M^3 MAPPING, MODELING AND MANAGING FLOOD RISKS

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JPTM for Sentinel Asia STEP3 (JPTM 2013), 27-28 Nov 2013, Bangkok, Thailand

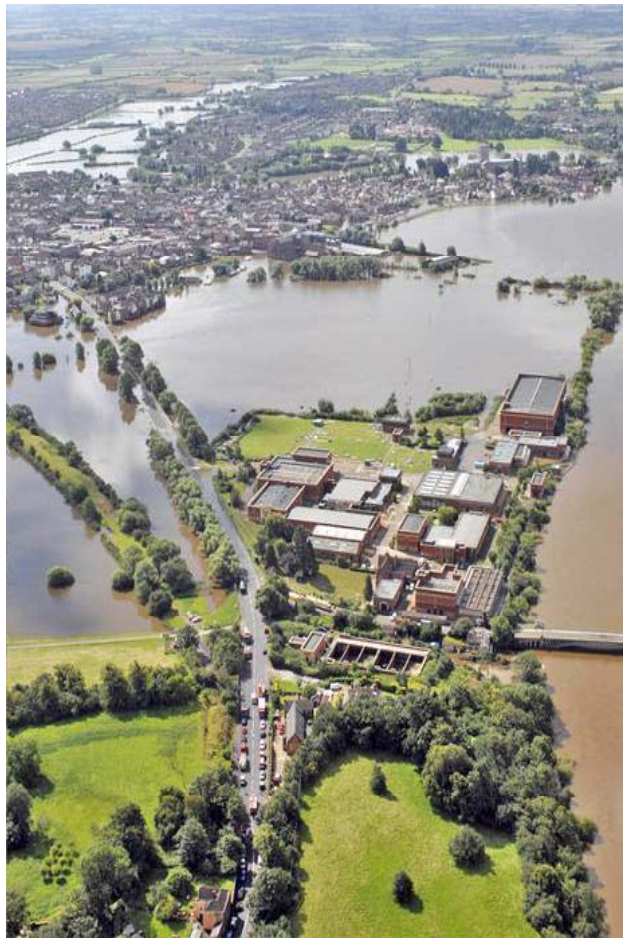
International Water Management Institute (IWMI)

OUTLINE

- Synthesis of global flood occurrence and hotspot analysis
- SA & SEA Flood Mapping Products using multi-scale satellite data for risk assessment
- Example of Flood Forecasting Tool using integrated satellite data for Flood Irrigation and Minimizing Risk in Sudan
- Opportunities & Minimizing flood risk

THE PROBLEM

- **Floods – primary natural disasters**
- **Precipitation intensity and variability is projected to increase – increasing risks of flooding globally and in Asia**
- **Global flood losses in 2011 >$100 Billion**
  - **Largest global losses:**
    - **Thailand (Jun-Nov) $40-50B**
    - **Australia (Jan-Feb) $20-30B**
    - **Hurricane Irene (Aug) $5-10B**
- **May rise to over $450B by 2030**



FLOODS: GOOD AND BAD

Floods costs and benefits:

- Costs = loss of life; disruption to livelihoods, disruption of transport, damage to infrastructure, loss of crops
- Benefits = fisheries, soil fertilization, g/w recharge, soil moisture and ecology
- Spatial distribution of costs and benefits is very uneven

In the LMB:

annual costs of flooding = US$ 60-70 million

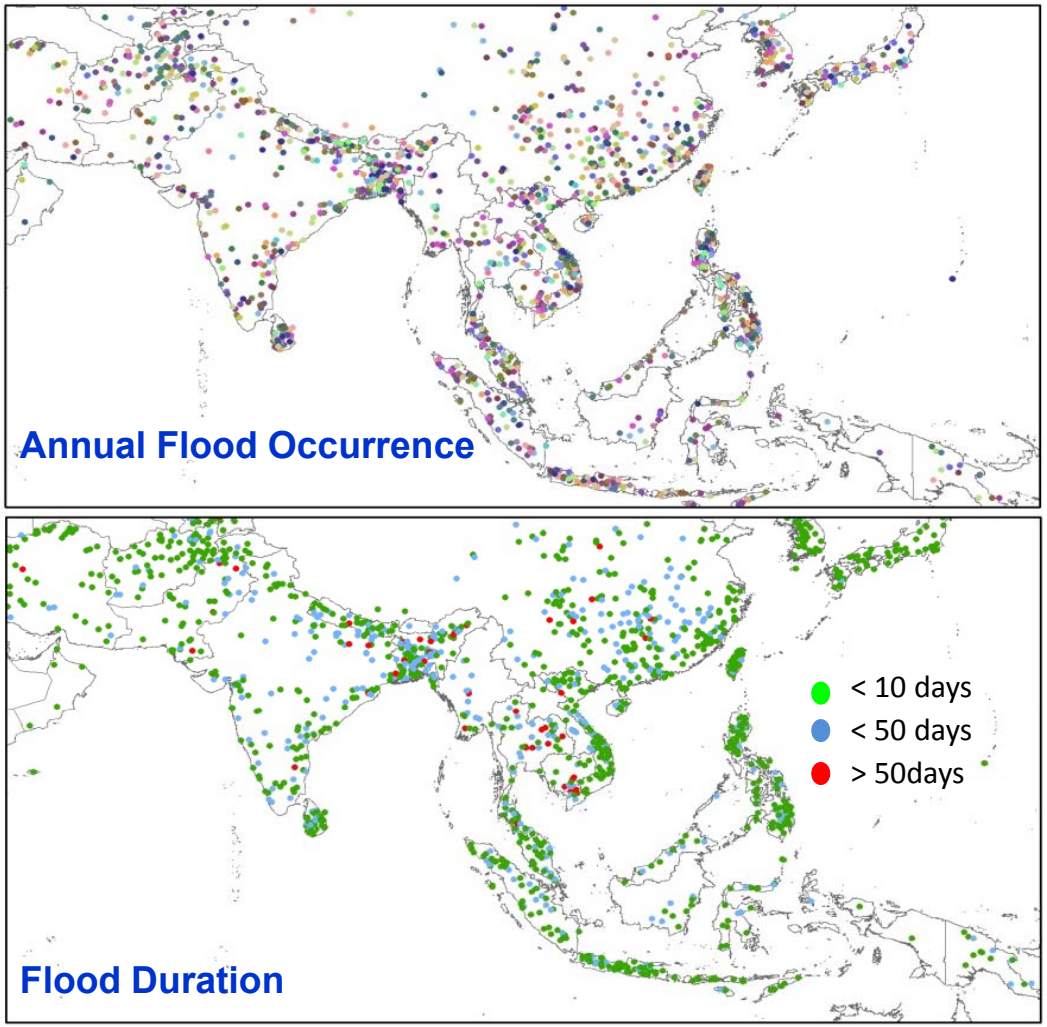
annual benefits of floods = US$ 8-10 billion

Mapping Flood Hotspots for Climatic Change

CATASTROPHIC FLOODS IN ASIA: 1900-2011

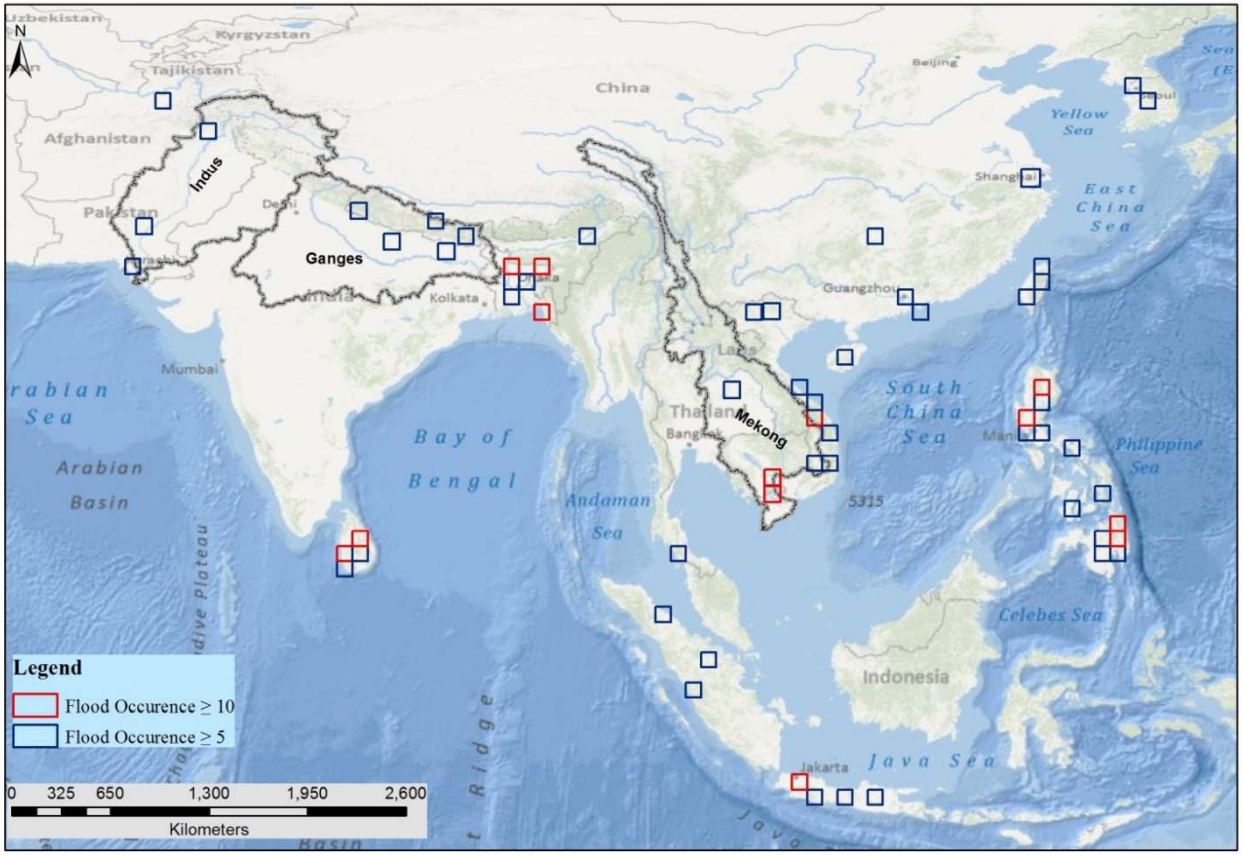
- Collated from 6 global sources
- >4000 floods globally
- Around 35% - in Asia

