# Introduction to Dartmouth Flood Observatory (DFO)


# Objective

To provide an overview of DFO for Flood Mapping and River Discharge Monitoring

# Outline

- About the DFO
- *Global and Regional Flooding Information*
- DFO River Watch
- Case study: Colombia Flood Event

# About the Dartmouth Flood Observatory (DFO)

# 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

# GeoSUR Uses DFO River Discharge and Flood Mapping Tools

http://www.geosur.info/geosur/index.php/en/flood-mapping-in-near-real-time

# Global and Regional Flooding Information from the DFO

# 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*

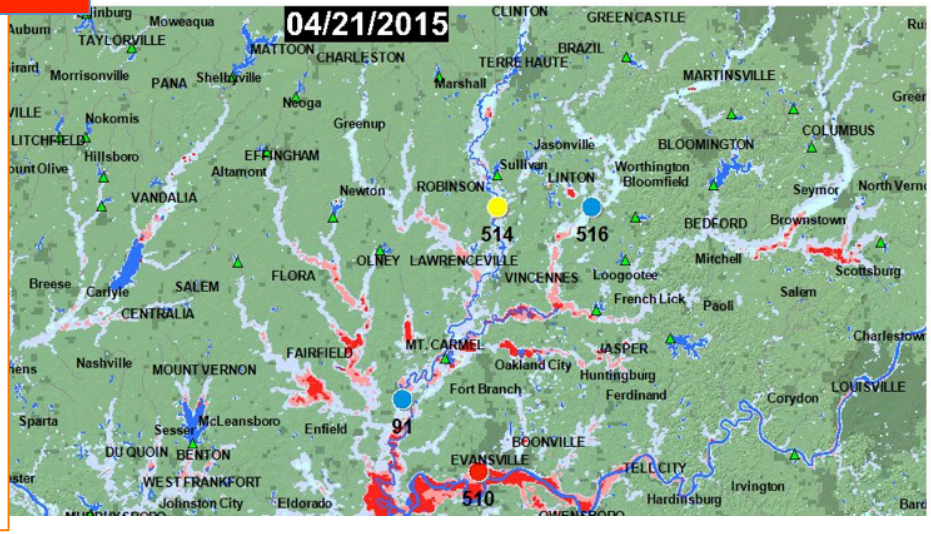
*Mission Statement*

*Community Surface Dynamics Modeling System*
*University of Colorado, Campus Box 450, Boulder, CO 80309 USA*

*New: example of Inundation Prediction Maps using combined microwave and optical remote sensing*

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

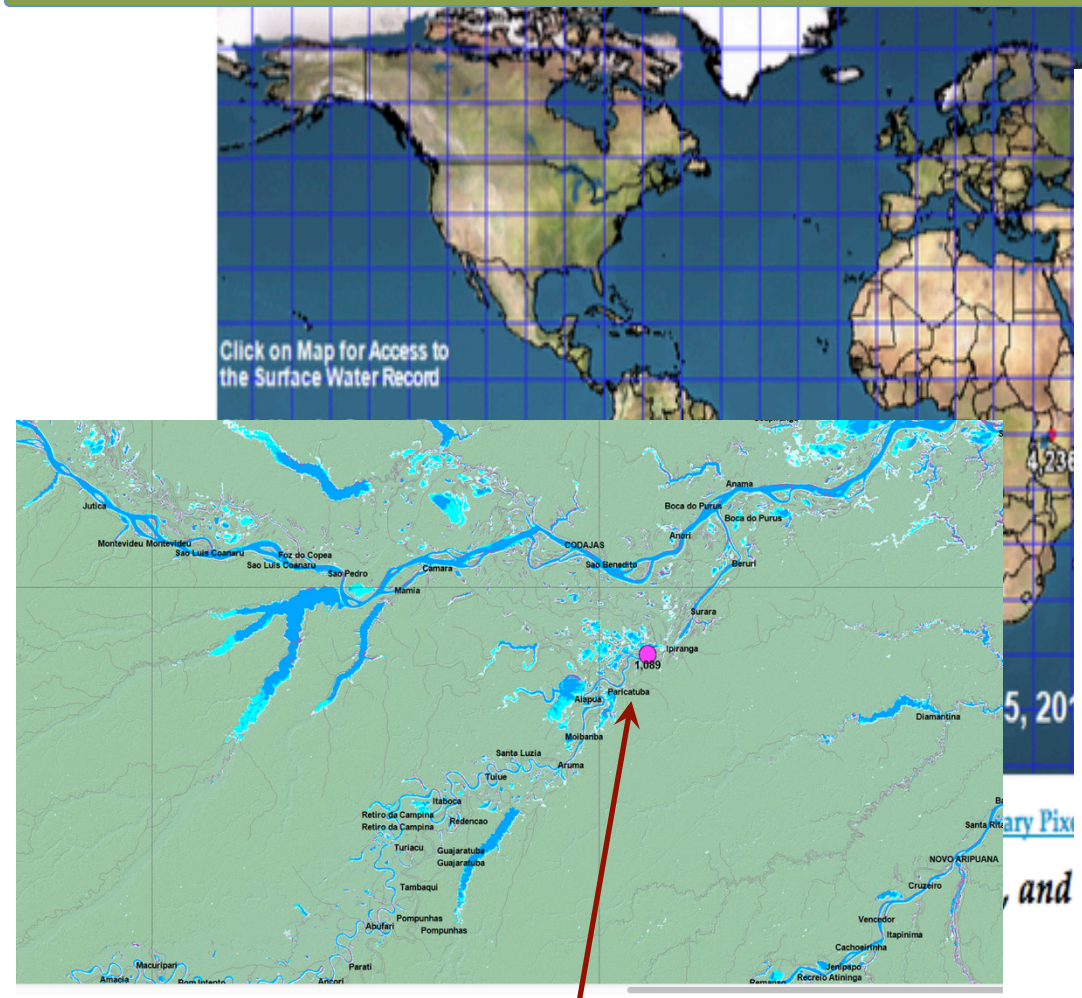
*nated product). Light Red: Flooded during this event, from earlier MODIS coverage or non-automated MODIS mapping. Darker Red: Flooded areas from high resolution Sentinel 1 or February, 2000 (SWBD). Very light blue, All flooding mapped by DFO since yr 2000. Also, CLICK on the colored dots to access River Watch sites. See also trial GoogleEarth version.*




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.

