Innovations and emerging applications in IDRM for Resilience Development

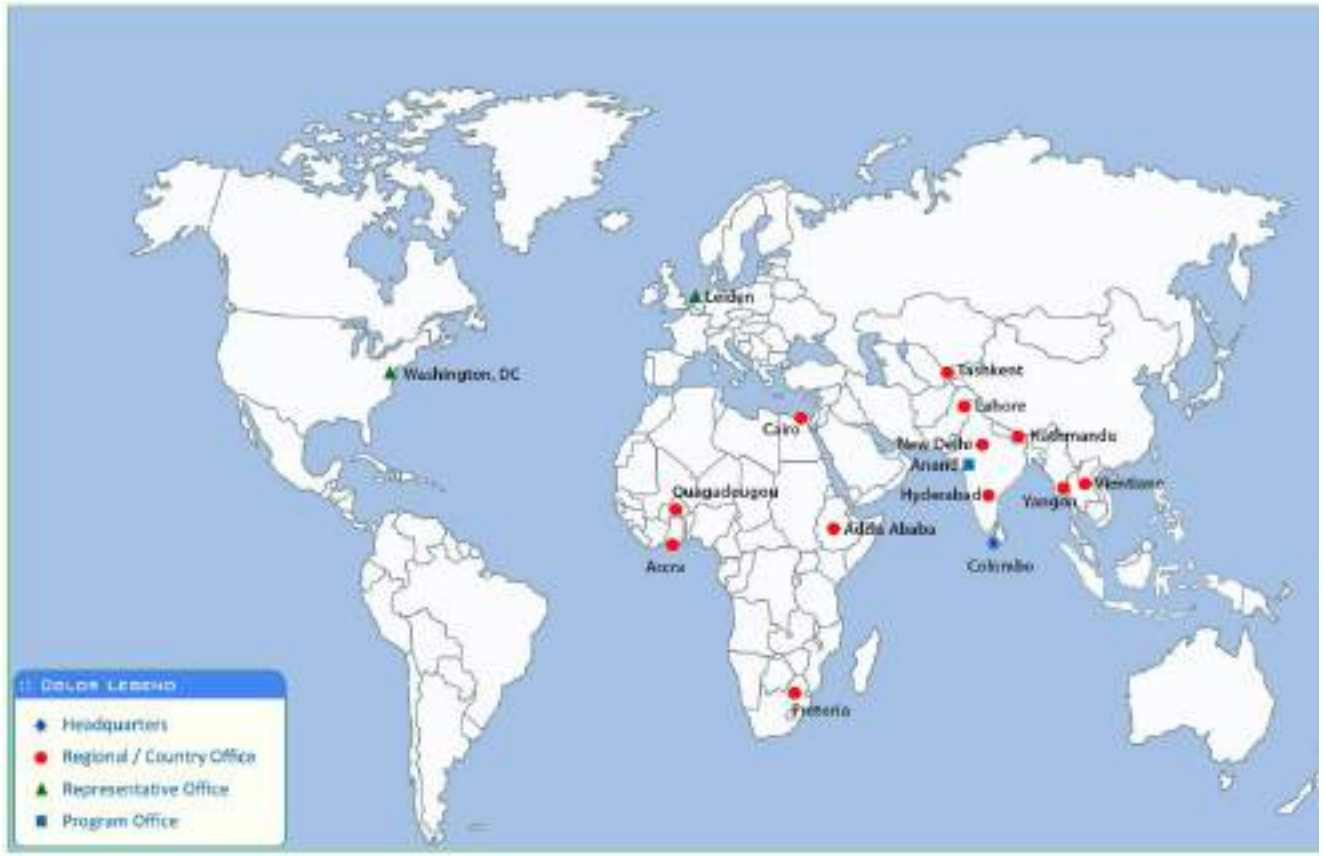
Giriraj Amarnath, Ph.D.
Research Group Leader: Water Risks and Disasters
International Water Management Institute (IWMI)

SAARC Regional Workshop and Capacity building programme on
Multi-hazard disaster risk assessment
06 December, 2019

IWMI International Water Management Institute

Our roles and where

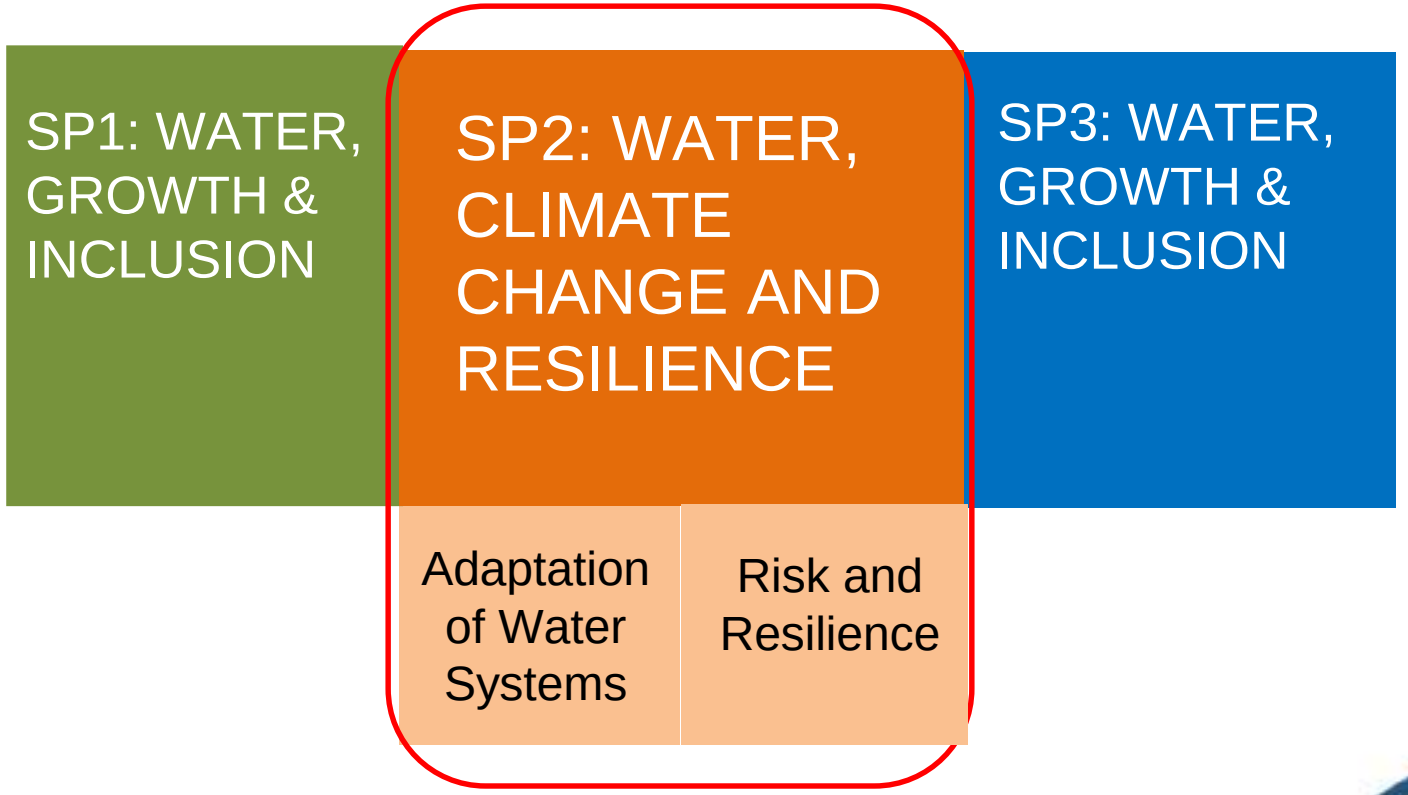
- **Think tank** conducting research to generative innovative solutions
- **Provider** of science-based products and tools
- **Facilitator** of learning to strengthen capacity and achieve uptake of research findings



IWMI International Water Management Institute

IWMI's strategy

A water-secure world



IWMI International Water Management Institute

Asia's Vulnerability to Climate Change

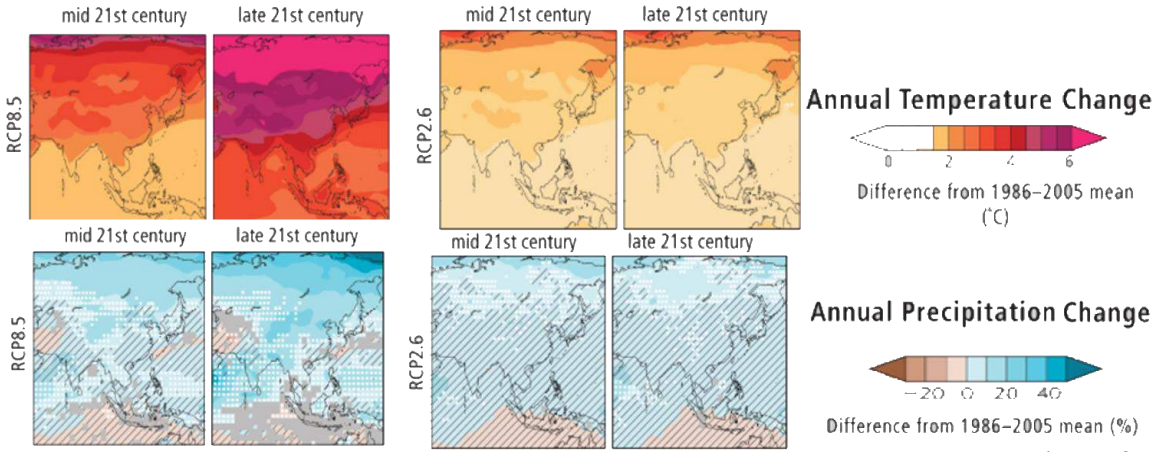
IPCC 5th Assessment Report observes **climate change** is already happening in Asia and **impacts are already being felt**

Average annual temperatures could rise by **more than 2°C** and more rainfall likely at higher latitudes by mid 21st century

More vulnerable due to **multiple stresses and low adaptive capacity**

More likelihood of extreme rainfall events related to monsoons

Increased water related risks -drought, flood, hails, cyclones and related water and food shortages.

