 derived from Landsat-8 OLI

Objective B: SE Asia Component Status (8/9)

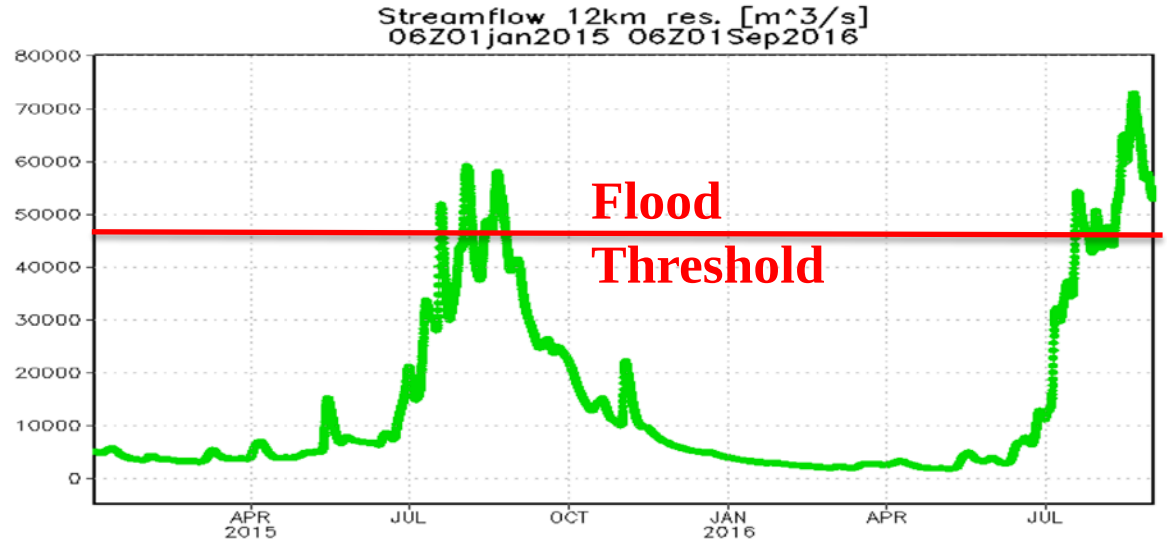
http://matsu-seasia.opensciencedatacloud.org/



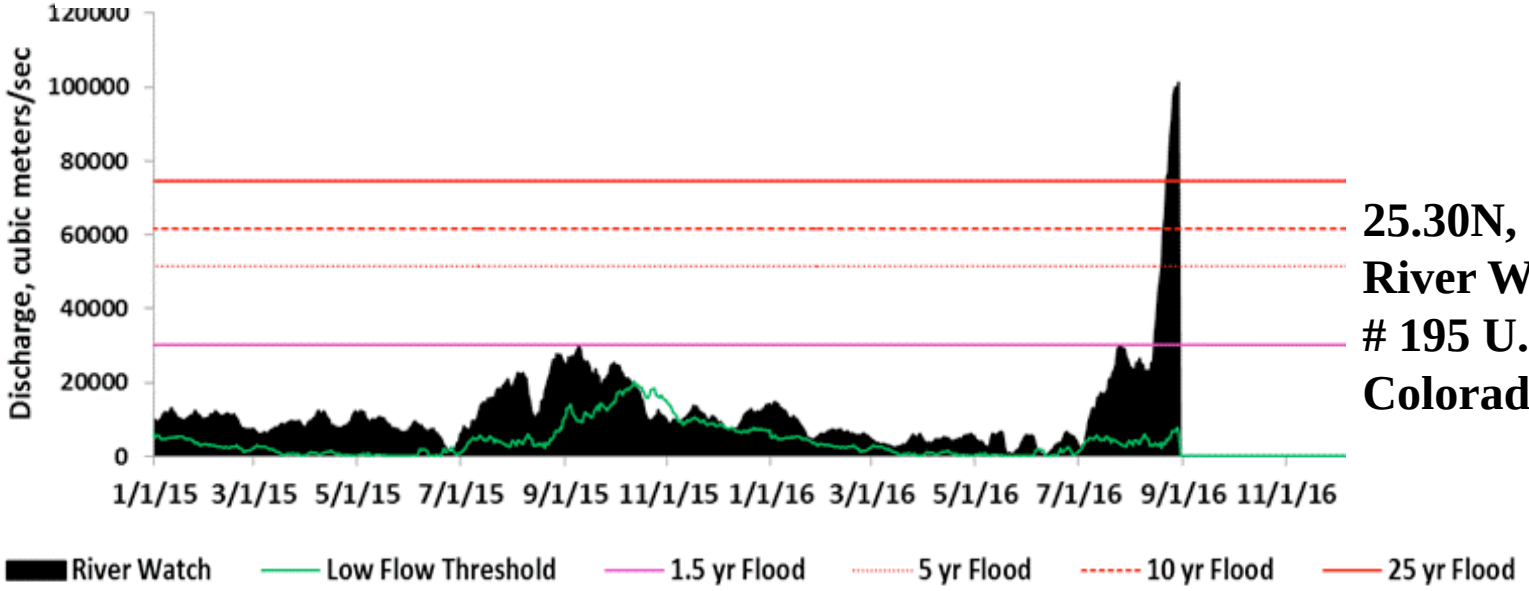
Objective B: SE Asia Component Status (9/9)

