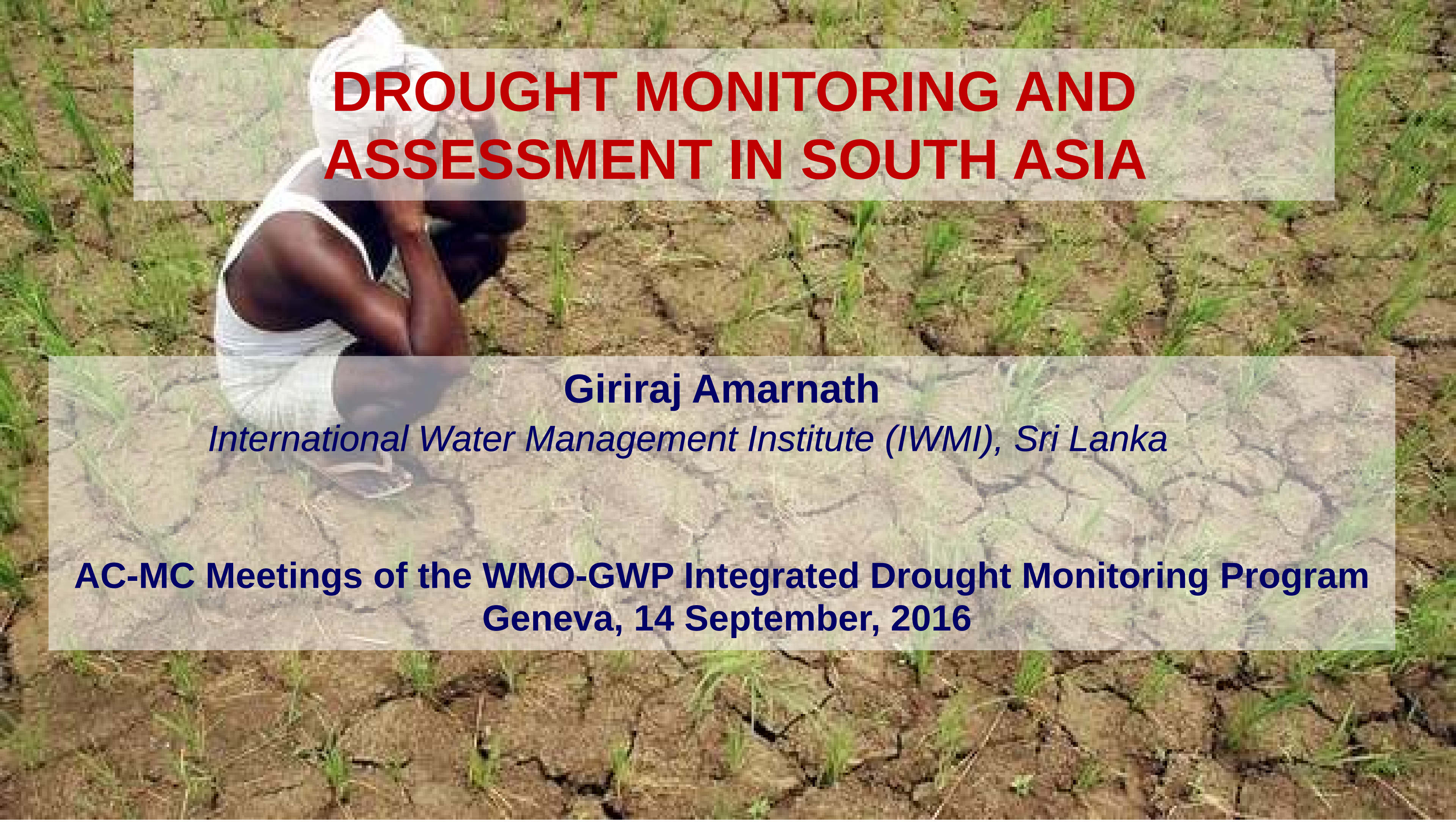


DROUGHT MONITORING AND ASSESSMENT IN SOUTH ASIA

Giriraj Amarnath

International Water Management Institute (IWMI), Sri Lanka

AC-MC Meetings of the WMO-GWP Integrated Drought Monitoring Program

