MANAGING WATER RESOURCES IN AGRICULTURE: OPPORTUNITIES FROM EARTH OBSERVATION

GIRIRAJ AMARNATH

***Contributors*: Bharat Sharma, Vladimir Smakhtin, Ameer Rajah, Niranga Alahacoon, Paul Pavelic**

International Water Management Institute (IWMI)

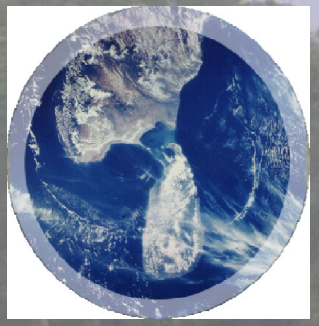
India Geospatial Forum, Hyderabad Convention Centre. 6 February 2013

CLIMATE CHANGE AGRICULTURE AND FOOD SECURITY

CGIAR RESEARCH PROGRAM ON Water, Land and Ecosystems

IWMI's 6 key challenge areas

More crop per drop



Managing climate risk

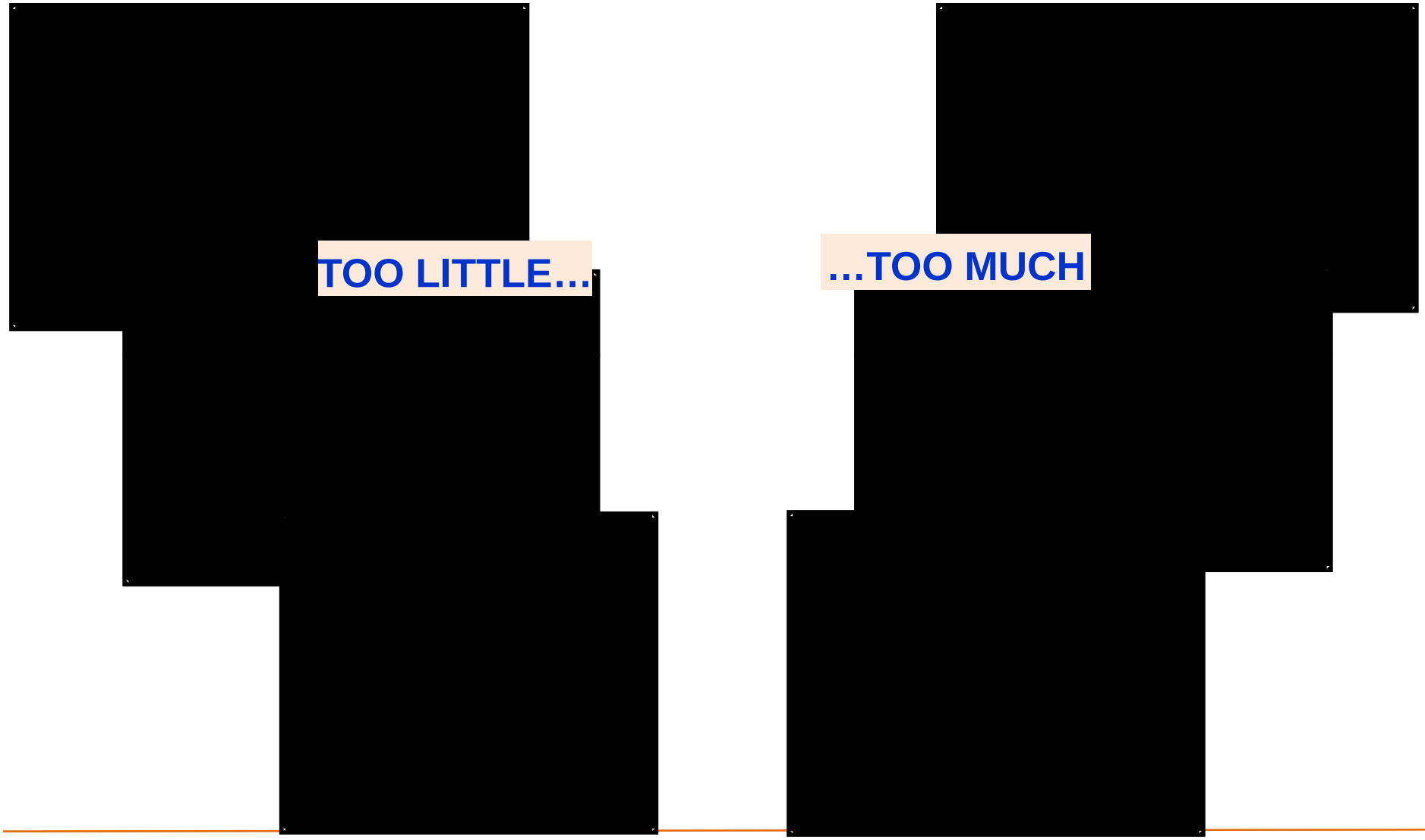
Productive ecosystems

Balanced growth

Sharing benefits

Recycling waste

EVERYTHING IS VARIABLE, WATER - TOO



INDIA: WATER AND FOOD CHALLENGES

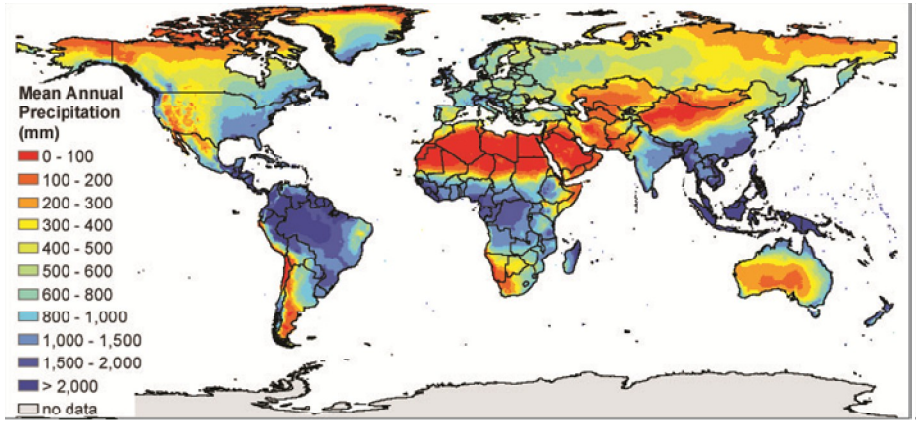
- **Indian Food Security** is Precariously Hinged on Very High Productivity from Relatively Small and Water Stressed Regions. Vast Areas have Low Land and Water Productivity.

- **Groundwater** is Now the Dominant Means of Indian Irrigation- But is Presently Ungoverned, Under-financed, Challenged by Energy-Irrigation Nexus and under Severe Stress.

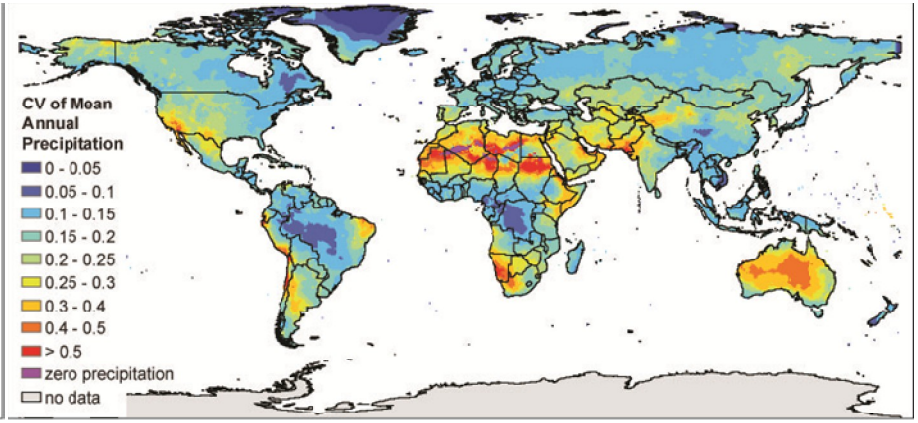
- **Rainfed Agriculture** has an Extremely Low, Variable and Vulnerable Productivity and Cries for an Immediate Small-Water-Based Turn-Around.

- **Climate Change** may have Serious Impact on Water Resources, Water Related Hazards and thus on both Rainfed and Irrigated Agriculture Productivity.

WATER VARIABILITY INCREASES WATER SCARCITY



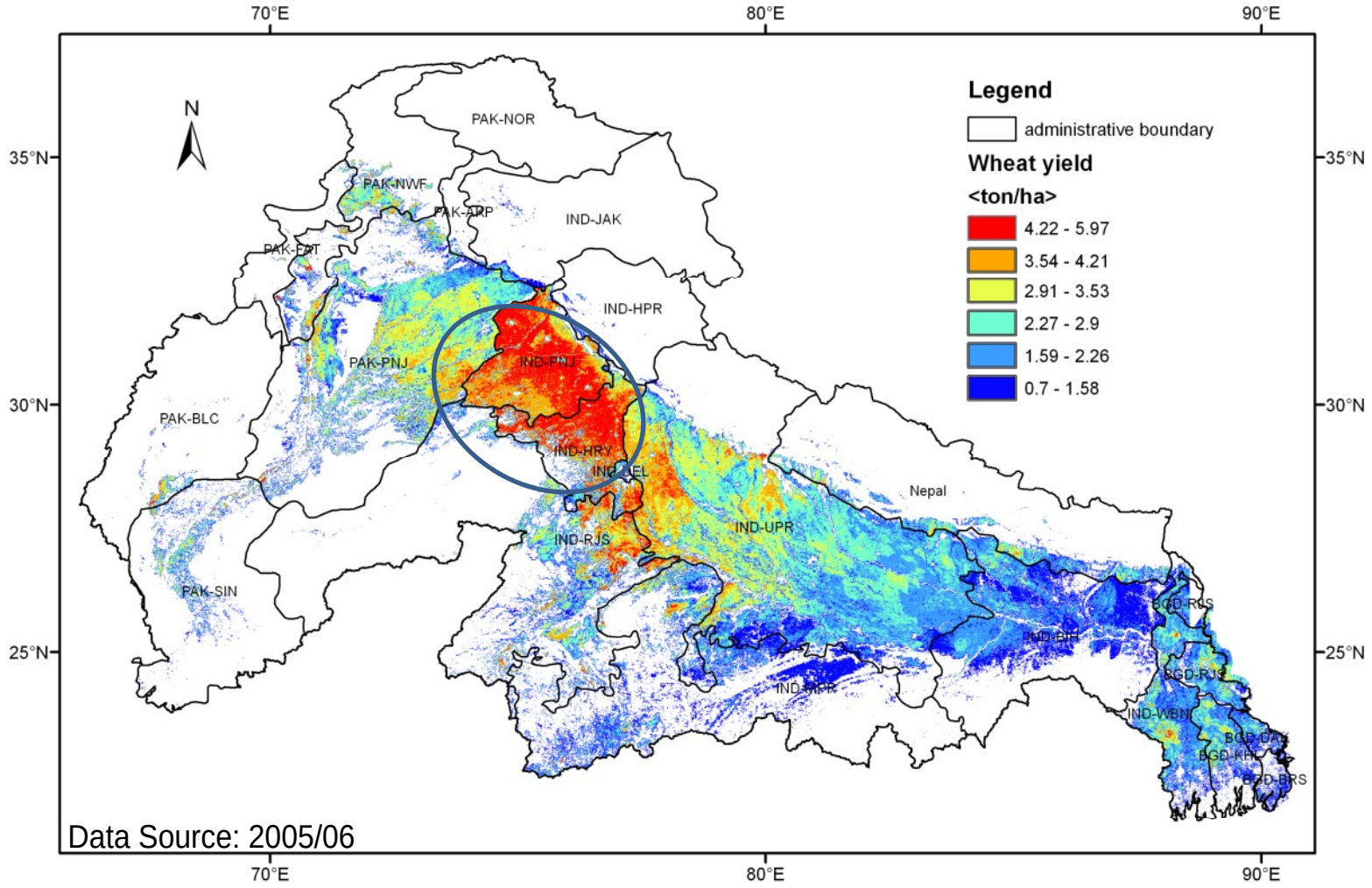
Mean Annual Precipitation (MAP)