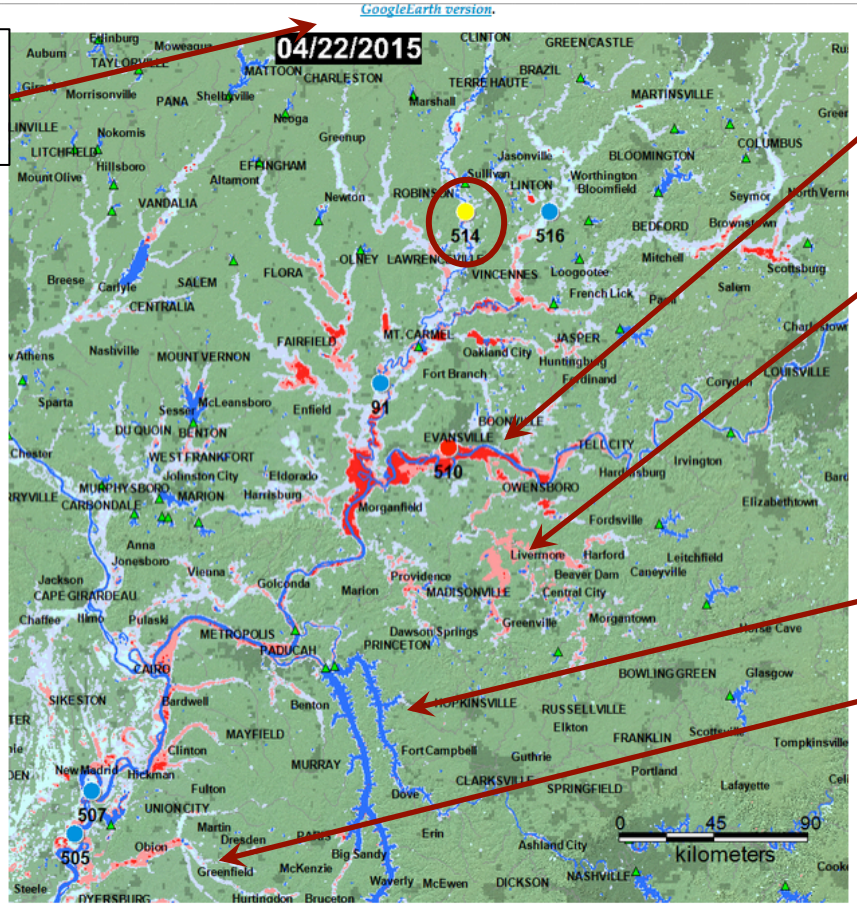
# Regional Flooding Event Using the NASA MODIS Inundation Mapping Tool