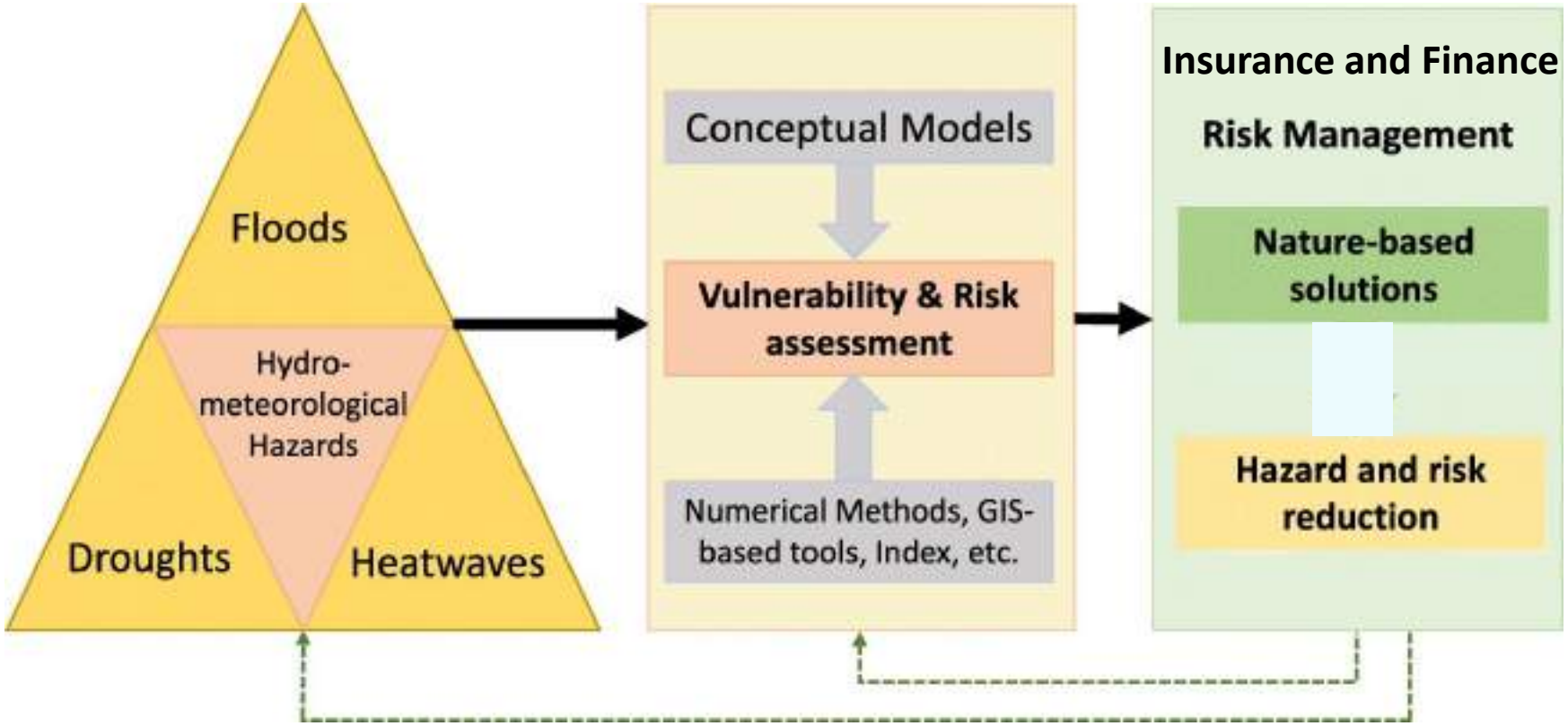


ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-Chap24_FGDall.pdf

IWMI International Water Management Institute

Talking points

Hydrometeorological hazards include tropical cyclones (also known as typhoons and hurricanes), thunderstorms, hailstorms, tornados, blizzards, heavy snowfall, avalanches, coastal storm surges, floods including flash floods, drought, heatwaves and cold spells.



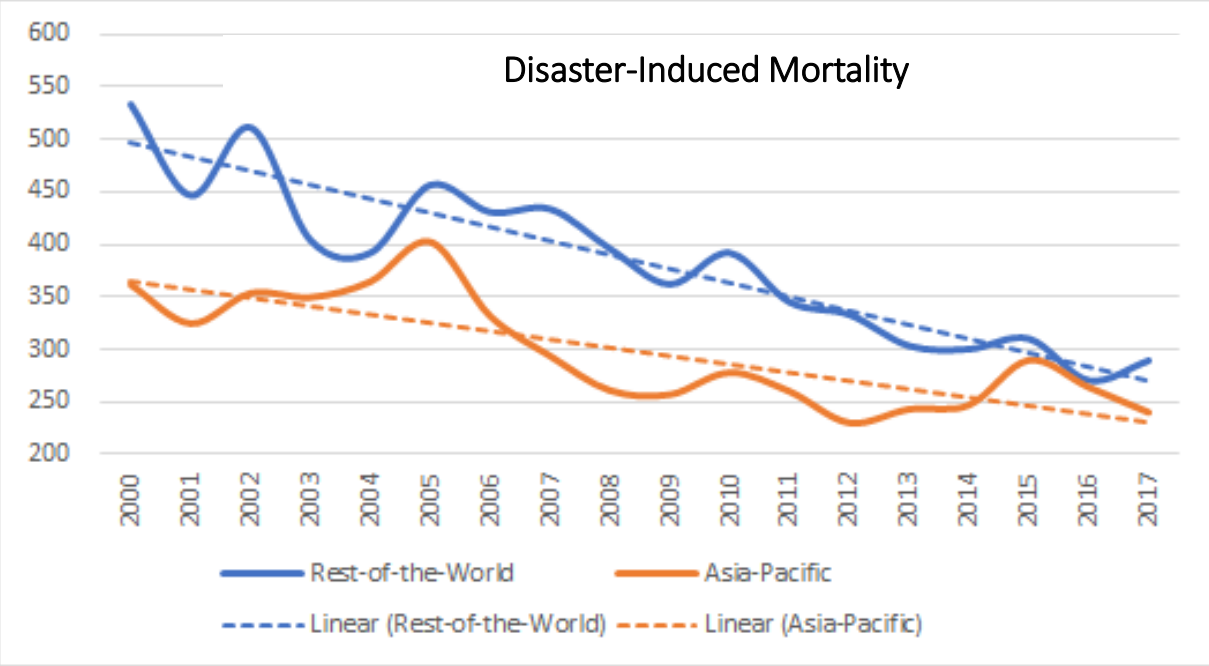
Sahani et al. 2019 and Amarnath et al. 2017 and 2019

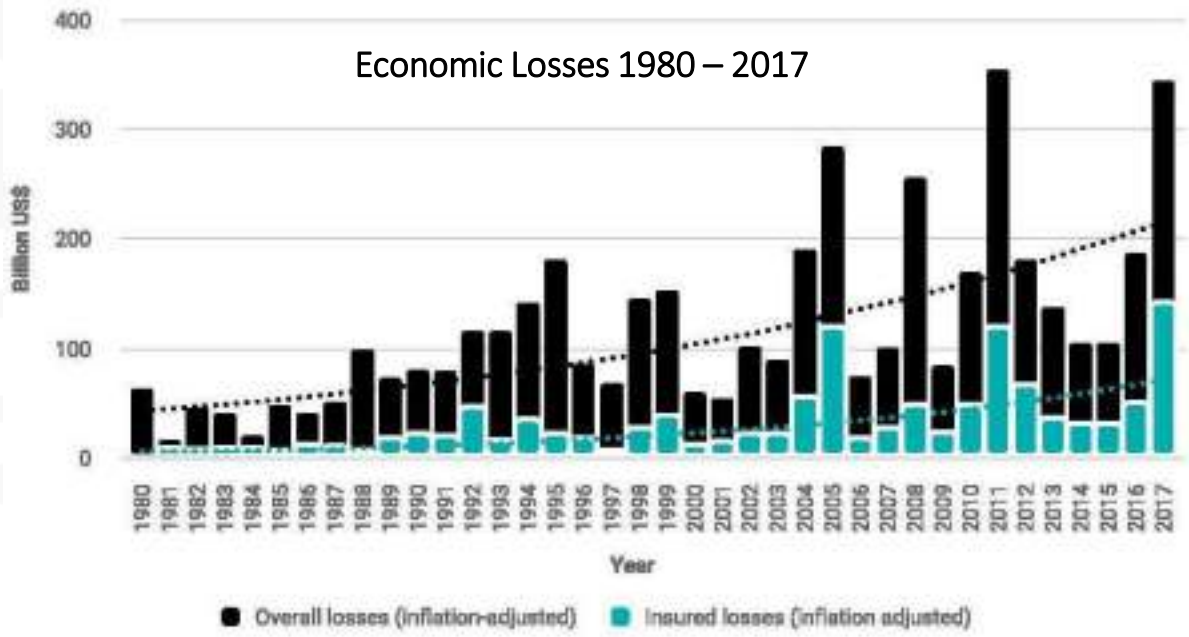
IWMI International Water Management Institute

Trends in disaster impact in Asia and the Pacific

Decreasing mortality; increasing economic losses

- Decrease in mortality
- Disaster losses are outpacing the region's economic growth
- Annual economic losses stand at US$675 billion, or 2.4% of the region's GDP (including drought impact)

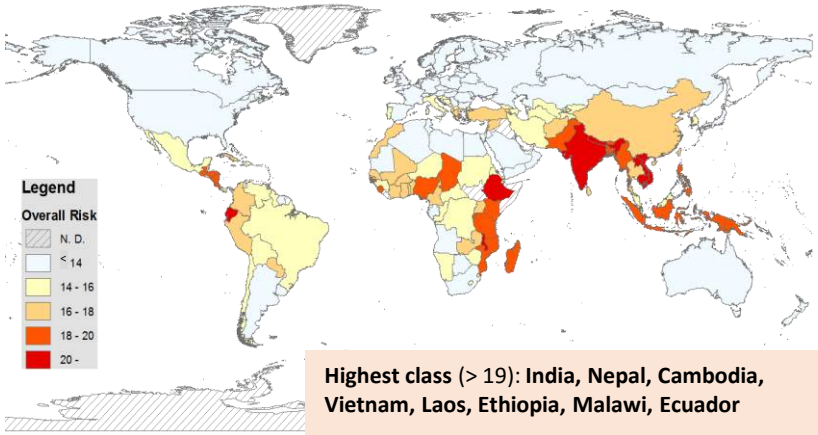




Source: UNDRR, ESCAP, EMDAT

Mapping global water-related disaster risk

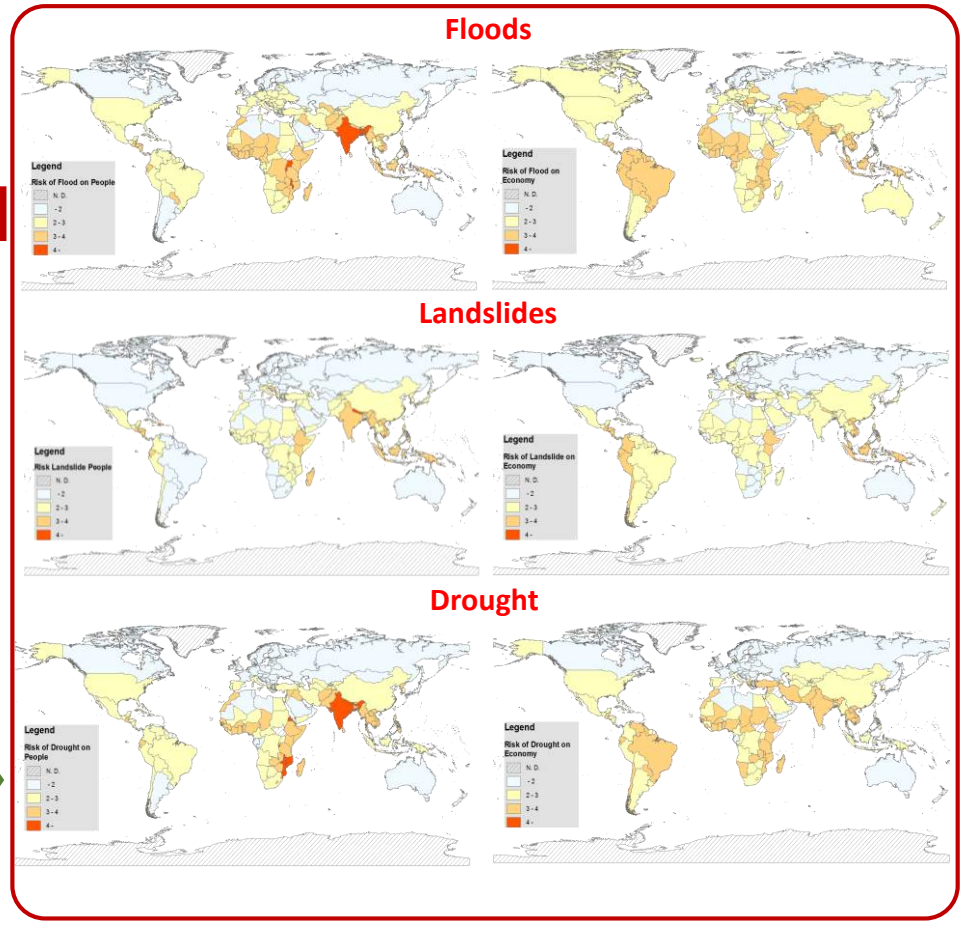
Overall Risk



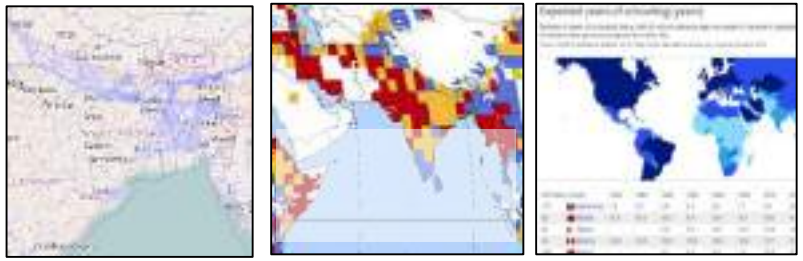
Highest class (> 19): **India, Nepal, Cambodia, Vietnam, Laos, Ethiopia, Malawi, Ecuador**

