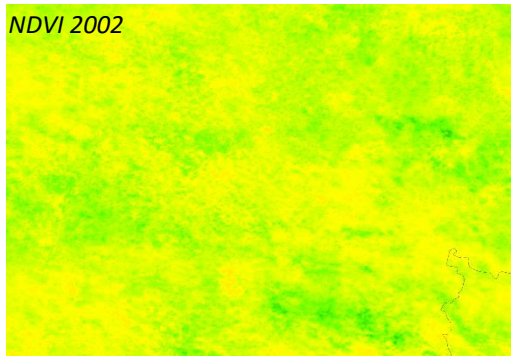
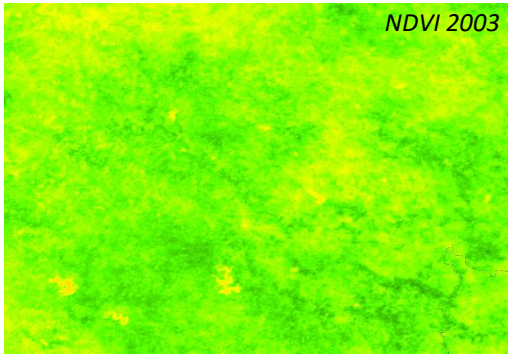
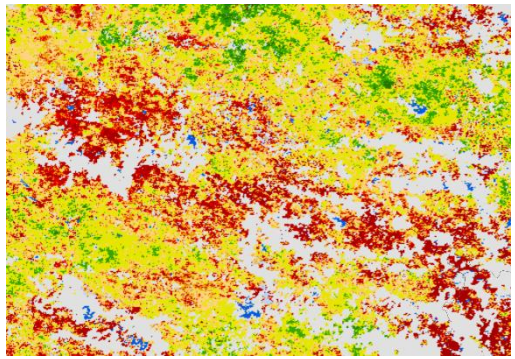
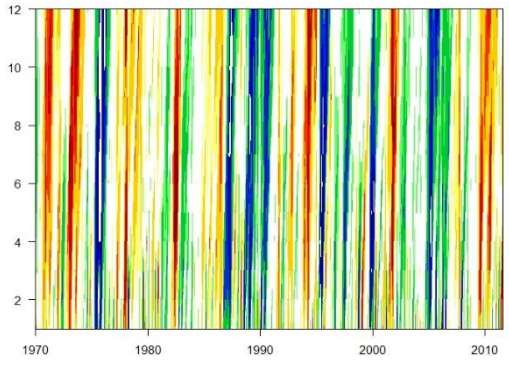
South Asia Drought Monitoring System (SADMS)

A Joint Collaborative project by IWMI, WMO, GWP and CGIAR WLE - CCAFS and MAFF









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We would like to acknowledge: GWP-CWP, DoM, DoA, MoDM, IARI, MNCFC, NDMC, IDMP for continued support and cooperation.

SOUTH ASIA DROUGHT MONITORING SYSTEM (DMS): OVERVIEW

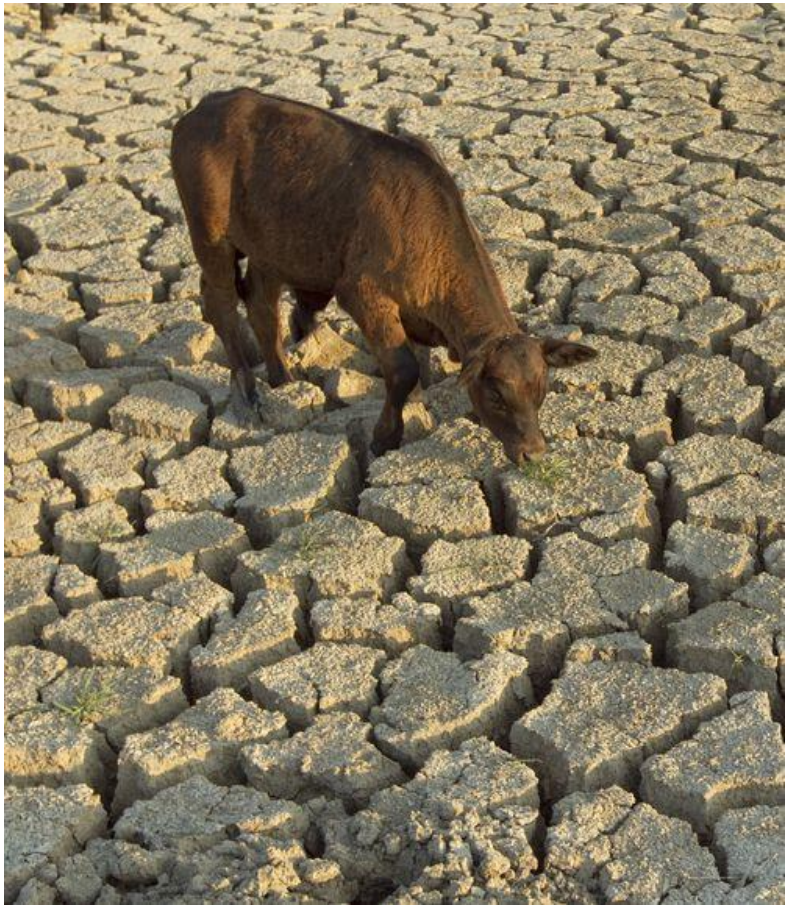
- Goal - build climate resilience, reduce economic and social losses, and alleviate poverty in drought - affected regions in SA through an integrated approach to drought management
- SADMS Integrates remote sensing and ground truth data (vegetation indices, rainfall data, soil information, hydrological data)
- SADMS supports regionally coordinated drought mitigation efforts that can be further tailored to national level
- SADMS is a partnership with WMO, GWP, CGIAR WLE and CCAFS, MAFF, and Governments in SA.

IWMI International Water Management Institute
World Meteorological Organization
Global Water Partnership
MAFF Ministry of Agriculture, Forestry and Fisheries 農林水産省
CGIAR RESEARCH PROGRAM ON Water, Land and Ecosystems
CLIMATE CHANGE AGRICULTURE AND FOOD SECURITY

1. Problem Statement

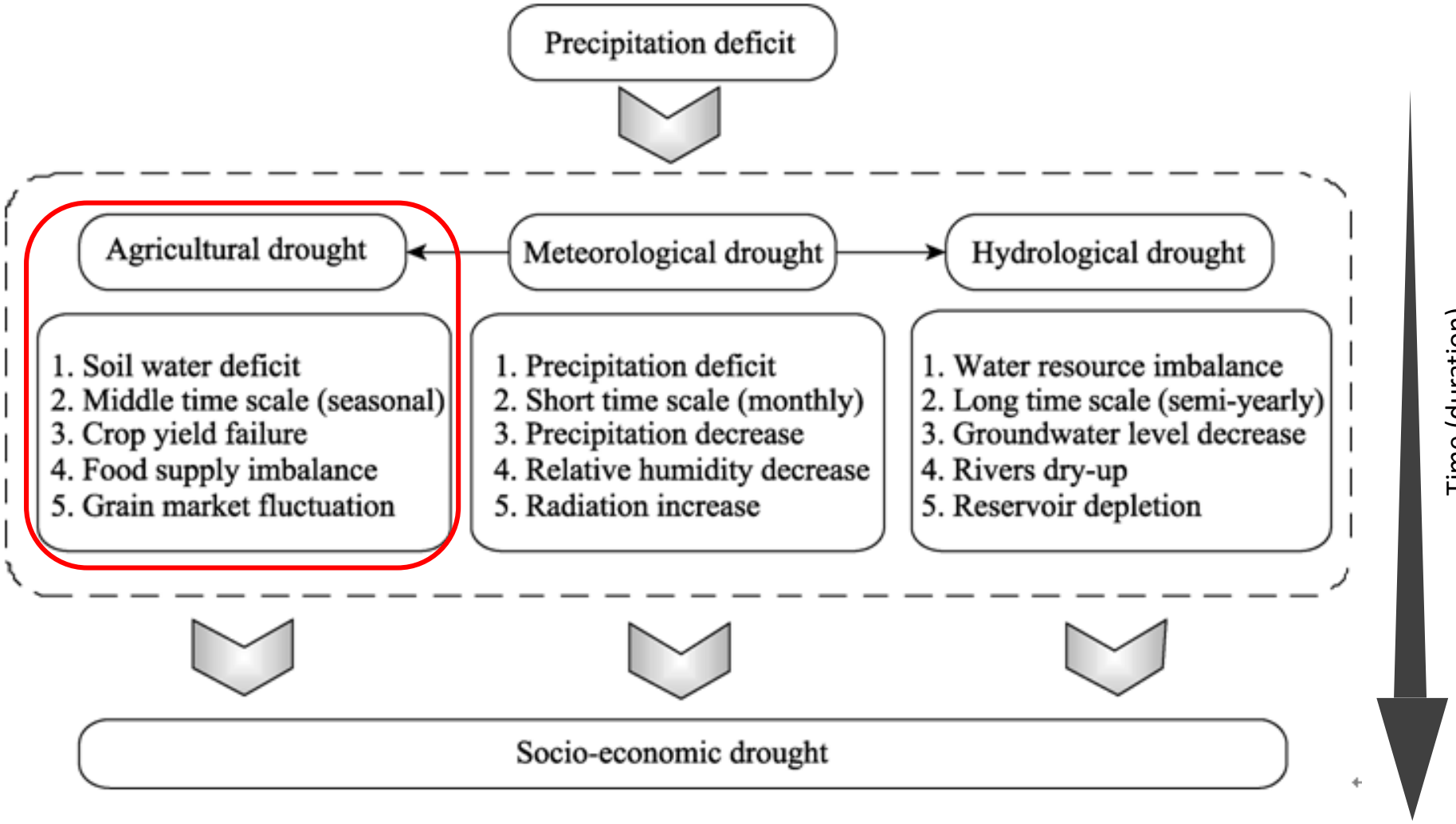
I. Drought

- Deficient precipitation compared to statistical multi-year average conditions (NDMC, 2008)
- significant economic, environmental and social impacts – direct and indirect
- among the most costly of all natural disasters
- ranks first in degree of severity, length of event, total areal extent and social effect when compared to other hazards (Wilhite, 2000, p. 6)
- Since 1980 more than 2 billion people were affected by more than 500 drought events (EM-DAT) (Guha-Sapir & Hoyois, n.d.)
- *Four types of droughts*
  - *Metorological*
  - ***Agricultural***
  - *Hydrological*
  - *Socio-economic*



Source: www.a2ua.com

Definition of drought: Four different types



Drought risk assessment

Hazard: Characterization of drought

- Spatial extent
- Magnitude / severity
- Frequency
- Intensity
- Duration
- ...


Photo: Daniel Asaré-Kyei

Vulnerability: Characterization of drought effects

→ The **characteristics** and circumstances of a **community**, **system** or **asset** that make it susceptible to the damaging effects of a hazard.


Photo: Daniel Asaré-Kyei

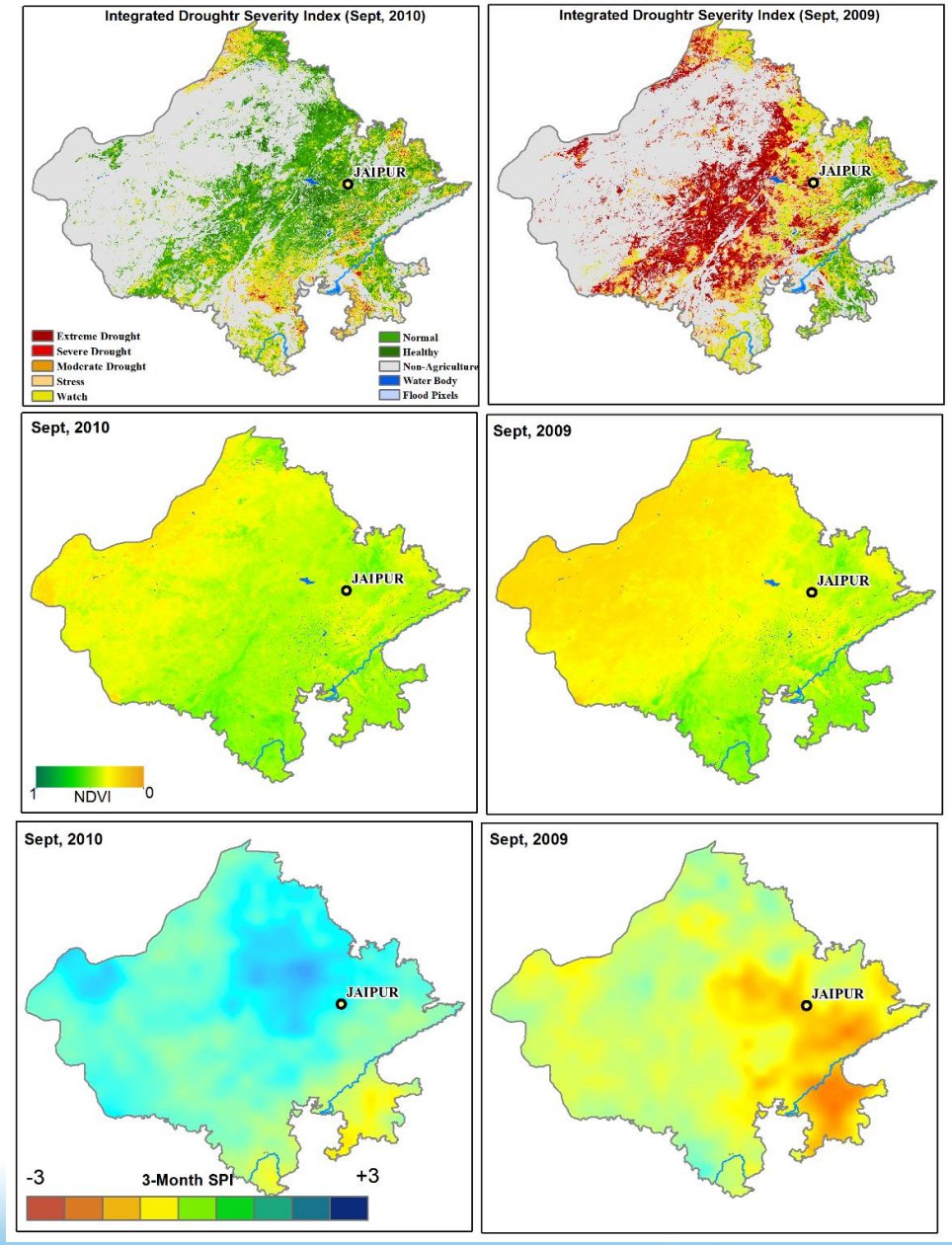
Source: UN/ISDR http://www.unisdr.org/eng/library/lib-terminology-eng.htm

2. Drought and Remote Sensing

II. Drought Indicators and Remote Sensing

Drought Hazard vs. Drought Risk

- Drought Hazard: meteorological parameters (Prec., Temp., PET, SM)
  - Palmer Drought Severity Index (PDSI, Palmer 1965)
  - Standardized Precipitation Index (SPI; Guttermann, 1998)
  - Crop Moisture Index (CMI; Palmer 1968)
  - Surface Water Supply Index (Shafer and Dezmann, 1982)



II.Drought Indicators and Remote Sensing

Example: Agricultural Stress Index System (ASIS): Global and Country Analysis

Agricultural Stress Index System is based on the Vegetation Health Index (VHI) (Kogan et al. 1995)

Vegetation condition index (VCI)

$$VCI_i = \frac{NDVI_i - NDVI_{\min}}{NDVI_{max} - NDVI_{min}}$$

Temperature condition index (TCI)

$$TCI_i = \frac{BT_{max} - BT_{\mathrm{i}}}{BT_{max} - BT_{min}}$$

Vegetation Health Index (VHI)

VHI = a*VCI + (1-a)* TCI

low VHI

high VHI

3. SADMS Project Approach

SADMS Objectives

Overall objective: Development of regional drought monitoring system and products on drought risk assessment through enhancing knowledge and skills for drought risk reduction as an integral part of the development process at community, national, sub-regional and regional levels.

- Development and testing new EO-based methods and the value-adding chain for drought risk reduction (DRR)
- Preparation and demonstration of their use at national levels, involving national authorities
- Contribution to the regional/national monitoring systems in the field of agricultural drought risk
- Transferability of approach between different geographical settings
- Develop and recommend protocol for drought monitoring and mitigation with inbuilt contingency measures including capacity development
- Introducing results into international programs and processes *(SFDRR, Global Partnership Earth Observation in SFDRR)*

SADMS Project Approach & BIG Picture

A: Schematic representation of SADMS elements

International Co… and Initiatives (WP 3)

National level implementation

SADMS
Drought hazard indicators

Input data

SFDRR
„Priorities for Action" Goal and targets

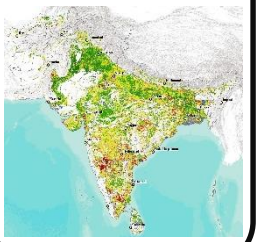
SDGs
Goals, targets, indicators

UNFCCC
Measures/ Goals of NAPAs

National Needs
- Capacities; Risk knowledge; Losses and damages; benfits/costs

Knowledge needs, national reporting

South Asia



Quality Transferability

Southern Africa

Development of Information products:

1. People affected per 100.000
2. Direct economic loss agricultural sector in relation to Gross Domestic Product
3. Drought hazard monitoring, extend, intensity and frequency
4. Agricultural exposure and social Vulnerability
5. Risk of yield and income loss
6. Recommendations for risk reduction and adaptation

Satellite Sensors (WP 1)
- MODIS
- …PM
- …
Processing chains:
Hazard, Exposure

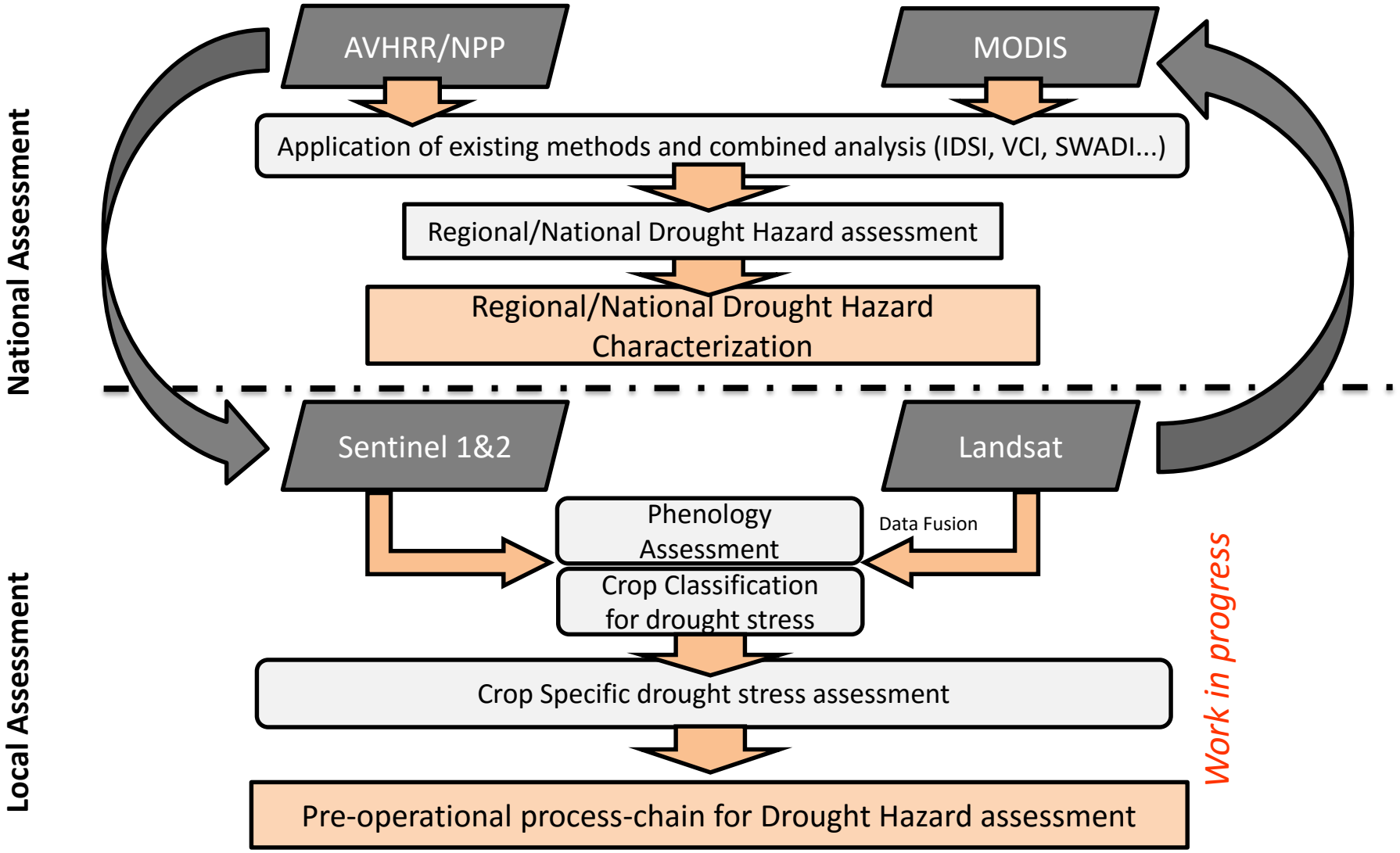
Socio-economic (WP 2)
- Statistics (incl. Agr…
- Census data, ADP*
Method:
Vulnerability and Risk assessment
*Agricultural dependent population

WP 1: Development of RS-based methods and products

WP 1
Development of improved and/or new methods
for hazard and exposure assessment
in the field of drought risk for the national use

WP 1.1	WP 1.2	WP 1.3
Multi-Scale drought hazard analysis	Agricultural exposure and yield assessment	Remote Sensing – based drought risk information
↓	↓	↓
Pre-operational process chain	Crop Maps Yield Distribution	Hectares affected Yield loss

Multi-Scale drought risk analysis with Remote Sensing



WP 2: Vulnerability and Risk Assessment

WP 2

Derivation of vulnerability indicators, combine information on hazard, exposure and vulnerability to assess overall drought risk and evaluate transferability of indicators between different countries.

