

ASIA PACIFIC REGIONAL SPACE AGENCY FORUM  
(APRSAF-28), VIETNAM

# EARTH OBSERVATION DATA FOR CLIMATE RESILIENCE AND STRENGTHENING DISASTER RISK MANAGEMENT

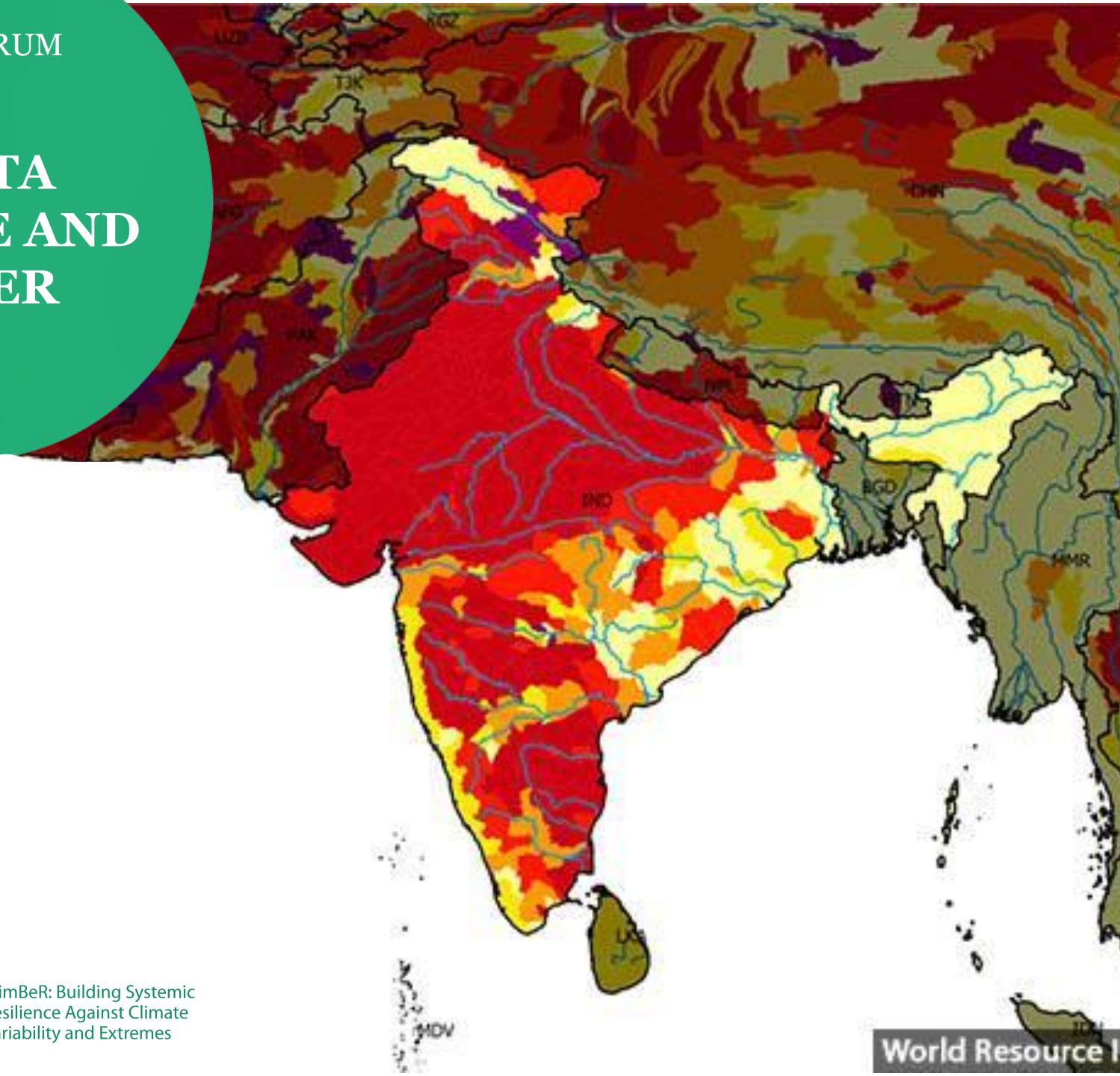
**GIRIRAJ AMARNATH**

Research Group Leader: Water Risk to  
Development and Resilience

**November 15, 2022**



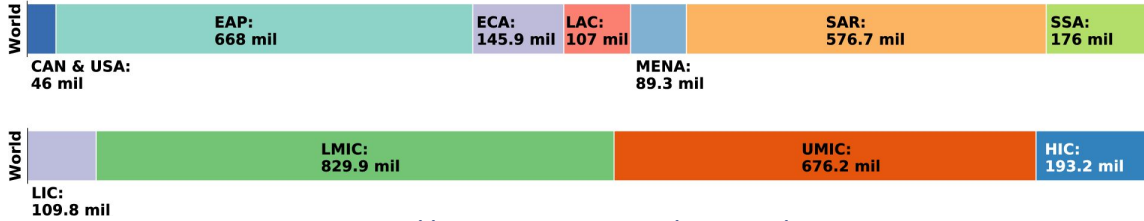
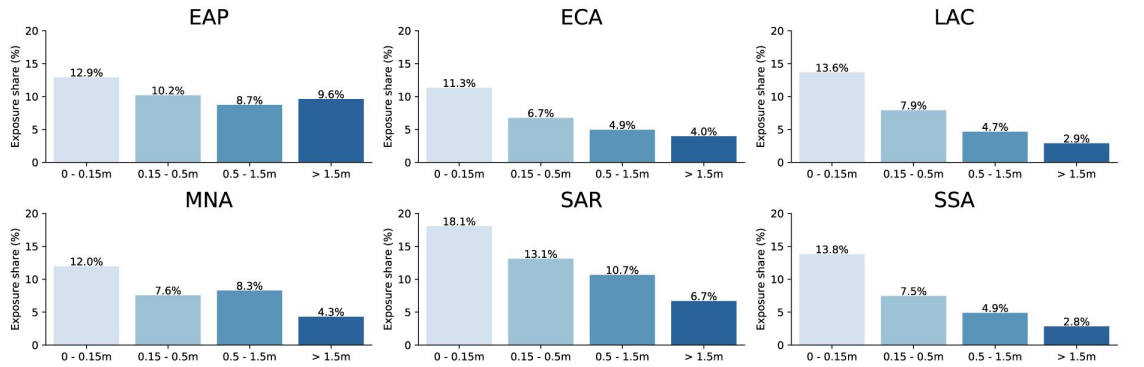
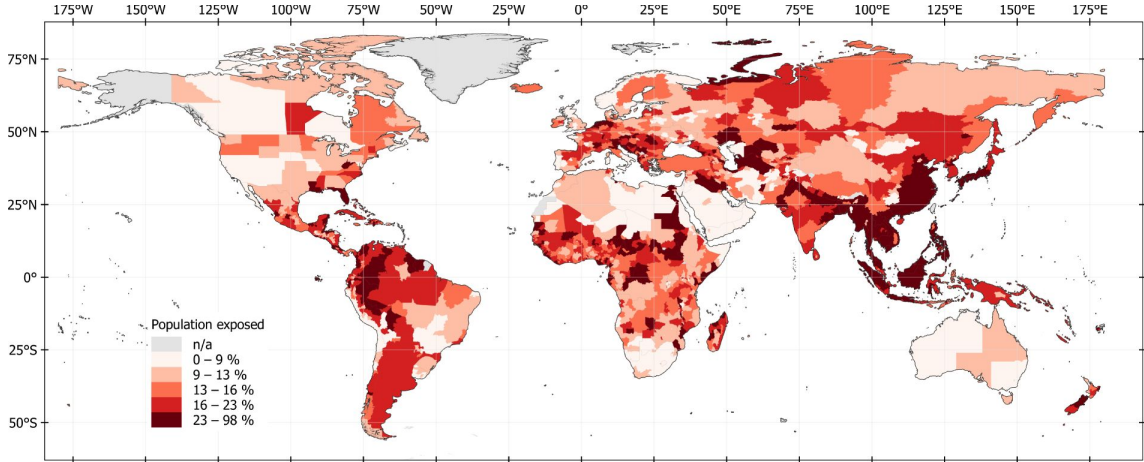
ClimBeR: Building Systemic  
Resilience Against Climate  
Variability and Extremes



World Resource I

# Global and regional flood exposure to poverty

- Flooding is among the most prevalent natural hazards, with particularly disastrous impacts in low-income countries
- 1.81 billion people (23% of world population) are directly exposed to 1-in-100-year floods.
- Of these, 1.24 billion are located in South and East Asia, where China (395 million) and **India (390 million)** account for over one-third of global exposure.
- < \$5.50 per day face high flood risk
- Flood mitigation measures to support resilient development.



