

WATER-RELATED HAZARD WORKING GROUP

Sentinel Asia Step3 Implementation

6th Joint Project Team Meeting of Sentinel Asia STEP3 (JPTM2018Awaji), Awaji-island, Hyogo, Japan

**Giriraj Amarnath,
International Water Management
Institute (IWMI), Sri Lanka**

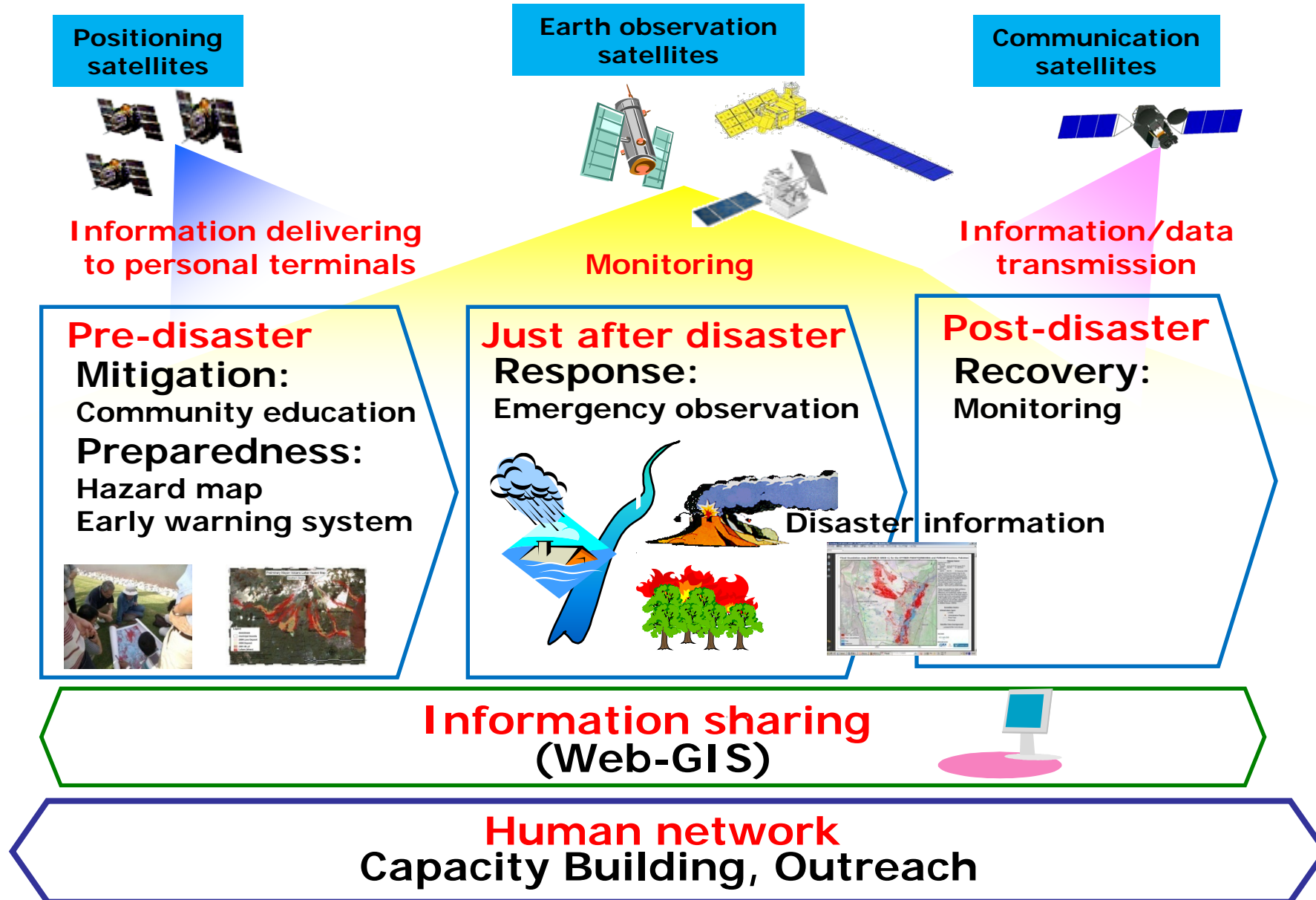
01 November 2018

Agenda

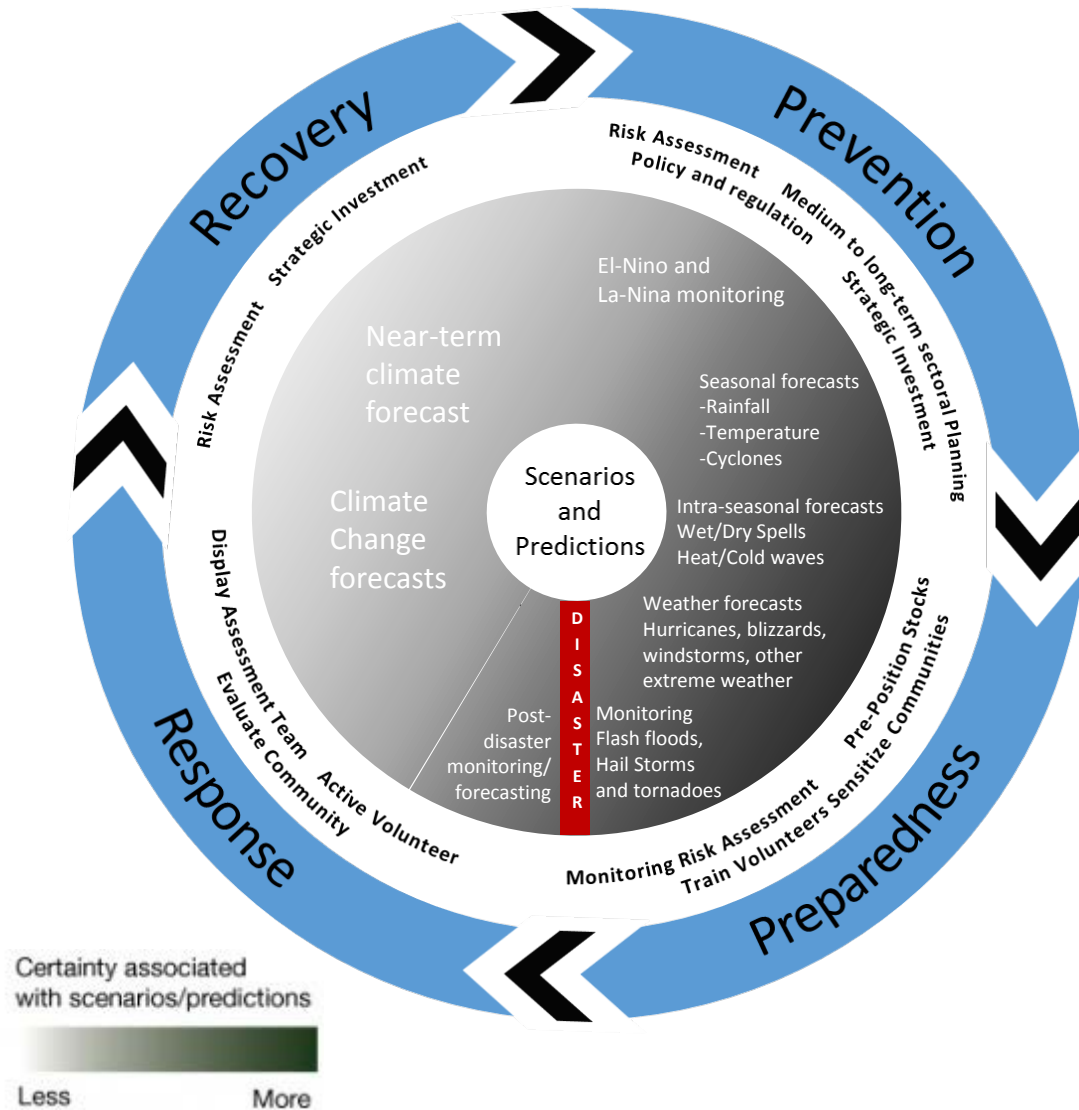
- To promote use of space technology in managing water-related hazards in all aspects of disasters;
- To share best practices among stakeholders to utilize knowledge products and science data/tools in regard to implementation of Step3 SA framework;
- To provide capacity building and joint implementation of the project activities in addressing Sendai framework for Disaster Risk Reduction and SDG;