Population Exposure

Economic Losses



Publicly available data sources



Global Risk Data Platform (UNEP)

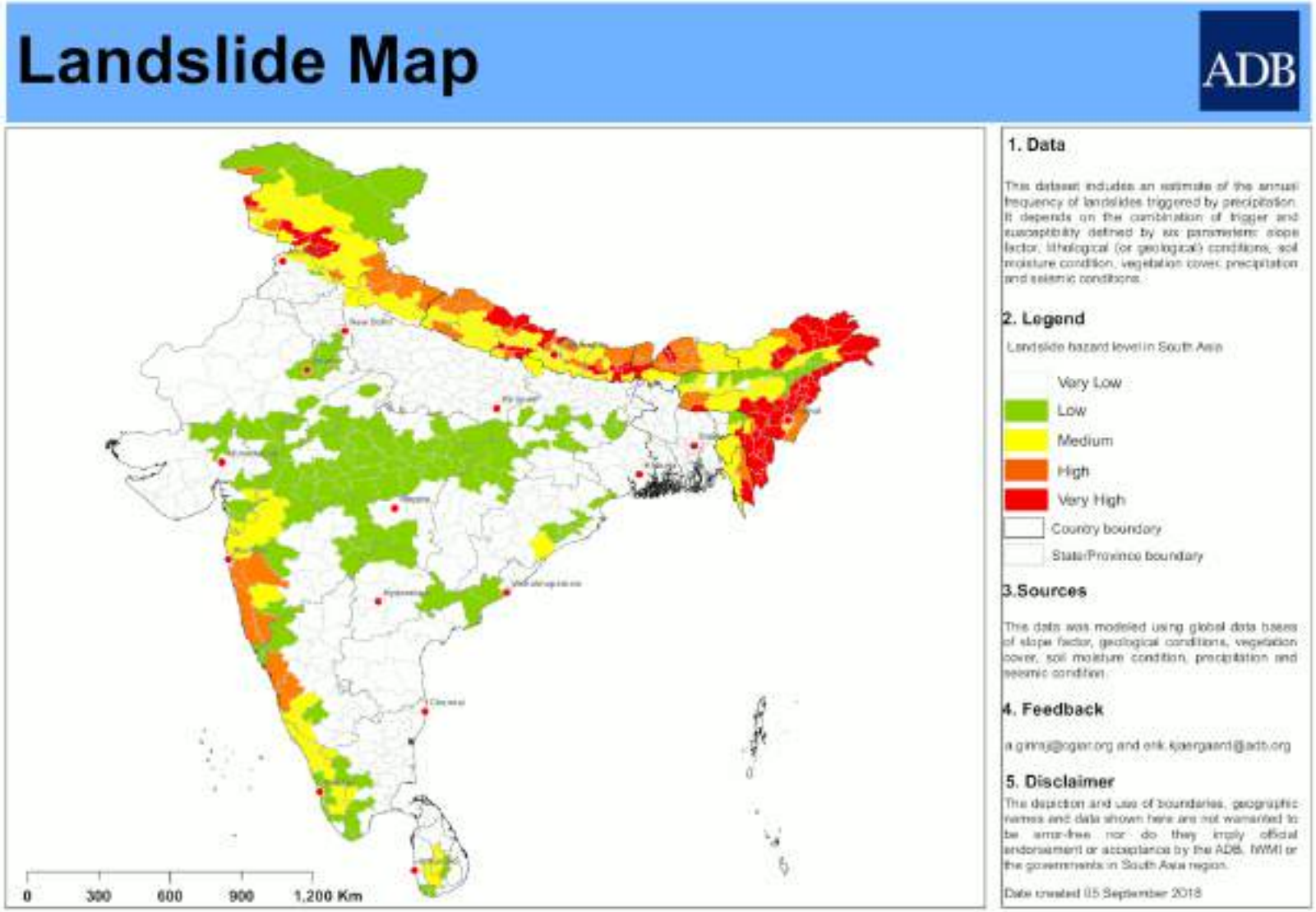
Socioeconomic Data and Applications Center (SEDAC)

Human Development Report (UNDP)

Amarnath G, Yoshimoto S, Goto K, Fujihara M, Smakhtin V, Aggarwal P, Ravan S, 2016, Global trends in water-related disasters using publicly available database for hazard and risk assessment, Congress of JRCSA 2016, held in Kyoto, Japan.

IWMI International Water Management Institute

Climate Screening products for investing in disaster resilience



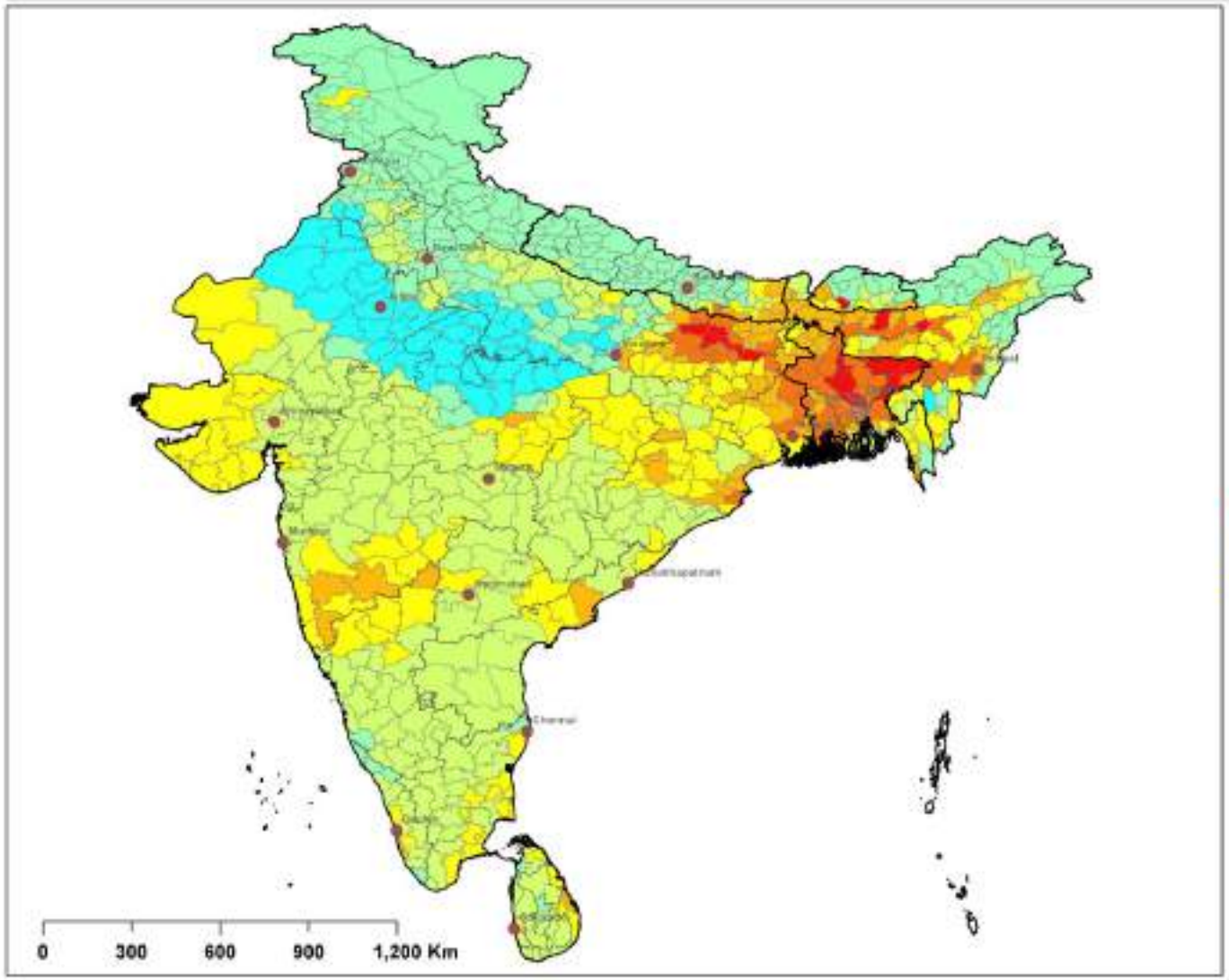
Not validated and atlas will be published in 2020

Source: IWMI

- Mapping individual hazards (Flood, Drought, Landslides, Coastal inundation, Cyclone, Forest fires, Earthquake, Extreme rainfall, Heatwaves and Sea level rise);
- Multi-hazard Risk Assessment to support in developing DRM policies and financial investment portfolio for building resilience

Multi-hazard Economic Exposure Map

Geospatial Intelligence Analysis



1. Data

This multi-hazard economic exposure map is based on different data sources including four individual hazard maps (flood, storm, earthquake and drought) and the 2015 Gross Domestic Product. The first step involved extraction of GDP values exposed to individual hazards and the second step applied weightage on the economic exposure using historical disaster losses from hazard events in the region year 1900-2017 obtained from EM-DAT. The weightage to individual hazards were: flood 62%, storm 23%, earthquake 11% and drought 4%. The final step consisted in normalizing the exposure of GDP with the total district GDP to identify the economic losses from multiple hazards across South Asia. The colour gradients indicate the relative economic exposure to multiple hazards at district level in South Asia.

2. Legend

Multi-hazard economic exposure in South Asia. Applied natural breaks (Jenks) classification method.

- < 9.5
- 9.6 - 20.3
- 20.4 - 30.9
- 31 - 40.6
- 40.7 - 53.6
- 53.7 - 74.5
- > 74.5
- Country boundary
- State/Province boundary
- District boundary

3. Sources

IWMI

4. Feedback

a.pitraj@cgiar.org and erikkjaergaard@hotmail.com

5. Disclaimer

The depiction and use of boundaries, geographic names, and data shown here are not warranted to be error-free nor do they imply official endorsement or acceptance by the IWMI, or the governments in South Asia.

