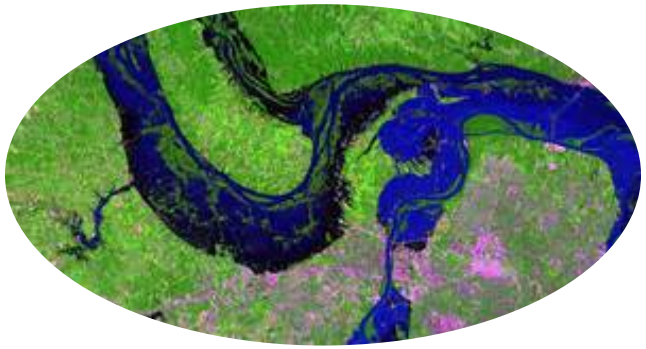
WELCOME TO
NASA APPLIED REMOTE SENSING TRAINING (ARSET)
WEBINAR SERIES

NASA REMOTE SENSING OBSERVATIONS FOR FLOOD MANAGEMENT

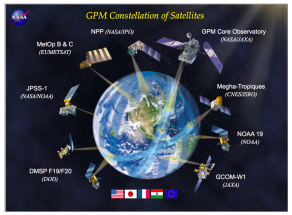
COURSE DATES: EVERY MONDAY, JUNE 8, 15, 22, 29
TIME: 8 TO 9 AM AND 1 TO 2 PM EDT



Applied Remote Sensing Training

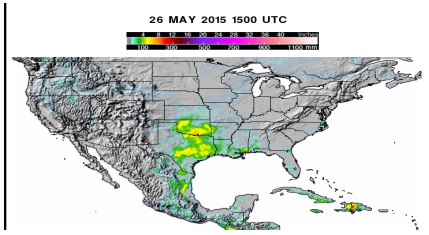
Webinar Outline

Week 1



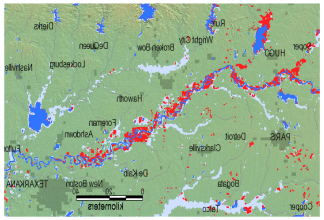
NASA Remote Sensing Data for Flood Management, Introduction to Flood Monitoring Tools

Week 2



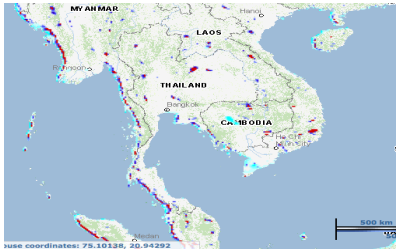
TRMM-based Flood Monitoring Web-tools

Week 3



Regional Flood Management over Africa, Demonstration of the MODIS-based Inundation Mapping

Week 4



Floodplain Management of the Mekong River, Demonstration of Selected Flooding Cases using Multiple Web-Tools and GIS

Training Team

Instructors:

- Amita Mehta (ARSET): amita.v.mehta@nasa.gov
- Brock Blevins (ARSET): bblevins37@gmail.com

Guest Speakers:

- **Ashutosh Limaye (NASA): ashutosh.limaye@nasa.gov (Week-3)**
- John Bolten (NASA): john.bolten@nasa.gov (Week-4)

Spanish Translation:

- David Barbato (ARSET): barbato1@umbc.edu

General inquiries about ARSET:

- Brock Blevins (ARSET) bblevins37@gmail.com
- Ana Prados (ARSET) aprados@umbc.edu

Important Information

Certificate of Completion (upon request):

You must attend all 4 live sessions

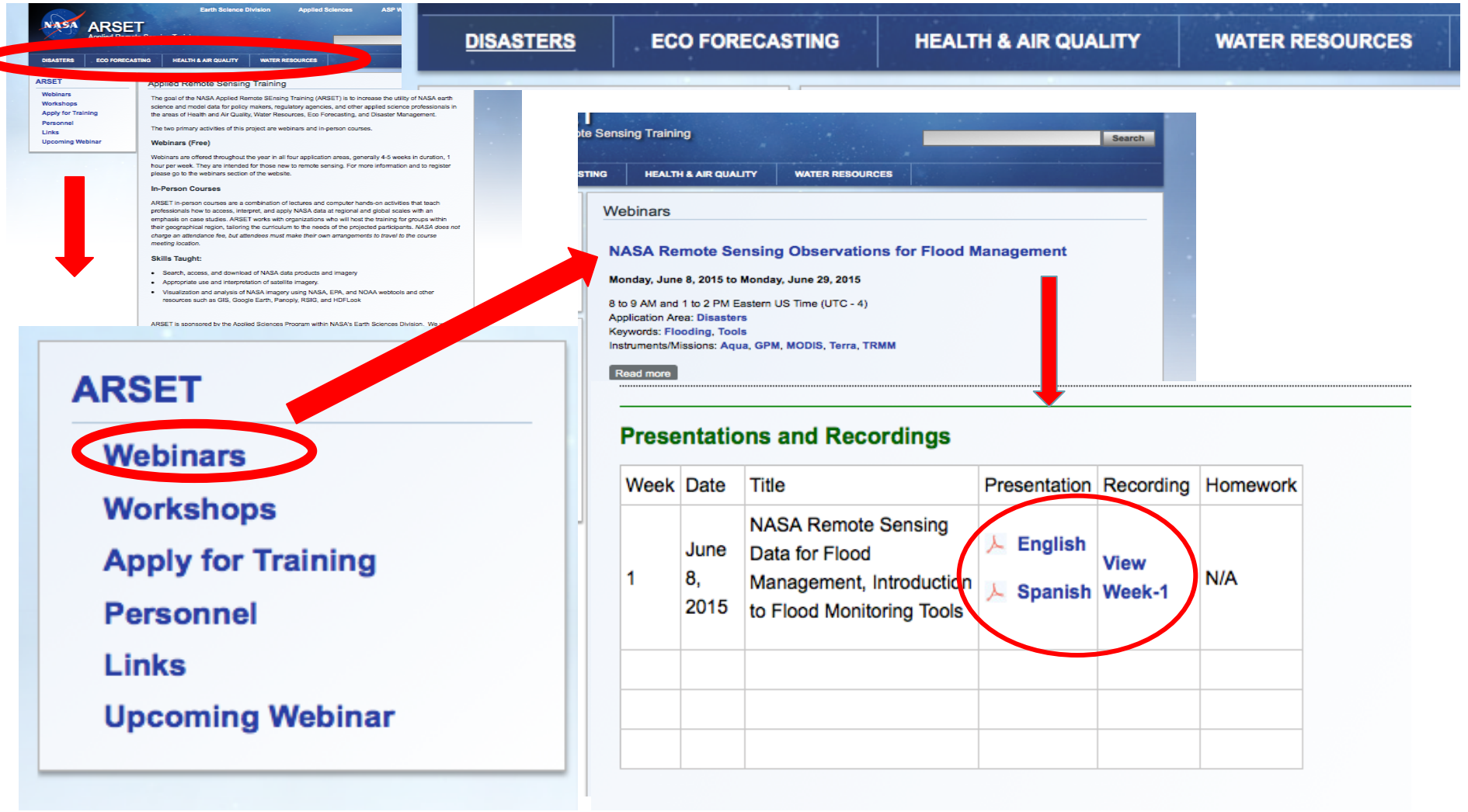
You must submit the homework assignment

(homework assignment link will be provided after Week-4)

Contact : Marines Martins

Email: marines.martins@ssaihq.com

Access to ARSET Trainings http://arset.gsfc.nasa.gov



Agenda for Week-3
Overview of the TRMM-based Flood Tools

- ‘Connecting Space to Village’
- Overview of MODIS:

i) MODIS Near-Real Time Global Flood Mapping

ii) Dartmouth Flood Observatory

iii) MODIS NRT (Live Demo)

Connecting Space to Village

Ashutosh Limaye

http://www.nasa.gov/mission_pages/servir/index.html

Connecting Space to Village

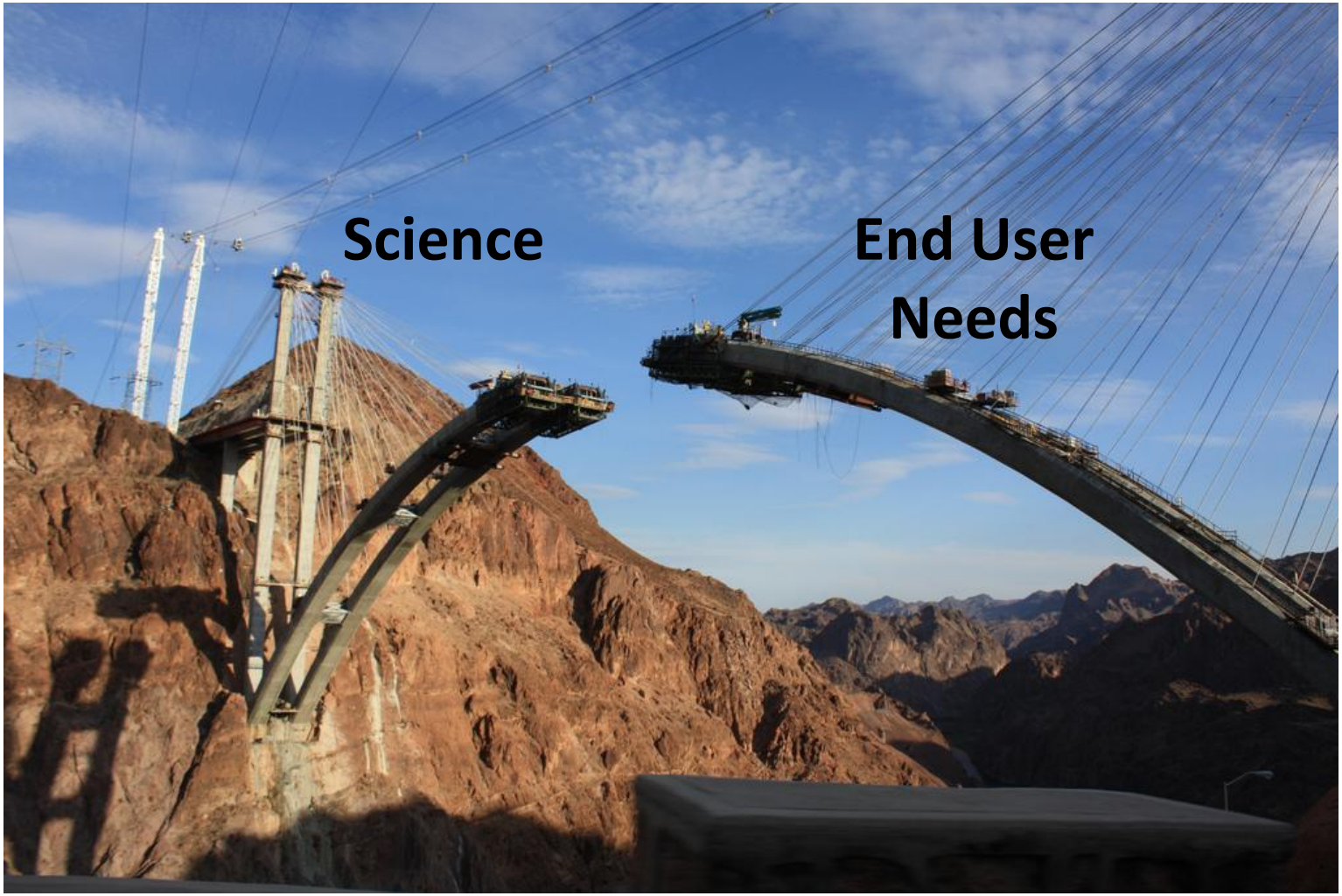
Ashutosh Limaye
SERVIR Project Scientist

