

# Managing Flood and Drought for Improved Risk Management Solution Using Space Technology

## IWMI's Research Program on Floods and Drought



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

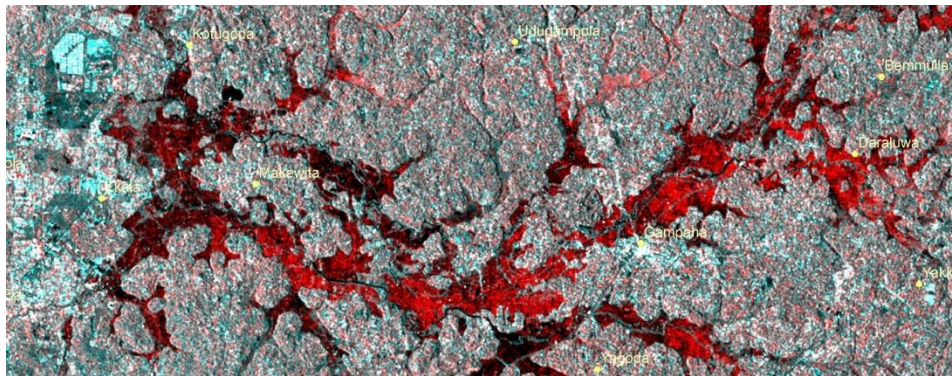
# Content

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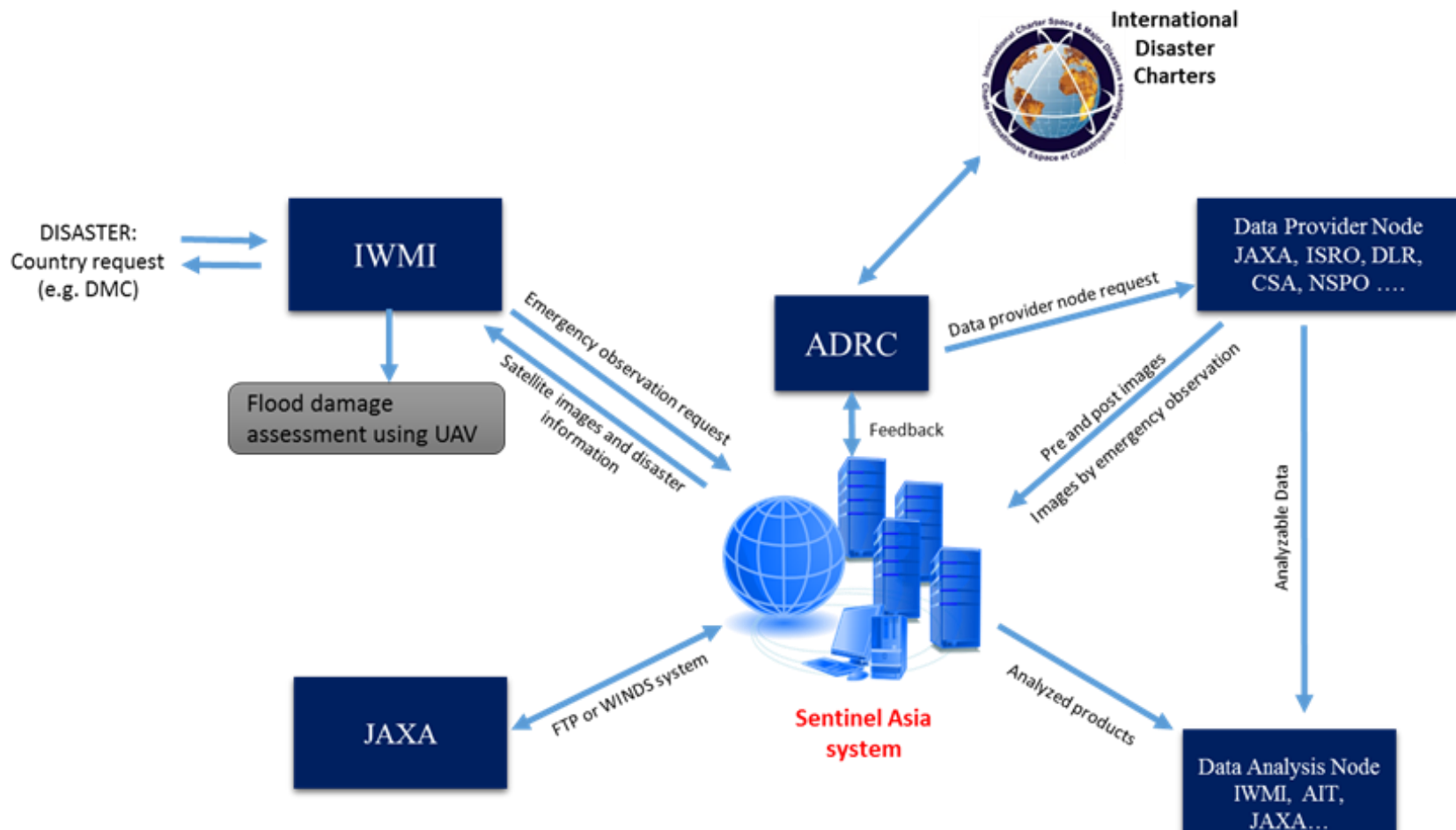
Drought Monitoring and Early Warning

# Sri Lanka Flood Monitoring



**Monitoring and Assessment of Flood Situation using IRS  
RISAT and DLR TerraSAR-X1 Satellite Imagery**

# How to get the data for Emergency flood monitoring





# 2015 FLOODS IN SRI LANKA MONITORED USING SATELLITE RAINFALL ESTIMATES

Satellite rainfall estimates from Global Precipitation Mission (GPM) and Tropical Rainfall Measuring Mission (TRMM) revealed extraordinary flooding in Sri Lanka caused by unusually strong monsoonal rainfall over the period 10 September - 30 September 2014.

The exceptional rainfall occurred mainly in the Southern, Northcentral and Uva Province of Sri Lanka. Massive flooding was reported in the districts of Kalutara, Ratnapura and in parts of Colombo, Galle and Matara. The accumulated rainfall was about 2 to 3 times as high as compared to the rainfall in the same period in 2014. For example, the southern provinces districts received an average accumulated rainfall of more than 100mm from 24 to 30 Sept. 2015 - compared to 75mm in 2014. At district level (Galle 198mm in 2015 vs. 121mm in 2014; Matara 142mm in 2015 vs. 78mm in 2014; Polonnaruwa 136mm in 2015 vs. 98mm in 2014).

From the public sources, at least 18,917 persons have been affected by the severe weather condition prevailing in the Southern Province for several days, the Disaster Management Center (DMC) said. The DMC was warned people living by the Gin Ganga to be vigilant on rising water levels, especially by-roads and low lands in the Galle District.

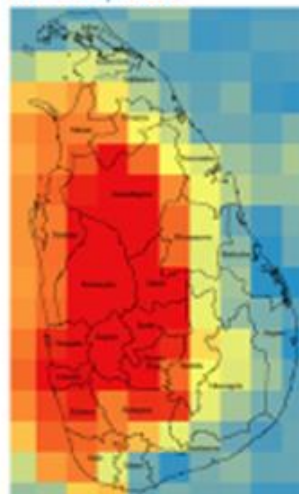
11-20 Sept 2014



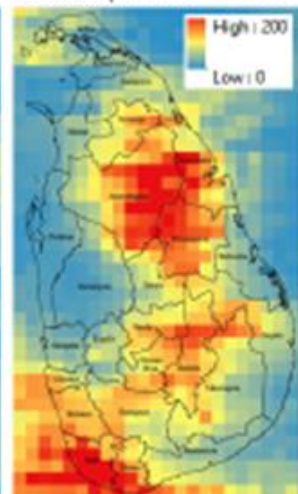
11-20 Sept 2015



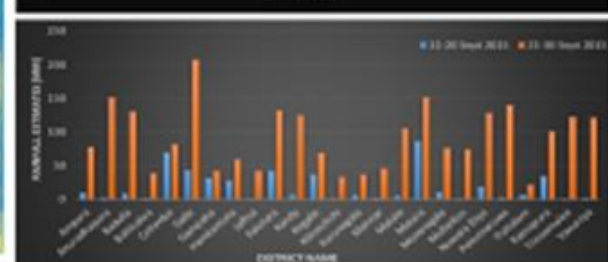
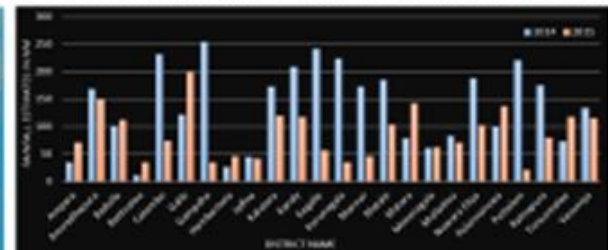
21-30 Sept 2014



21-30 Sept 2015



Accumulated rainfall Sept. (2014 and 2015) & Rainfall events from 11 - 30 Sept.



24 Sept 2015



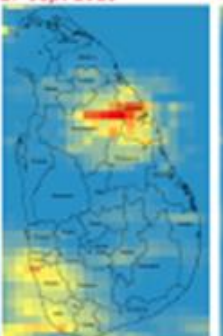
25 Sept 2015



26 Sept 2015



27 Sept 2015



28 Sept 2015



29 Sept 2015



30 Sept 2015



Map Prepared by  
 International Water  
 Management Institute (IWMI)



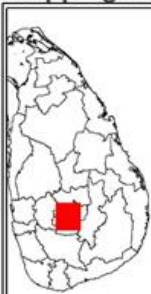
Data Source





# Mapping Flood Extent for Colombo, Gampaha and Kurunegala and its surrounding using RISAT - 1 Satellite imagery

21 May 2016 | FL-2016-0001-SL | Version 2.2



The recent low pressure system in Indian Ocean caused heavy rainfall across Sri Lanka since 14 May 2016 causing widespread flooding and landslide in as many as 19 districts, including around Colombo. Kelani Ganga is one of the main river basin in Sri Lanka which is currently experiencing large scale flooding and subsequent damage to property and livelihoods. Kelani basin received 350 mm of total rainfall within three days (15 to 17 May 2016). Regular monitoring of flood situation in North and Northwestern provinces with the support of International Disaster Charter and Sentinel Asia, allows rapid assessment of flood extent on a daily basis. The current flood images is from Indian Remote Sensing Satellite (IRS) from RISAT-1 dated 20th May 2016 to estimate areas where floods are progressing and declining. The information is being provided to Disaster Management Centre for relief and damage assessment.

The flood water has receded considerably in Kelani Ganga river compare to the report on 18th May 2016. As of today, the estimated inundated area is approximately 200sq km for Kelani Ganga but other river basins are also affected including Deduru Oya (353sq km) as the maximum inundation followed by Attanagalu Oya (165sq km) and Maha Oya and Karambalan Oya average inundation about 150sq km. In total the region of interest covering the basin is approximately 1,231.10sq km covering 12 river basins. As mentioned earlier, most of this standing water are noticed in abandoned croplands, banana cultivations and large scale devastation in household area as well as several roads have been disconnected restricting the movement of general population. Six to ten feet of flood waters were observed in some household localities causing untold damage to rural households and gardens/croplands. Area under banana cultivation and rubber plantations are also currently under standing water. The flood affected Grama Niladhari (GN) divisions includes: Kolonnawa GND – Wellampitiya, Kelanimulla, Gotatuwa, Udumulla North and Kaduwela – Walpola, Kaduwela, Mahadeniya, Rangala, Welivita, Malabe West, Pahala Bomiriya, Ihala Bomiriya) and for the Gampaha GN divisions - Gampaha, Biyagama, Dompe, Jaela, Diulapitiya based on the reports from DMC.