WP 2.1	WP 2.2	WP 2.3
Drought vulnerability analysis	Drought risk assessment	Evaluation of indicator transferability
Vulnerability indicators of the social-agricultural system	Risk of people affected and loss in the agricultural sector	Unified set of indicators versus country specific indicators

WP 3: Development of RS-based methods and products

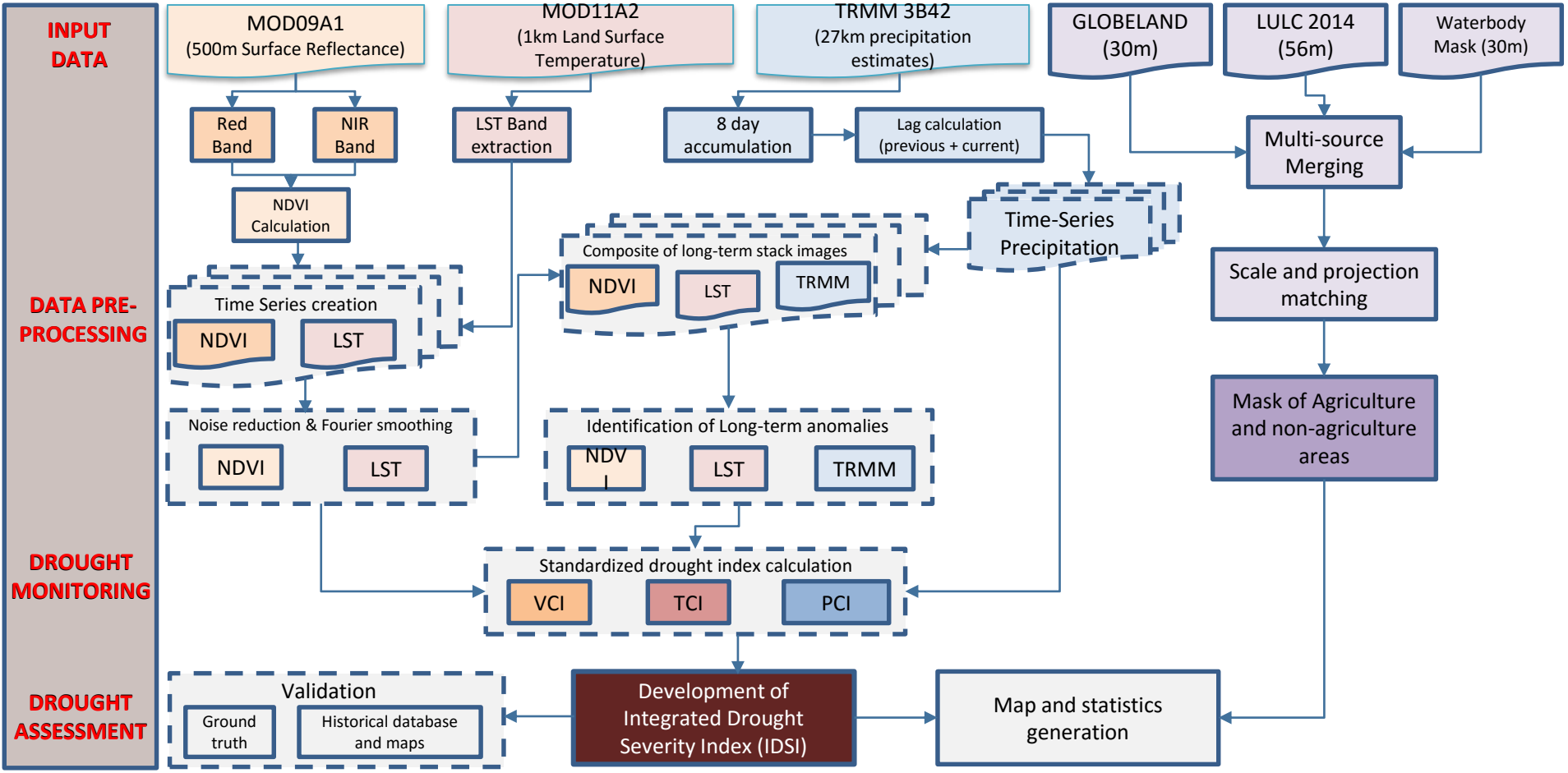
WP 3

Feasibility of implementation at national level, User dialogue and dissemination

WP 3.1	WP 3.2	WP 3.3
User dialogue and dissemination	Work flow test and result communication	Feasibility study on implementation
Information requirements and transfer of results	Recommended practices	Hectares affected Yield loss

3. SADMS Details Step by Step

Drought Monitoring Approach



Notes: MOD09A1 – MODIS Surface Reflectance of every 8-Day product at 500m resolution; MOD11A1 – MODIS Land Surface Temperature (LST) daily product at 1,000m resolution; TRMM – Tropical Rainfall Measuring Mission; LULC NRSC – Land Use and Land Cover from National Remote Sensing Centre; Water body mask from Landsat images; NDVI – Normalized Difference Vegetation Index; VCI – Vegetation Condition Index; TCI – Temperature Condition Index (TCI); Precipitation Condition Index (PCI), IDSI – Integrated Drought Severity Index

Calculation of Drought Monitoring Indices

Index: Vegetation Condition Index (VCI)

Data : MODIS Surface Reflectance Spatial: 500m Temporal: Every 8-day

$$VCI_n = \frac{NDVI_n - NDVI_{LT\_min}}{NDVI_{LT\_max} - NDVI_{LT\_min}}$$

Where,

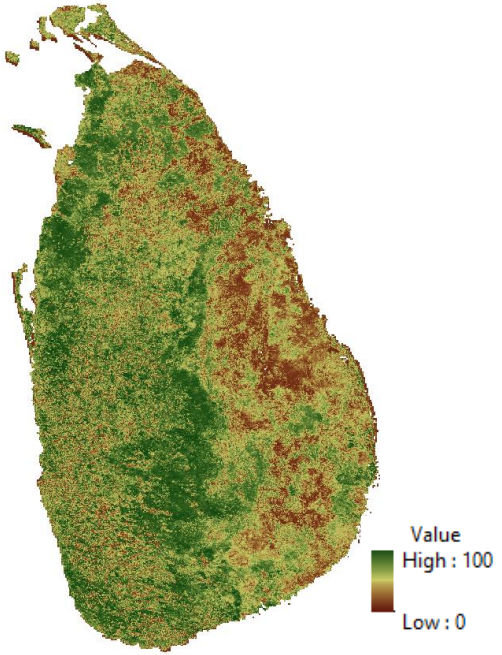
VCI_n = Vegetation Condition Index of an 8 days composite

$NDVI_n$ = Mean Normalized Difference Vegetation Index off current and previous composite

n = 8 days composite

$NDVI_{LT\_max}$ & $NDVI_{LT\_min}$ = Long term (2001-2014) max & min of $NDVI_n$

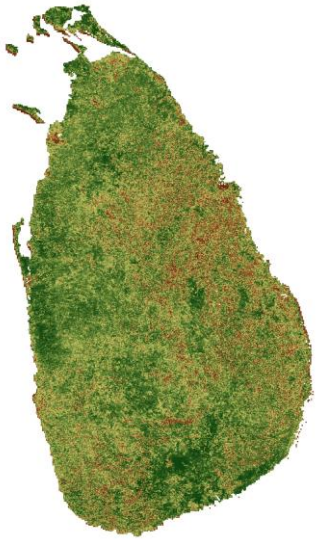
- VCI is an indicator on the status of the vegetation cover as a function of the NDVI minimum and maximum.
- Also, VCI values indicate how much the vegetation has progressive or declined in response to weather. It was concluded that VCI has provided an assessment of spatial characteristics of drought.
- The 8-day NDVI is been layer stacked and used in the study. April, May, June, July, August and September of every year from 2001 to 2014 is been grouped in mean, then each pixel's minimum and maximum can be used to derive the vegetation conditional index



Vegetation Condition Index (VCI) for Sri Lanka

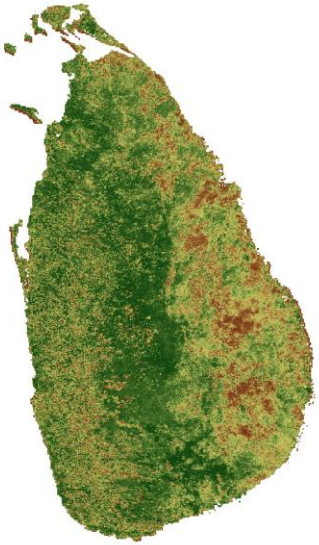
Weekly composite

June 2, 2013

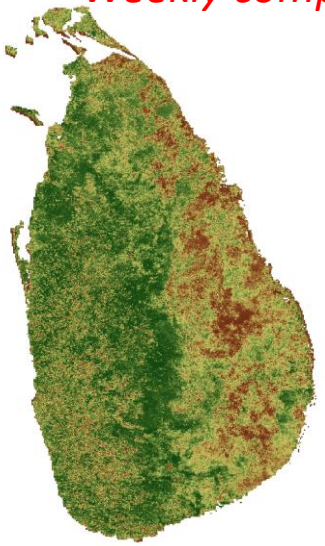


June 4, 2013

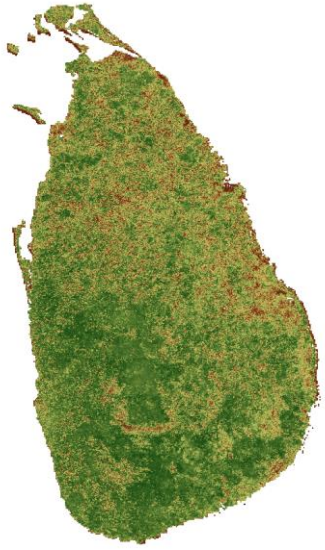
July 2, 2013



July 4, 2013



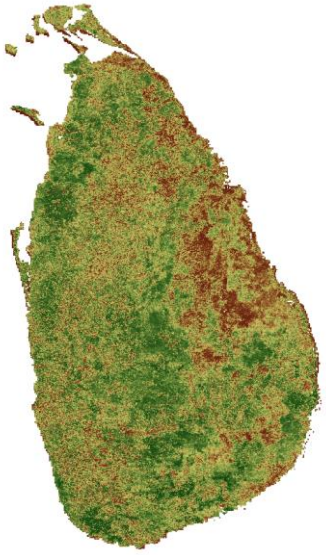
August 3, 2013



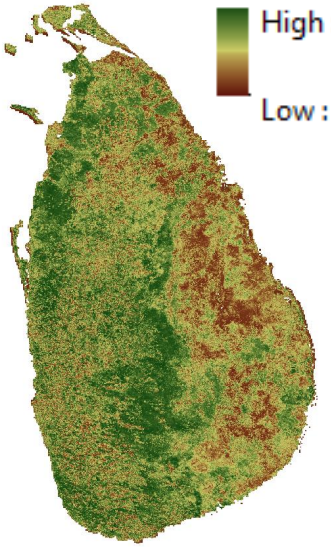
November 1, 2013

October 3, 2013

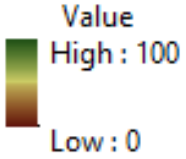
October 1, 2013



September 3, 2013



September 1, 2013



Calculation of Drought Monitoring Indices

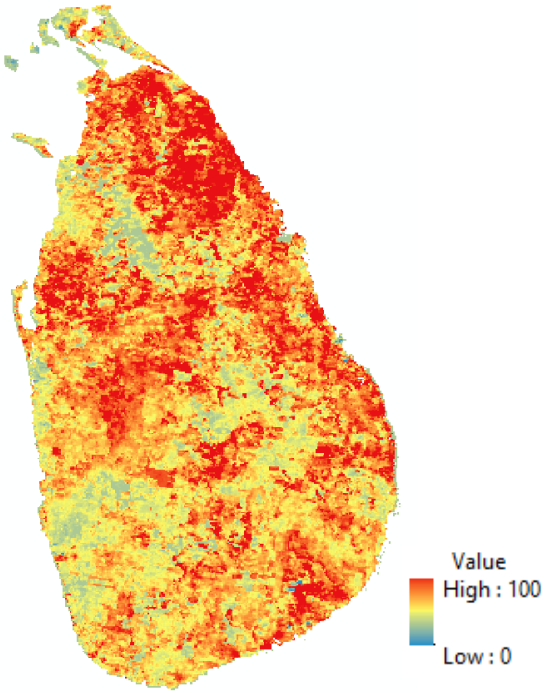
Index: Temperature Condition Index (TCI)

Data : MODIS Land Surface Temperature Spatial: 1000m Temporal: Every 8-day

$$TCI_n = \frac{LST_{max} - LST}{LST_{max} - LST_{min}}$$

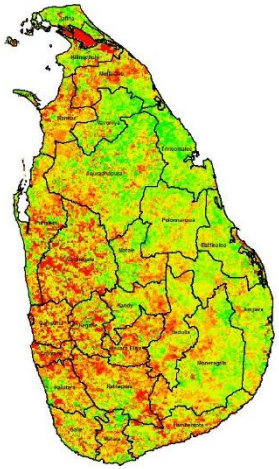
Where, T is brightness temperature. Maximum and minimum T values are calculated from the long-term record of remote sensing images for a period of 2002-2014. Low TCI values indicate very hot weather.

- TCI, a remote sensing based thermal stress indicator is proposed to determine temperature-related drought phenomenon
- TCI assumes that drought event will decrease soil moisture and cause land surface thermal stress;
- TCI algorithm is similar to the VCI one and its conditions were estimated relative to the maximum/minimum temperature in a given time series. However, opposite to the NDVI, high LST in the vegetation growing season indicates unfavorable conditions while low LST indicates mostly favorable condition

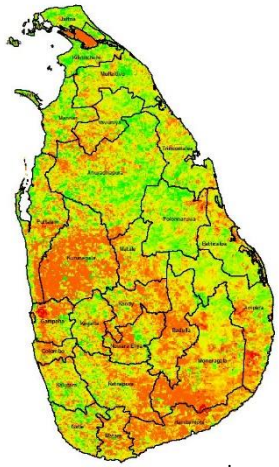


Temperature Condition Index (TCI) for Sri Lanka

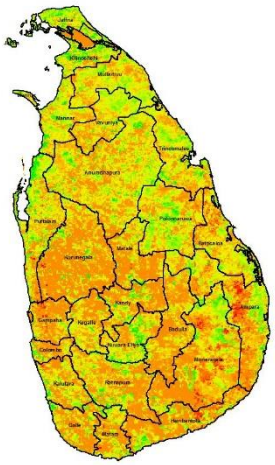
2001 Weekly composite



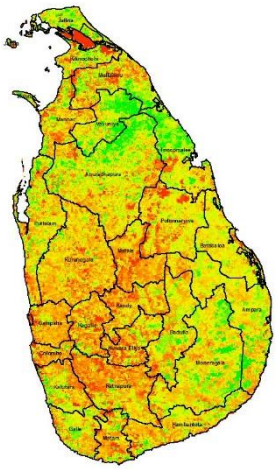
121 – May1st week



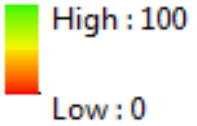
201 – July 3rd week

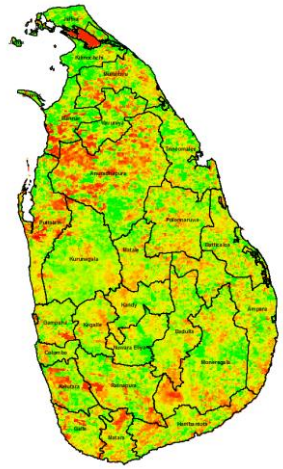


225 – Aug 2nd week

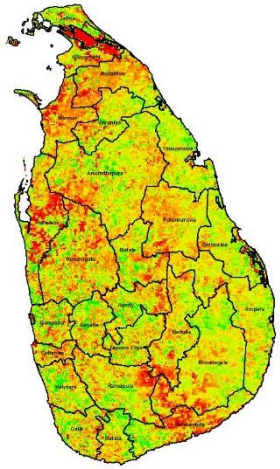


241 – Aug-4th Week

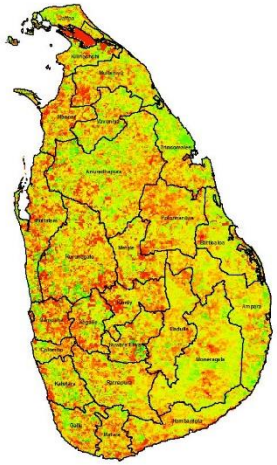




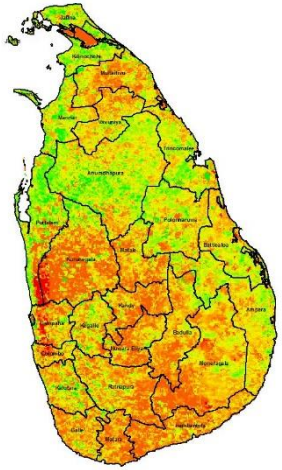
305 – Nov 1st week



281 – Oct 3rd week



273 –Oct 1st week



257 – Sep 2nd week

Calculation of Drought Monitoring Indices

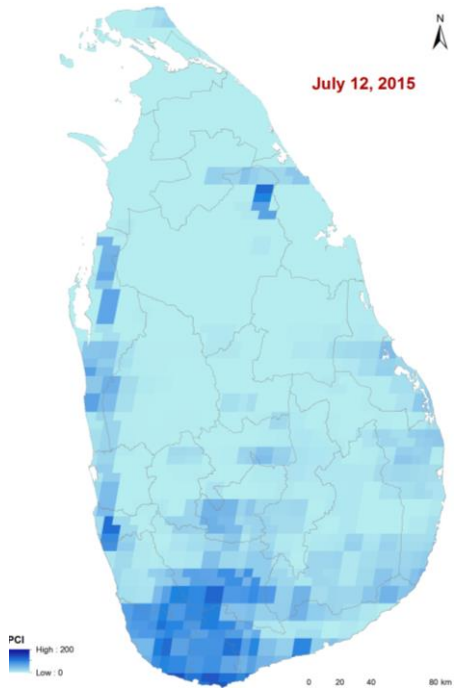
Index: Precipitation Condition Index (PCI)

Data : TRMM 3B42 Spatial: 0.25degree Temporal: Daily (accumulated rainfall rate)

$$TCI_n = \frac{TRMM - TRMM_{min}}{TRMM_{max} - TRMM_{min}}$$

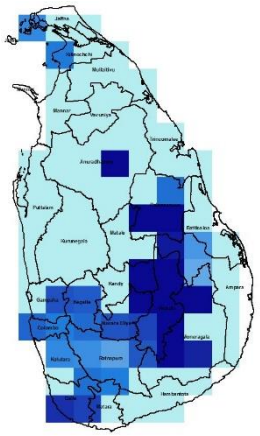
Where, TRMM, $TRMM_{max}$ and $TRMM_{min}$ are the pixel values of precipitation and maximum, minimum of it respectively in daily during 2000 – 2014.

- TRMM data provides meteorological drought information and has spatial and temporal climate component but it cannot be directly analyzed with VCI and TCI.
- PCI was normalized by the TRMM 3B42 data using a similar algorithm of VIC to detect the precipitation deficits from climate signal.
- PCI also changes from 0 to 1, corresponding to changes in precipitation from extremely unfavorable to optimal.
- In case of meteorological drought which has an extremely low precipitation, the PCI is close or equal to 0, and at flooding condition, the PIC is close to 1.