SERVIR

USAID
FROM THE AMERICAN PEOPLE

NASA

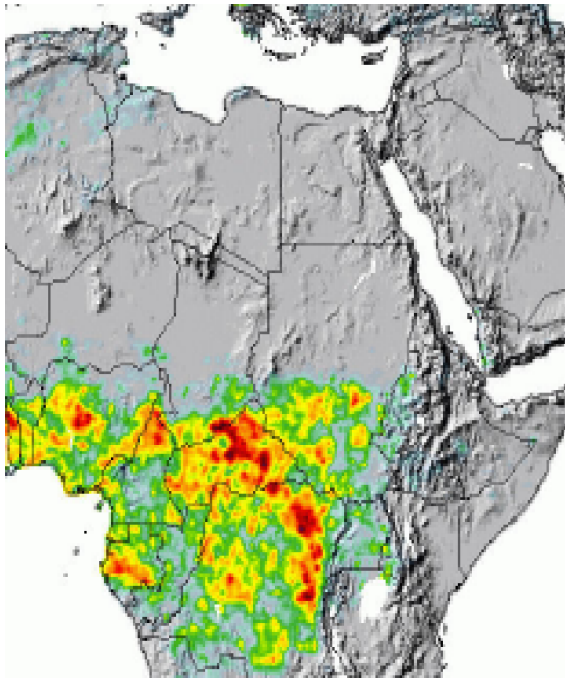
Linking Science to End User Needs



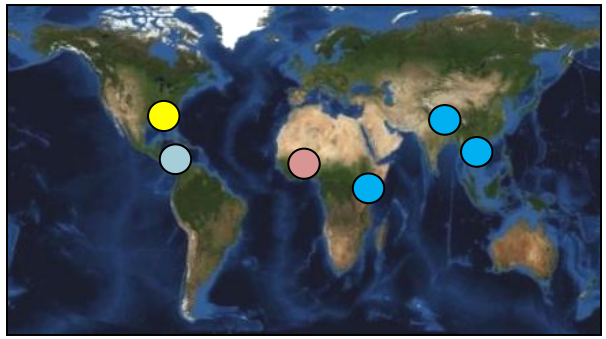
Courtesy: alifayre

What We Do

- Identify needs in SERVIR regions
- Link science products from research institutions to meet those needs through improved access to data, models, online maps, and visualizations
- Build capacity of regional institutions, stakeholders, and young professionals
- Strengthen partnerships and foster collaboration across SERVIR network



Background - Timeline



SERVIR Network

2008: SERVIR-Eastern and Southern Africa at RCMRD

2014: SERVIR-Lower Mekong

2003: SERVIR Concept

2005: SERVIR-Mesoamerica at CATHALAC

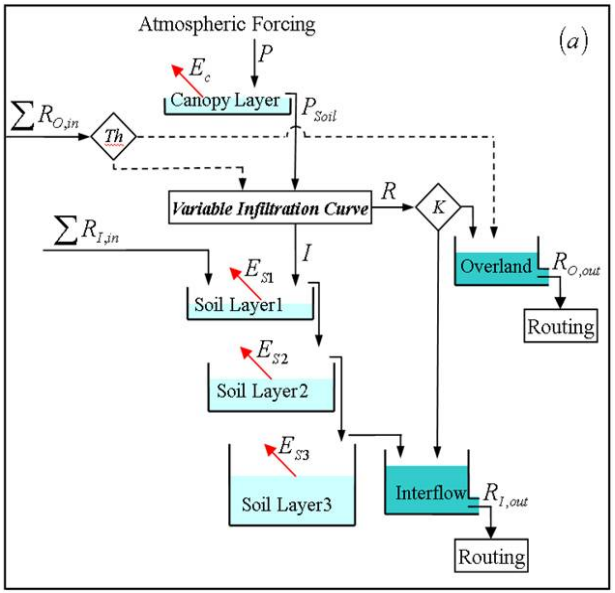
2010: SERVIR-Himalaya at ICIMOD

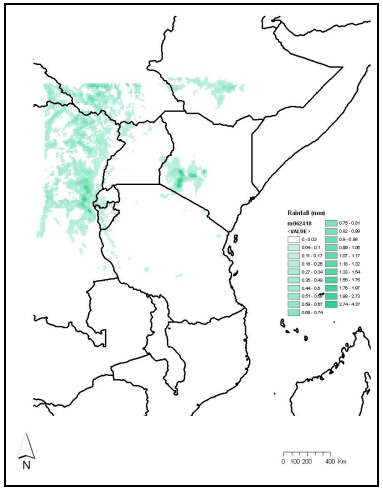
Results Summary

Results (cumulative totals)	as of Feb 2014	as of Feb 2015
People trained	1,800	2,060
Institutions with improved capacity to use Earth observations	223	322
Scientists or decision-makers participating in exchanges between SERVIR hubs or partner institutions	209	339
Stakeholders using climate information in their decision-making	976	1,139
Decision Support Tools developed	43	62
SERVIR activities in countries	29	38
SERVIR use of Earth observing sensors and products	19	22
Map Requests made	1,029,470	2,368,939
Data Layers Standardized	1,734	1,793

SERVIR Eastern and Southern Africa Hydrological Modeling

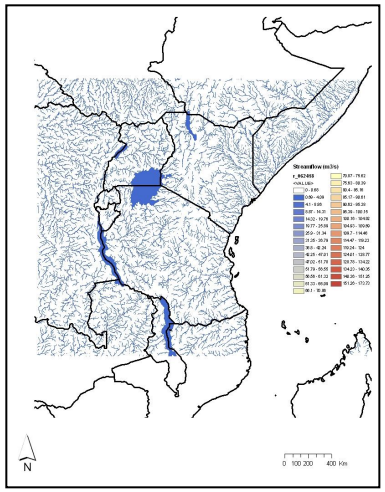
- Ministry of Water in Kenya, Rwanda, Uganda, and Namibia did not have real time assessments of hydrologic conditions
- Spatially distributed hydrologic model CREST, developed by NASA Goddard Space Flight Center for one Kenyan watershed
- Spatial resolution 1km, run every 3 hours in the Amazon cloud infrastructure
- Uses near real-time satellite-derived rainfall estimates and rainfall forecasts from Kenya Meteorological Service (KMS) to produce streamflow

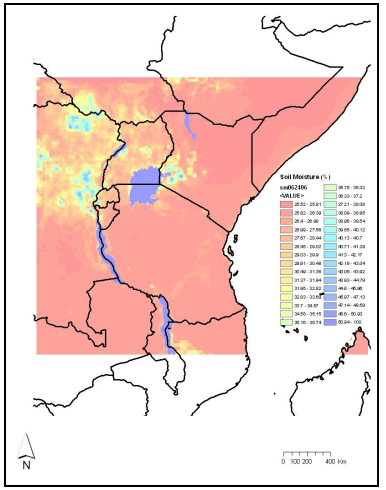




KMS QPF

Streamflow

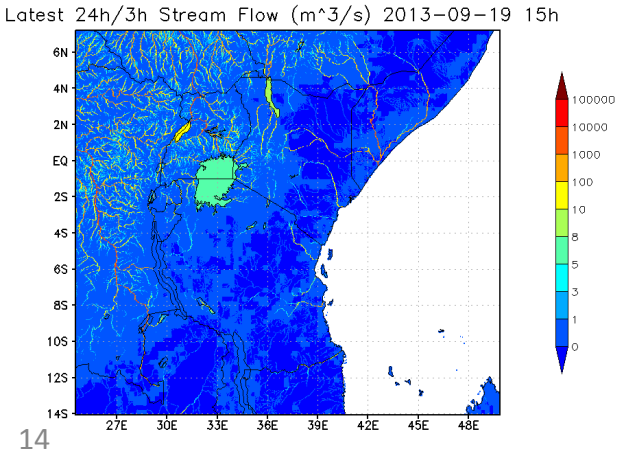


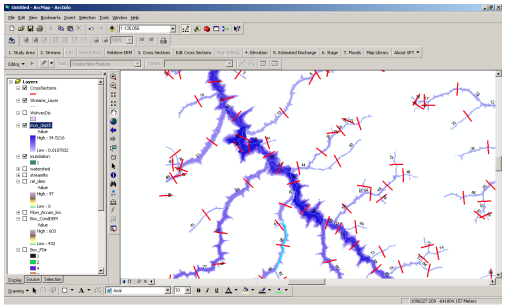


Soil Moisture

Historical Data Perspective

- 10+year historical satellite rainfall data to drive the CREST model, resulting in historical daily streamflow at 1 km resolution.
- 5^{th}, 20^{th}, 80^{th} and 95^{th} percentiles using historical data put the real time streamflow in context. Those historical and near real time data are shared with Kenya Department of Water Resources (KDWR).
- SERVIR has created additional tools for better uptake of hydrologic products from CREST. Flood mapping tool, a standalone version of USGS GIS Flood Tool, and CREST Viewer show continued use and interest.
- SERVIR is coordinating a joint working group within Kenya for hydrologic model product generation across government ministries and has resulted in wider use of model products.