## Legend

Disaster Image : RISAT - 1 (ISRO)  
Date : 20 May, 2016

- Basin
- Division Map
- Cities/Town
- Streams

Map Prepared by:

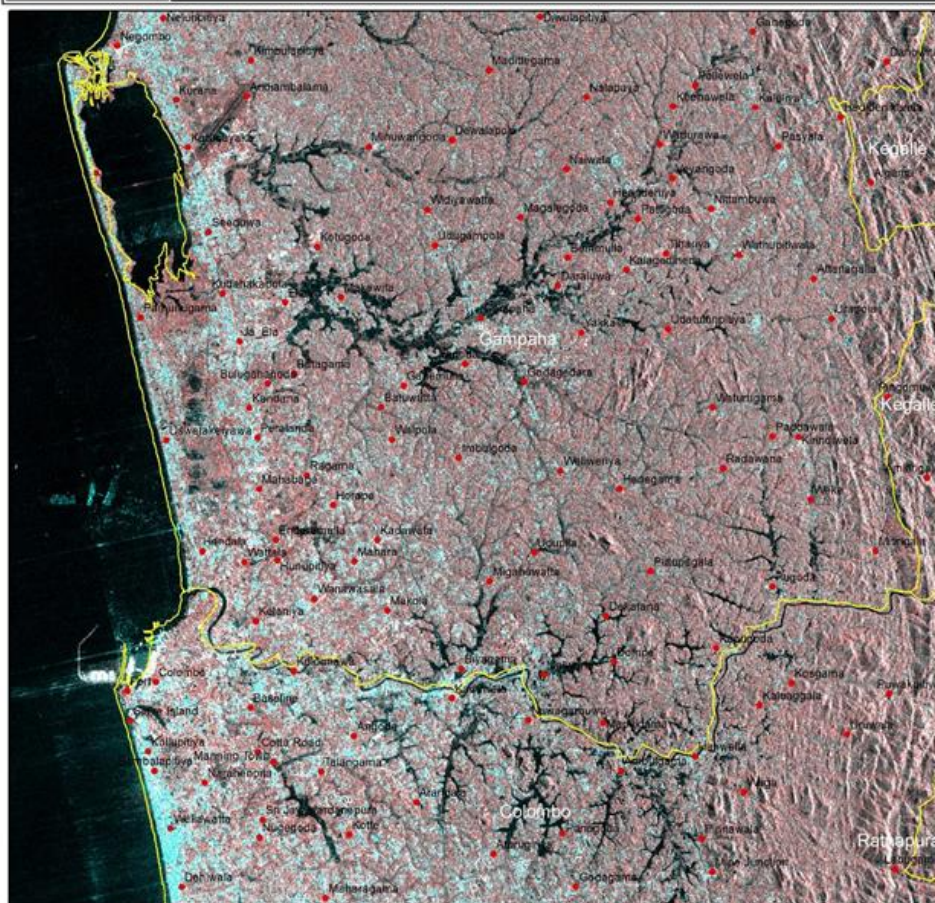


Data Provided by:



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.

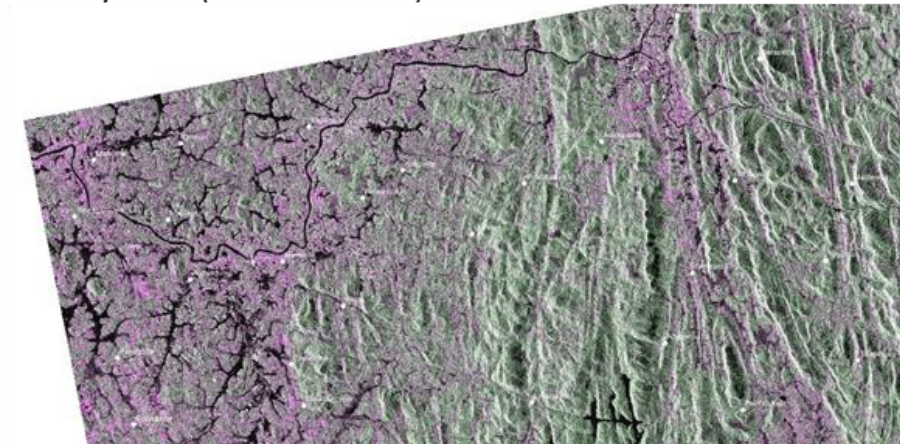
The depiction and use of boundaries, geographic names and related data shown in these maps are based on the sources they have been drawn from and quoted. These are neither error-free nor do they imply official endorsement or the position of IWMI.



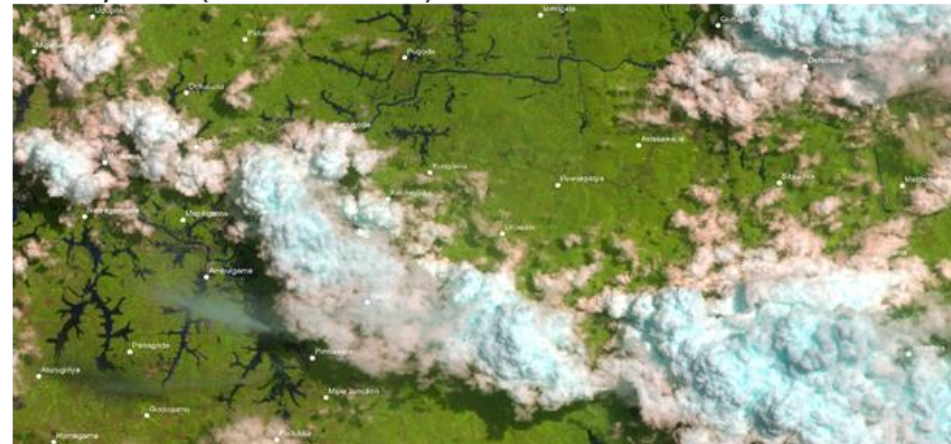


# Progressive Flood Mapping from Multisource remote sensing data from JAXA, IRS, USGS, DLR covering Colombo and parts of Gampaha Districts in Sri Lanka

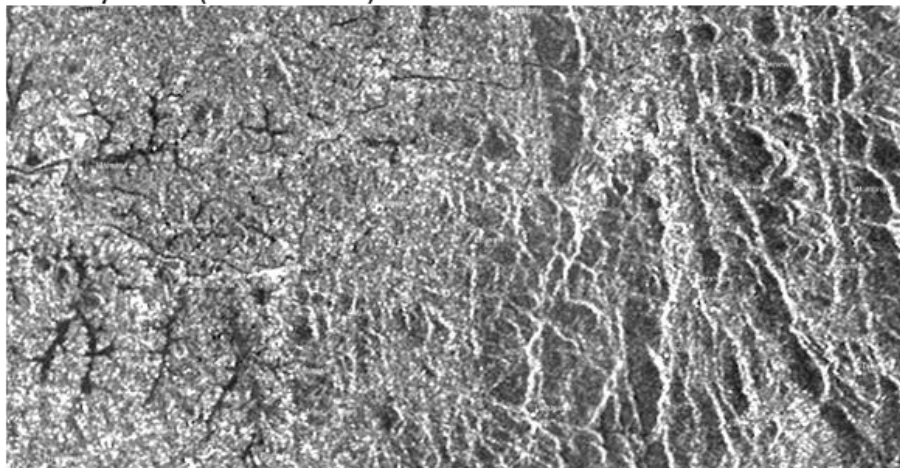
16 May 2016 (JAXA-2 ALOS-2)



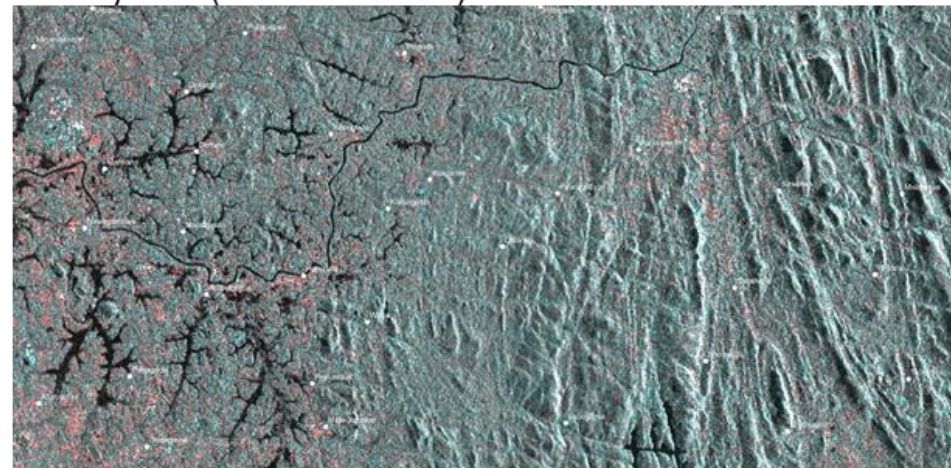
18 May 2016 (USGS Landsat 8)



18 May 2016 (IRS RISAT-1)



20 May 2016 (DLR TerraSAR-X1)

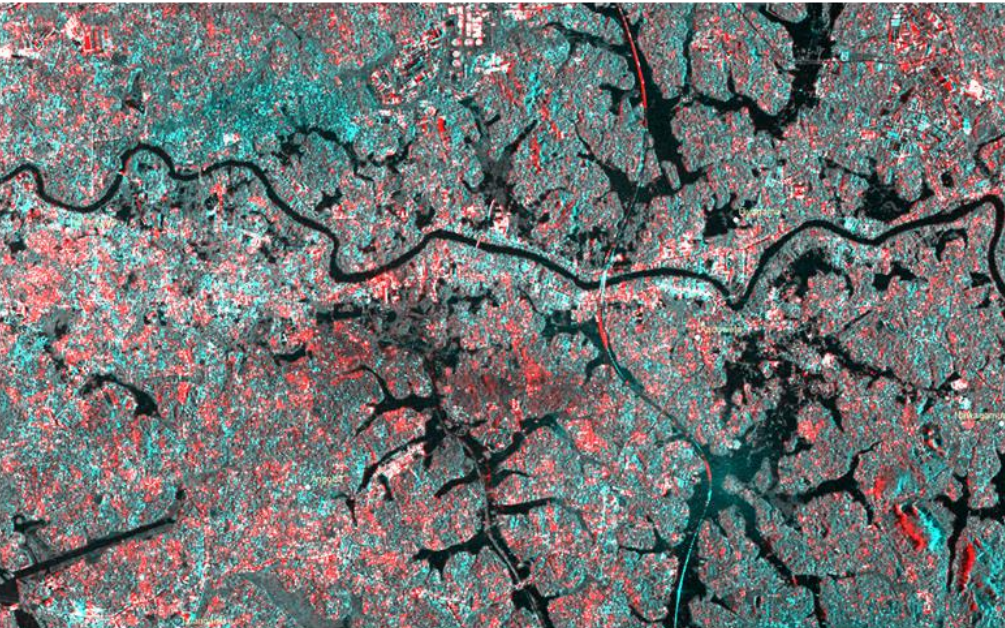


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[www.iwmi.org](http://www.iwmi.org)