# IWMI's framework on Water Risks and Disasters



## GOVERNANCE, POLICY AND INSTITUTIONAL ARRANGEMENT



**Risk Identification**

- HISTORICAL HAZARD DATA, ANALYSIS AND CHANGING HAZARD TRENDS
- EXPOSED ASSETS & VULNERABILITY
- RISK QUANTIFICATION



**Risk Reduction**

- PREPAREDNESS: EARLY WARNING SYSTEMS, EMERGENCY PLANNING AND RESPONSE CAPACITIES
- MITIGATION AND PREVENTION: MEDIUM TO LONG TERM SECTORAL PLANING (E.G. BUILDING RESILIENT INFRASTRUCTURE)



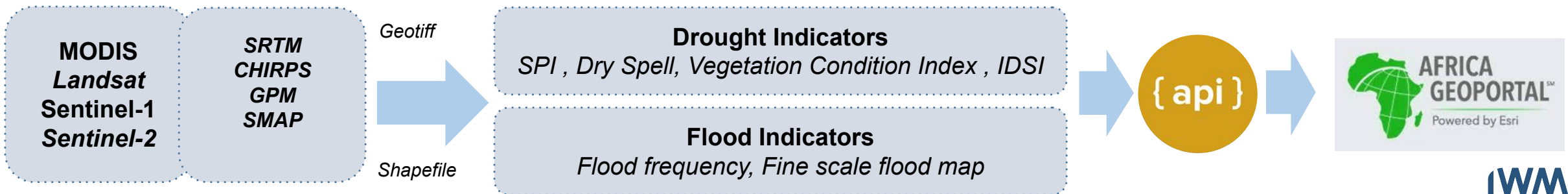
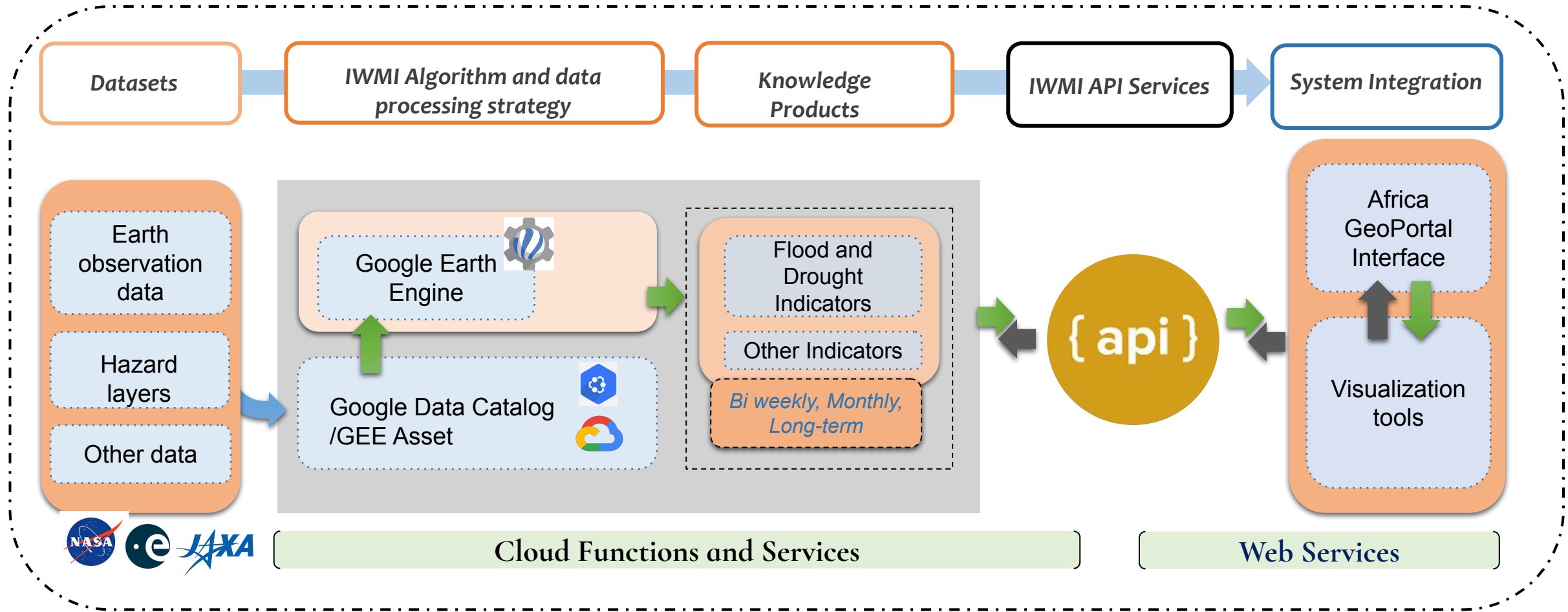
**Risk Transfer**

- CAT INSURANCE
- WEATHER RISK MANAGEMENT
- OTHER EMERGING PRODUCTS

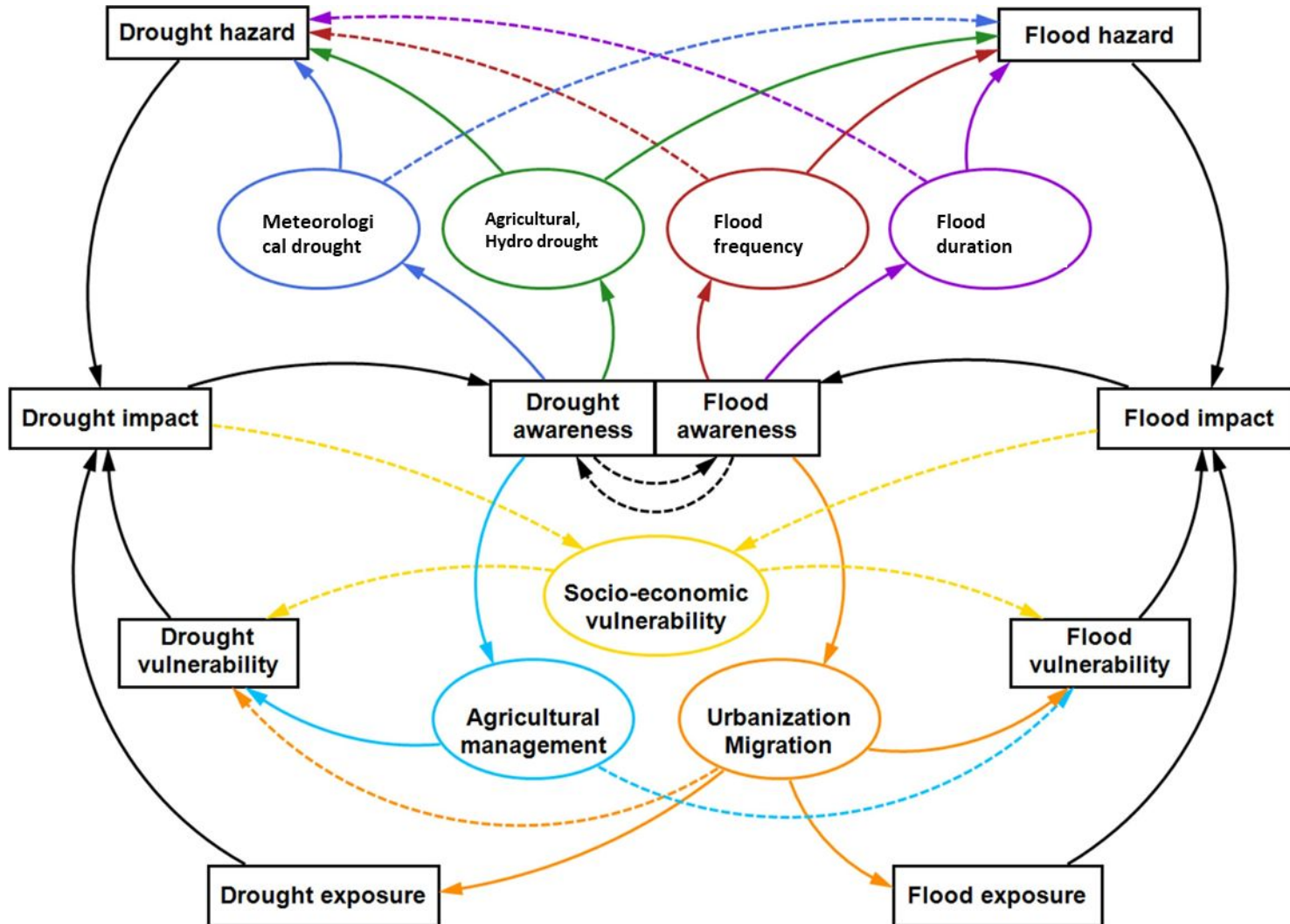
## CAPACITY BUILDING & GENDER, YOUTH & INCLUSIVENESS

## KNOWLEDGE PRODUCTS & ADVISORY SERVICES

# EO-based Flood and Drought Monitor



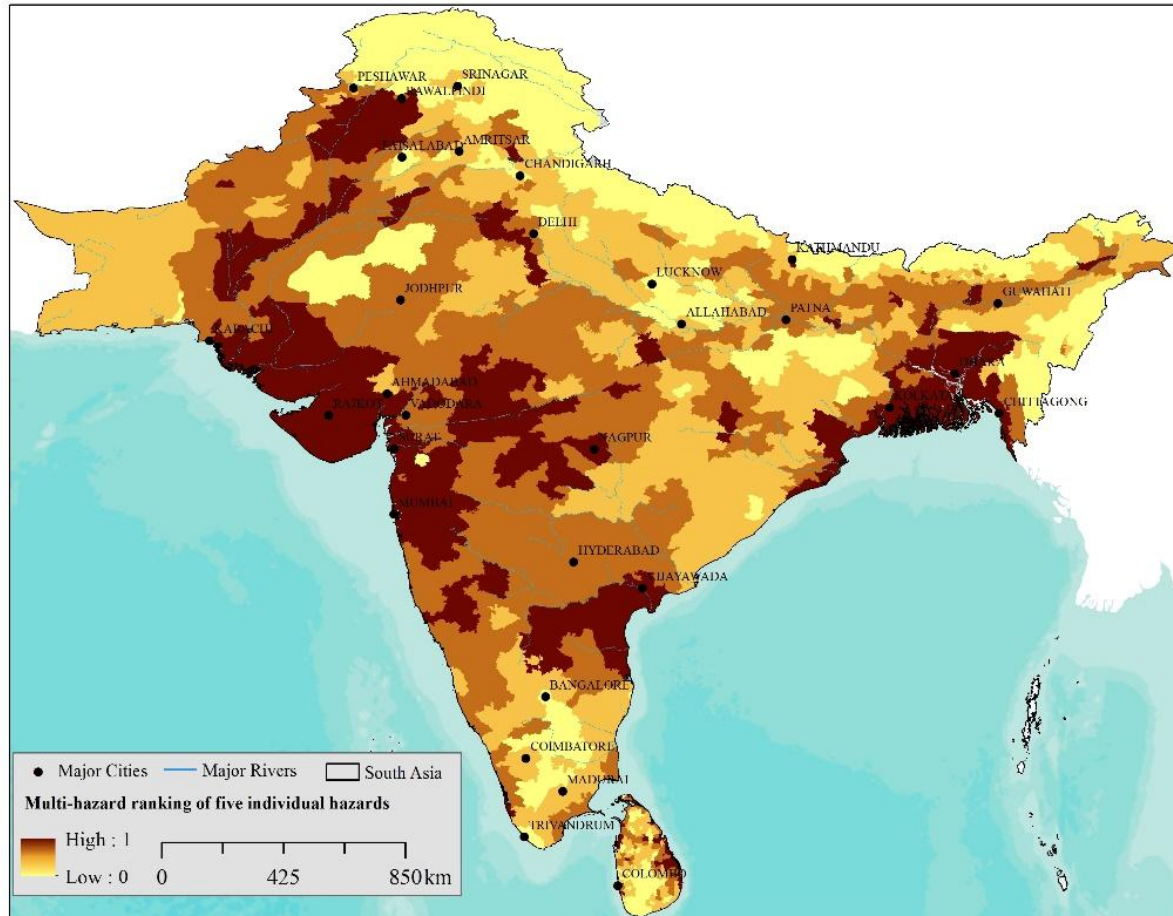
# Africa – Flood and Drought Risk Assessment