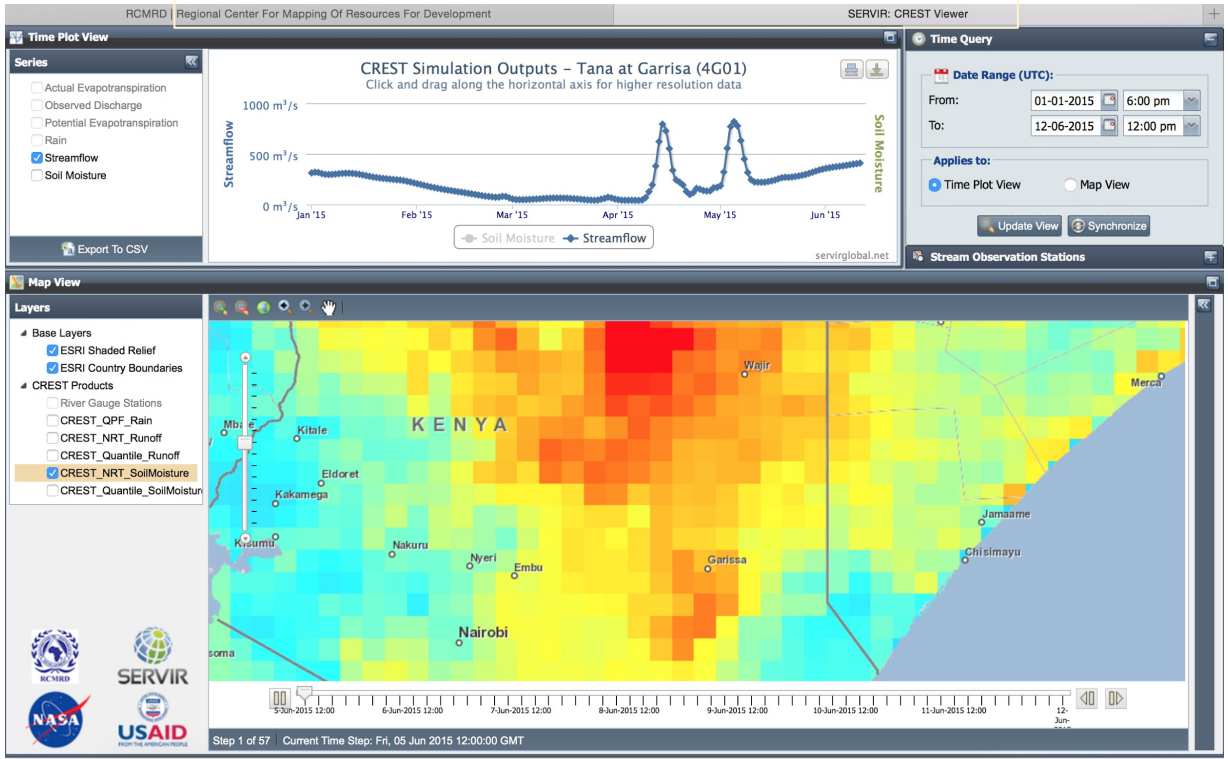


CREST Viewer

- At the request of Ministries of Water in Kenya, SERVIR Eastern and Southern Africa developed a CREST Viewer – an online visualization tool for the CREST outputs.

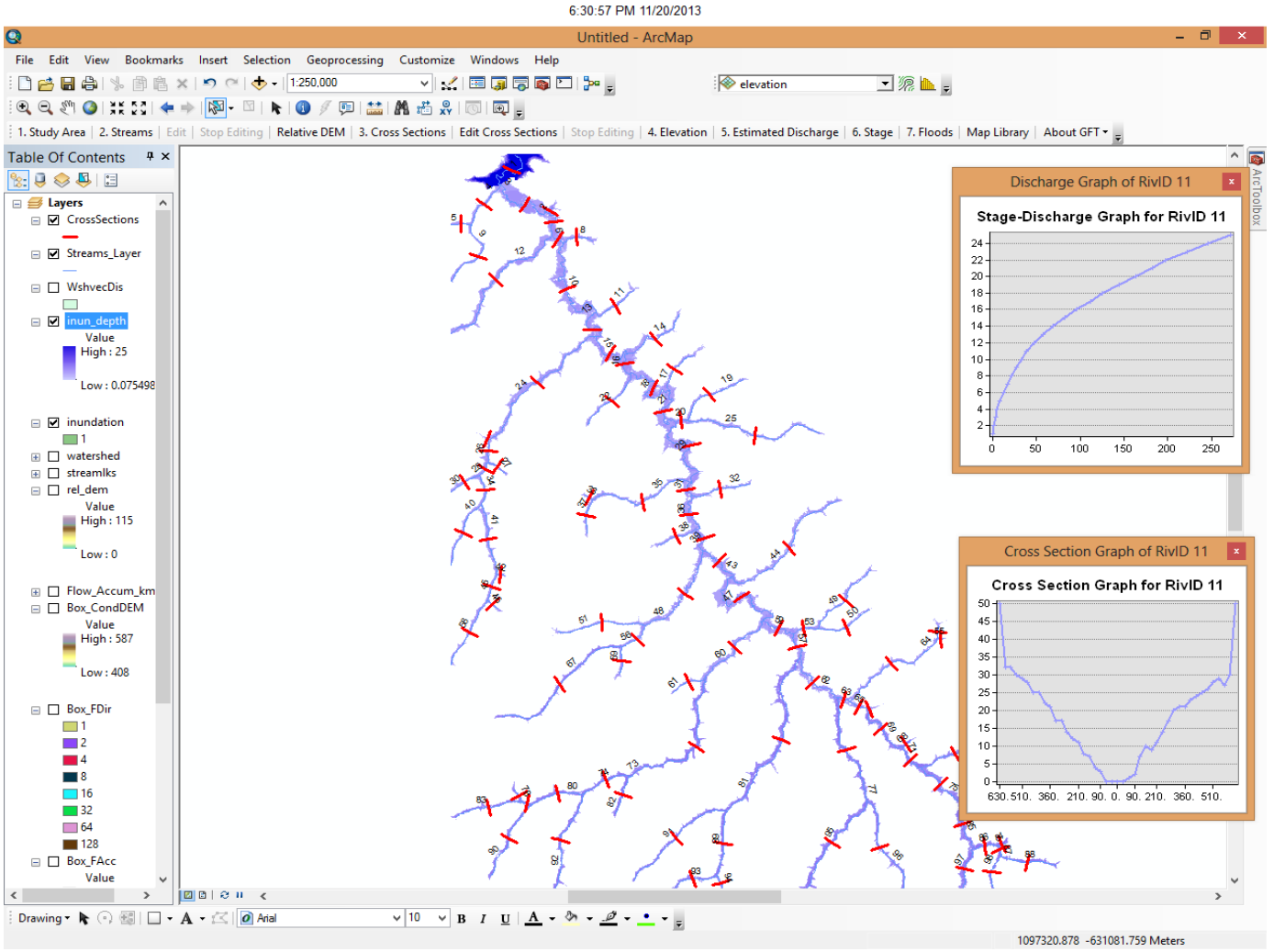
- It can display near real time, as well as historical modeled streamflow for nearly 400 locations being monitored across Eastern Africa.

- The viewer is also available on mobile platforms.
  http://ags.servirlabs.net/crestviewer/



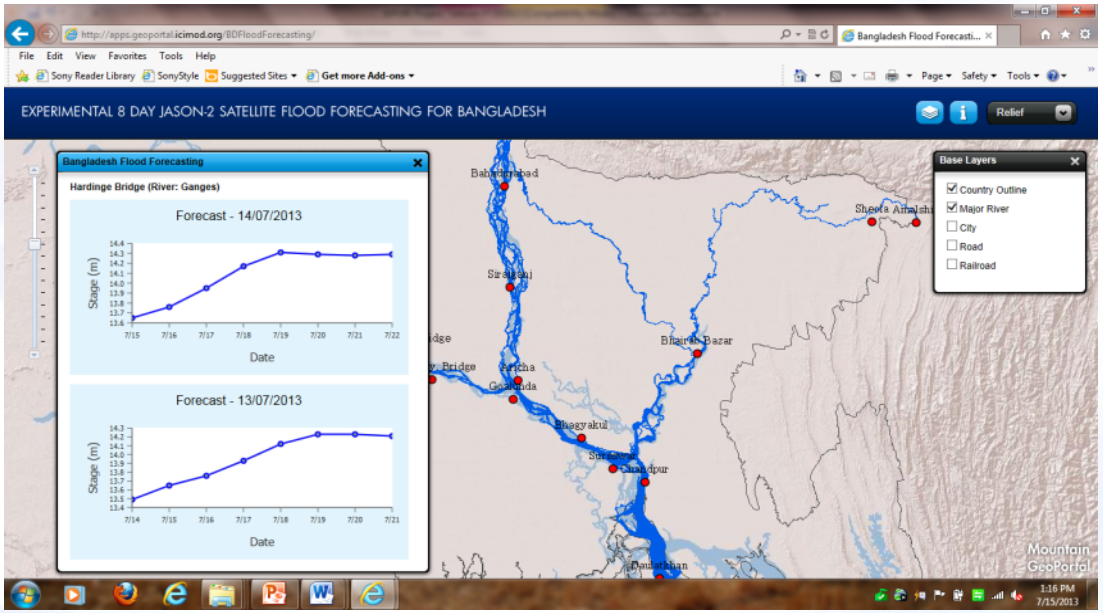
Flood Inundation Mapping

- **Problem**: Kenya Dept of Water Resources (KDWR) needed high-res elevation maps with flooded areas marked, for faster and more accurate flood planning and preparedness.
- **SERVIR Tool**: Links with satellite rainfall data, generates streamflow estimates and sends daily email updates with modeled estimates of streamflow for selected locations.
- **Results**: This tool will be released in August 2015, in collaboration with KDWR personnel.