Water-related hazard group is being led by IWMI, Sri Lanka and ICHARM, Japan

Concept of Sentinel Asia Step 3



The Four Part Disaster Cycle

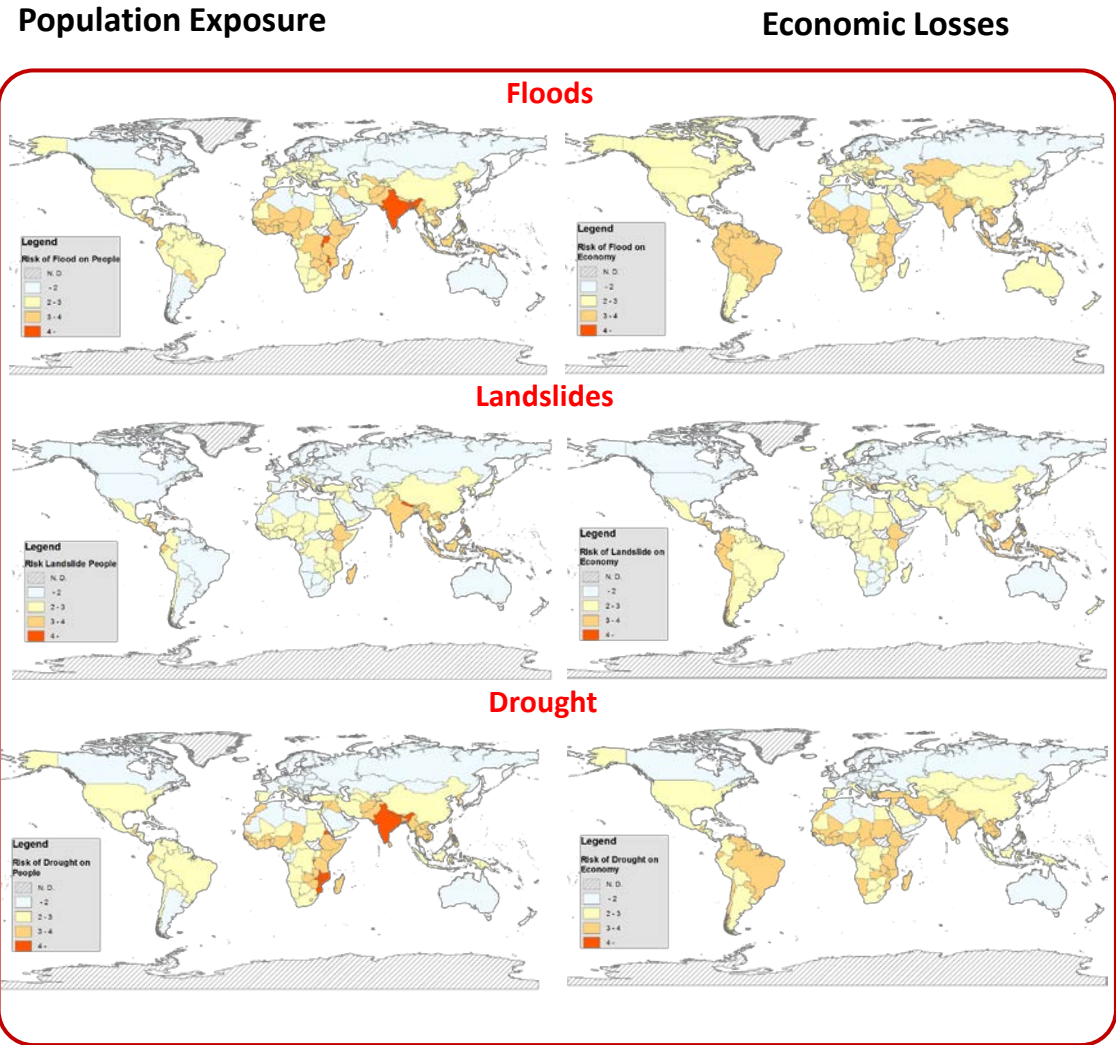
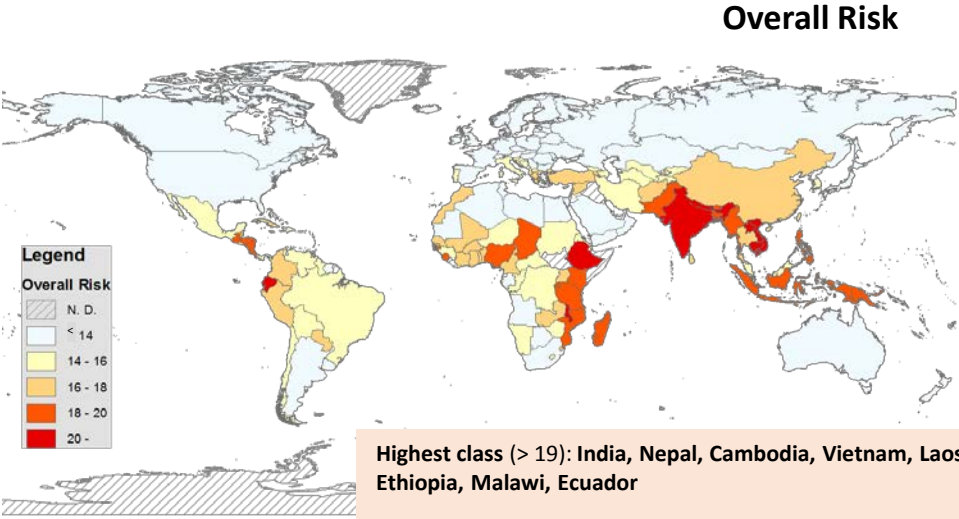


1. **Prevention.** Long-term efforts to prevent hazards from becoming disasters or make them less damaging. These include structural measures such as creating flood levees or reinforcing buildings, as well as **non-structural measures** such as **risk assessment** and land-use planning.
2. **Preparedness.** Planning for when disaster strikes, including developing **communication** strategies, **early warning systems**, and stockpiling supplies.
3. **Response.** Implementing plans after a disaster. This includes mobilising emergency services, coordinating search and rescue, and **mapping the extent of the damage**.
4. **Recovery.** **Restoring an area**, often through rebuilding and rehabilitation, then returning to mitigation measures.

Understanding disaster risks.....



Evaluation of global water-related disaster risk



Publicly available data sources

Global Risk Data Platform (UNEP)

Socioeconomic Data and Applications Center (SEDAC)

Expected years of schooling (years)
Number of years of schooling that a child of school entrance age can expect to receive if present enrolment rates persist throughout the child's life.
Source: UNESCO Institute for Statistics (UIS). Data Centre. <http://data.uis.unesco.org>. Accessed 24 March 2015.

Human Development Report (UNDP)

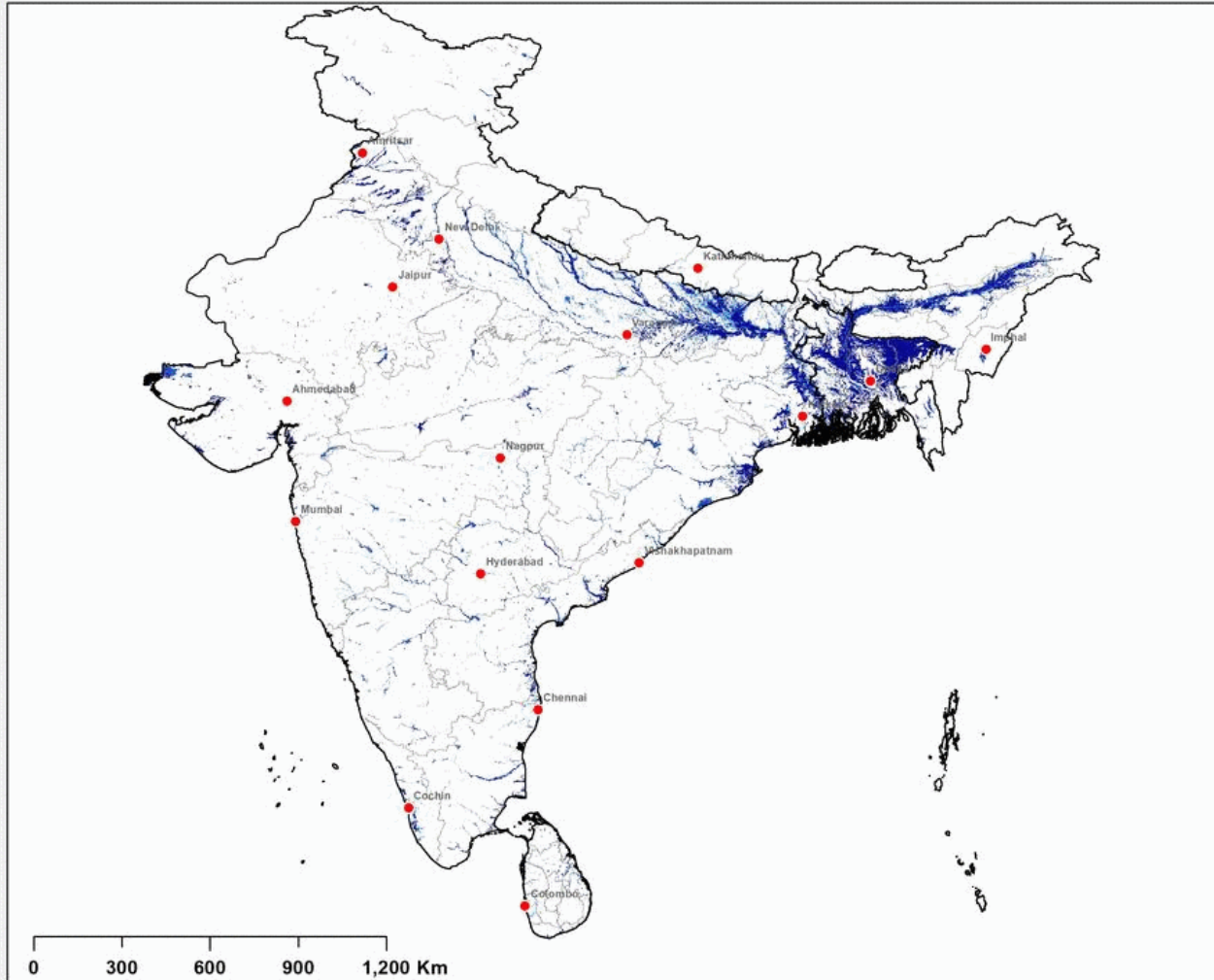
Country	1990	1995	2000	2005	2010	2015	2020
119	11.8	12.0	12.2	12.4	12.6	12.8	13.0
85	11.2	11.5	11.8	12.1	12.4	12.7	13.0
83	10.9	11.2	11.5	11.8	12.1	12.4	12.7
24	10.8	11.0	11.2	11.4	11.6	11.8	12.0

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.

Flood Hazard Map



Historical hazard events reported by global data sources



1. Data

This flood hazard map is based on time-series satellite data from 2000 to 2017. A flood algorithm was applied to detect flood pixels on each eight-day satellite image to map the monthly, seasonal and annual flood extent over South Asia. The color gradients indicate the relative flood frequency based on eighteen years' of data at 500 m resolution.

2. Legend

Flood hazard level in South Asia. Applied natural breaks (Jenks) classification method.