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

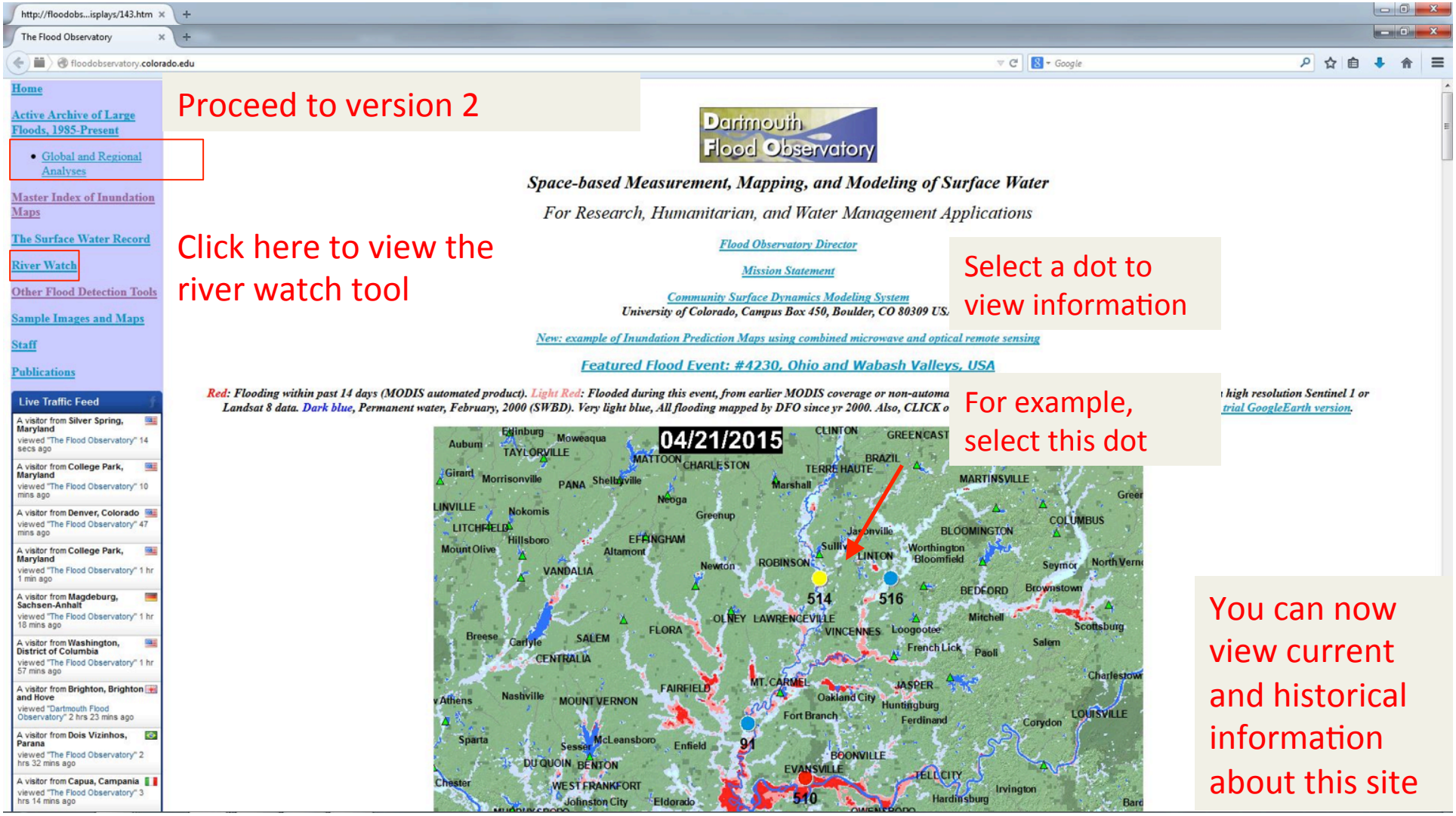
# DFO: River Watch

- TRMM Microwave Imager, GPM Microwave Imager, and Advanced Microwave Scanning Radiometer-2 from GCOM-W (a Japanese Space Agency mission) observations are sensitive to the proportion of water and dry land.

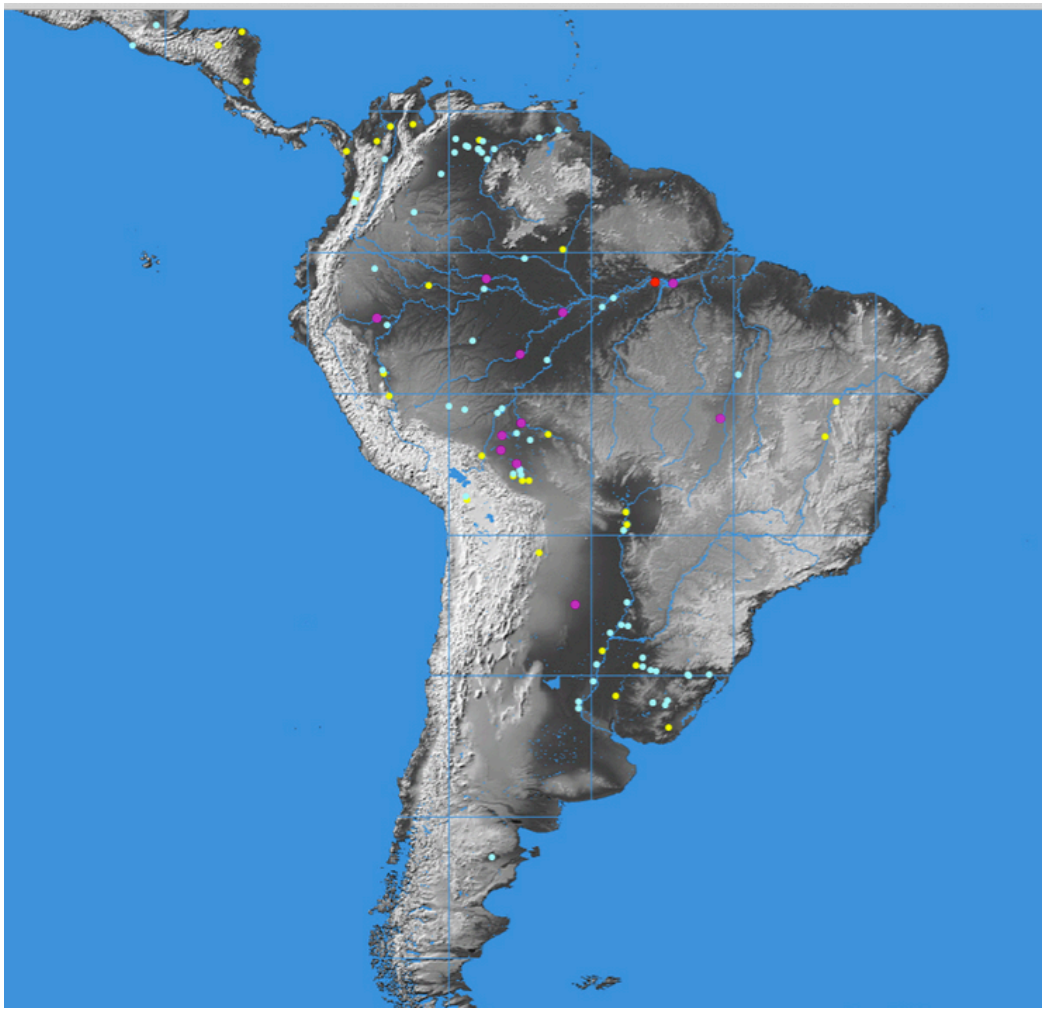
- **These Microwave observations are converted to actual river discharge** (similar to streamflow, cubic meter of water flowing per second) by combining them with surface discharge measurements and then to runoff by using a Water Balance Model (WBM).

- Runoff calculations are available starting in 2003, seven-day runoff deviation starts in 2003-2007. Mean runoff is mapped to indicate low, normal, moderate flooding, and major flooding.

# DFO: River Watch for a Flood Event



# DFO: River Watch



Updated Daily at 14:00 MDT

1) In early 2014, many new sites are being added for Latin America in cooperation with local water ministries and the GeoSUR project.

2) New data from JAXA's AMSR-2 aboard GCOM-W and from NASA's GPM is allowing re-establishment of river measurement sites at higher latitudes.

**White triangles**: ice covered.
**Yellow dots**: low flow (<5th percentile mean daily runoff for this date, 1998-2012)
**Blue dots:** normal flow;
**Purple dots**: moderate flooding (>1.33 yr recurrence)
**Red dots:** major flooding (> 5 yr recurrence)

# More Information on Flooding

# Global Flood Archives

Click here to see the flood archive data

The Flood Observatory

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

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Sample Images and Maps

Staff

Publications

Live Traffic Feed

A visitor from Silver Spring, Maryland viewed "The Flood Observatory" 14 secs ago

A visitor from College Park, Maryland viewed "The Flood Observatory" 10 mins ago

A visitor from Denver, Colorado viewed "The Flood Observatory" 47 mins ago

A visitor from College Park, Maryland viewed "The Flood Observatory" 1 hr 1 min ago

A visitor from Magdeburg, Sachsen-Anhalt viewed "The Flood Observatory" 1 hr 18 mins ago