Examples of DRR measures and their interactions with hazard, exposure, and vulnerability across the flood and drought domains.

# Identifying vulnerability hot spots for climate change

Some areas will be more affected than others.  
 IWMI design locally relevant adaptation measures.



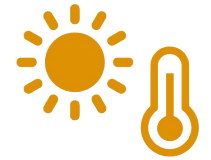
**Drought**  
 70% land



**Floods**  
 12% land



**Cyclones**  
 8% Land



**Extreme heat**  
 Widespread



**Salinity**  
 Coastal  
 ingression



**Climate change**  
 Very  
 vulnerable



**Food security and poverty**  
 key issues



# The case for Climate Resilience Value Chain



IWM  
International Water  
Management Institute

## Resilience Applications

Policies & Governance  
Climate & Sustainable  
finance  
Basin toolkit  
Vulnerability Analysis  
Mapping  
Sustainable GW Mng.  
Green infrastructure

Land use planning  
Infrastructure  
Investment  
Flood Insurance  
Emergency Response

Drought hotspots  
Drought proofing  
Agriculture  
Contingency plans  
Watershed  
Development  
Drought Insurance

River basin planning  
Disaster Risk  
Assessment  
Resilient Water  
infrastructure  
Drought proofing  
Strategies with Water  
Accounting  
Climate finance  
Conflict and migration  
Local development  
plans  
Prioritize CSA  
investment and  
bundled solutions e.g.  
BICSA

Risk Identify and  
Measures

Disaster Risk  
Screening tools

Flood EWS

Drought EWS

Risk identification

Socio-economic  
Development

Bundled services for  
climate resilience

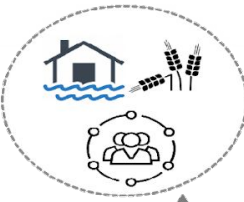
Sustainable Agriculture  
Productivity

Climate Risks Assessment  
(Past, Present and Future)

Early Warning System

Drought / Flood  
Monitoring Indicators

Climate Services and  
Climate Smart  
Agriculture



Resilience  
Value Chain



WASA

CGIAR  
IDT's

## Data, Algorithms and Models

Historical flood and drought  
records

Biophysical, Environmental and  
Socio-economic Indicators

Hydrological model - Deltares  
WFlow and FEWS

Model Calibration, Validation  
and Evaluation

Near real-time EO data access  
(Google and AWS)

Flood and Drought Indicators

Ready Analysis Data, Knowledge  
Products and Statistics

Data-Driven Decision Making,  
Visualization, Analytics

Data gathering,  
Surveys, Integration

Models, GIS,  
Statistical Tool

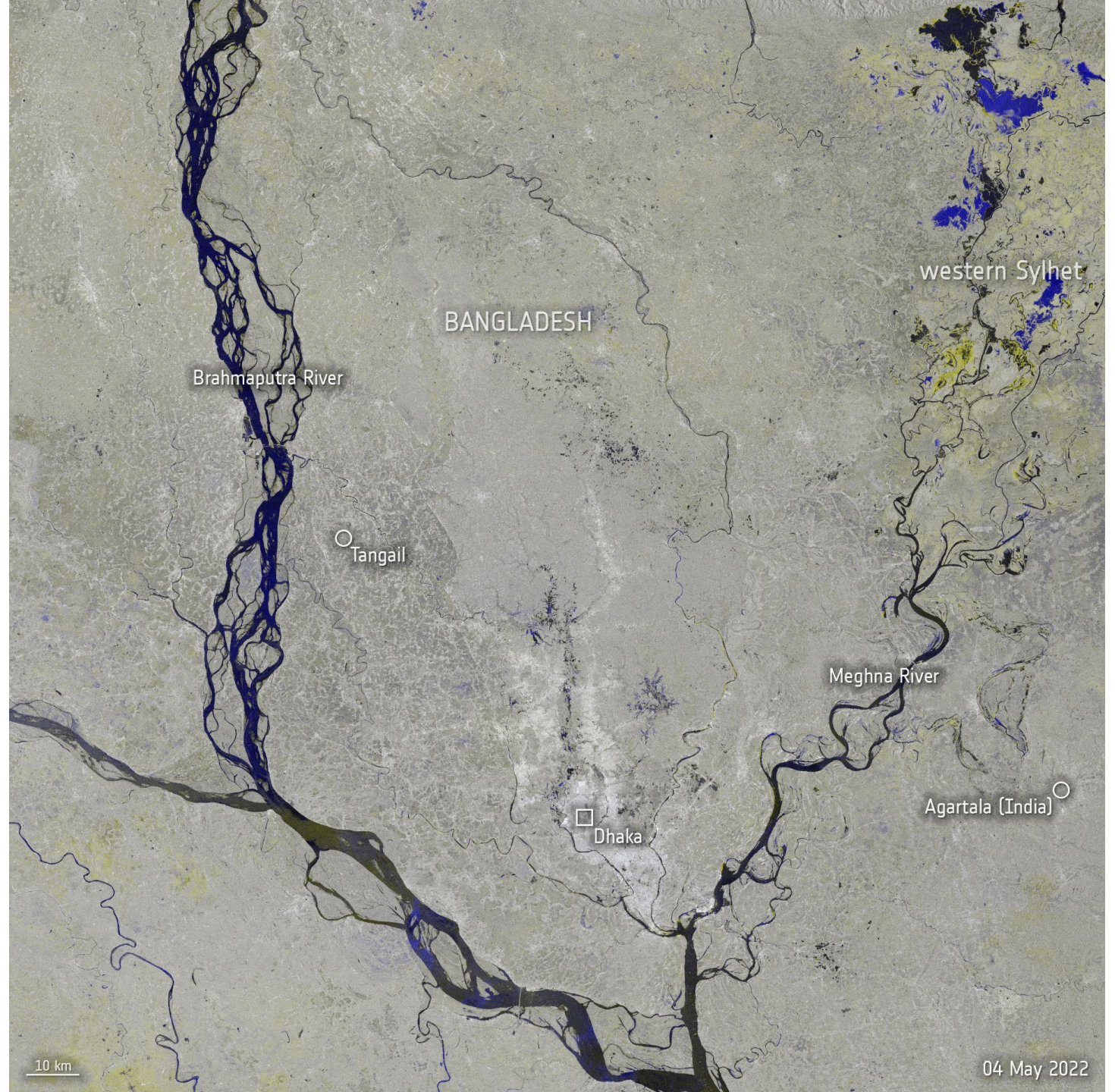
Cloud Services,  
ML/AI and APIs

Data Analysis and  
Decision Support

DIWASA Resilience Initiatives in advancing Climate Resilience  
Development to achieve SDG, NDCs, NAPA, SFDRR