Coefficient of Variation (CV) of MAP

Source: Smakhtin and Schipper, 2008

WHEAT YIELD MAP IN IG BASIN

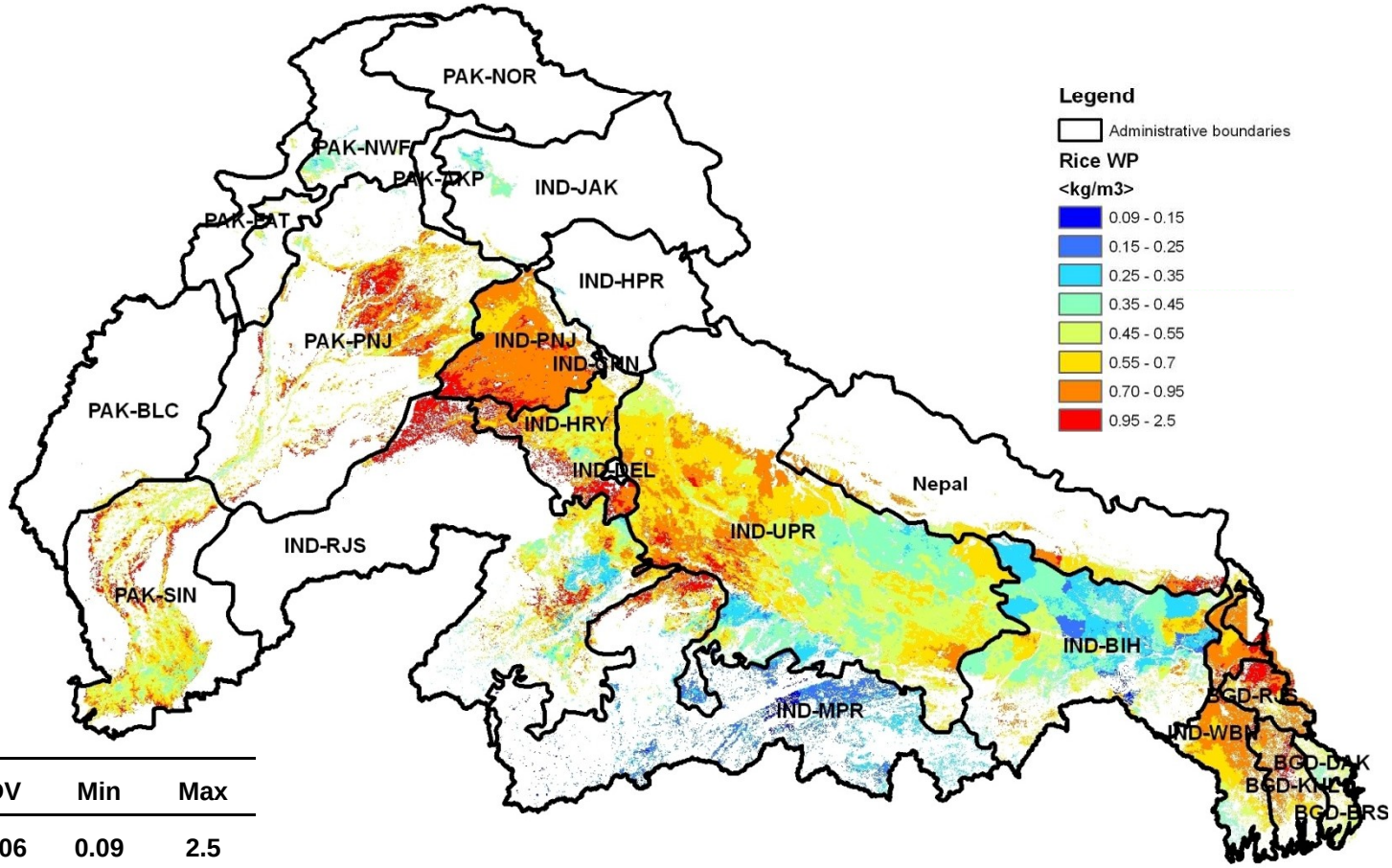


Data Source: 2005/06

This is about 7 per cent of the basin area which produces the most food for the vast population- and is under serious hydrological threat.

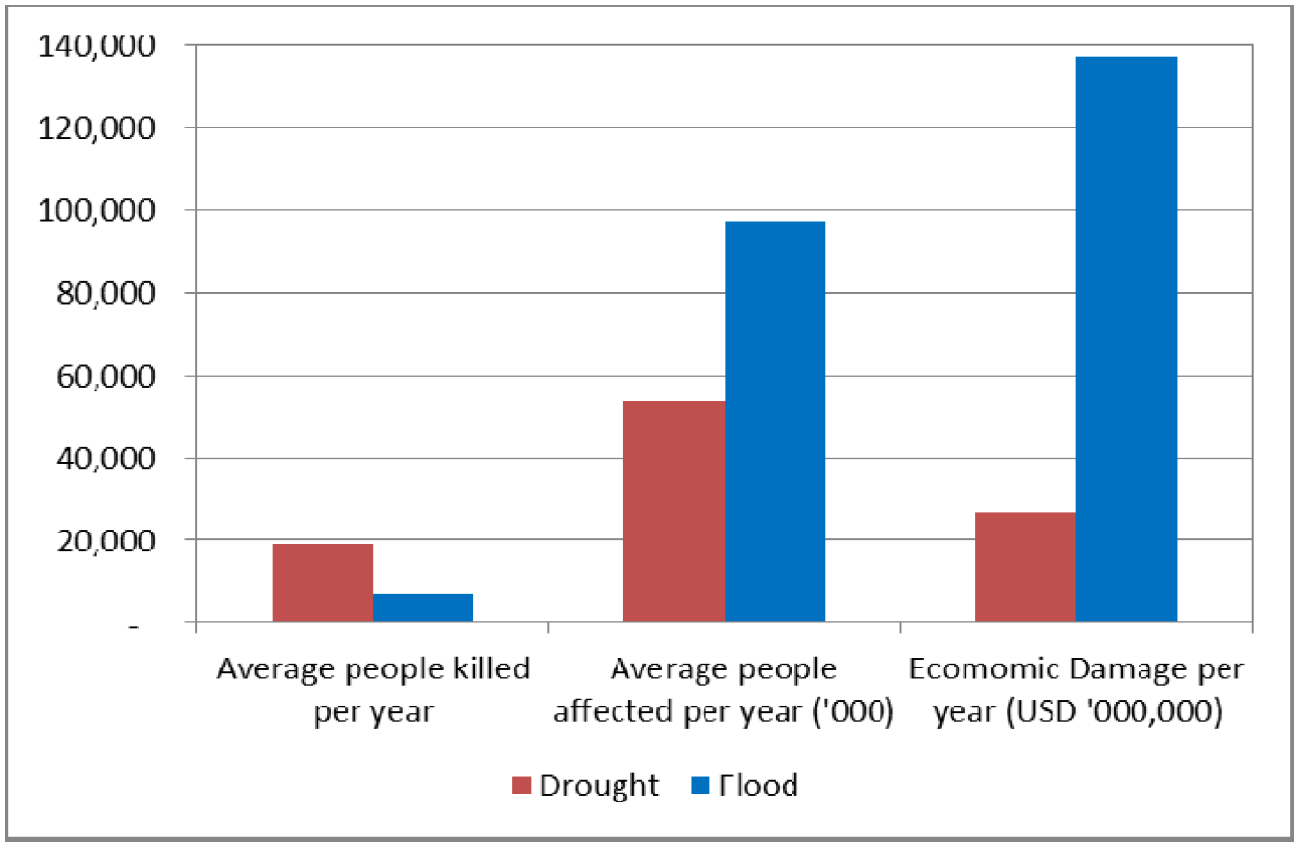
WATER PRODUCTIVITY MAPS

Rice productivity (kg/m^3)



Mean	AVG	SDV	Min	Max
0.618	0.618	0.306	0.09	2.5

WATER VARIABILITY MANIFESTS ITSELF IN DROUGHT AND FLOOD DAMAGES



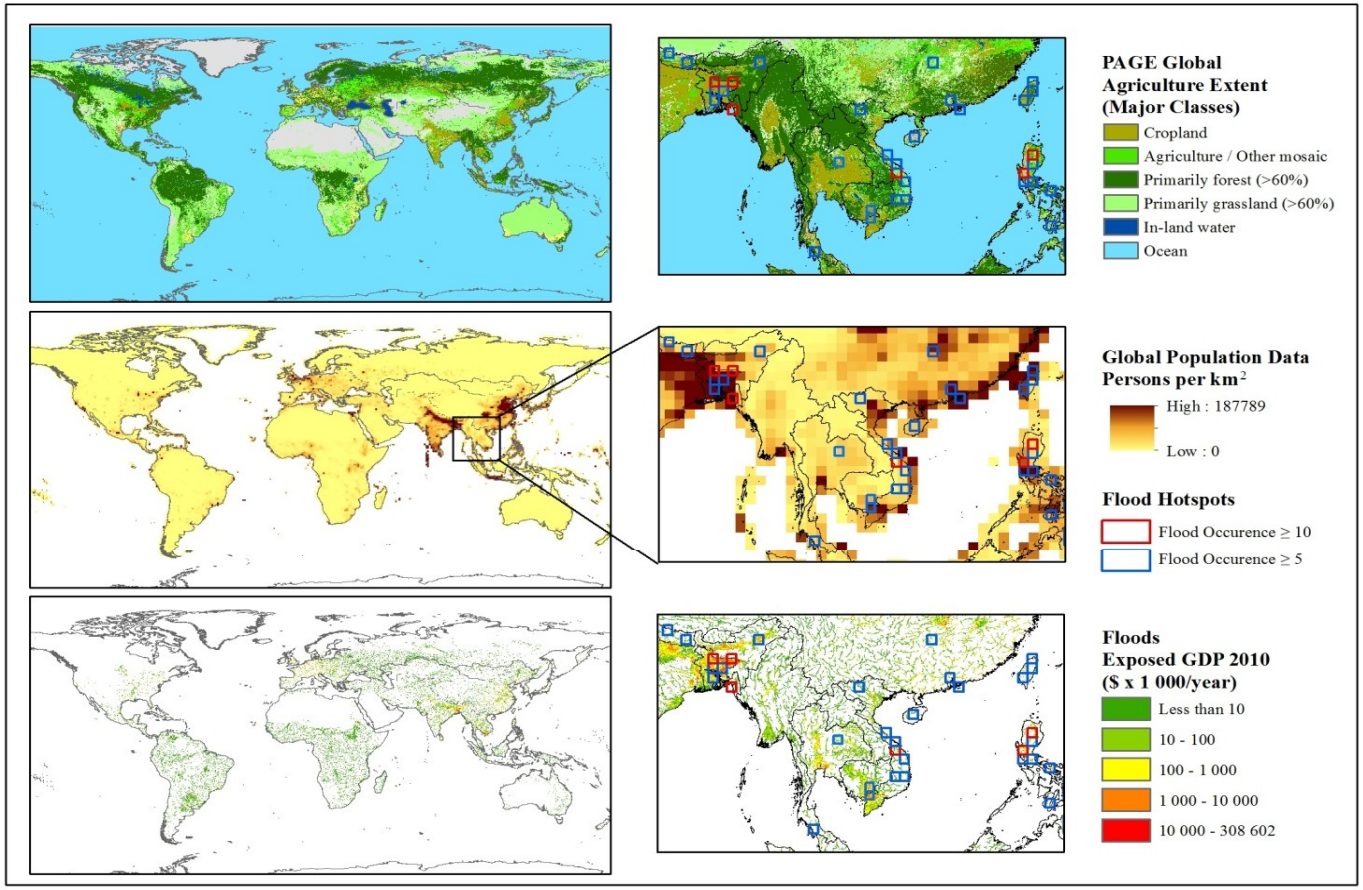
Average annual characteristics over 1980-2008