A visitor from Washington, District of Columbia viewed "The Flood Observatory" 1 hr 57 mins ago

A visitor from Brighton, Brighton and Hove viewed "Dartmouth Flood Observatory" 2 hrs 23 mins ago

A visitor from Dois Vizinhos, Parana viewed "The Flood Observatory" 2 hrs 32 mins ago

A visitor from Capua, Campania viewed "The Flood Observatory" 3 hrs 14 mins ago

Dartmouth Flood Observatory

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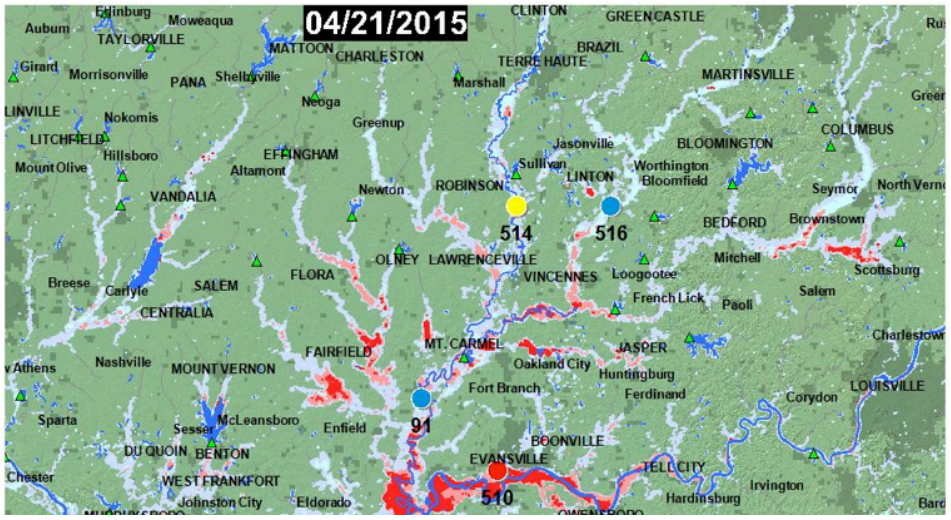
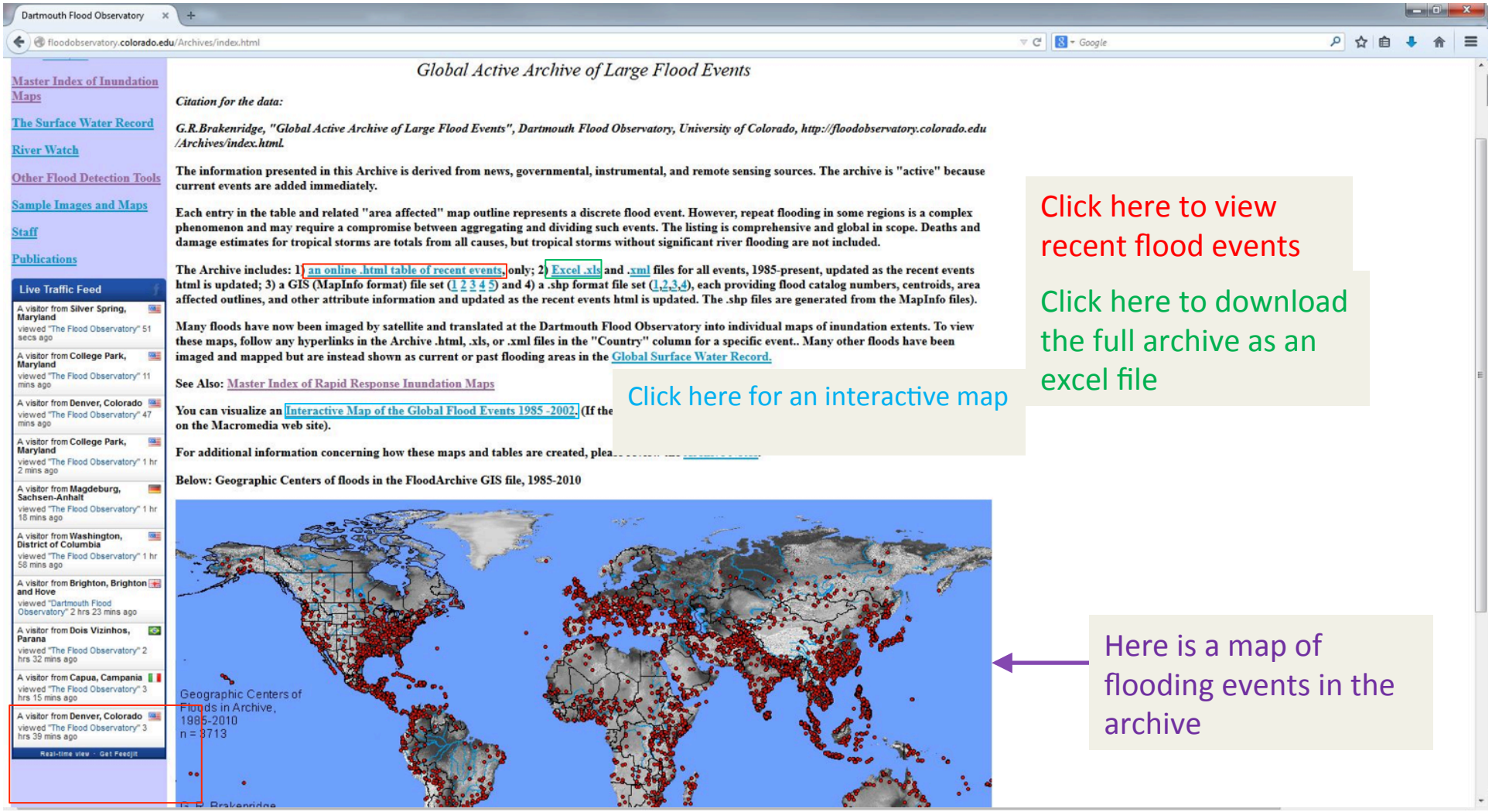
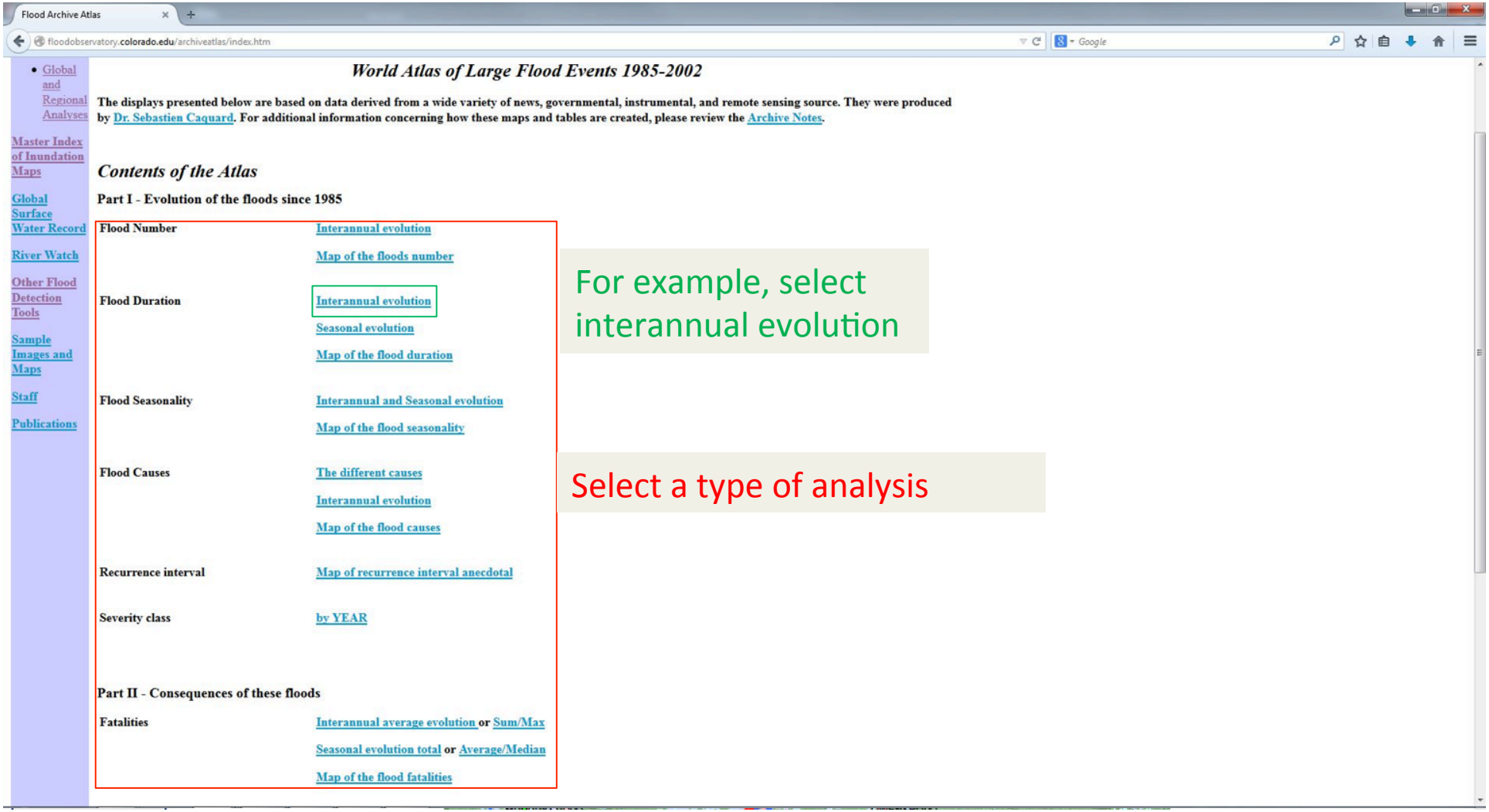