- Very Low (< 6.66)
- Low (6.67 - 33.33)
- Medium (33.34 - 53.33)
- High (53.33 - 79.9)
- Very High (80.0 - 100)
- Country boundary
- State/Province boundary

3. Source

NASA MODIS Terra (MOD09A1) 8-day surface reflectance data.
<https://search.earthdata.nasa.gov/>

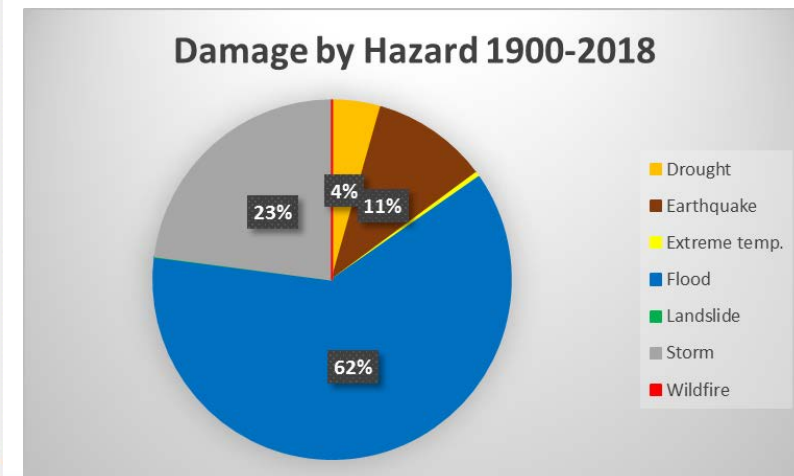
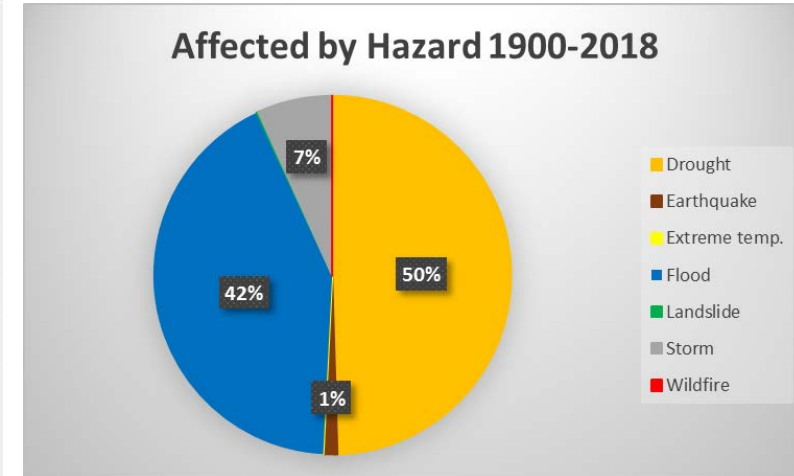
4. Feedback

a.giriraj@cgiar.org and erik.kjaergaard@adb.org

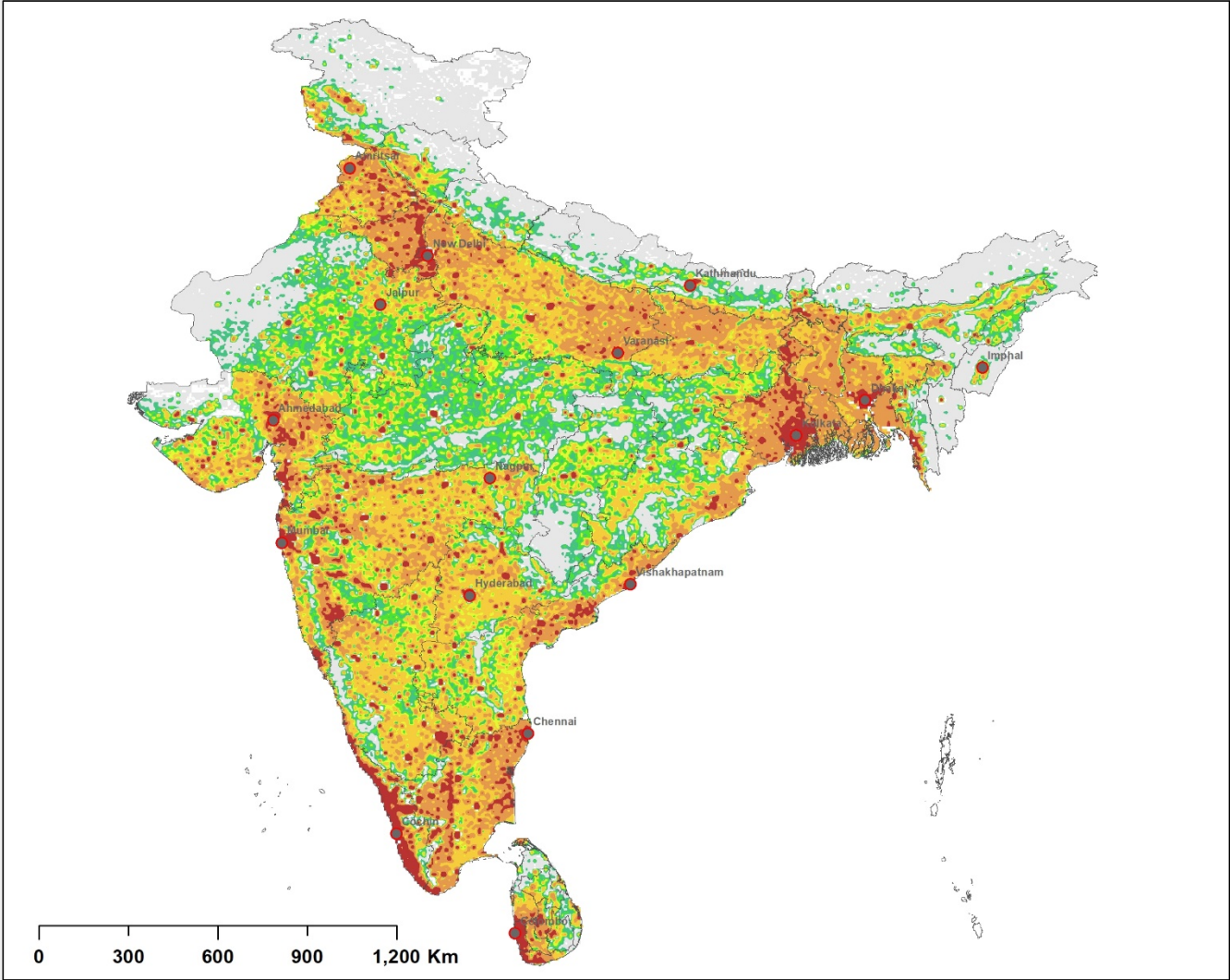
5. Disclaimer

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 ADB, IWMI or the governments in South Asia.

Version 5
29 October 2018



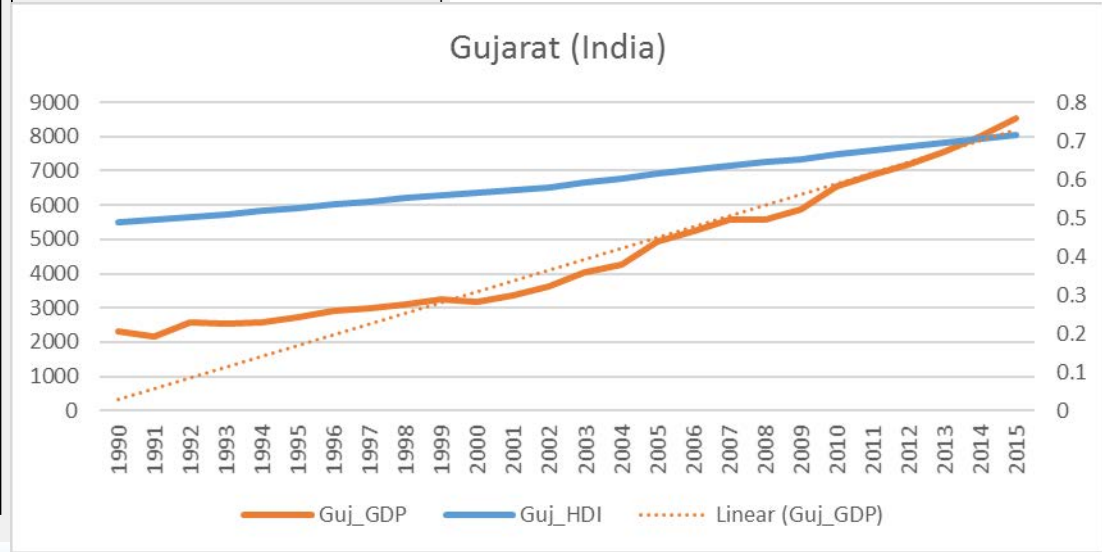
Gross Domestic Production (GDP) Map for the year 2015



1. Data
 The gridded total Gross Domestic Production (GDP) dataset obtained from Dryad Digital Repository together with the full national GDP dataset from the most recent (2015) World Bank Development Indicators Database. The constant 2015 international US dollars of CIA fact sheets were converted to constant 2011 international US dollars, the unit in which national GDP from World Bank was given. For missing countries, the study used data from the CIA's World Factbook. The spatial resolution of the GDP at 450 m

2. Legend
 Total GDP in South Asia. Units Multiplied by one million as given in USD. Applied equal interval

0 - 25	101 - 200
26 - 50	201 - 500
51 - 75	> 500
76 - 100	



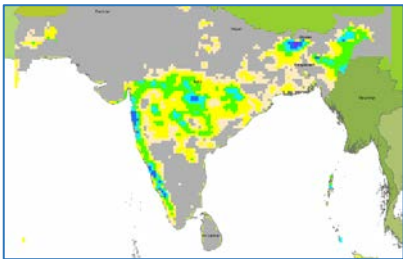
South Asia regional flood modeling

- Enables flood early warning and forecasting to help decision makers
 - *Combines VIC + CaMa-Flood model to map inundation extent with advance prediction over 10days*