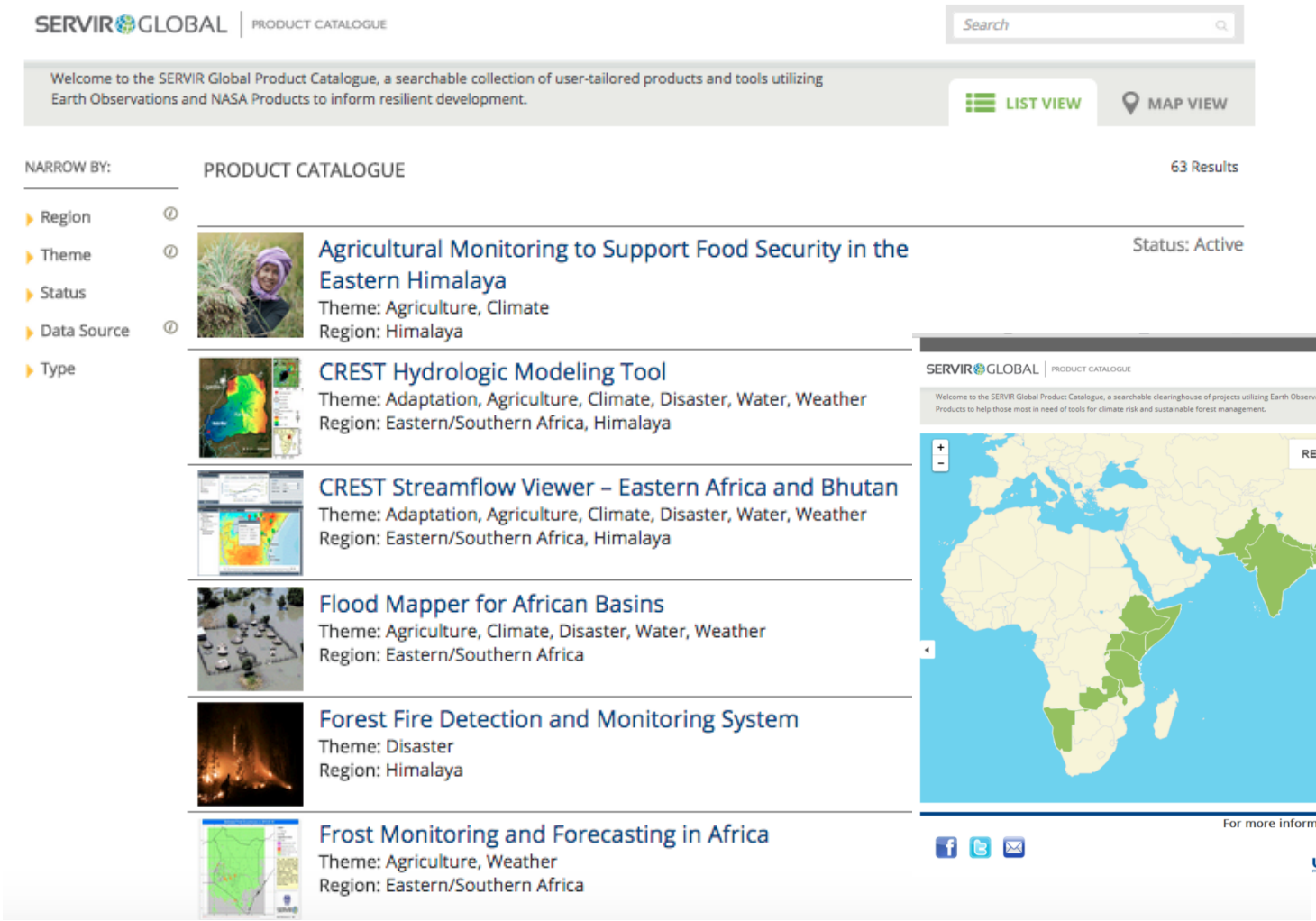
Improved Flood Forecasting in Bangladesh

- **Problem:** Bangladesh's severe flooding affects millions of residents every year. The Flood Forecast Warning Center (FFWC) issues flood forecasts in Bangladesh just 3 days in advance – insufficient time for families and farmers to prepare.
- **What SERVIR did:** A SERVIR AST effort led by Faisal Hossain linked satellite altimetry data (JASON 2) to flood forecasts. SERVIR-HKH has trained FFWC scientists to generate flood forecasts 8 days in advance using this near real time satellite data.



- **Results:** FFWC has begun generating experimental 8-day forecasts representing river levels for the 2014 monsoon season. The satellite-derived system is being run independently by FFWC. It accurately predicted August 2014 flood wave. It is adopted as part of the official forecasting system for the 2015 monsoon season. The 8-day forecasts are providing 160 million impacted citizens with longer lead time for disaster preparedness.

SERVIR Product Catalog



SERVIRcatalog.net / SERVIRcatalogue.net

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Summary

- SERVIR is a link between research institutions and end user decision making.

- SERVIR efforts are led by the needs of the region. Floods are common across the SERVIR regions. SERVIR builds capacity of technical institutions in the region to use Earth observations for improved decision making.

- Presence of SERVIR Hub, a technical institution with regional governmental support, makes the linkage sustainable.

More information:
SERVIR Global: http://www.servirglobal.net

SERVIR Contacts:
Nancy Searby – Applied Sciences Capacity Building Program Manager
Daniel Irwin – Project Director
Ashutosh Limaye – Project Scientist (Ashutosh.Limaye@nasa.gov)

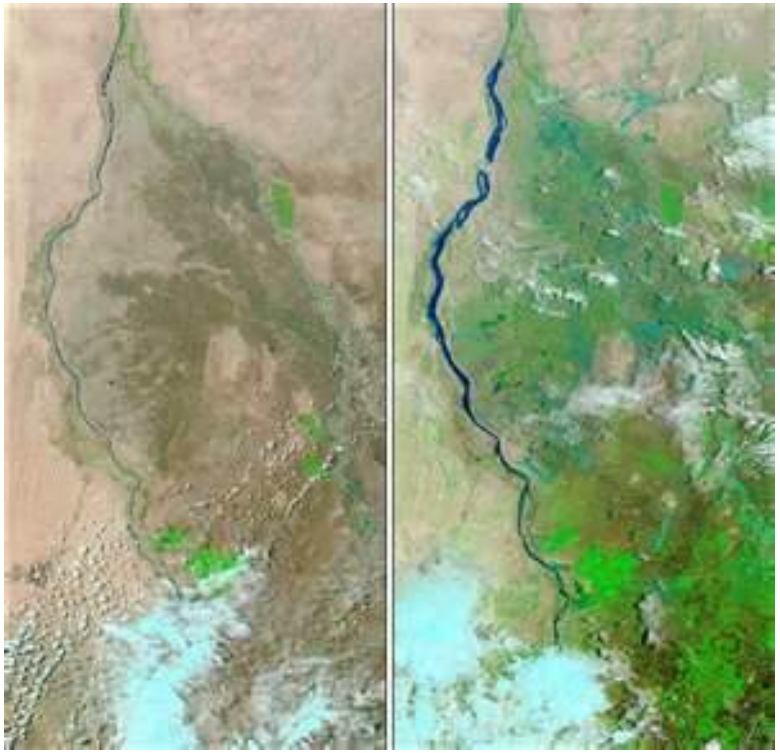
Overview of MODIS

MODerate Resolution Imaging Spectroradiometer (MODIS)

http://modis.gsfc.nasa.gov

- Flying on-board Terra and Aqua – polar orbiting satellites
- Global measurements, 1 to 2 times per day
- 36 spectral bands observing atmosphere, ocean, and land properties
- Measurement footprints vary from **250 m to ~1 km**

Aqua 6/19/2003 **Terra** 8/11/2003



Flooding along the White Nile, Sudan from the Natural Hazards page of earthobservatory.nasa.gov

MODIS Data for Inundation Mapping

MODIS Reflectance in Optical Bands 1, 2, and 7:
(620-670 nm), (841-876 nm), and (2105-2155 nm)

- MODIS provides observations of land-surface. MODIS reflectance from these bands indicates the presence of water on land surface, previously not covered by water
- A global reference database of water bodies is formed – inundation is mapped with respect to the reference water

Spatial Resolution:	250m x 250m
Spatial Coverage:	Global
Temporal Resolution:	Daily, 8-day, 16-day
Temporal Coverage:	1998 to present

MODIS Data for Inundation Mapping

Strengths:

- High Resolution, Globally Consistent
- Can provide Coastal Inundation Mapping due to storm surge or tsunamis

Limitations:

- MODIS provides surface inundation mapping only outside the water bodies, it does not provide information about water depth or water flow
- It can not view the surface in the presence of clouds
- Mountain and cloud shadows may be erroneously interpreted as water inundated surfaces