Source -EM-DAT: The OFDA/CRED International Disaster Database, Brussels

VARIABILITY MANAGEMENT MUST RECEIVE MUCH MORE SCIENCE, POLICY AND INVESTMENT ATTENTION

- Better quantification of variability hot spots, risks and extent
- Harnessing satellite data in managing variability and improving agriculture-water management
- Conjunctive management of floods and droughts in river basins through subsurface solutions (vs. just surface ones)

IDENTIFY AND QUANTIFY HOT SPOTS



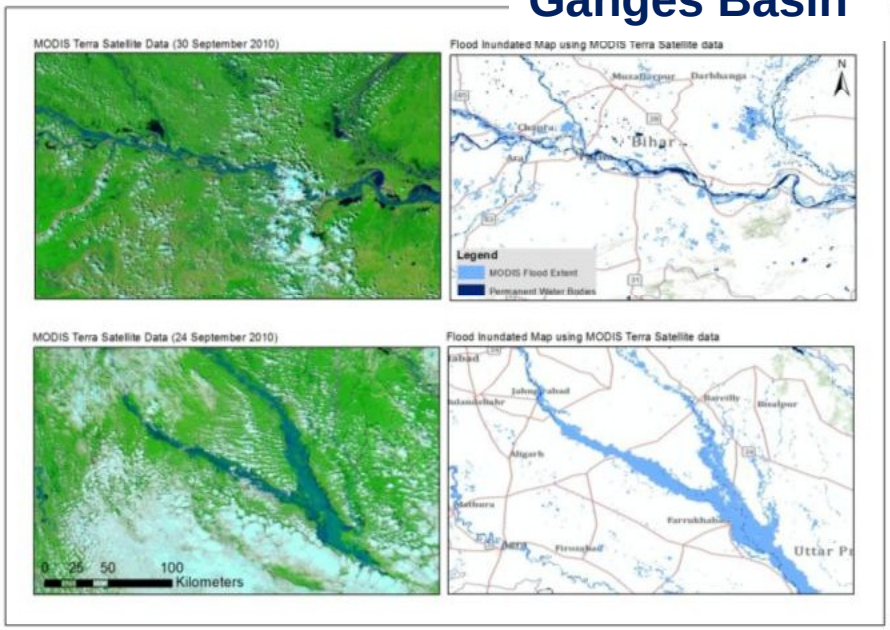
AGRICULTURE;
PAGE (2005)