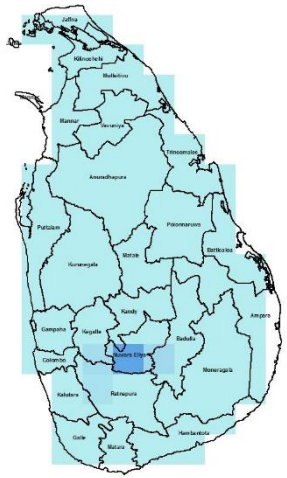


Precipitation Condition Index (PCI) for Sri Lanka

2001 Weekly composite

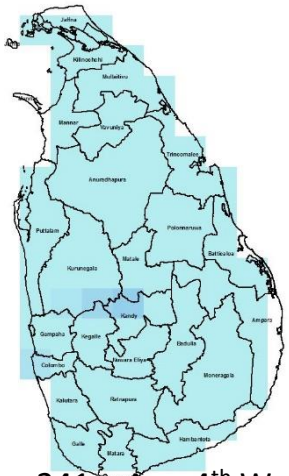


121 – May1st week

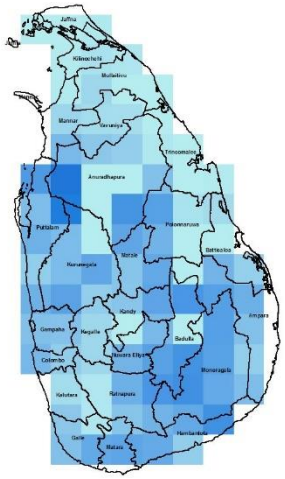


201 – July 3rd week

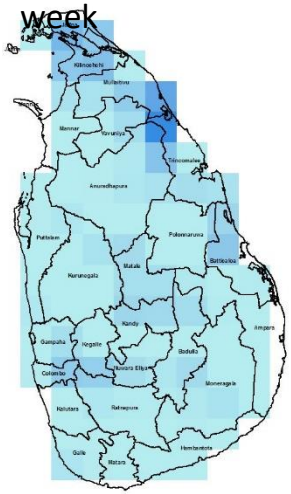
225 – Aug 2nd week



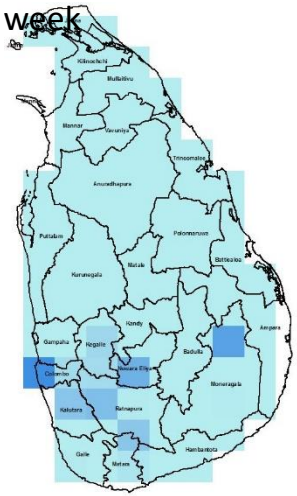
241 – Aug-4th Week



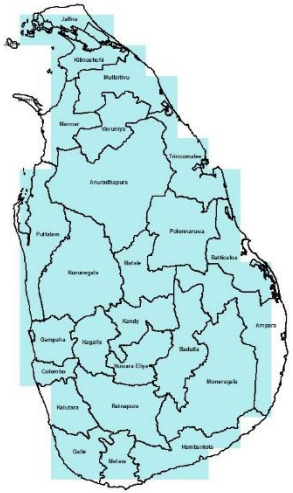
305 – Nov 1st week



281 – Oct 3rd week

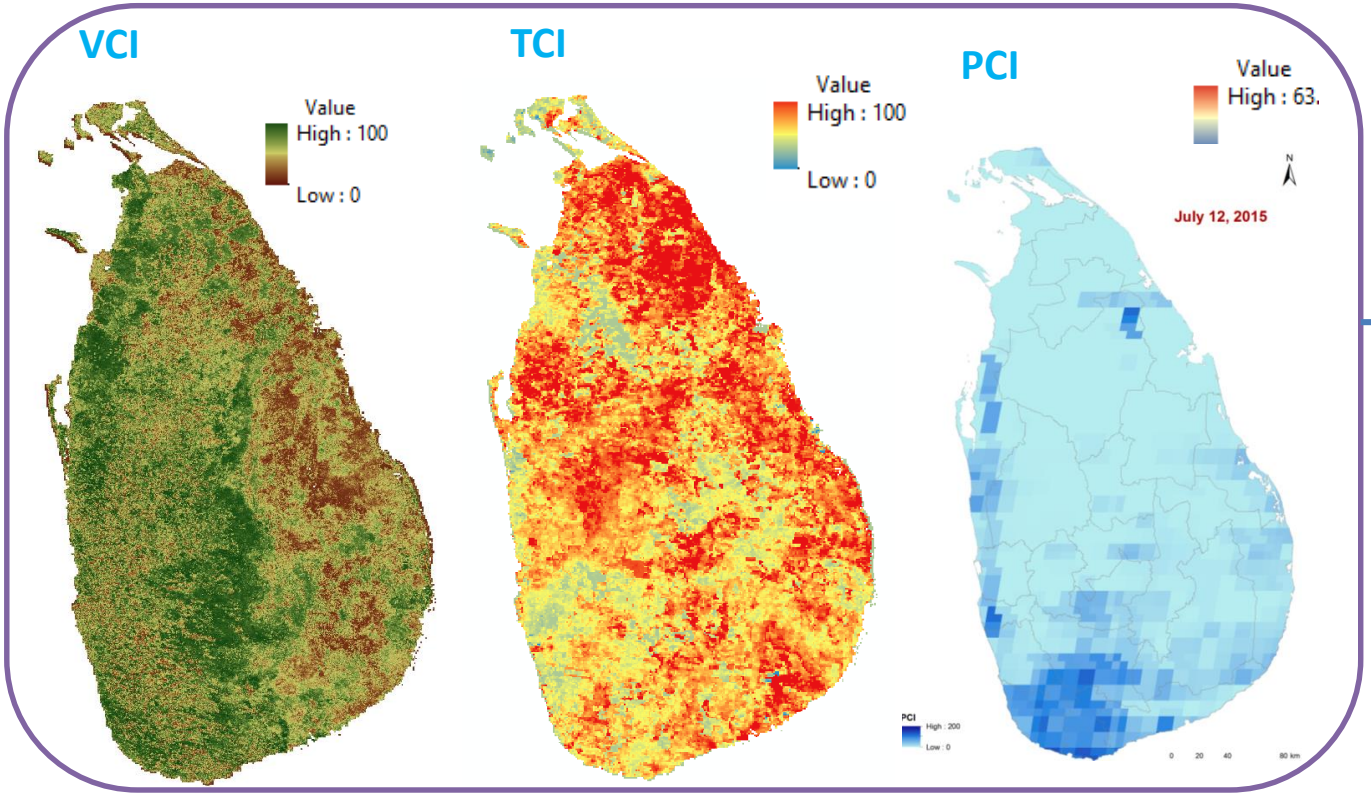


273 –Oct 1st week

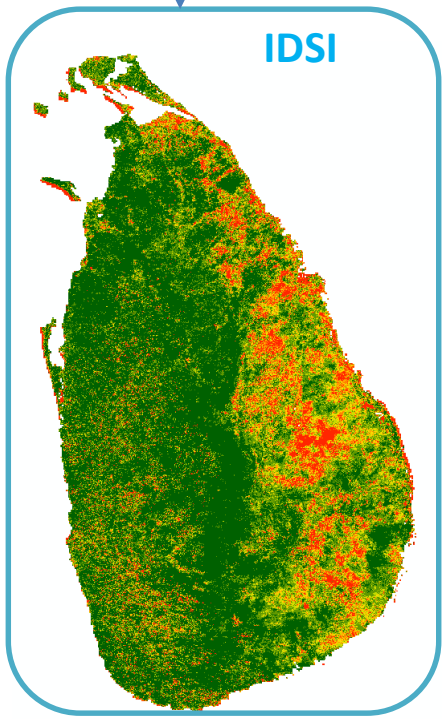


257 – Sep 2nd week

Integrated Drought Response Index (IDSI) – Sri Lanka



1st Week – September 2013

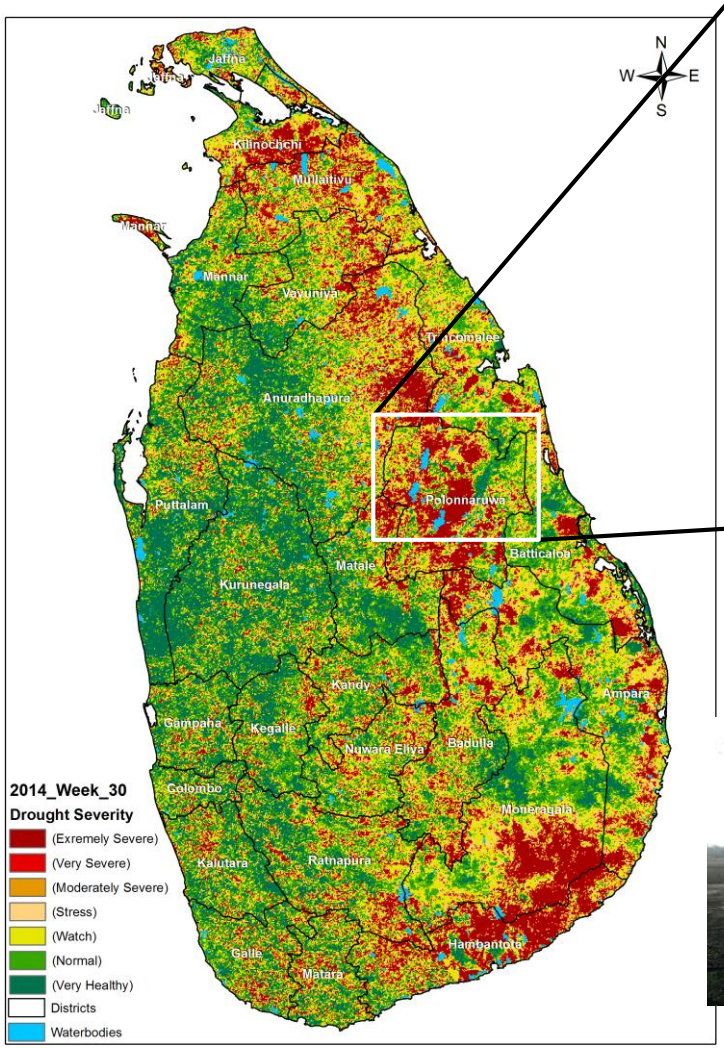


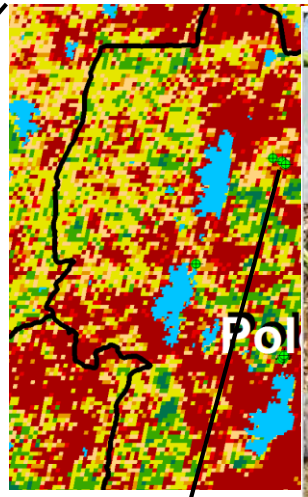
VCI – Vegetation Condition Index; TCI – Temperature condition Index; PCI – Precipitation condition Index; IDSI – Integrated Drought Severity index

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

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 vegetation growth is good, precipitation is high and temperature is favourable.

Characterizing Drought Severity



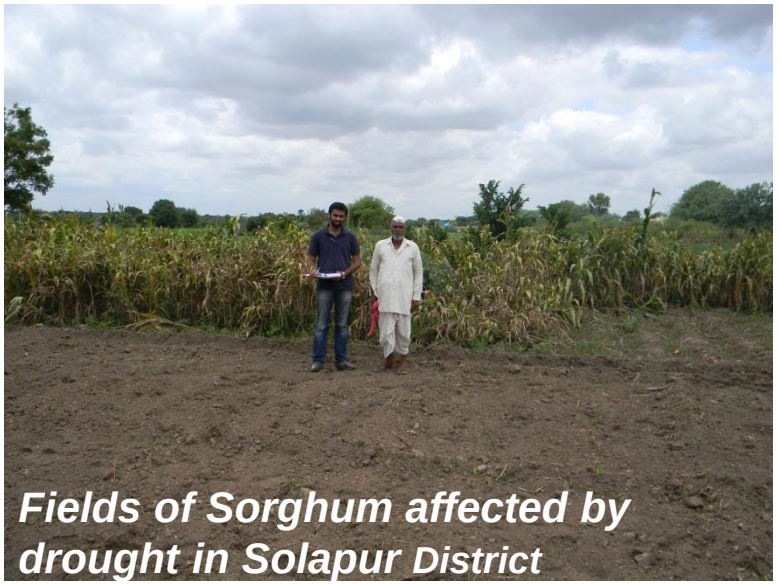


Characterizing Drought Severity

Category	Description	Possible impacts	IDSI Ranges
D4	DS Extreme	Exceptional and widespread crop/pasture losses Shortages of water in reservoirs, streams, and wells creating water emergencies	< 5 (with very low values of VCI, PCI and TCI)
D3	DS Moderate	Major crop/pasture losses Widespread water shortages or restrictions	5 – 10 (with low values of VCI, PCI and TCI)
D2	DS Severe	Crop or pasture losses likely Water shortages common Water restrictions imposed	10 – 15 (with moderate values of VCI, low PCI and TCI)
D1	Stress	Some damage to crops, pastures Streams, reservoirs, or wells low, some water shortages developing or imminent Voluntary water-use restrictions requested	15 – 20 (with moderate VCI, low PCI and moderate TCI)
D0	Watch	Going into drought: short-term dryness slowing planting, growth of crops or pastures Coming out of drought: some lingering water deficits pastures or crops not fully recovered	20 – 40 (with moderate values of VCI, PCI and TCI)
Normal	Normal		>40 (vegetation growth is normal with essential variables with a function of high VCI-TCI-PCI)
Healthy	Healthy		>60 (vigor vegetation with strong correlation on climate indicators)

2014 DROUGHT IN MAHARASHTRA STATE, INDIA

Groundnut and other crops impacted due to lack of water supply in OS District

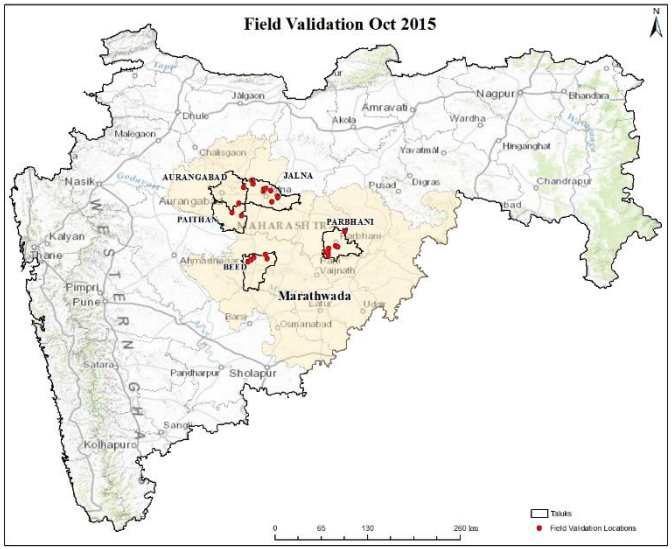


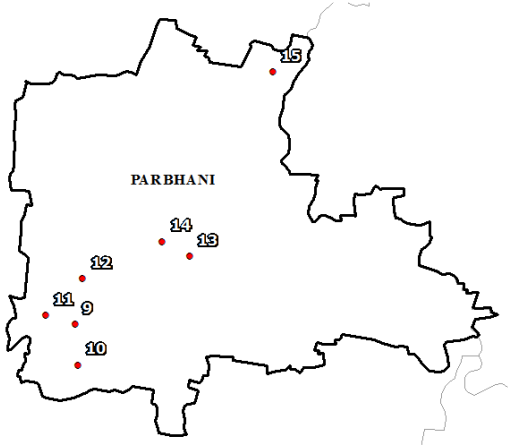
Fields of Sorghum affected by drought in Solapur District

Drinking water supply in drought affected areas of Beed district

Grape fields affected by drought in Osmanabad District

2015 DROUGHT IN MAHARASHTRA STATE, INDIA





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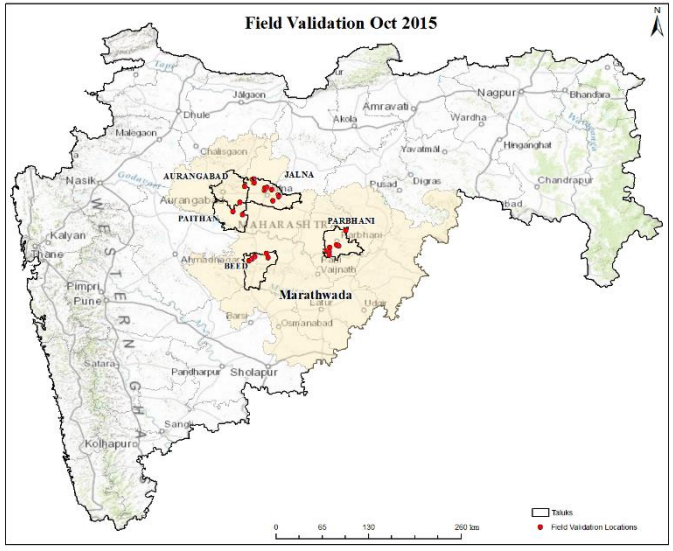
2015 DROUGHT IN MAHARASHTRA STATE, INDIA



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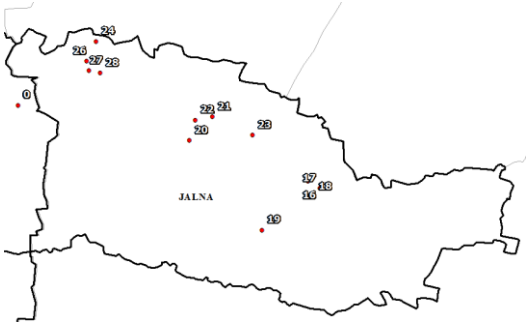

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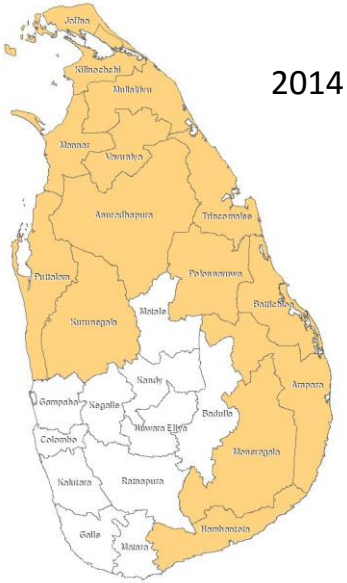
16

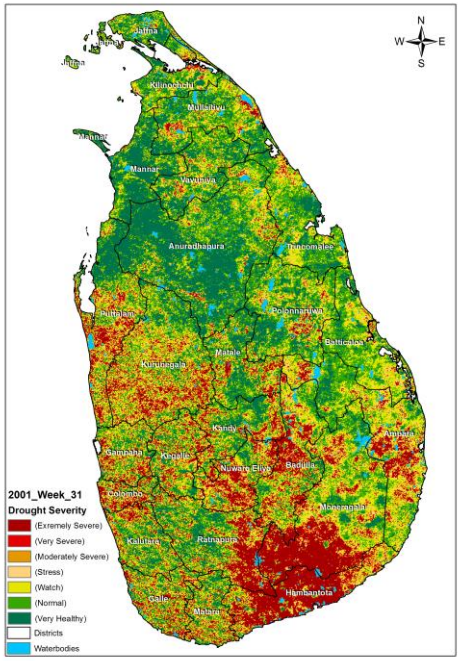
SL Disaster Management Centre (DMC) Drought Maps

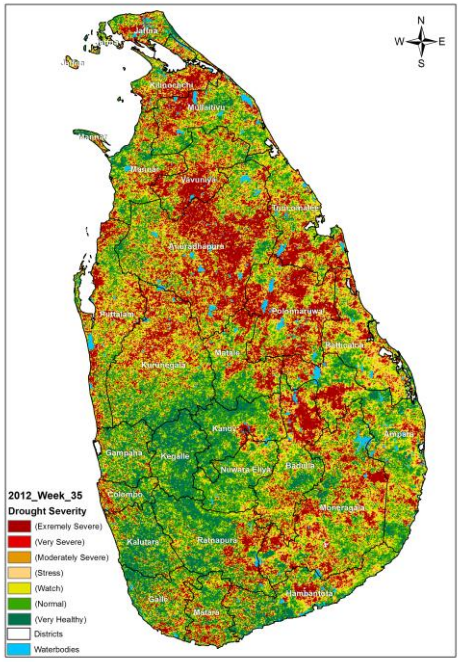
2001

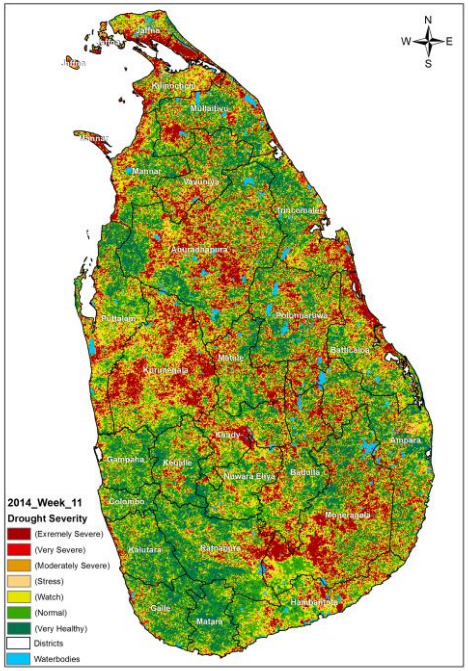
2012



2014

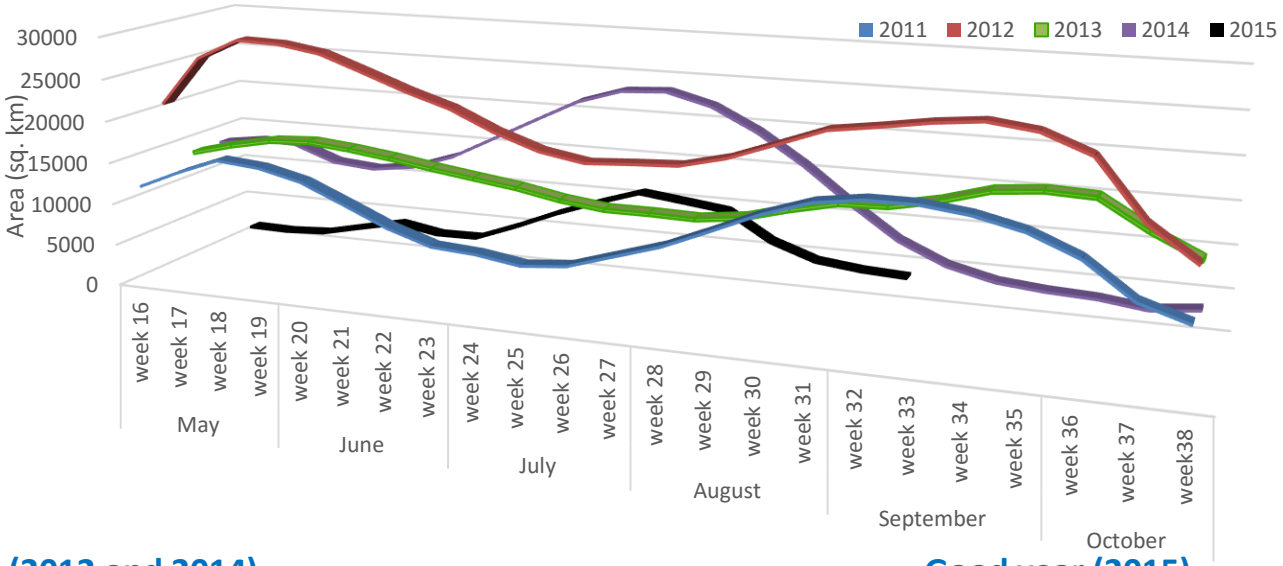




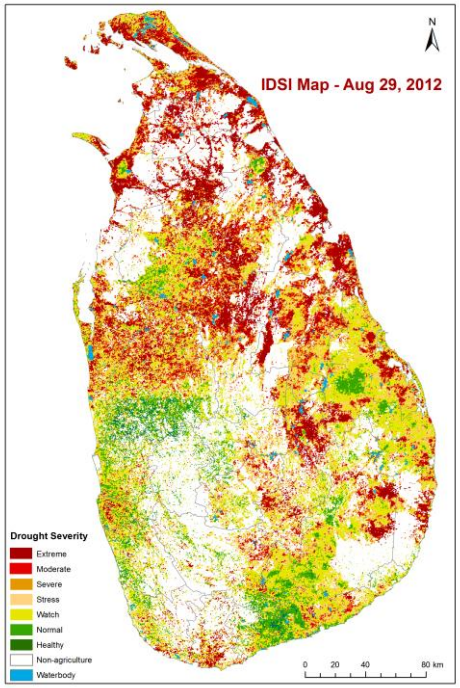


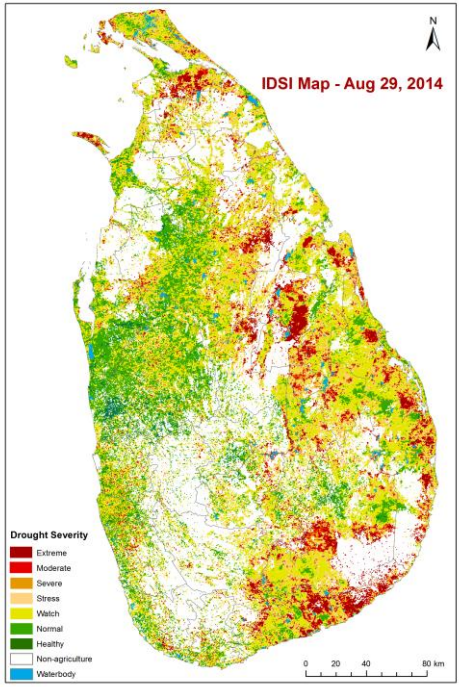
4. SADMS Products and Scaling Up

Spatio-temporal (yearly) pattern of drought severity index for drought years (2012 and 2014) and good year (2015)

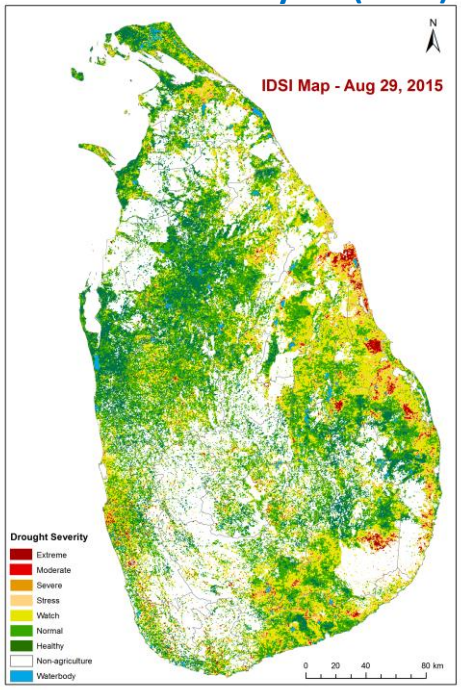


Drought year (2012 and 2014)