# DFO: Flood Archive Information



# Flood Analysis




For example, select interannual evolution

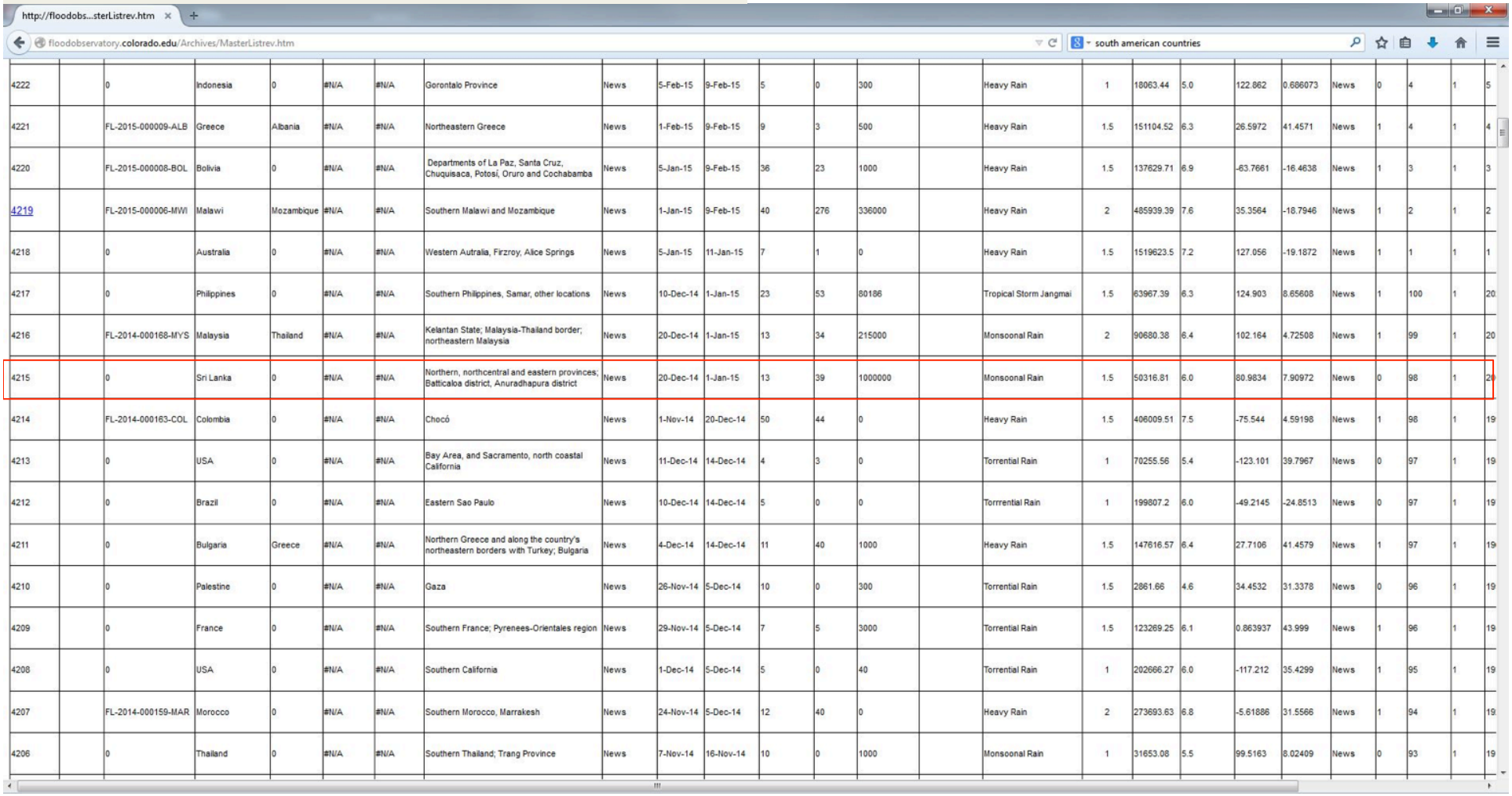
Select a type of analysis

# Flood Event Example

Chocó, Colombia

11/1/14-12/20/14

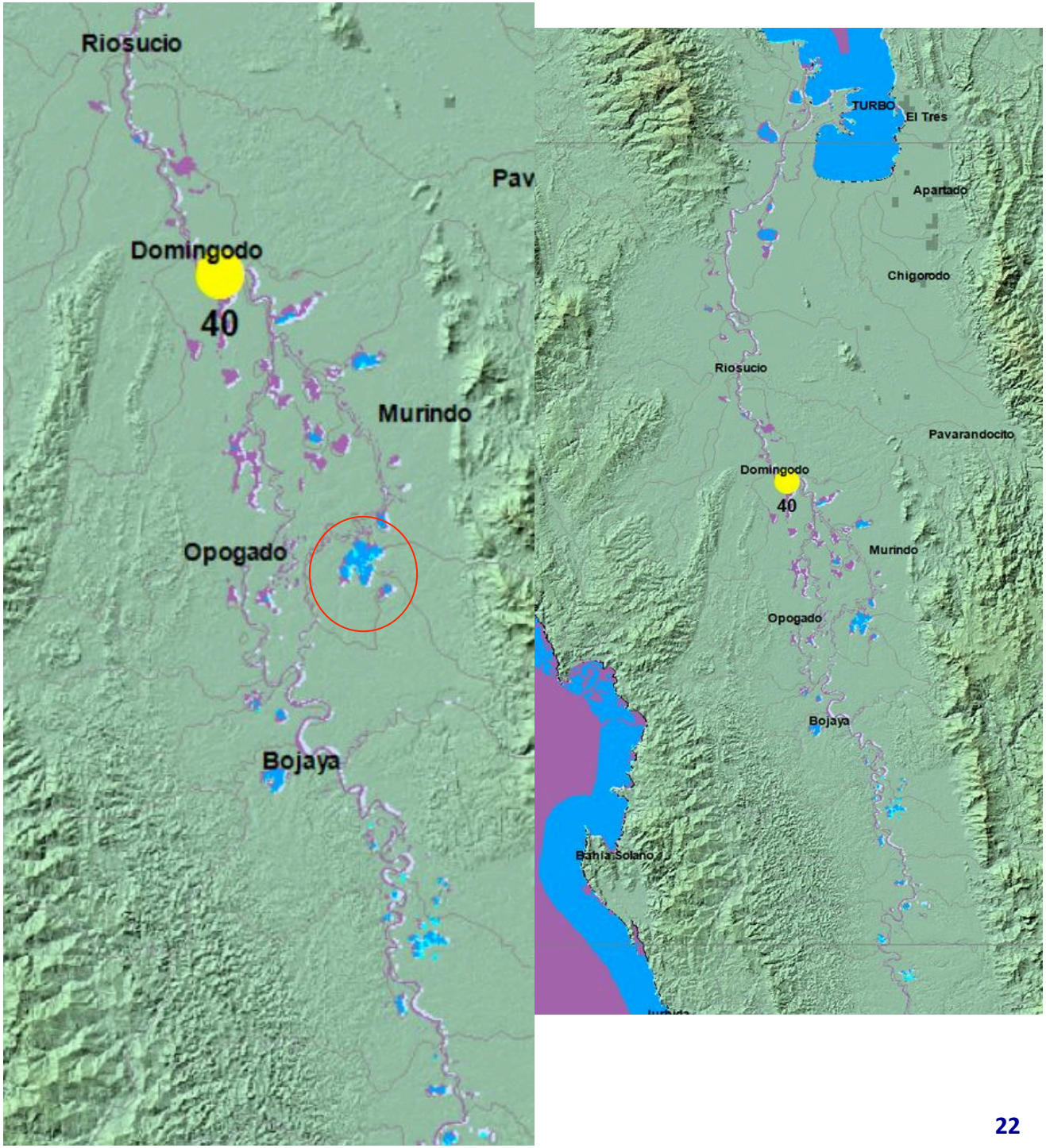
# The Flood event in the recent flood archive