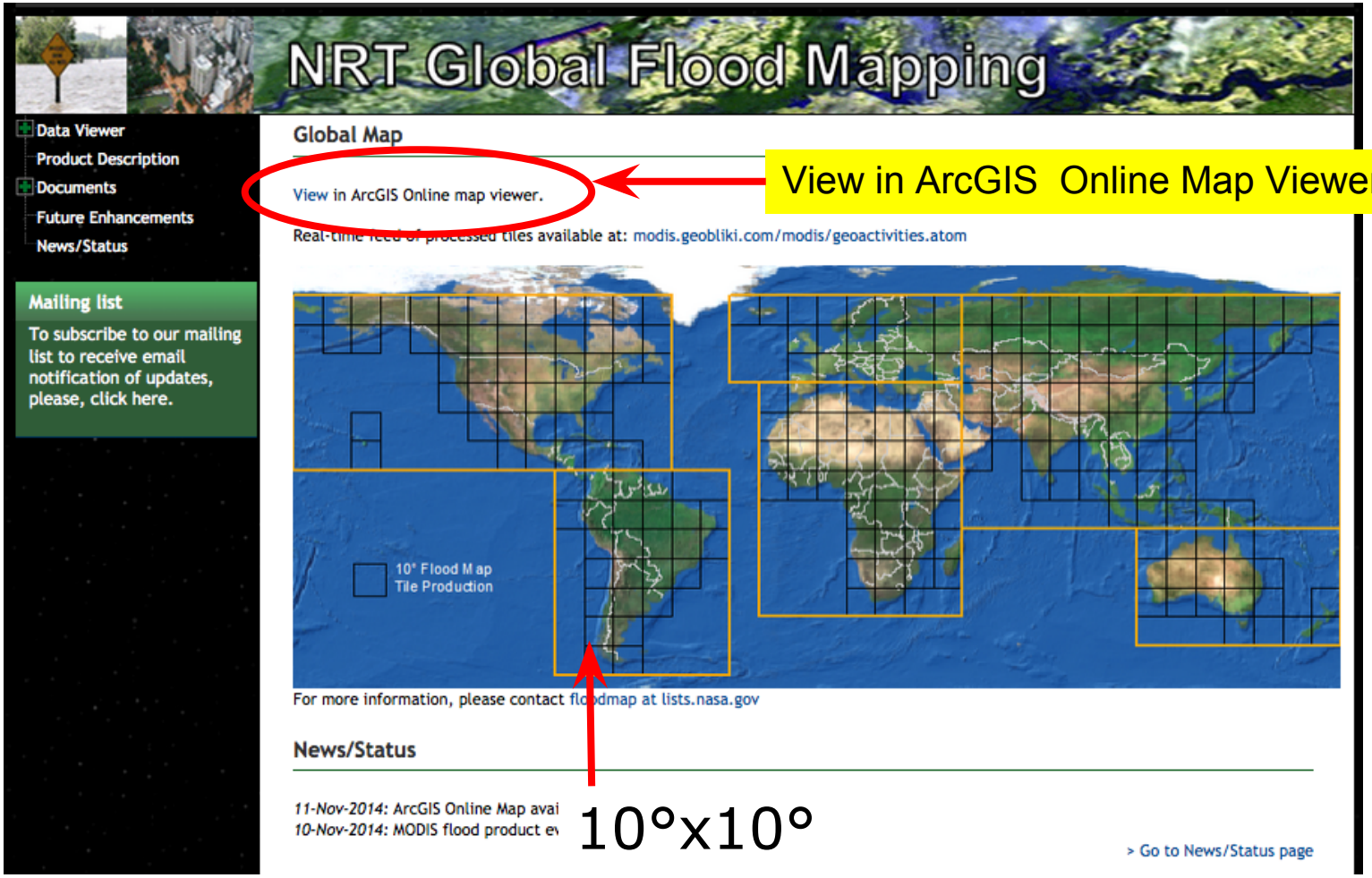
MODIS-Based Interactive Flood Tools

- Near-Real Time Global MODIS Flood Mapping
- Dartmouth Flood Observatory (DFO)

Near-Real Time Global MODIS Flood Mapping Tool

MODIS Inundation Mapping

http://oas.gsfc.nasa.gov/floodmap/

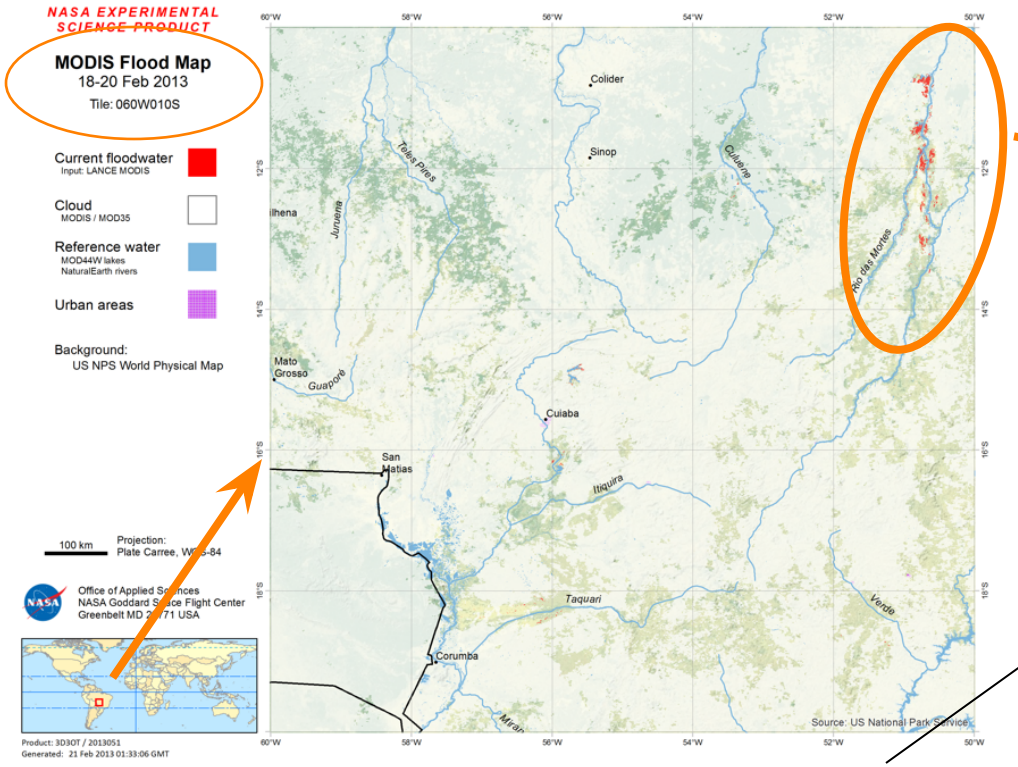


MODIS Inundation Mapping: Zoom on a region

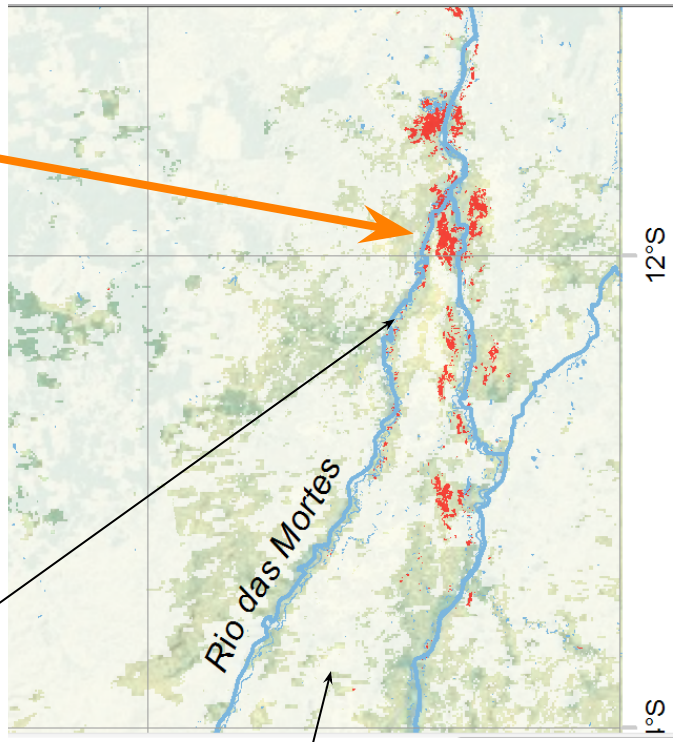
http://oas.gsfc.nasa.gov/floodmap/

Red Shading Shows Inundated Surface

Regional Mapping



Pixel size 250 m



Blue Shading Shows Reference Water

White Shading Shows Cloud Cover

MODIS Inundation Mapping

http://oas.gsfc.nasa.gov/floodmap/

PRODUCTS:

MFM: MODIS Flood Map = annotated 10x10 degree map/graphic product (currently available in png format).

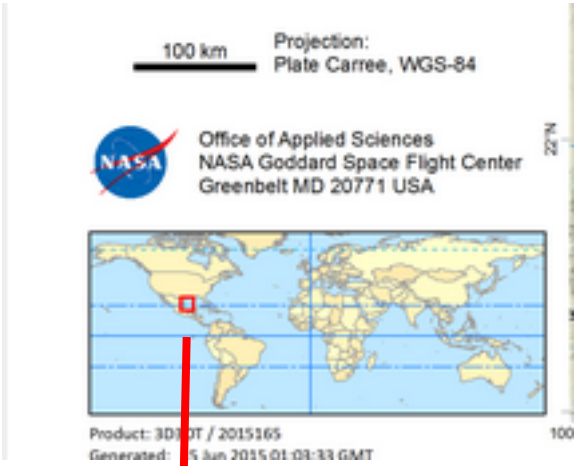
MSW: MODIS Surface Water (Pixel classified with presence of water = Reference Water + Flood Water). This is based on a ratio of MODIS bands 1, 2, and 7 reflectance values.

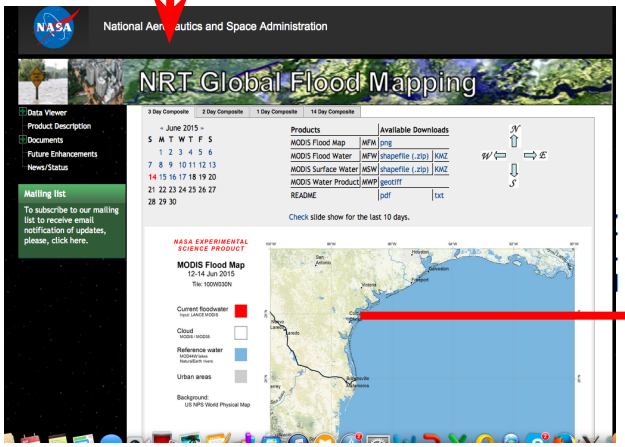
Reference Water: based on MODIS reflectance and Shuttle Radar Topography Mission Water Body Data.