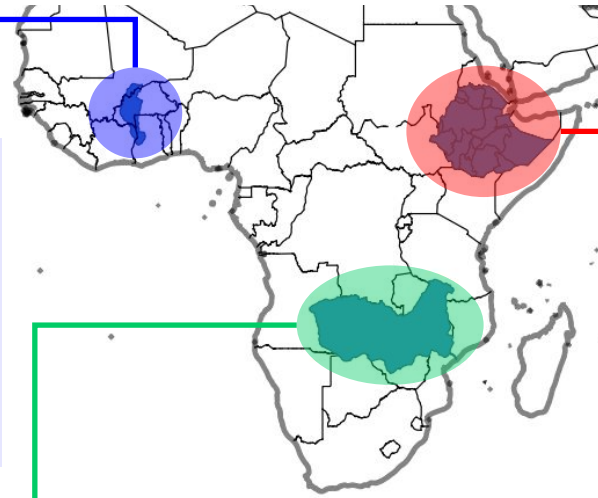
Source: Amarnath et al. 2021

**Space is on  
hand to  
diagnose  
and resolve  
problems**

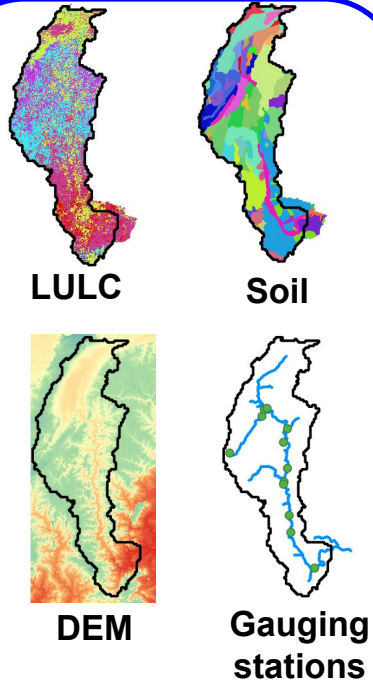




# African Basins – DIWASA FEWS Countries

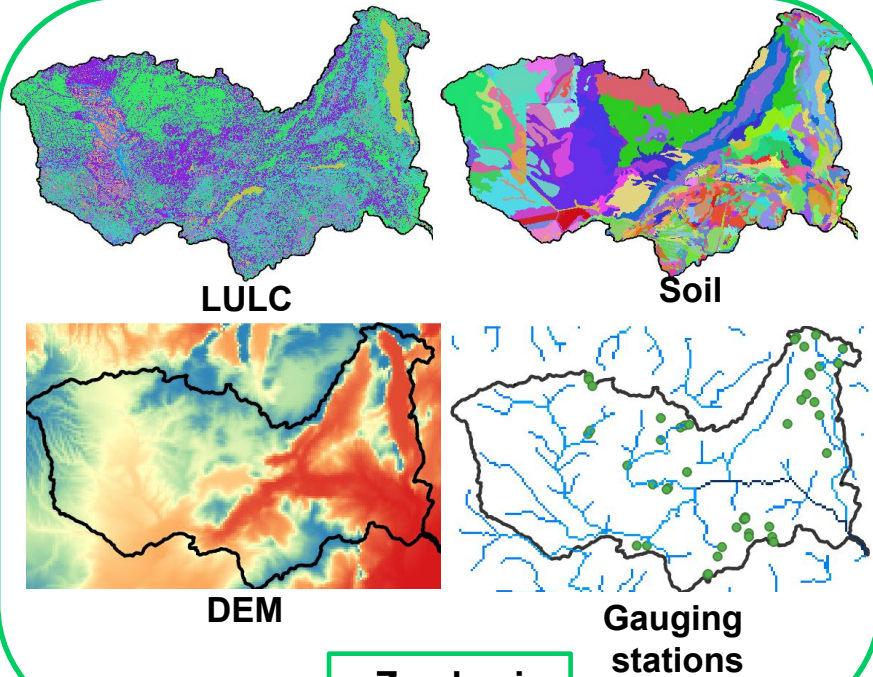


- ❑ **Source:** Cascades of Burkina
- ❑ **Length:** 1352 km
- ❑ **Basin area:** 1,47,000 km<sup>2</sup>
- ❑ **Countries:** Ghana, Burkina Faso, Ivory Coast
- ❑ **Avg discharge:** 3,400 m<sup>3</sup>/s



**LULC**      **Soil**  
**DEM**      **Gauging stations**

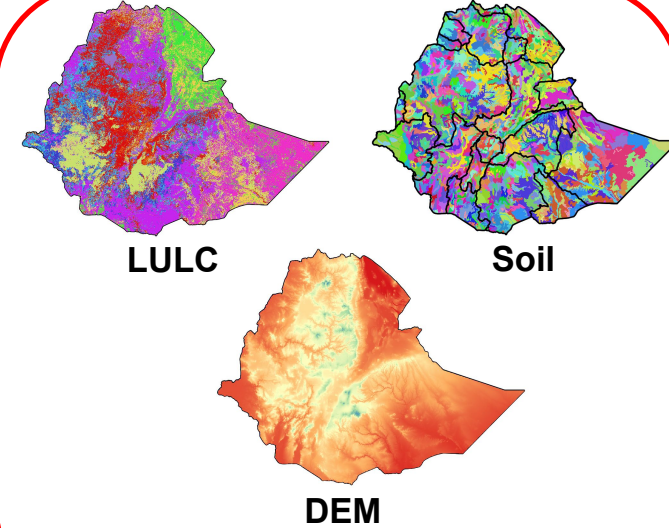
**Black Volta**



**LULC**      **Soil**  
**DEM**      **Gauging stations**

**Zambezi**

- ❑ **Source:** Mwinilunga
- ❑ **Length:** 2,574 km
- ❑ **Basin area:** 13,90,000 km<sup>2</sup>
- ❑ **Countries:** Zimbabwe, Zambia, Mozambique, Namibia, Angola
- ❑ **Avg discharge:** 3,400 m<sup>3</sup>/s

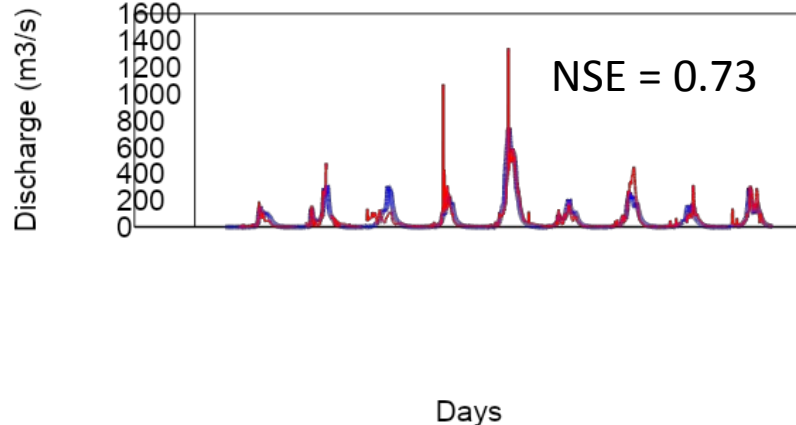
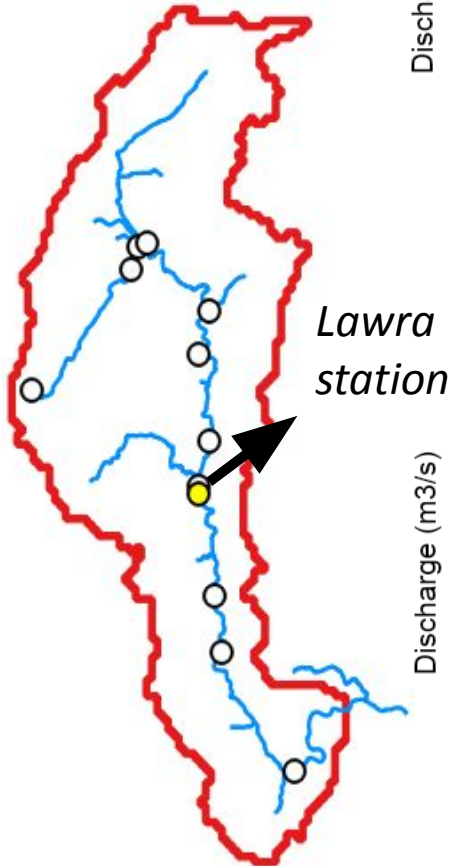


**LULC**      **Soil**  
**DEM**

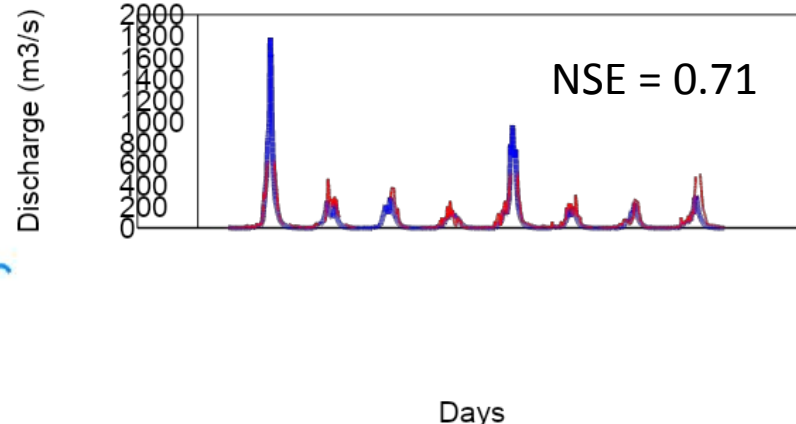
**Ethiopian basins**

- ❑ **Source:** Gilgel Abay
- ❑ **Length:** 1,450 km
- ❑ **Basin area:** 3,25,000 km<sup>2</sup>
- ❑ **Countries:** Ethiopia, Sudan
- ❑ **Avg discharge:** 1,548 m<sup>3</sup>/s