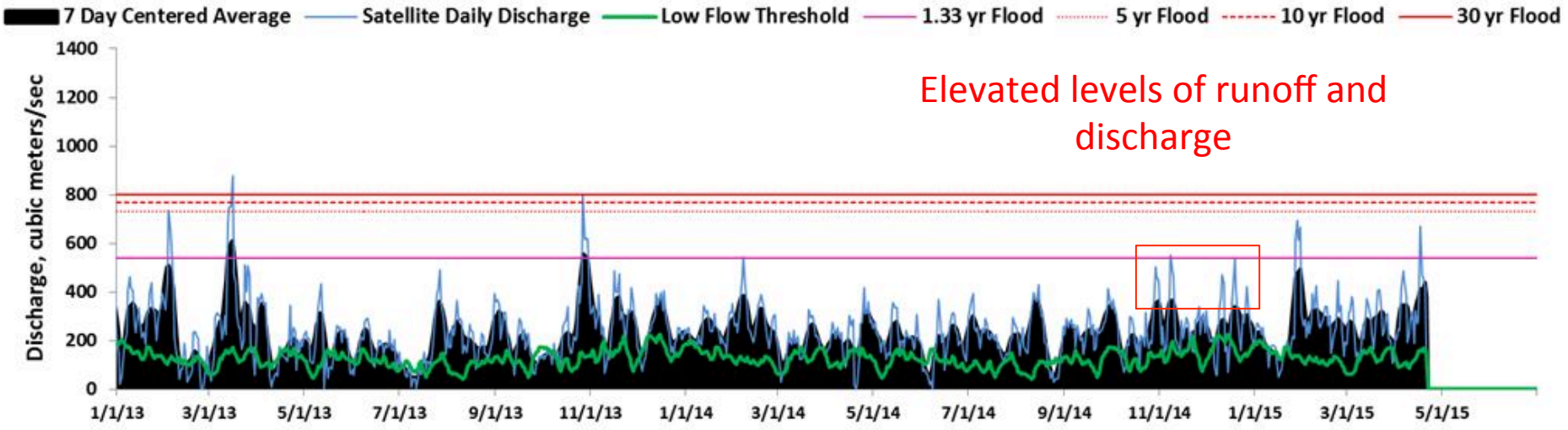



| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4222 | | 0 | Indonesia | 0 | #N/A | #N/A | Gorontalo Province | News | 5-Feb-15 | 9-Feb-15 | 5 | 0 | 300 | | Heavy Rain | 1 | 18063.44 | 5.0 | 122.862 | 0.686073 | News | 0 | 4 | 1 | 5 |
| 4221 | | FL-2015-000009-ALB | Greece | Albania | #N/A | #N/A | Northeastern Greece | News | 1-Feb-15 | 9-Feb-15 | 9 | 3 | 500 | | Heavy Rain | 1.5 | 151104.52 | 6.3 | 26.5972 | 41.4571 | News | 1 | 4 | 1 | 4 |
| 4220 | | FL-2015-000008-BOL | Bolivia | 0 | #N/A | #N/A | Departments of La Paz, Santa Cruz, Chuquisaca, Potosí, Oruro and Cochabamba | News | 5-Jan-15 | 9-Feb-15 | 36 | 23 | 1000 | | Heavy Rain | 1.5 | 137629.71 | 6.9 | -63.7661 | -16.4638 | News | 1 | 3 | 1 | 3 |
| 4219 | | FL-2015-000006-MWI | Malawi | Mozambique | #N/A | #N/A | Southern Malawi and Mozambique | News | 1-Jan-15 | 9-Feb-15 | 40 | 276 | 336000 | | Heavy Rain | 2 | 485939.39 | 7.6 | 35.3564 | -16.7946 | News | 1 | 2 | 1 | 2 |
| 4218 | | 0 | Australia | 0 | #N/A | #N/A | Western Autralia, Firzroy, Alice Springs | News | 5-Jan-15 | 11-Jan-15 | 7 | 1 | 0 | | Heavy Rain | 1.5 | 1519623.5 | 7.2 | 127.056 | -19.1872 | News | 1 | 1 | 1 | 1 |
| 4217 | | 0 | Philippines | 0 | #N/A | #N/A | Southern Philippines, Samar, other locations | News | 10-Dec-14 | 1-Jan-15 | 23 | 53 | 80186 | | Tropical Storm Jangmai | 1.5 | 63967.39 | 6.3 | 124.903 | 8.65608 | News | 1 | 100 | 1 | 20 |
| 4216 | | FL-2014-000168-MYS | Malaysia | Thailand | #N/A | #N/A | Kelantan State; Malaysia-Thailand border; northeastern Malaysia | News | 20-Dec-14 | 1-Jan-15 | 13 | 34 | 215000 | | Monsoonal Rain | 2 | 90680.38 | 6.4 | 102.164 | 4.72508 | News | 1 | 99 | 1 | 20 |
| 4215 | | 0 | Sri Lanka | 0 | #N/A | #N/A | Northern, northcentral and eastern provinces; Batticaloa district, Anuradhapura district | News | 20-Dec-14 | 1-Jan-15 | 13 | 39 | 1000000 | | Monsoonal Rain | 1.5 | 50316.81 | 6.0 | 80.9834 | 7.90972 | News | 0 | 98 | 1 | 20 |
| 4214 | | FL-2014-000163-COL | Colombia | 0 | #N/A | #N/A | Chocó | News | 1-Nov-14 | 20-Dec-14 | 50 | 44 | 0 | | Heavy Rain | 1.5 | 406009.51 | 7.5 | -75.544 | 4.59198 | News | 1 | 98 | 1 | 19 |
| 4213 | | 0 | USA | 0 | #N/A | #N/A | Bay Area, and Sacramento, north coastal California | News | 11-Dec-14 | 14-Dec-14 | 4 | 3 | 0 | | Torrential Rain | 1 | 70255.56 | 5.4 | -123.101 | 39.7967 | News | 0 | 97 | 1 | 19 |
| 4212 | | 0 | Brazil | 0 | #N/A | #N/A | Eastern Sao Paulo | News | 10-Dec-14 | 14-Dec-14 | 5 | 0 | 0 | | Torrential Rain | 1 | 199807.2 | 6.0 | -49.2145 | -24.8513 | News | 0 | 97 | 1 | 19 |
| 4211 | | 0 | Bulgaria | Greece | #N/A | #N/A | Northern Greece and along the country's northeastern borders with Turkey; Bulgaria | News | 4-Dec-14 | 14-Dec-14 | 11 | 40 | 1000 | | Heavy Rain | 1.5 | 147616.57 | 6.4 | 27.7106 | 41.4579 | News | 1 | 97 | 1 | 19 |
| 4210 | | 0 | Palestine | 0 | #N/A | #N/A | Gaza | News | 26-Nov-14 | 5-Dec-14 | 10 | 0 | 300 | | Torrential Rain | 1.5 | 2861.66 | 4.6 | 34.4532 | 31.3378 | News | 0 | 96 | 1 | 19 |
| 4209 | | 0 | France | 0 | #N/A | #N/A | Southern France; Pyrenees-Orientales region | News | 29-Nov-14 | 5-Dec-14 | 7 | 5 | 3000 | | Torrential Rain | 1.5 | 123269.25 | 6.1 | 0.863937 | 43.999 | News | 1 | 96 | 1 | 19 |
| 4208 | | 0 | USA | 0 | #N/A | #N/A | Southern California | News | 1-Dec-14 | 5-Dec-14 | 5 | 0 | 40 | | Torrential Rain | 1 | 202666.27 | 6.0 | -117.212 | 35.4299 | News | 1 | 95 | 1 | 19 |
| 4207 | | FL-2014-000159-MAR | Morocco | 0 | #N/A | #N/A | Southern Morocco, Marrakesh | News | 24-Nov-14 | 5-Dec-14 | 12 | 40 | 0 | | Heavy Rain | 2 | 273693.63 | 6.8 | -5.61886 | 31.5566 | News | 1 | 94 | 1 | 19 |
| 4206 | | 0 | Thailand | 0 | #N/A | #N/A | Southern Thailand; Trang Province | News | 7-Nov-14 | 16-Nov-14 | 10 | 0 | 1000 | | Monsoonal Rain | 1 | 31653.08 | 5.5 | 99.5163 | 8.02409 | News | 0 | 93 | 1 | 19 |