# Current flood situation for major flood rivers and administrative units based on IRS RISAT and DLR TerraSAR-X1 Images (20<sup>th</sup> and 21<sup>st</sup> May 2016)



*Note: Fused images of two different dates (20<sup>th</sup> May and 21<sup>st</sup> May 2016) to determine flood receding areas. Black areas denotes areas in both the images are flooded and the light grey explains the withdrawal of standing waters along the Kelani Ganga river*

Statistics on basin wise flood affected areas for the AOI satellite imagery

Basin Name	Basin Area	Flood Affected area in sq.km
Attanagalu Oya	1087.81	165.319
Deduru Oya	2772.89	353.496
Kelani Ganga	2341.53	168.119
Rathambala Oya	556.21	59.003
Kalu Ganga	3079.08	100.707
Karsmbalan Oya	779.80	153.995
Maha Oya	1709.14	186.066
Total flood affected area		1186.70

Statistics on district wise flood affected areas for the AOI satellite imagery

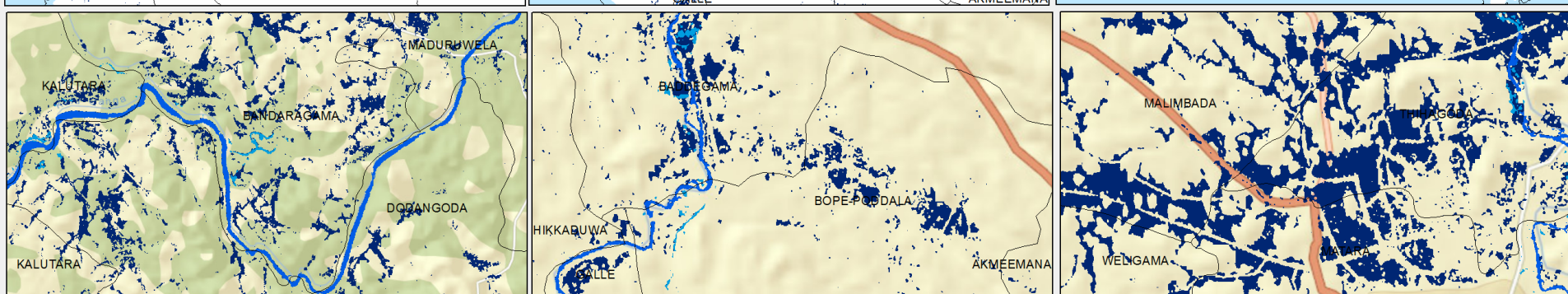
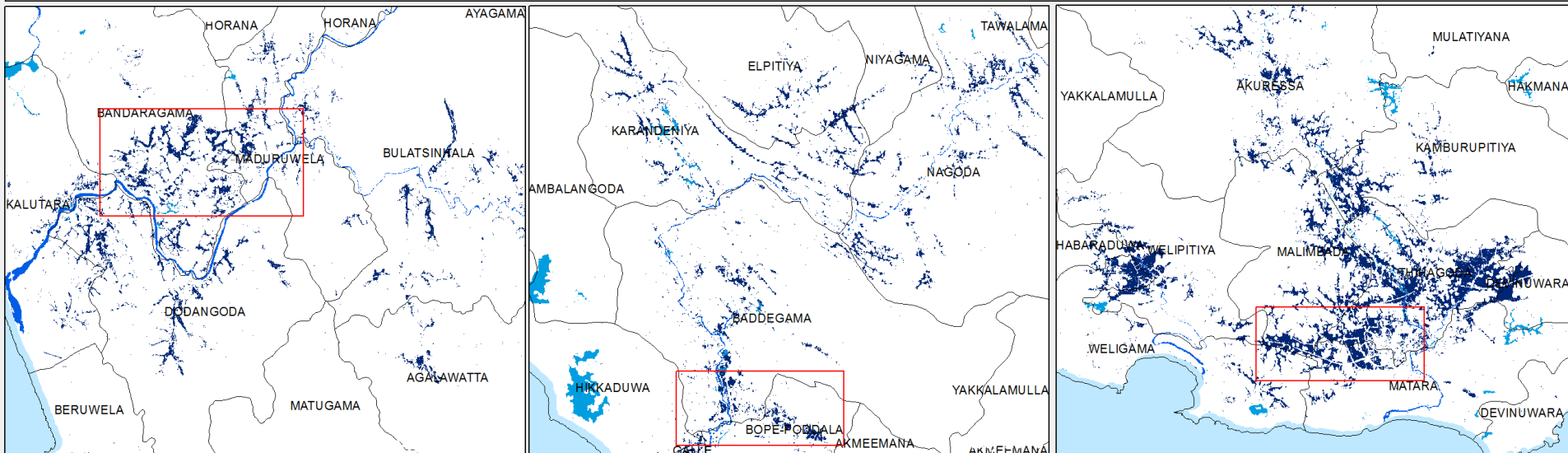
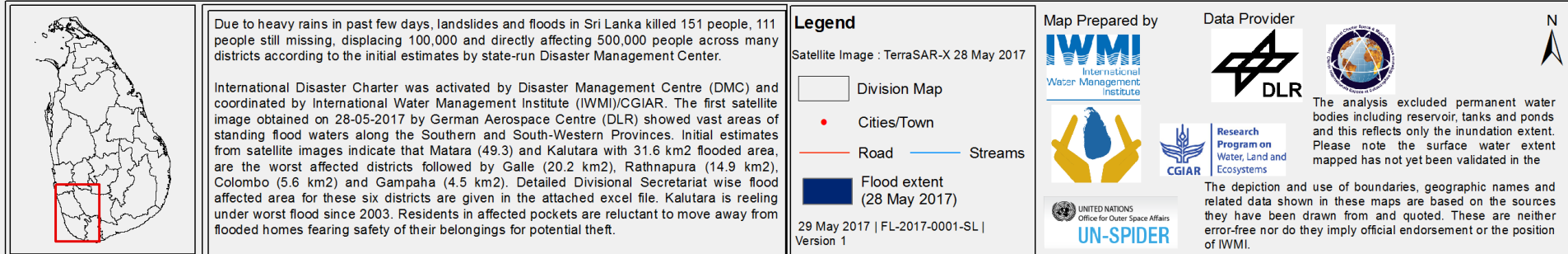
Basin Name	Flood Affected area in sq.km
Kurunegala	552.97
Gampaha	218.12
Puttalam	160.29
Colombo	94.53
Kegalle	83.21
Kalutara	79.13





# Flood Monitoring -2017

## Mapping Inundation extent for Southern and parts of Western and Sabaragamuwa Provinces in Sri Lanka using TerraSAR-X Satellite Data



# Flood Monitoring -2017

## Closer view of Matara town and its surroundings in Southern Province (Sri Lanka) using ESA Sentinel-2 satellite data (28May2017)



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 km<sup>2</sup> flooded area, are the worst affected districts followed by Galle (20.2 km<sup>2</sup>), Rathnapura (14.9 km<sup>2</sup>), Colombo (5.6 km<sup>2</sup>) and Gampaha (4.5 km<sup>2</sup>). 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 : ESA Sentinel-2  
28 May 2017