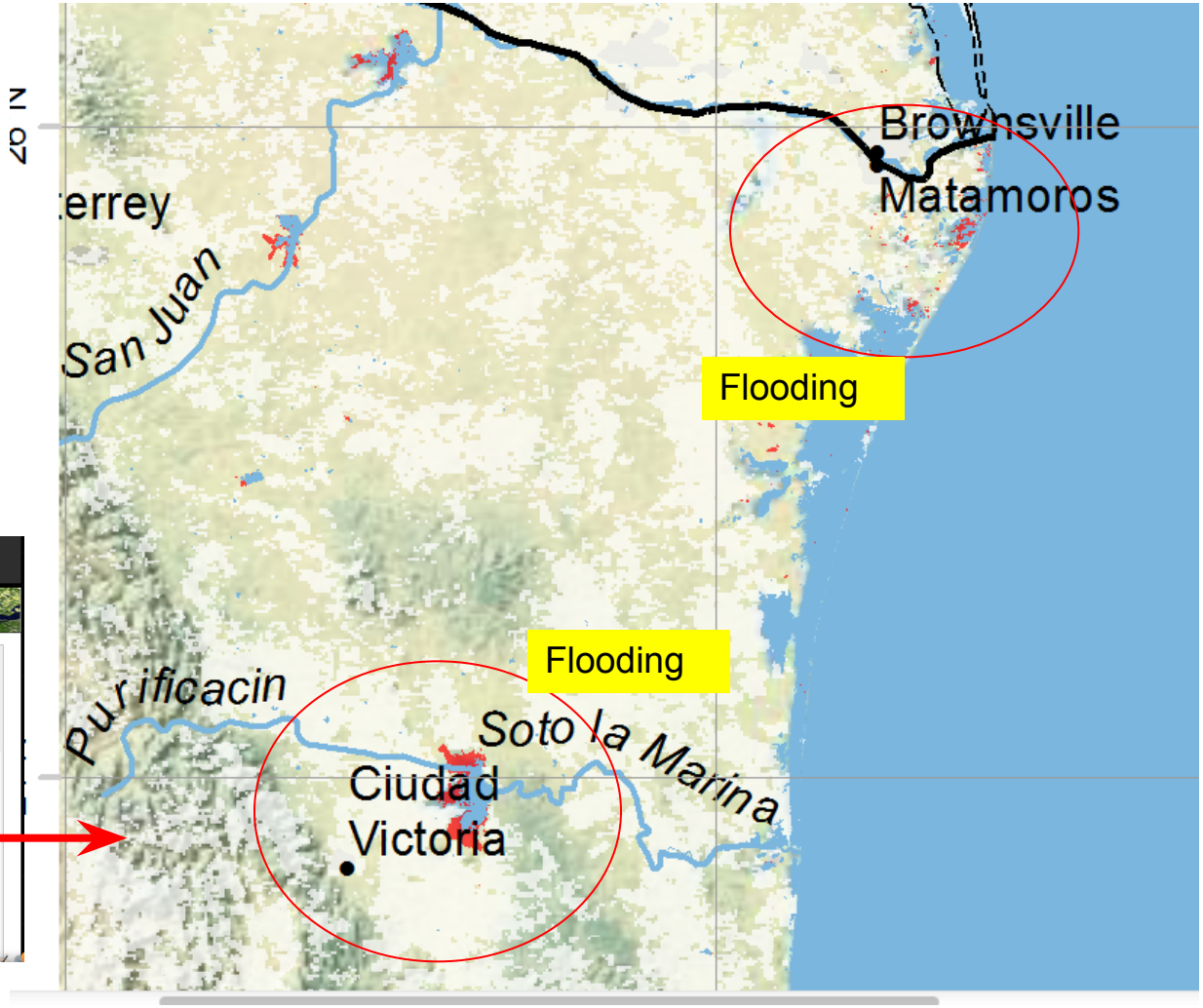
MFW: MODIS Flood Water – Obtained by subtracting Reference Water from MSW.

MWP: MODIS Water Product (Each pixel is assigned a number to identify as either undecided, water not detected, reference water detected, flood water detected where there is no reference water present)

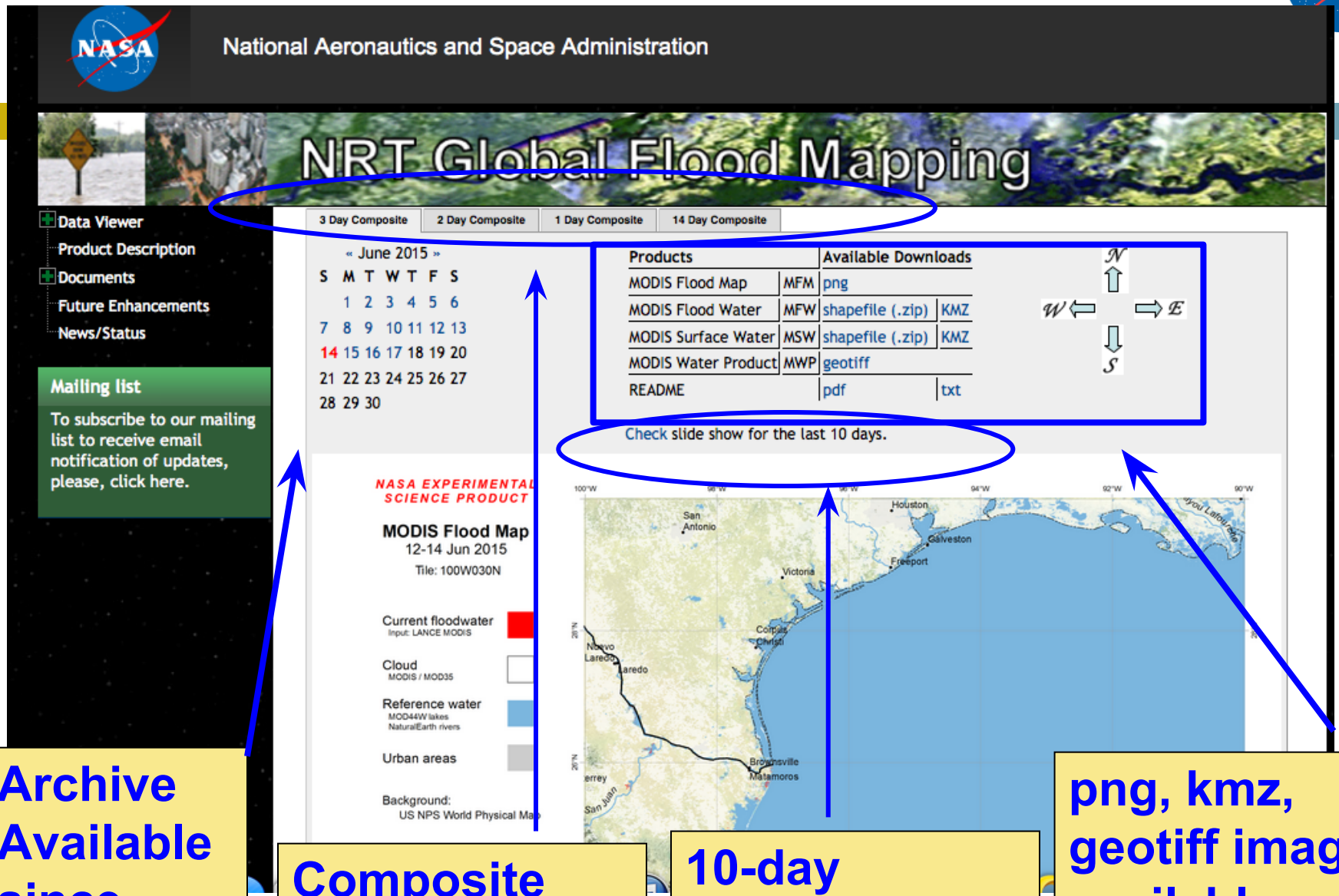
MODIS Inundation Mapping







MODIS Inundation Mapping



Archive Available since 2010

Composite Map

10-day Sequencing

png, kmz, geotiff images available

Dartmouth Flood Observatory

DFO Objectives

An Interactive Web-tool Developed for Humanitarian, Water Resources Management Research and Applications

The DFO Goals are to:

- Conduct global remote sensing-based fresh water measurement and mapping in "near real time" and record such information into a permanent archive.
- Collaborate with humanitarian and water organizations in partnerships for enabling the maximum utility of such information.
- Perform hydrological research in the area of surface water variability, using both remote sensing and modeling, and continue to develop new methods of measuring the Earth's water.

Supported by: NASA, the U.S. Geological Survey, the World Bank, the Development Bank of Latin America, the UNISDR, and from the European Commission's Global Disaster Alert and Coordination System (GDACS) at the Joint Research Centre
.

NASA Remote Sensing Observations Used by the DFO

The DFO uses:

- the MODIS Inundation Mapping Information
- TRMM-TMI (and in the future GPM GMI) Observations, together with a model to derive river discharge
- Terrain data from Shuttle Radar Topography Mission (SRTM)

Selected End-Users of the DFO

- Flood Control 2015
- Global Risk Information Platform
- Malawi Spatial Data Portal
- PreventionWeb
- European Environment Agency
- Humanitarian Early Warning Service
- GeoSUR

The DFO Website

http://floodobservatory.colorado.edu/

- Home
- Active Archive of Large Floods, 1985-Present
  - Global and Regional Analyses
- Master Index of Inundation Maps
- The Surface Water Record
- River Watch
- Other Flood Detection Tools
- Sample Images and Maps
- Staff
- Publications