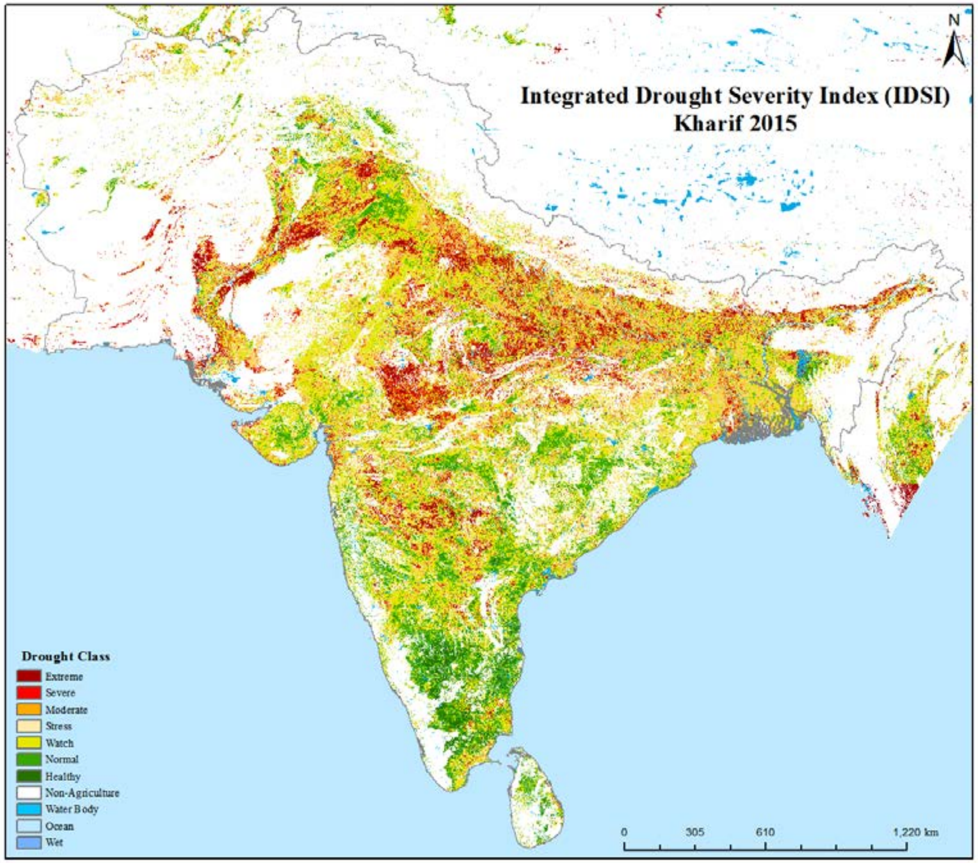
Geneva, 14 September, 2016

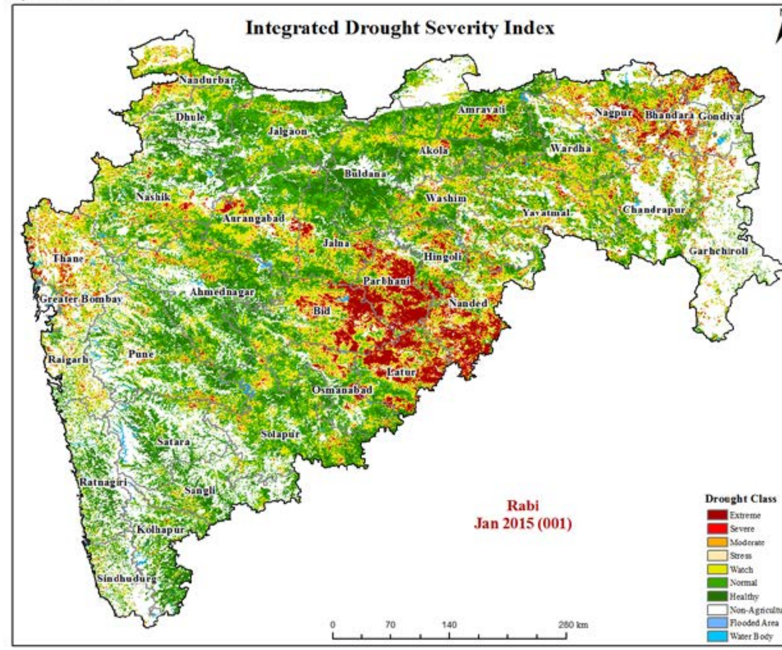
SOUTH ASIA DROUGHT MONITORING SYSTEM (DMS): OVERVIEW

- 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 CCAFS and WLE and Governments in SA.