Country	Flood Occurrence
India	237
China P Rep	209
United States	155
Indonesia	142
Philippines	116
Brazil	112
Bangladesh	83
Iran Islam Rep	72
Pakistan	72
Vietnam	67

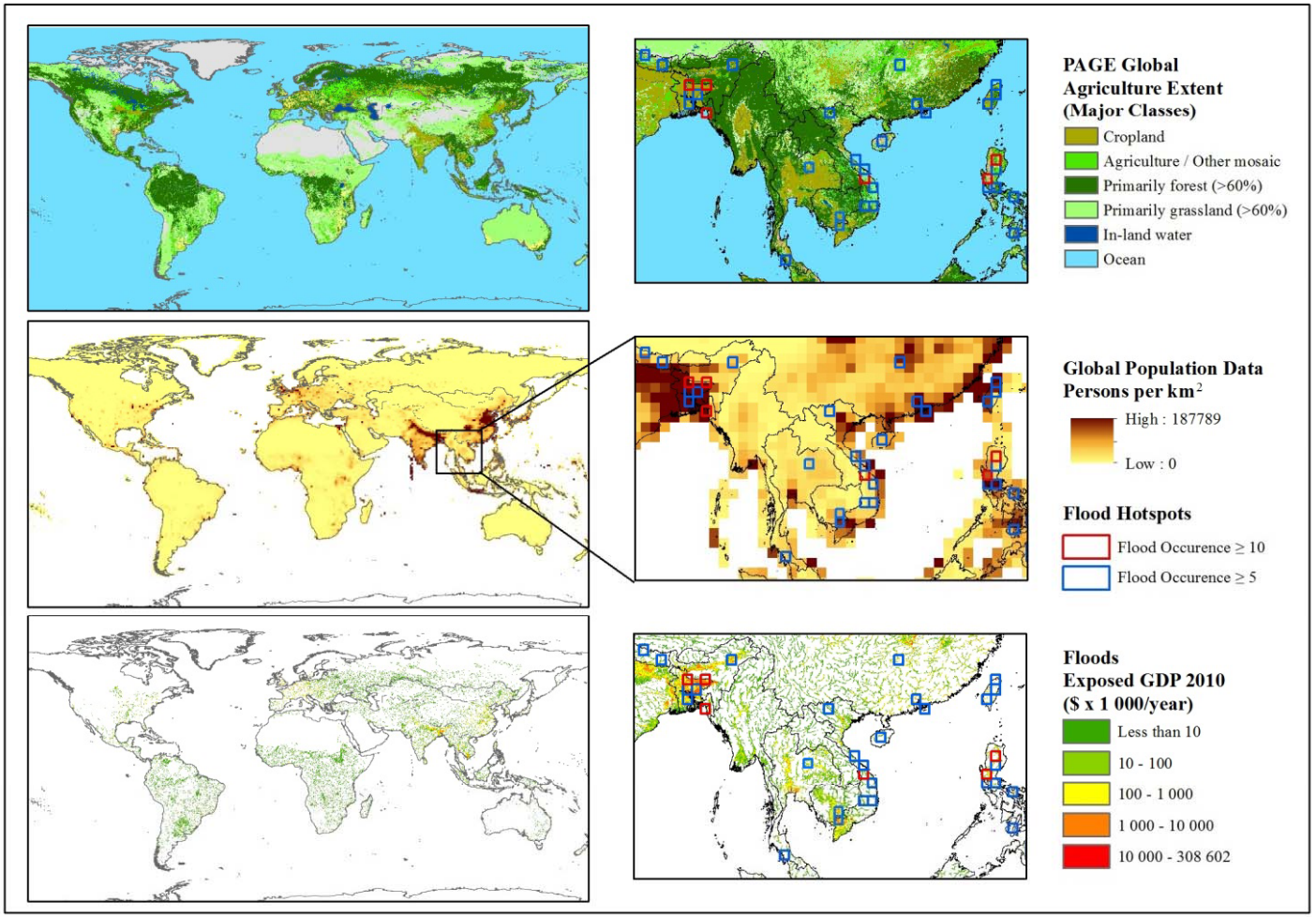


IDENTIFYING FLOOD HOTSPOTS

- 100 km grid over the globe;
- numbers of floods in each cell over 1900-2011



CHARACTERISING FLOOD HOTSPOTS



AGRICULTURE;
PAGE (2005)

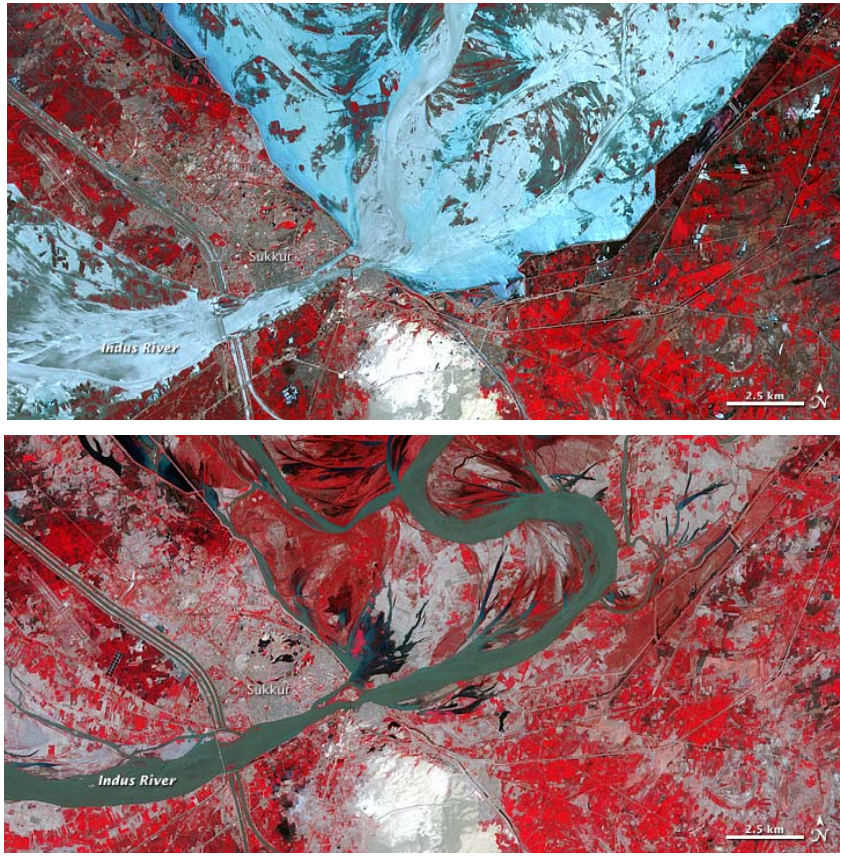
POPULATION
CIESIN - 2010

FLOOD EXPOSED GDP
WB, 2010

CHARACHERIZING FLOOD HOTSPOTS

- Globally - 90 grid cells with catastrophic flood occurrence ≥ 5;
- 60% of these cells -in Asia

- Estimated total over these hotspots:
  - annual economic loss due to floods - $20bn
  - 30 million affected people
  - 500,000 km^2 of affected croplands