# FEWS Performance

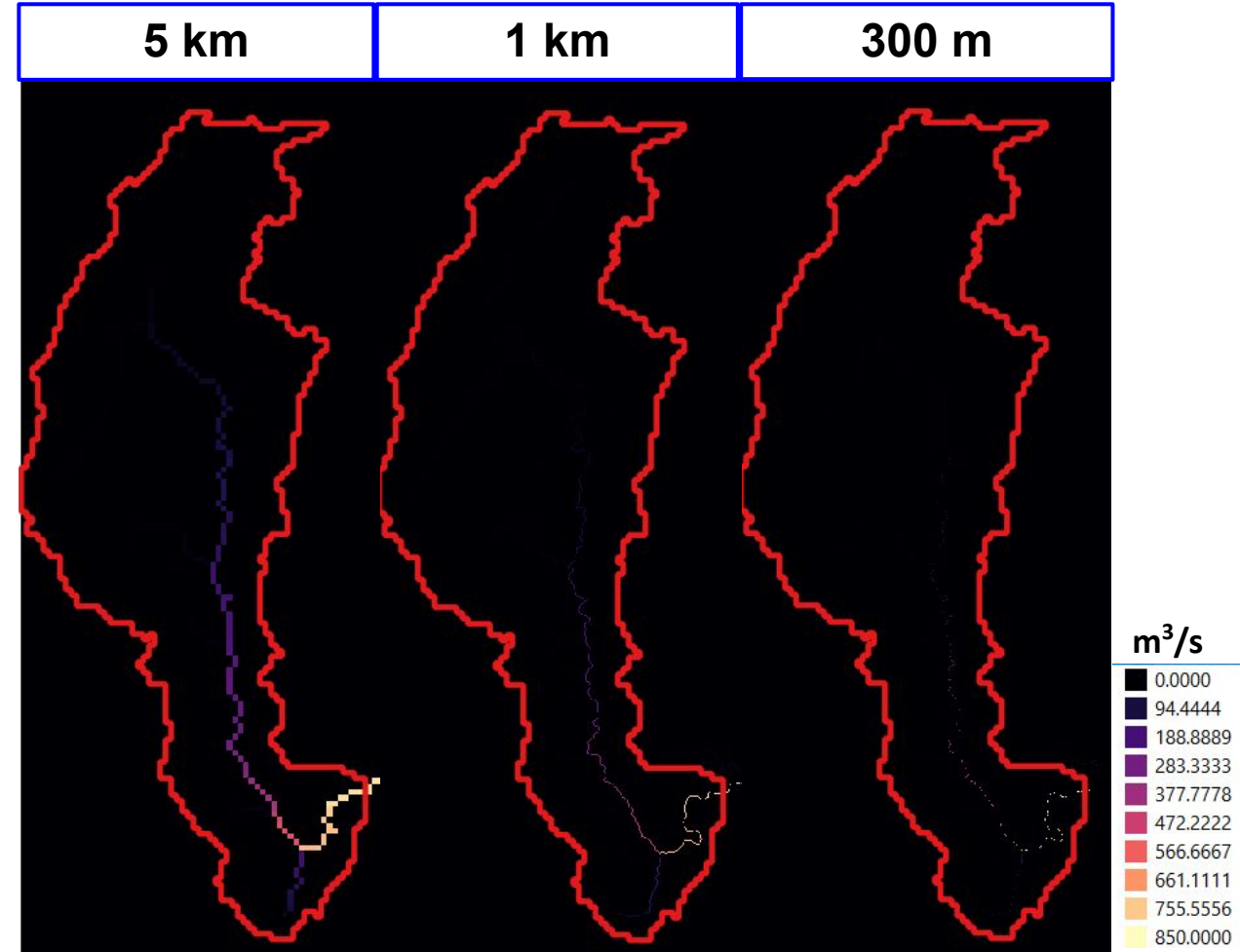


Calibration period (1990 - 1998)



Validation period (1999 - 2007)

## Multi-resolution discharge



# Operational Flood Forecast [Experimental]

## Forecast framework

Historical	Real-time	Forecast
------------	-----------	----------

Station  
Gridded

Bias corrected  
ERA-5

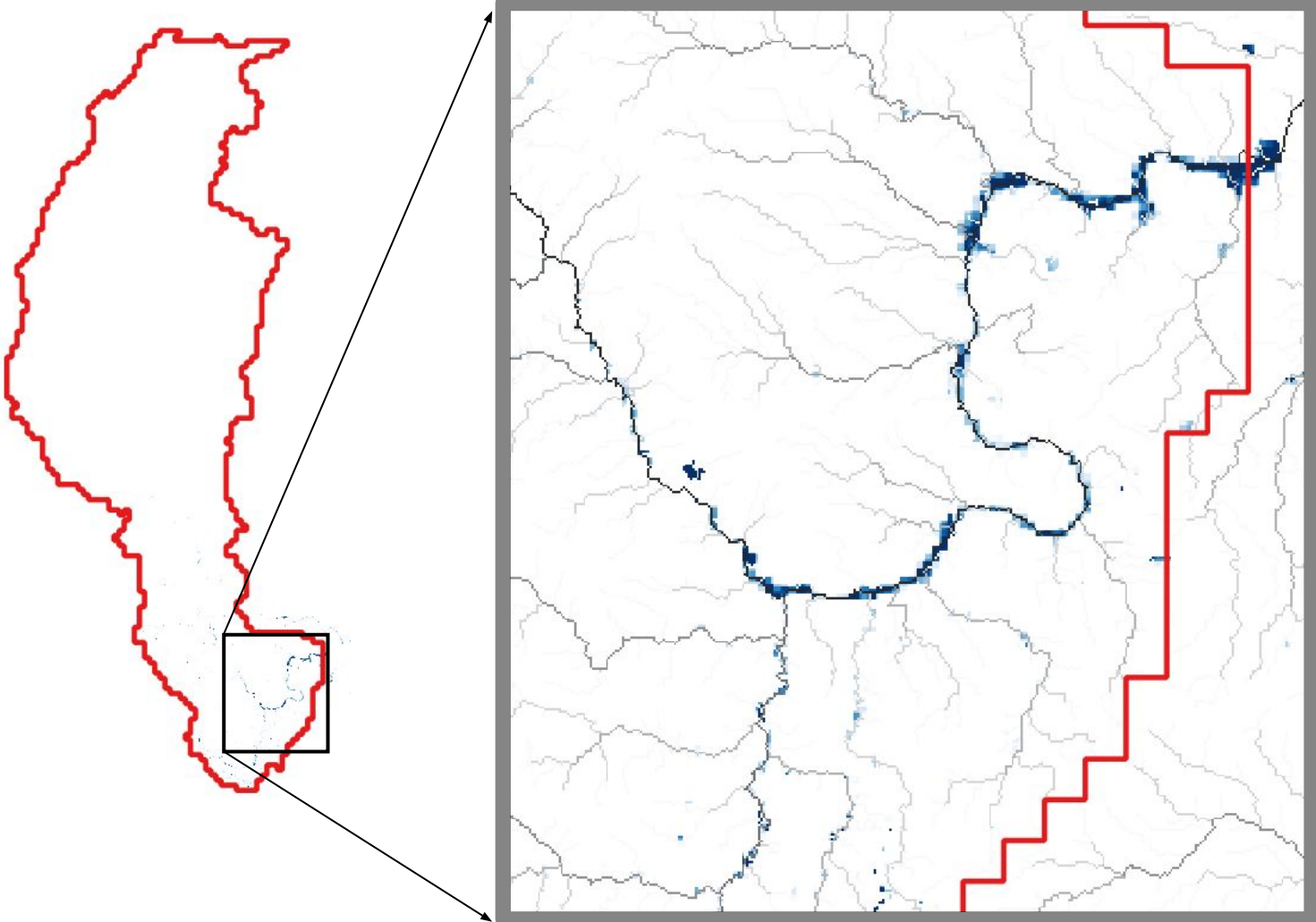
GEFS v12

## Forecast data

Source	GEFS v12 ensemble mean
Resolution	0.25 degree
Forecast	10 days (240 hours)
Time interval	6 hourly
Cycles per day	4 times
Output resolution	5 km, 1 km, 300 m
Outputs	Discharge, Water level, Flood extent, Soil moisture

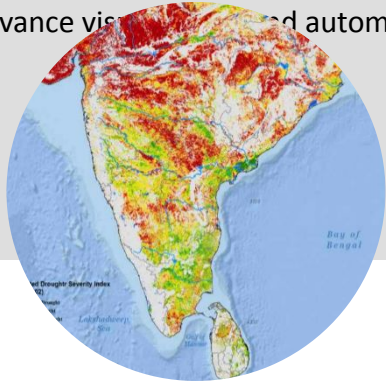
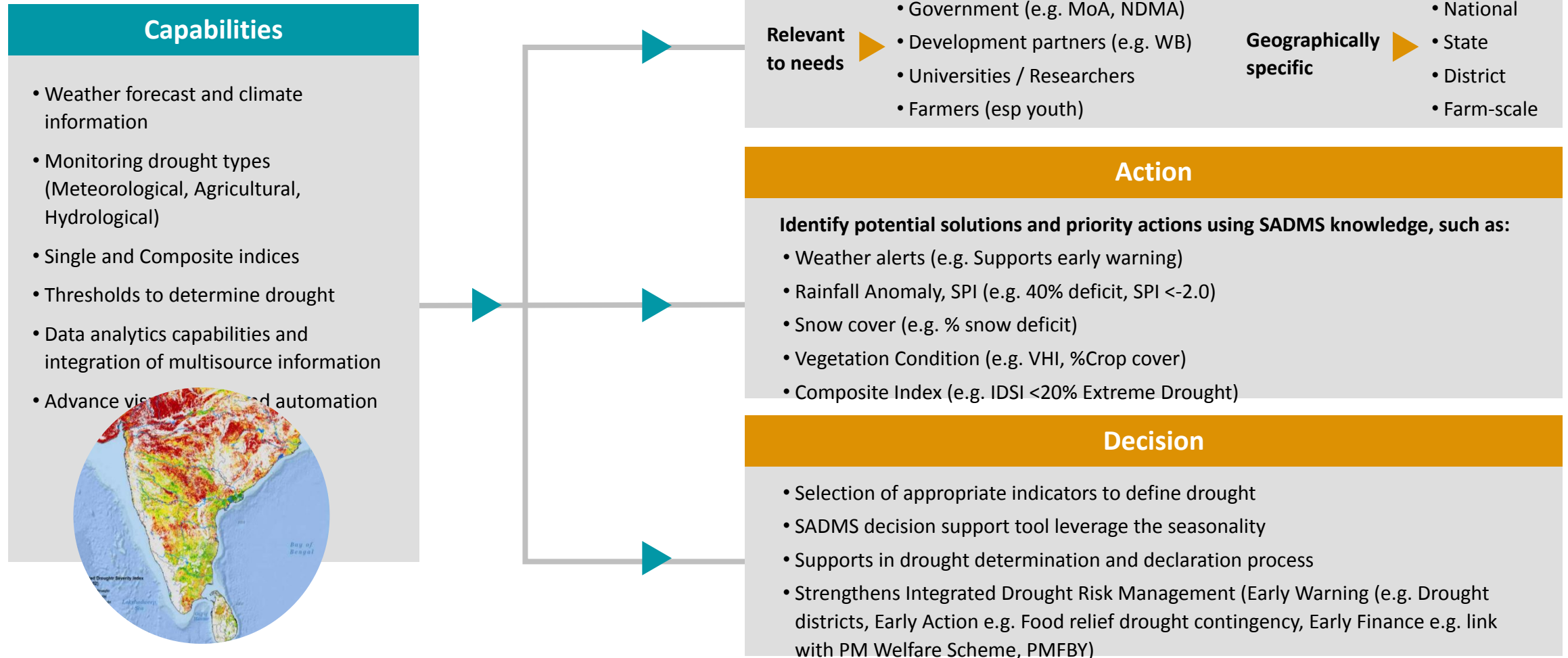
## Inundation map