POPULATION
CIESIN - 2010

FLOOD EXPOSED GDP
WB, 2010

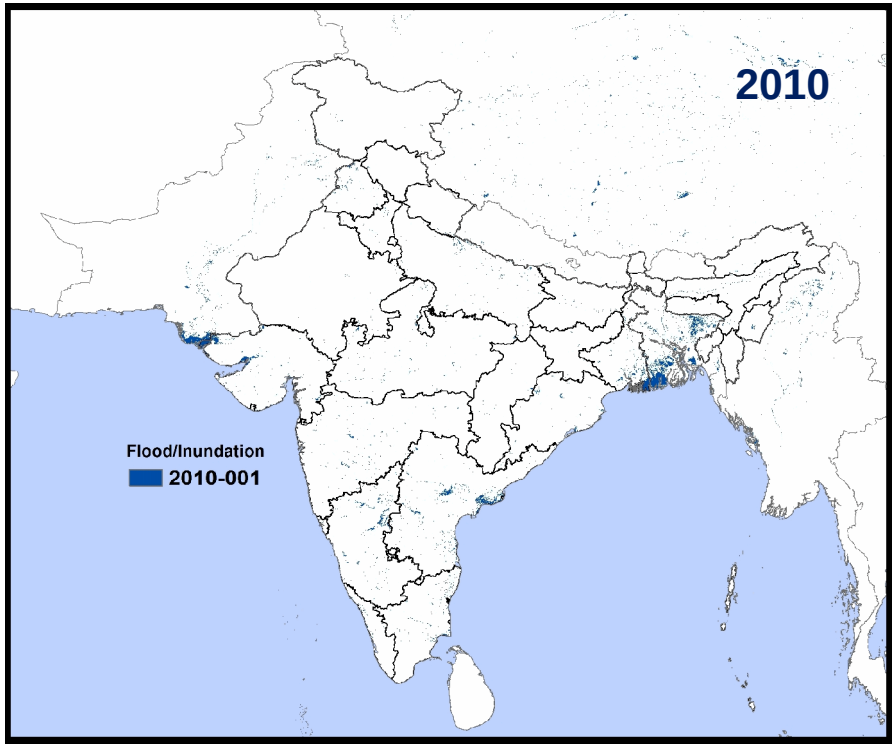
QUANTIFY RISK AND EXTENT

Ganges Basin

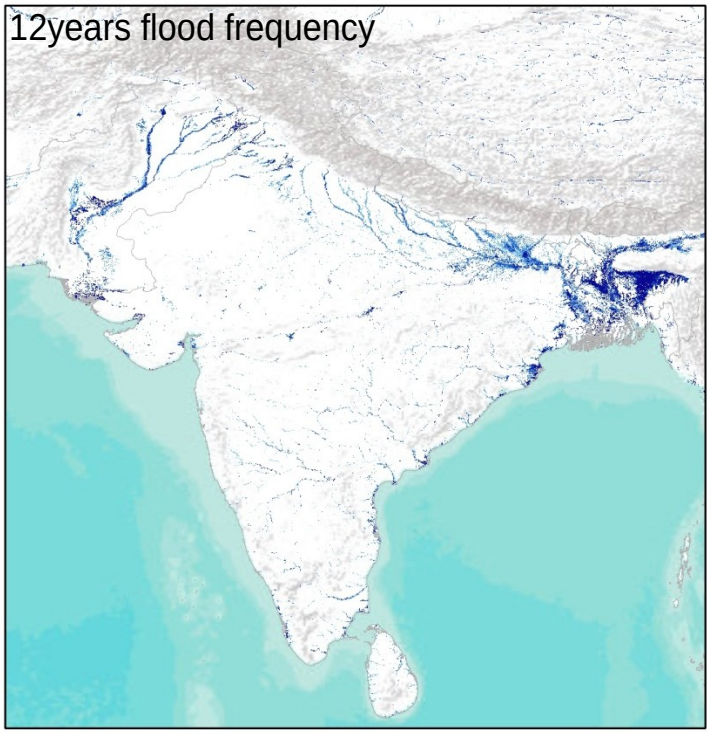


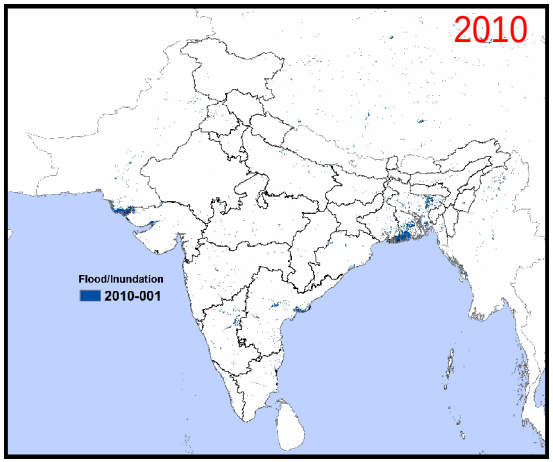
Source: Amarnath et al, 2012

8-days maps of inundation extent



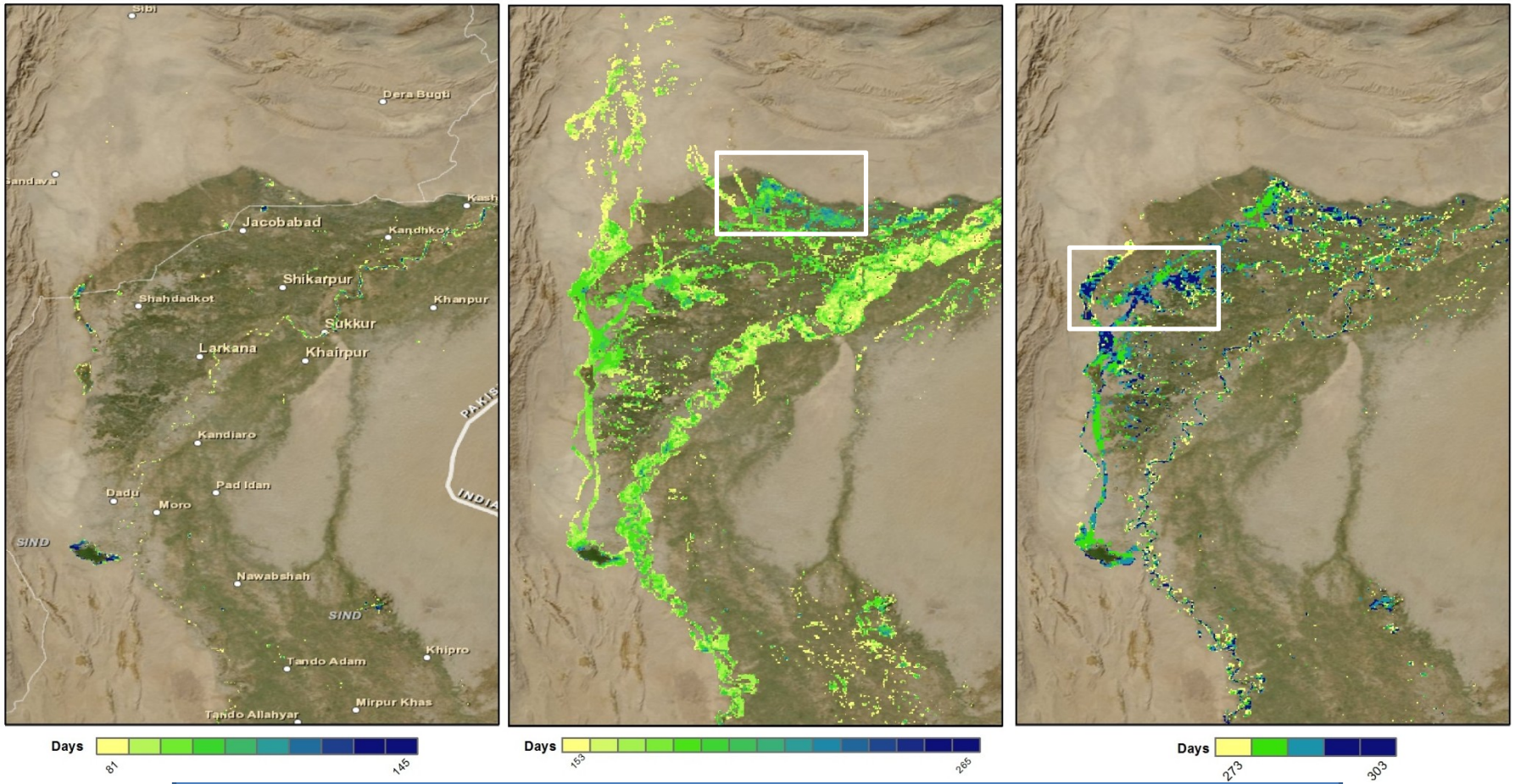
SOUTH ASIA PRODUCTS



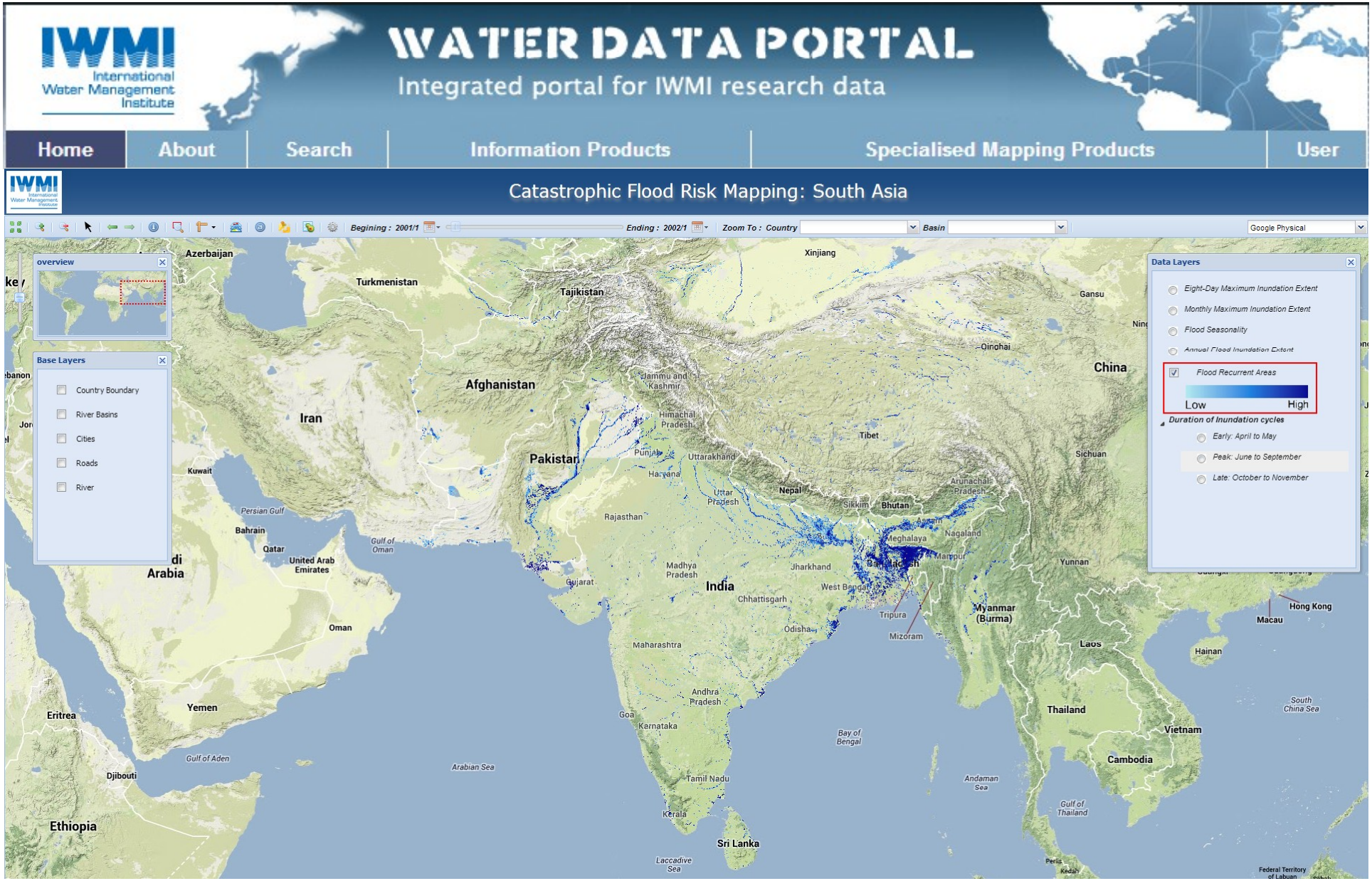


Country	Flood Affected Area	Area (sqkm)	Percent Area
Bangladesh	69,025.93	147,570	46.78
India	135,568.18	3,287,240	4.12
Nepal	1,442.34	147,181	0.98
Pakistan	97,057.15	796,095	12.19
SriLanka	838.27	65,610	1.28

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


IWMI
International Water Management Institute
WATER DATA PORTAL
Integrated portal for IWMI research data
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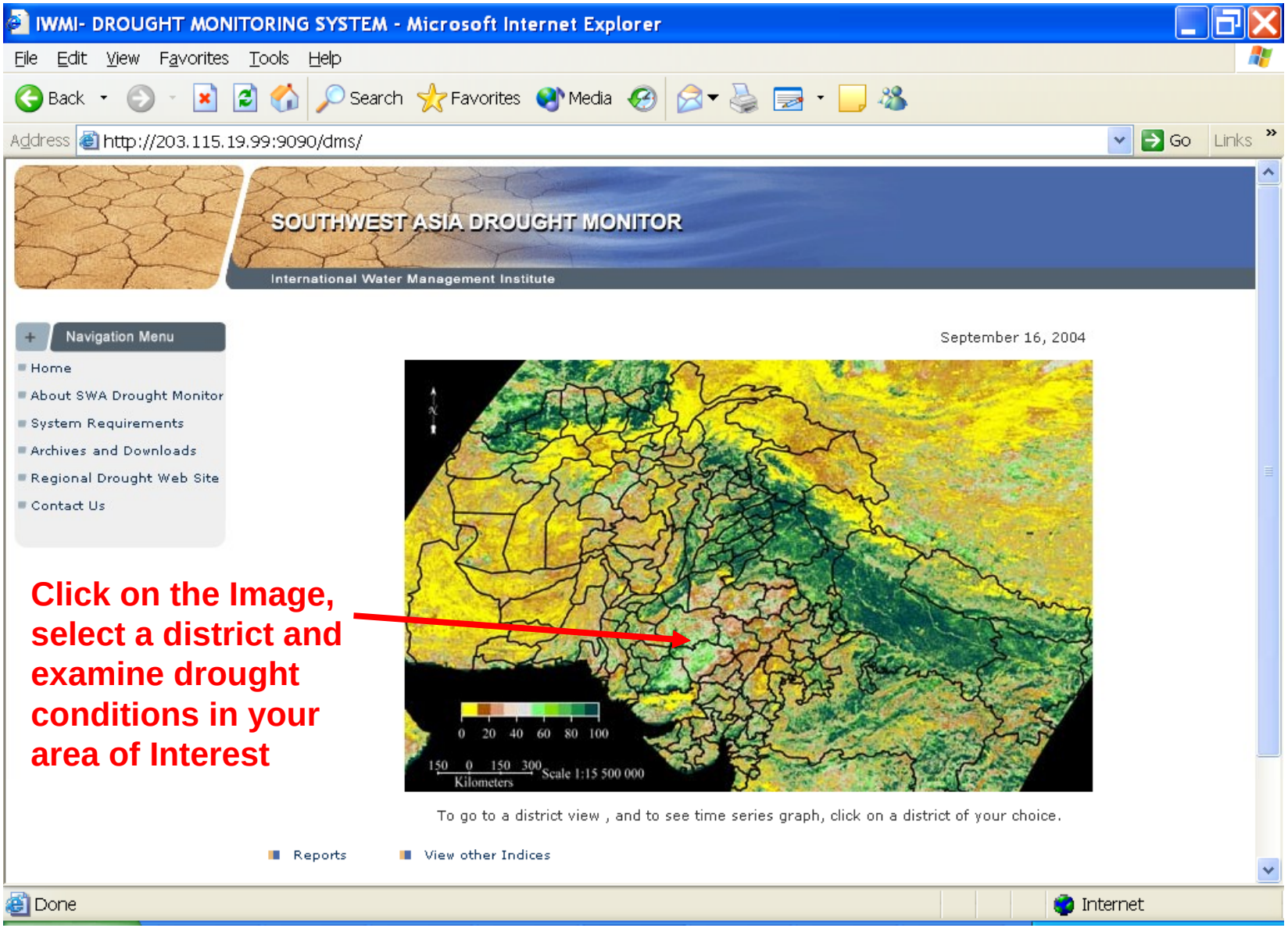
Information Products
Specialised Mapping Products
User
Catastrophic Flood Risk Mapping: South Asia
Begining : 2001/1
Ending : 2002/1
Zoom To : Country
Basin
Google Physical
overview
Base Layers
Country Boundary
River Basins
Cities
Roads
River
Data Layers
Eight-Day Maximum Inundation Extent
Monthly Maximum Inundation Extent
Flood Seasonality
Annual Flood Inundation Extent
Flood Recurrent Areas
Low
High
Duration of Inundation cycles
Early: April to May
Peak: June to September
Late: October to November
Azerbaijan
Turkmenistan
Tajikistan
Xinjiang
Gansu
Qinghai
China
Afghanistan
Iran
Pakistan
Jammu and Kashmir
Himachal Pradesh
Punjab
Uttarakhand
Haryana
Tibet
Sichuan
Kuwait
Nepal
Uttar Pradesh
Sikkim
Bhutan
Arunachal Pradesh
Rajasthan
Persian Gulf
Bahrain
Qatar
United Arab Emirates
Gulf of Oman
Meghalaya
Nagaland
Manipur
Yunnan
Madhya Pradesh
Jharkhand
Gujarat
India
West Bengal
Chhattisgarh
Tripura
Mizoram
Myanmar (Burma)
Hong Kong
Macau
Oman
Odisha
Laos
Hainan
Maharashtra
Andhra Pradesh
Goa
Karnataka
Thailand
Vietnam
South China Sea
Bay of Bengal
Eritrea
Yemen
Gulf of Aden
Djibouti
Arabian Sea
Tamil Nadu
Andaman Sea
Cambodia
Gulf of Thailand
Kerala
Ethiopia
Sri Lanka
Laccadive Sea
Perlis
Kedah
Federal Territory of Labuan