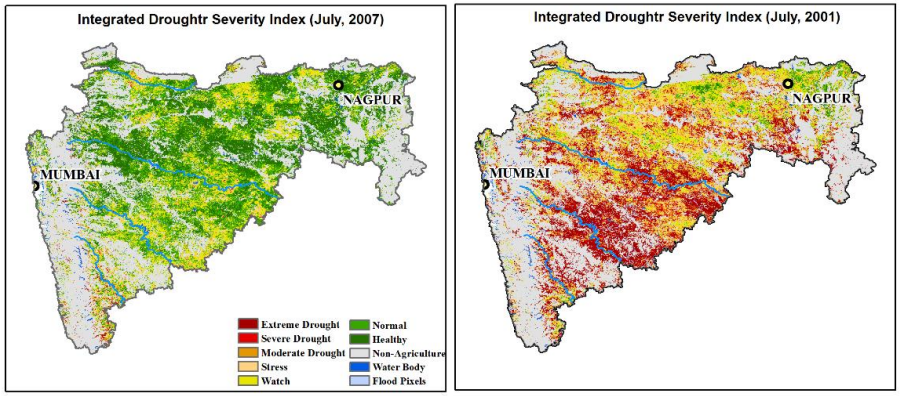


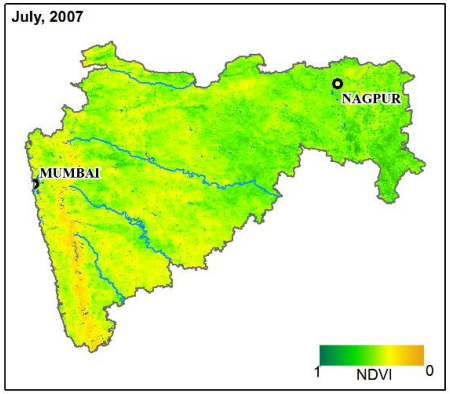


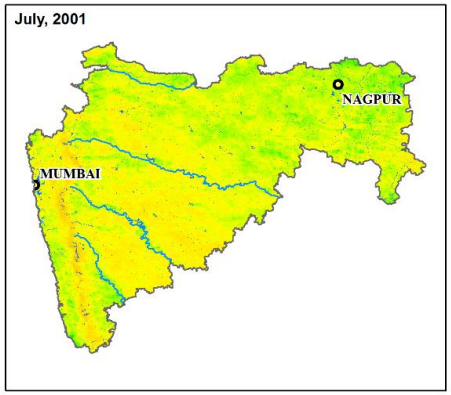
Good year (2015)

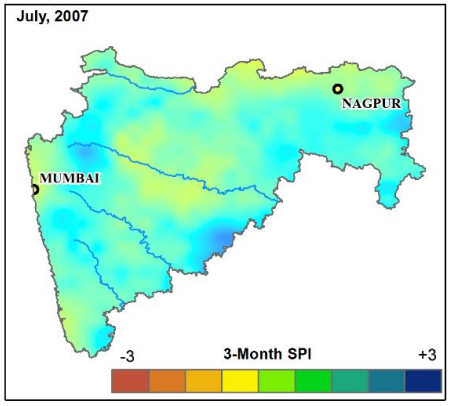


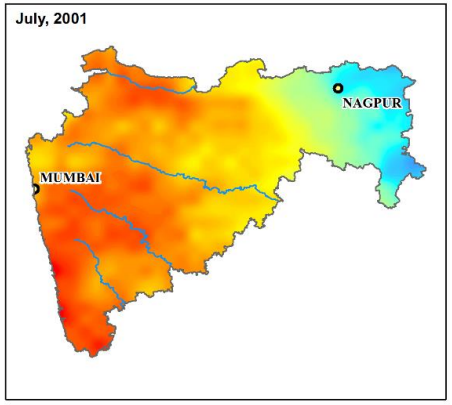
VCI, PCI and Drought Indices for drought year (2001) and normal year (2007), Maharashtra

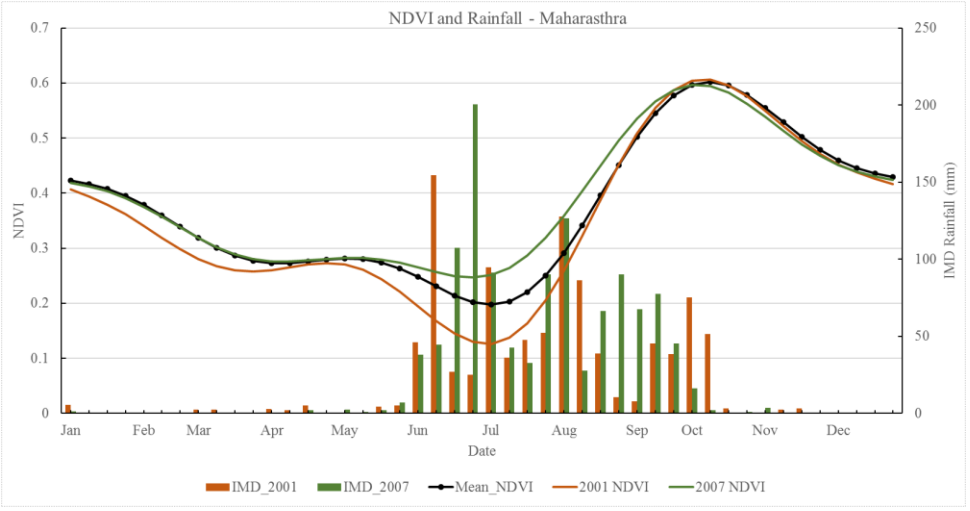




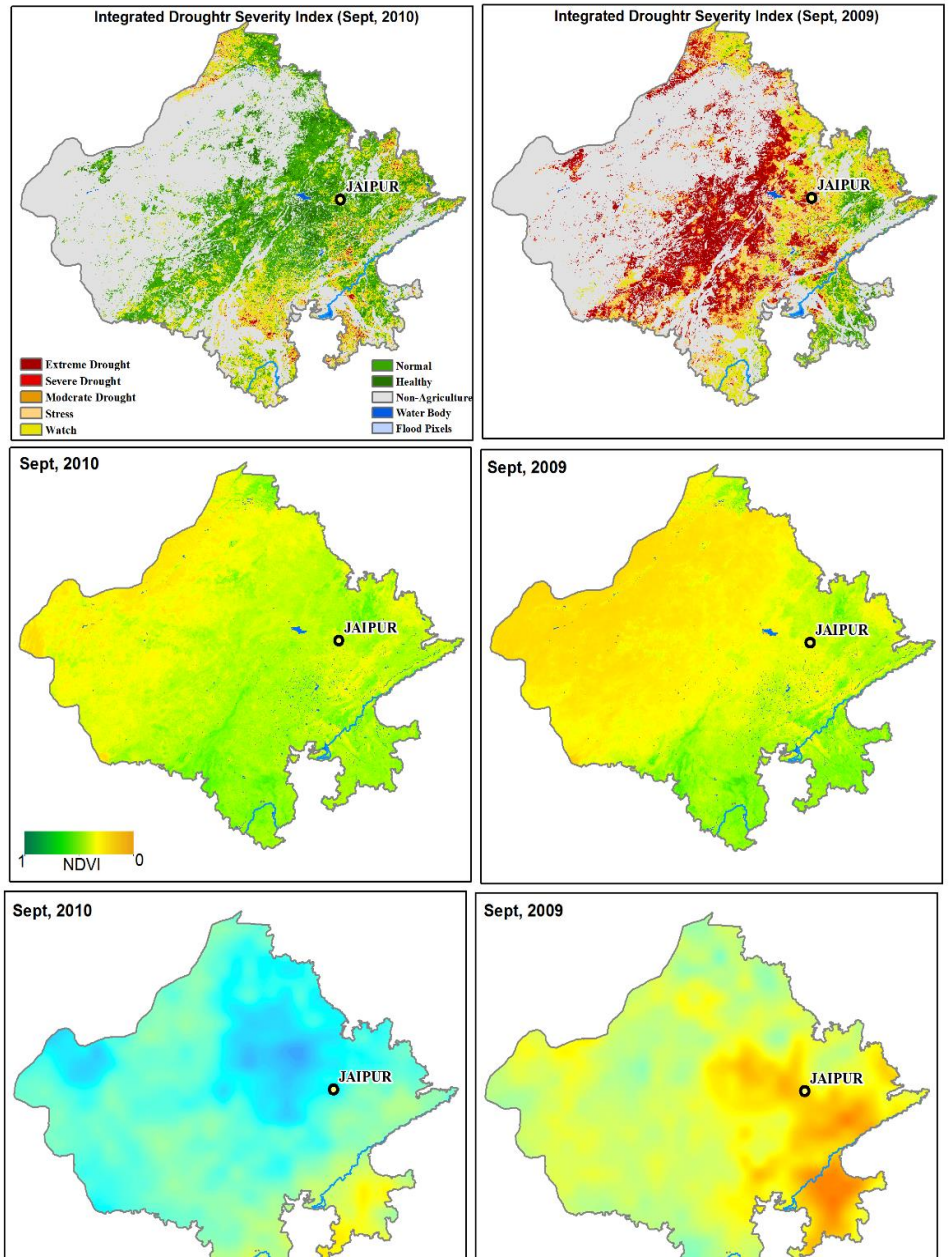






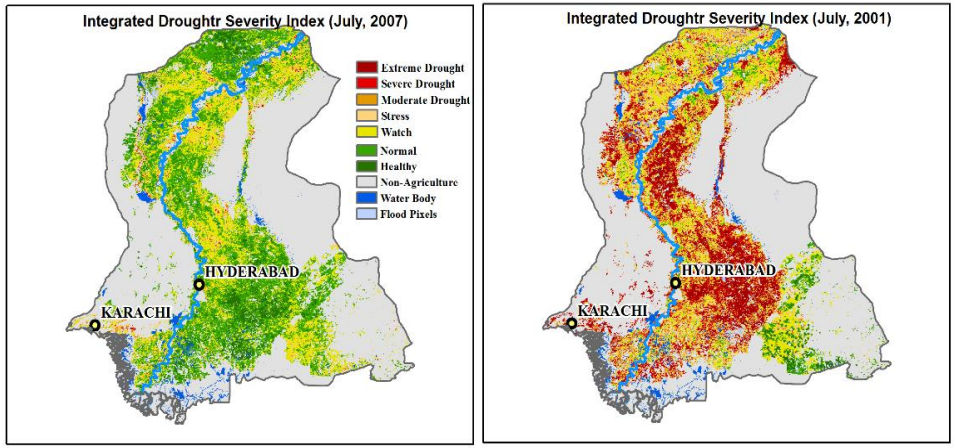


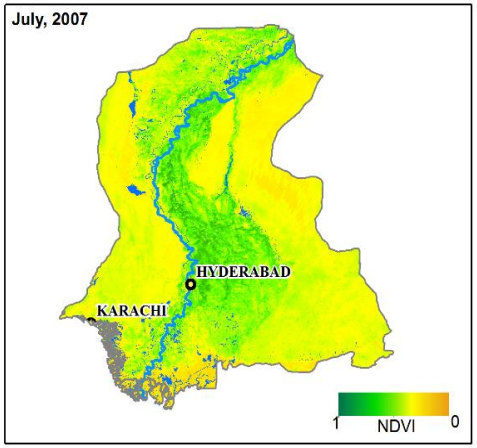
VCI, PCI and Drought Indices for drought year (2009) and normal year (2010), Rajasthan

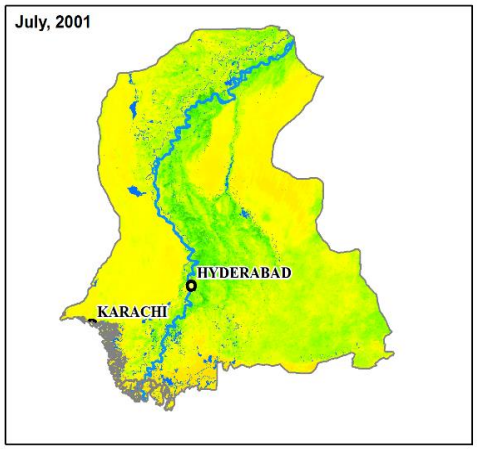


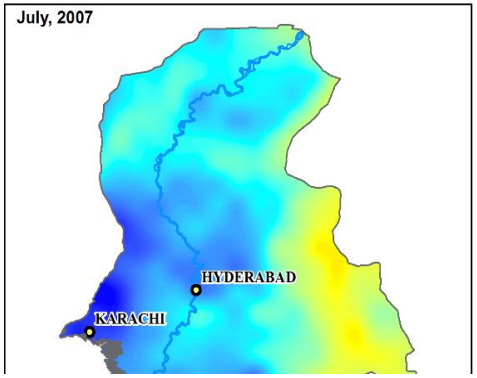
- Long term NDVI records for 15years at each 8-day products of rain-fed season (July–September) was used in the present study.
- Two consecutive years, 2009 and 2010 were chosen for their distinct NDVI characteristics.
- Good correlation observed between the precipitation, vegetation condition and IDSI for drought year and normal year.

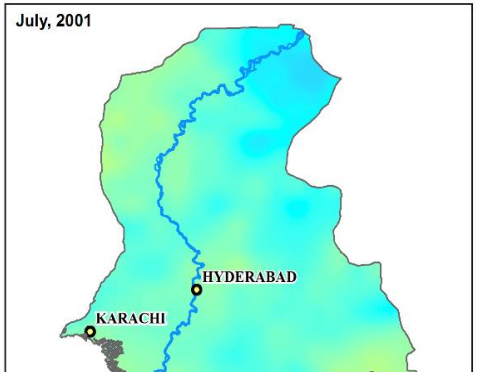
VCI, PCI and Drought Indices for drought year (2001) and normal year (2007), Sindh Province, Pakistan





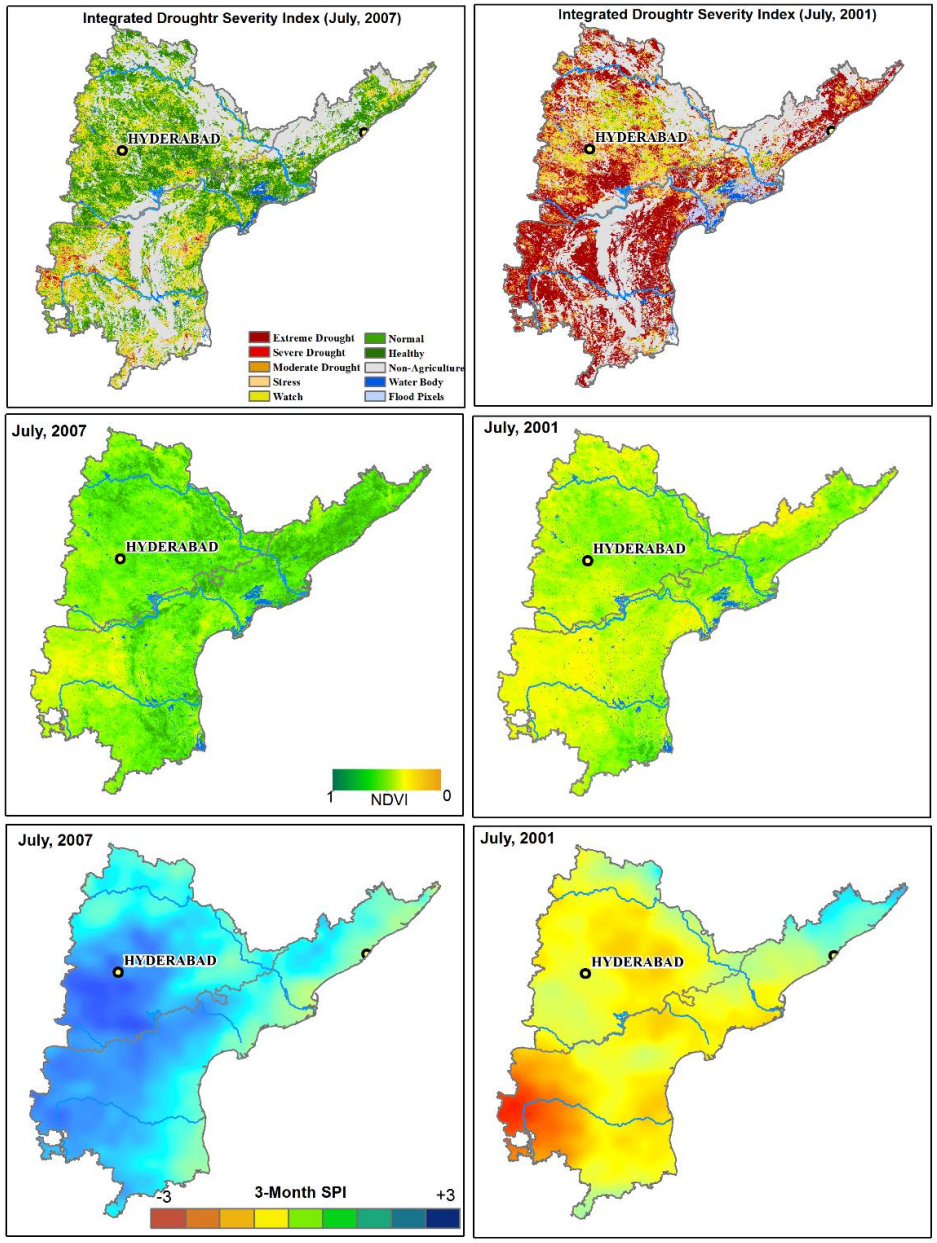


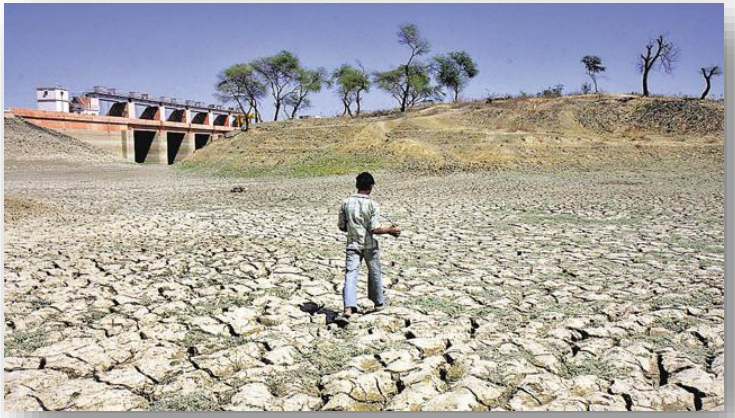




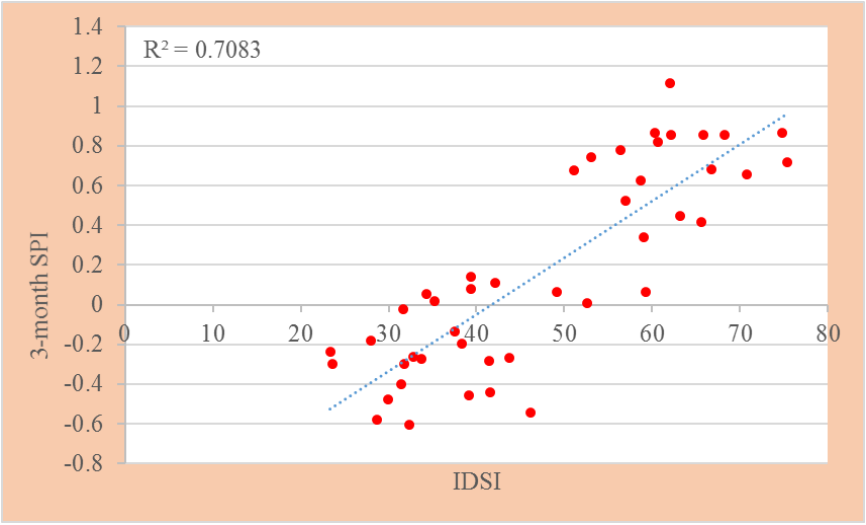
- Long term NDVI records for 15years at each 8-day products of rain-fed season (July–September) was used in the present study.
- Normal year (2007) and drought year (2001) characterize the effects of precipitation on vegetation condition and drought severity.
- Drought affected districts : Tharparkar, Mirpur Khas, Sanghar, Tando Allahyar

VCI, PCI and Drought Indices for drought year (2001) and normal year (2007), Andhra Pradesh





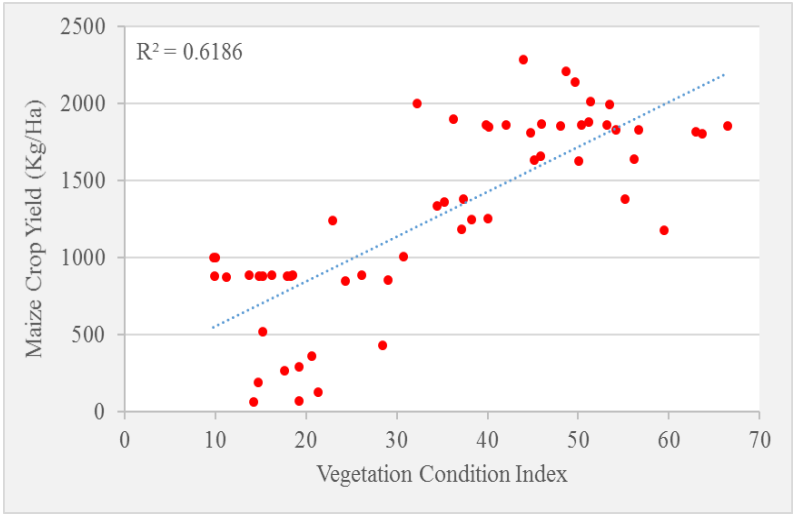
High correlation observed between 3-month SPI, IDSI and rice crop production



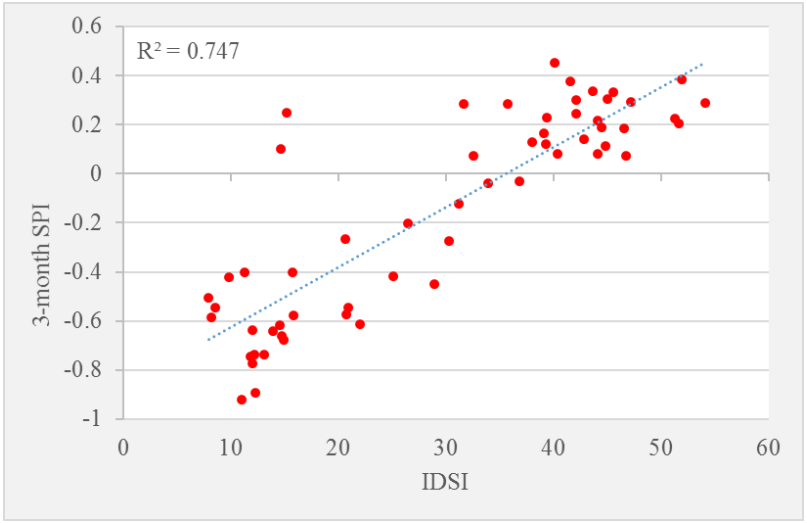
VCI, PCI and Drought Indices for drought year (2009) and normal year (2010), Rajasthan