Dartmouth Flood Observatory

Space-based Measurement, Mapping, and Modeling of Surface Water

For Research, Humanitarian, and Water Management Applications

Flood Observatory Director

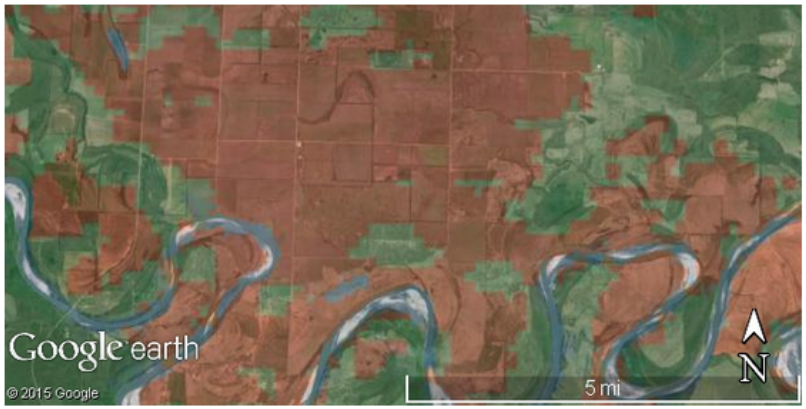
Observatory Mission Statement

Community Surface Dynamics Modeling System

University of Colorado, Campus Box 450, Boulder, CO 80309 USA

For latest data, flooding in E. Texas and region, DFO #4134, May-June, 2015

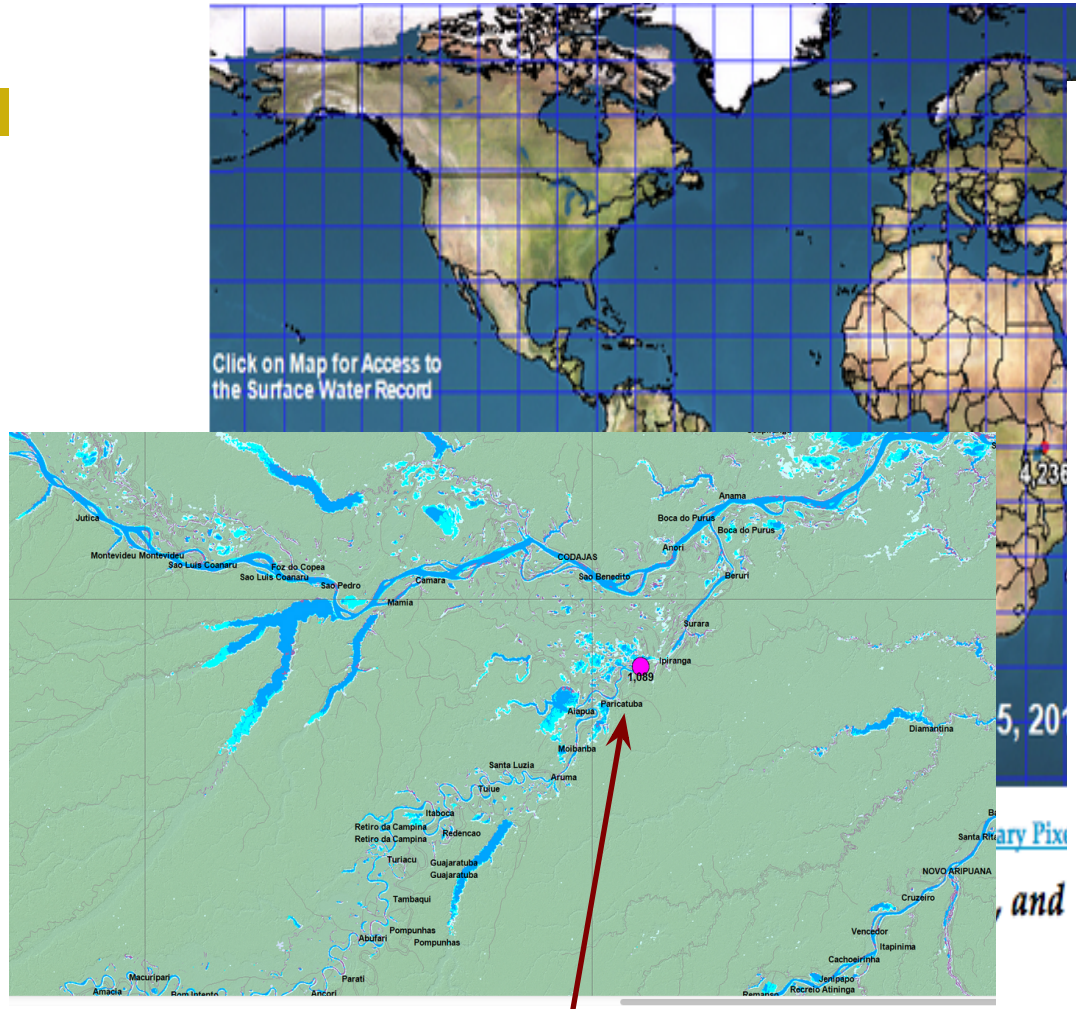
Tour the flooding Red River Valley, Arkansas and Oklahoma, June 17, 2015



Featured Event of Regional Flooding - Updated Daily

Global Flood Events Using MODIS Inundation

http://floodobservatory.colorado.edu/



Select the Flood Event

Map Legend

At the time of map date:

Large areas of purple are dry land (formerly water in February, 2000, when the reference SWBD water database was obtained). At higher latitudes, such areas may be ice-covered water.

Small areas of purple are water SWBD, mapped by but are too small to be mappable by MODIS.

Dark blue is current water, imaged by MODIS and by SWBD in 2000 ("permanent" water).

Bright blue is flooding: expanded water areas mapped by MODIS compared to reference water. Any post-2000 reservoir or new water body is also depicted in bright blue.

Light blue-gray is all previous flooding imaged and mapped by the Flood Observatory (now dry land). Note: in mountainous areas, local shadows are commonly mis-classified as water.

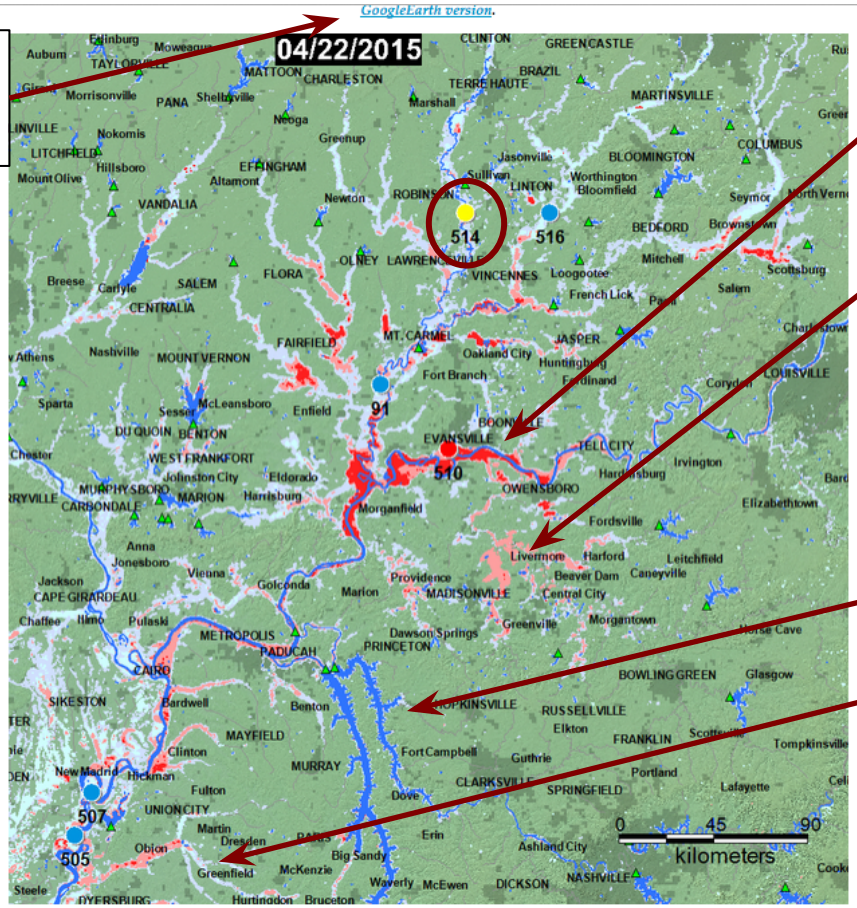
Regional Flooding Event Using the NASA MODIS Inundation Mapping Tool

http://floodobservatory.colorado.edu/

Click for more information

Featured Flood Event: #4230, Ohio and Wabash Valleys, USA

View in Google Earth



Red: Flooding within the past 14 days (MODIS automated product)

Light Red: Flooded during this event, from earlier MODIS coverage or non-automated MODIS mapping.

Darker Red: Flooded areas from high resolution Sentinel 1 or Landsat 8 data.

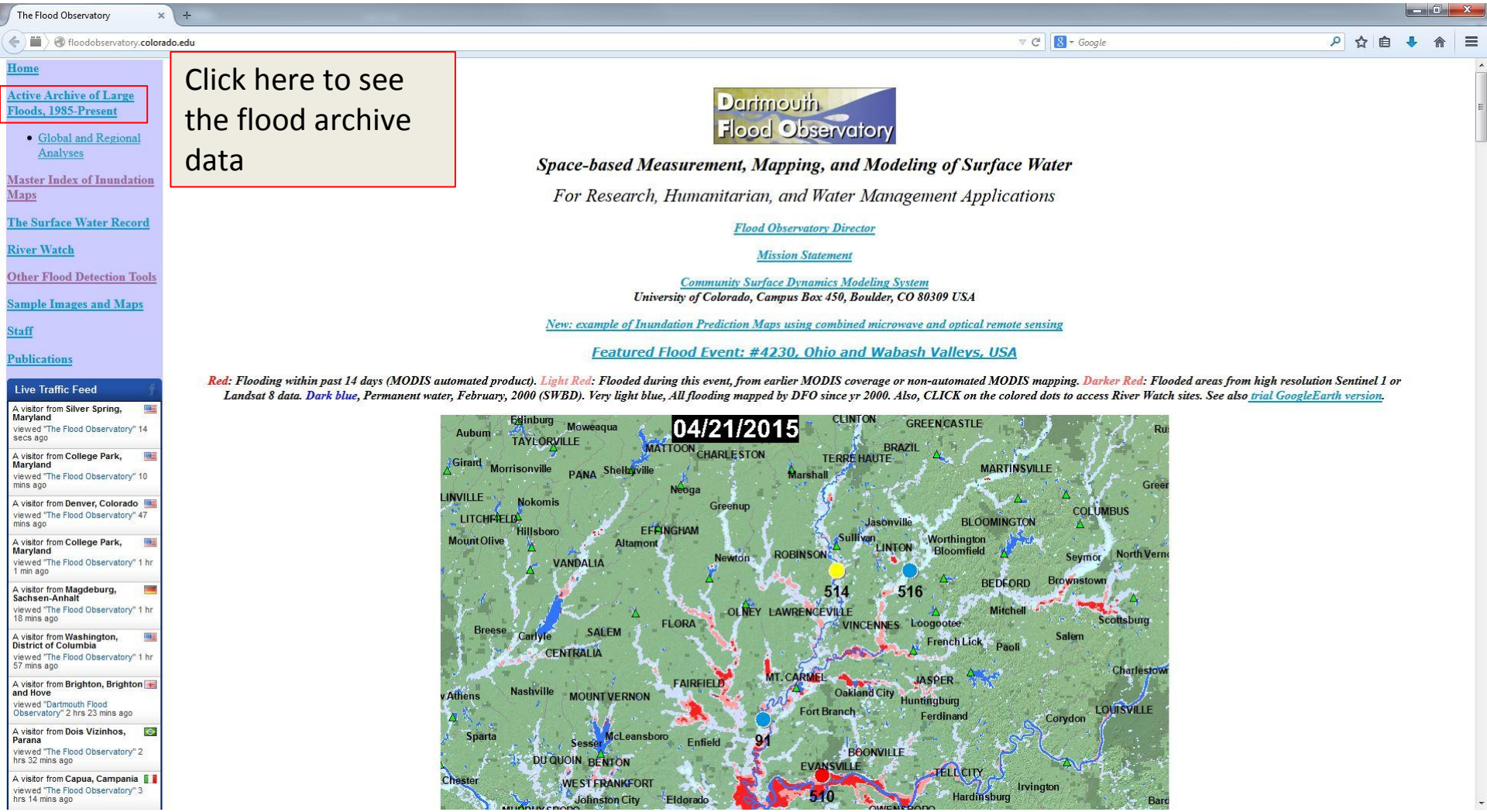
Dark blue, Permanent water, February, 2000 (SWBD).