Real-time satellite observation/Ensemble forecast

↓ Rainfall, temperature, wind

VIC model

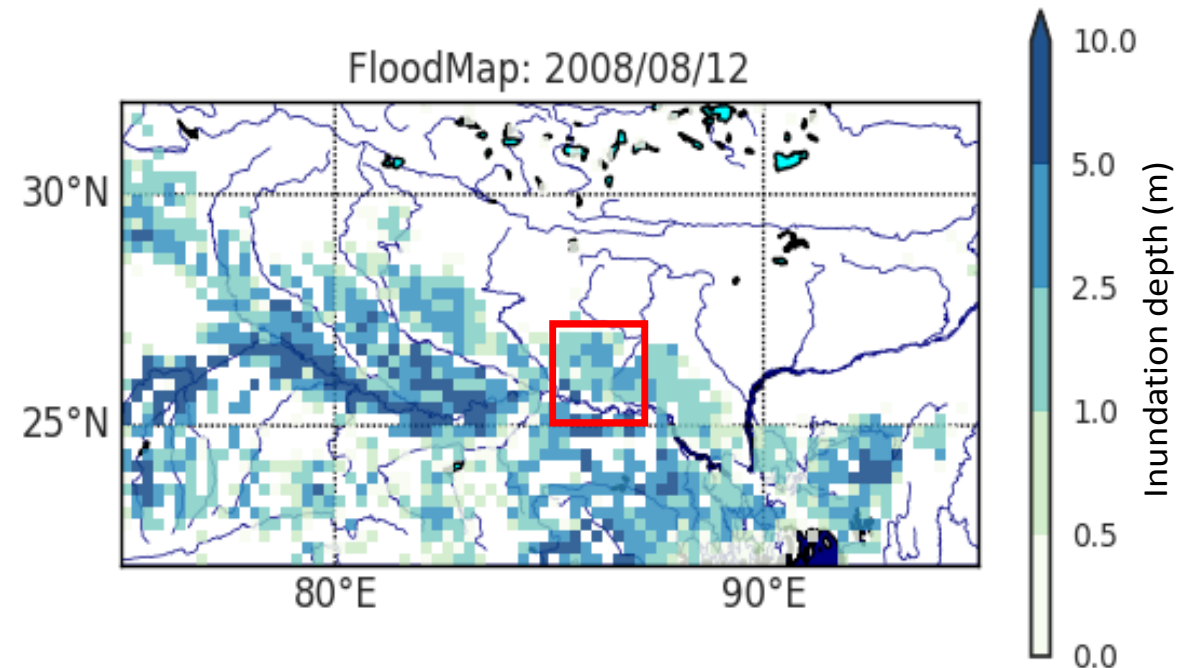


↓ Runoff, grid-based

CaMa-Flood Model

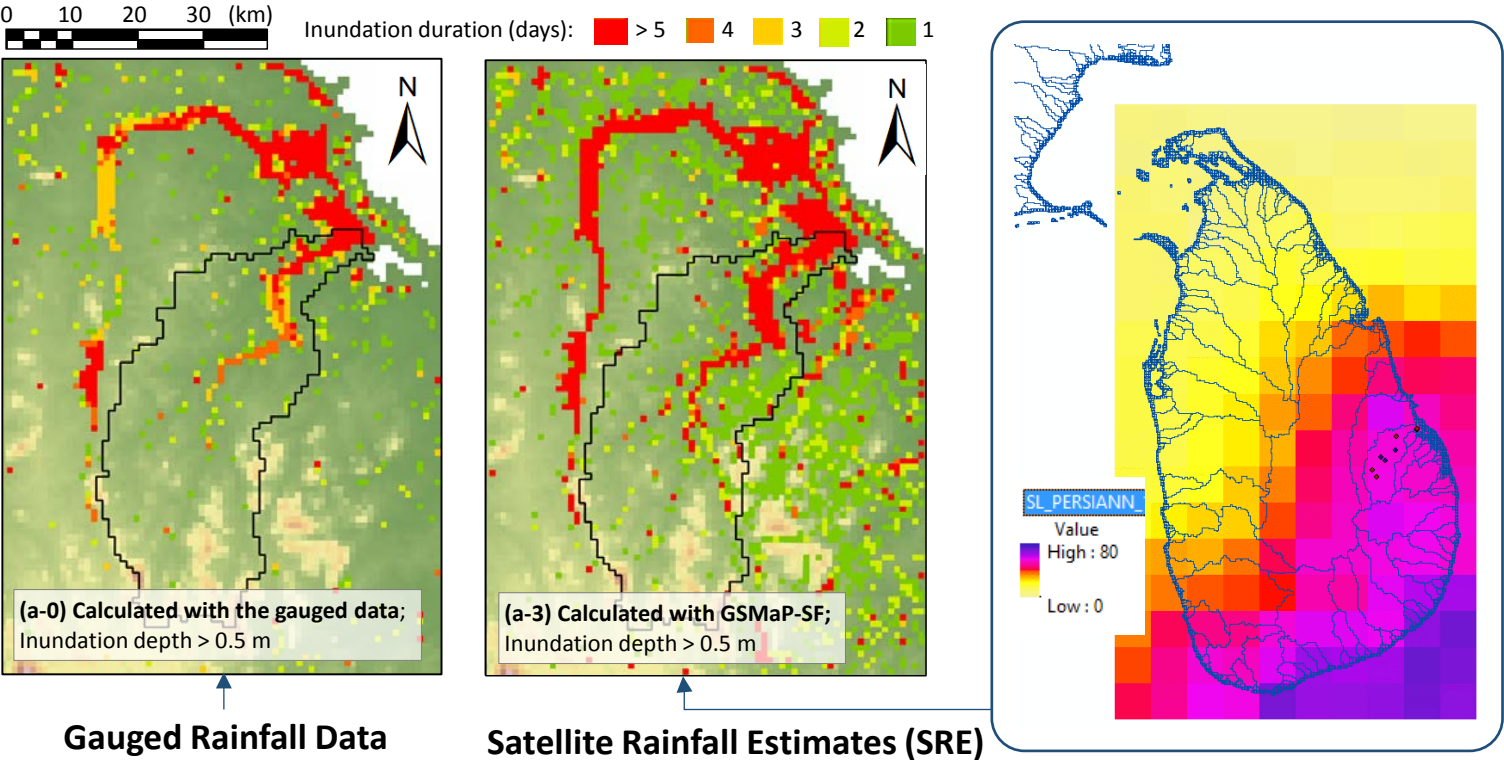
↓ River discharge, flood inundation extent

Ganges basin – Flood Inundation Depth map

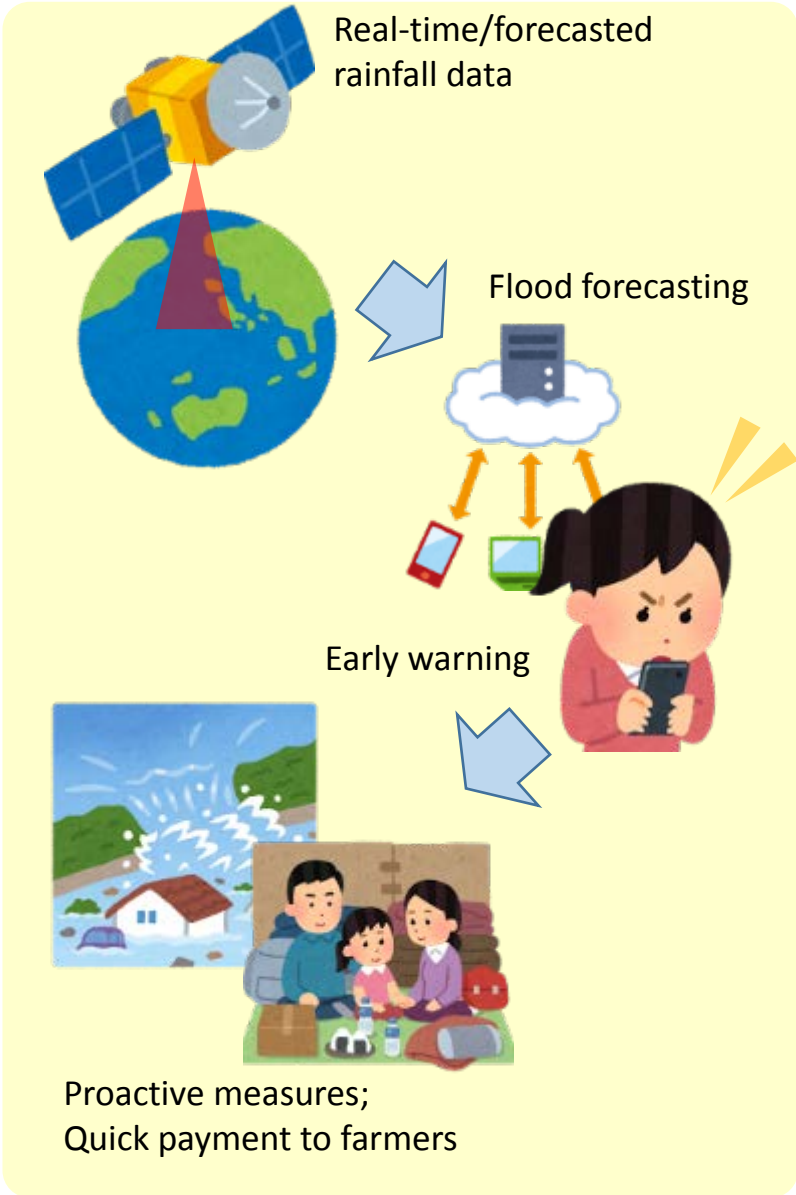


Application of SRE and Flood Early Warning

Especially in area where in-situ observation are limited or poorly measured, SRE would provide opportunity to quickly predict flood situation for better decision making.



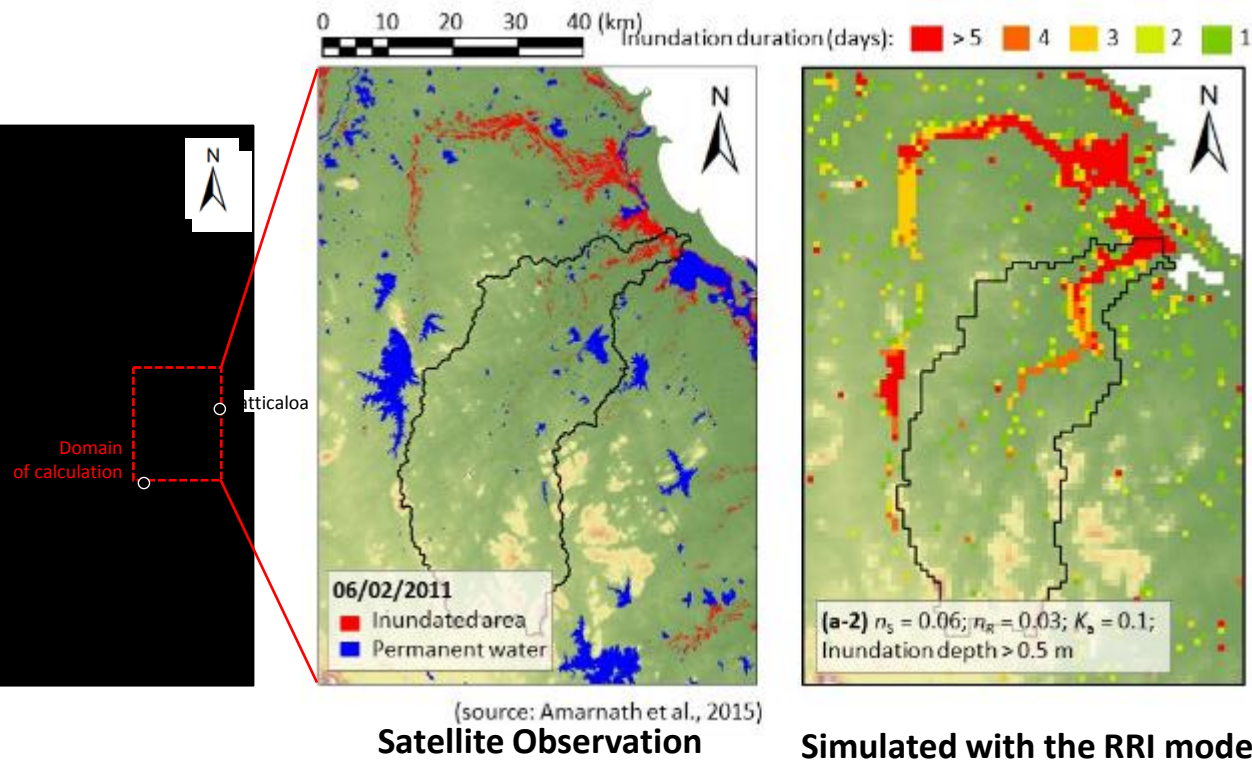
Yoshimoto, S.; Amarnath, G., 2017, Applications of satellite-based rainfall estimates in flood inundation modeling—A case study in Mundeni Aru River Basin, Sri Lanka. *Remote Sens.* **9**, 998.