Crop type: Maize

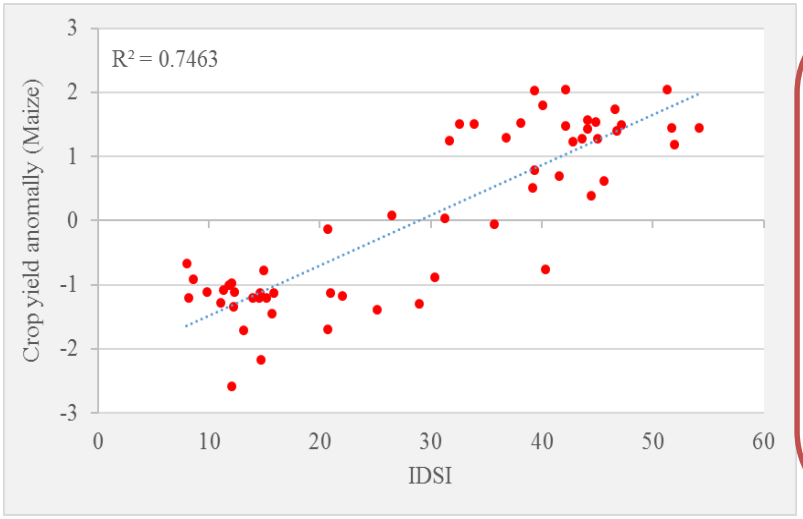
VCI vs. Crop Yield



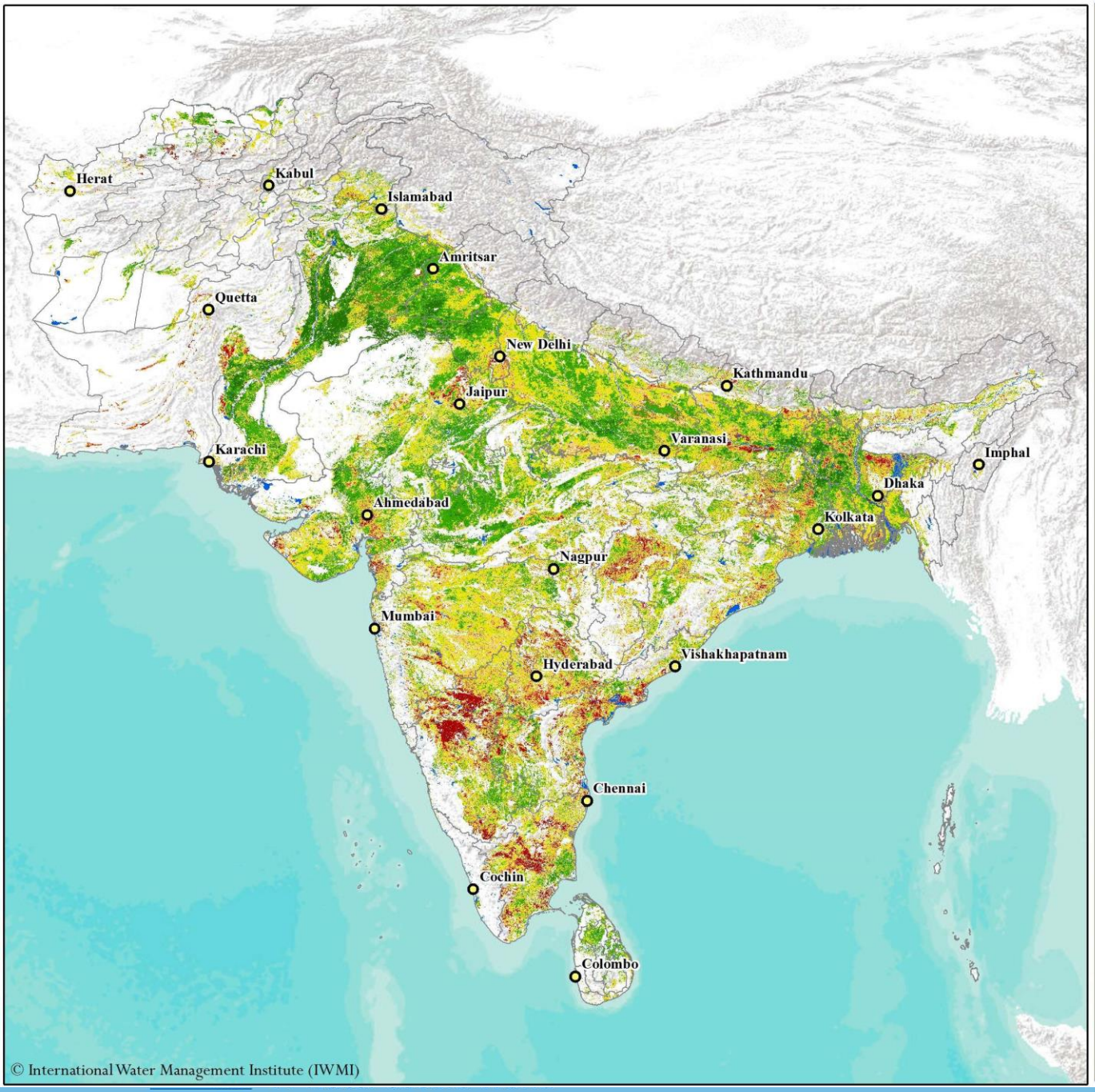
SPI vs. IDSI



YAI vs. IDSI



- Average VCI of rain-fed season was compared with yield of major rain-fed (kharif) crops which reveals that a good agreement
- 3-month SPI also had a good correlation with IDSI for drought year and normal year
- High correlation co-efficient (r) was found to be 0.71, 0.72 and 0.71 (p = 0.05) for sorghum, pearl millet and maize respectively which reveals that there is a strong positive correlation present between VCI and yield of major kharif crops



IWMI
International Water Management Institute

South Asia Drought Monitor

17-24 Jan, 2017

Rabi

The Drought Monitoring System produces Integrated Drought Severity Index (IDSI) on a weekly basis by combining satellite derived information on the conditions of vegetation, temperature and rainfall datasets using long-term (15 years) record.

Drought Classes

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

IDSI product was developed in a joint collaboration with World Meteorological Organizations (WMO), Global Water Partnership (GWP) and CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) led by CIAT and Water, Land and Ecosystems

0 305 610 1,220 km

Drought Assessment on Population Exposure and Agricultural losses

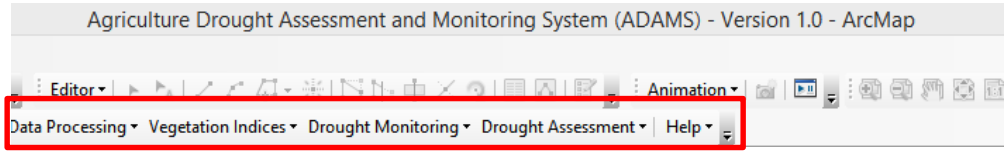
Country Name	Geographical area (km^2)	Agriculture area (km^2)	Average	% from total area	% from Agriculture area
India	3,263,578	1,734,193	683,538	20.94	39.42
Sri Lanka	65,846	22,013	5,956	9.05	27.06
Pakistan	793,931	286,805	105,484	13.29	36.78
Afghanistan	644,073	379,100	16,390	2.54	4.32
Bangladesh	135,033	105,130	35,767	26.49	34.02
Bhutan	39,652	2,776	326	0.82	11.73
Nepal	146,879	51,216	12,594	8.57	24.59

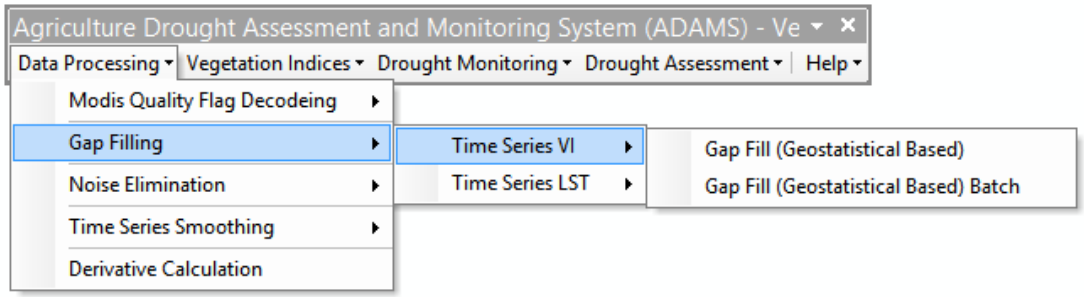
Country	Population	Average Affected (2001-2015)	% affected (2001-2015)
India	1,251,695,584	279,246,978	22.31
Sri Lanka	20,770,749	1,357,281	6.53
Pakistan	188,924,874	39,814,332	21.07
Afghanistan	32,564,342	2,748,627	8.44
Bangladesh	160,995,642	35,459,353	22.03
Bhutan	774,830	35,547	4.59
Nepal	28,679,524	5,737,401	20.01

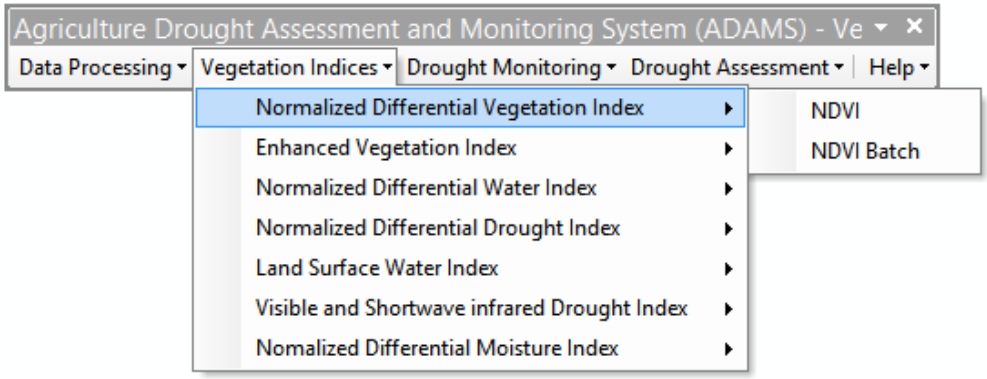
- Average drought affected area in agriculture approx. 860,000sq.km for South Asia between 2001 to 2015;
- Among SA countries, India ranks the highest drought affected area ~683,000sq.km followed by Pakistan (105,484sq.km), Bangladesh (35,767sq.km)
- In terms of Population exposure from drought approx. 365 million people of which Indian parts covers 279million followed by 39 million in Pakistan, Bangladesh 35million and others

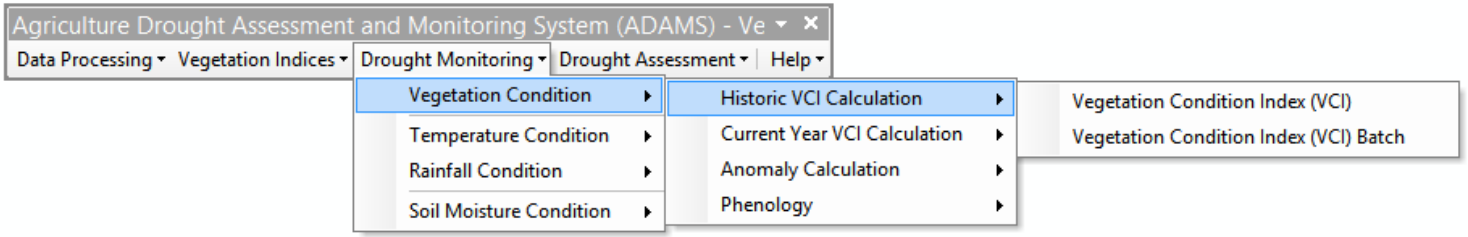
3. SADMS Tools, Portal and Outreach

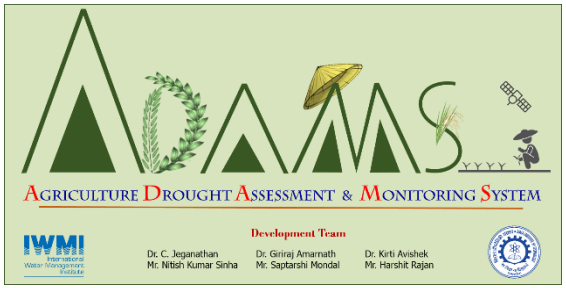
Drought Monitor tool (DMS)



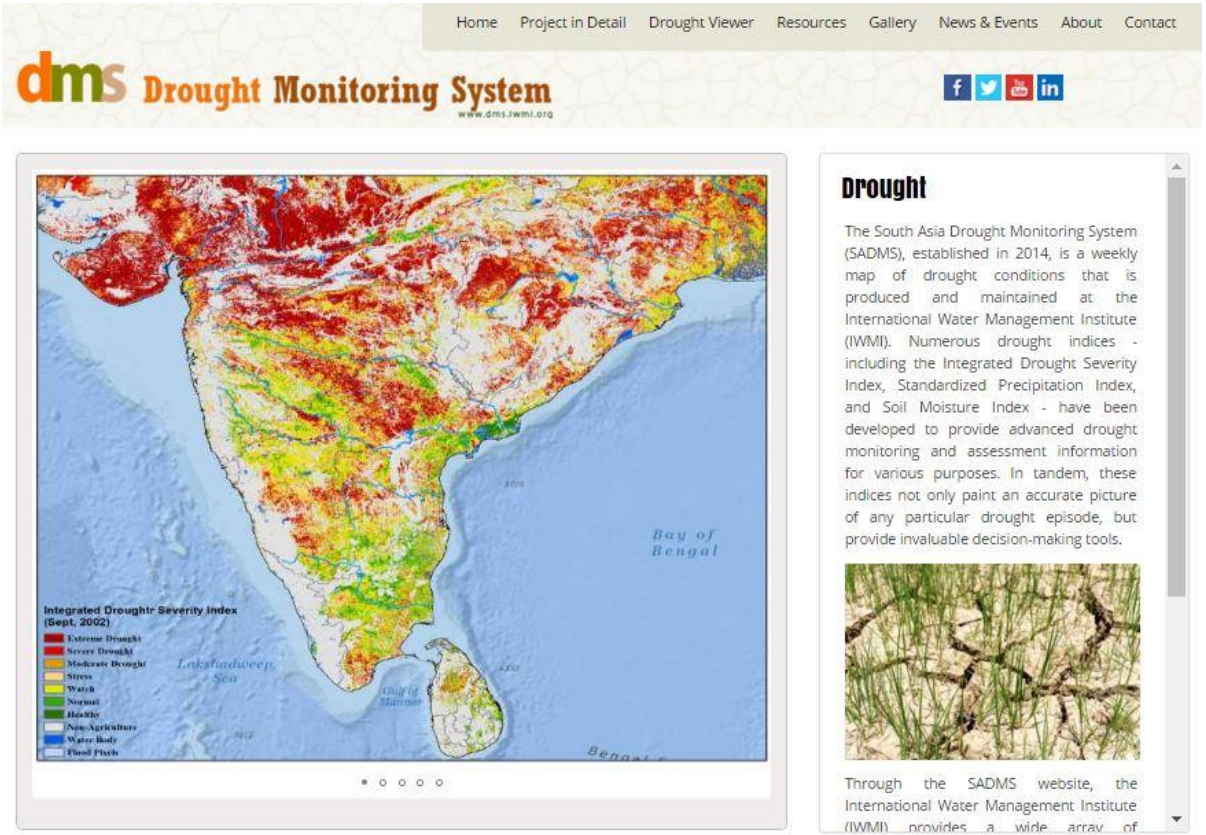








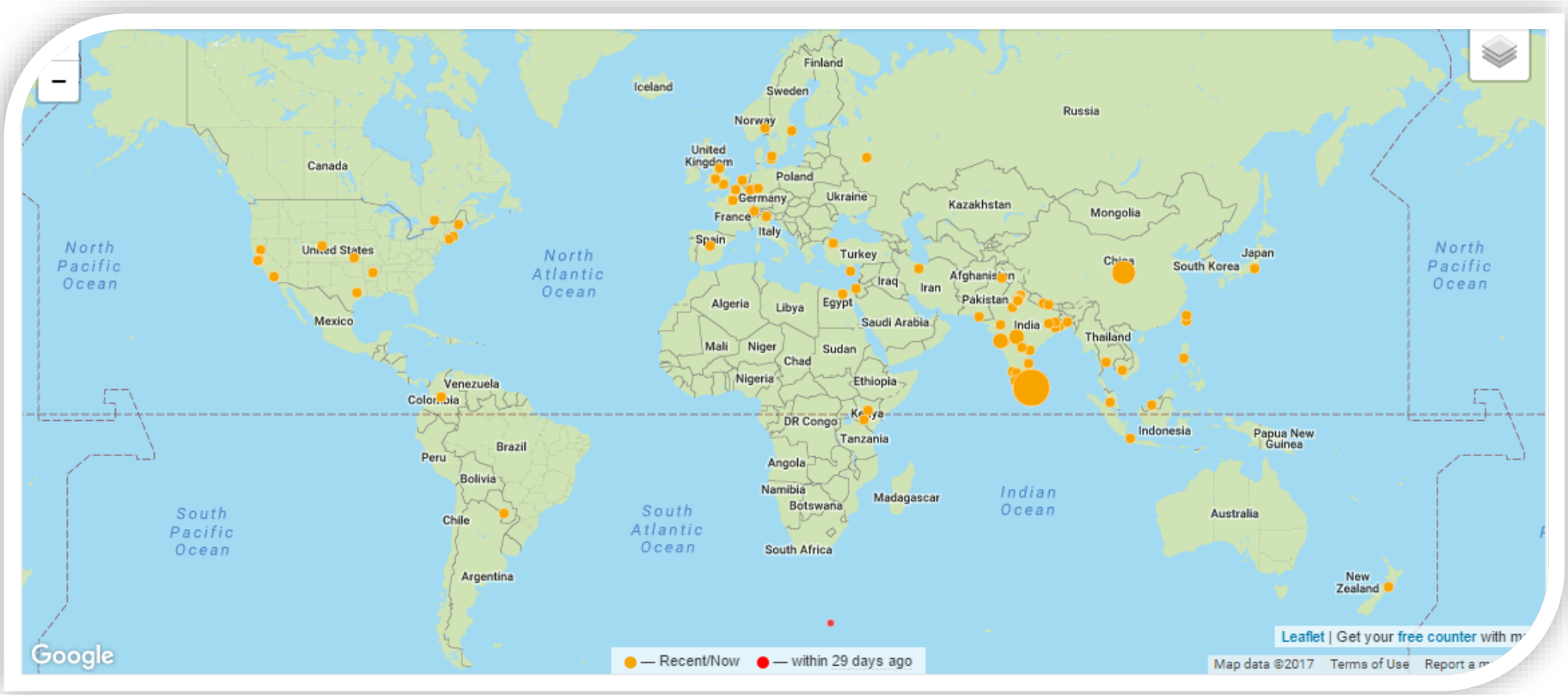
DMS tool was developed using ESRI ArcGIS interface



Key remarks

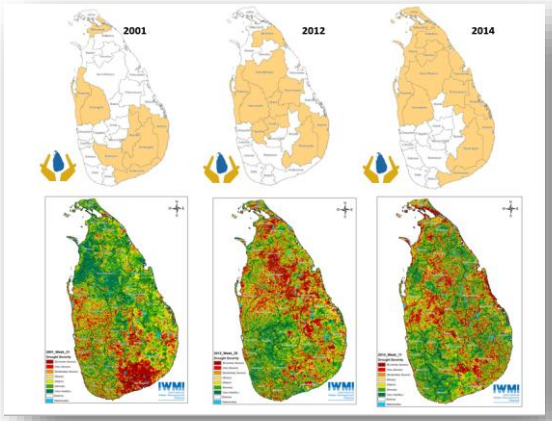
- An operational platform that integrates various drought products to provide advanced drought monitoring and assessment information for various purposes
- A first regional platform for South Asia and have inherently finer spatial detail (500m resolution) than other commonly available global drought products

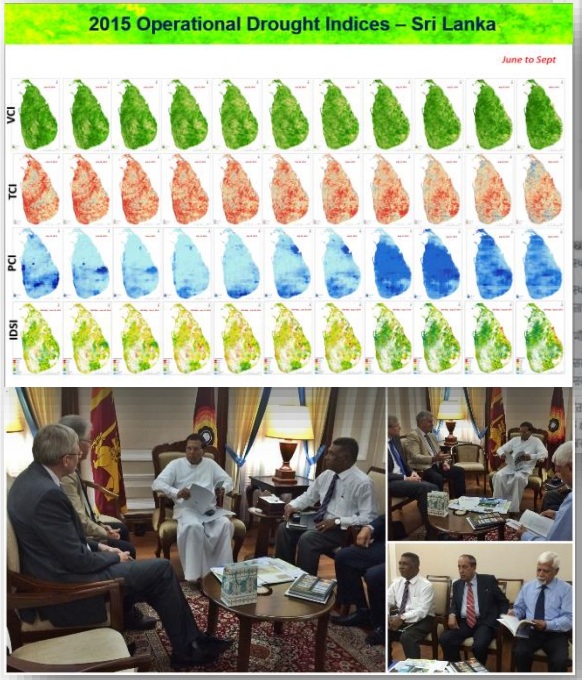
SADMS Portal Visitor



- 33 Countries
- 400 page views since Jan 11
- South Asia dominant visitors

OUTREACH





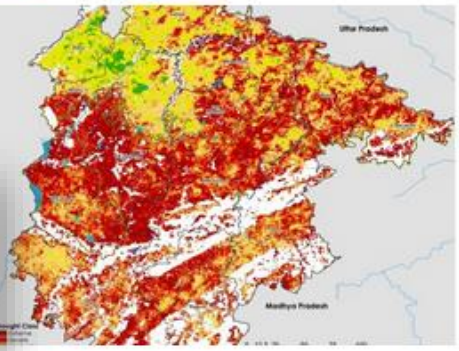
गाँव कनेक्शन
India's Rural Newspaper

होम | विस्तृत समाचार | संवाद | कृषि व्यापार | खेती किसानी | बदलता इंडिया | नारी | सेहत कनेक्शन

स्वयं प्रोजेक्ट | गाँव कनेक्शन फ़ाउन्डेशन | रूरलवायर | बात पते की | मनोरंजन | रिपो | गाँव चौपाल

होम » विस्तृत समाचार

बुंदेलखण्ड की इस तस्वीर में पानी ढूंढिए तो जानें



Daily News paper (Lanka)

Uncertain waters: Dealing with increasing floods and droughts demands new thinking and new technologies

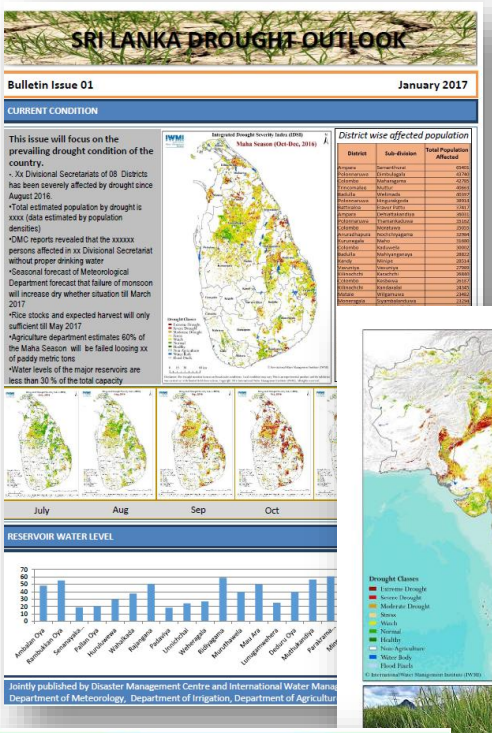
Times of India Newspaper (India)

IWMI
International Water Management Institute

A water-secure world

OUTREACH

Bulletin


SRI LANKA DROUGHT OUTLOOK

Bulletin Issue 01 January 2017

CURRENT CONDITION

This issue will focus on the prevailing drought condition of the country.