Forecasted on 11<sup>th</sup> oct, 2021  
Forecasted for 17<sup>th</sup> oct, 2021

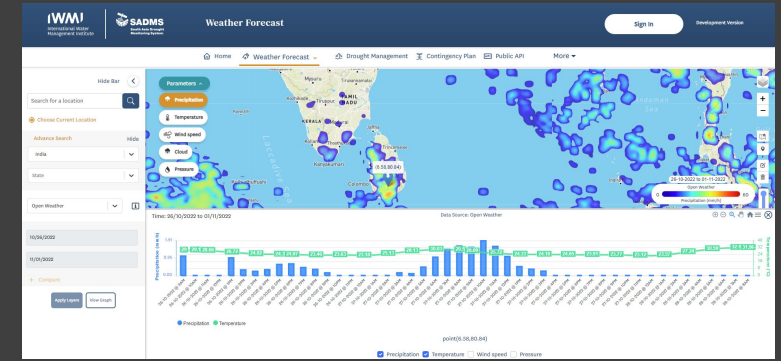


# The South Asia Drought Monitoring System (SADMS)

How can we leverage the SADMS for action and decision making?

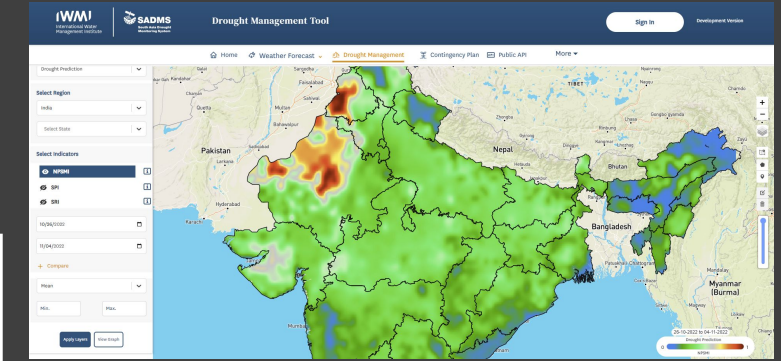


# Weather and Climate Monitor



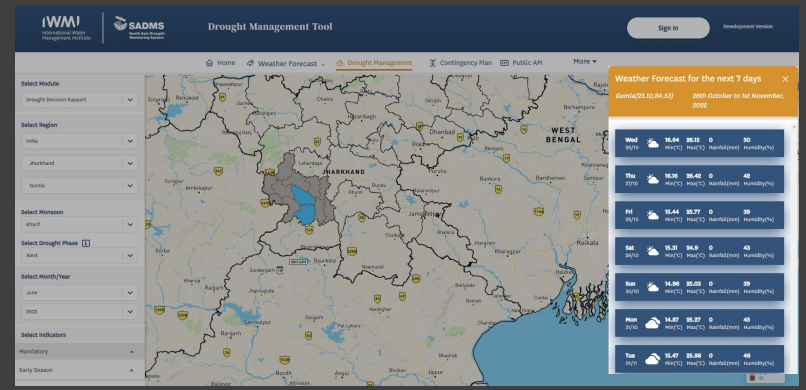
Products: (Sub)seasonal, short-term forecast  
Source: IMD, IRI, ECMWF, NOAA

# Drought Prediction



Products: Drought prediction using VIC model  
Source: NOAA GEFS, GPM, ERA-5, IMD

# Drought Decision Support tool



Products: Drought alert and active phase  
Source: NASA MODIS, GPM, SMAP

# Dynamic Drought contingency plan

Phase	Groundwater / Groundwater situations	Farming	Crop/irrigation system	Change in crop/irrigation system	Agronomic measures	Remarks
Early season (delayed onset)	No change	No change	No change	No change	No change	
Delay by 8 weeks (Aug 1st week)	Groundwater / No change	Red water	Red water	No change	No change	
Delay by 8 weeks (Aug 1st week)	Groundwater / No change	Red water	Red water	No change	No change	
Delay by 8 weeks (Aug 1st week)	Groundwater / No change	Red water	Red water	No change	No change	
Delay by 8 weeks (Aug 1st week)	Groundwater / No change	Red water	Red water	No change	No change	

Products: Drought phase wise indices to activate contingency plans  
Source: NASA MODIS, GPM, SMAP

# Drought Monitor

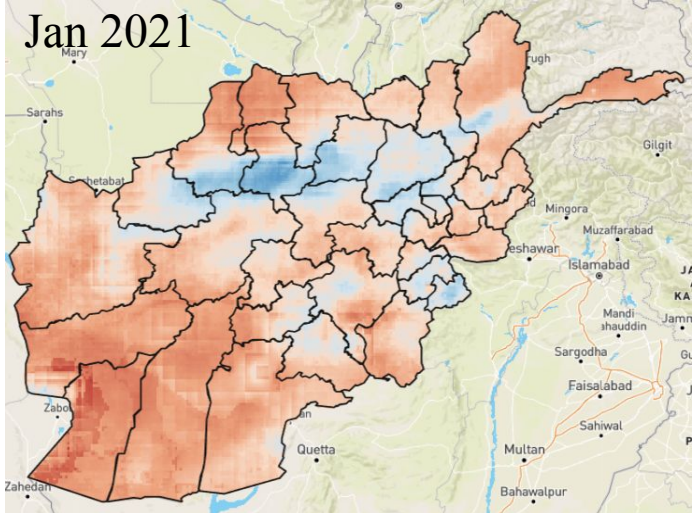
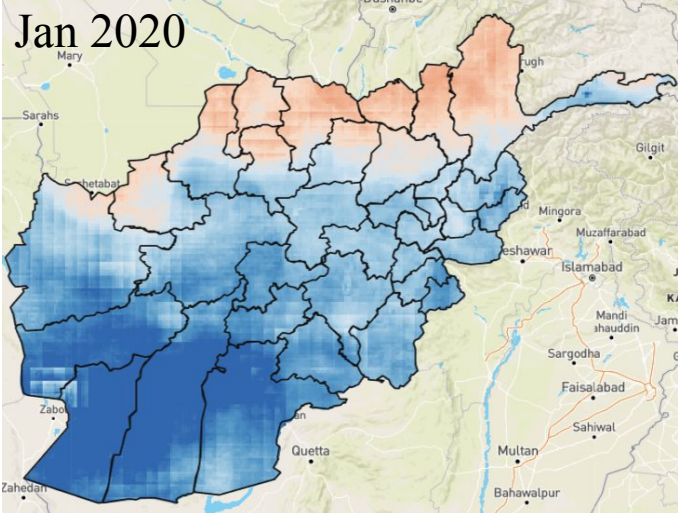
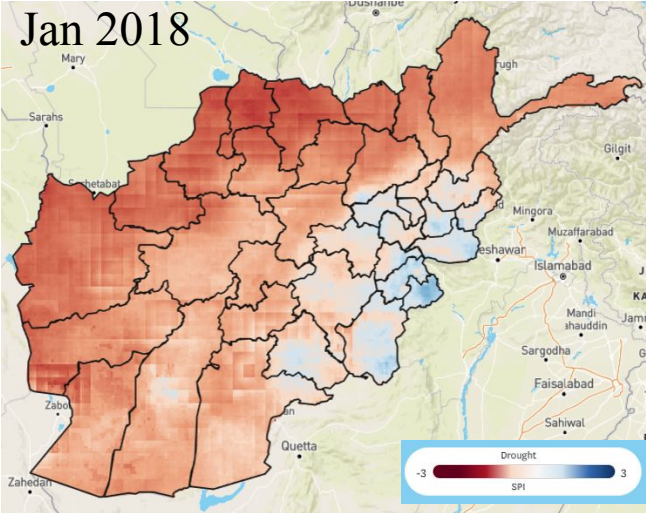


Products: Drought indices mandatory and impact indicators e.g. SPI, VCI, VHI, IDIS  
Source: NASA MODIS, GPM, SMAP