Version 5
02 April 2019

IWMI

Multi-hazard Data
+
Population Exposure
+
Gross Domestic Product (GDP)
+
Historical loss and event database

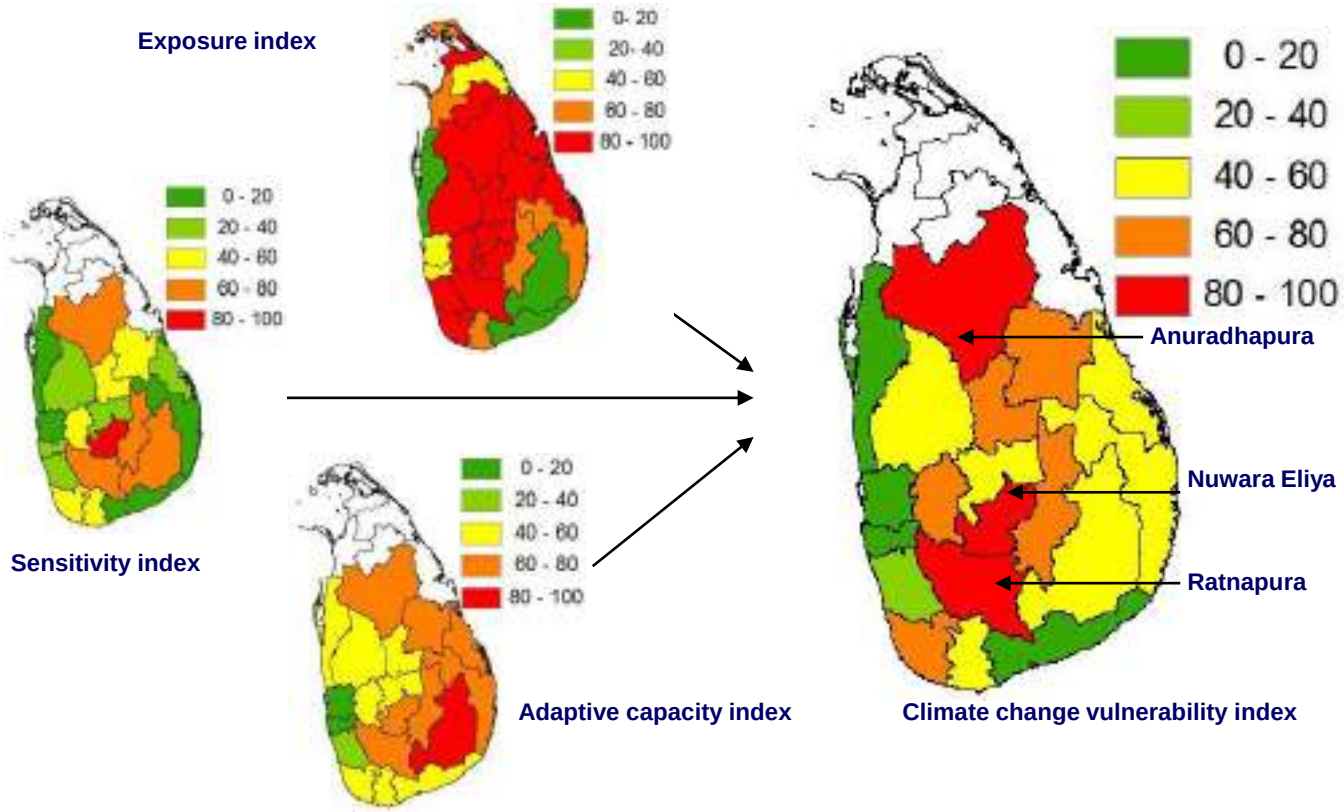
=

Multi-hazard Economic Exposure Map for disaster insurance and DRM policy perspective

IWMI International Water Management Institute

Some areas will be more affected than others:

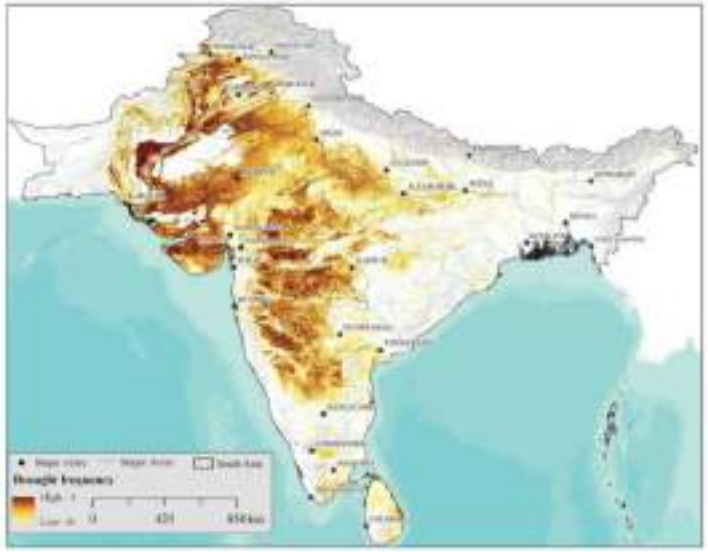
Identifying vulnerability hot spots for climate change to design locally relevant adaptation measures



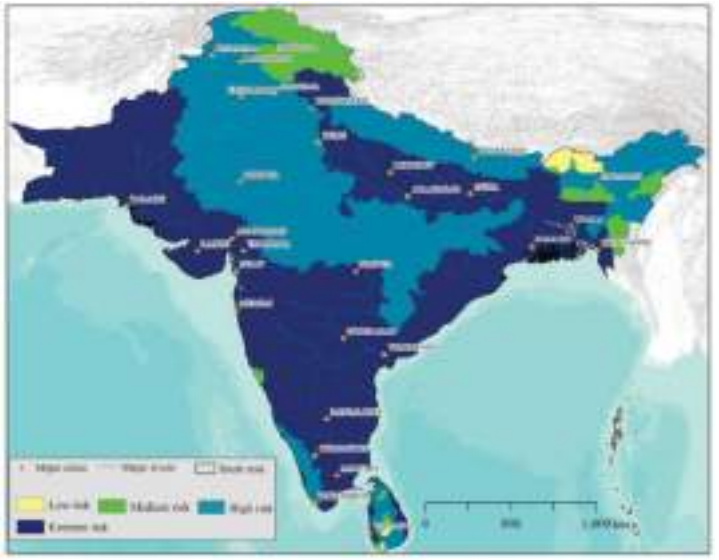
Multiple hazard and risk assessment in South Asia

Combined risk index (hazards - floods, drought, extreme rainfall, heat waves, sea level rise, vulnerability and exposure) to identify RISK areas to district and sub-national level for climate adaptation strategy and risk investment in SA

Spatial distribution of drought frequency based on 13 years' time series of MODIS imagery



Climate change vulnerability map of SA based on exposure, sensitivity and adaptive capacity to multiple hazards



Amarnath, G.; Alahacoon, N.; Smakhtin, V.; Aggarwal, P. 2017. Mapping multiple climate-related hazards in South Asia. IWMI Research Report 170, 41p. doi: 10.5337/2017.207

IWMI International Water Management Institute

Integrated Drought Risk Management (IDRM) Framework

International Water Management Institute

Monitoring & Forecasting / Early warning

- Understanding drought risk for planning;
- Indices/ indicators linked to impacts and action triggers;
- Feeds into the development/delivery of information and DSS

Vulnerability & impact assessment

- Identifies who and what is at risks and why?
- Involves monitoring/archiving of impacts to improve drought characterization
- Coping capacity of the communities

Mitigation & response planning and contingency measures

- Pre-drought program and actions to reduce risks (short and long-term);
- Operational drought contingency plans during drought disasters;
- Safety net and social program, research and extension

Three pillars of drought risks management

- Meteorological, Hydrological, and
- Agricultural Droughts
- Drought bulletin

- Drought vulnerability
- Impact evaluation
- Risk transfer using index insurance

- Drought declaration
- Support national policies

International Water Management Institute

IWMI's ongoing drought resilience projects

South Asia

Southern Africa

MENA

Senegal and Ethiopia

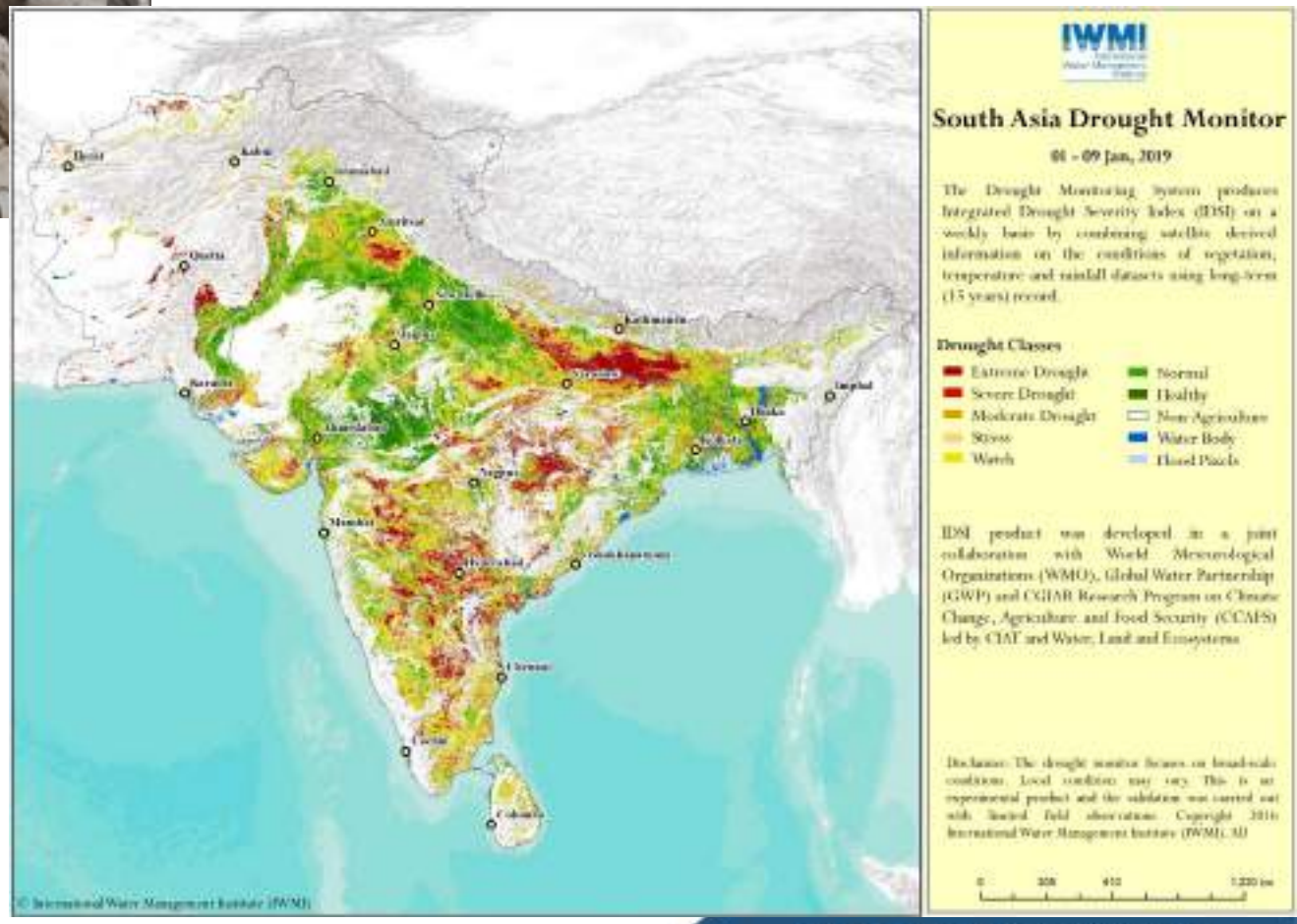
FOOD AVAILABILITY

Indian governments make the leap to drought relief for farmers using real-time data

Governments in India are using satellite data combined with ground measurements to assess and mitigate drought damage to crops. The data improved drought response in three districts and fed into development of 620 district-level drought plans.