SOUTH ASIA DROUGHT MONITOR SYSTEM (SA-DMS)

IWMI International Water Management Institute | World Meteorological Organization | Global Water Partnership | CGIAR | Research Program on Water, Land and Ecosystems | Climate Change, Agriculture and Food Security



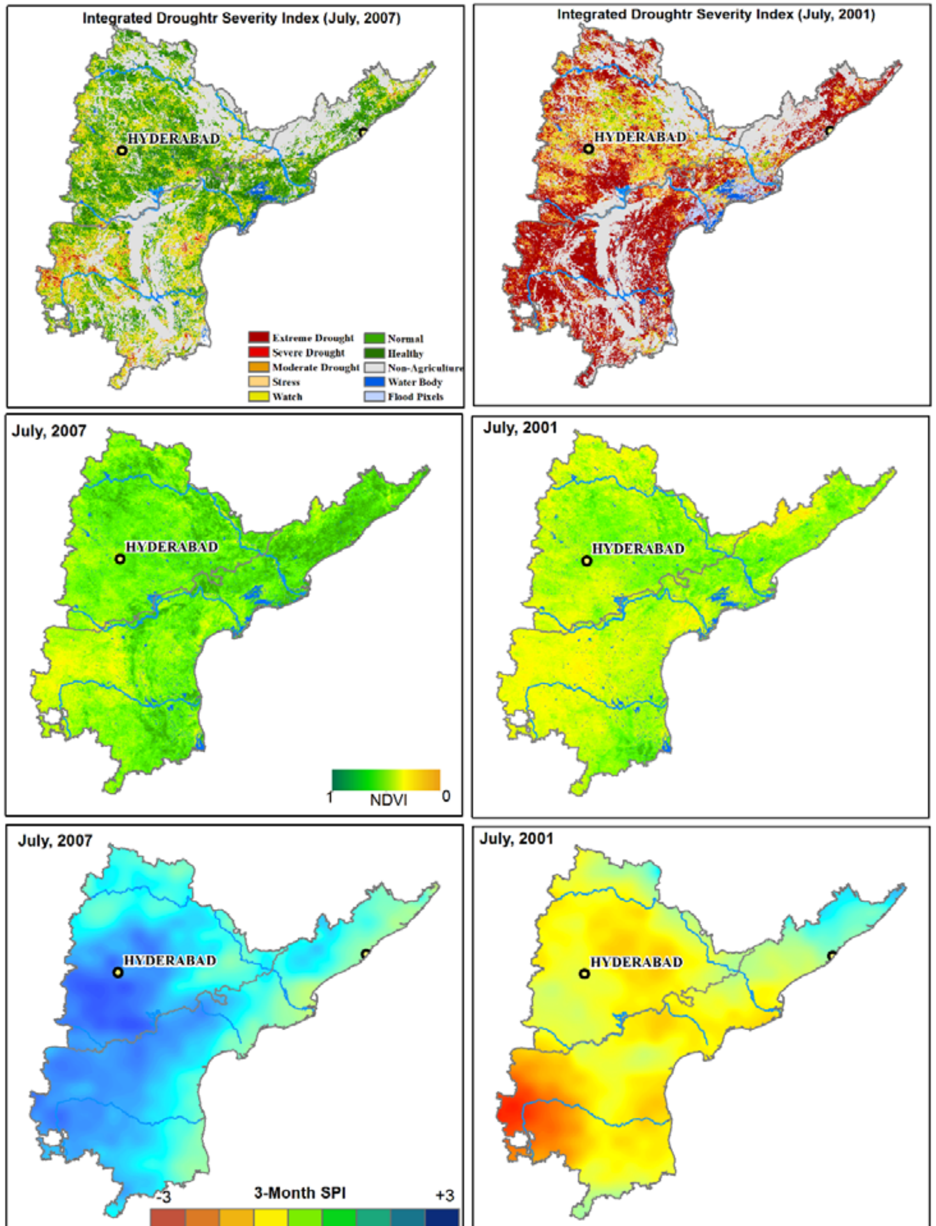


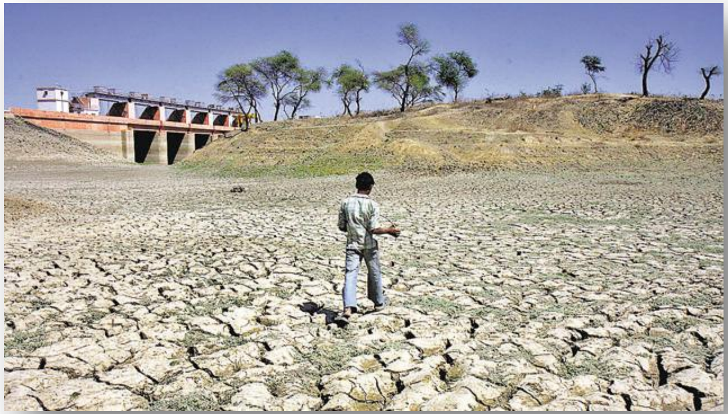
2015 field observations in Jalna, Maharashtra

- 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;