- Cities/Town
- Road
- SL DSD
- River

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

Map Prepared by

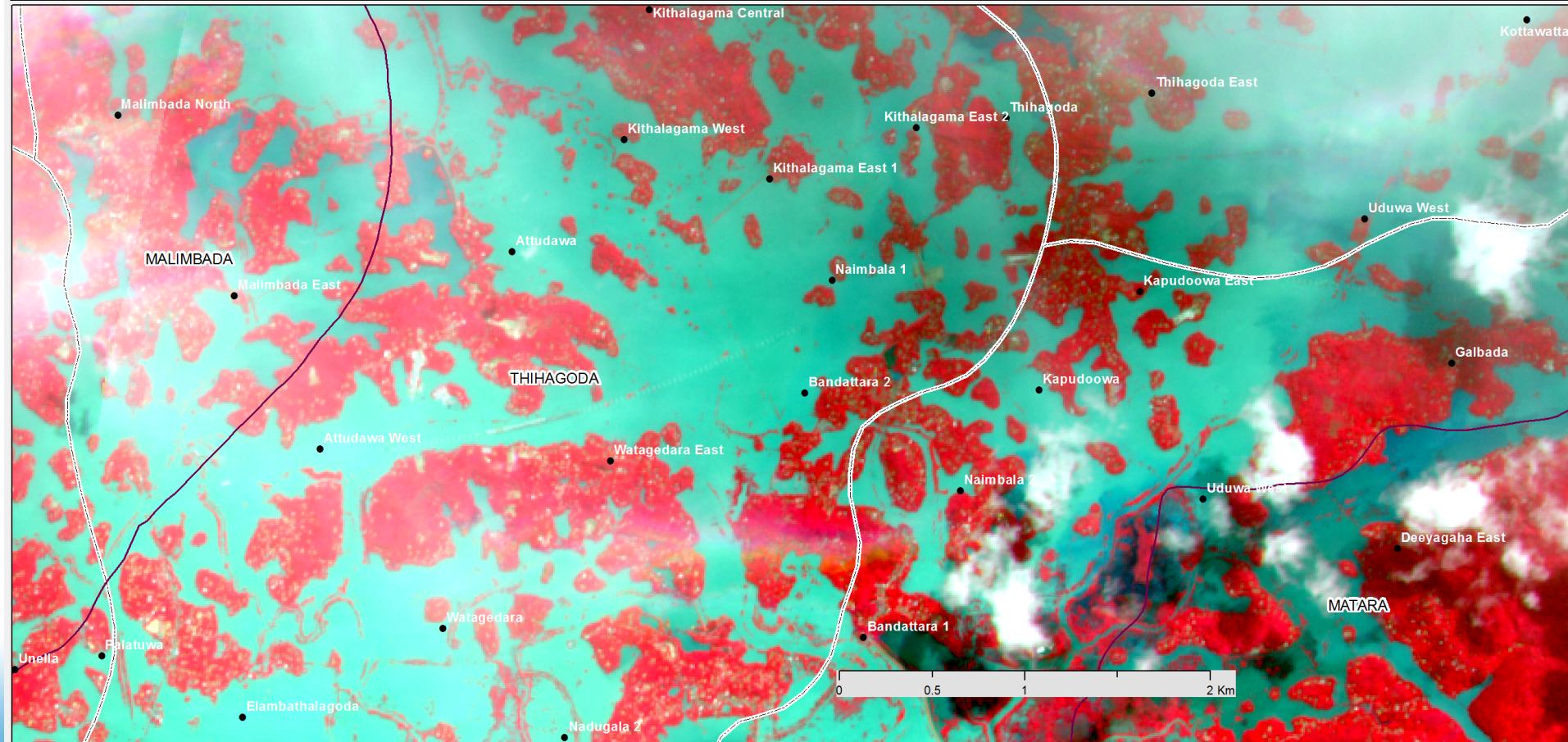


Data Provider

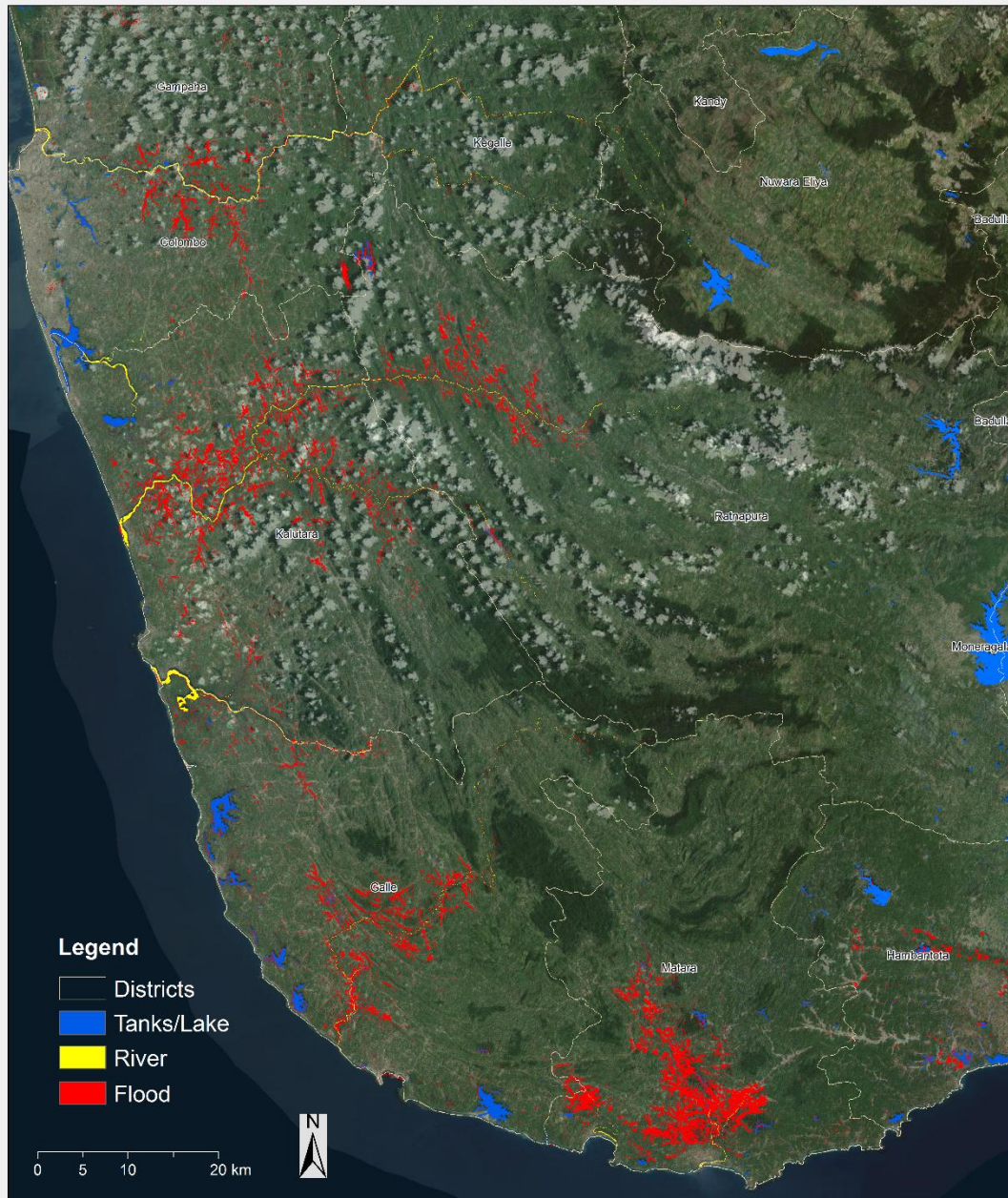


The analysis excluded permanent water bodies including reservoir, tanks and ponds and this reflects only the inundation extent. Please note the surface water extent mapped has not yet been validated in the

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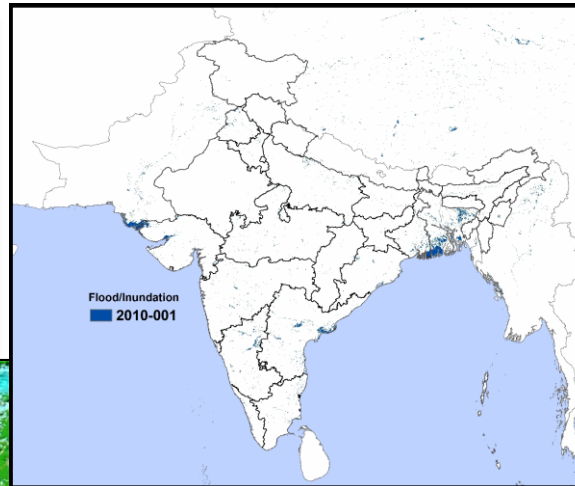


## Total Flood extent 2017

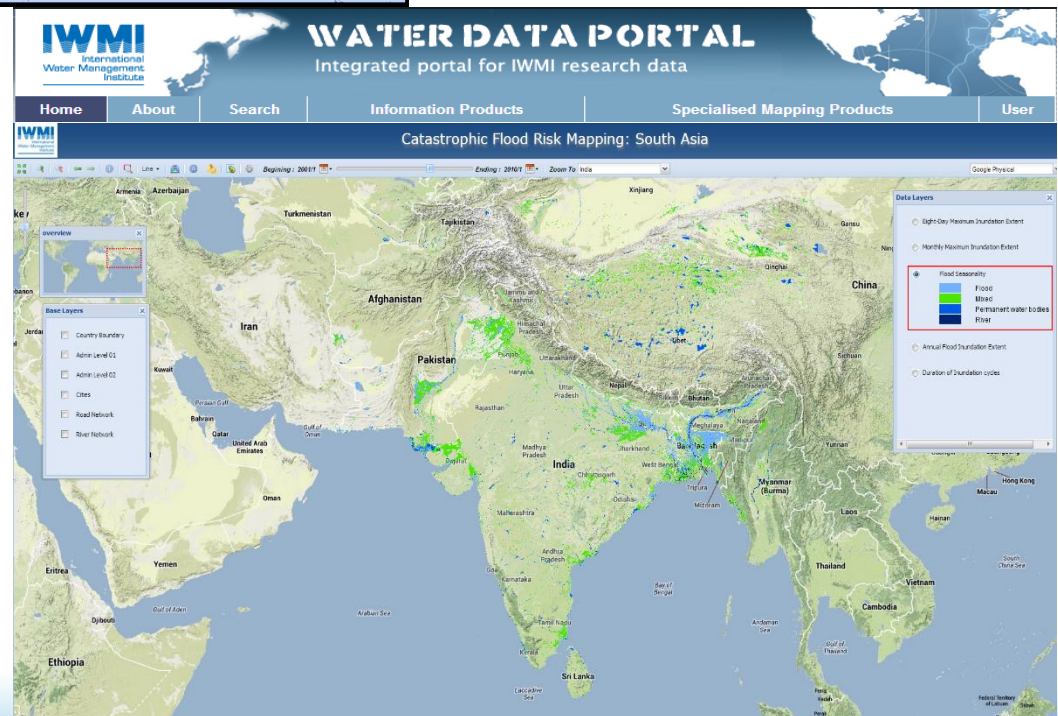
# Historical Flood Mapping



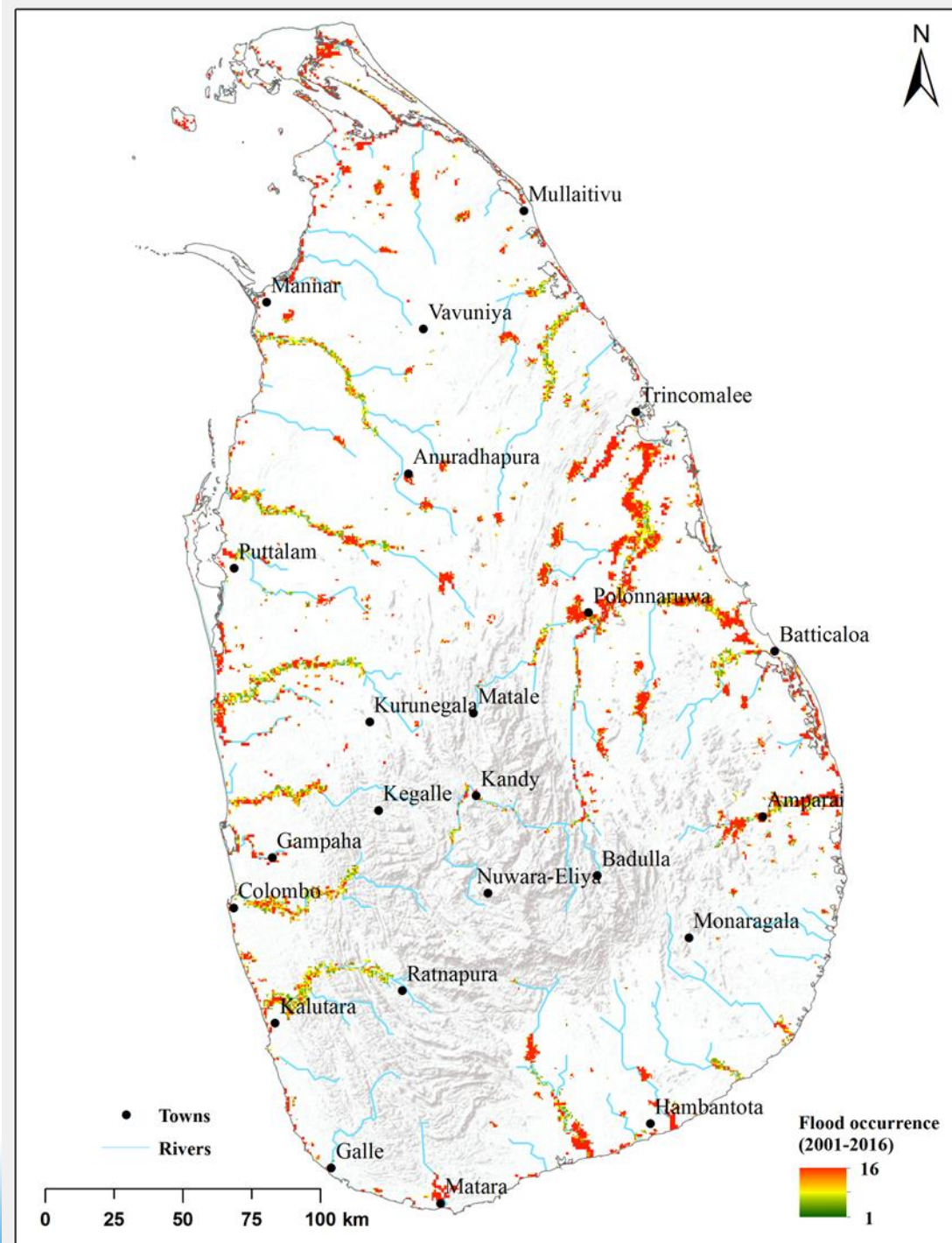
# REGIONAL FLOOD RISK MAPPING - SA and SEA



- Mapping algorithm based on MODIS data
- 8-days maps of inundation extent
- Annual maps of maximum inundation
- Inter-annual variation of regional flooding extent