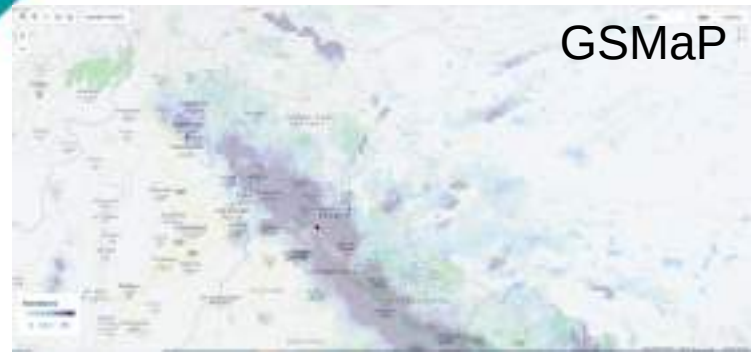
Throughout 2017-2018, the South Asia Drought Monitoring System (SADMS) provided an index that integrates rainfall data with data on vegetation, soil moisture and temperature. Every eight days, the system publishes drought bulletins with detailed maps showing drought severity across Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka.

SADMS Monitor



Evaluation and comparison of satellite-based rainfall products

Location: [31.69302777, 76.4163889], HP, India



Sl. No	Data Source	Prec (mm)
1	CHIRPS	65.87
2	TRMM	109.13
3	PERSIANN-CDR	44.64
4	GPM_L3	94.66
5	GSMaP	94.66

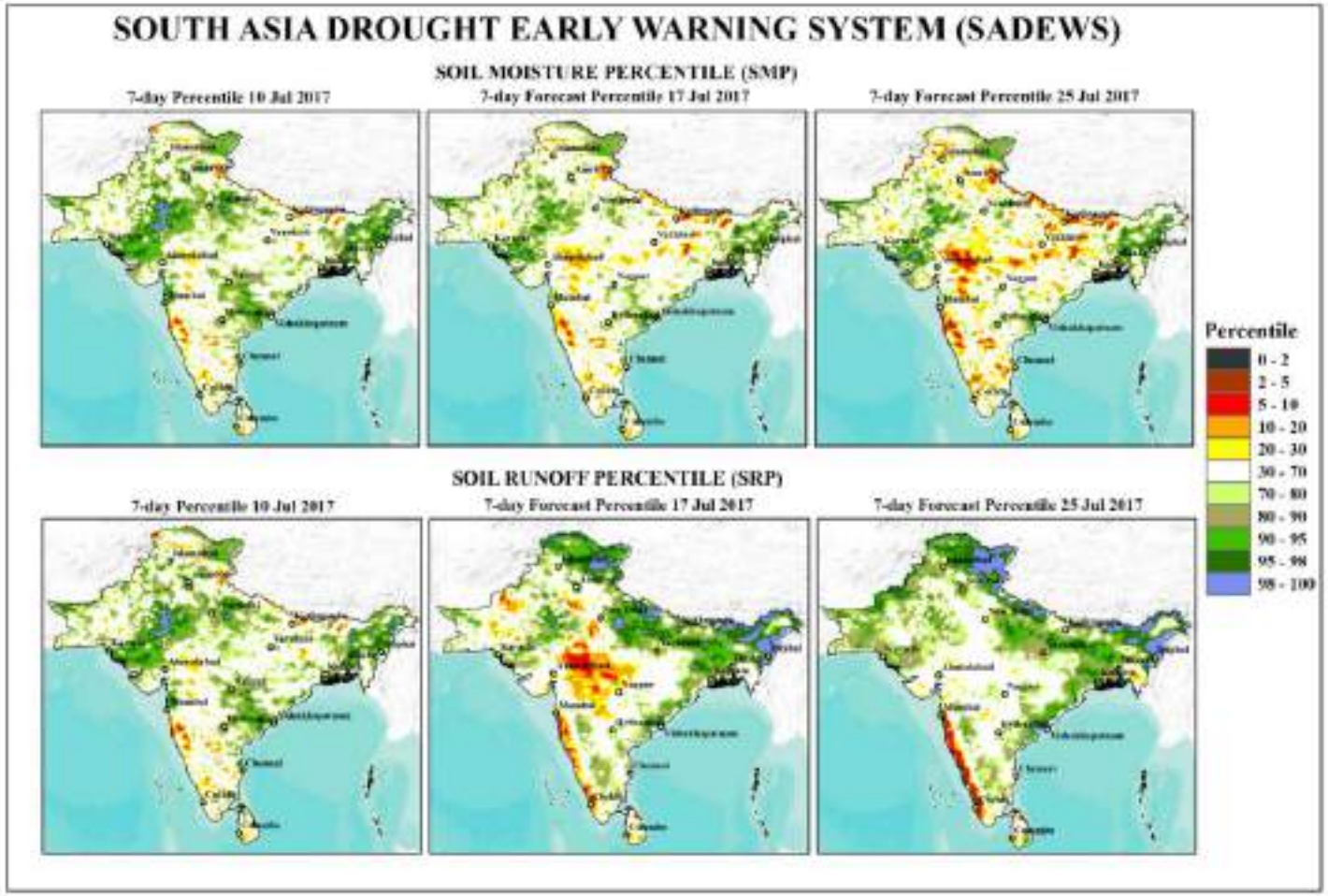
AWS Record 117.4mm (13 August 2018)

Date : 13/08/2018

- Except PERSIANN and CHIRPS rest of the SRE products are closer to the AWS data with an error by 9 to 19%
- Satellite rainfall products can complete hydromet for flood forecasting
- Combined products reduces uncertainties in extreme weather events

IWMI International Water Management Institute

South Asia Drought Early Warning System (SADEWS)



Current Condition: 10 July 2017
Forecast Period : 17 July and 25 July 2017
Standardized Soil Moisture and Runoff Index for regional drought and early warning

Summary:

The experimental drought forecast products for research/scientific use based on 10th July 2017 initial condition. These forecast products are based on the real time weekly operational forecast generated by Global ENSemble (GENS), a weather forecast model made up of 21 separate forecasts, or ensemble members developed at The National Centers for Environmental Prediction (NCEP), NOAA.

Drought Forecast Outlook:

- The initial condition has improved over Telangana, Andhra Pradesh, Rajasthan, Western UP and North-eastern states..
- Initial condition on the Soil Runoff Index (SRI) explains similar trend to SSI.
- Some level of dryness is expected in the following weeks over central parts of the region such as MP, eastern Gujarat and Jharkhand.
- The leeward side of the western ghats along the southern Maharashtra seems to be progressing towards dryness.
- In reference to IMD actual rainfall for India, several east-central states are in deficit rainfall condition which is affecting the crop productivity and advance need for State and Local authorities for better planning and coordination on water resources management.

The SADEWS is regional scale early warning system developed as a collaborative project between International Water Management Institute (IWMI) and Indian Institute of Technology – Gandhi Nagar (IIT-GN).

Thanks to Dr. A.K. Sahai, IITM for sharing the ERPAS Weather Forecast Data

IWMI International Water Management Institute

Sri Lanka – Climate and Food Security Bulletin (UN WFP and IWMI/WLE)

Climate & Food Security Monitoring Bulletin

July - August 2019

August 2019

A joint bulletin by the United Nations World Food Programme & International Water Management Institute

World Food Programme PRISM IWMI CGIAR Water, Land and Ecosystems

1. Bulletin Highlights

First half of 2019, total rainfall has been below average, despite the fact that June, July and the first ten days of August experienced considerable rainfall, confined mostly to the South-Western Regions. Meteorological forecasts suggest areas in the dry-zone are expected to remain dry through to September.

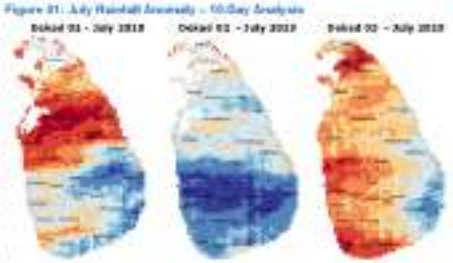
Abnormally dry and moderate drought conditions remain in pockets of North, North-Western, North-Central, Uva and Eastern Provinces. Focus must be placed on risk reduction, adaption measures, and preparedness for drought response interventions; including integrated drought resilience programs to promote improved drought resilience strategies from climate shocks.

Major water reservoirs are becoming dangerously low at only 19% capacity, compared with 33% at the same time last year. Water assistance is being provided to 177,173 households across 17 Districts.

Surplus Maha (2018/19) and Yala (2019) paddy production means there is no immediate food shortage, and total rice availability is sufficient to meet demand until January 2020 (Department of Agriculture). However, dry conditions and pest attacks in pockets of Kurunegala, Batticaloa, Ampara, Puttalam and Trincomalee caused the destruction of 4,262 ha of paddy. This will not have a major impact on overall paddy production, but will have adverse localised impacts.

Following forecasts issued in the previous bulletin (June 2019), July was set to be warm and relatively dry for most of the country. While total rainfall was slightly higher than the average, the Northern and North Central Provinces were dry and rainfall in these areas was below average. Majority of the rainfall fell across the Central, Western, Sabaragamuwa and Southern Provinces, however, it was concentrated in short bursts during the second dekad of July, and resulted in landslips and flash floods to areas in Nuwara Eliya (Figure 1).

Figure 01: July Rainfall Anomaly – 10-Day Analysis



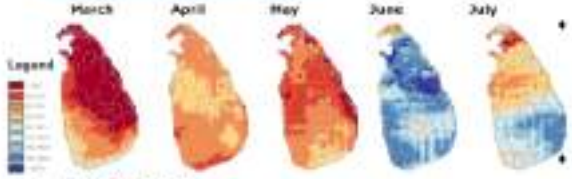
Source: Platform for Real-time Information and Situation Monitoring (PRISM) (CHIRPS Data)

Most of the regions that received below average rainfall have also been exposed to prolonged dry conditions and are in need of targeted and timely intervention. The probabilistic forecasts issued by the Department of Meteorology in July suggests below normal rainfall is likely to continue through August and September in the Northern, North Central, North Western and Eastern Provinces. Lower rainfall will put further stress on access to water and soil conditions. So far, rains received during the first ten days of August show above normal rainfall in many regions of the country.

This bulletin highlights recent key climatic seasonal trends across the country, and how these have, and will, impact the population's access to water for consumption, domestic, and agricultural purposes.

2. Seasonal Observations

Figure 02: Rainfall Anomaly March – July 2019

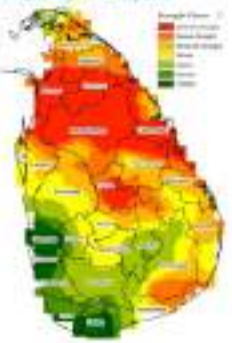


Source: PRISM (CHIRPS data)

- Following dry conditions in March, April and May, parts of the country, particularly in the Central, Western, Southern, and areas in the Uva Provinces experienced above normal rain conditions throughout June (Figure 02).
- In July, the North Central, North and Eastern Provinces remained dry due to the fact that the concentration of rain over the last two months has been predominately in the southern parts of the country.

3. Agricultural Conditions and Food Security

Figure 06: Soil Water Anomaly Drought Index (SWADI) – 11-20 July 2019



- Soil Water Anomaly Drought Index (SWADI) is a measure of moisture held in the soil. From the map shown in Figure 06, it becomes clear that water stress and dry conditions are persistent through much of the country, particularly in Hikkaduwa, Mannar, Vavuniya, Anuradhapura, Trincomalee, Polonnaruwa, Batticaloa, and Matale.
- This information is further confirmed by the Vegetation Health Index (VHI) in 16 Day lapses (Figure 07). While the persisting dry conditions have improved slightly over the 32 day period, the health of vegetation has been adversely impacted in the same districts.
- No immediate food security emergencies are predicted due to Maha paddy cultivation of 2,397,000 Mt and predictions of a Yala season of 1,471,000 Mt (slightly lower than season 2017/18).
- According to Department of Agriculture, paddy production for season 2018/19 is expected to meet domestic rice demand until January 2020. Total rice production is set to be 2.75 million Mt this year (Figure 08).
- Rice production has, however, been impacted by drought conditions with 4,265 ha being damaged in Kurunegala, Batticaloa, Ampara, Puttalam and Trincomalee as a direct result of the prolonged dry conditions.