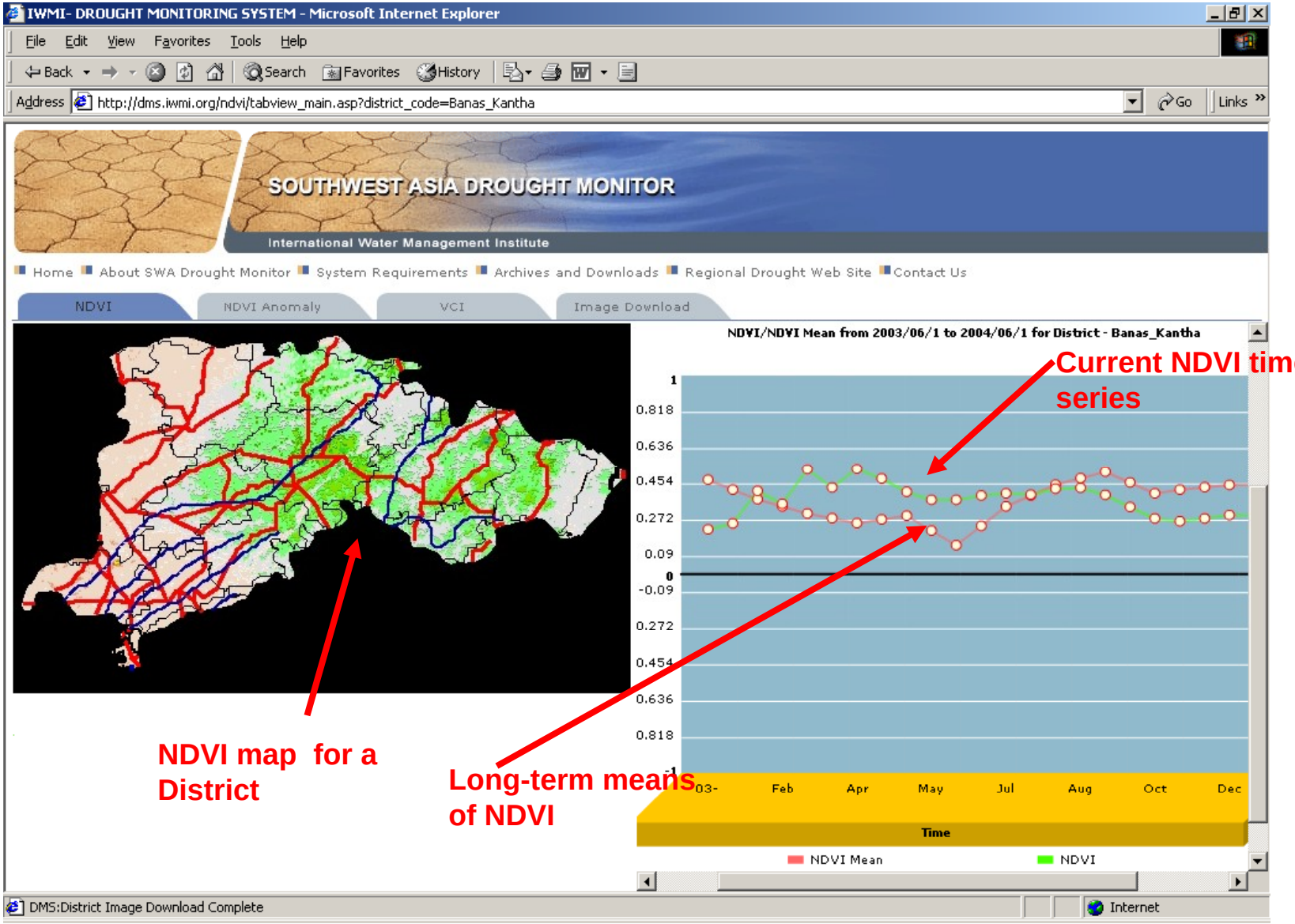
ONLINE DROUGHT MONITORING SYSTEM FOR SW ASIA: FRONT PAGE

http://dms.iwmi.org



Click on the Image, select a district and examine drought conditions in your area of Interest

ONLINE DROUGHT MONITORING SYSTEM FOR SW ASIA
DISTRICT VIEW - NDVI



Harnessing the power of satellite data in Flood Irrigation Mapping & Modeling (Eastern Sudan)

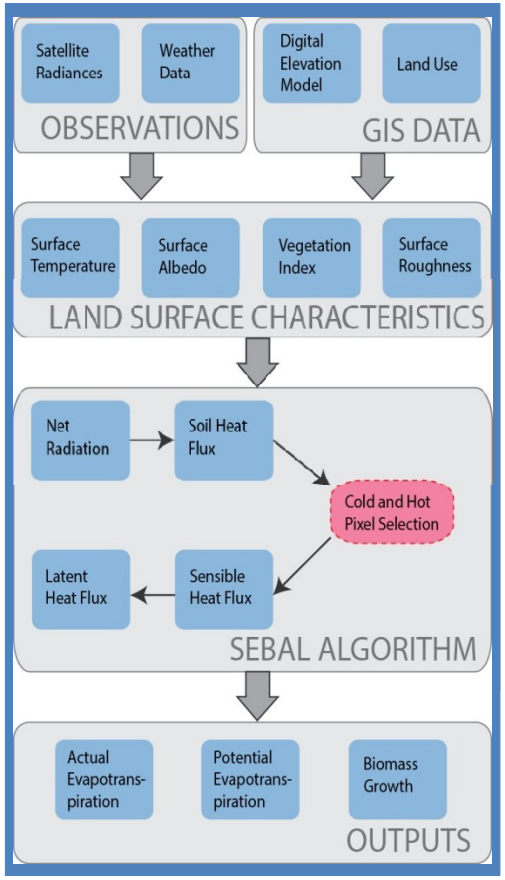
Canal Uptake and Sorghum flowering in Gash Delta, Sudan

RESEARCH COMPONENTS

Flood Services

- Flood Inundation Mapping
- Flood Forecasting Model

Crop Biomass

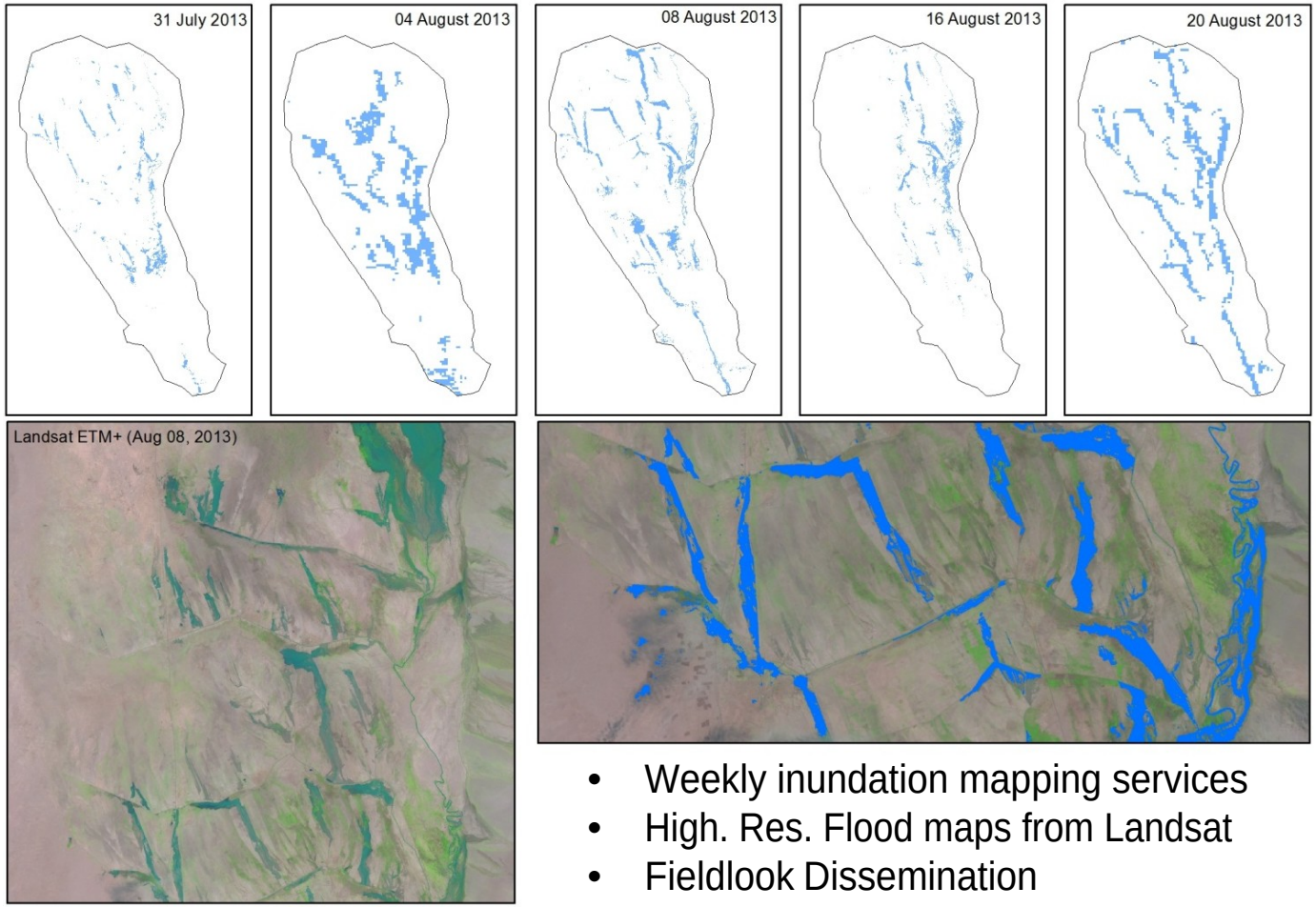


Operational Services

- Daily / Weekly Flood Inundation Extent
- Weekly Crop growth and Irrigation Performance

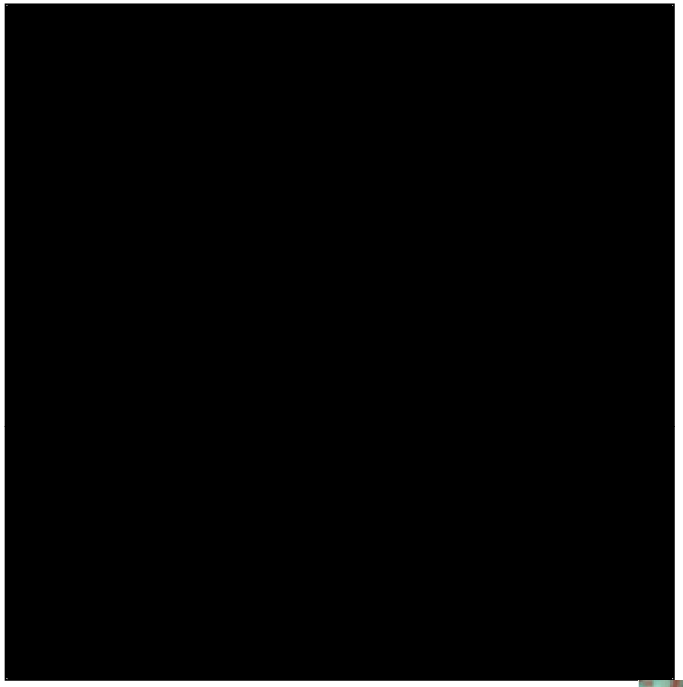
Fieldlook Portal + SMS

OPERATIONAL FLOOD INUNDATION MAPPING (MODIS + Landsat Images)

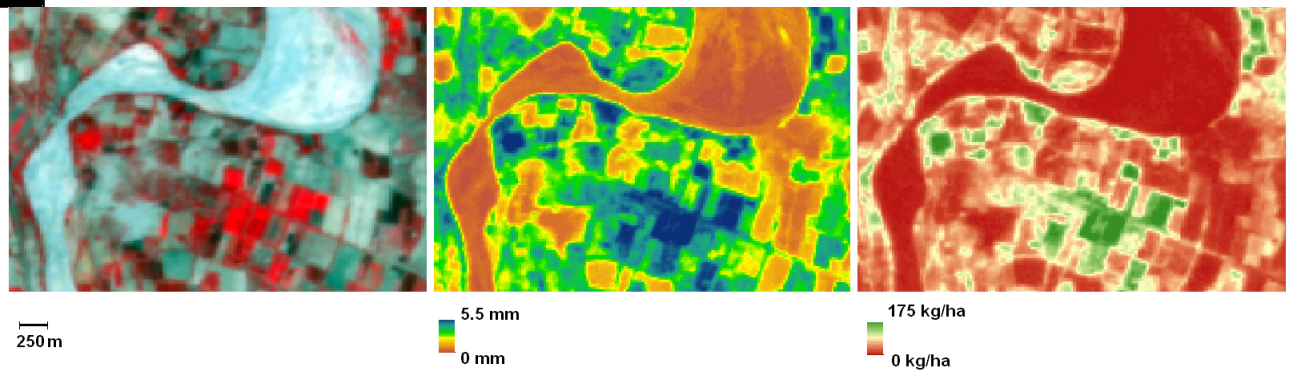


- Weekly inundation mapping services
- High. Res. Flood maps from Landsat
- Fieldlook Dissemination

OPERATIONAL BIOMASS PRODUCT



Raw DMC satellite data for 21-11-2012 (L), and derived daily evapotranspiration (M) and biomass production (R).