FLOOD RISK MAPPING AND ASSESSMENT

Flooding in Indus river, Pakistan

SUB-CONTINENTAL SCALE FLOOD MAPPING

Examples from SA and SEA – MODIS images

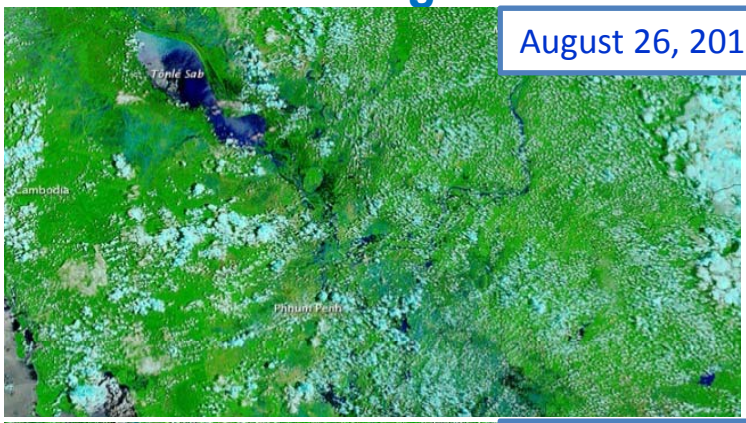
Indus

August 18, 2009

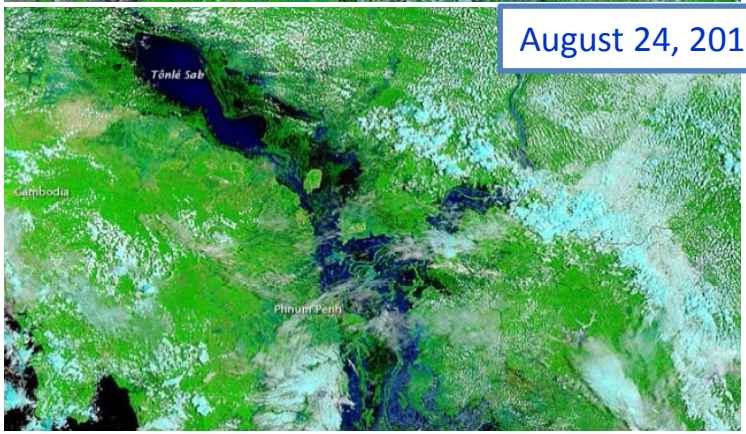
August 17, 2010

Mekong

August 26, 2010

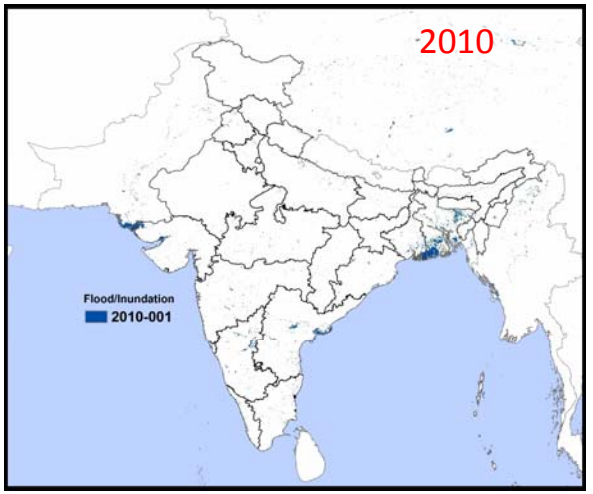


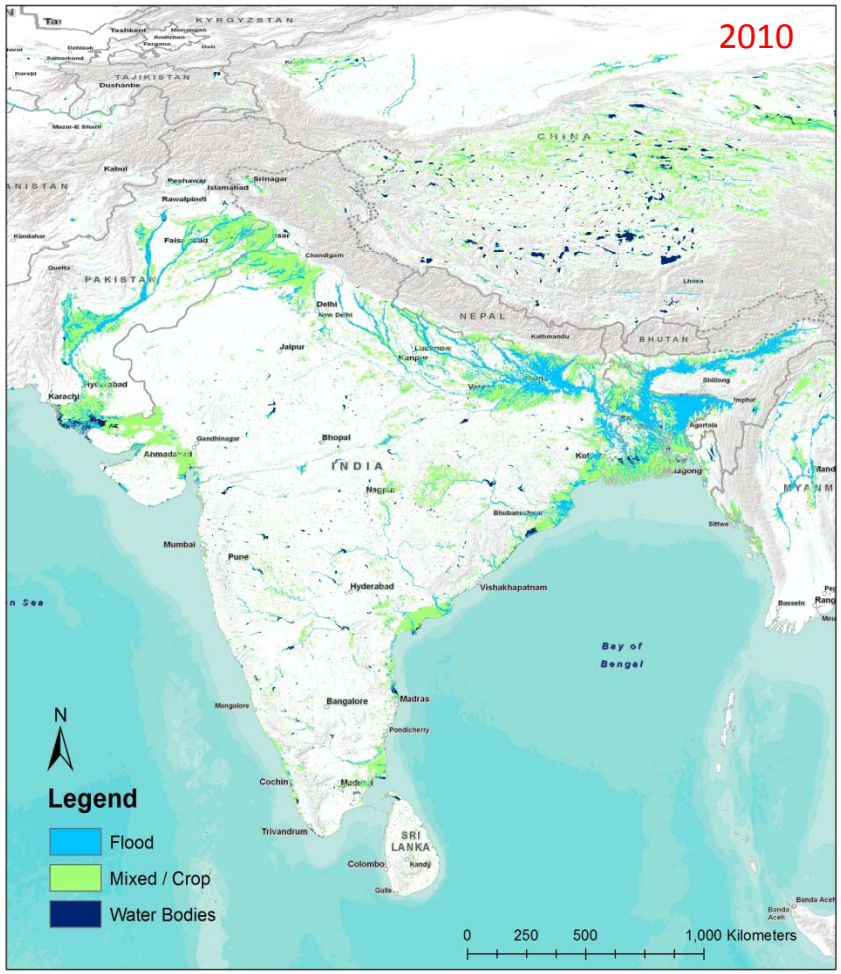
August 24, 2011

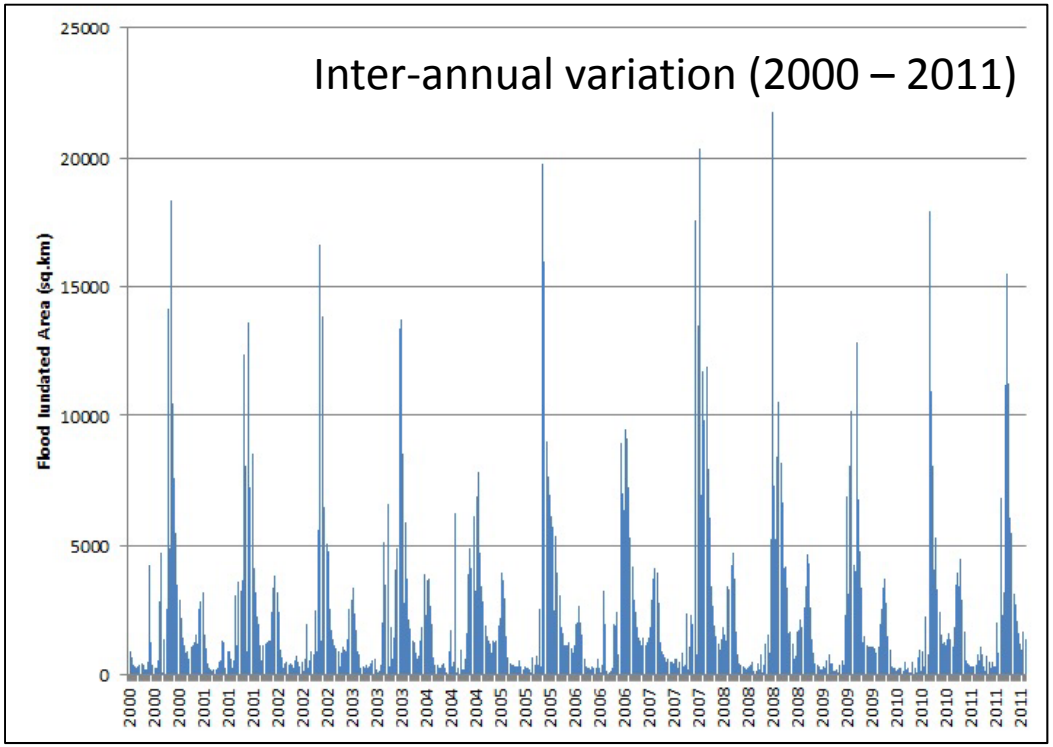


EXAMPLE PRODUCTS

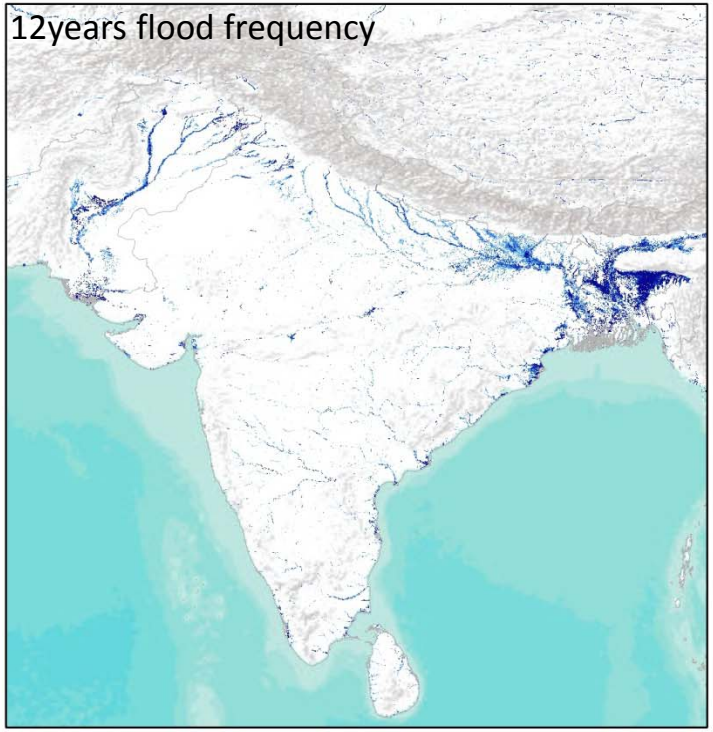
- 8-days maps of inundation extent
- Annual maps of maximum inundation
- Inter-annual variation of regional flooding extent