- Other Planned Activites
  - Indonesia and Java risk assessments and subsidence calculations (Deltares-Villars)
    - Status: on hold due to funding constraints.
- 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.
  - Provided demonstration of the Open GeoSocial API interface on the ojo-streamer client to World Bank GFDRR and Humanitarian Open Street Map Team (HOT) personnel July 2016.

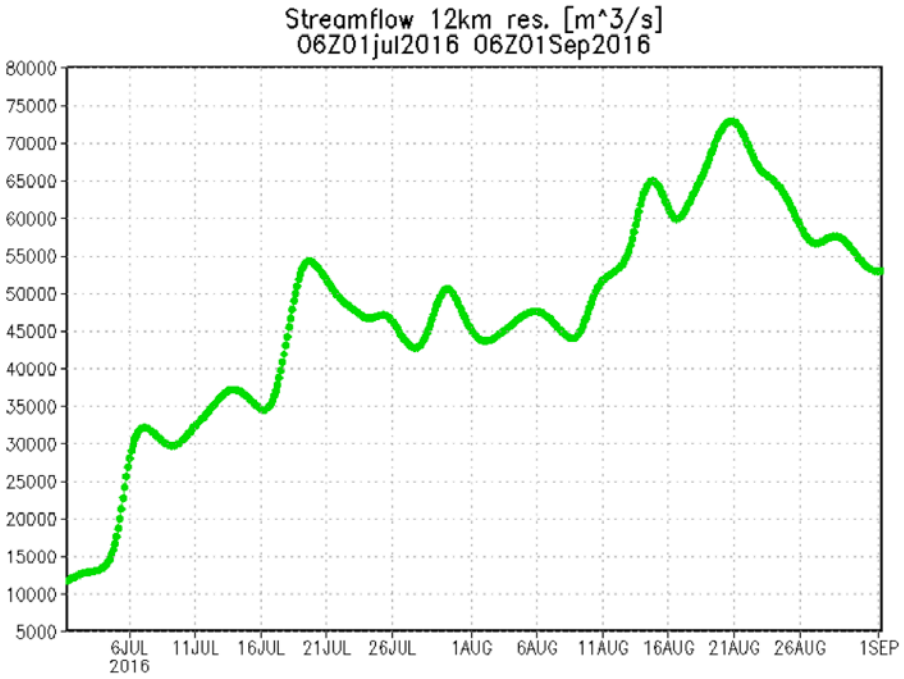
Ganges River Flooding August 2016
(Comparison of GFMS and Other Information)