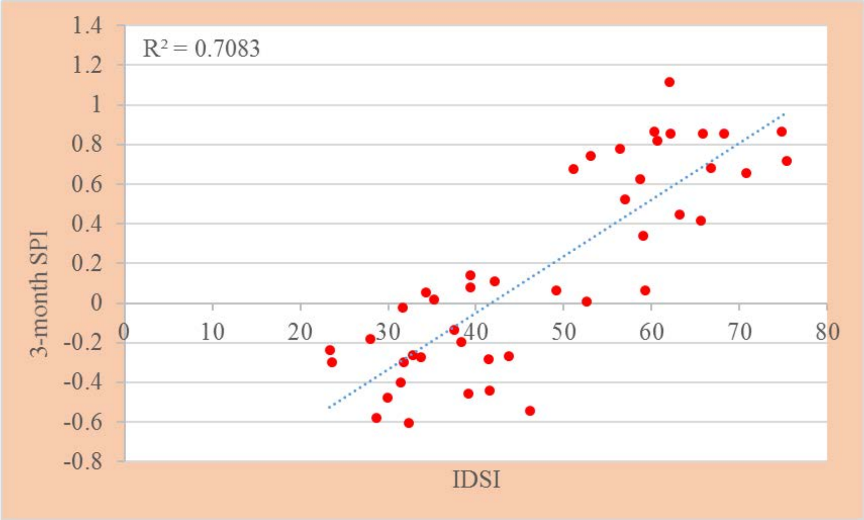
Drought Monitor Indices for Andhra Pradesh and Telangana - *drought year (2001) and normal year (2007)*

Credit: WDRM sub-theme





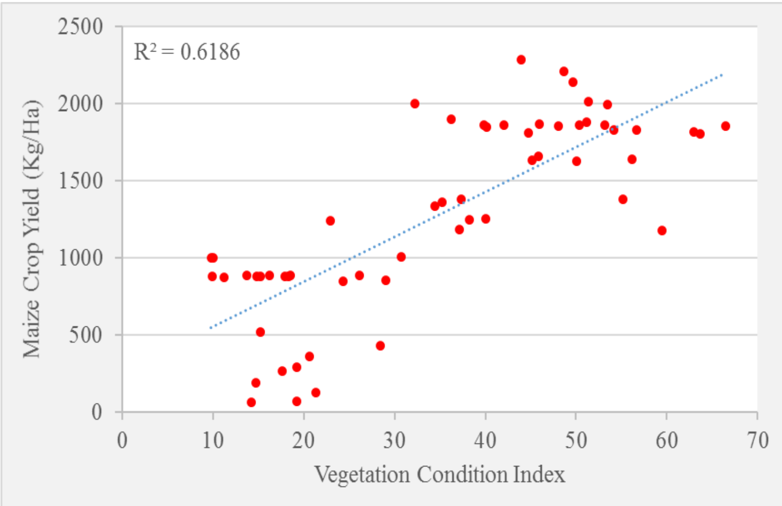
High correlation observed between 3-month SPI, IWMI's IDSI and rice crop production



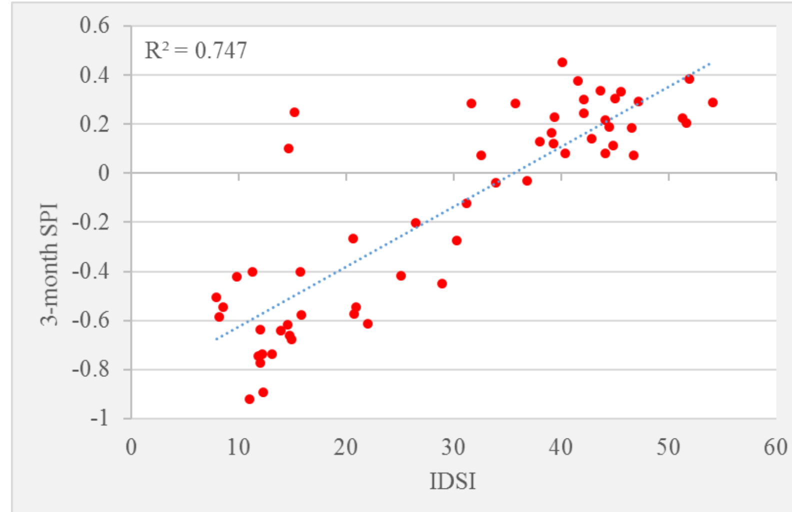
VCI, PCI and Drought Indices for drought year (2009) and normal year (2010), Rajasthan