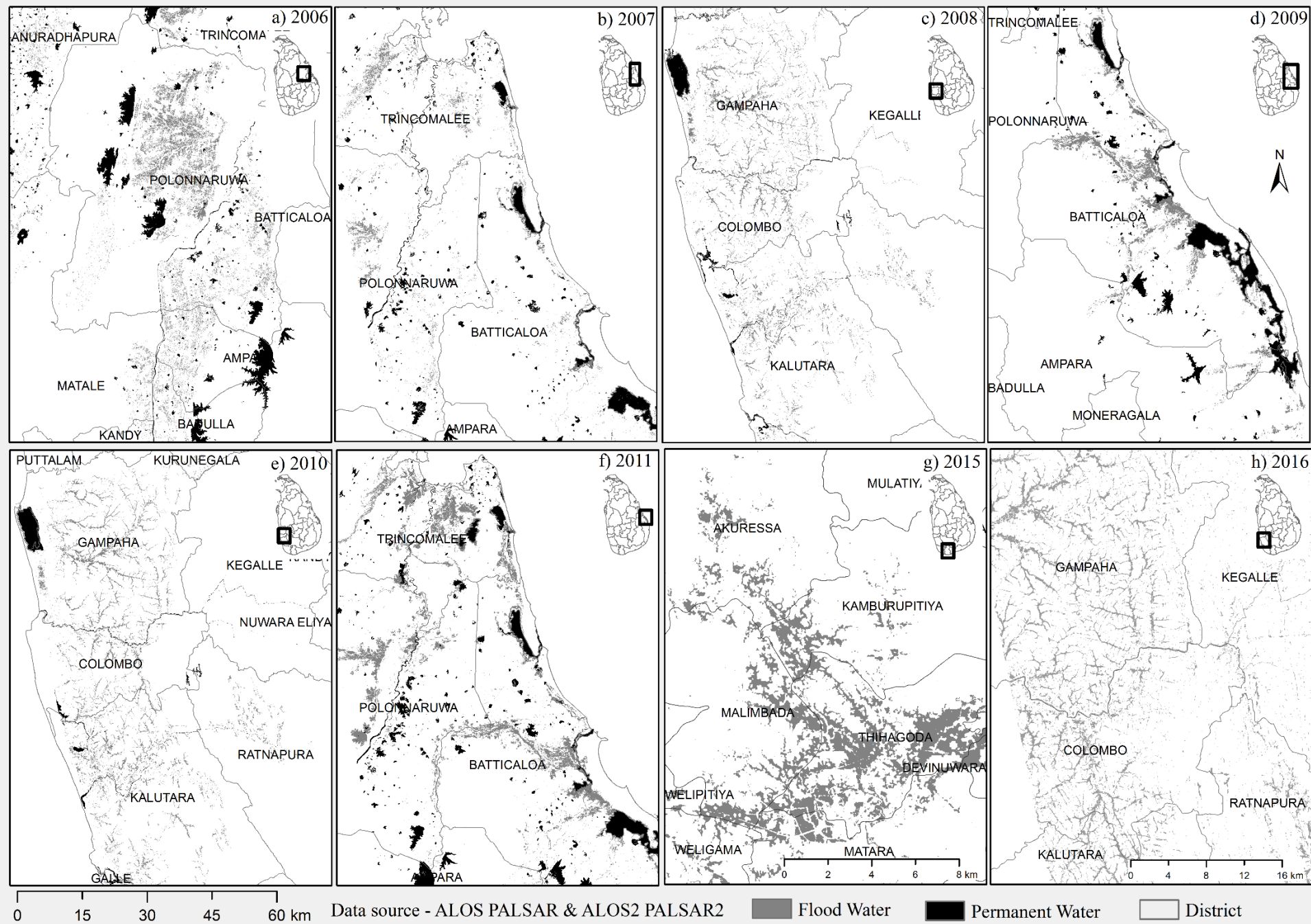


# Historical Flood occurrence of Sri Lanka

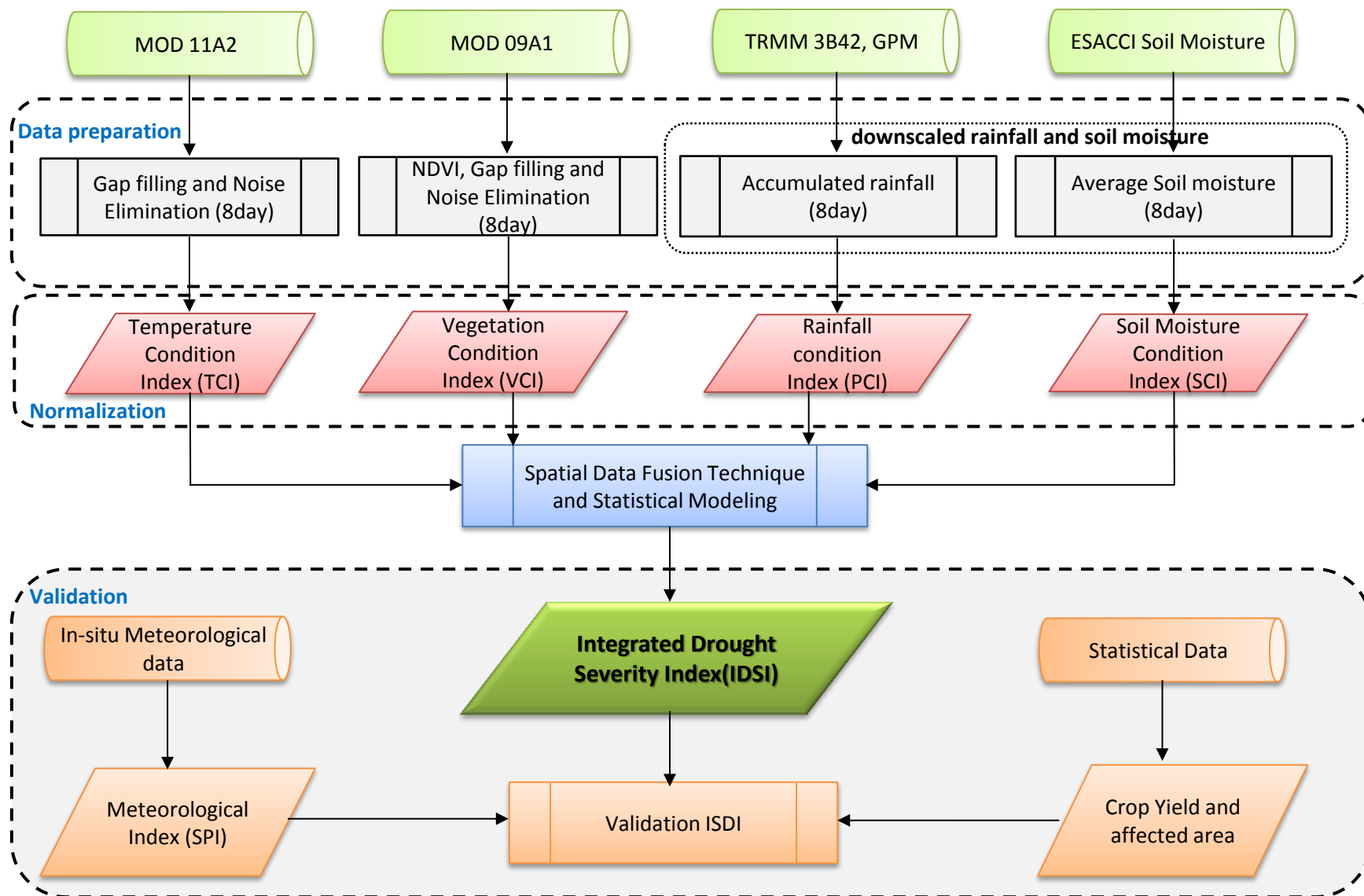




# High Resolution flood mapping

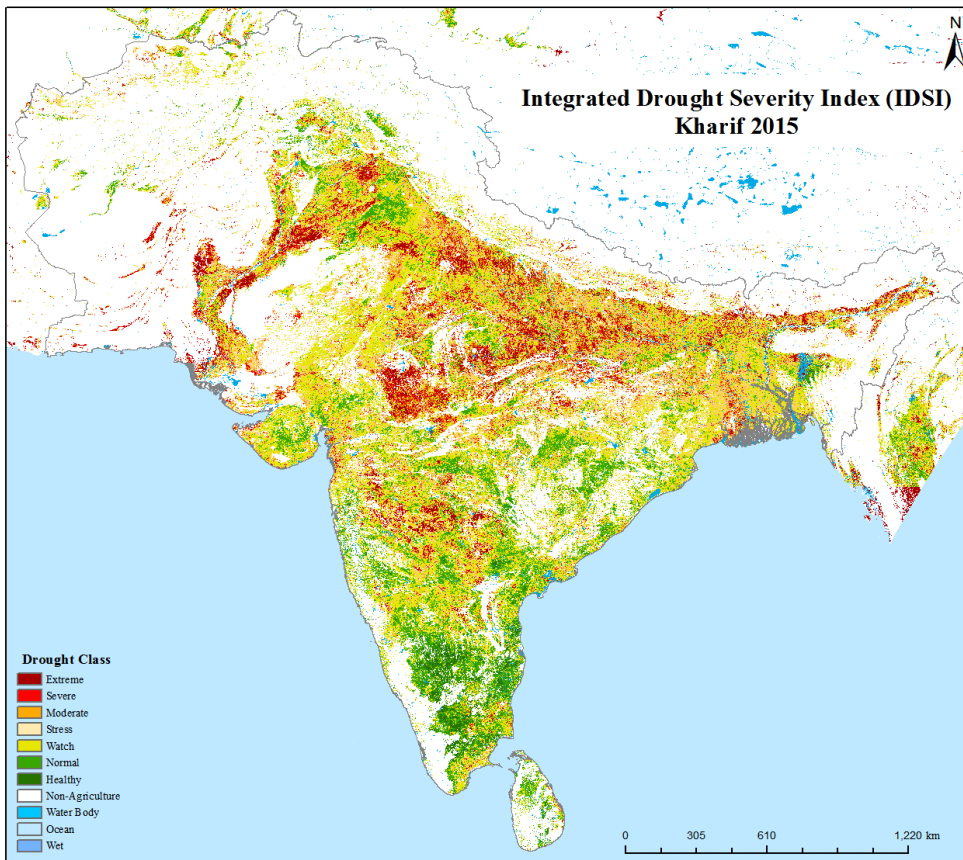


# Drought Monitoring Approach



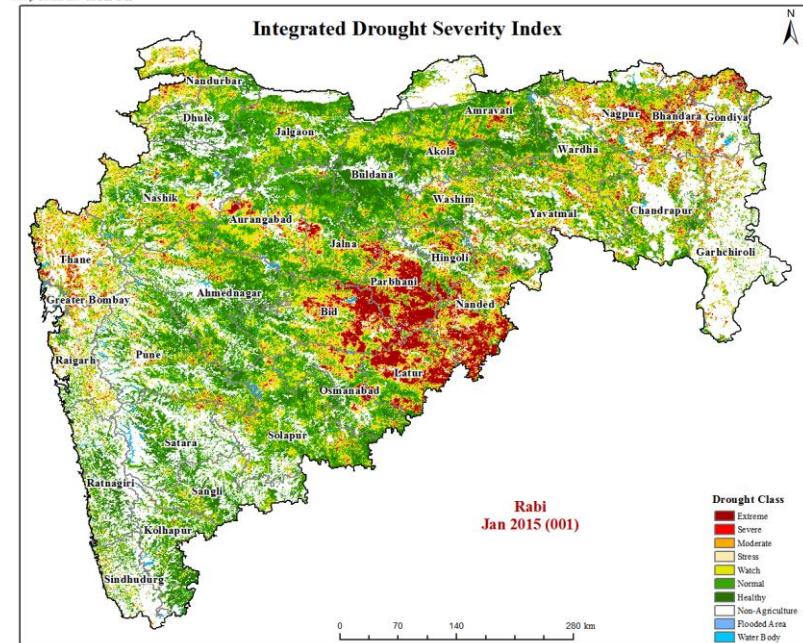


# SOUTH ASIA DROUGHT MONITOR SYSTEM (SA-DMS)



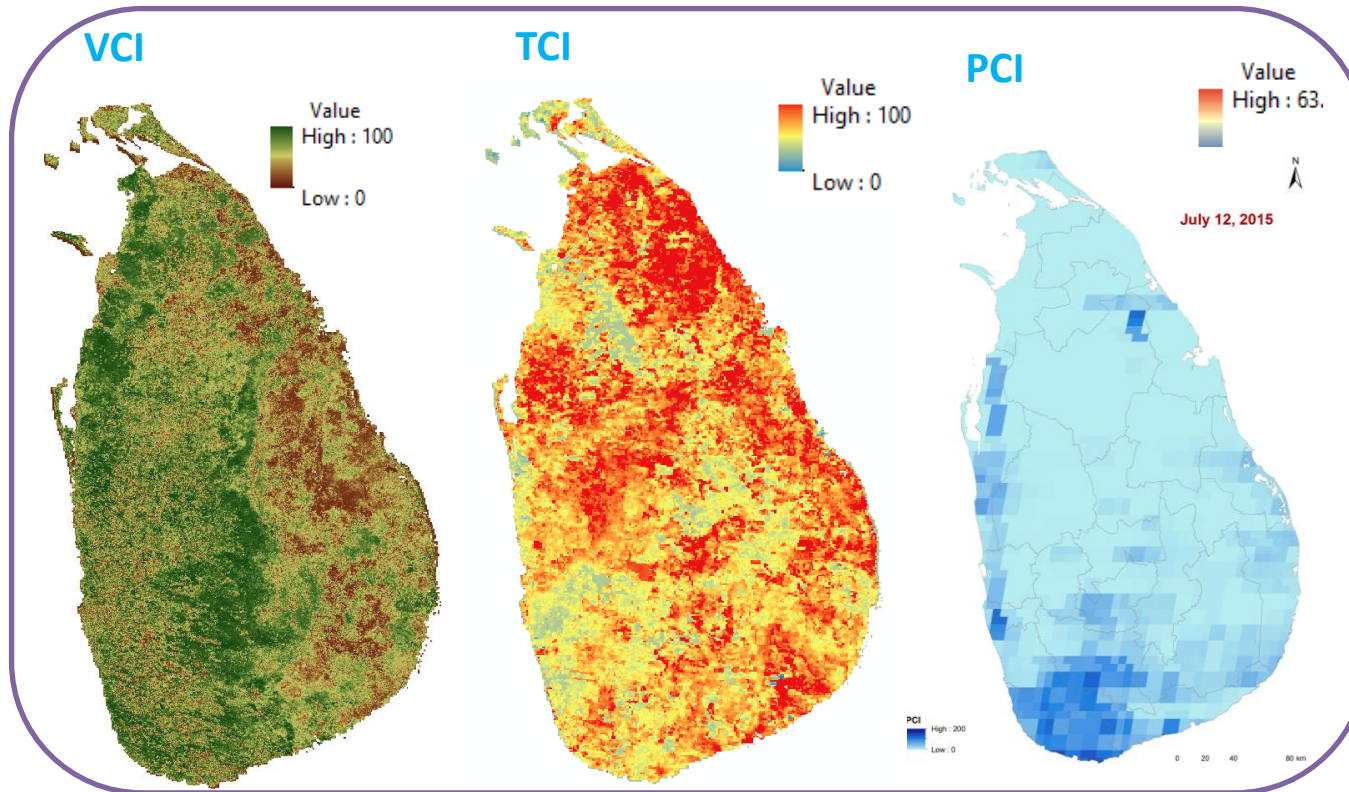
- First of its kind to establish for entire South Asia using multisource remote sensing observations;
- Historical drought risk mapping and assessment covering SA countries (2000 – Current);
- IDSI allows better understanding on drought frequency, duration over the 15years;