Flood Inundation Extent Modelling for Simulation

Simulated extents of flood inundation by the models:

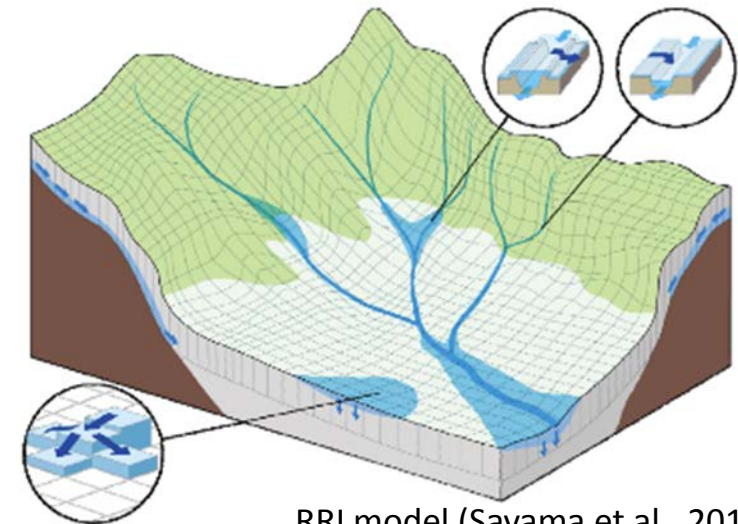
- Able to complement discrete-time results of satellite images (and also in cloudy periods);
- Applicable to hazard prediction & vulnerability evaluation;
- Able to assist NRT simulation for early alert framework, even in poorly gauged basins.



The RRI model: Numerical model for simulation of two-dimensional flood inundation distribution which was developed by ICHARM

Merit of the RRI model

- 1) Combination of slope flow and channel discharge: this helps to apply to areas which have hills and flood plains.
- 2) Free of charge; this could help decision making in developing countries.




RRI model (Sayama et al., 2012)

Rapid emergency response to 2017 flood in Sri Lanka

Fine-scale flood-risk products mapped using satellite datasets.

Maps have been provided online and to governmental agencies and aiding-NGO staffs.

Mapping Inundation extent for Gin Ganga and Galle in Western Province (Sri Lanka) using CSA RADARSAT-2 Satellite Data (29 May 2017)



Due to heavy rains in past few days, landslides and floods in Sri Lanka killed 151 people, 111 people still missing, displacing 100,000 and directly affecting 500,000 people across many districts according to the initial estimates by state-run Disaster Management Center.

International Disaster Charter was activated by Disaster Management Centre (DMC) and coordinated by International Water Management Institute (IWMI)/CGIAR. The first satellite image obtained on 28-05-2017 by German Aerospace Centre (DLR) showed vast areas of standing flood waters along the Southern and South-Western Provinces. Initial estimates from satellite images indicate that Matara (49.3) and Kalutara with 31.6 km² flooded area, are the worst affected districts followed by Galle (20.2 km²), Rathnapura (14.9 km²), Colombo (5.6 km²) and Gampaha (4.5 km²). Detailed Divisional Secretariat wise flood affected area for these six districts are given in the attached excel file. Kalutara is reeling under worst flood since 2003. Residents in affected pockets are reluctant to move away from flooded homes fearing safety of their belongings for potential theft.

Legend

- Satellite Image : RADARSAT-2
29 May 2017
- SL GND
- SL DSD
- River
- Flood extent (29 May 2017)

29 May 2017 | FL-2017-0001-SL | Version 1

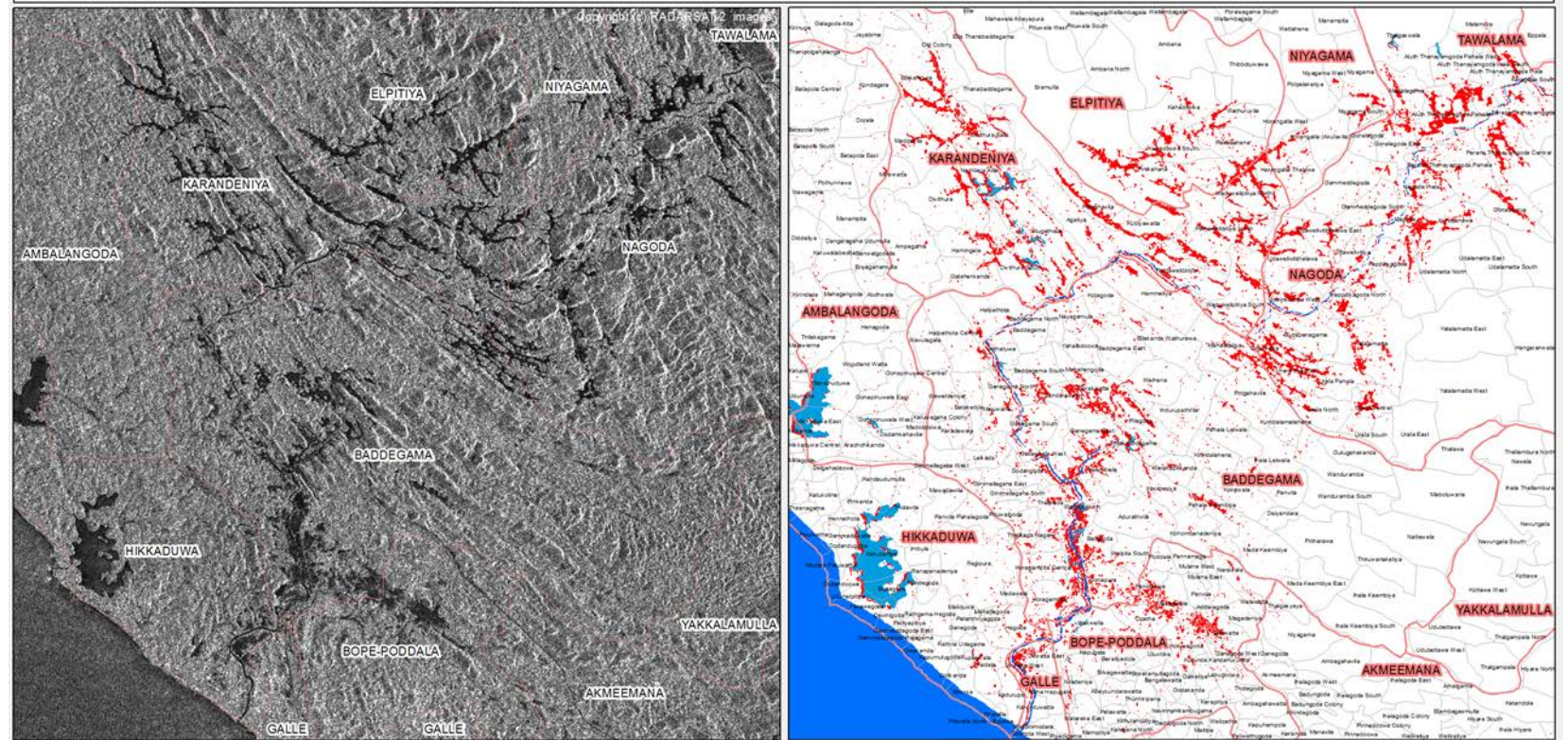
Map Prepared by
IWMI
International Water Management Institute

Data Provider
CSA ASC
Research Program on Water, Land and Ecosystems
CGIAR

UN-SPIDER
UNITED NATIONS Office for Outer Space Affairs

The analysis excluded permanent water bodies including reservoir, tanks and ponds and this reflects only the inundation extent. Please note the surface water extent mapped has not yet been validated in the field.

The depiction and use of boundaries, geographic names and related data shown in these maps are based on the sources they have been drawn from and quoted. These are neither error-free nor do they imply official endorsement or the position of IWMI.



Available also in the IWMI website

IWMI
International Water Management Institute

ABOUT | ISSUES | REGIONS | RESEARCH | PUBLICATIONS | RESOURCES | NEWS

30
May 17

IWMI responds once again to extreme weather in Sri Lanka

Sri Lanka faces another episode of flooding and landslides, as the southwest monsoons continue to trigger extreme weather in parts of the country. IWMI together with the Disaster Management Centre of Sri Lanka (DMC-SL) have activated their disaster charter with Sentinel Asia (as of May 26). Within this framework, the Institute has been providing satellite-based high-resolution maps of the affected regions to the DMC and military to assist with rescue missions and further assessments. IWMI's participation forms part of the CGIAR Research Program on Water, Land and Ecosystems (WLE), supported by the CGIAR Fund.