Crop type: Maize

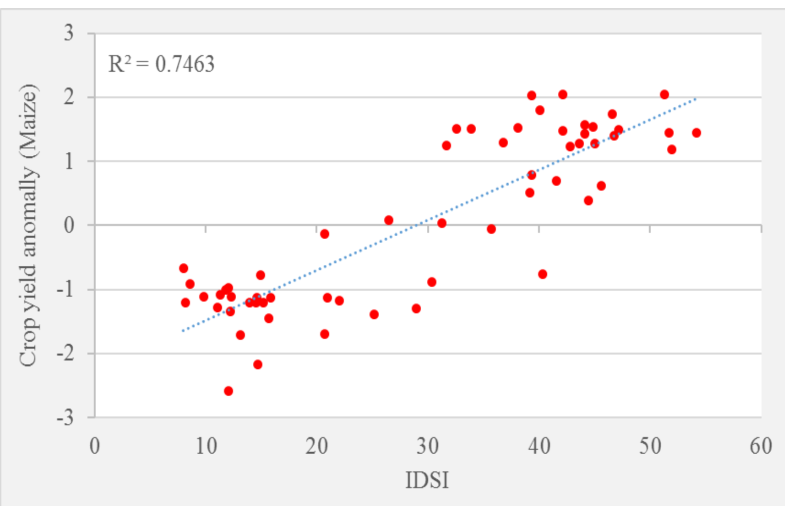
VCI vs. Crop Yield



SPI vs. IDSI

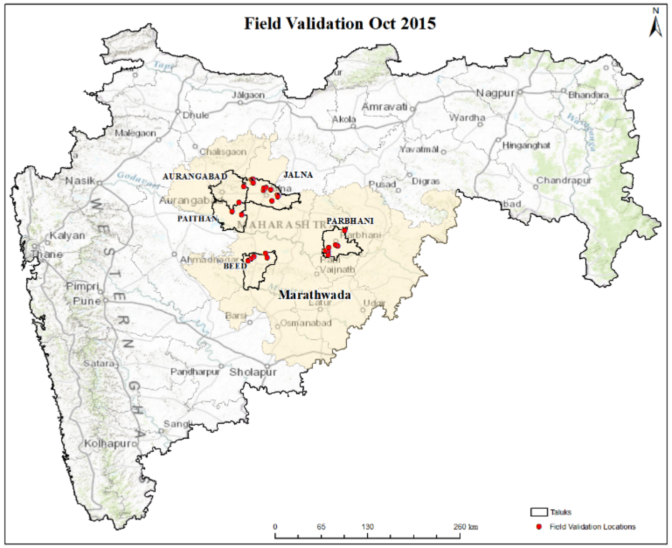


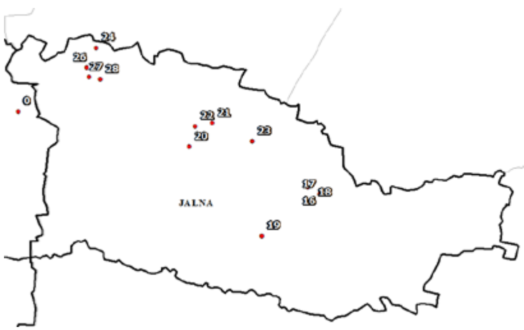
YAI vs. IDSI



- 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