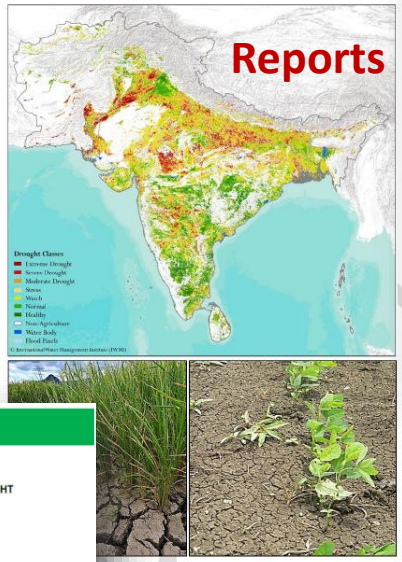
- Xx Divisional Secretariats of 08 Districts has been severely affected by drought since August 2016.
- Total estimated population by drought is xxxx (data estimated by population densities)
- DMC reports revealed that the xxxxxx persons affected in xx Divisional Secretariat without proper drinking water
- Seasonal forecast of Meteorological Department forecast that failure of monsoon will increase dry whether situation till March 2017
- Rice stocks and expected harvest will only sufficient till May 2017
- Agriculture department estimates 60% of the Maha Season will be failed loosing xx of paddy metric tons
- Water levels of the major reservoirs are less than 30 % of the total capacity

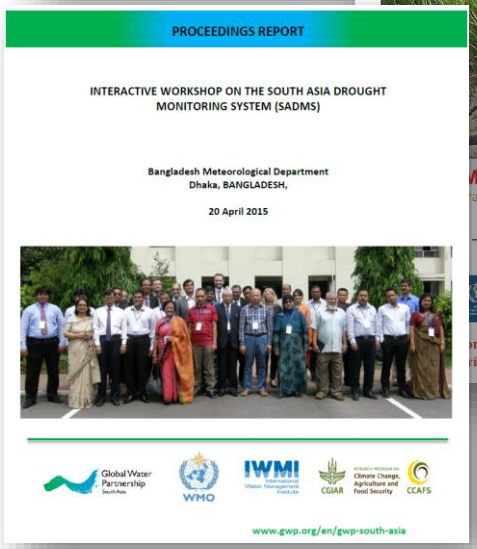
District wise affected population

RESERVOIR WATER LEVEL

Jointly published by Disaster Management Centre and International Water Manag
Department of Meteorology, Department of Irrigation, Department of Agricultur

Reports


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


PROCEEDINGS REPORT

INTERACTIVE WORKSHOP ON THE SOUTH ASIA DROUGHT MONITORING SYSTEM (SADMS)

Bangladesh Meteorological Department
Dhaka, BANGLADESH,

20 April 2015

www.gwp.org/en/gwp-south-asia


South Asia drought monitoring system

A collaborative program to build greater resilience to drought, and mitigate its impacts on societies and economies

Key facts on Asia's drought disasters between 1900 and 2013

- Number of drought events: 117
- Total number of people killed: 5,308
- Population affected: 1.3 billion
- Total damages: USD 37.43 billion
- Major drought events: 1987, 1999, 2000, 2002, 2009, 2014

Source: EM-DAT 2015.

Background

Drought is one of the major constraints affecting the food security and livelihoods of more than two billion people that reside in the dry areas, which constitute 41% of the world's land surface. In South Asia, drought occurs frequently in arid and semi-arid regions. From early 2000 onwards, severe droughts affected vast areas of South Asia, including western India, and southern and central Pakistan. The South Asian regions have been among the perennially drought-prone regions of the world. India, Pakistan and Sri Lanka have reported droughts at least once in every 3 years in the past five decades, while Bangladesh and Nepal also suffer from frequent droughts.

In recent years, the increased pressure on natural resources, soil degradation, decrease in water resources and projected future climate change scenarios have become important areas of concern. Proper quantification of drought impacts and monitoring of areas prone to such events are needed for formulating management plans. Therefore, it is critical to better understand drought climatology, and to establish a comprehensive and integrated drought information system that incorporates climate, soil and water supply factors.

In view of the above, the International Water Management Institute (IWMI) proposed an innovative approach to developing an operational drought monitoring system for South Asia, using remote sensing data from multiple sources. The main monitoring tool will be the Integrated Drought Severity Index (IDSI) covering South Asia on a weekly basis, which reflects the effects of droughts as observed through (i) satellite-derived vegetation data, and (ii) the level of dryness expressed by traditional, climate-based drought indices. Additional biophysical environmental characteristics, such as eco-region, elevation, land use and land cover (LULC) type, and soil type, are also considered because they can influence climate-vegetation interactions.

The South Asia drought monitoring system is being developed and implemented by IWMI, and is supported by the World Meteorological Organization (WMO), Global Water Partnership (GWP), and the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

Articles

Monitoring and Assessment in South Asia
ation of satellite technology and the future of food security
– September 2016

rm of the report is in draft stage and has not yet been approved by
ider circulation.

Dr. Giriraj Amarnath

Giriraj Amarnath is a remote sensing researcher specialized in the application of remote sensing and geographic information systems in the study of risk assessment across a wide range of natural hazards and monitoring land and water resources in Asia and Africa. His interests include studying the relationship between land use changes, hydrology, impact of flooding on food security and livelihood.

Join @ScidevNet_SA for a Twitter Chat

"Floods, droughts and South Asia's settlements." #UrbanResilience

Wednesday, August 10 at 15:00 IST

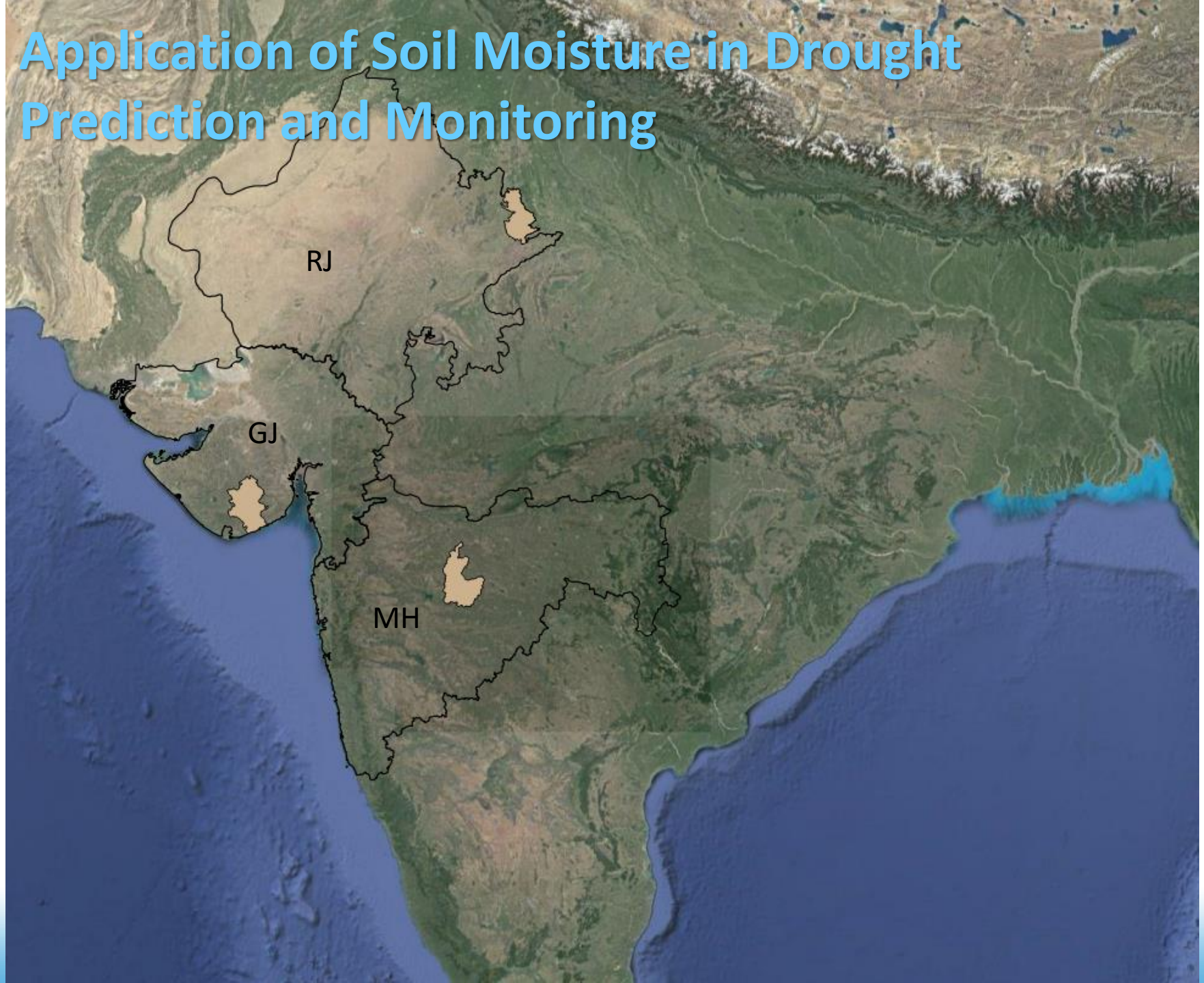
SADMS - SWOT Matrix

SWOT MATRIX	
Strength	Weakness
• Drought Monitoring System tailored specifically for South Asia • Created using opens source, freely available remote sensing datasets. • Rigorously tested methodology with multi-country field validation • Ability to monitor / explore conditions / severity at different scales i.e from regional to district level • Enhanced accessibility of dataset through interactive web-based interface. • Potential to upscale to any regions and develop own country specific drought monitoring modules • Ability to link data to policy	• Need further validation across diverse agro-climatological conditions across South Asia for future improvements. • Accessibility in countries with low internet penetration. • Low to medium technical capability of South Asian countries other than India and Pakistan for early adoption through establishment of countrywide node. • Current lack of linkages with drought forecasting system (will be integrated in the future).
Opportunities	Threats
• Existence of national/state disaster management center/associations for wide adaption across South Asia. • Ongoing activities to tie and foster capacity building programs on application of space technologies for disaster management in South Asian countries with limited capability. • Possibility to integrate with other regional monitoring programs and drought forecast system for improved reliability of information. • Adoption at SAARC organization level for enhanced visibility and eventual applicability • Large private sector end users from insurance companies particularly in India	• Requires consistent updation of dataset to provide reliable, timely drought information. • Future human and financial commitments necessary for the constant maintenance of SADMS by multilateral and ownership organization. • Lack of awareness and capacity building for stakeholders at district / sub-district level. • Conflicts between South Asian countries might impede cop-operation of SADMS for regional development in the future

Draft version

4. SADMS New Initiatives

Application of Soil Moisture in Drought Prediction and Monitoring



Datasets

- Root zone soil moisture
  - daily, 0.1 degrees spatial resolution
  - derived from ASCAT sensors on-board MetOp-A and MetOp-B satellites
  - very good performance over India (Bhimala and Goswami, 2015)
- Normalized Difference Vegetation Index (NDVI)
  - processed by Peejush and Niranga
  - gapfree
  - 8 daily, 500 m spatial resolution

Soil Water Anomalies based Drought Index (SWADI)

SWADI classification:

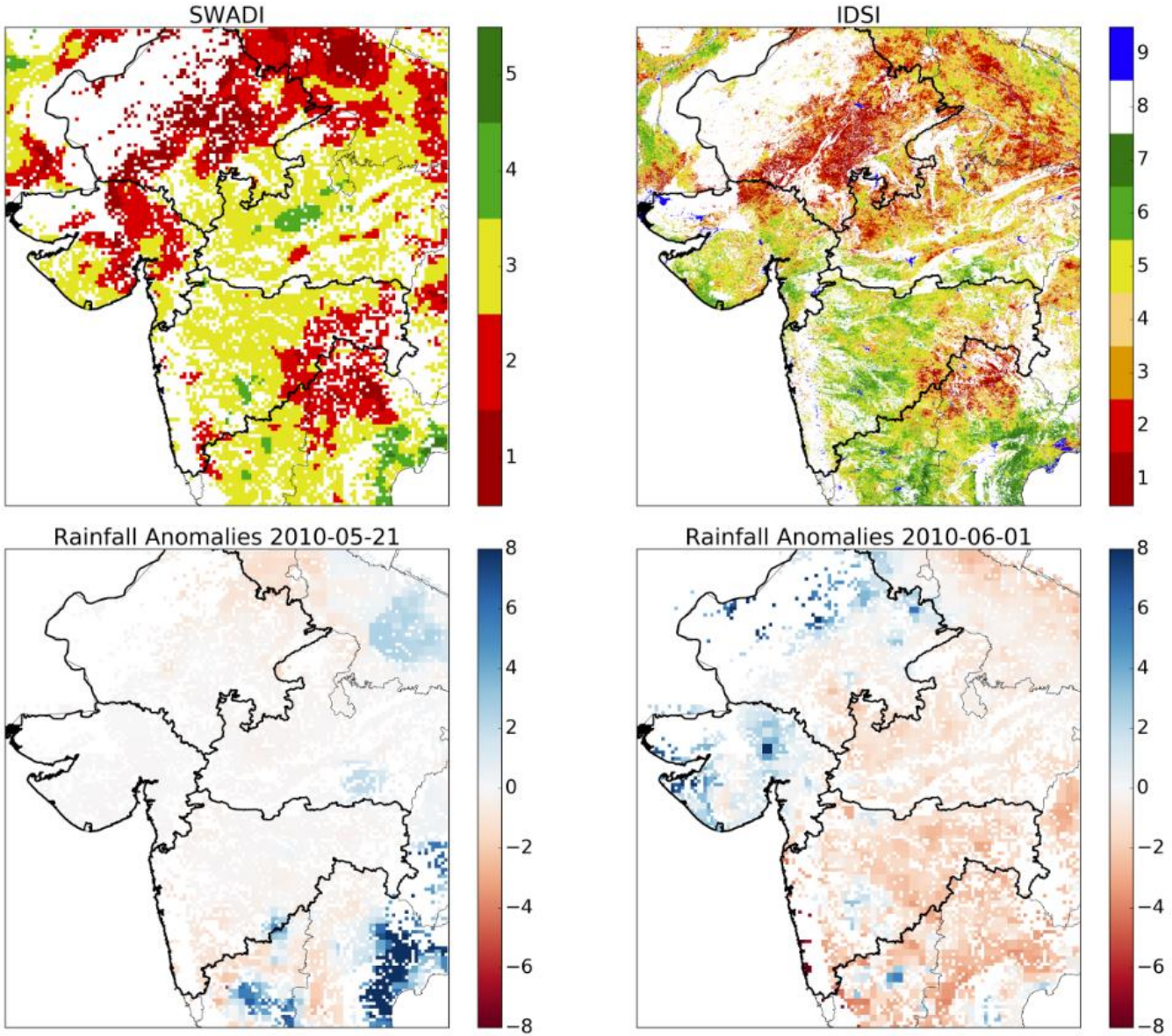
SWI Anomaly value [%]	SWADI value	Vegetation State/Drought Level
< -10	1	Severe Drought
-10 to -5	2	Moderate Drought
-5 to 2	3	Watch
2 to 9	4	Normal
> 9	5	Healthy

SWADI is compared to IDSI and IMD Rainfall:

- visually compared to each other
- calculation of correlation coefficient of time series
- correlation coefficient between rainfall and soil moisture