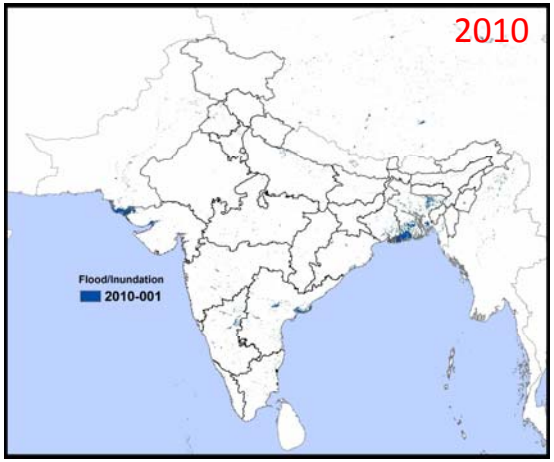






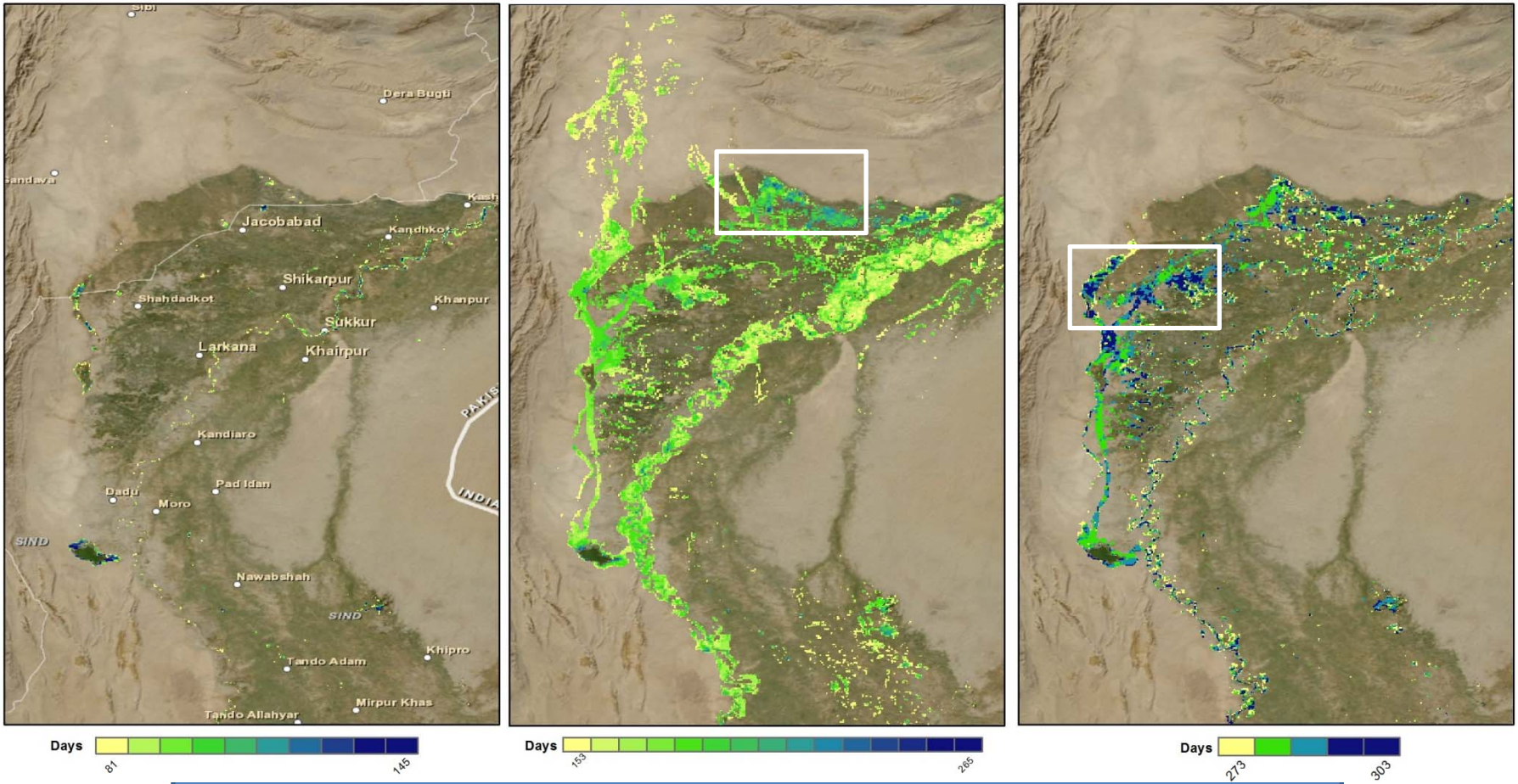
SOUTH ASIA PRODUCTS





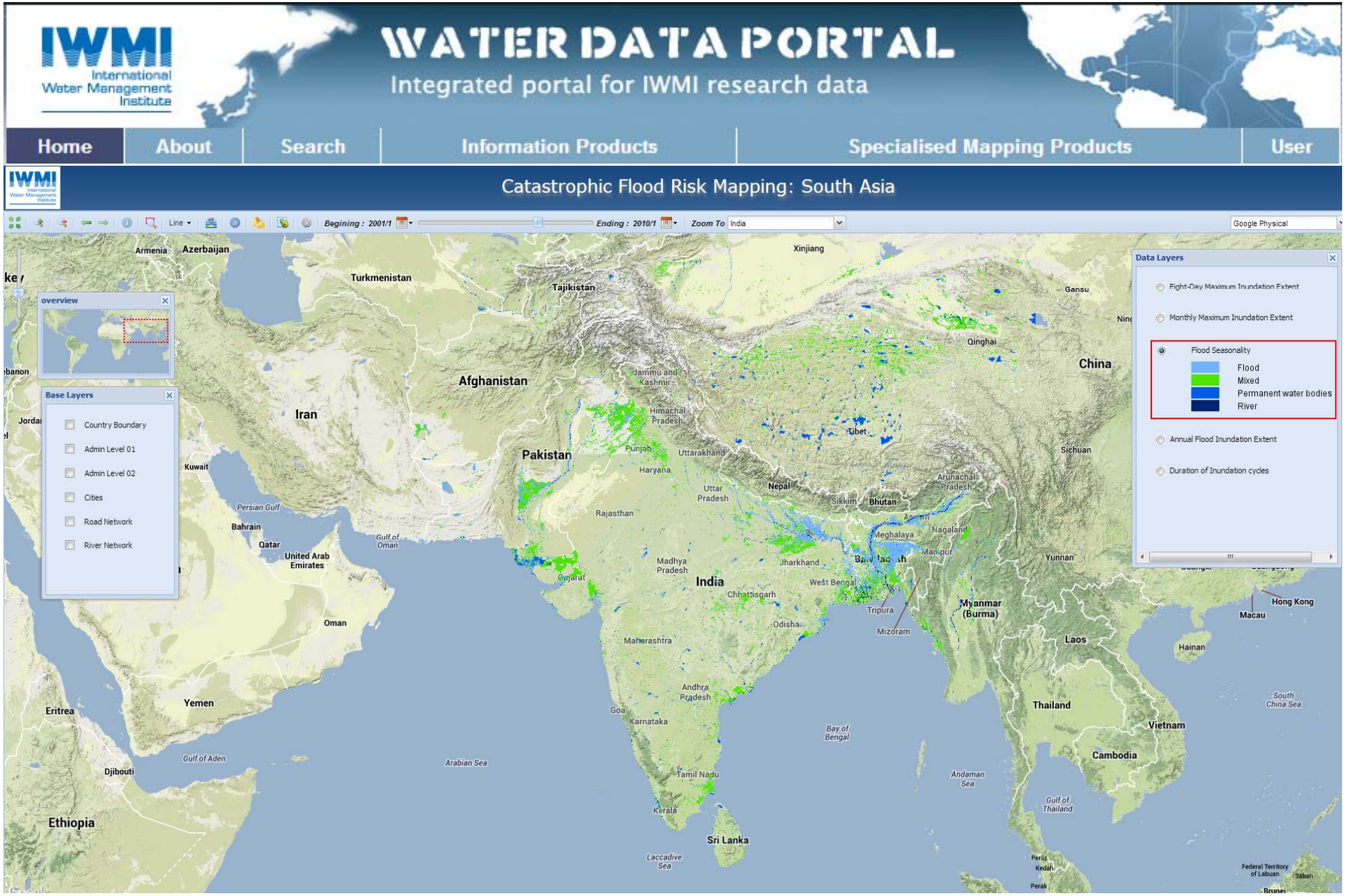
Country	Flood Affected Area	Area (sqkm)	Percent Area
Bangladesh	69,025.93	147,570	46.78
India	135,568.18	3,287,240	4.12
Nepal	1,442.34	147,181	0.98
Pakistan	97,057.15	796,095	12.19
SriLanka	838.27	65,610	1.28

Flood Duration : Indus Basin, Pakistan

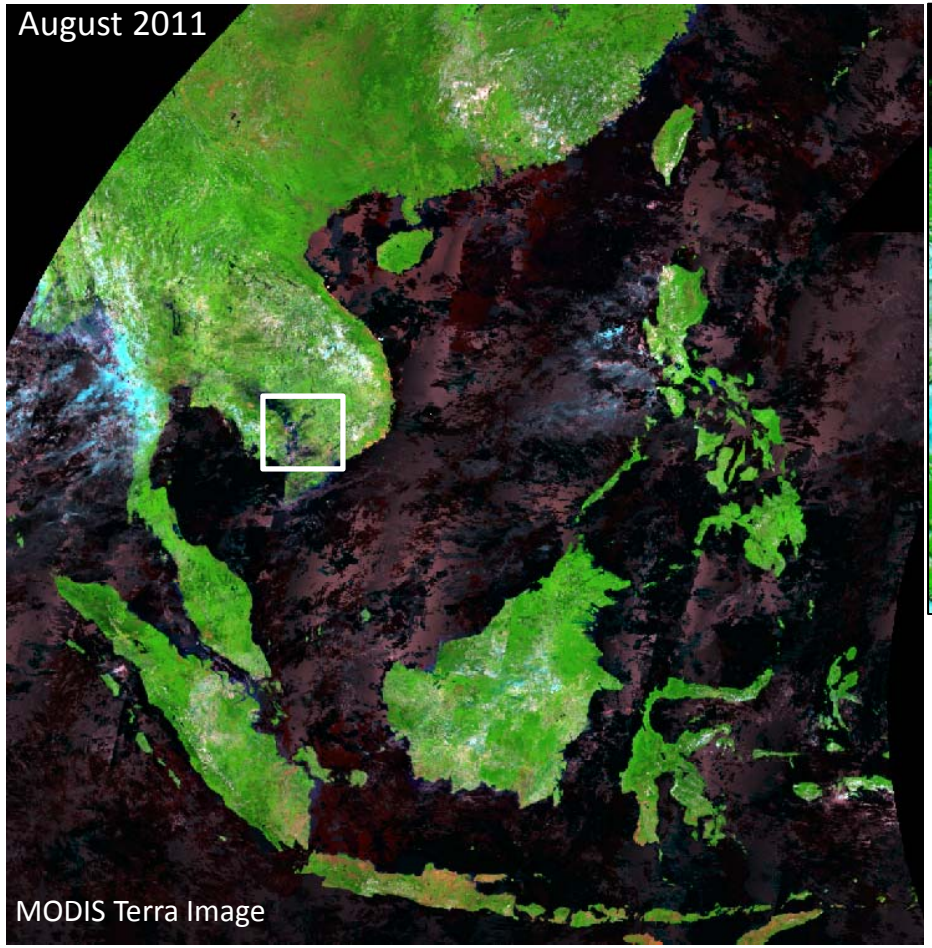


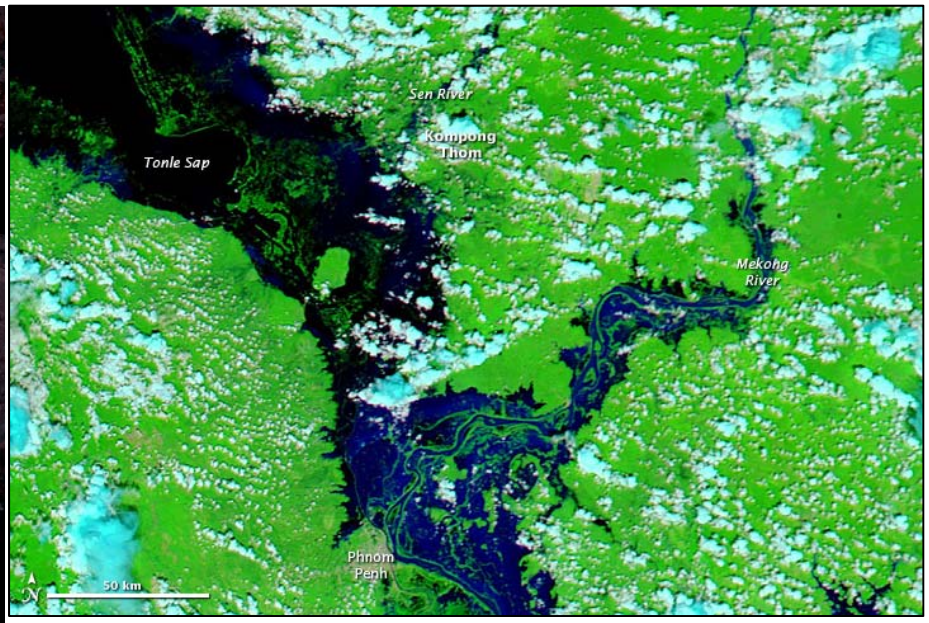
- Duration of annual flood inundation is defined from the start and end dates of annual flood inundation
- Longer flood duration significantly increase the flood risk damage

Flood Data Now Online !!