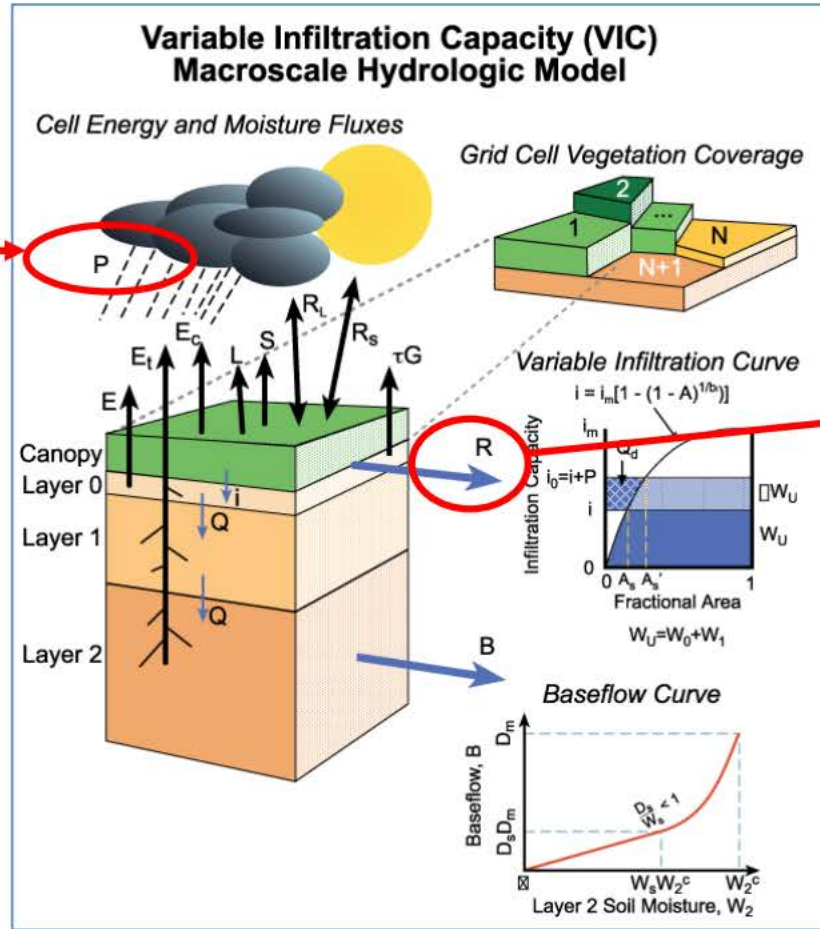
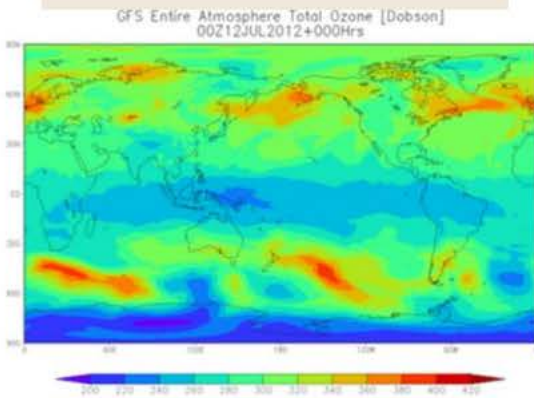
Boat provided by the Disaster Management Centre (DMC) being used to rescue people around Kalutara

Drought forecasting and early warning (SADEWS)

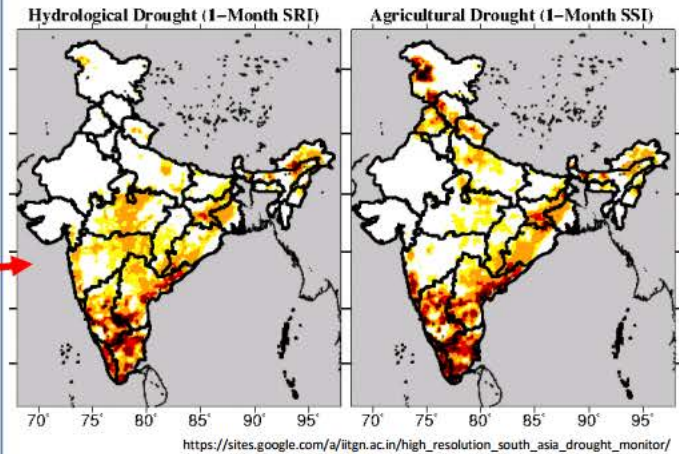
Near-real-time rainfall estimate



Rainfall forecast by GCM



SRI: Hydrological drought severity
SSI: Agricultural drought severity



Forecasting impact on agriculture

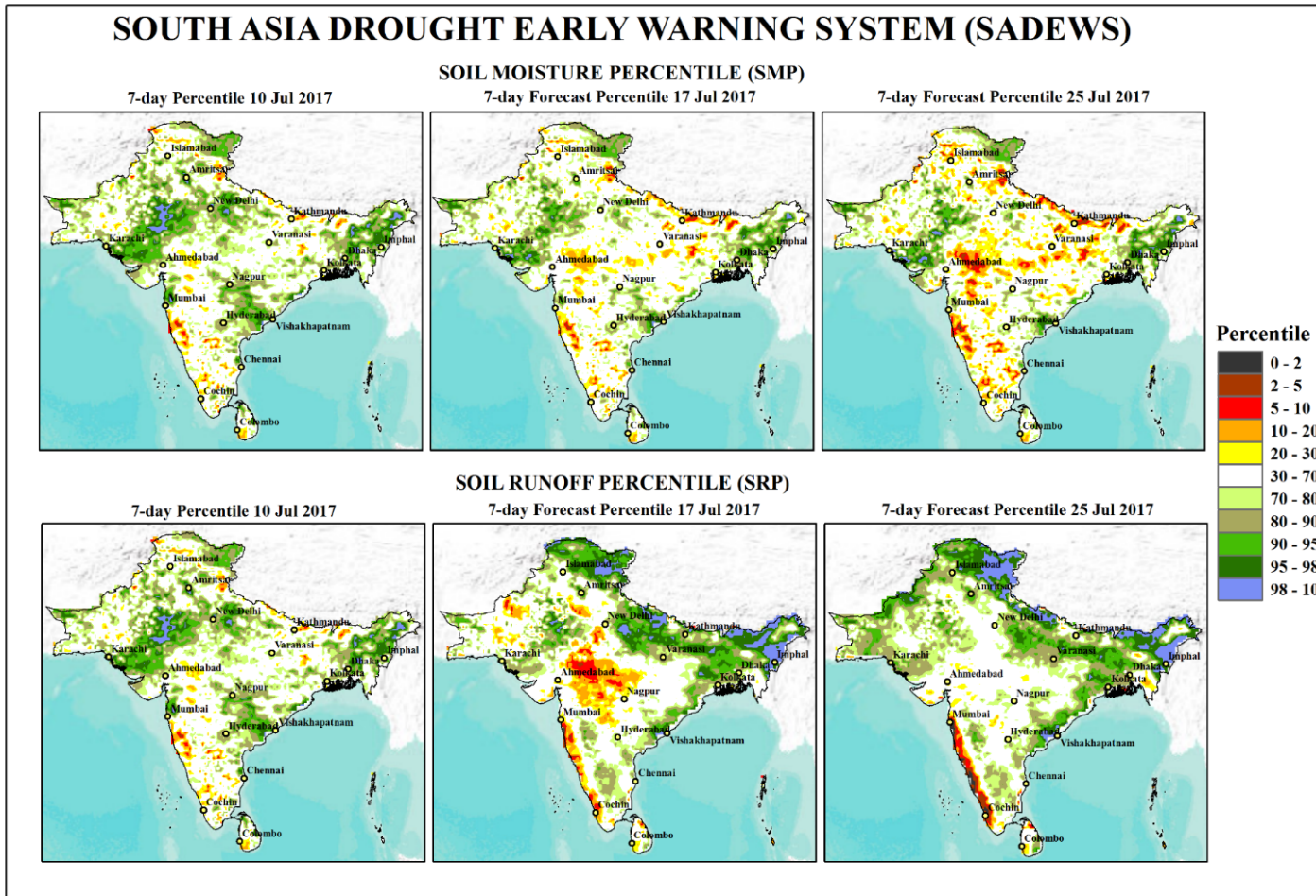


South Asia Drought Early Warning System (SADEWS)

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.

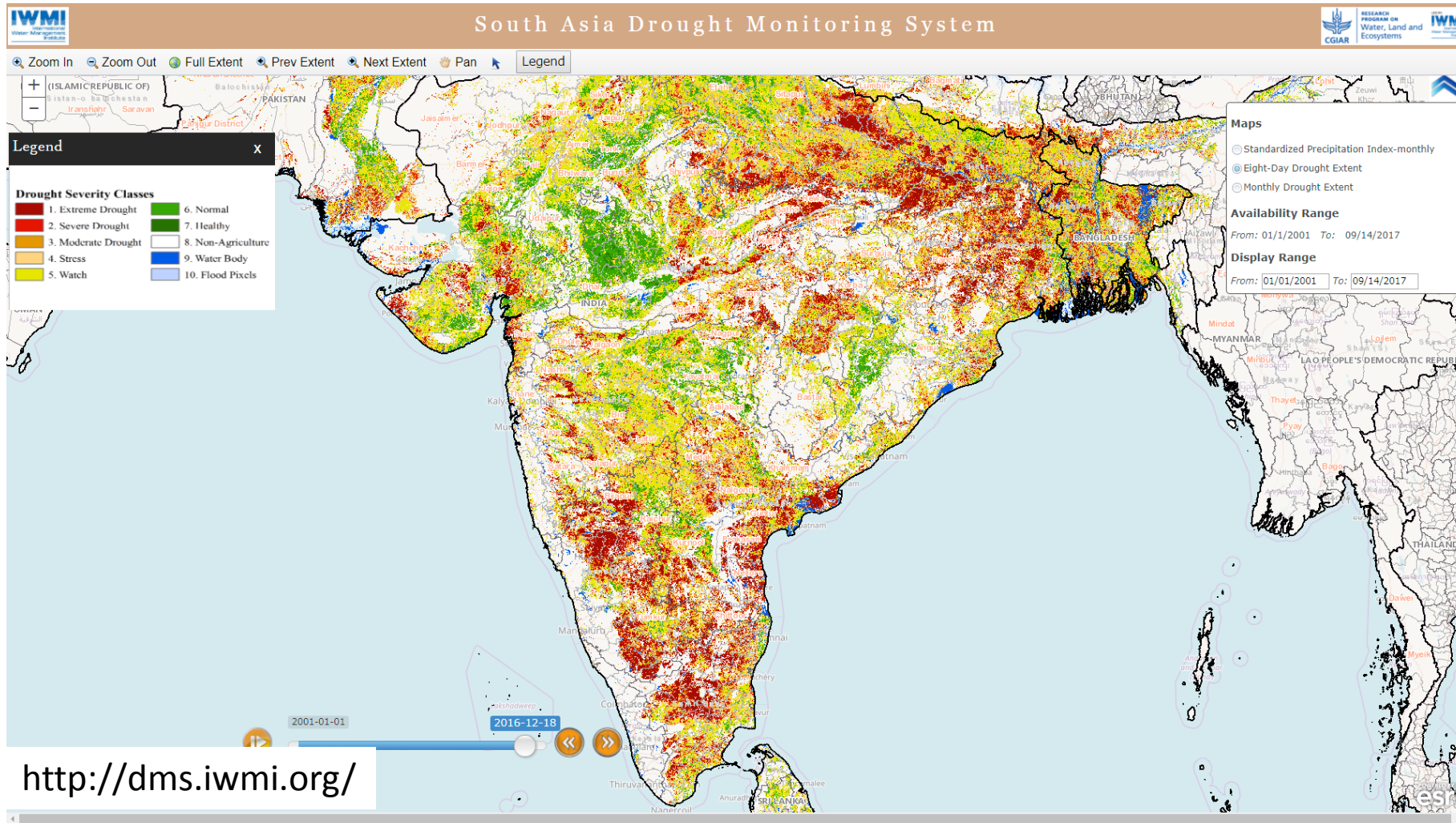
Drought Forecast Outlook:

- 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).