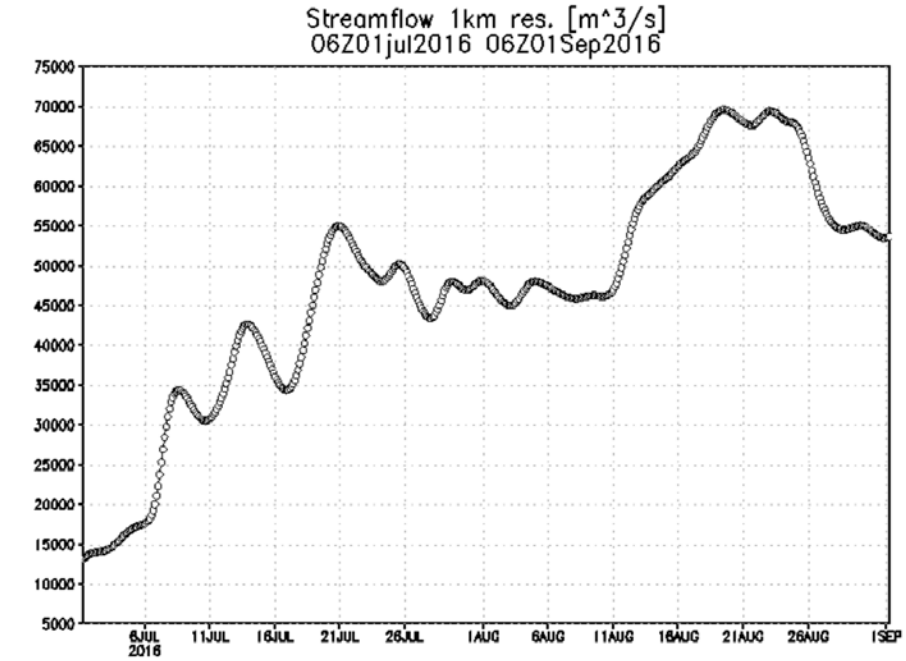
GFMS Streamflow at 25.30N, 86.56E, location of River Watch Site # 195



25.30N, 86.56E, River Watch Site # 195 U. of Colorado)