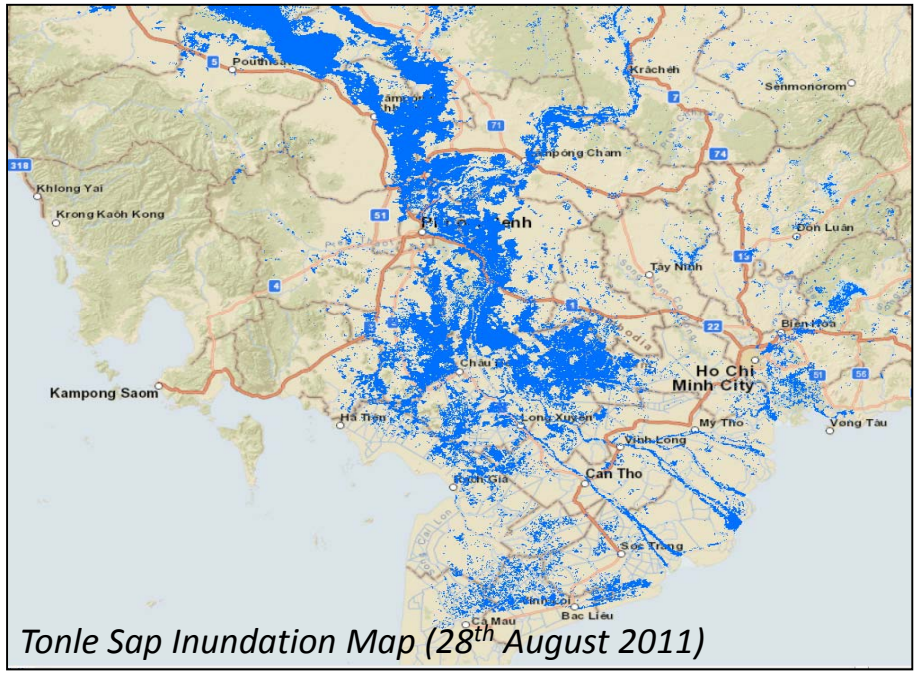
SOUTH EAST ASIA^{++} Flood Mapping / UTFI





MODIS 15 tiles covering SE Asia^{++}
Total Images (2000 – 2011) = 7590

Work In Progress!!

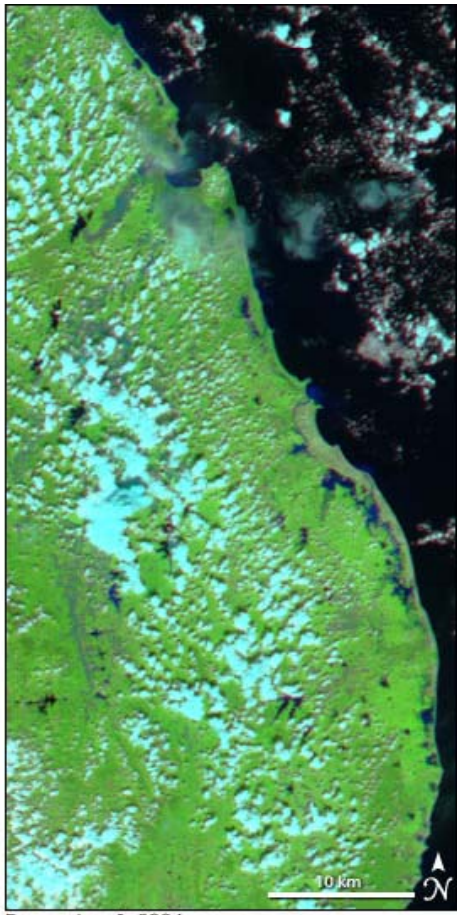


Tonle Sap Inundation Map (28th August 2011)

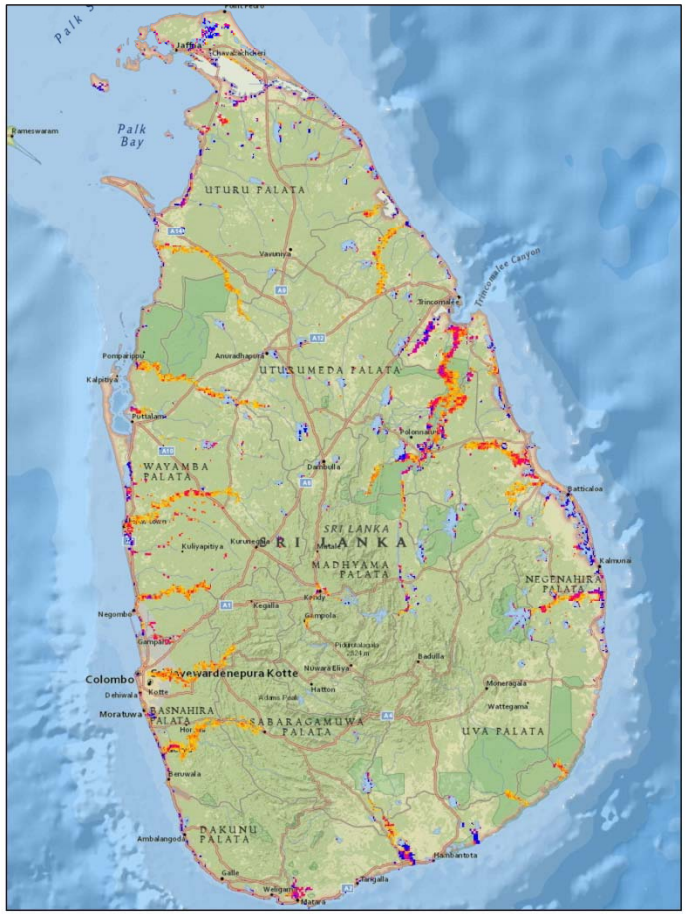
Remote Sensing-based Flood Risk Mapping : Sri Lanka

- RS approach was employed to estimate flood frequency and extent
- Agriculture Impact from floods is being studied
- Potential of flood risk mapping + piloting agricultural insurance products using EO Data and Models are the future research in Sri Lanka

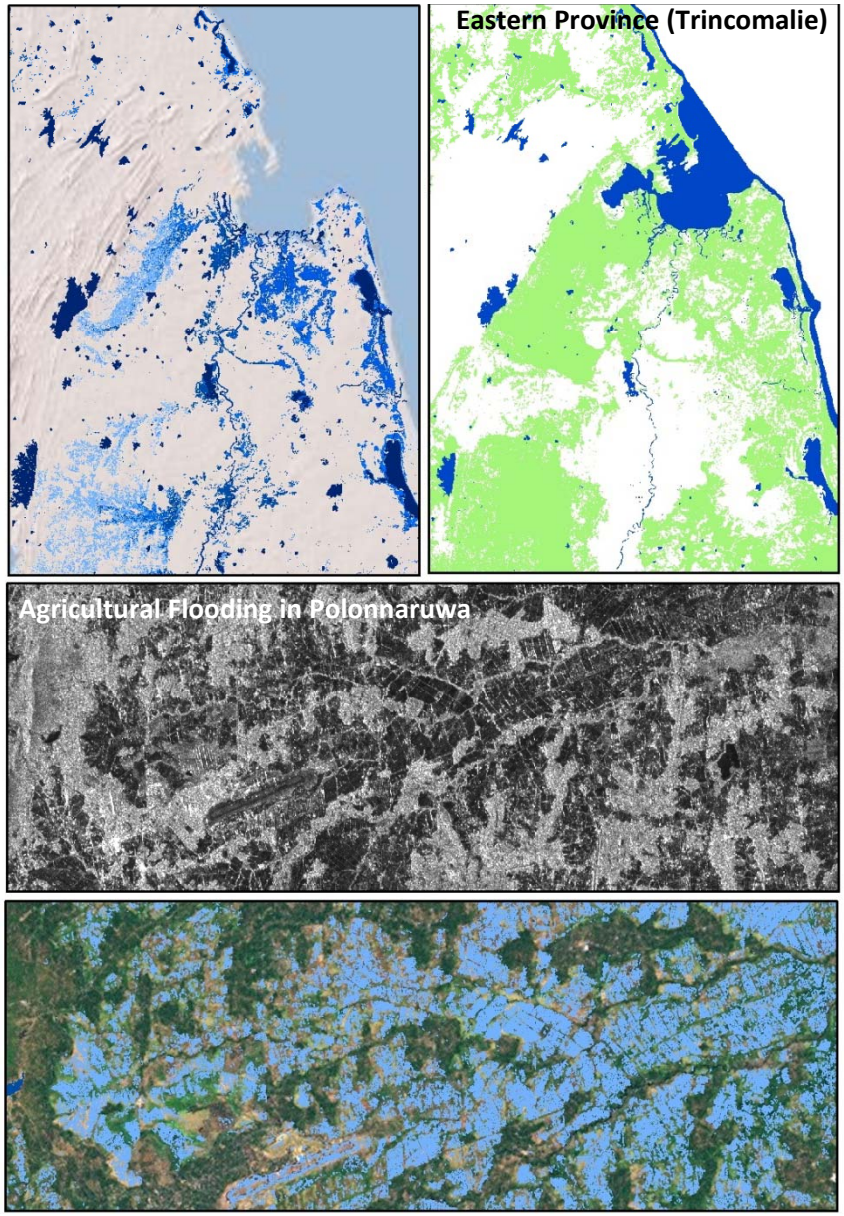
December 19, 2004



December 1, 2004



Extent of flooding during the years 2006–2011 derived from ALOS PALSAR data (left) and cropland extent (right) in Sri Lanka