Figure 07: 16 Day Vegetation Health Index (VHI) – June to Mid-July 2019

Agricultural Market Shifts

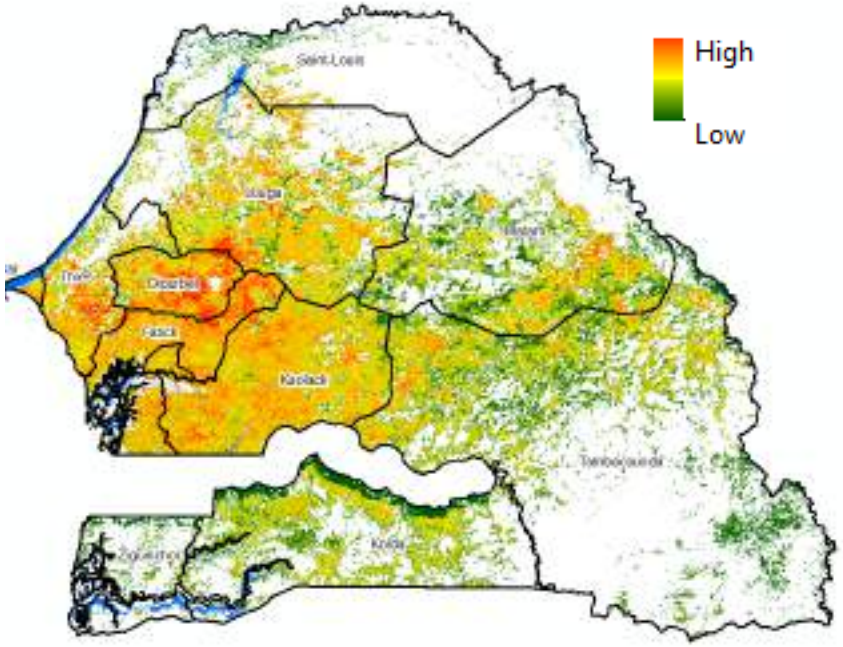
- Average price of rice has fallen significantly from roughly 120 rupees per kg to under 100 rupees compared with this time last year. This price has remained relatively constant since April 2019, after the Maha harvest and the positive projections in rice yields this year (Figure 09).
- The price of most vegetables have decreased from the same time last year, conversely, important protein sources including fish, meat and eggs have all increased.
- Due to the country's economic challenges, particularly the downturn in tourism industry due to the Easter bombing incident, depreciation of the rupee and increased rates of indirect taxes, affordability of a nutritious food basket is challenging for vast majority of people, in spite of the lower cost of staples.

Figure 08: Total Rice Production Outlook

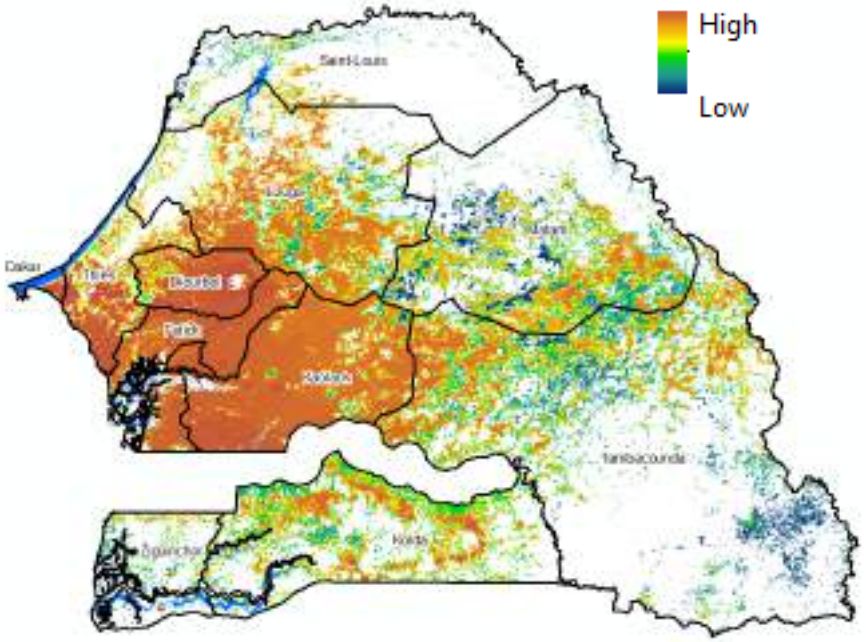
Source: Socio Economic Planning Centre of Department of Agriculture
Note: Total 2019 Rice Production includes forecasts for Yala 2019

Senegal Drought Risk Mapping (beta)

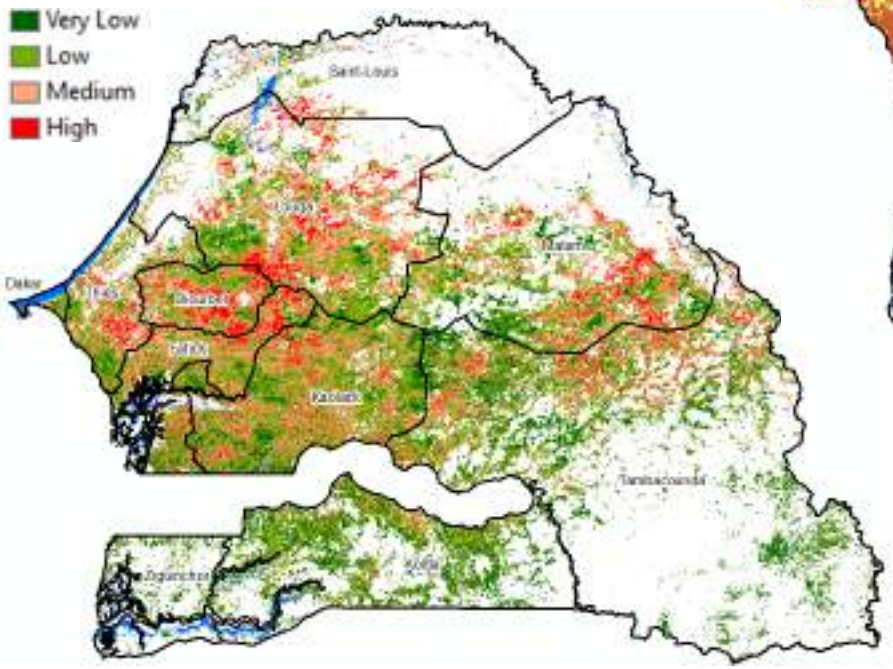
Drought Risk (Hazard + Exposure)



Anthropogenic Stress (WorldPop and GDP)



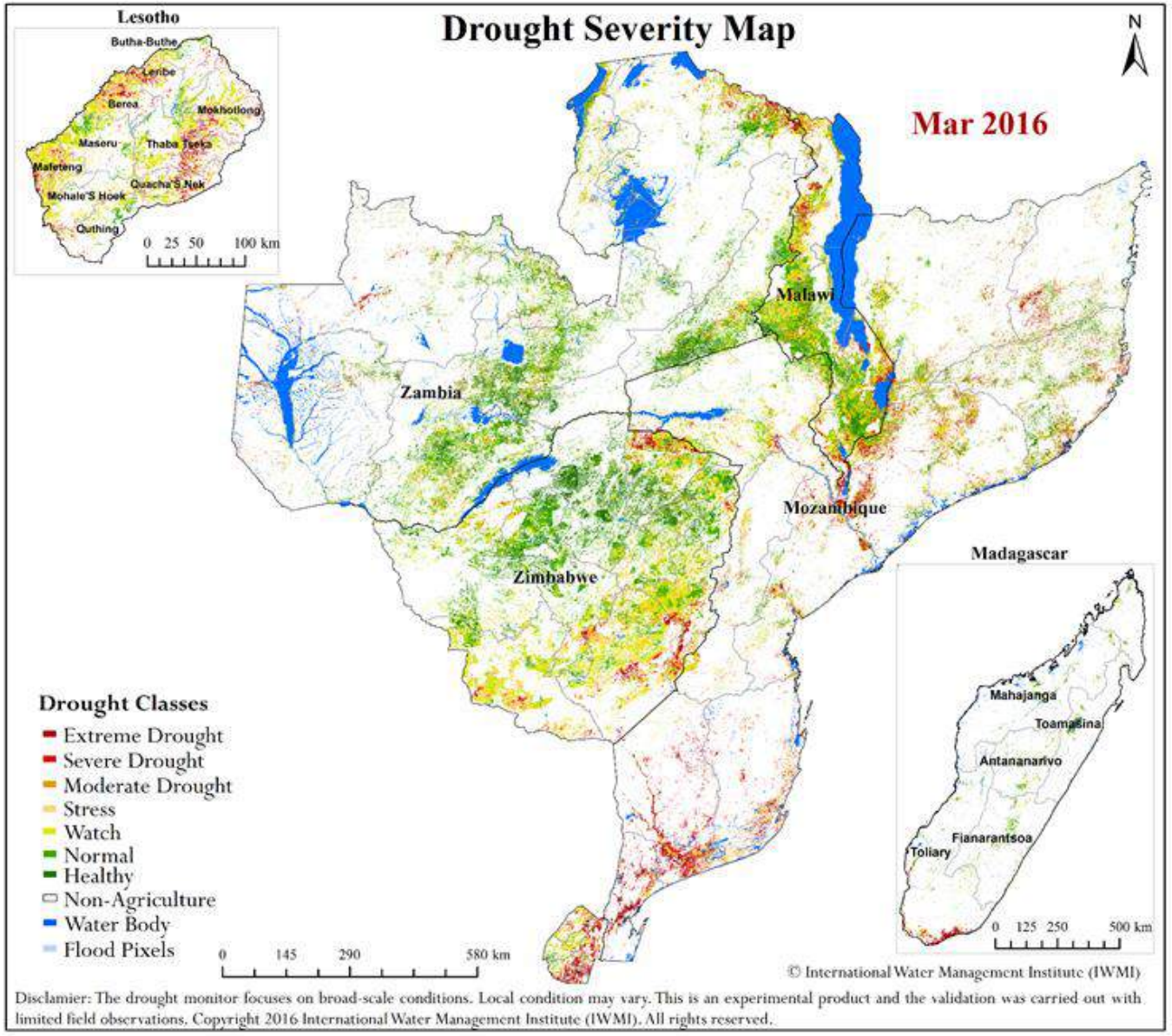
IWMI Drought Hazard
(2000 – 2018)



- Historical to current drought hazard areas using IDSI index
- Changes in the population exposure using CIESIN, WorldPop
- Risk map combined hazard, changes in population, cropland and socio-economic data