- Products are useful tools in drought mitigation studies and in decision-making process;

www.gf-wmimr.com - UNWIS2010ED

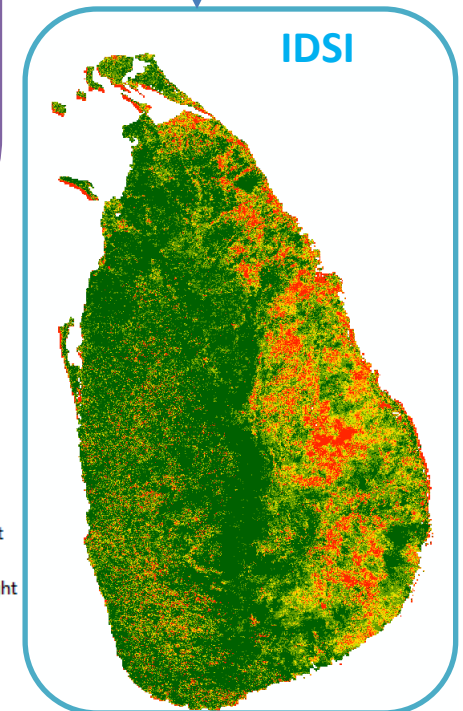


2015 field observations in Jalna, Maharashtra

# Integrated Drought Response Index (IDSI) – Example for Sri Lanka



1<sup>st</sup> Week – September 2013



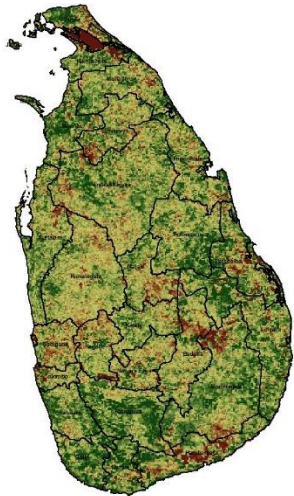
VCI – Vegetation Condition Index; TCI – Temperature condition Index; PCI – Precipitation condition Index; IDSI – Integrated Drought Severity index

- Extream Drought
- Severe Drought
- Moderate Drought
- Abnormal Dry
- Healthy
- Very Healthy