2015 DROUGHT IN MAHARASHTRA STATE, INDIA





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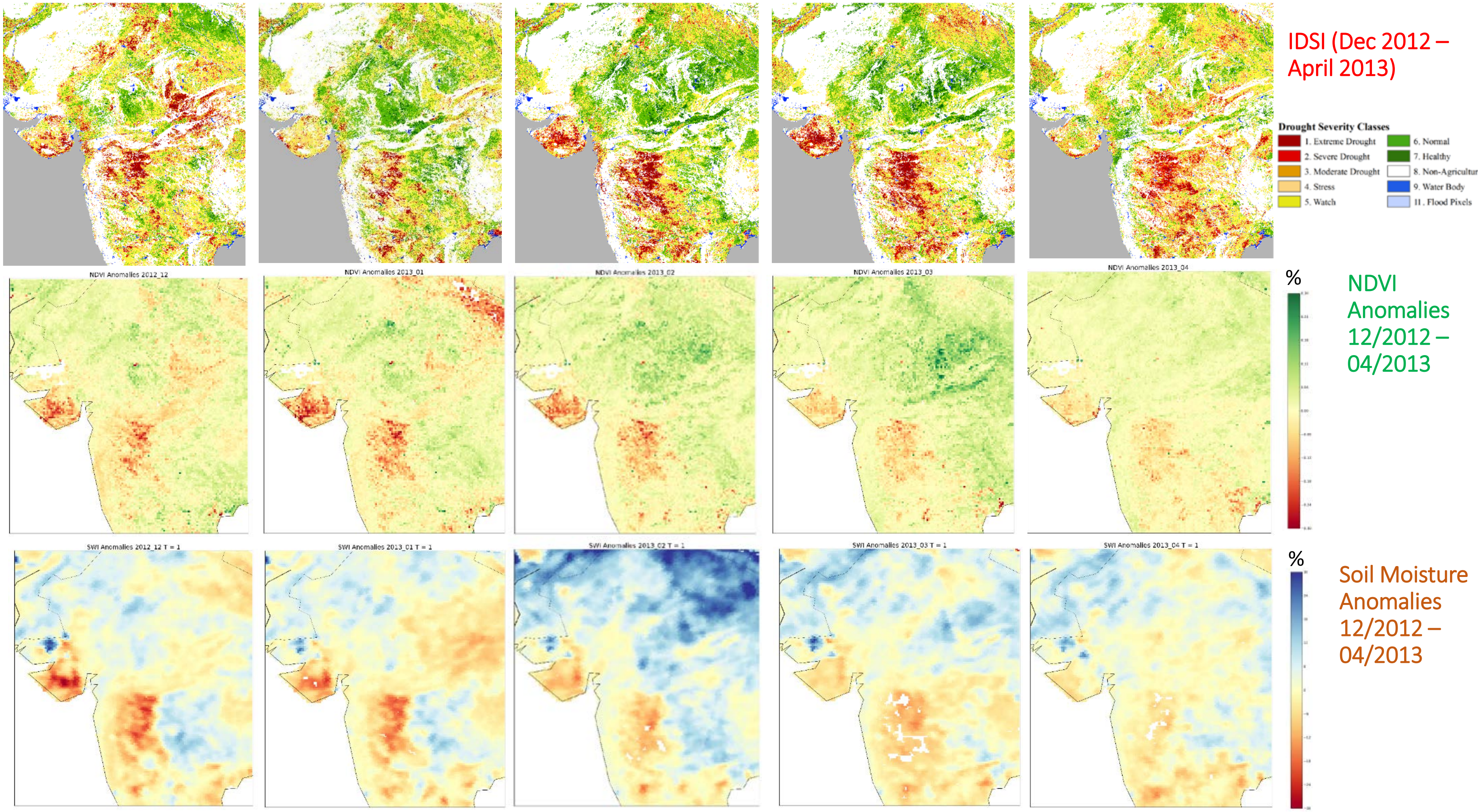
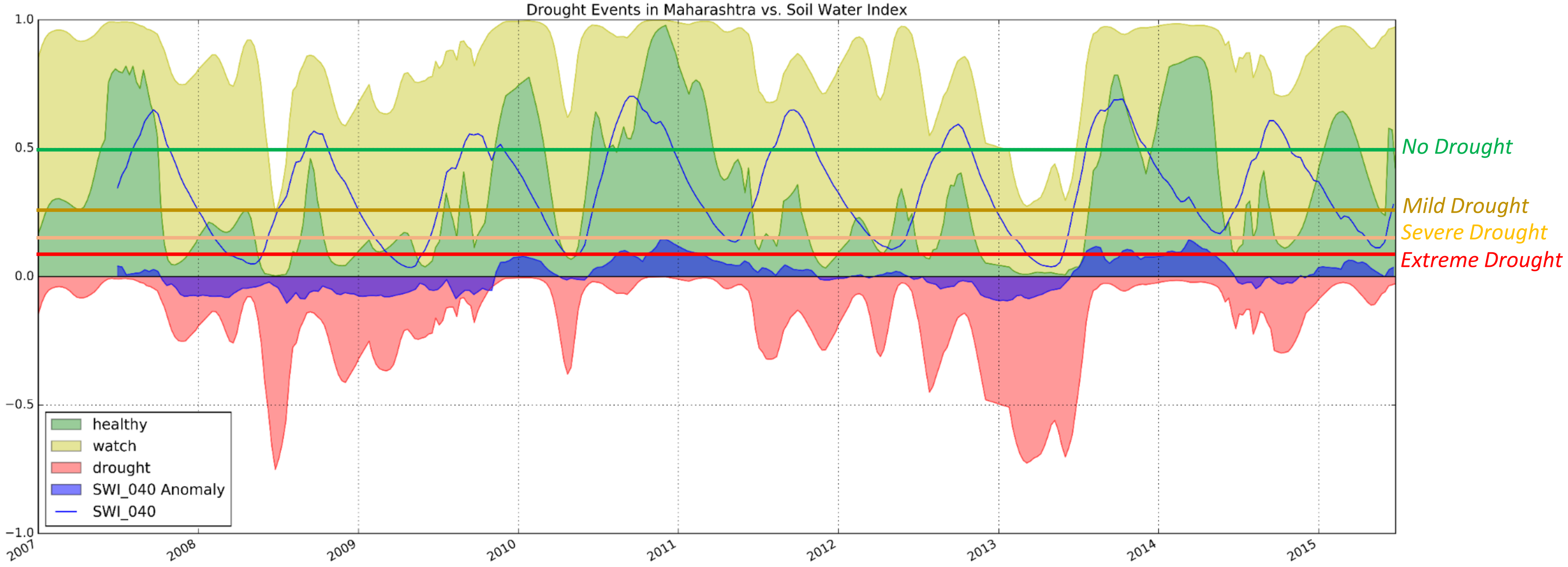
Evaluation of drought indices IDSI and its correlation with Soil Moisture