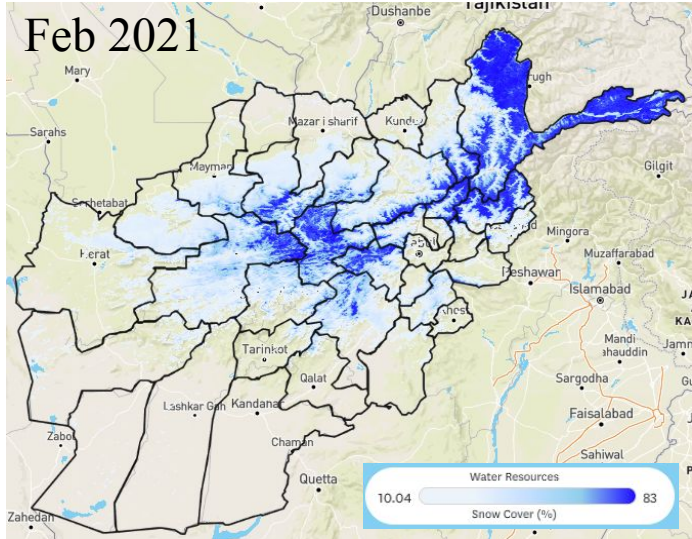
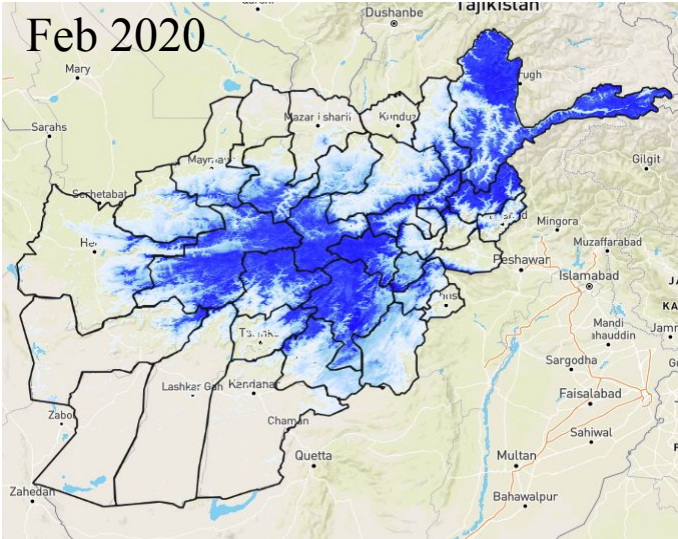
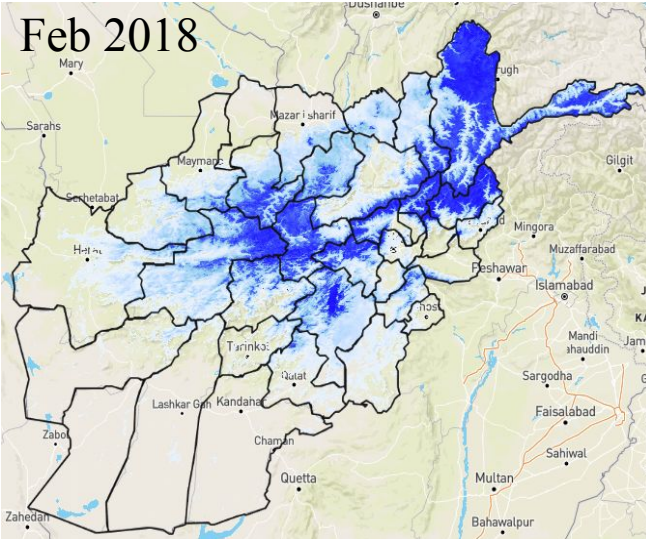
# Drought Monitor – Case study Afghanistan



**SPI (CHIRPS) - Standardized Precipitation Index**



**Extent of Snow Cover**



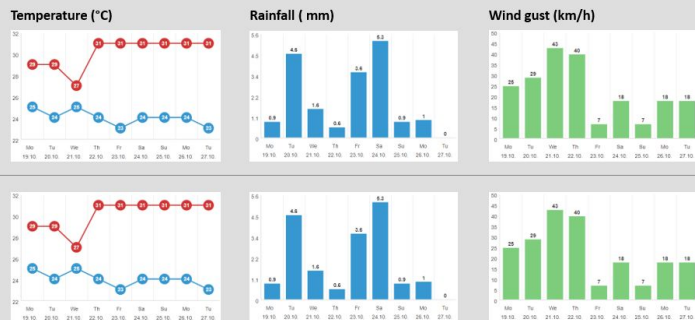
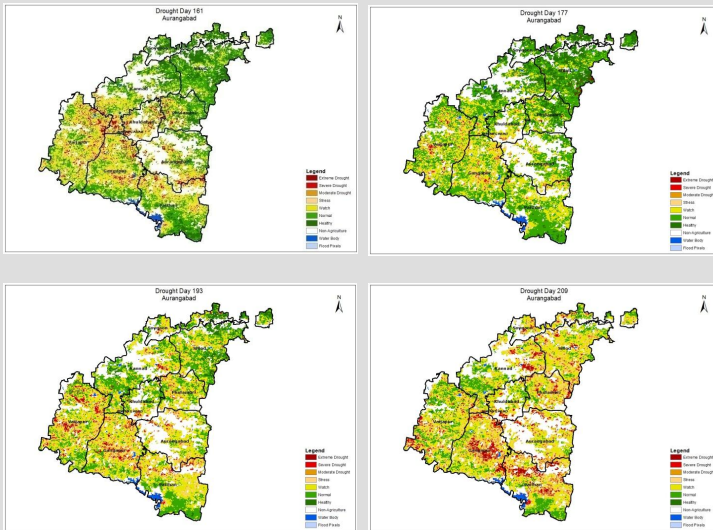
Source: SADMS Portal

# Drought Surveillance System for South Asia

GEOSPATIAL  
WORLD  
AWARDS

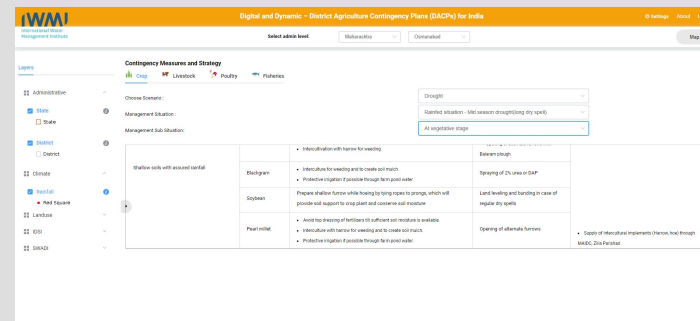


## Drought Severity Maps



## Digital and Dynamic Contingency Plans

- Ridge and furrow sowing, BBF for Soybean
- Sprinkler & Drip irrigation
- Harvested Water for protective irrigation
- Spraying of KNO<sub>3</sub>



Preparedness and real time measures taken up:

## Impact

- Soybean+ Pigeon pea: 7-8 q/ acre for Soybean
- 5-5q/acre only Pigeon pea
- Cotton: 12-14 q/acre



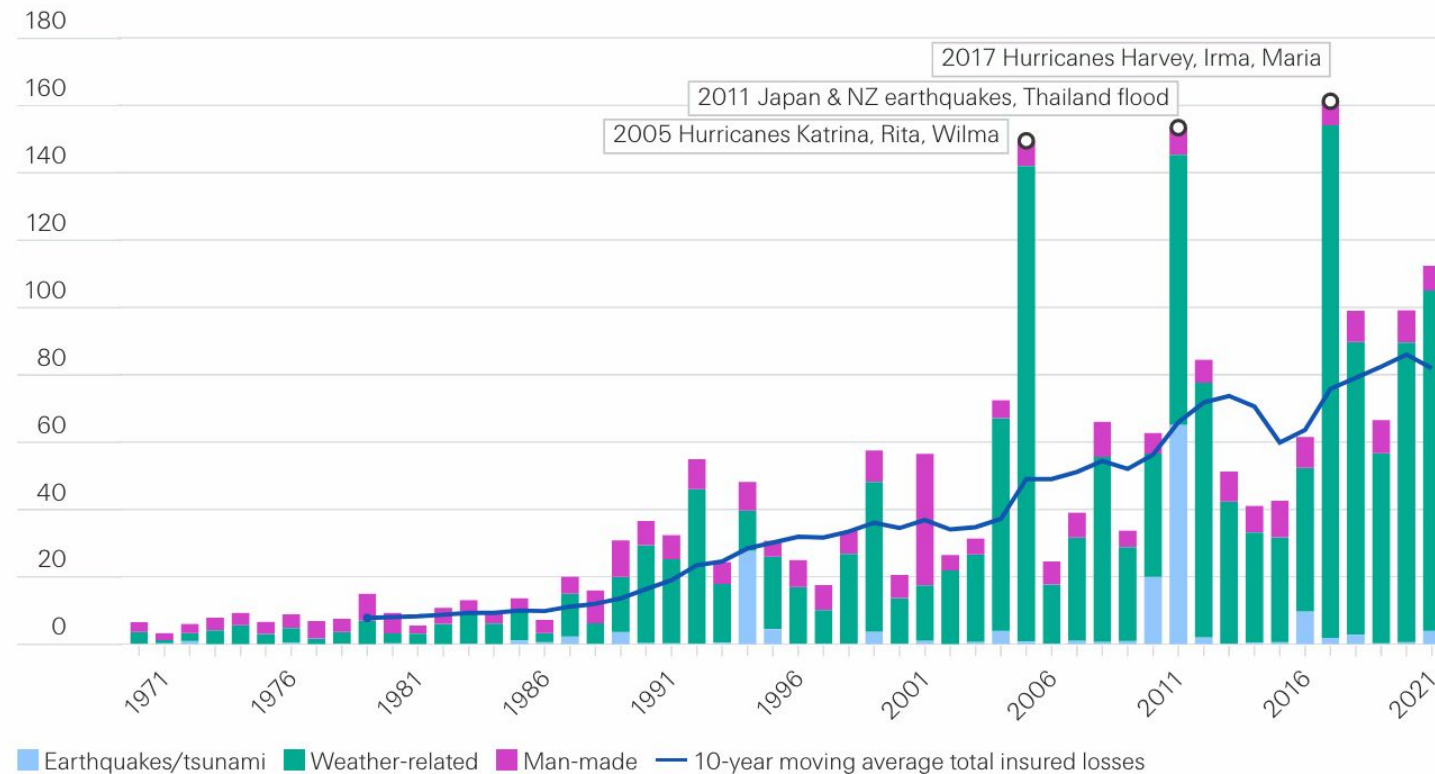
Drought response strategies integration information and knowledge products for decision making process