IWMI International Water Management Institute

Southern Africa Drought Maps

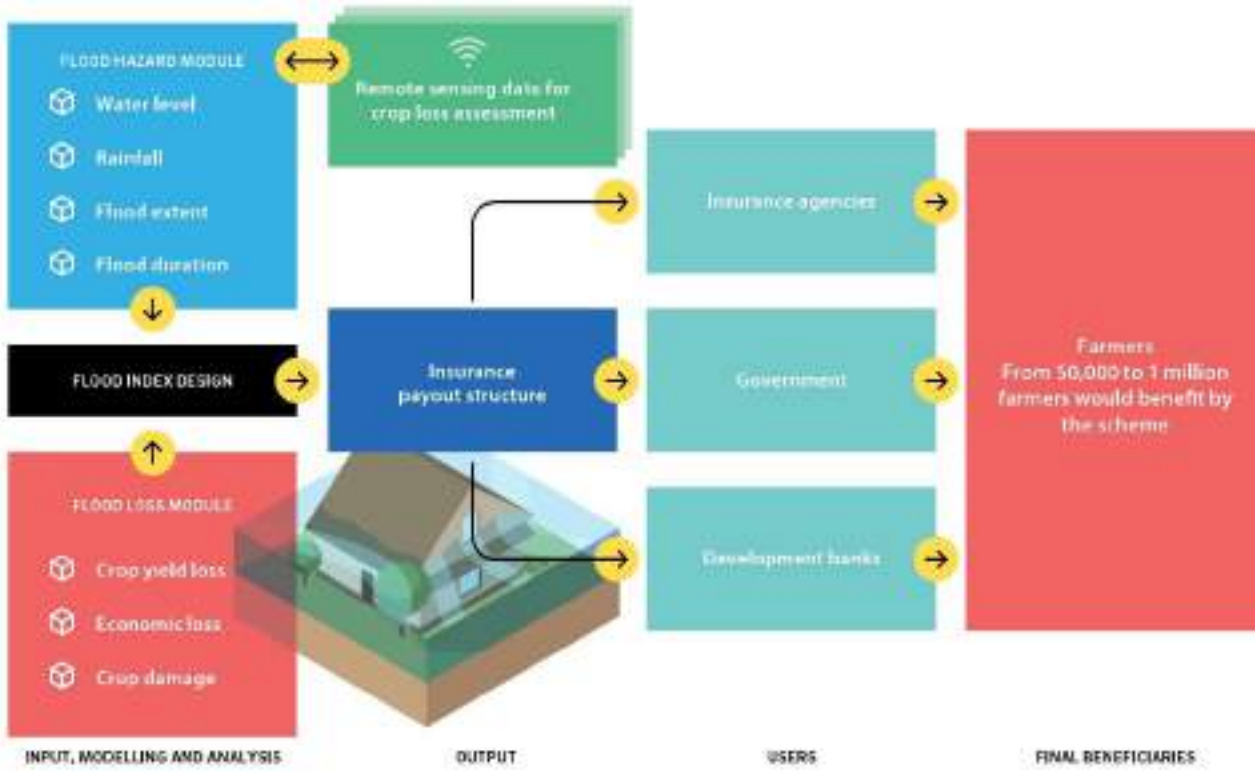


- IWMI implemented drought monitoring and agriculture-water management with the support of FAO and SADC following the 2015–2016 El Niño
- Drought indices developed for southern Africa region for agriculture planning and food security bulletin which is under consultation with member states
- Scaling the Senegal efforts to Southern Africa, theses products can be utilized

Detail report: https://cgiar-my.sharepoint.com/:b:/g/personal/a_giriraj_cgiar_org/Edp_BKIeU0xIpBboN7bc5PsB4XnYXyZDSs-RioFjvCsX8Q?e=OxxmnW

IWMI International Water Management Institute

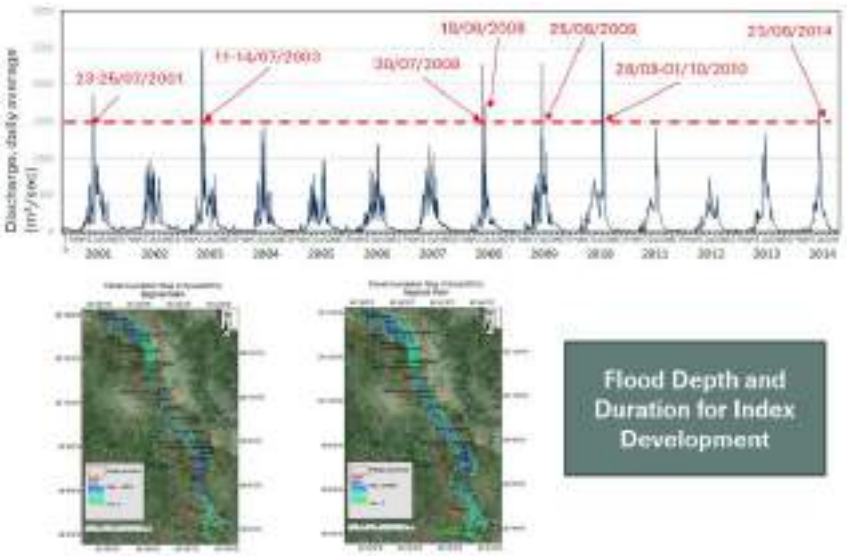
IBFI – Flood proofing communities and agriculture resilience…



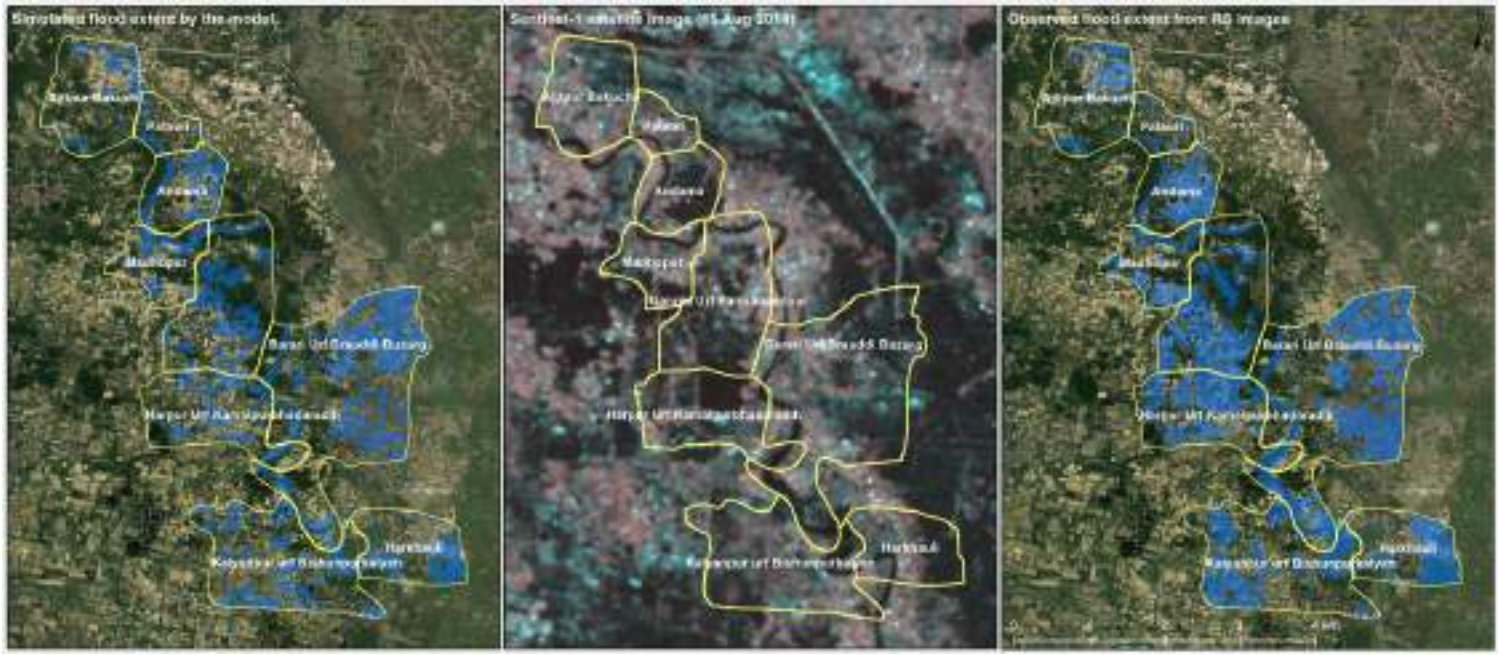
Source: Amarnath, 2017.

2018 Pilot (Bihar)

Flood Depth and Duration

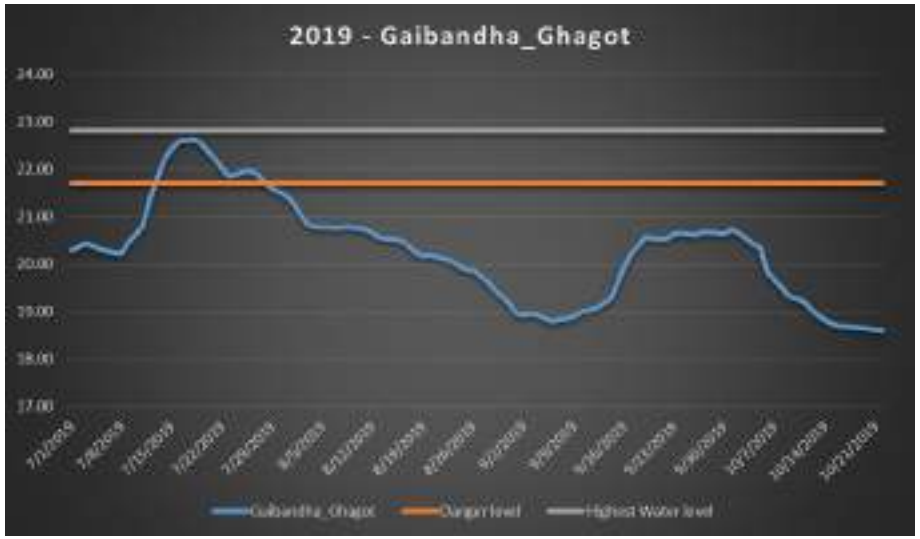


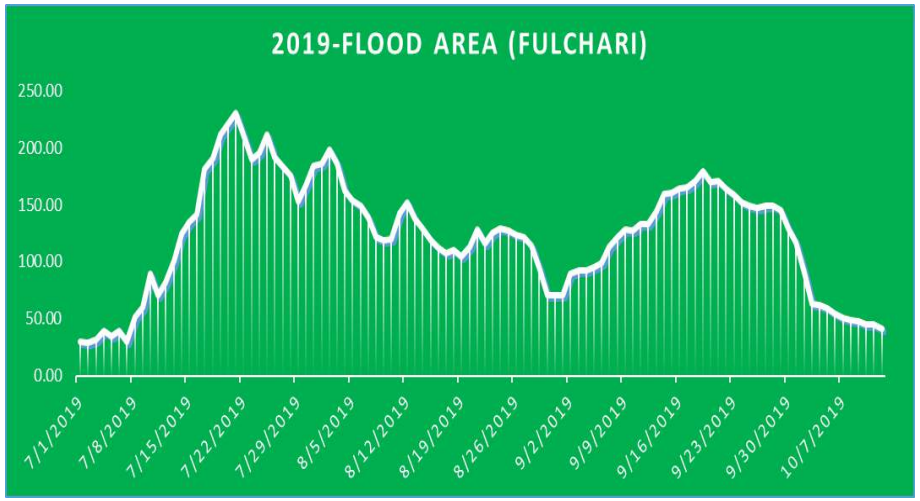
Comparison of flood model and satellite data