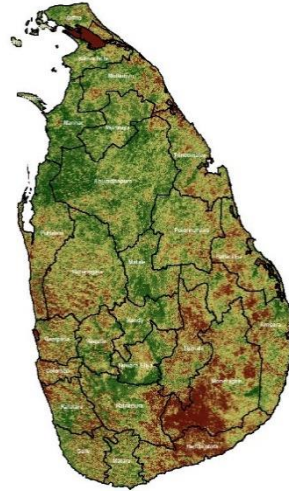


# Integrated Drought Severity Index (IDSI) for Sri Lanka

*2001 Weekly composite*



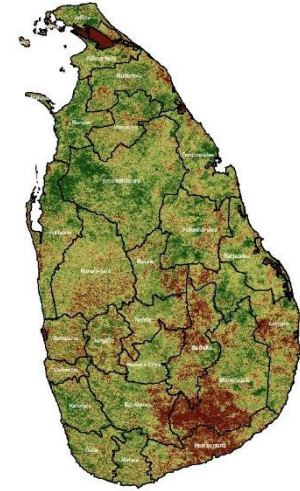
121 – May 1st week



201 – July 3<sup>rd</sup> week



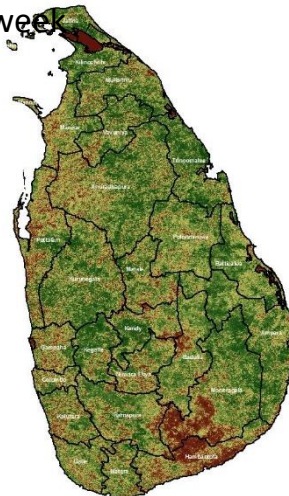
225 – Aug 2<sup>nd</sup> weeks



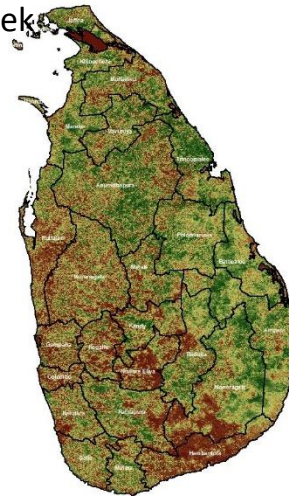
241 – Aug-4<sup>th</sup> Week



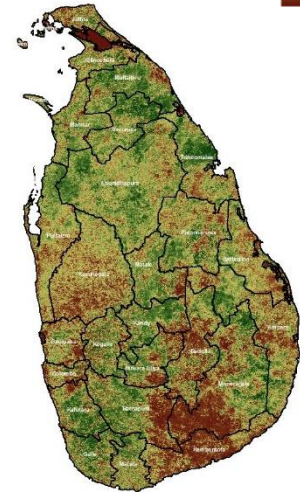
305 – Nov 1<sup>st</sup> week



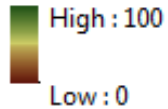
281 – Oct 3<sup>rd</sup> week



273 – Oct 1<sup>st</sup> week

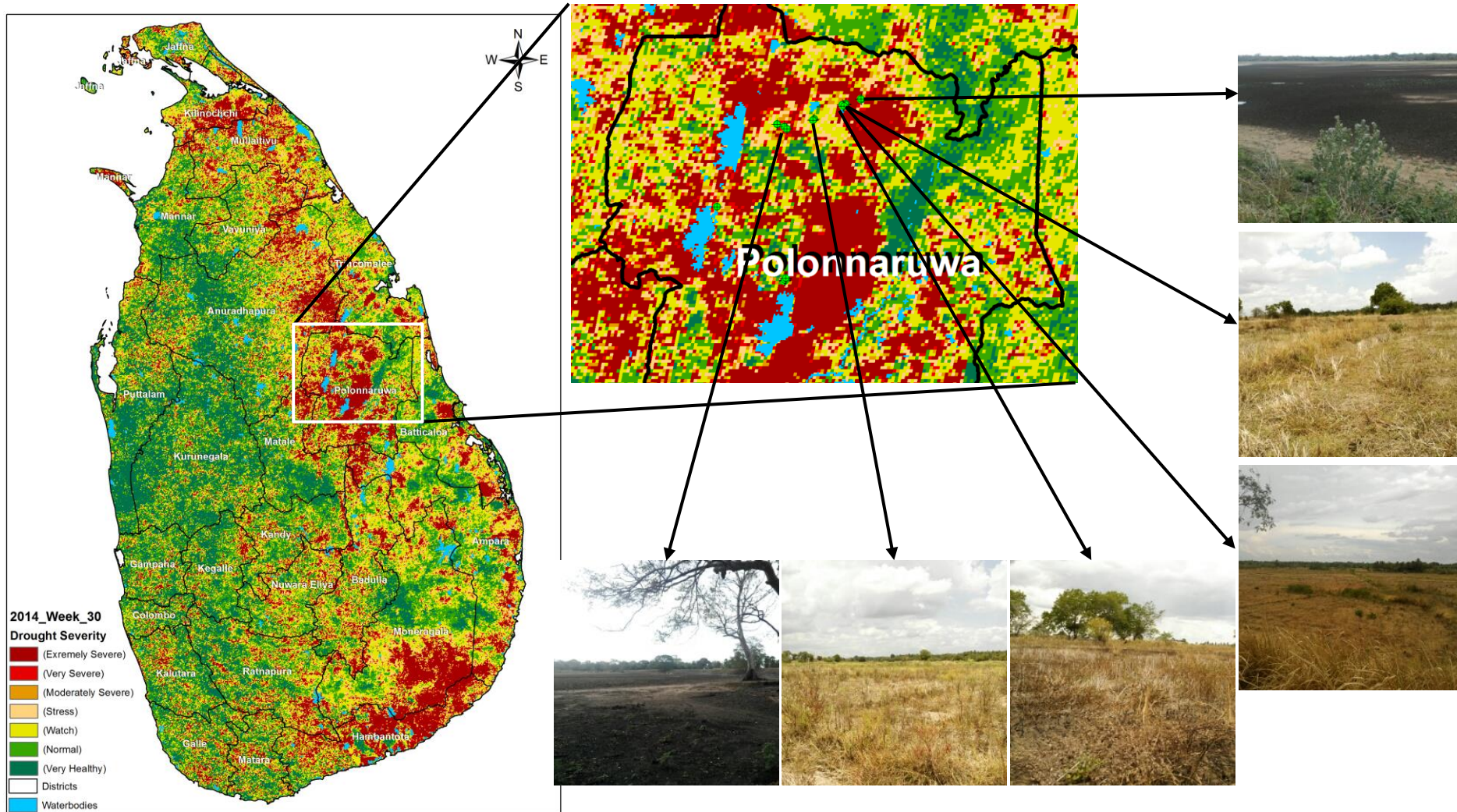


257 – Sep 2<sup>nd</sup> week



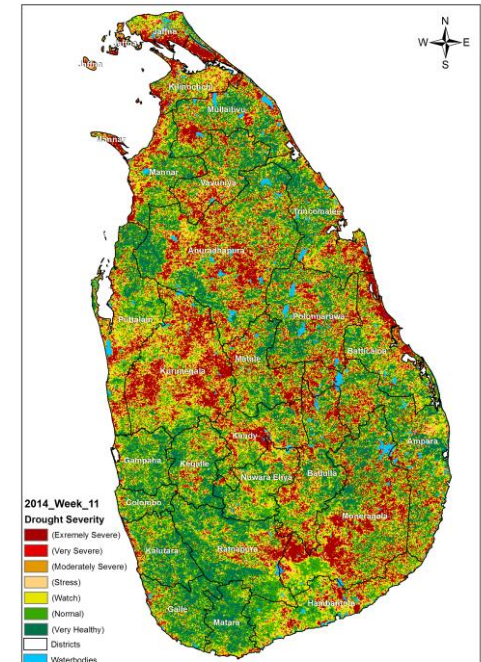
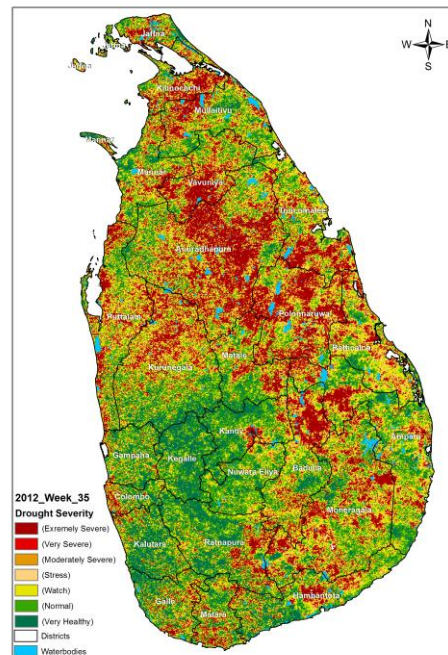
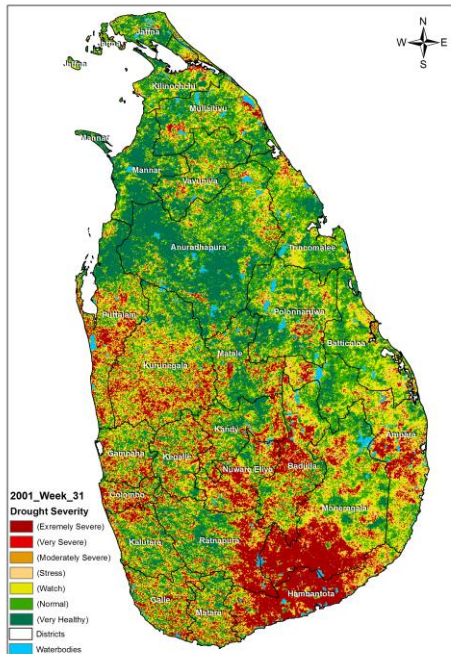


# Characterizing Drought Severity





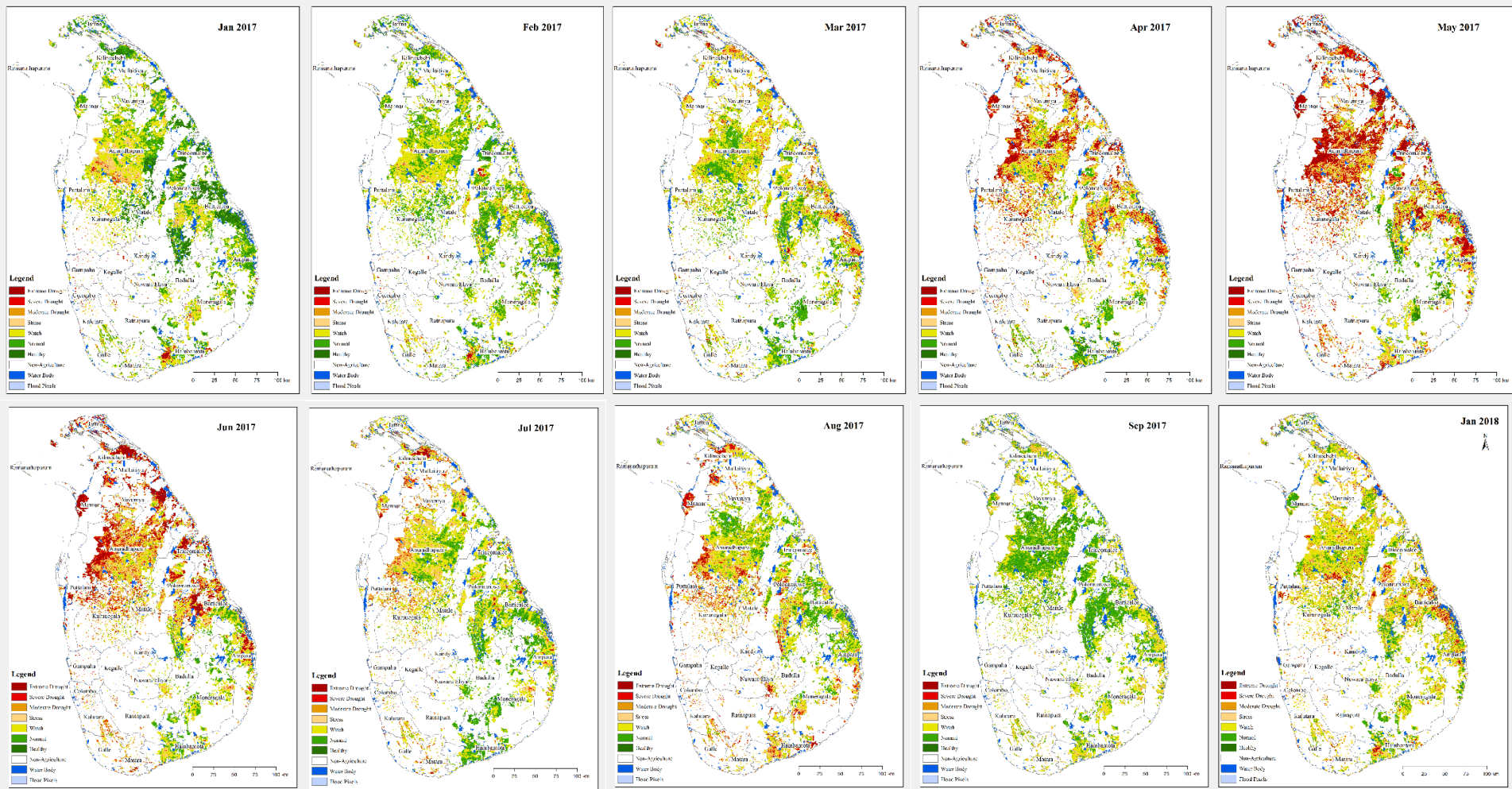
# SL Disaster Management Centre (DMC) Drought Maps