DEVELOPMENT OF FLOOD FORECASTING SYSTEM HEC HMS+RAS

Basin Characteristics

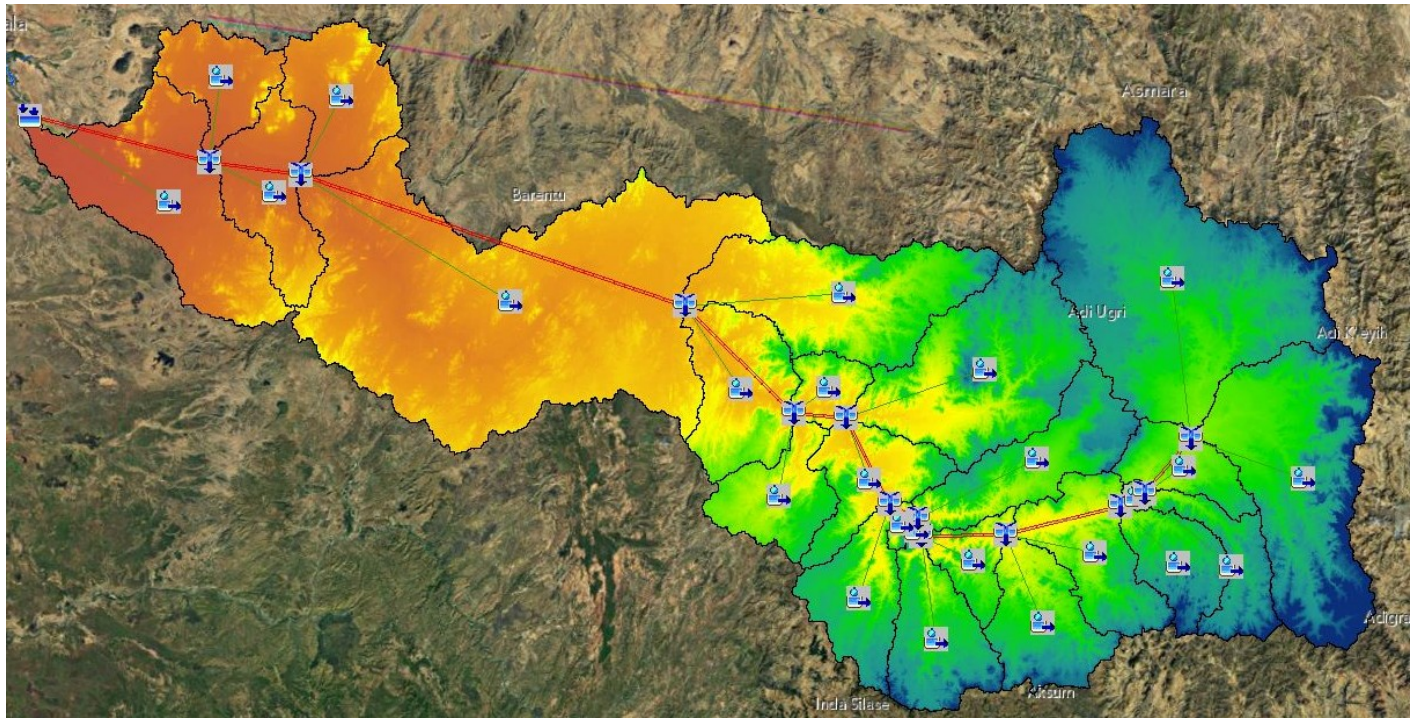
25 sub-basin
Watershed ~20,000km^2
12 river segments

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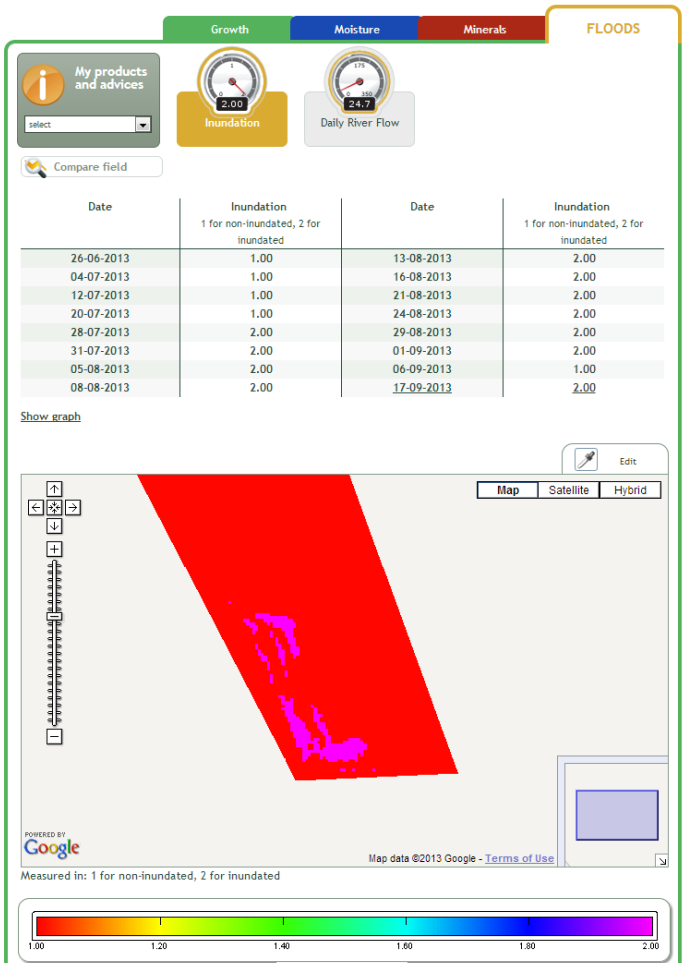
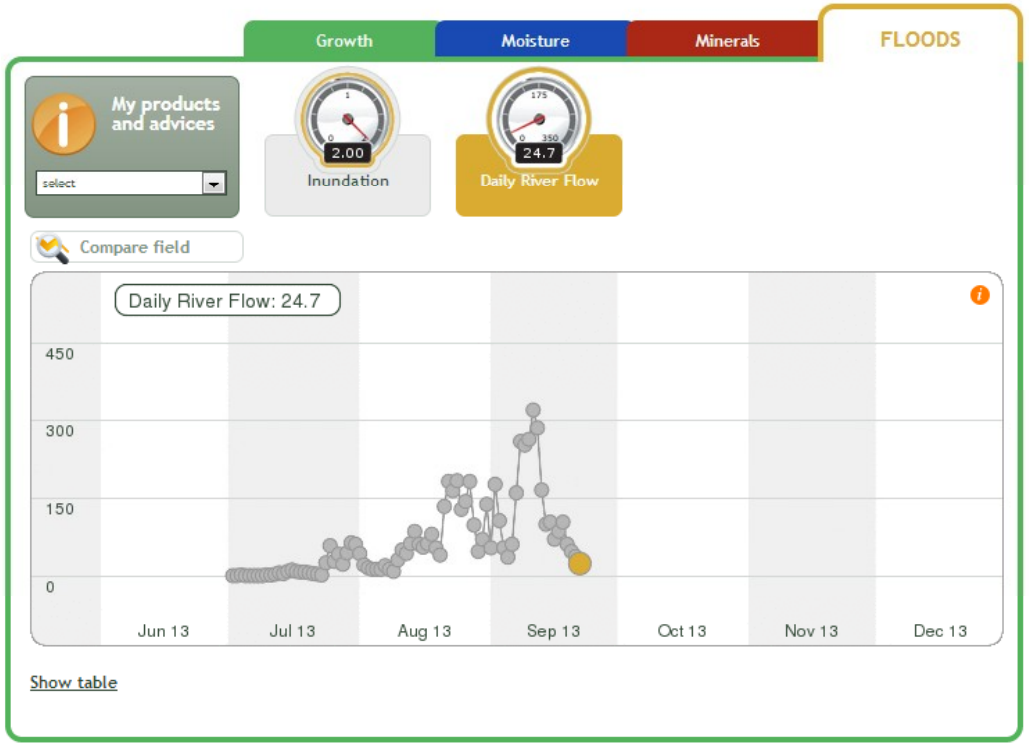
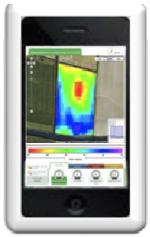
From pixels….to information….to simple action messages







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CONJUNCTIVE FLOOD AND DROUGHT MANAGEMENT

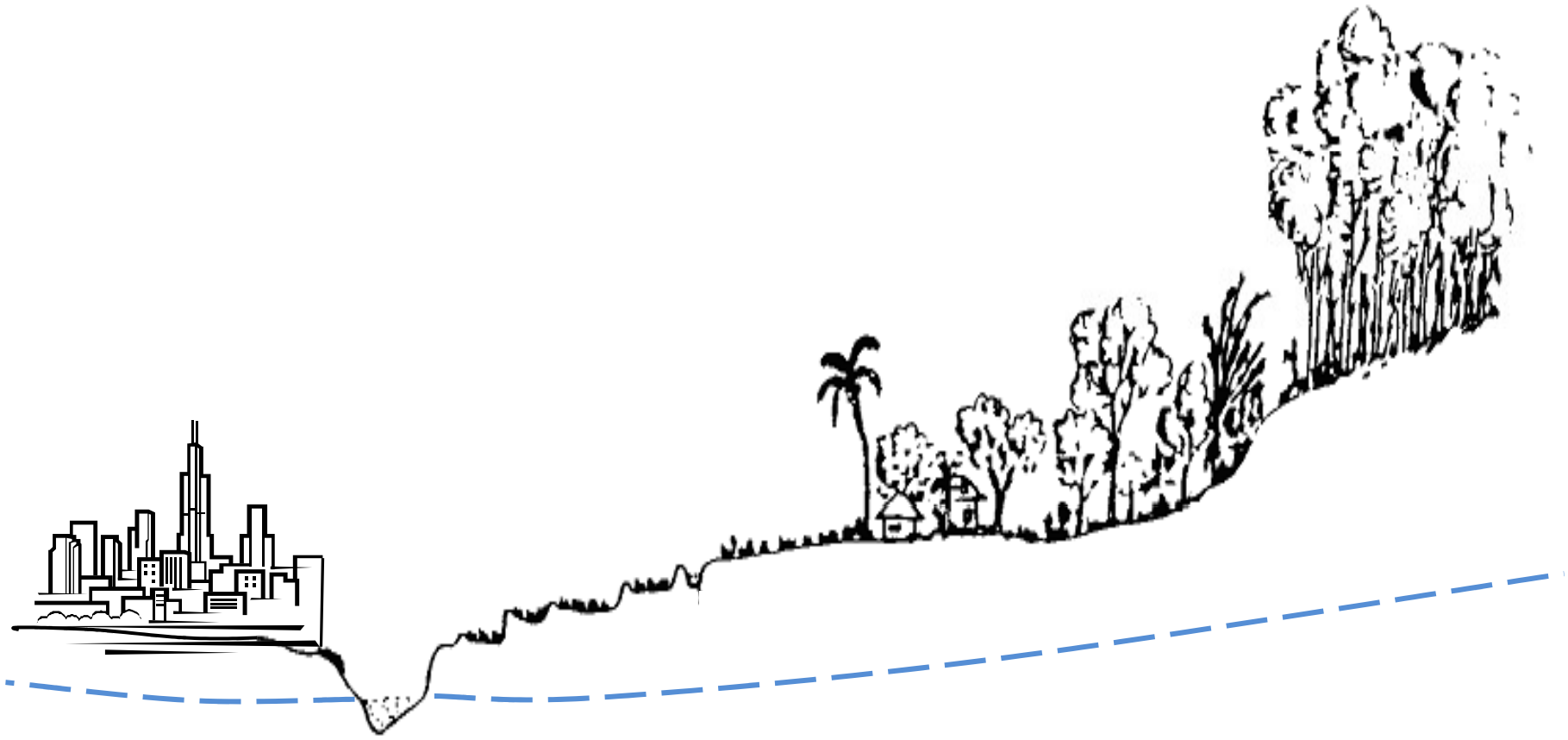
UTF-I desktop case study: Chao Phraya basin, Thailand