Disclaimer: The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the International Water Management Institute (IWMI) and its partners concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The views expressed in this information product are those of the author(s) and do not necessarily reflect the views or policies of IWMI.

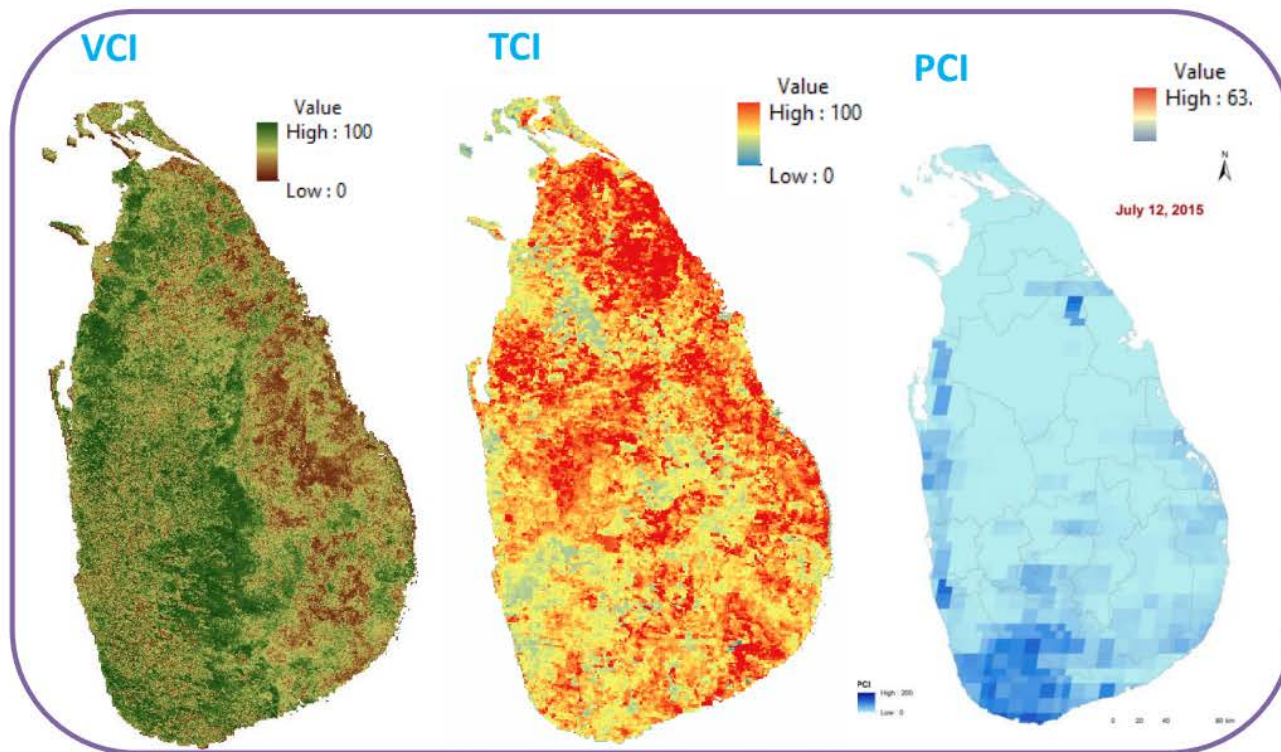
South Asia Drought Monitor System (SADMS)



SADMS provides customized tools and models that use satellite technology to accurately and scientifically monitor and plan for droughts. SADMS supports AWM agencies in the region.



Integrated drought severity index (IDSI)

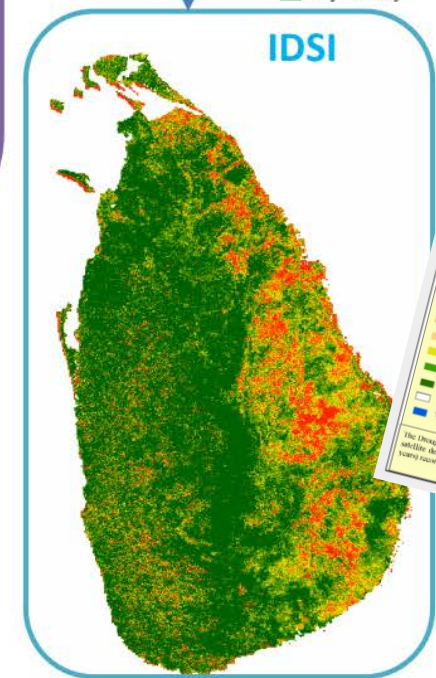


VCI – Vegetation Condition Index; TCI – Temperature condition Index; PCI – Precipitation condition Index; IDSI – Integrated Drought Severity index

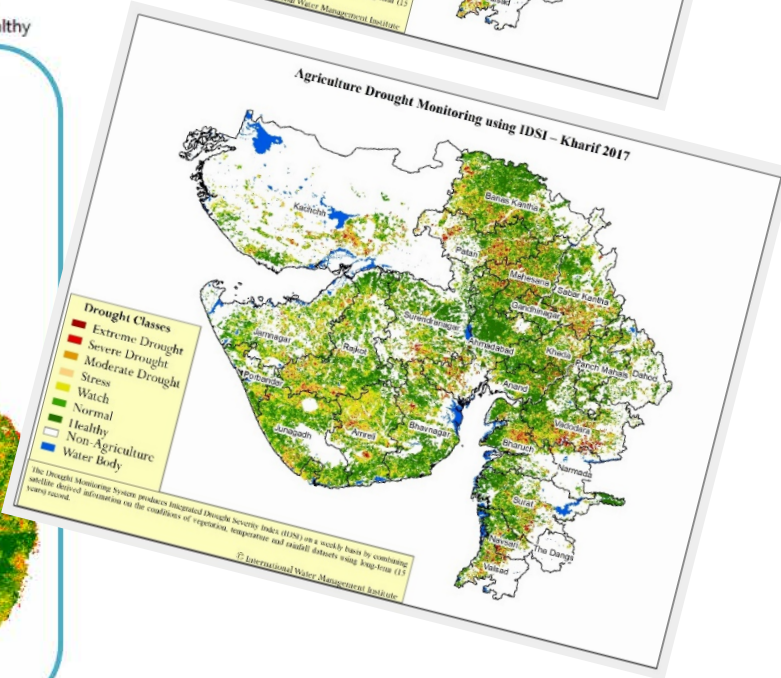
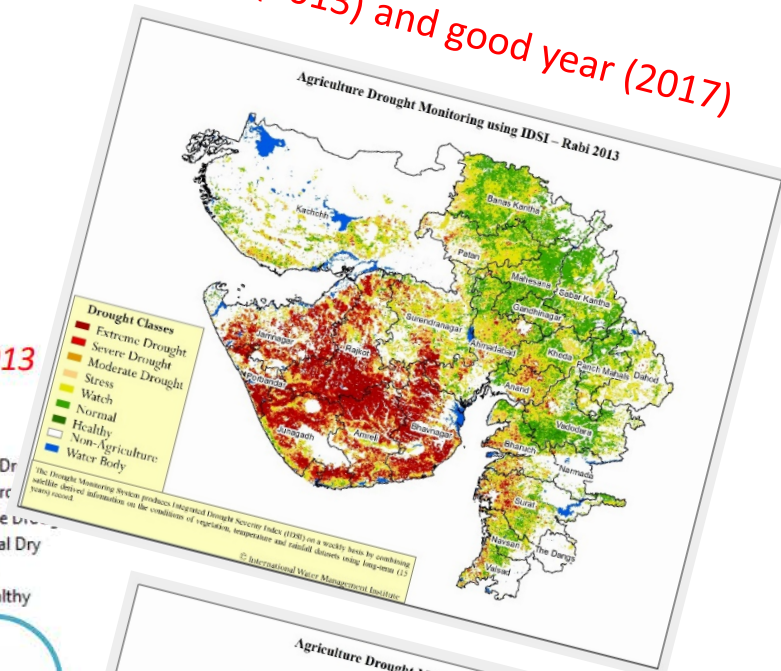
$$IDSI_{ijk} = \left[L * VCI_{ijk} * \left\{ c + \frac{1}{(L*(VCI_{ijk}+TCI_{ijk}+PCI_{ijk}+c))} * (TCI_{ijk} + PCI_{ijk}) \right\} \right]$$

Where, $IDSI_{ijk}$, VCI_{ijk} , TCI_{ijk} and PCI_{ijk} are IDSI, VCI, TCI and PCI value for pixel i in composite j of year k . The IDSI value ranges between 0 to 100; L is the normalization factor to keep the output value in expected range and c is a constant to avoid null in denominator. The values close to 0 reveals extreme drought situation as vegetation is under stress, precipitation is very low and temperature is very high. Likewise, the values closer to 100 reveals normal situation as

1st Week – September 2013



Bad (2013) and good year (2017)



- Extrem Drc
- Severe Drc
- Moderate Drc
- Abnormal Dry
- Healthy
- Very Healthy

- Extreme Drought
- Severe Drought
- Moderate Drought
- Stress
- Watch
- Normal
- Healthy
- Non-Agriculture
- Water Body