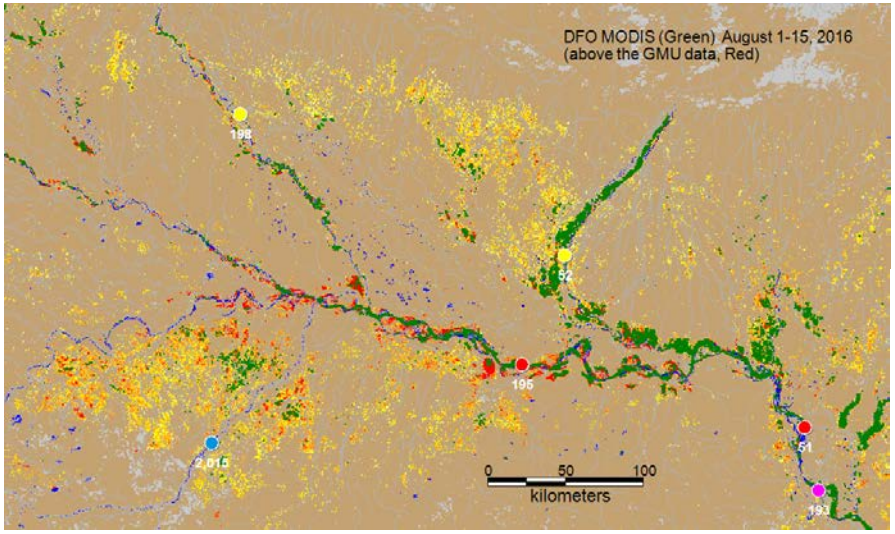


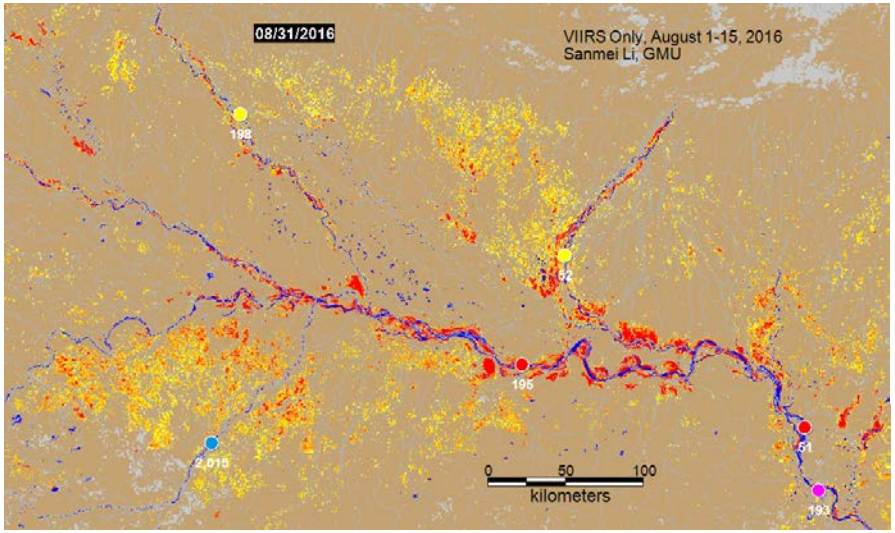
GFMS 12 km Streamflow

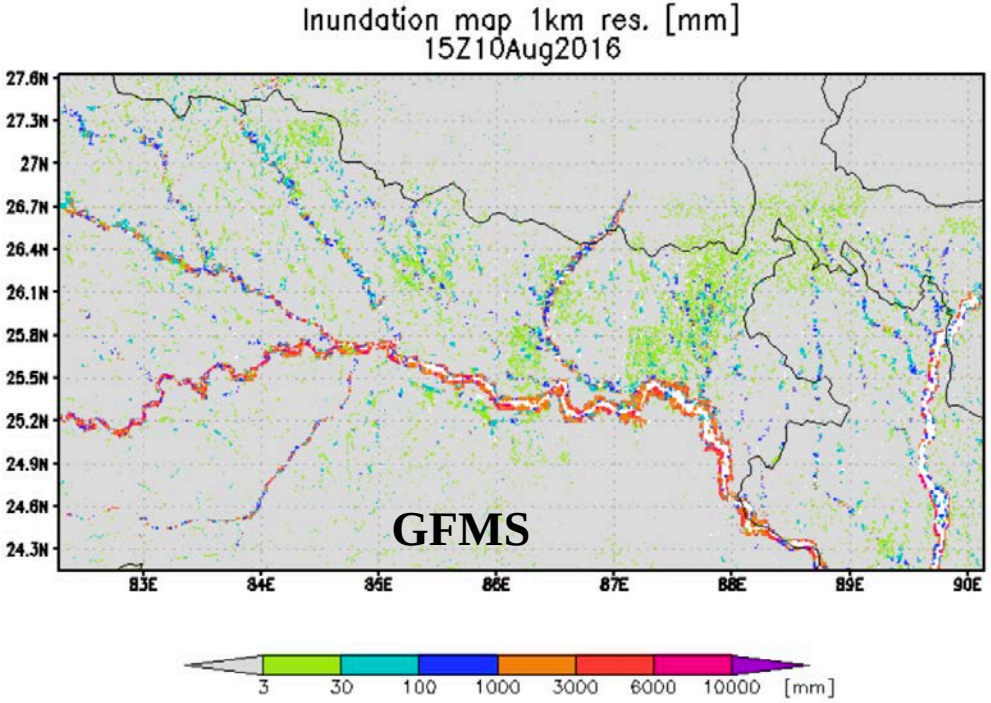