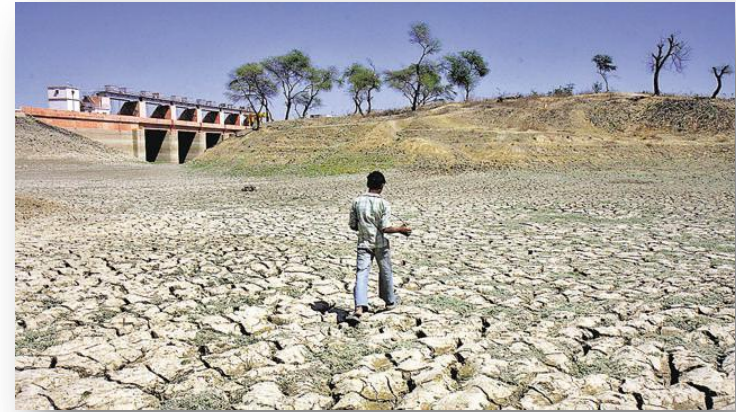
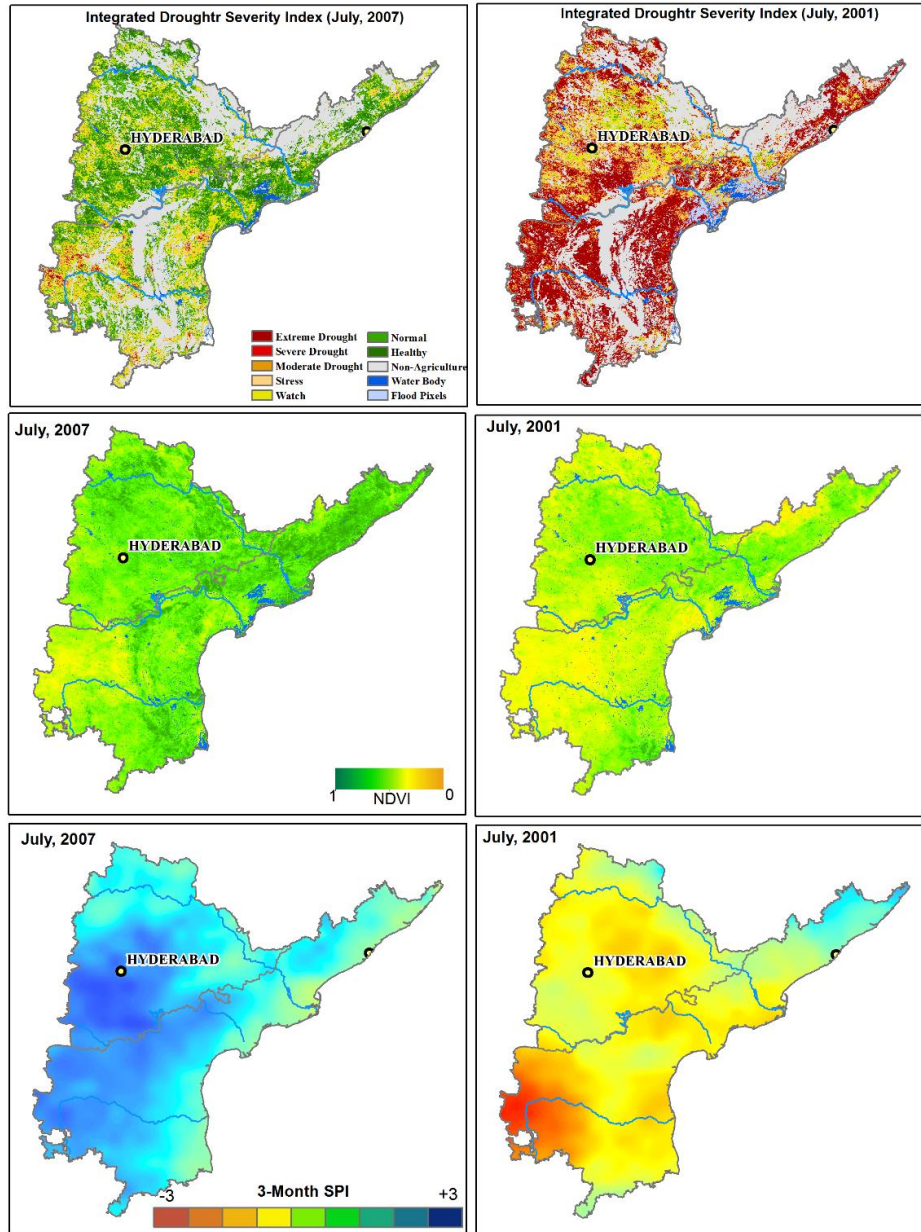




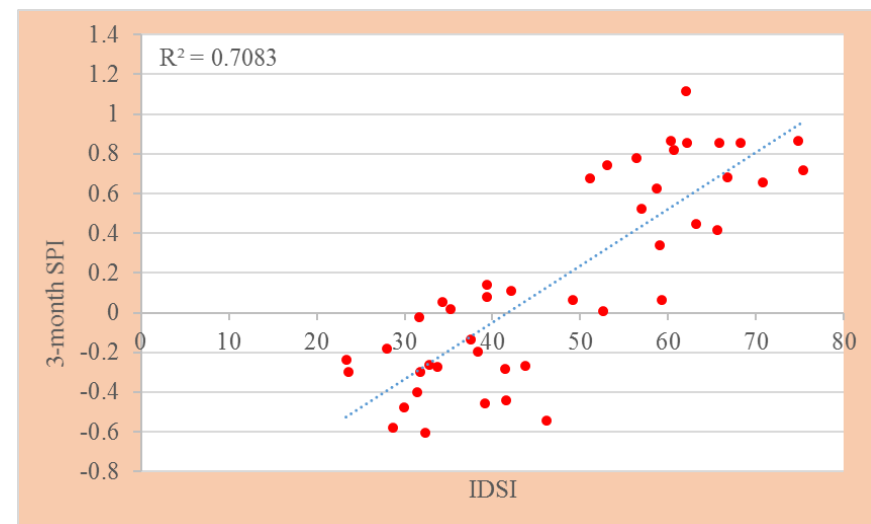
# 2017-2018 Drought



# Drought Monitor Indices for Andhra Pradesh and Telangana - drought year (2001) and normal year (2007)



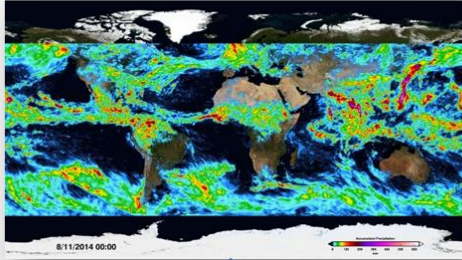
*High correlation observed between 3-month SPI, IWMI's IDSI and rice crop production*



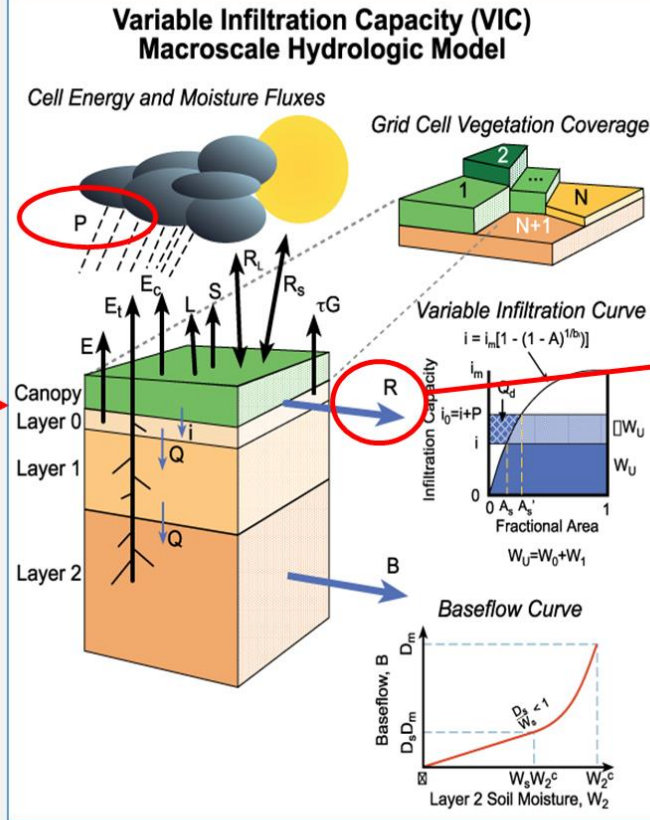
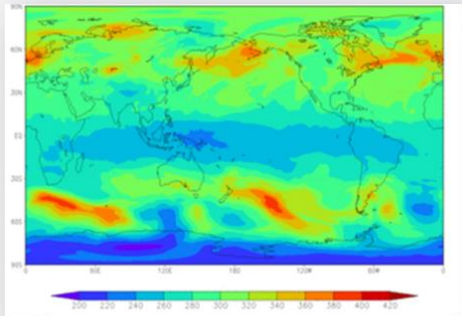


# South Asia Drought Early Warning System (SADEWS)

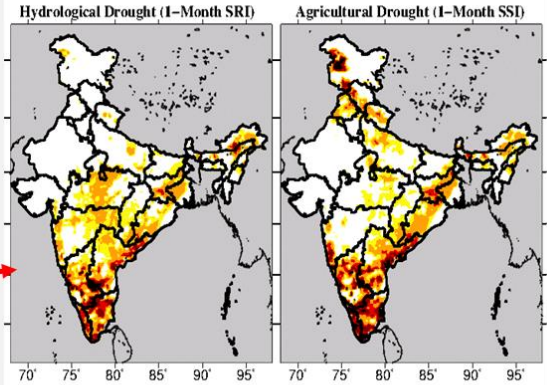
Near-real-time rainfall estimate/GPM



NOAA Global Ensemble Reforecast Data



SRI: Hydrological drought severity  
SSI: Agricultural drought severity



[https://sites.google.com/a/litgn.ac.in/high\\_resolution\\_south\\_asia\\_drought\\_monitor/](https://sites.google.com/a/litgn.ac.in/high_resolution_south_asia_drought_monitor/)

## Forecasting impact on agriculture



# South Asia Drought Early Warning System (SADEWS)

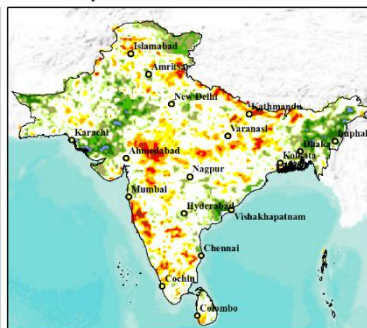
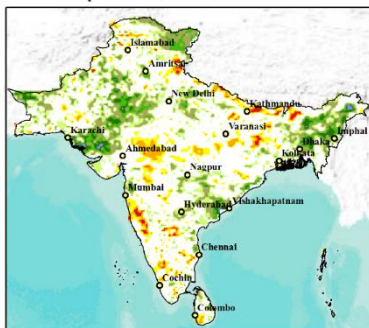
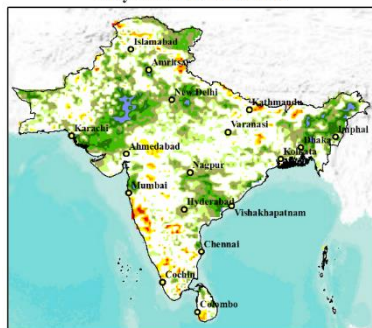
## SOUTH ASIA DROUGHT EARLY WARNING SYSTEM (SADEWS)

### SOIL MOISTURE PERCENTILE (SMP)

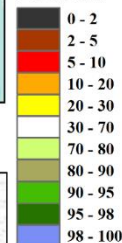
7-day Percentile 10 Jul 2017

7-day Forecast Percentile 17 Jul 2017

7-day Forecast Percentile 25 Jul 2017



Percentile

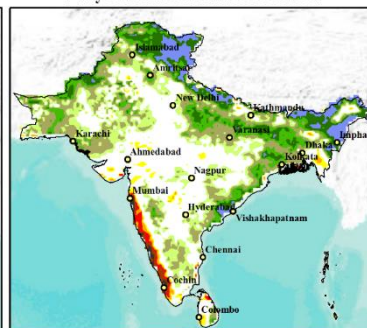
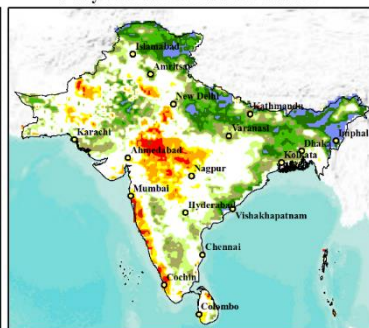
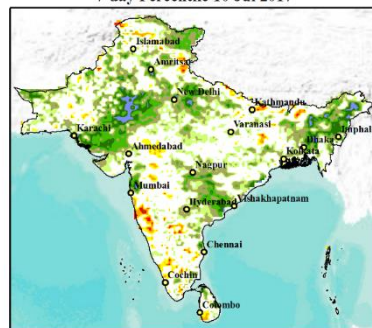


### SOIL RUNOFF PERCENTILE (SRP)

7-day Percentile 10 Jul 2017

7-day Forecast Percentile 17 Jul 2017

7-day Forecast Percentile 25 Jul 2017



**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 10<sup>th</sup> 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).

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