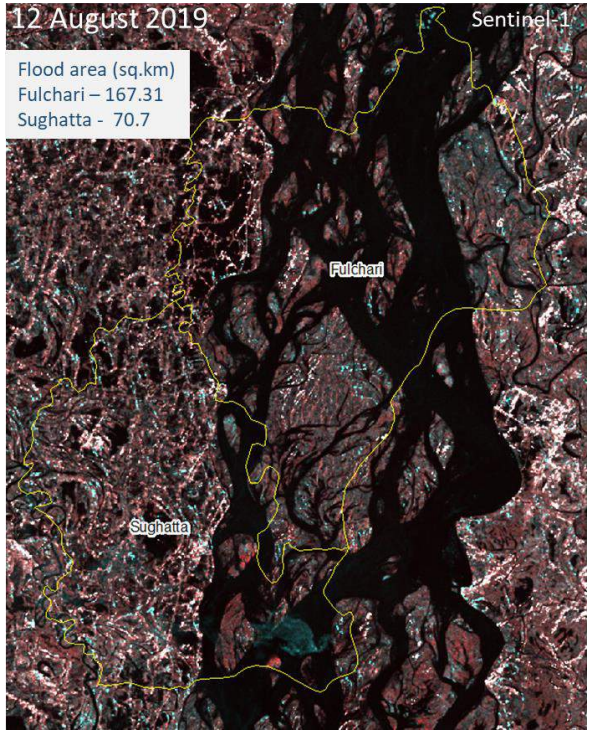


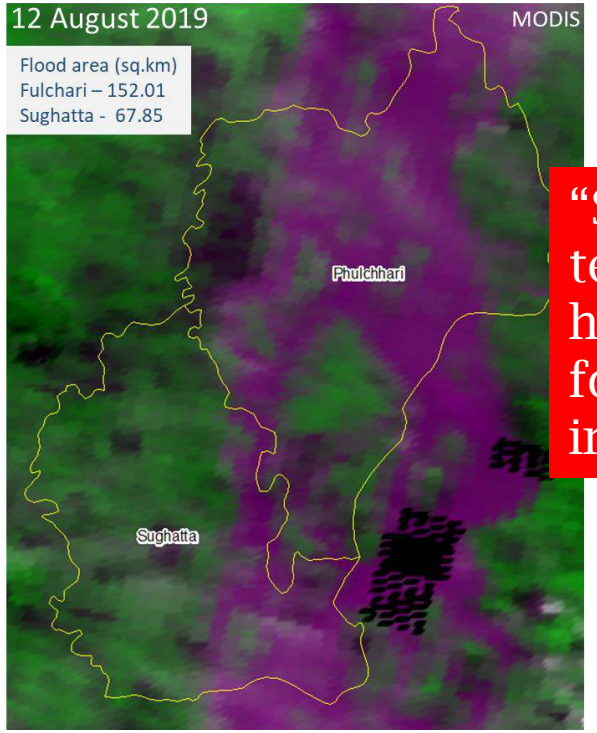
Three years of successful IBFI pilot (2017 – 2019)

2019 Flood Claim – Fluchari Upazila, Bangladesh







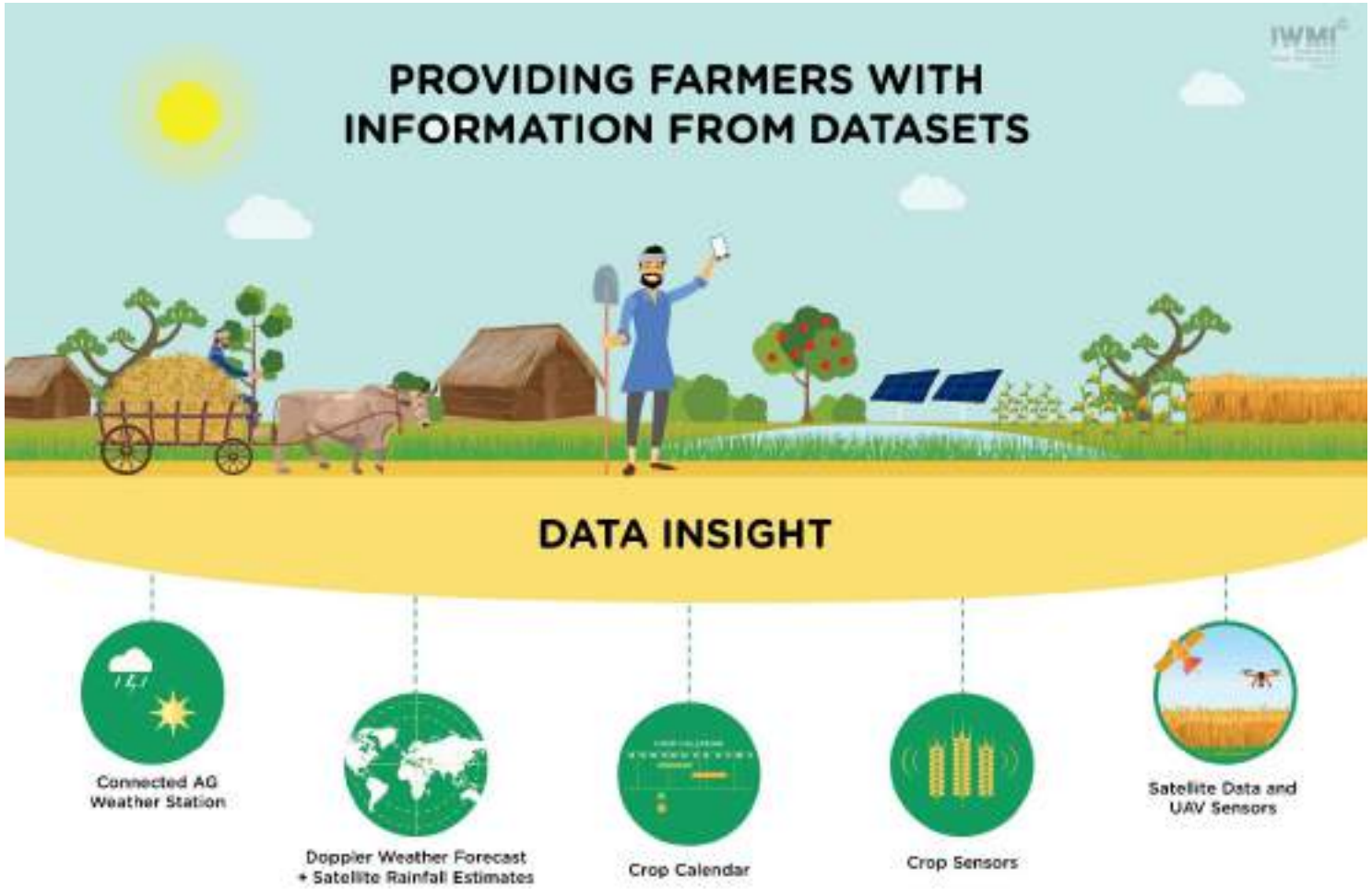


"Space technology has huge potential for insurance industry"

- Over 5 Million Affected by monsoon floods
- Flood Insurance payout with category 50% area inundated covering 14 consecutive days
- Approx. 6,000 BDT eligible for individual farmers

IWMI International Water Management Institute

Bundled insurance solutions with climate resilient seeds and weather advisory services



IWMI International Water Management Institute

BICSA
in partnership with Seed, Insurance and weather advisory company

The core idea of BICSA implementation is to adapt agricultural technologies (Seeds + Insurance) and scaling of gender responsive ARM strategies for vulnerable smallholder farmers through bundled solutions.

Business Case	What we did	Impact
Bundled Solutions of Index Insurance with Climate Information & Seed Systems to manage Agricultural Risks(BICSA)	• **Package of Practices (PoP):** Farm Advisory to maximize the farmers' farm income. • **Weather Forecast:** Accurate 7-day weather forecast shared with the farmers via SMS or mobile application • **Plant Doctor:** Instant Identification of pests / disease and its remedy by sharing of a photo of the plant through smartphone and details about the location-wise vulnerability of crops to disease • **Water Management:** Prediction of rainfall basis historic data, along with information on water management • **Insurance against rainfall:** If the rainfall is less than the set level, then the farmers of the affected area were eligible for payout	Launched in 2019, covered 1,100 households; USD 9 contribution from farmers and rest from project contribution; Demonstrated commercially viable and sustainable by clubbing it with other risk management services

Rolling out……

Farmers awareness and enrolment

Drought insurance policy and AWS installation in pilot blocks, Gaya district

Seeds distributions to farmers in Pilot districts in Bihar

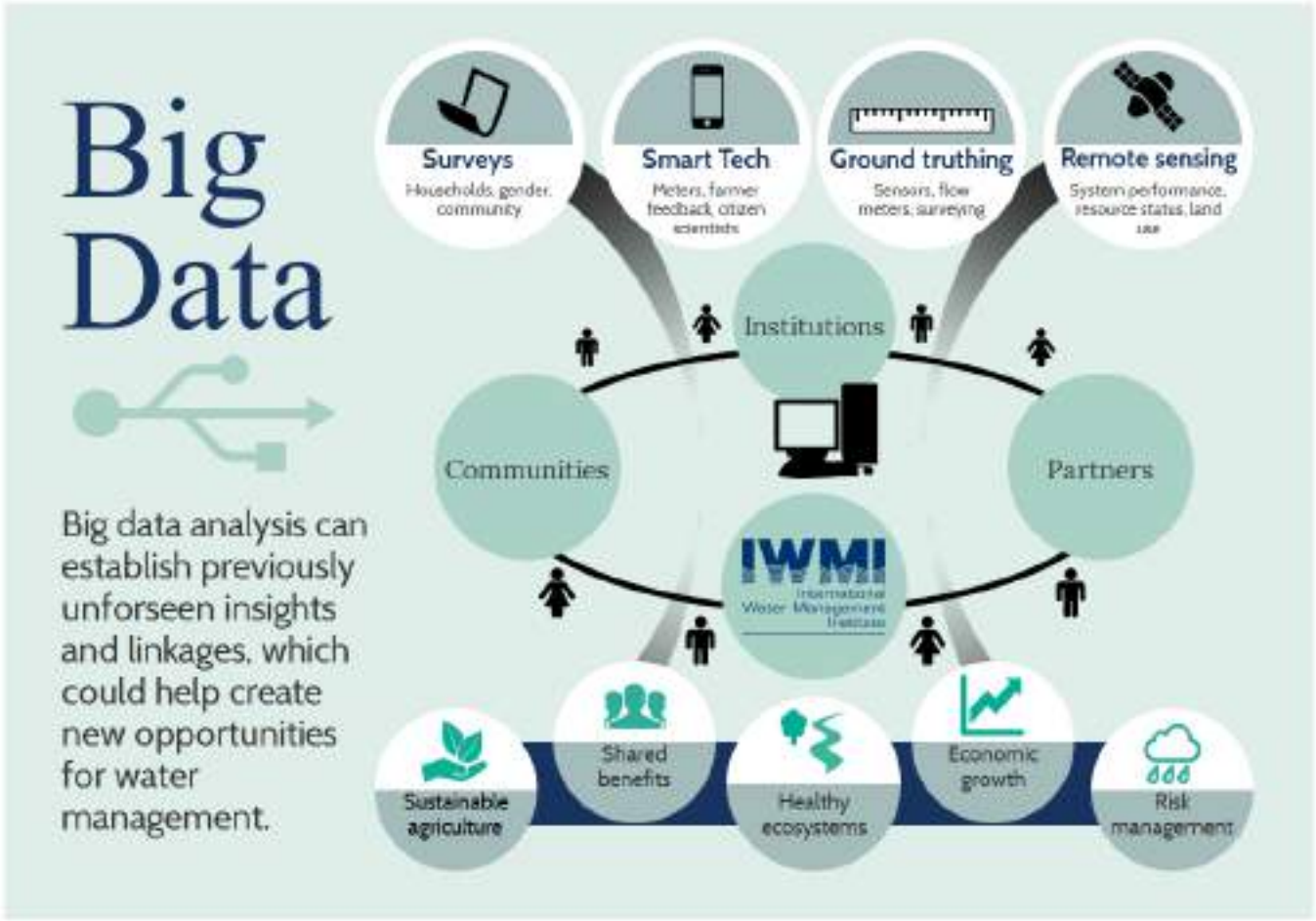
IWMI International Water Management Institute

Drought tolerant rice variety ready for harvest in Nov 2019

Lentil Seed distribution with bundled solutions – 29 Oct 2019

IWMI International Water Management Institute

Can Big data support IDRM?



Providers of Earth observation information

Decision makers (Disaster managers)

IWMI International Water Management Institute

Thank You

Contact: a.giriraj@cgiar.org

IWMI International Water Management Institute