Very light blue, All flooding mapped by DFO since year 2000.

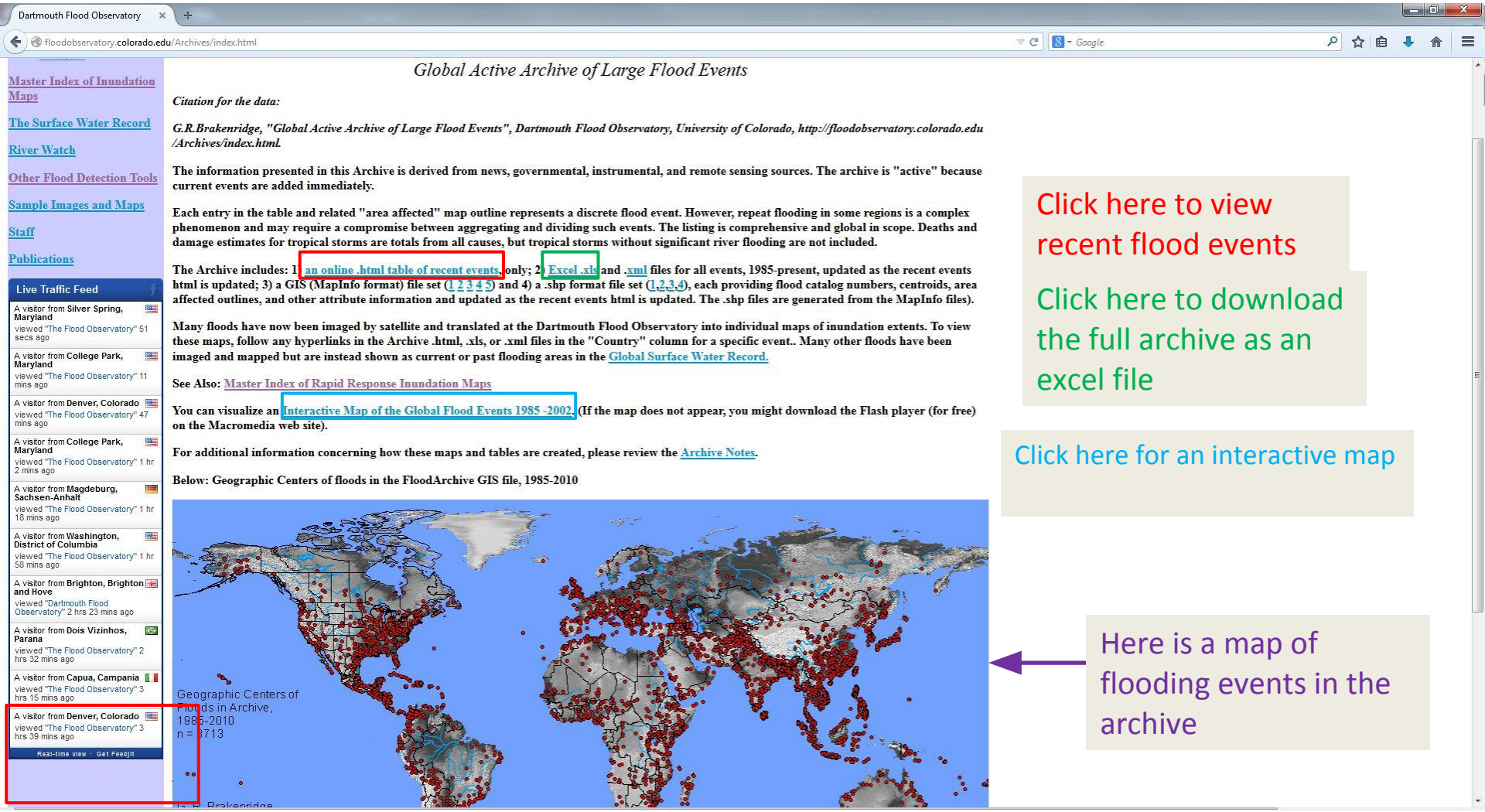
CLICK on the colored dots to *access River Watch Site*

Featured Event of Regional Flooding – Updated Daily

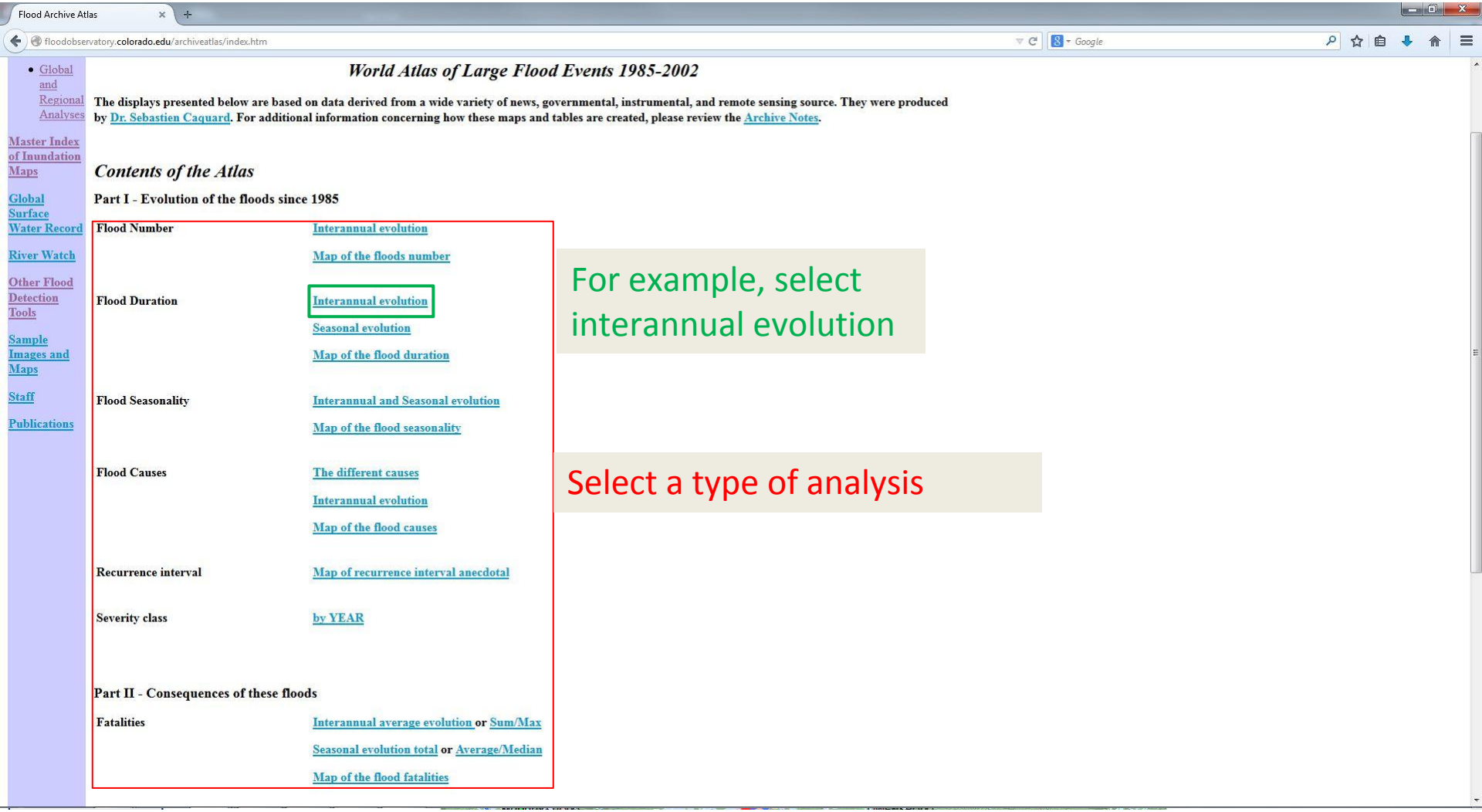
Global Flood Archives



DFO: Flood Archive Information



Flood Analysis



For example, select interannual evolution

Select a type of analysis

Live Demonstration of MODIS NRT Flood Mapping

Next Week:

1) Floodplain Management of the Mekong River

2) Demonstration of Selected Flooding Cases using Multiple Web-Tools and GIS

Thank You!

Amita Mehta

email: amita.v.mehta@nasa.gov