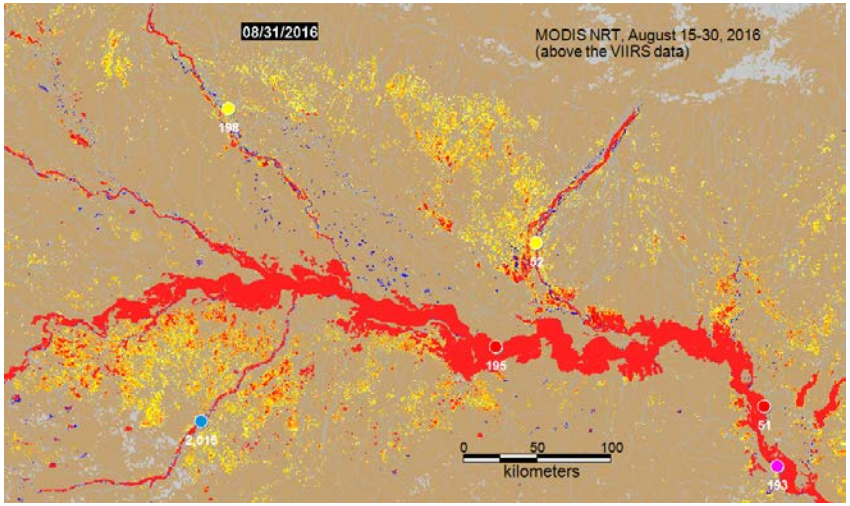
GFMS 1 km Streamflow

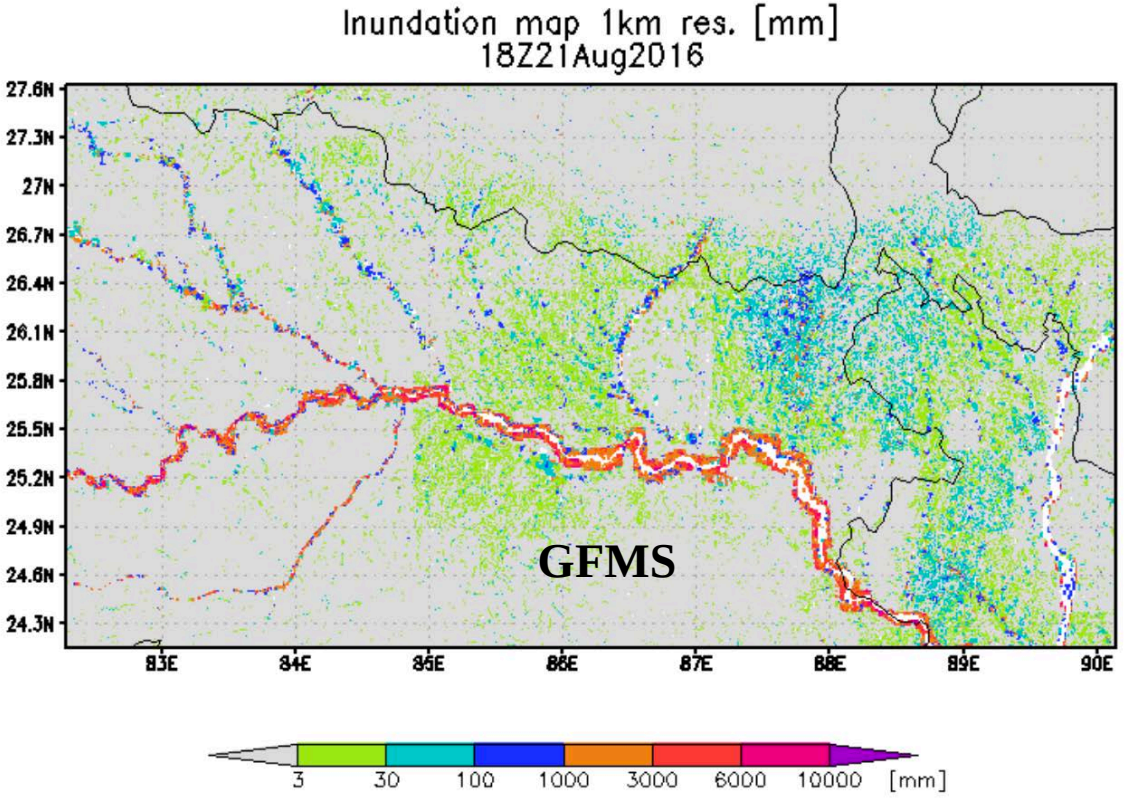
Inundation Estimates

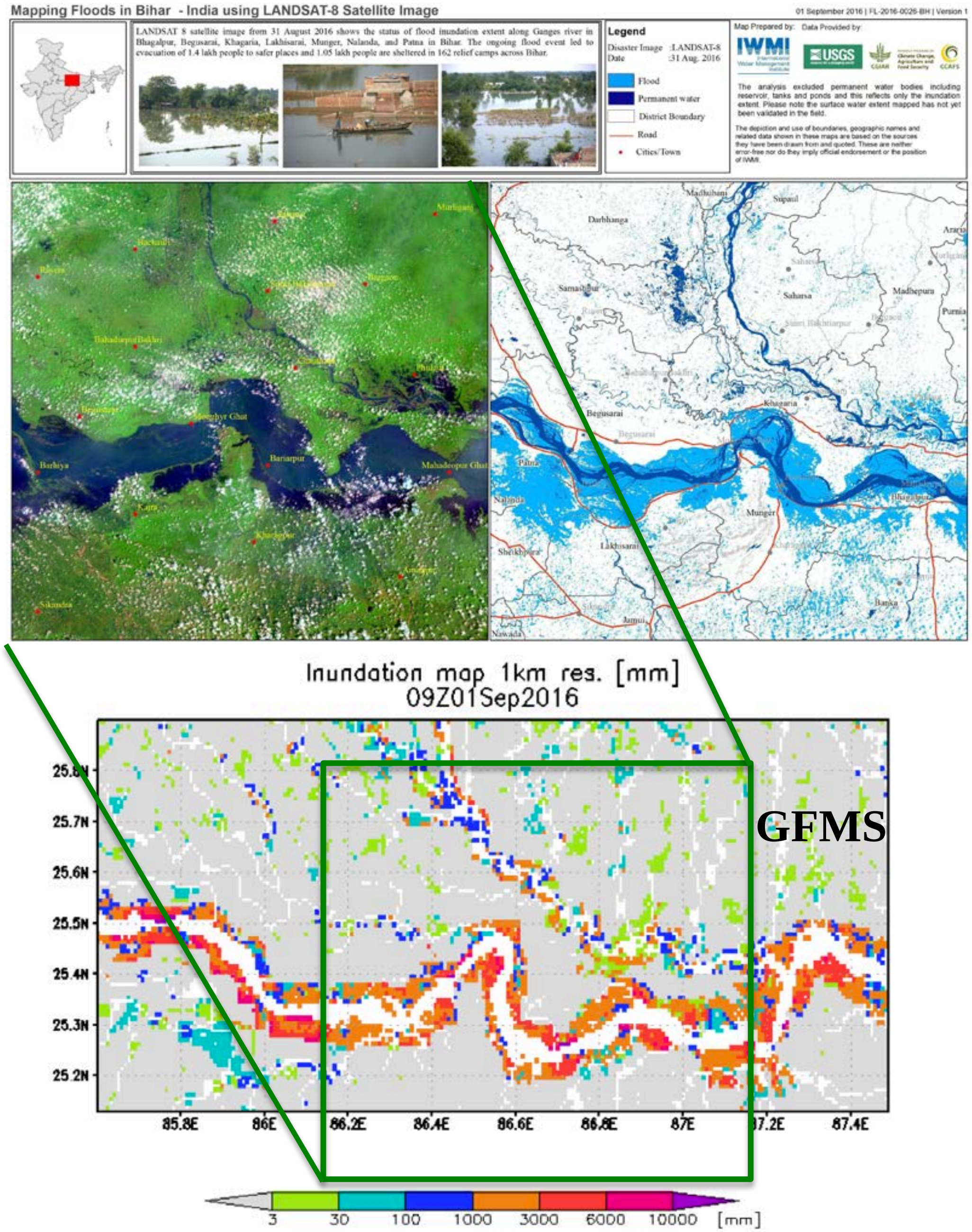