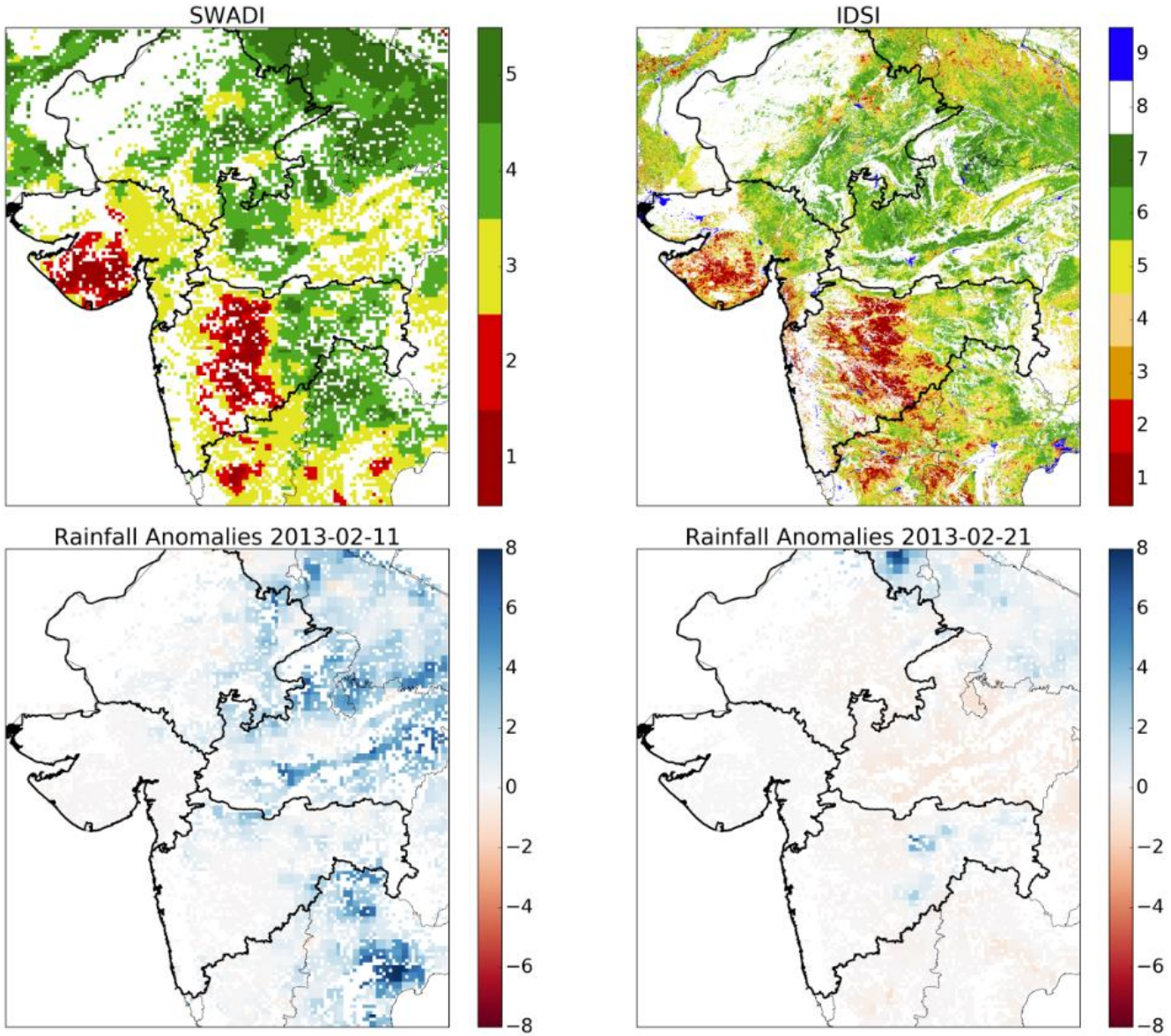
Evaluation: June 2010 (IDSI vs SWADI

Application of Soil Moisture in Drought Prediction and Monitoring

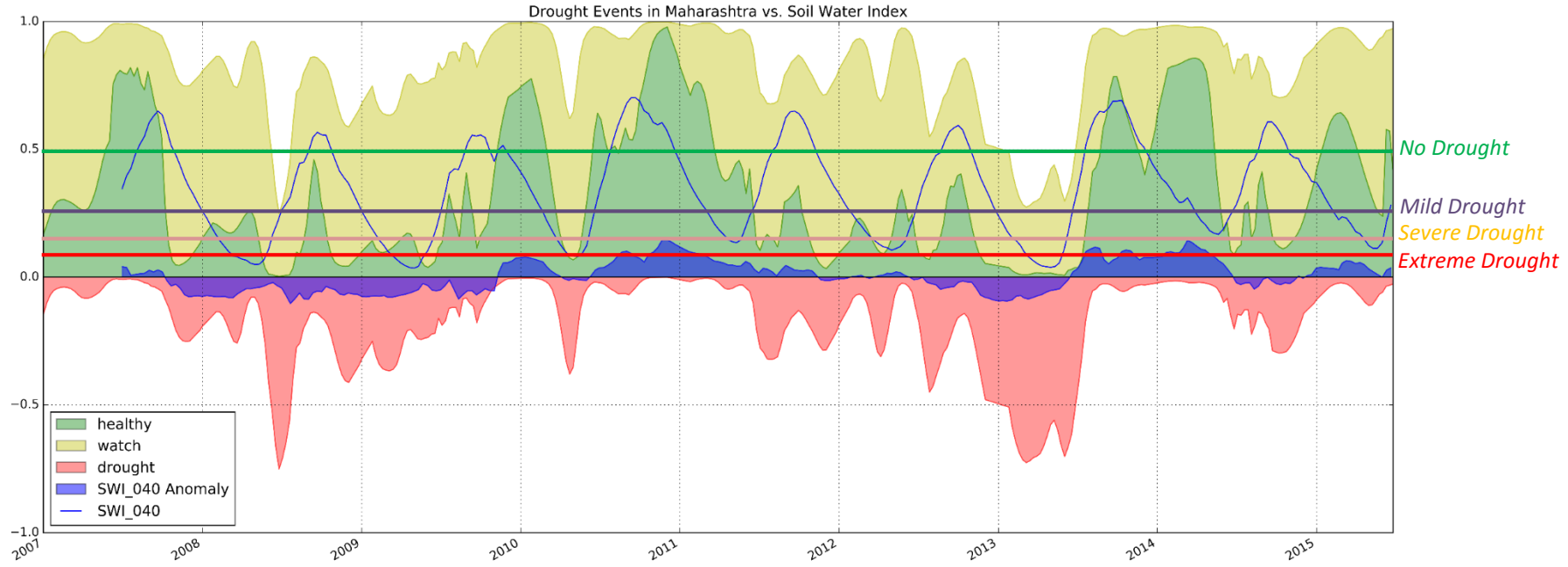


Evaluation: Feb 2013 (IDSI vs SWADI

Application of Soil Moisture in Drought Prediction and Monitoring



Comparison of IDSI and Soil Water Index

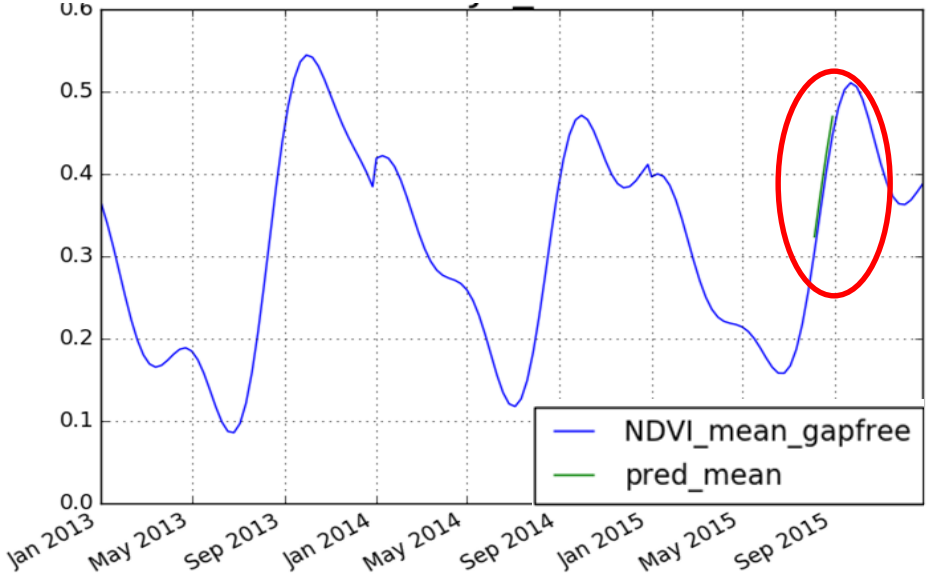


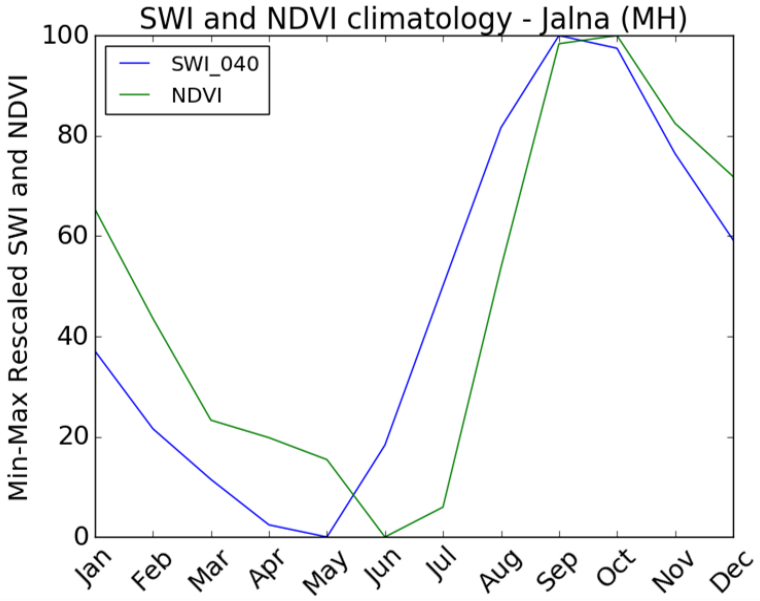
- The Soil Water Index quantifies the moisture condition at various depths in the soil. It is mainly driven by the precipitation via the process of infiltration.
- High correlation was achieved between IDSI and SWI for different test sites in India.
- Table shows SWI for soil root zone depth with high correlation in reference to increase in soil depth

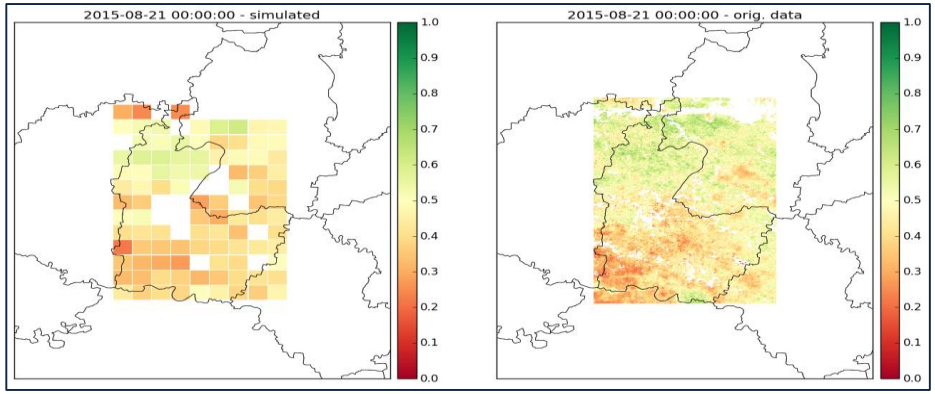
SWI	Correlation
SWI 001	0.595
SWI 005	0.647
SWI 010	0.694
SWI 015	0.724
SWI 020	0.743
SWI 040	0.766
SWI 060	0.761
SWI 100	0.702

Credit: WDRM sub-theme

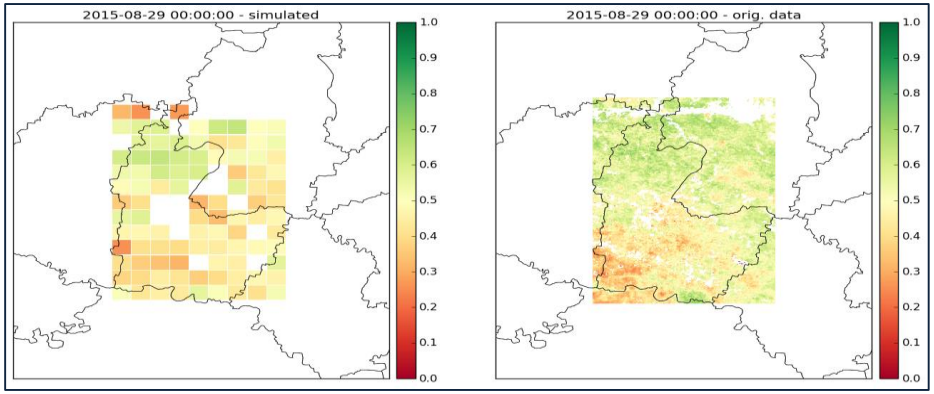
Advancing Drought Prediction using Satellite-based Surface Soil Moisture Data in Agriculture Drought Monitoring







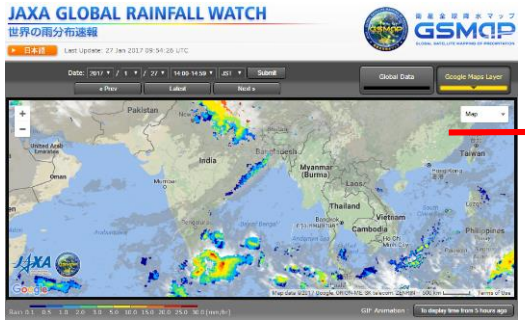
21 Aug 2015 (Pred vs Obs Veg)



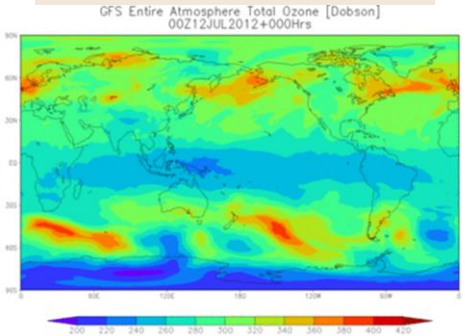
29 Aug 2015 (Pred vs Obs Veg)

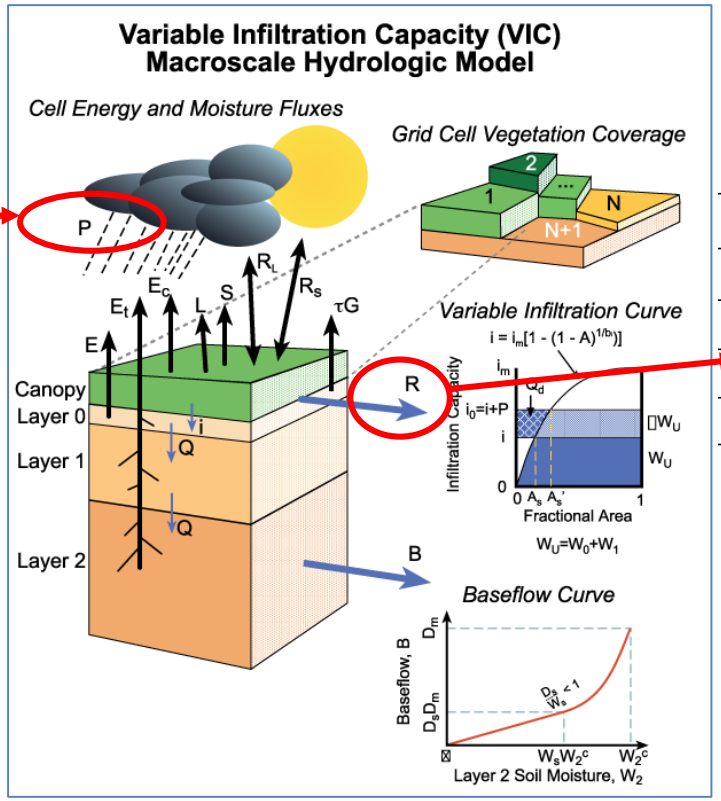
South Asia Drought Forecasting and Early Warning (SADEWS)

Near-real-time rainfall estimate

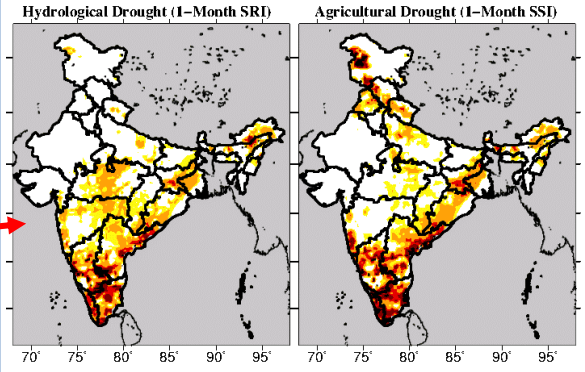


Rainfall forecast by GCM





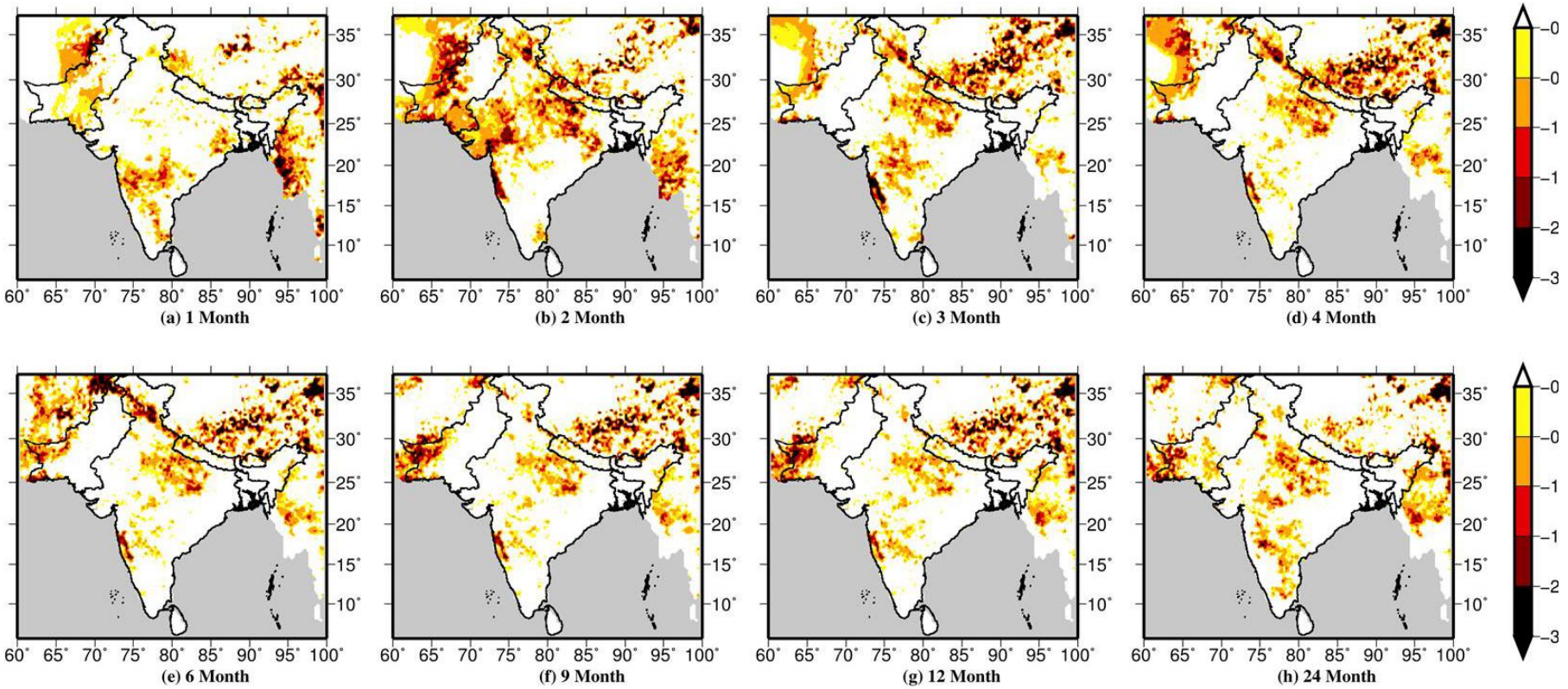
SRI: Hydrological drought severity
SSI: Agricultural drought severity



Forecasting impact on agriculture

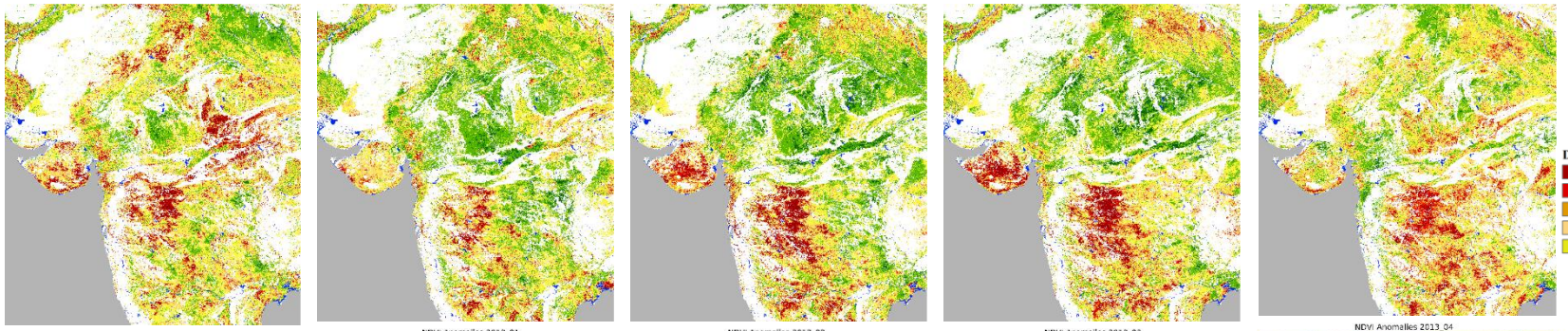
South Asia Drought Forecast System

Standardized Runoff Index (SRI)



The monitor successfully captures the hydrological drought of 2015 at the end of the monsoon (JJAS)

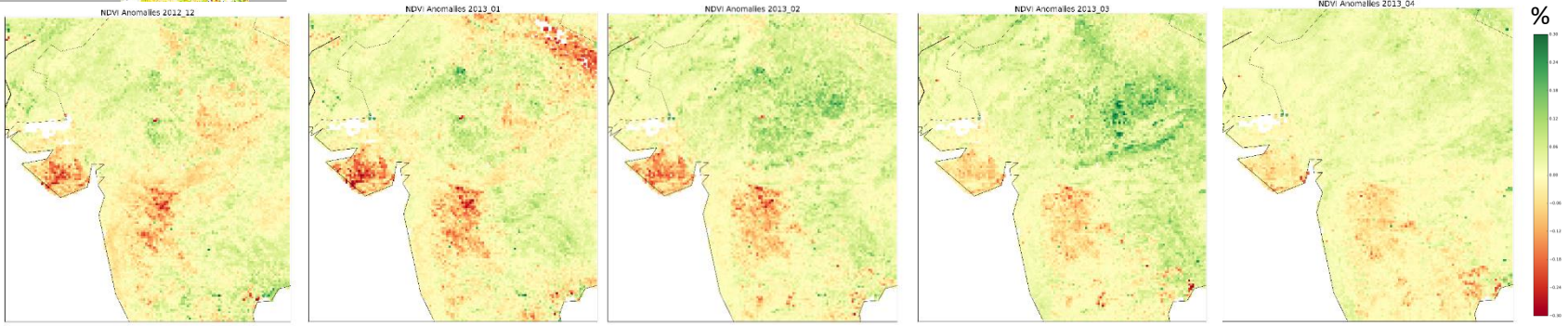
Evaluation of drought indices IDSI and its correlation with Soil Moisture



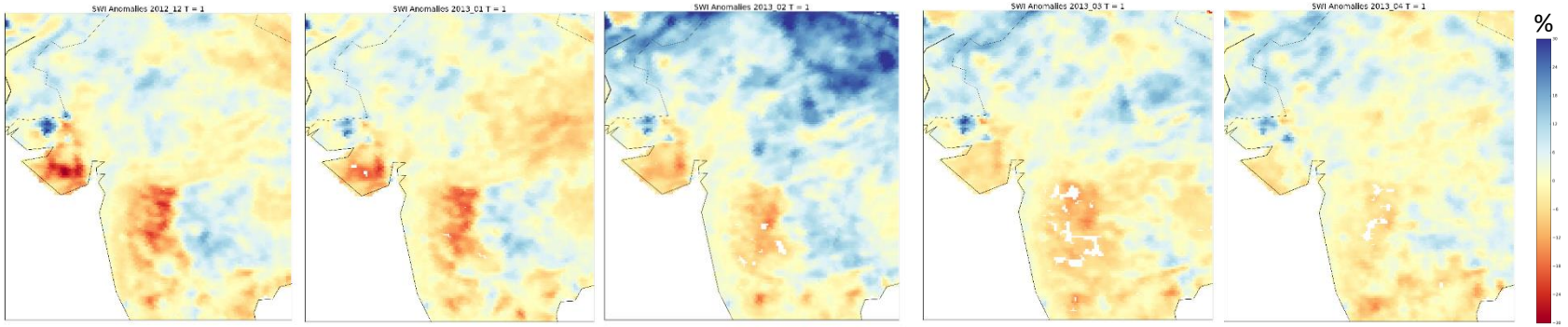
IDSI (Dec 2012 – April 2013)

Drought Severity Classes

1. Extreme Drought	6. Normal
2. Severe Drought	7. Healthy
3. Moderate Drought	8. Non-Agriculture
4. Stress	9. Water Body
5. Watch	11. Flood Pixels



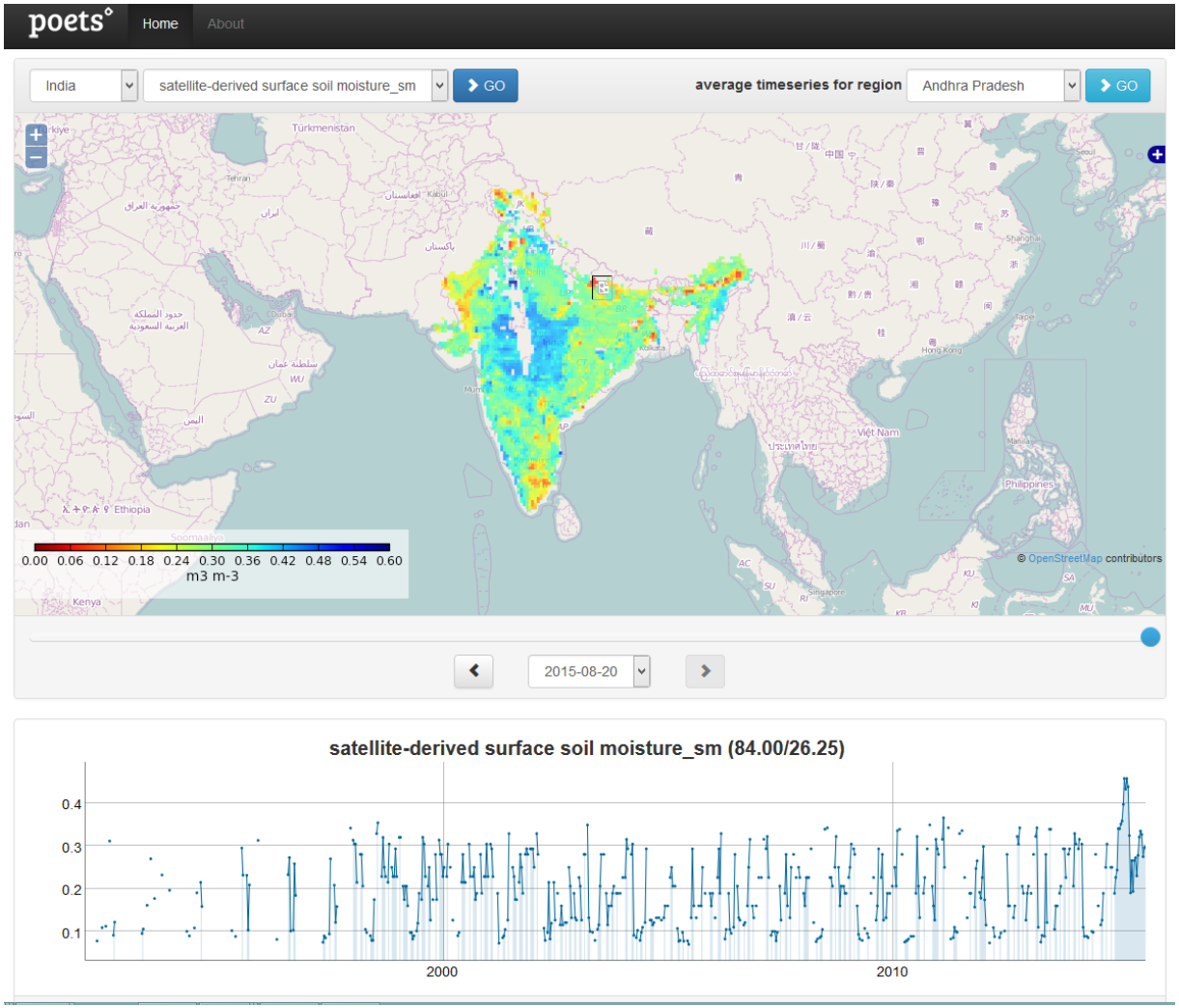
NDVI Anomalies 12/2012 – 04/2013



Soil Moisture Anomalies 12/2012 – 04/2013

- Comparison of IDSI, NDVI and Surface Soil Moisture anomaly for the drought year Dec 2012 – April 2013
- High correlation observed among the IDSI and other essential variables in drought prediction and early warning.
- The SM can be used to predict by 15-30days in advance on the vegetation condition for better decision making among stakeholders