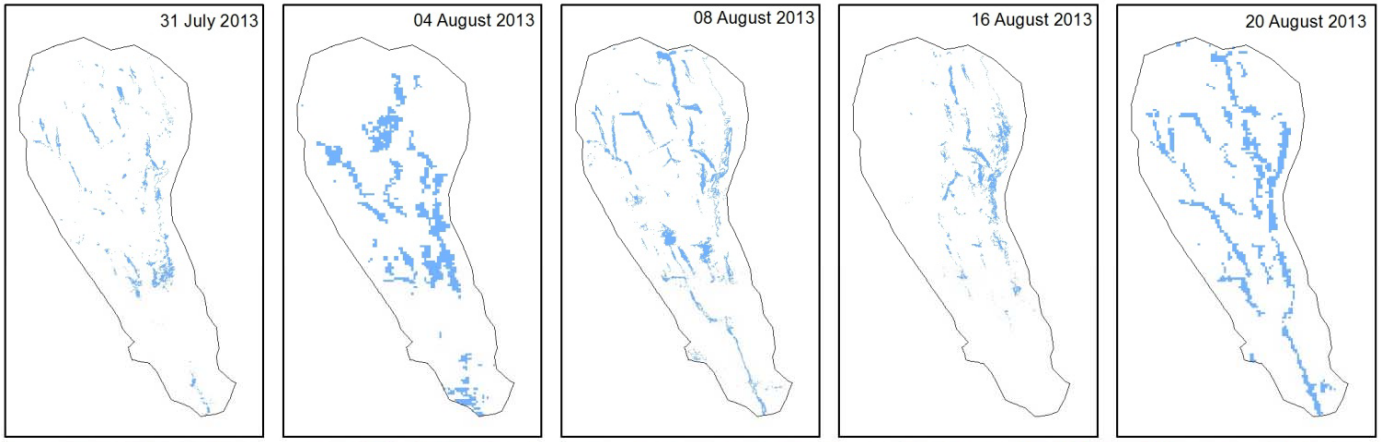
- Existing flood images provided from Sentinel Asia Website
- Procured 23 images (before flood) for preparing pre-disaster database for impact assessment
- Additional flood images from 2006-2011 procured for flood recurrent maps

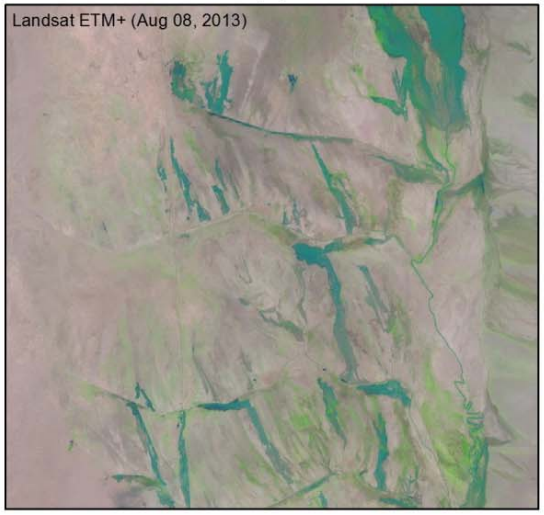
- Fine-scale flood risk products mapped using satellite datasets from 2000 to 2011
- Province wise flood statistics and agriculture impacts is being analyzed
- Knowledge generated here can be used by DMC, Irrigation Dept. for mitigation, preparedness and index based crop insurance

Flood Mapping and Modeling in Spate Irrigation System in Sudan

Canal Uptake and Sorghum flowering in Gash Delta, Sudan

OPERATIONAL FLOOD INUNDATION MAPPING (MODIS + Landsat Images)





- Weekly inundation mapping services
- High. Res. Flood maps from Landsat
- Fieldlook Dissemination

DEVELOPMENT OF FLOOD FORECASTING SYSTEM HEC HMS+RAS

Basin Characteristics

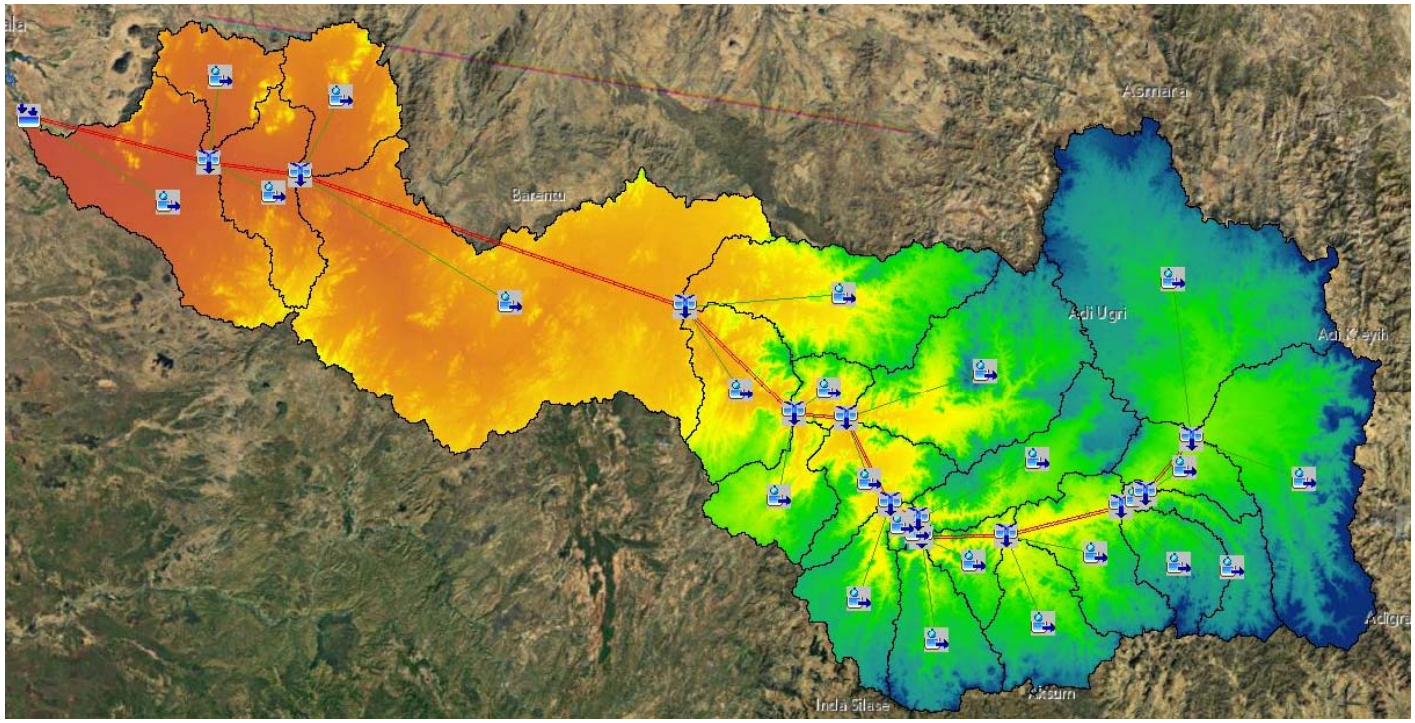
25 sub-basin
Watershed ~20,000km^2
12 river segments

Model Inputs

5 raingauges (Ethiopia)
El Gera flow data (GRTU)
TRMM, RFE, CMORPH SRE Data
DEM, LULC, FAO Soil Data

HMS Parameters

Loss (SCS Curve Number)
Transform (SCS Unit Hydrograph)
Baseflow (Constant Monthly)
Routing (Muskingum)



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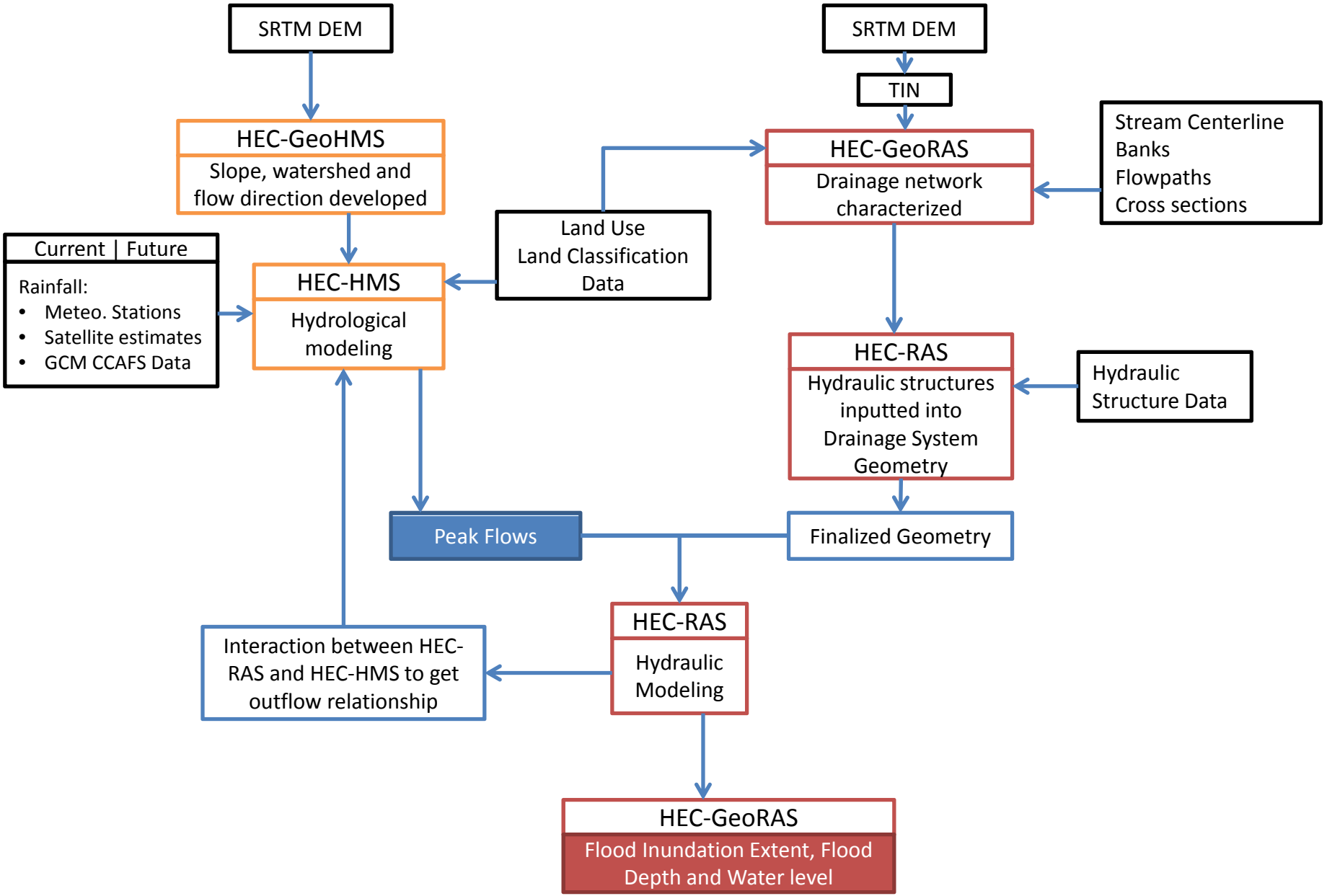
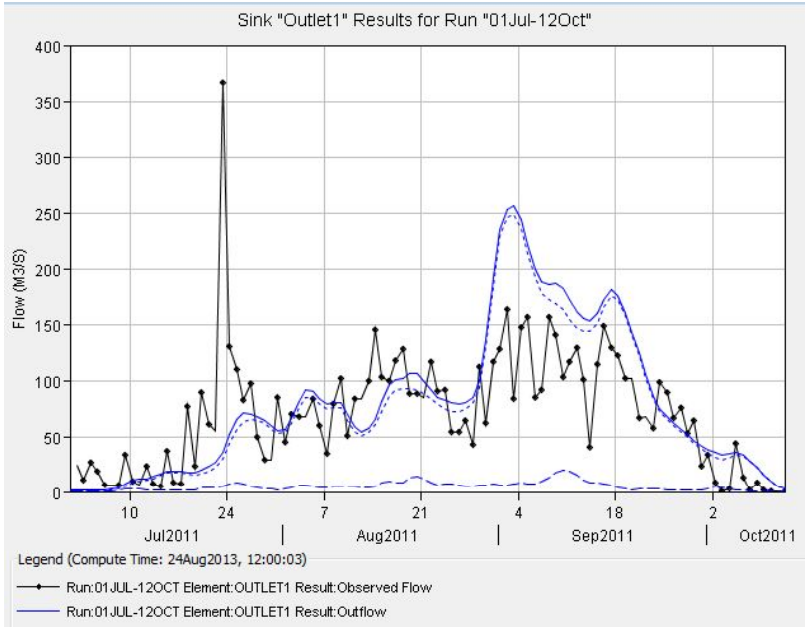
DEVELOPMENT OF FLOOD FORECASTING SYSTEM USING HEC TOOLS