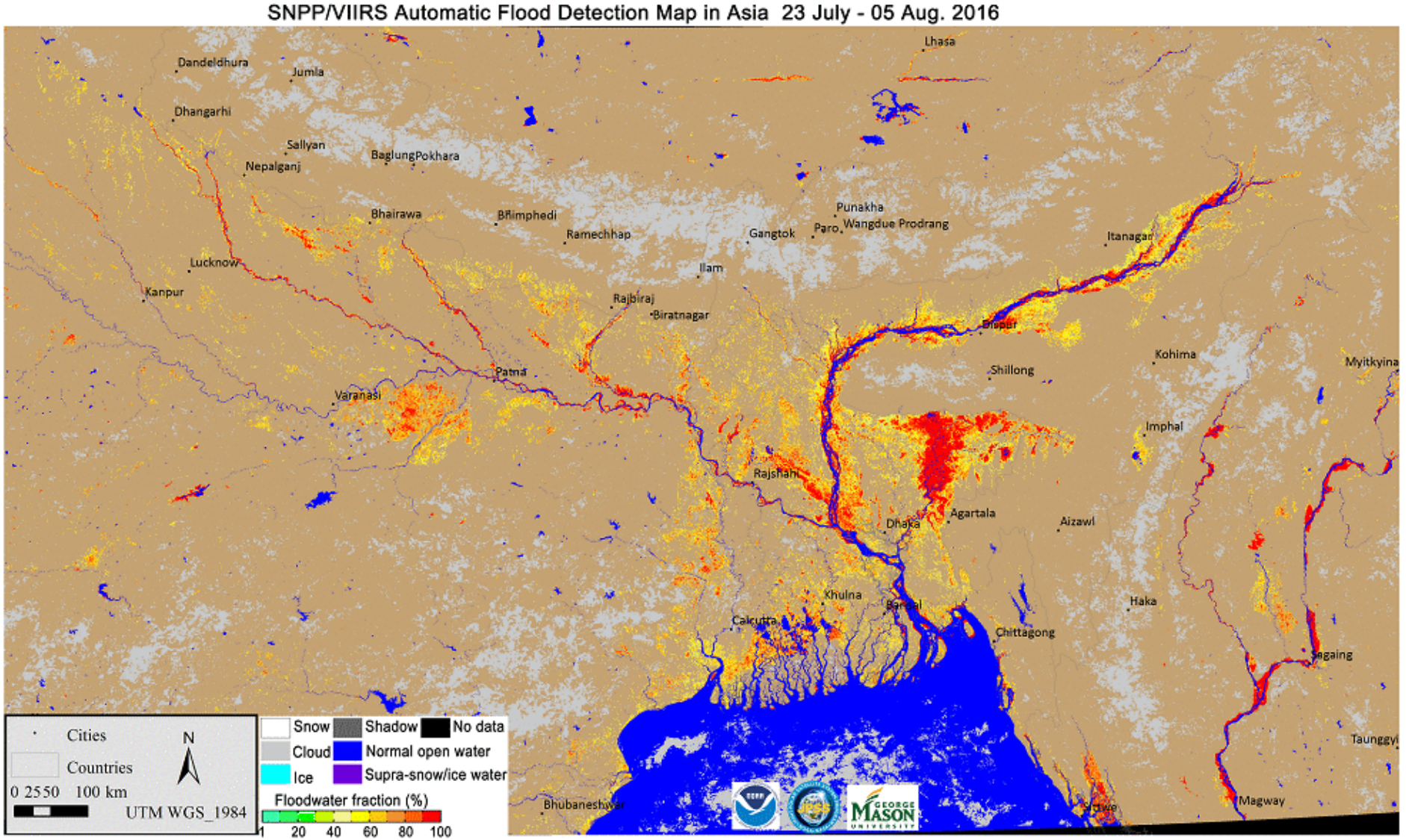





08/31/2016
MODIS NRT, August 15-30, 2016
(above the VIIRS data)
198
195
2,016
91
193
0
50
100
kilometers


Inundation map 1km res. [mm]
18Z21Aug2016
27.6N
27.3N
27N
26.7N
26.4N
26.1N
25.8N
25.5N
25.2N
24.9N
24.6N
24.3N
83E
84E
85E
86E
87E
88E
89E
90E
GFMS
3
30
100
1000
3000
6000
10000
[mm]