South Asia Soil Moisture Based Drought Anomaly Index (SWADI)



Soil Moisture Product for Drought Stress

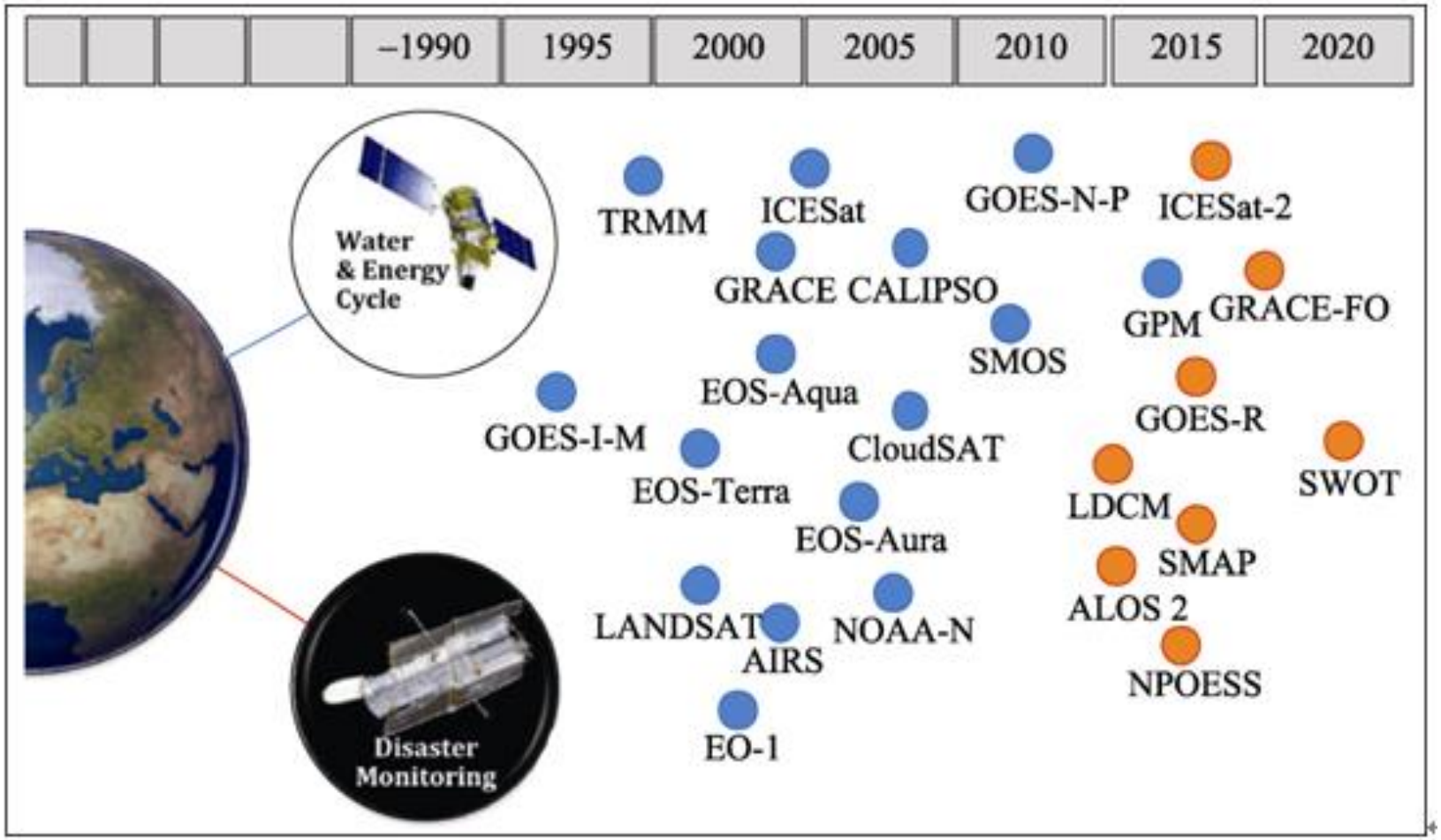
- Globally available ESA CCI SM product is being used to estimate surface soil moisture estimates at a spatial resolution of 0.25 degrees
- Daily updates via satellite-derived near real-time (NRT) soil moisture observations

TU WIEN

IWMI International Water Management Institute

MAFF Ministry of Agriculture, Forestry and Fisheries

Current and future satellite missions relevant to drought monitoring



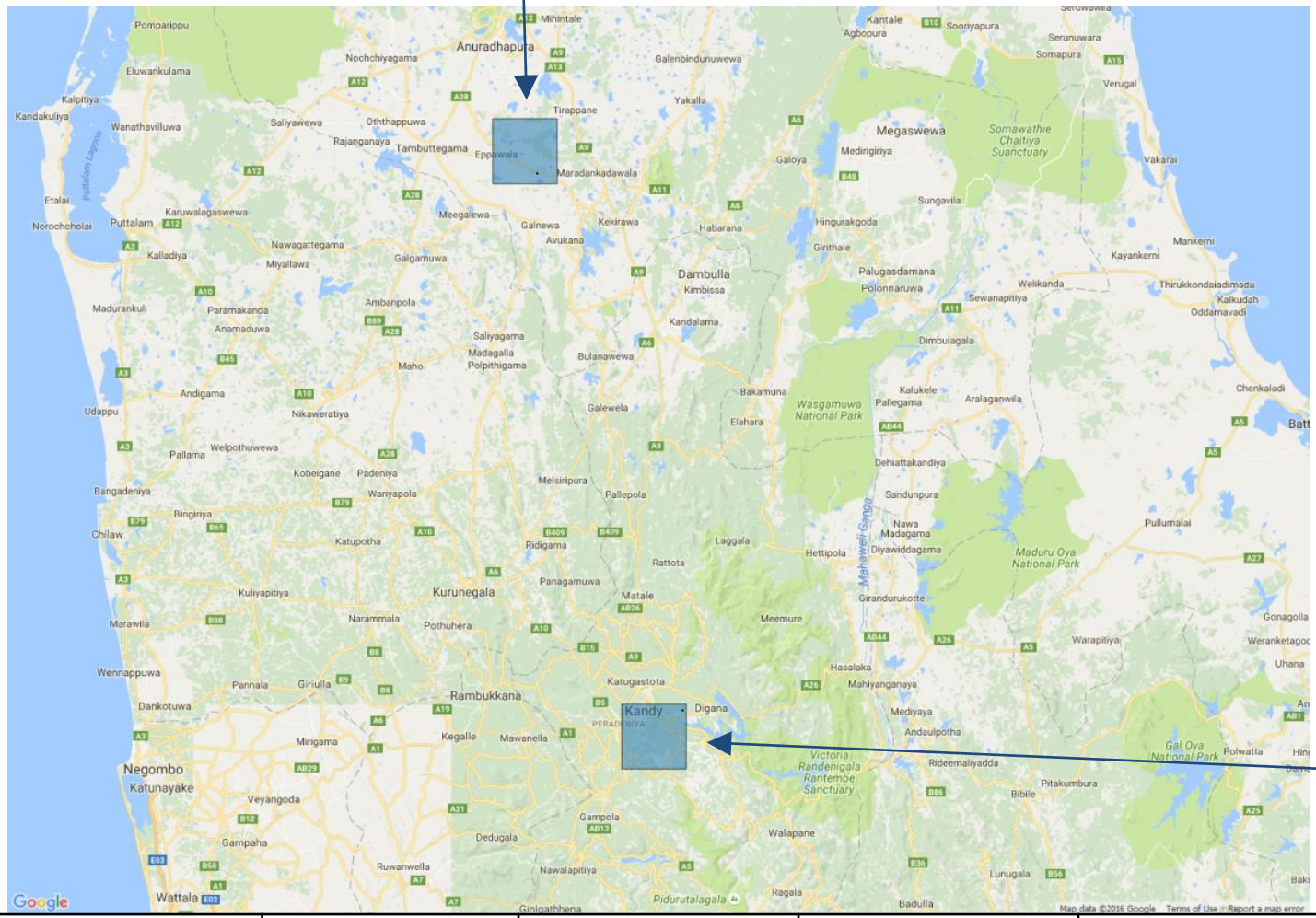
Measuring Soil Moisture using FlowerPower Sensors

Parrot FlowerPower device

- Data collection is done via a Smartphone Application
  - ‘Parrot Flower Power’ App for Android and iOS
- Fast and straight-forward, but you need to be near the device
  - Measurements every 15 mins.

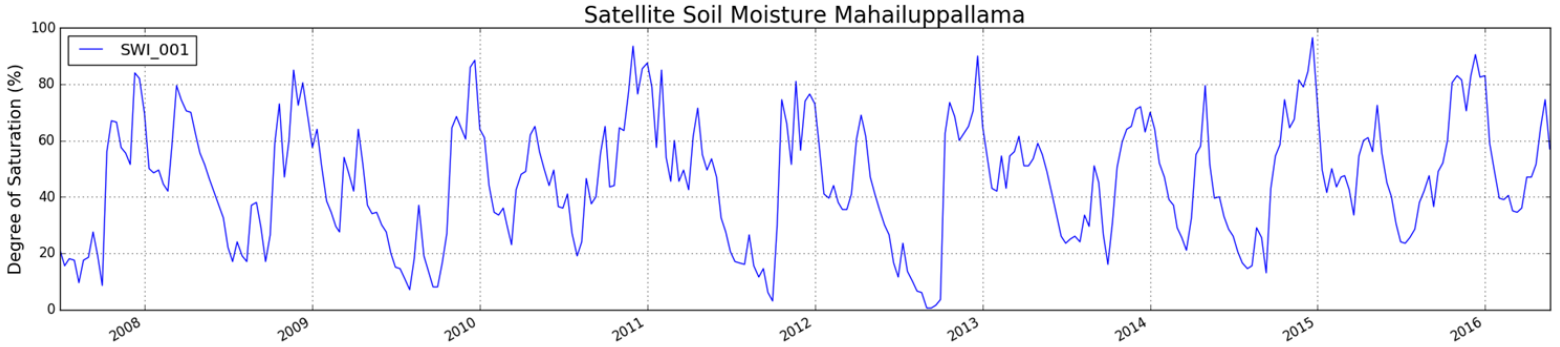
Test Sites

Mahailluppallama

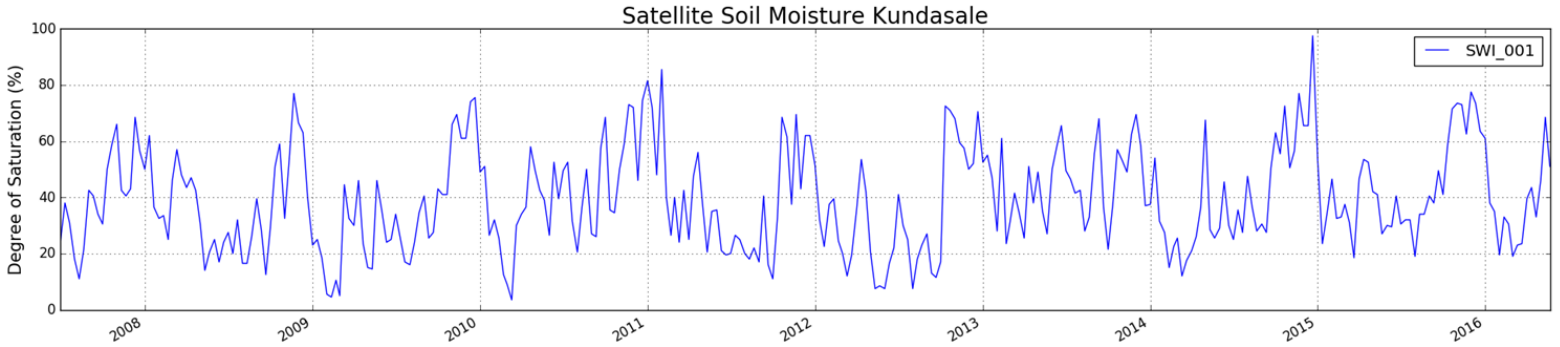


Test Site	Sensor lon	Sensor lat	SWI GP lon	SWI GP lat
Mahailluppallama	80.468046	8.110454	8.45	8.15
Kundasale	80.694805	7.290307	80.65	7.25

Mahailluppallama - Meteorological Unit



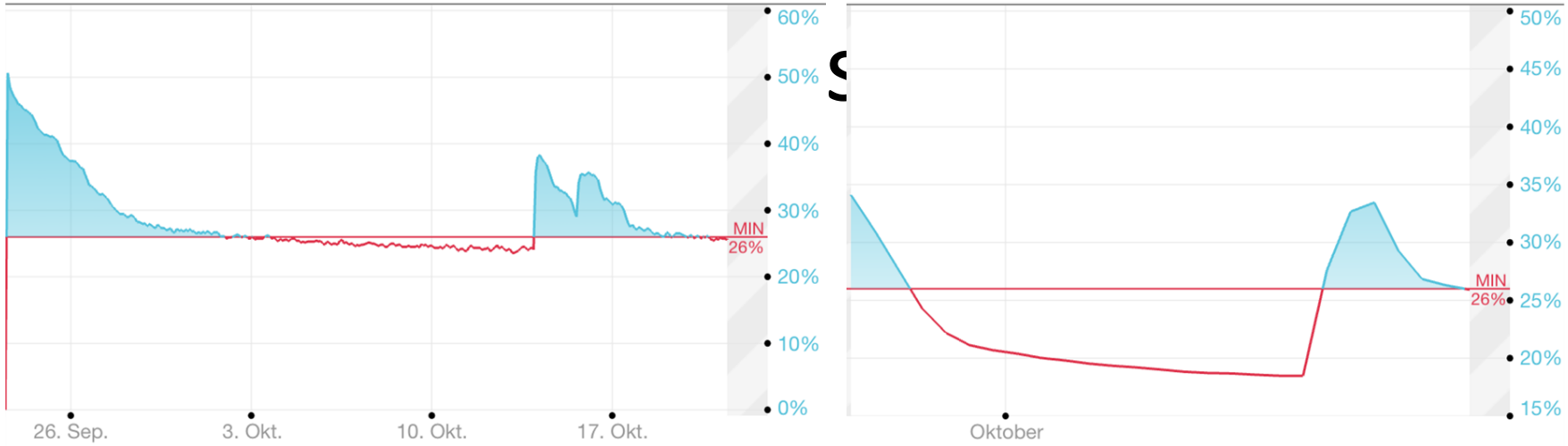
Kundasale - Meteorological Unit

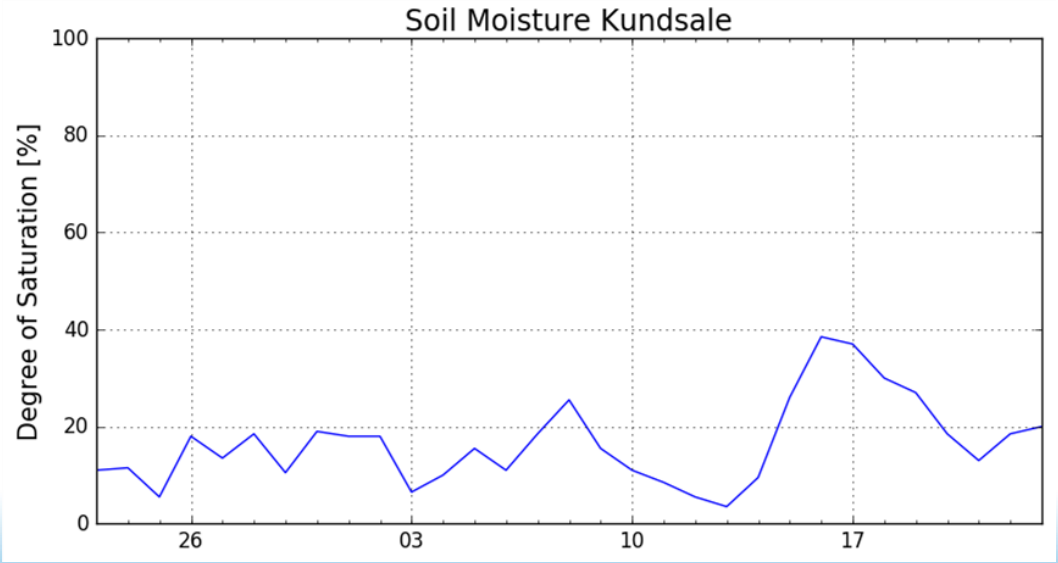


Instrumentation:

- soil thermometers
- rain gauge
- wind vane indicator
- anemometer
- Stevensons's screen

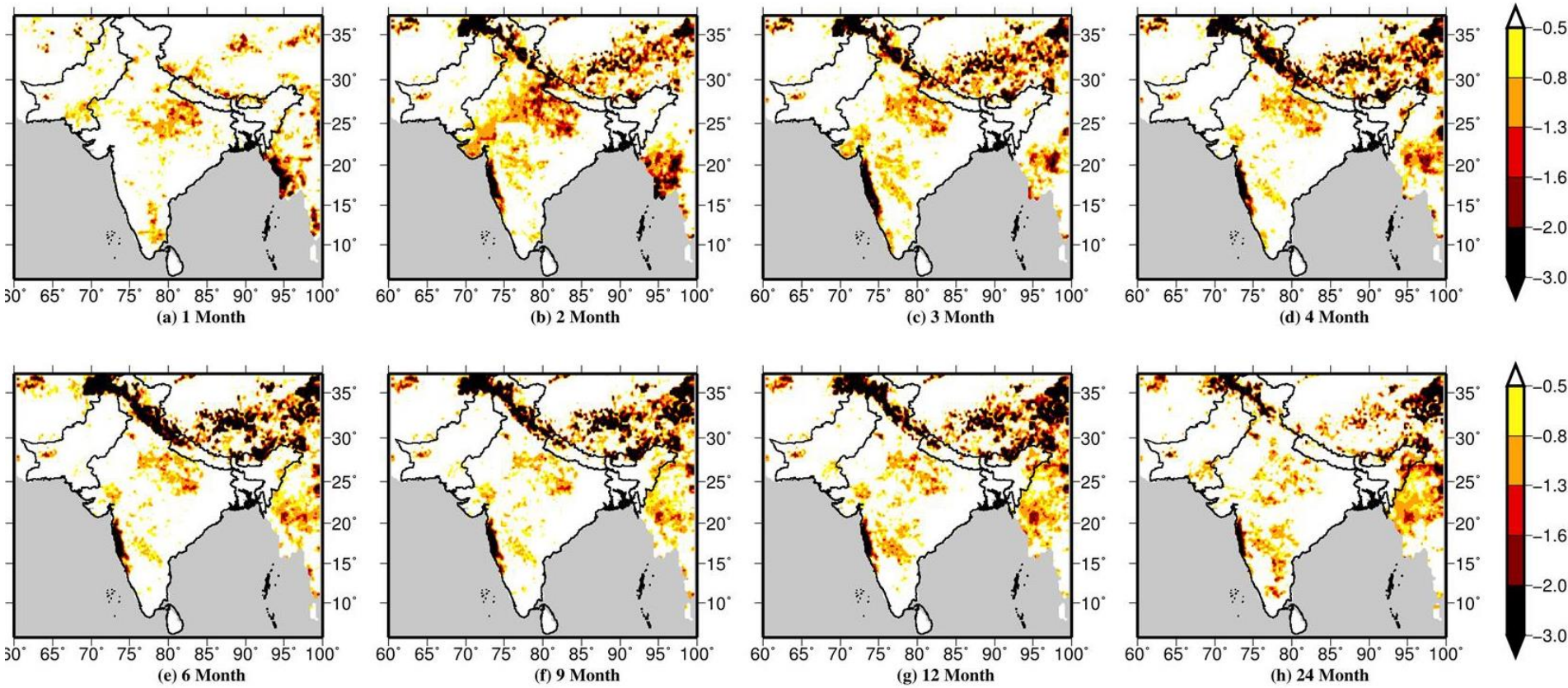
FlowerPower data and Satellite data





South Asia Drought Forecast System

Standardized Soil Moisture Index (SSI)



The monitor successfully captures the agricultural drought of 2015 at the end of the monsoon (JJAS)

5. SADMS - Global to National Relevanace

Addressing the SFDRR

Understanding drought risk and drought Preparedness;
National Targets on indicators;

Target B: Reduce people affected

Affected people/
global population
2020-2030 Average << 2005-2015 Average

Economic loss/
global GDP
2030 Ratio << 2015 Ratio

- Open-Ended Intergovernmental Expert Working Group: indicators' proposal
- Terms affected, livelihoods, disruption difficult to define

- Suggestion:

➢ **B-7a** Number of workers in agriculture with crops damaged or destroyed by hazardous events (what are relevant crops, what is effect of drought hazard on specific crops, etc)

➢ **C-2** Direct agricultural loss due to hazardous events. (C2a=the number of hectares of crops affected C2b=the number of livestock lost)

➢ **C2a** Number of hectares of crops affected (damaged or destroyed)

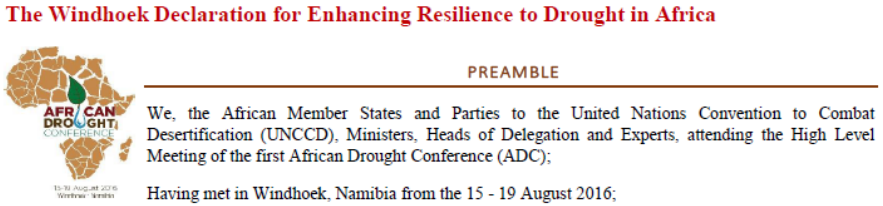
Sustainable Development Goals: the relevance of space technology

SADMS

SADMS Partners in cooperation with UN agencies

- Transfers results to Sendai framework working groups and partnerships
- Disseminates at UNISDR events (Global platform)

- Transfers to Windhoek declaration
- Transfers to NDMA, UNISDR, UNCCD, UNFCCC


The Windhoek Declaration for Enhancing Resilience to Drought in Africa

PREAMBLE

We, the African Member States and Parties to the United Nations Convention to Combat Desertification (UNCCD), Ministers, Heads of Delegation and Experts, attending the High Level Meeting of the first African Drought Conference (ADC);

Having met in Windhoek, Namibia from the 15 - 19 August 2016;

- Tests developed workflow
- Dissemination through Knowledge Portal


THANK YOU