(Source: Pavelic et al, 2012)

- Harvest water only in very wet years - approximately 1 year in 4
- Around 200 km^2 land dedicated to flood harvesting may be needed (< 1% of the total basin area)
- Additional 65,000- 270,000 ha of irrigation possible
- $150 mill / year - mean income to smallholder farmers
- Cost of implementation < $ 1 Bill. Payback time can be 7 -14 years, depending on the efficiency of the scheme
- Farmers' participation is critical
- No analogs so far exist

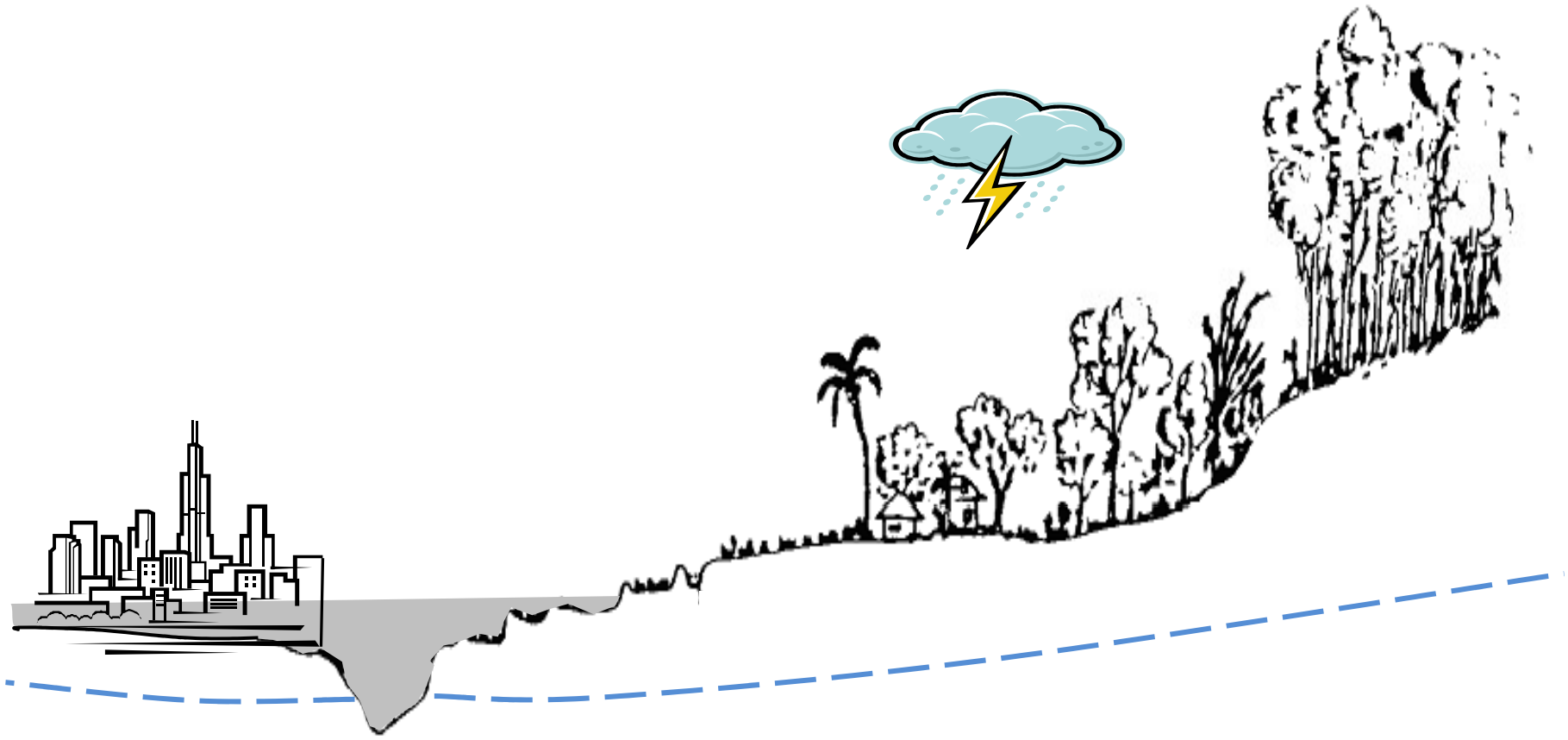
CONJUNCTIVE FLOOD AND DROUGHT MANAGEMENT

Current Climate – Dry Season



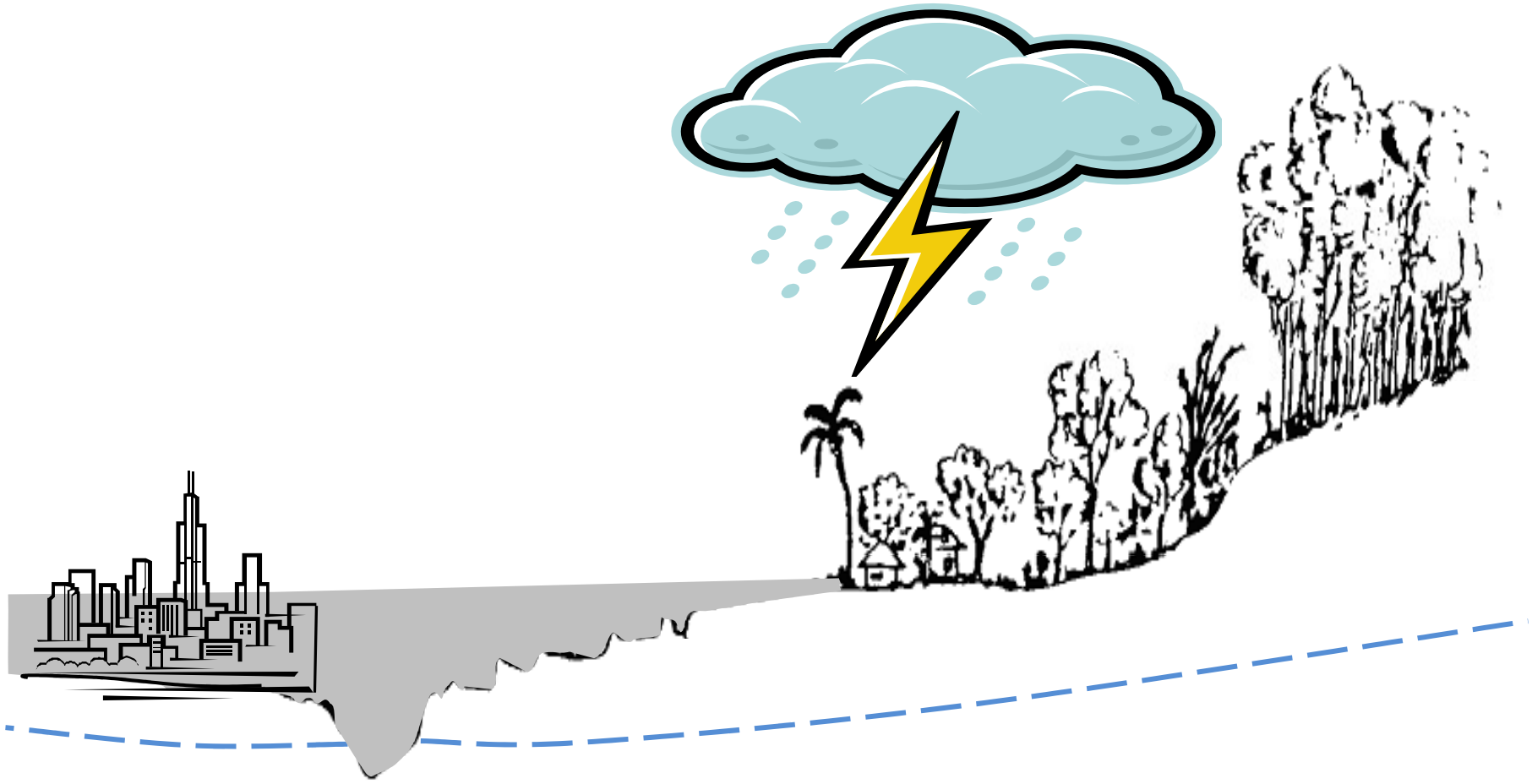
CONJUNCTIVE FLOOD AND DROUGHT MANAGEMENT

Current Climate – Wet Season



CONJUNCTIVE FLOOD AND DROUGHT MANAGEMENT

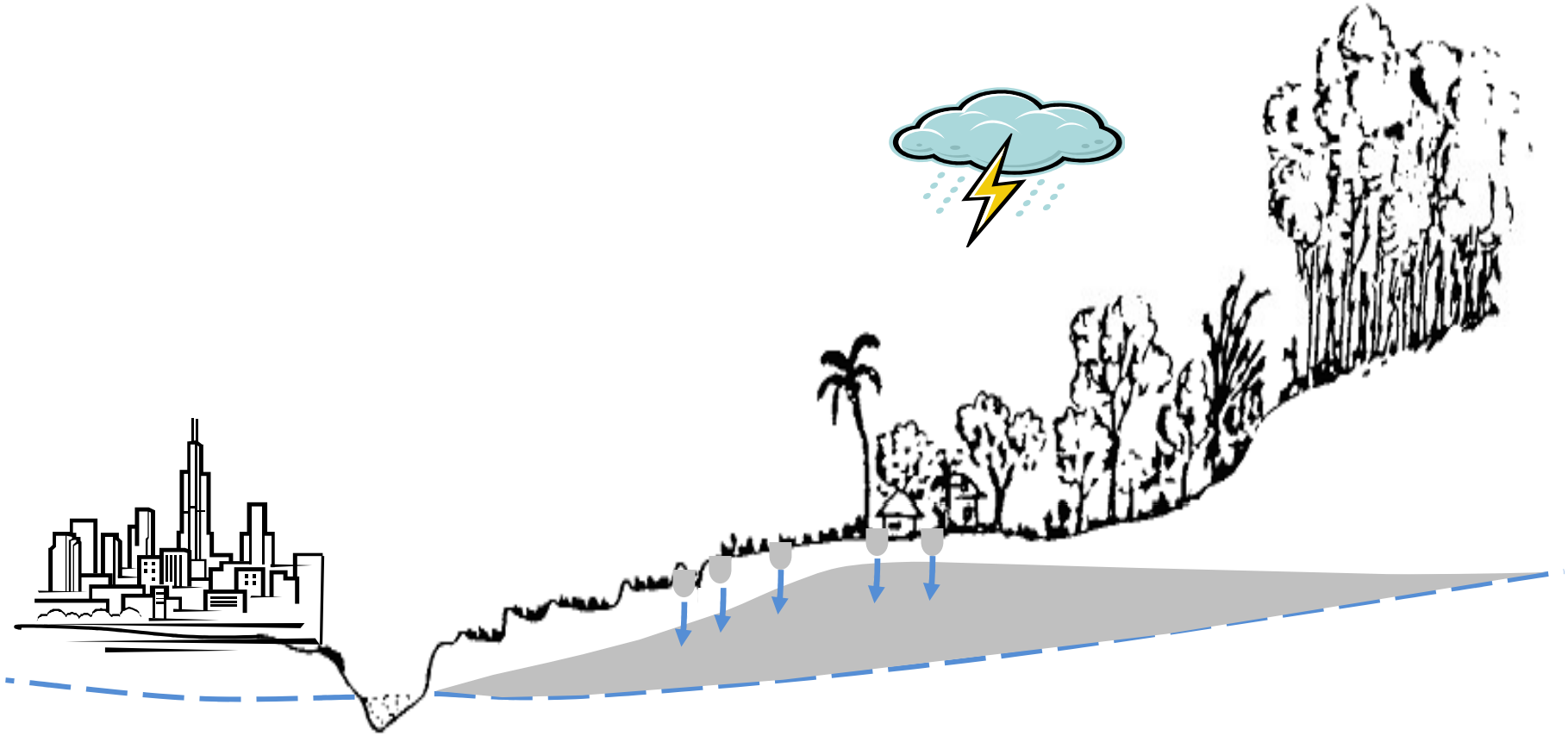
Future Climate - Wet Season



CONJUNCTIVE FLOOD AND DROUGHT MANAGEMENT

Underground Taming of Floods for Irrigation (UTF-I);