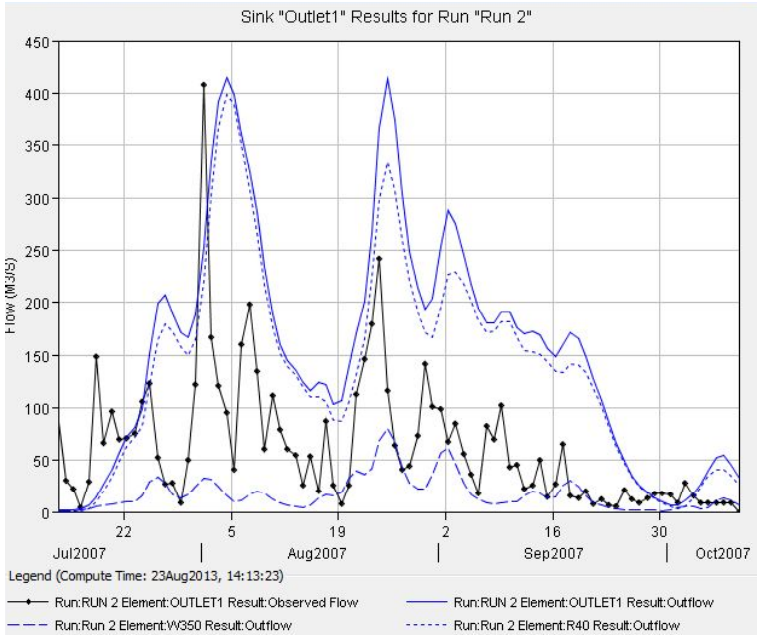


DEVELOPMENT OF FLOOD FORECASTING SYSTEM USING HEC-HMS

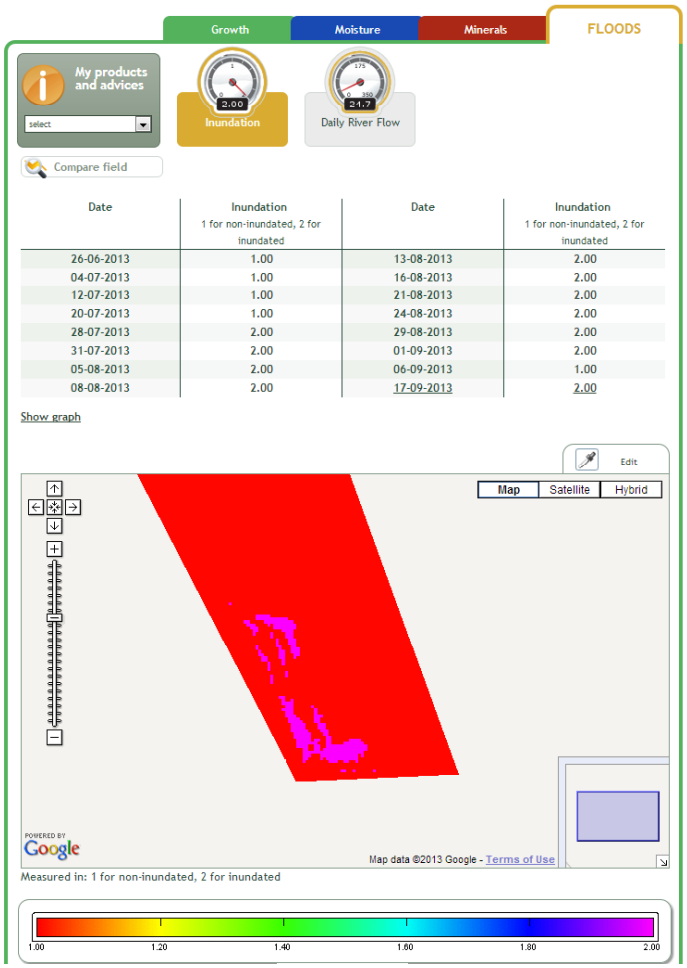
Observed vs. Simulated flow data “2011 flood season”

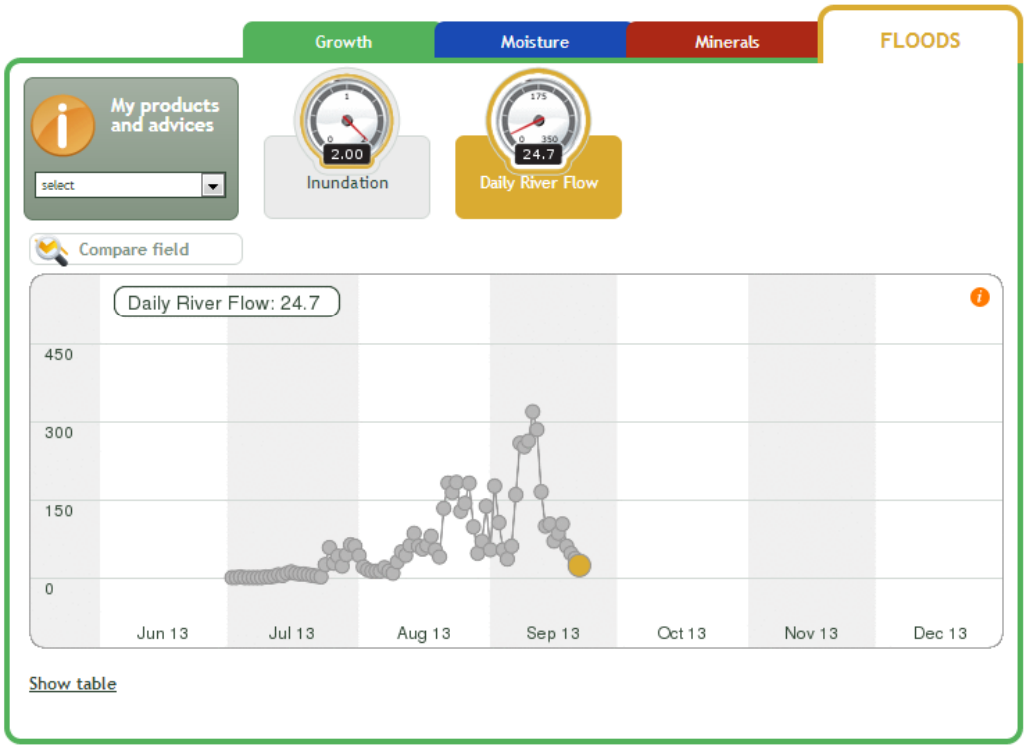


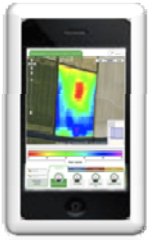
Observed vs. Simulated flow data “2007 flood season”