Investing in DRR and Resilience



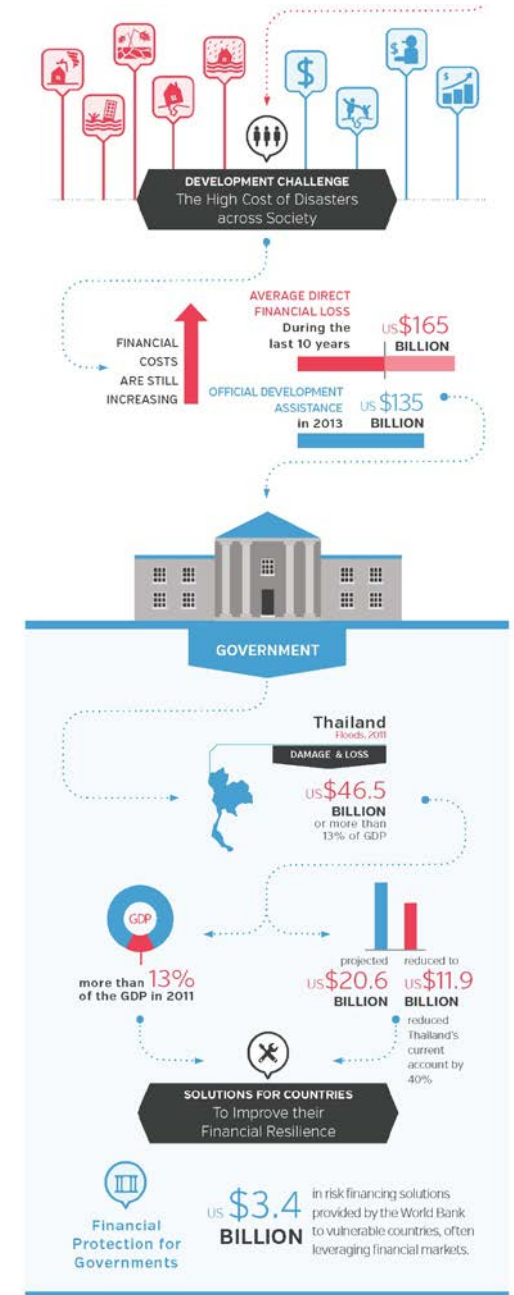
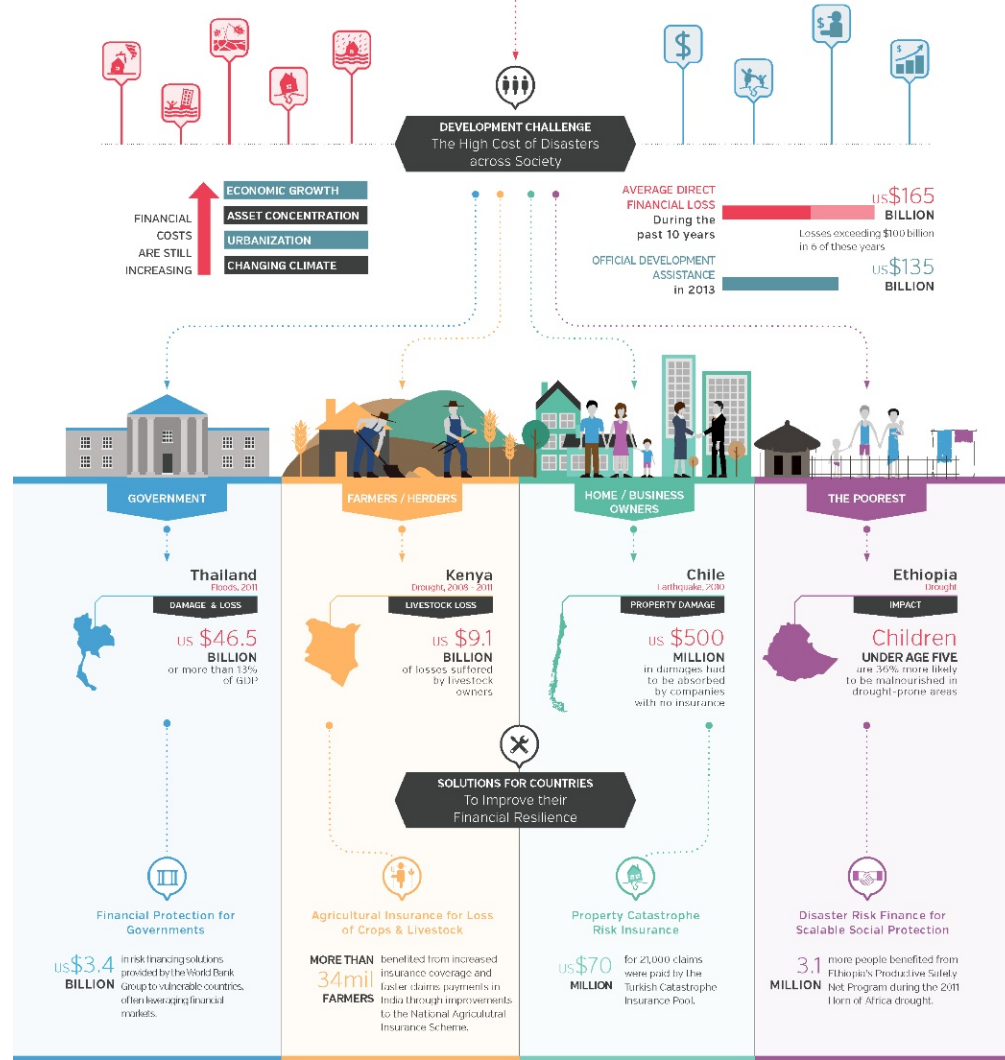
What need to be done?

- Helping developing countries manage the cost of disaster and climate shocks.
- Support governments to become more effective risk managers, rather than emergency borrowers, protecting their fiscal balance and the welfare of households and businesses.
- Support the development of comprehensive financial protection strategies, develops innovative policies and instruments, and structures insurance programs.

- Asia is at high risk of catastrophic disaster and climate shocks that cause damage and erode welfare and economic gains.
- Financial protection strategies have been recognized by countries and their development partners as important tools to protect countries from these effects and to thereby support them in reducing poverty and increasing shared prosperity.

DISASTER RISK FINANCE: Protecting Livelihoods and Development

ENDING POVERTY AND BOOSTING SHARED PROSPERITY



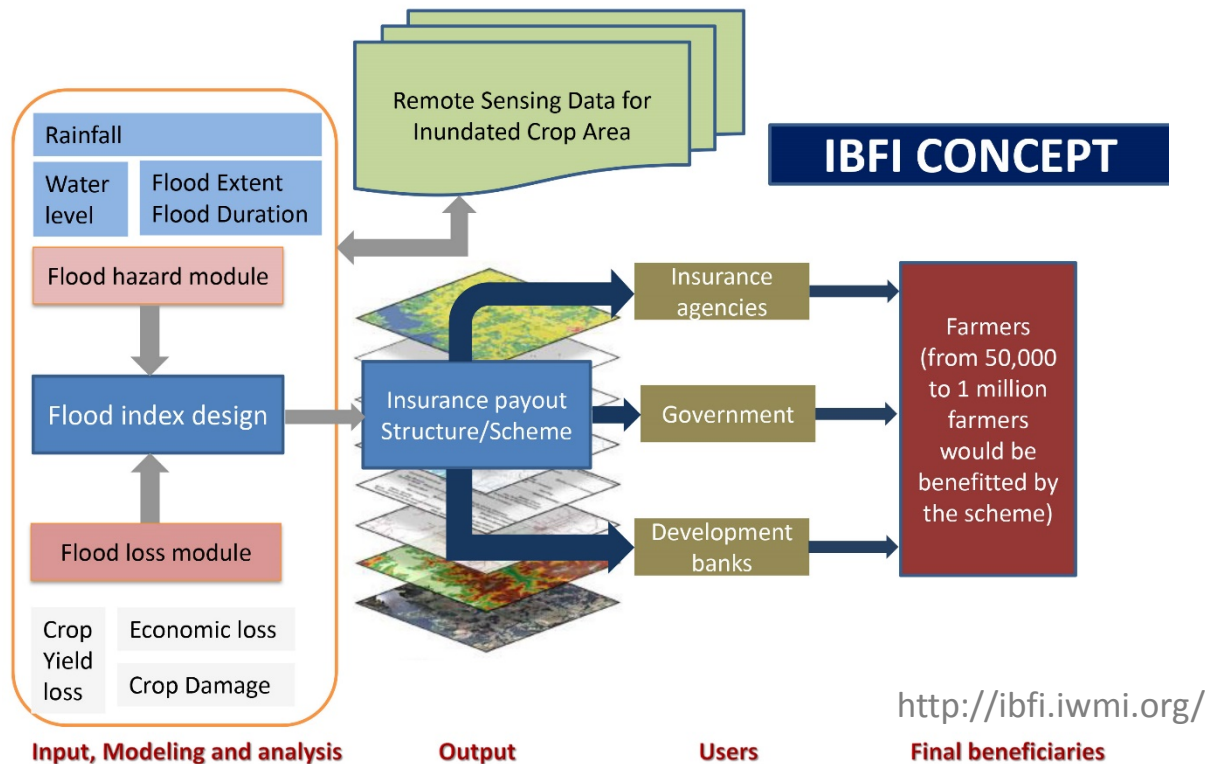
Index-based Flood Insurance (IBFI)



RESEARCH PROGRAM ON
Climate Change,
Agriculture and
Food Security



IBFI is an innovative approach to developing effective payout schemes for low-income, flood-prone communities. It enables speedy compensation payouts to farmers, based on flood modeling and satellite image analysis techniques.



Shri Radha Mohan Singh, Union Minister for Agriculture & Farmers Welfare, India distributing dummy check on 22 Feb 2018 to eligible farmers

Expectations from Water-related hazard WG

- SA Secretariat would like to improve the WG which requires active cooperation from JPTM members mainly the NDMOs;
- To share best practices (Prevention, Preparedness, Response and Recovery) by NDMOs to SA members;
- To promote knowledge products and tools and possibly develop joint project case studies to promote implementation of SA Step3
 - Application of SRE and flood early warning including IFAS; GloFAS
 - Combining rapid response and flood damage assessment;
 - Drought monitoring and assessment using EO data;

SAS and Water-related hazard WG would like to have your feedback and suggestion. Kindly send email to Mr. Miyoshi Takanori miyoshi.takanori@jaxa.jp ;

Dr. Giriraj Amarnath a.giriraj@cgiar.org

Thank You



Nayabazaar, Morang