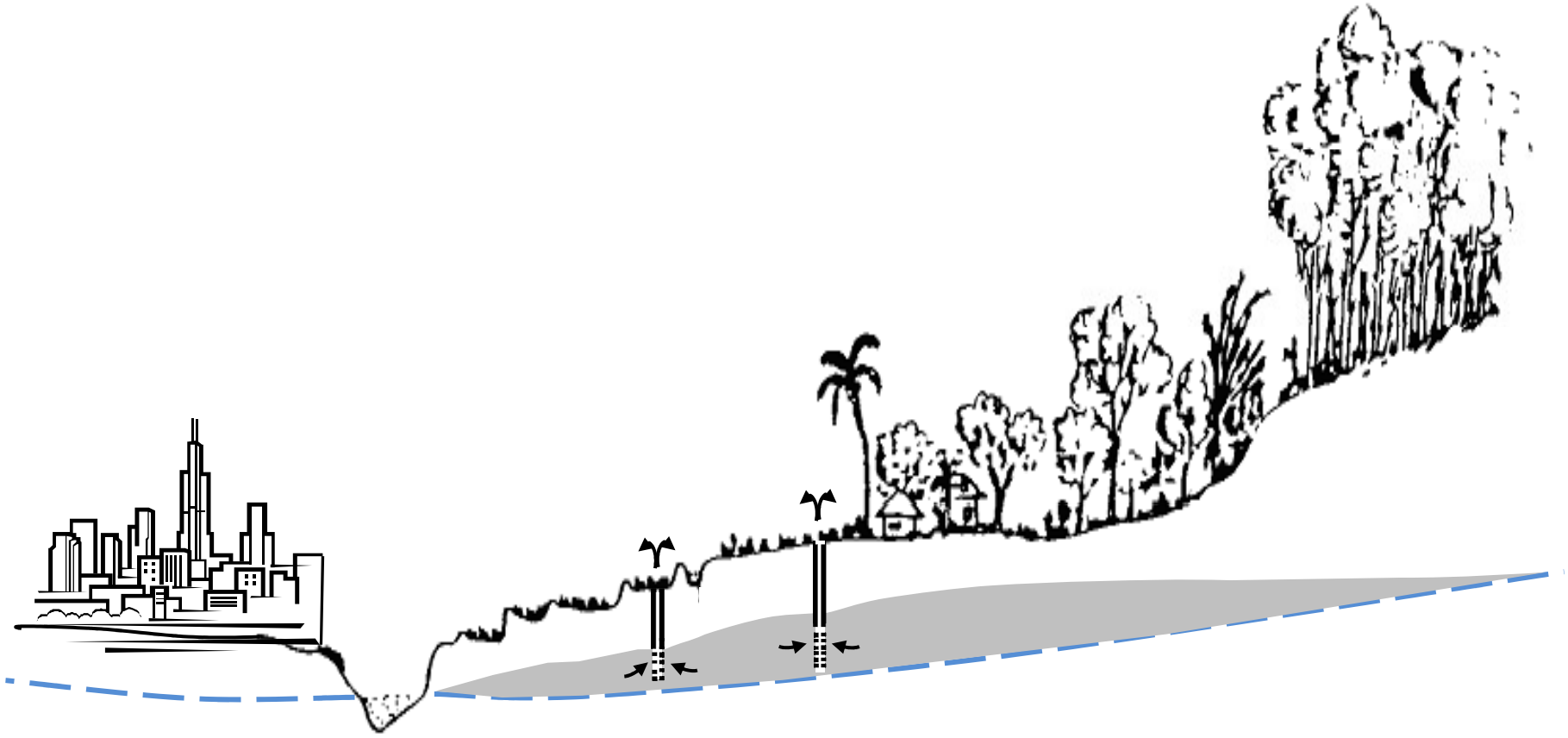
Wet season



CONJUNCTIVE FLOOD AND DROUGHT MANAGEMENT

Underground Taming of Floods for Irrigation (UTF-I);

Dry season

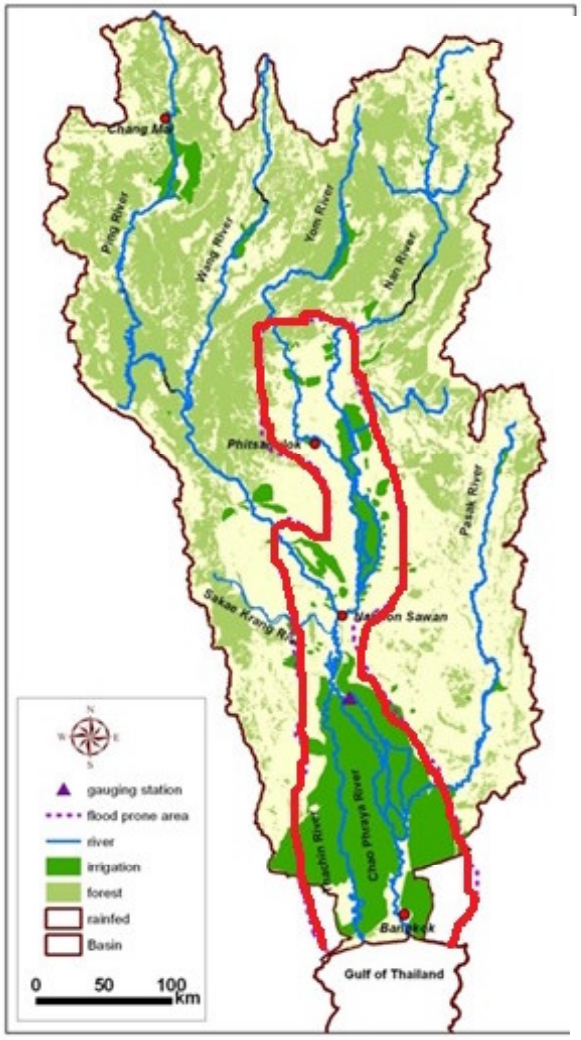


CONJUNCTIVE FLOOD AND DROUGHT MANAGEMENT

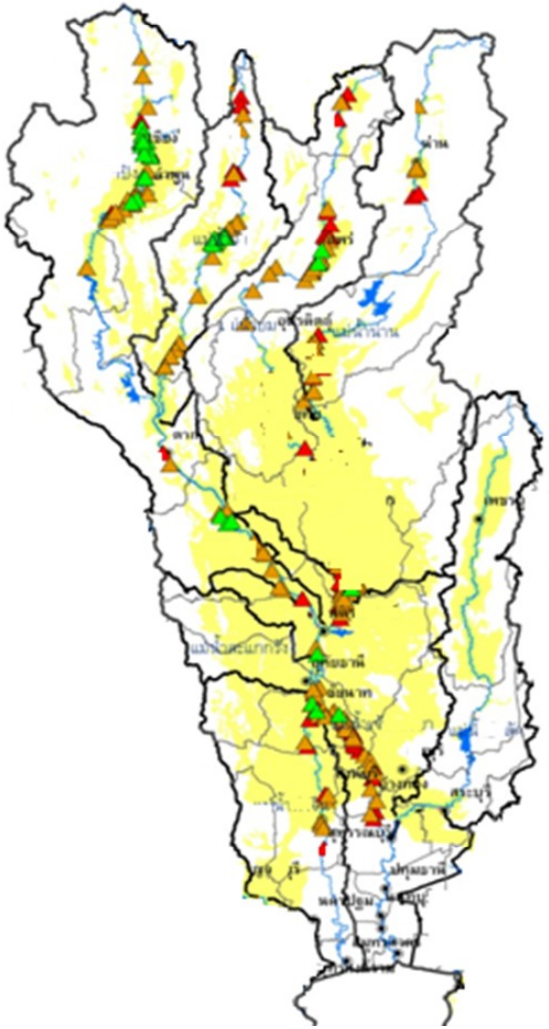
UTF-I desktop case study: Chao Phraya basin, Thailand

(Source: Pavelic et al, 2012)

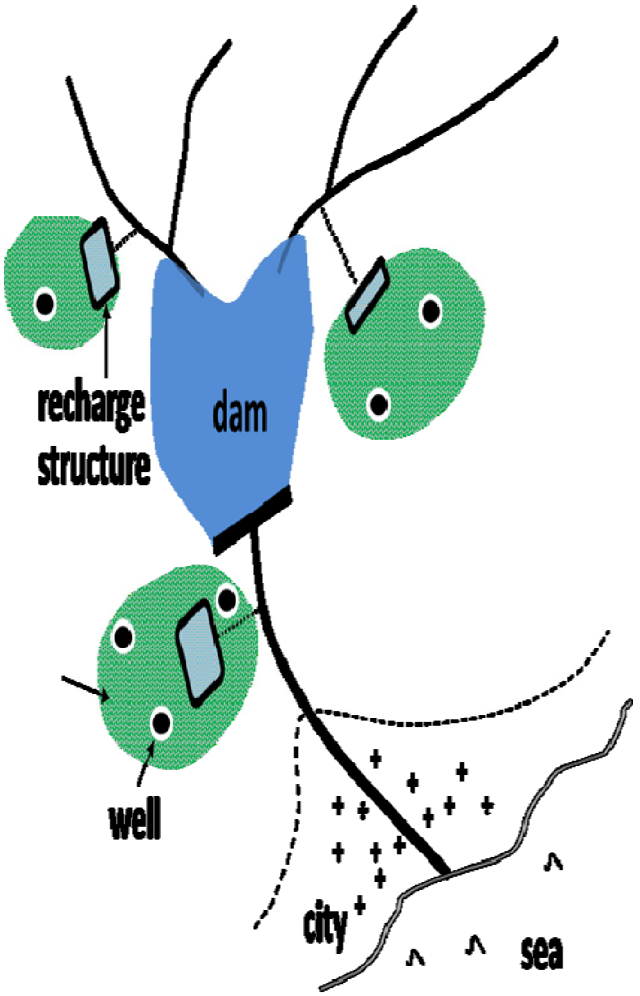
Land Use



Alluvium aquifers



UTFI in plan view



KEEPING VARIABILITY ?

- Variability has positive effects too, e.g. the range of high and low flows, their proper timing and frequency is needed to ensure a healthy river

- The challenge is to alleviate negative aspects of variability, while maintaining its positive side

Capacity Development & Partnership

Thank you

Contact: a.giriraj@cgiar.org