From pixels….to information….to simple action messages







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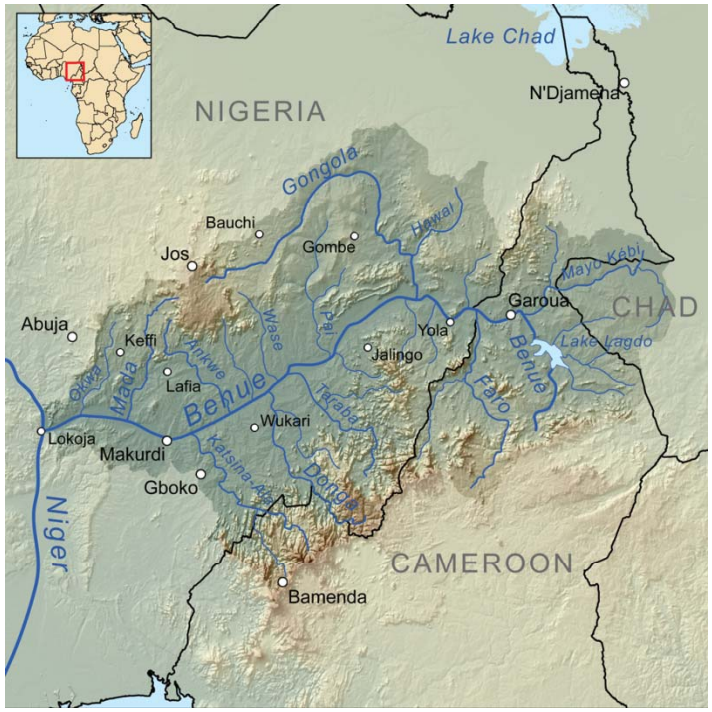
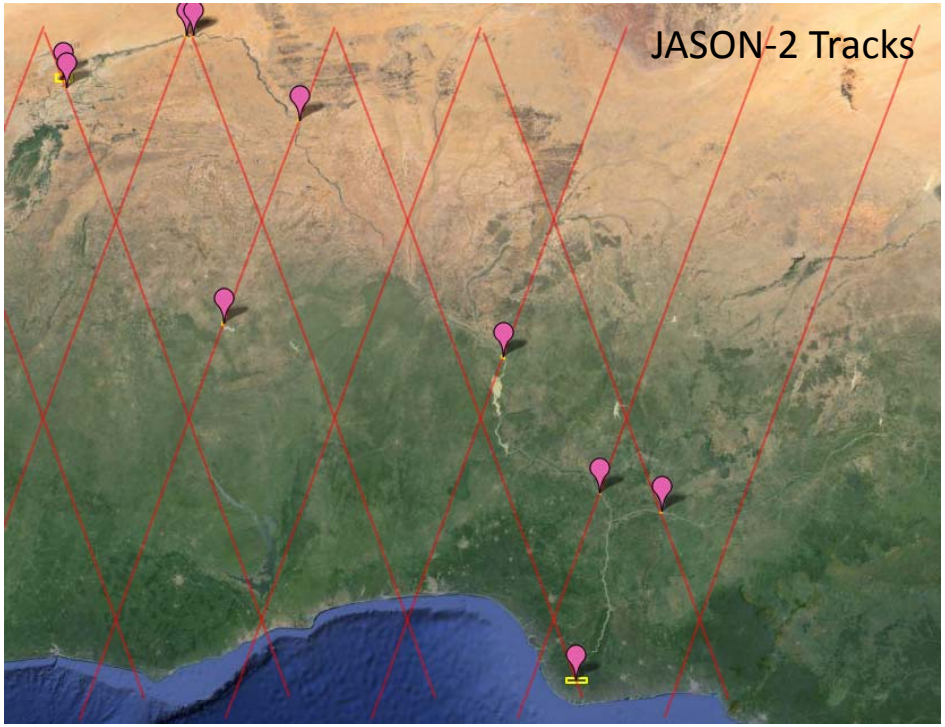
Flood Forecasting Model along Benue-Niger River Basin



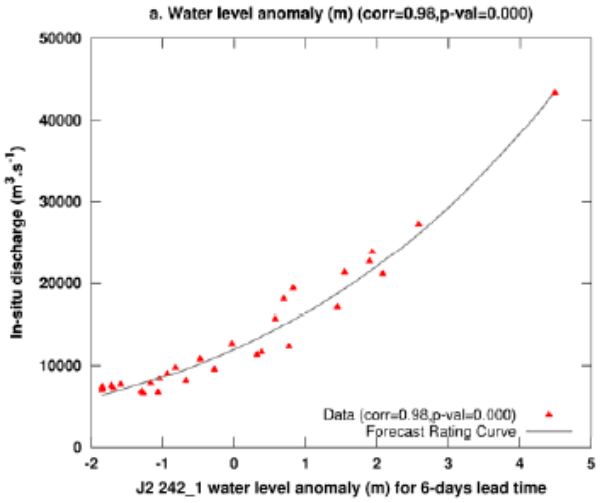


The Role of Altimeter Satellites in Transboundary Flood Forecasting

How best satellites could provide an indirect way of measuring the upstream flow or water level, then the accuracy of a downstream forecasting system could be improved considerably?

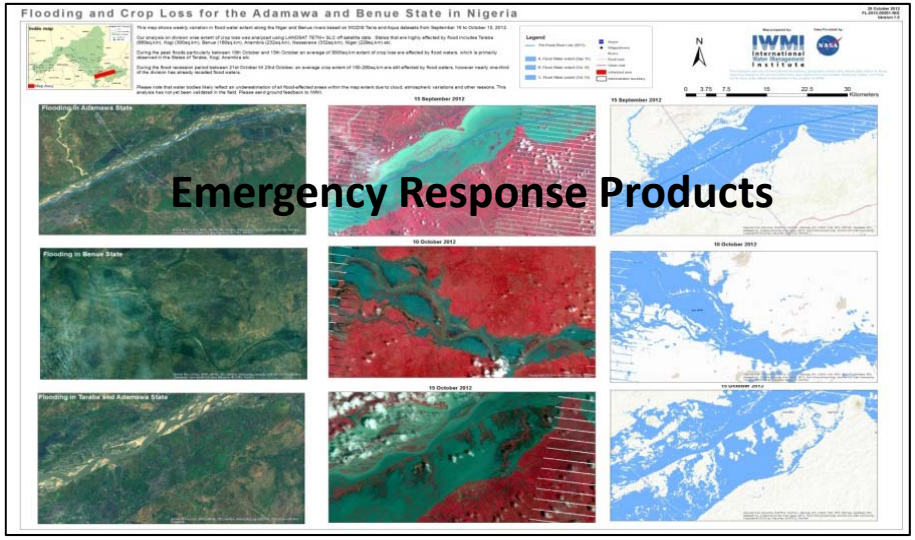
JASON-2 and JASON-3 (2015)

Example of Brahmaputra River: Forecasting Rating Curve

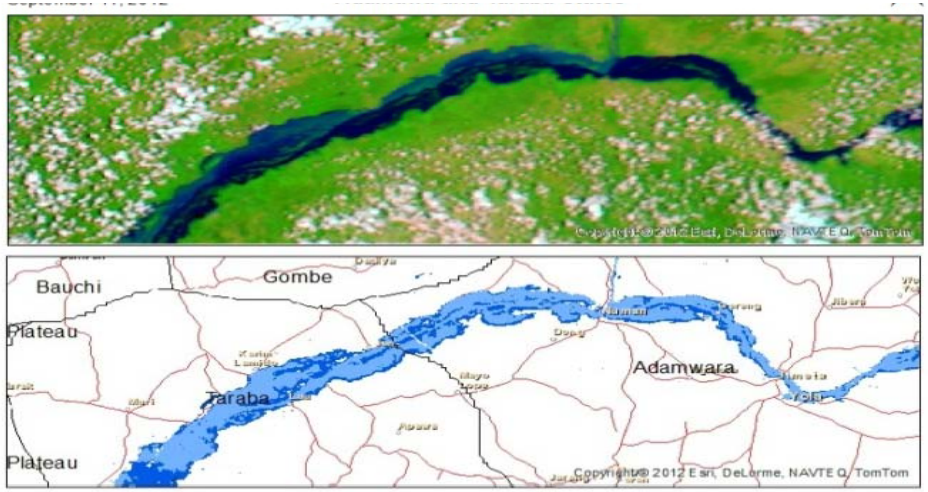


FLOOD RECESSION AGRICULTURE : NIGERIA

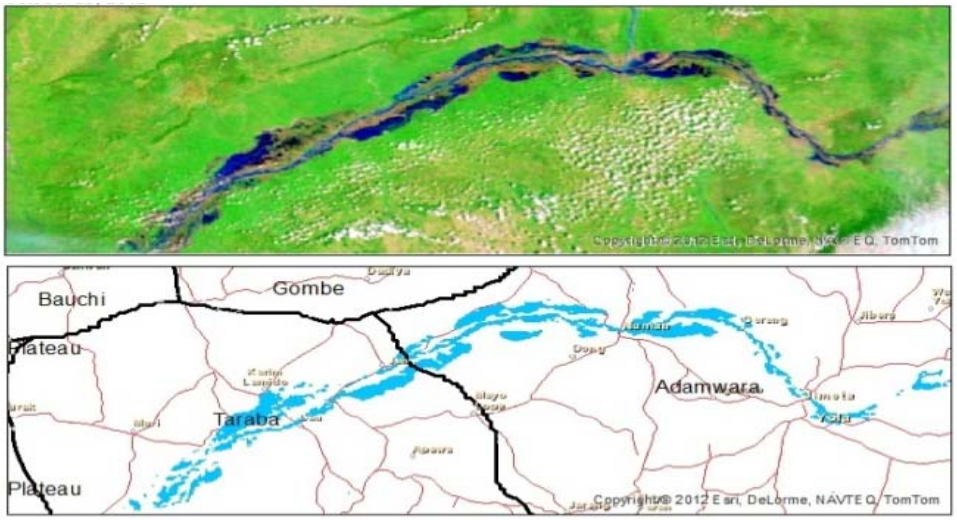
- Spatial and temporal quantification of inundation extent
- Rapid Emergency Response Mapping
- Crop loss quantification due to flooding
- Min. of Agriculture utilized “Flood Recession map” for irrigation planning



Peak Flooding – September 2012
Benue – Niger River basin



Flood Recession Map – October 2012



2013 – OUTREACH ACTIVITIES

Workshop / Training

- 2 Sudan (18 institutions); 1 Bangladesh (17); 1 India (20 institutions); 1 China (18)
- >100 participants; 73 institutes from 23 countries

Release of Flood Risk Atlas Bangladesh : Secretary, Ministry of Disaster Management

Partners:
UN-OOSA/UN-SPIDER
UN-CSSTEAP; UN-ESCAP; UNEP-CDMP
ISRO / NRSC; APSCO

POSSIBLE COLLABORATION
SAS-STEP3

- Sharing flood digital products of Sri Lanka using ALOS-PALSAR images
- Capacity building support “Flood Mapping and Modeling” for stakeholders in Sri Lanka support from JAXA /ICHARM
- IWMI’s contribution during emergency response mapping under SAS
- Joint project JAXA/IWMI - Use of rainfall estimates from GSMAP in assessing floods and drought prediction


THANK YOU
Email contact: a.giriraj@cgiar.org
“ Let not a single drop of water received from rains go waste into the sea without benefiting the man and the beast ”
King Parakramabahu (1153-1186 AD)