Mapping Floods in Bihar - India using LANDSAT-8 Satellite Image
01 September 2016 | FL-2016-0026-BH | Version 1
LANDSAT 8 satellite image from 31 August 2016 shows the status of flood inundation extent along Ganges river in Bhagalpur, Begusarai, Khagaria, Lakhisarai, Munger, Nalanda, and Patna in Bihar. The ongoing flood event led to evacuation of 1.4 lakh people to safer places and 1.05 lakh people are sheltered in 162 relief camps across Bihar.
Legend
Disaster Image :LANDSAT-8
Date :31 Aug. 2016
Flood
Permanent water
District Boundary
Road
Cities/Town
Map Prepared by:
Data Provided by:
IWMI
USGS
The analysis excluded permanent water bodies including reservoir, tanks and ponds and this reflects only the inundation extent. Please note the surface water extent mapped has not yet been validated in the field.
The depiction and use of boundaries, geographic names and related data shown in these maps are based on the sources they have been drawn from and quoted. These are neither error-free nor do they imply official endorsement or the position of IWMI.
Inundation map 1km res. [mm]
09Z01Sep2016
GFMS
25.8N
25.7N
25.6N
25.5N
25.4N
25.3N
25.2N
85.8E
86E
86.2E
86.4E
86.6E
86.8E
87E
87.2E
87.4E
3
30
100
1000
3000
6000
10000
[mm]


SNPP/VIIRS Automatic Flood Detection Map in Asia 23 July - 05 Aug. 2016
Lhasa
Dandeldhura
Jumla
Dhangarhi
Sallyan
Baglung
Pokhara
Nepalganj
Punakha
Paro
Wangdue Prodrang
Gangtok
Itanagar
Bhairawa
Bhimphedi
Ramechhap
Ilam
Lucknow
Kanpur
Rajbiraj
Biratnagar
Kohima
Shillong
Myitkyina
Patna
Varanasi
Imphal
Rajshahi
Agartala
Dhaka
Aizawl
Khulna
Barisal
Haka
Calcutta
Chittagong
Sagaing
Taunggyi
Bhubaneshwar
Magway
Cities
Countries
0 2550 100 km
UTM WGS_1984
N
Snow
Shadow
No data
Cloud
Normal open water
Ice
Supra-snow/ice water
Floodwater fraction (%)
1 20 40 60 80 100

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
  - **Objective C: Capacity Building**
- **Issues and Risk Management**

Objective C: Capacity Building Status (1/2)

- Caribbean/Central American Component:
  - Implemented previously mentioned Open GeoSocial API Flood Monitoring software suite
    - Training workshop by NASA GSFC personnel (supported by SERVIR and USAID) in Costa Rica held in May
    - Now creating products in real time and delivering to regional partners
  - Working through AmeriGEOSS to extend this capability to other portions of the Americas (Chile, Colombia, and Mexico)
    - 2-day disaster training course on disasters (including floods) for AmeriGEOSS participants conducted in Bogata in June
- Southern Africa Component:
  - Nothing to report since March WGDisasters meeting

Objective C: Capacity Building Status (2/2)

- Southeast Asia Component:
  - SERVIR funding (J. Bolten) for new ADPC flood products, including ADPC-produced NDVI differences in the Mekong as a new product
  - Provided demonstration of the Open GeoSocial API interface on the ojo-streamer client to ADPC in April and to the Sri Lanka head disaster manager in July

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**

Issues and Risk Management Approach

- Data ordering and distribution among participating CEOS agencies are labor intensive for pilot members due to manual processes and variations across agencies for tasking and data delivery requirements — this is a challenge for both current Flood Pilot operations and longer-term sustainability

Data Use: Recent (since March) Publications / Conference Presentations

Publications

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, 2016: Unlocking the Full Potential of Earth Observation during the 2016 Texas Flood Disaster. *Water Resources Research*, **52(5)**, 3288-3293.

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*, 6408319.

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.

Conference presentations (oral unless otherwise noted)

Jones, B., and S. Frye, 2016: International Charter / CEOS Flood Pilot. NASA Flood Response Workshop.

Kuligowski, R. J., and S. Frye, 2016: The CEOS Working Group on Disasters Flood Thematic Pilot (poster). NASA Flood Response Workshop.

Rudari, R., S. Frye, and B. Kuligowski, 2016: CEOS Disaster Risk Management Flood Pilot. 2016 Understanding Risk Forum.

Tolomei, C., S. Salvi, A. Lugari, J. Beckers, M. Huber, G. Pezzo, and L. Rossi, 2016: Multitemporal InSAR data to develop natural hazard scenarios for the Bandung area (Western Java, Indonesia). ESA Living Planet Symposium 2016.

Questions / Discussion