surface water record for the event

Flooding is represented by bright blue






Elevated levels of runoff and discharge

These are the flood event time frames

**Monthly Runoff (total of daily runoff for each month; mm)**

| | Jan | Feb | Mar | April | May | June | July | Aug | Sept | Oct | Nov | Dec | Annual Total (mm) | Comparison Station Total (mm) | Mean Discharge (m3/sec) | Annual Total % of 2002-2013 | Mean Discharge 2002-2013 226 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1998 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 490974.0 | | | |
| 1999 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 491118.0 | | | |
| 2000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 491262.0 | | | |
| 2001 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.1 | 5.1 | 491406.0 | | | |
| 2002 | 57.0 | 41.1 | 57.2 | 60.2 | 45.6 | 50.6 | 28.6 | 24.3 | 31.3 | 32.7 | 30.2 | 31.7 | 490.4 | 491550.0 | 188 | 0.83 | |
| 2003 | 35.5 | 35.7 | 39.3 | 46.5 | 21.1 | 37.8 | 20.7 | 27.4 | 32.6 | 42.0 | 79.4 | 47.1 | 465.1 | 491694.0 | 178 | 0.79 | |
| 2004 | 53.9 | 32.8 | 26.2 | 19.4 | 18.0 | 29.7 | 19.2 | 32.0 | 20.3 | 30.7 | 23.6 | 23.2 | 329.1 | 491838.0 | 126 | 0.56 | |
| 2005 | 43.4 | 32.6 | 29.0 | 36.0 | 55.4 | 49.2 | 41.9 | 32.8 | 23.0 | 35.8 | 52.3 | 63.0 | 494.2 | 491982.0 | 190 | 0.84 | |
| 2006 | 50.9 | 26.3 | 59.0 | 55.1 | 64.8 | 48.9 | 42.8 | 34.3 | 50.5 | 42.9 | 39.3 | 56.9 | 571.7 | 492126.0 | 219 | 0.97 | |
| 2007 | 48.1 | 64.1 | 41.7 | 38.1 | 52.1 | 41.9 | 32.2 | 38.5 | 53.9 | 81.6 | 76.5 | 100.0 | 668.7 | 492270.0 | 255 | 1.13 | |
| 2008 | 75.2 | 57.3 | 81.6 | 66.6 | 93.1 | 88.7 | 53.4 | 33.2 | 35.1 | 53.0 | 56.9 | 101.2 | 795.2 | 492414.0 | 306 | 1.36 | |
| 2009 | 44.6 | 42.0 | 36.8 | 58.0 | 25.6 | 16.7 | 35.9 | 33.3 | 42.1 | 38.1 | 35.5 | 35.5 | 444.1 | 492558.0 | 167 | 0.74 | |
| 2010 | 30.8 | 17.4 | 26.4 | 24.8 | 37.9 | 30.1 | 35.2 | 31.7 | 45.9 | 29.0 | 88.8 | 136.9 | 534.9 | 492702.0 | 205 | 0.91 | |
| 2011 | 61.6 | 30.2 | 71.3 | 100.6 | 109.6 | 31.5 | 31.2 | 40.4 | 40.4 | 81.6 | 75.2 | 166.2 | 839.7 | 492846.0 | 319 | 1.41 | |
| 2012 | 128.1 | 137.3 | 90.6 | 83.5 | 101.5 | 62.3 | 43.3 | 25.5 | 35.3 | 46.4 | 61.4 | 55.8 | 870.8 | 492990.0 | 327 | 1.45 | |
| 2013 | 64.6 | 47.5 | 73.6 | 41.5 | 43.4 | 38.0 | 33.3 | 46.8 | 43.8 | 58.3 | 62.3 | 53.2 | 606.4 | 493134.0 | 228 | 1.01 | |
| 2014 | 53.4 | 59.1 | 40.7 | 45.7 | 47.9 | 38.0 | 48.2 | 45.5 | 53.6 | 52.0 | 58.5 | 59.0 | 601.7 | 493278.0 | 231 | 1.02 | |
| 2015 | 51.4 | 58.1 | 56.6 | 49.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 215.7 | 493290.0 | 272 | 1.21 | |

**Next:**

Hands-on Activity using MODIS Inundation Mapping