- 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

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

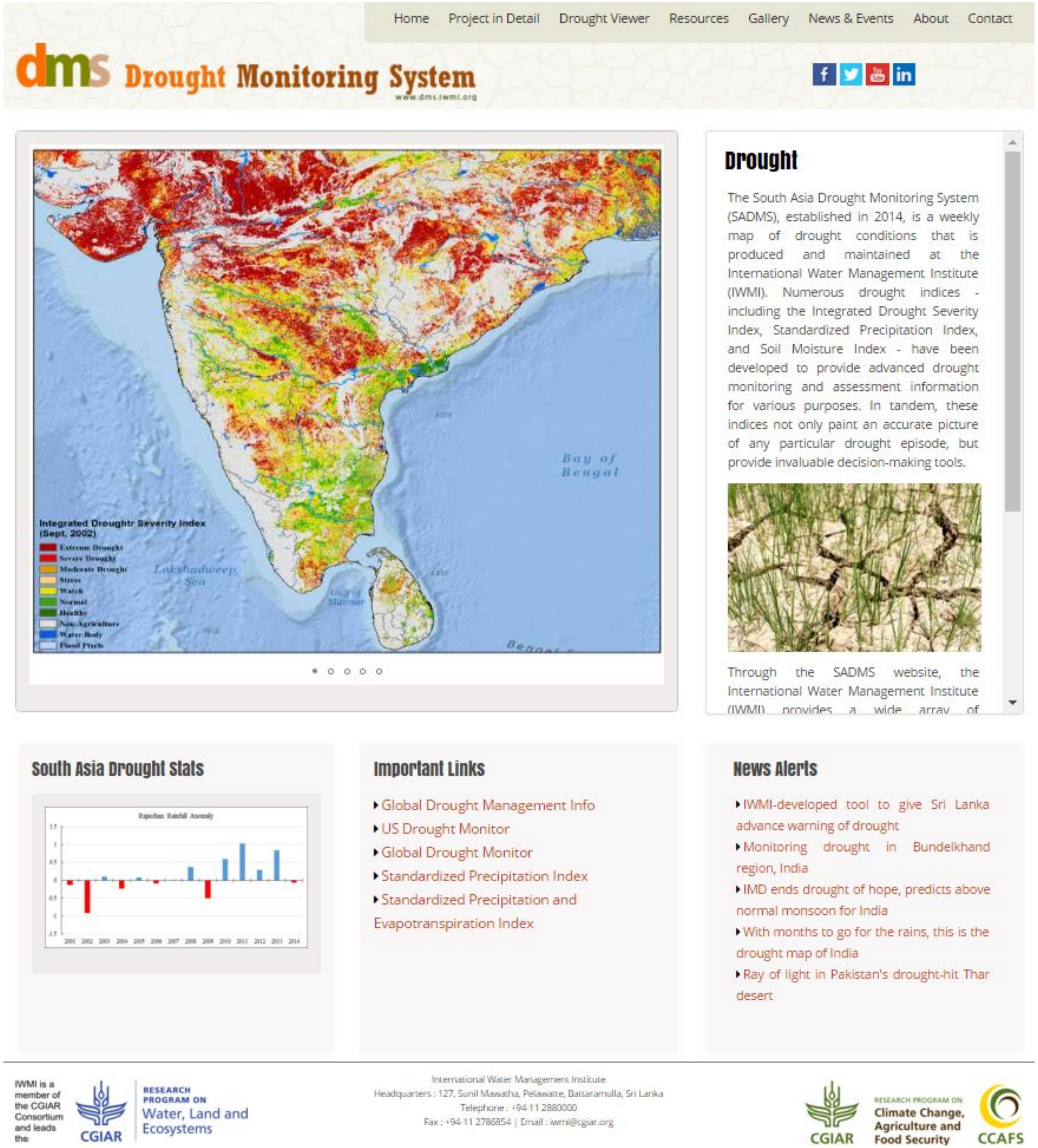
Credit: WDRM sub-theme

Drought Assessment on Population Exposure and Agricultural losses

Country Name	Geographical area (km²)	Agriculture area (km²)	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