# How insurance can help combat climate change?

## Insured losses since 1970

USD billion (in 2021 prices)

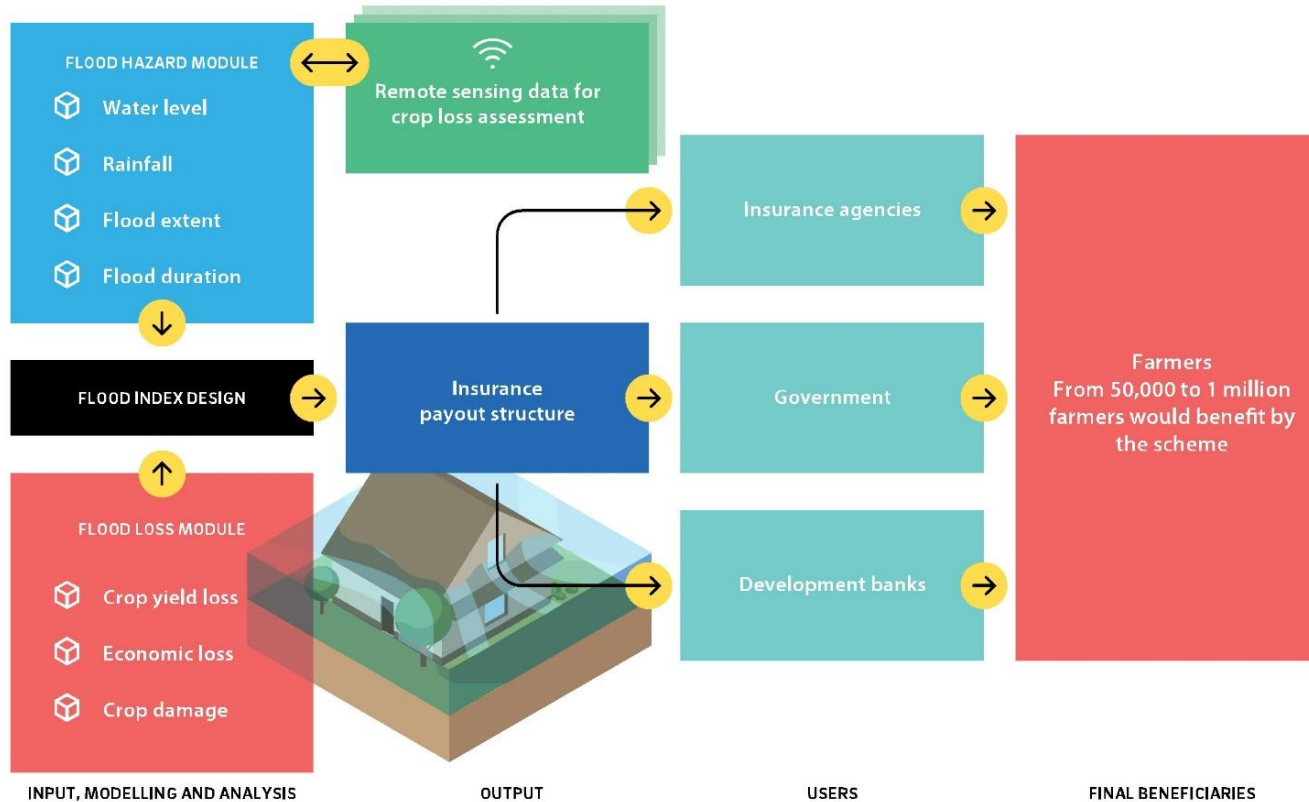
Rollover/touch chart for details



Source: Swiss Re Institute



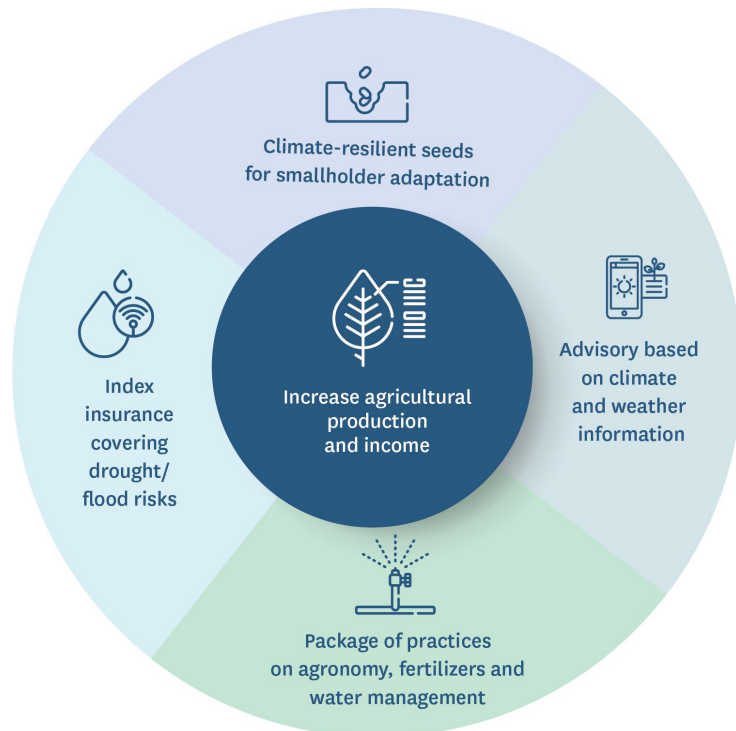
# Flood proofing communities and agriculture resilience



**Index-based flood insurance (IBFI) is an innovative approach to developing effective payout schemes for low-income, flood-prone communities.**

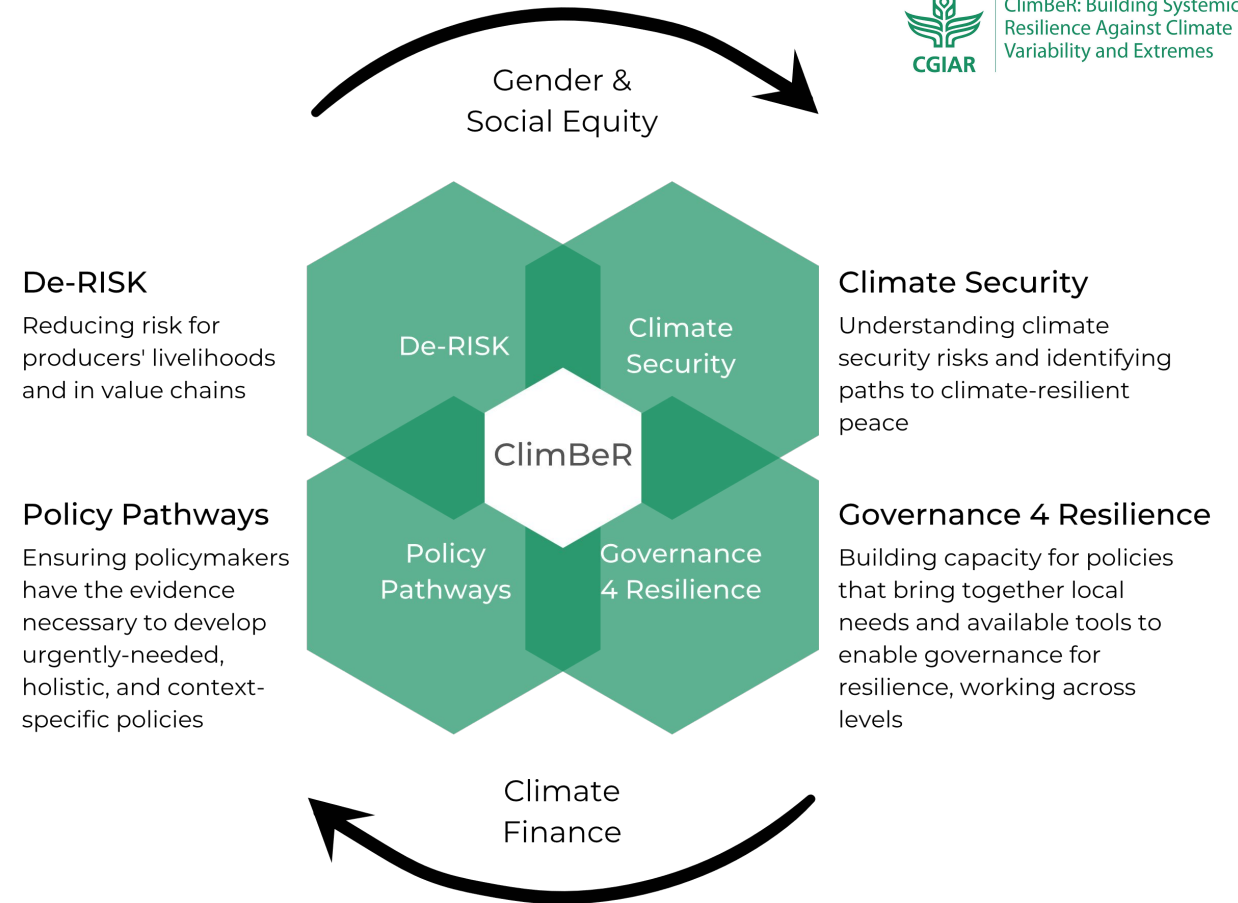
# Why poor farmers need bundled solutions against climate disasters

Investing in climate smart solutions including insurance programs for poor farmers today could save tens of billions of dollars in coming decades as climate change upsets growing patterns and makes harvests fail.



# Transformational change in climate risk management and adaptation

**CGIAR Climate Resilience initiatives working with partners in Africa to promote innovative technological interventions are critical, but enabling social, institutional and governance factors are the actual drivers of the transformative process.**



# Thank you

Giriraj Amarnath

Email: [a.giriraj@cgiar.org](mailto:a.giriraj@cgiar.org)