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 - SWOT Matrix

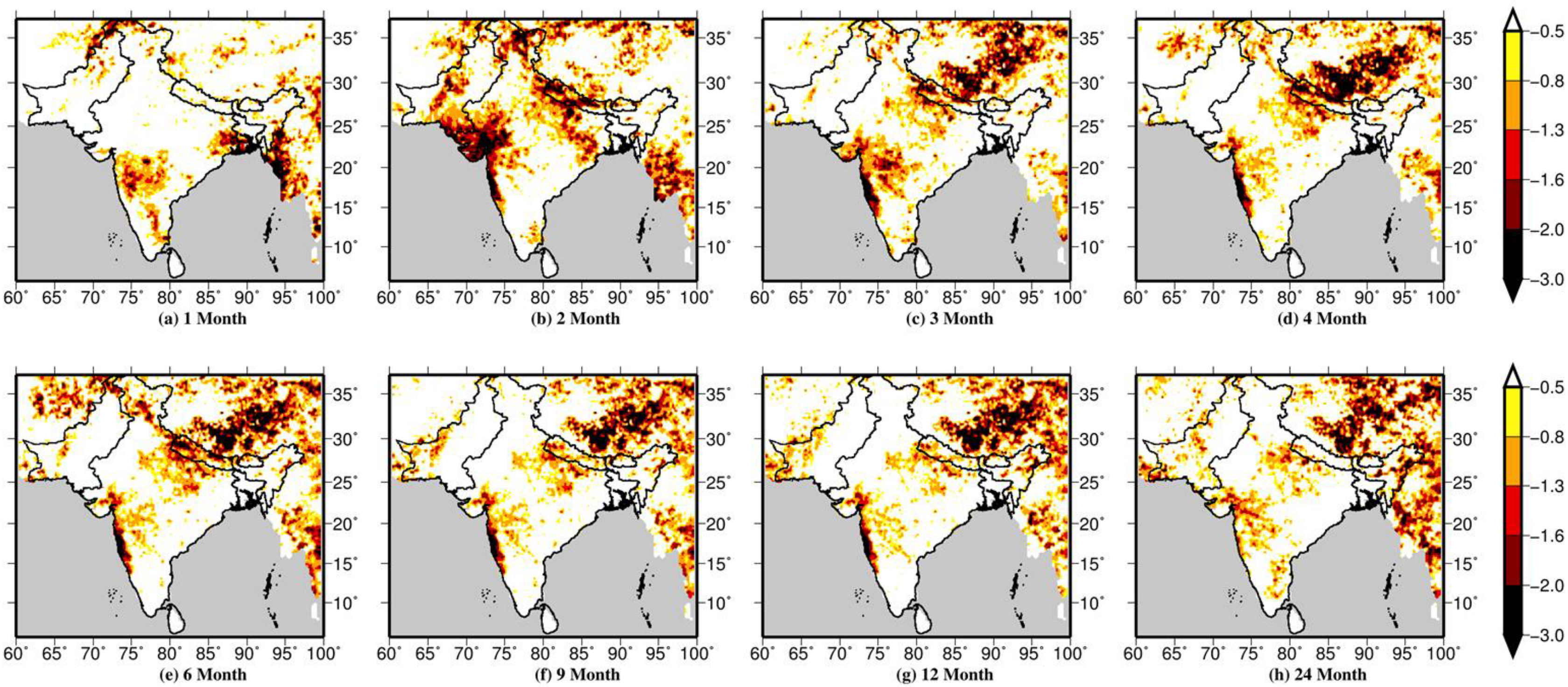
<table>
<tr><th colspan="2">SWOT MATRIX</th></tr>
<tr><th>Strength</th><th>Weakness</th></tr>
<tr><td>
• Drought Monitoring System tailored specifically for South Asia
• Created using opens source, freely available remote sensing datasets.
• Rigorously tested methodology with multi-country field validation
• 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
</td><td>
• 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).
</td></tr>
<tr><th>Opportunities</th><th>Threats</th></tr>
<tr><td>
• 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
</td><td>
• 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
</td></tr>
</table>

Draft version

South Asia Drought Forecast System

- To utilize real-time precipitation and air temperature data for drought monitoring in South Asia
- To evaluate the relationship between drought indices for the selected geographical regions
- Development of real-time drought monitoring and forecast system for South Asia

Standardized Precipitation Index



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

Media brief

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

Giriraj Amarnath and James Clarke

In the city of Latur, guards are currently stationed at all six of the municipality's water tanks. In nearby Parbhani, the local council has banned water extraction from the town's lakes and reservoirs. Trains carrying lakhs of litres of water are being sent to Latur to provide relief. These extreme measures are just a few examples of how severely the drought that is ravaging much of central India is affecting communities.

For city folk water rationing is now almost inevitable. For farmers, the prolonged dry spell heralds disaster. Many have been unable to grow winter crops and are struggling to survive. Climate scientists warn us that extreme weather is the "new normal". In the future we can expect much more water variability. For a country like India which already has a highly seasonal pattern of rainfall, this could be disastrous.

Thankfully there is much we can do to make sure that the effects of this change in our weather are manageable. Flooding, for instance, could be a boon to farmers. If excess water can be channelled underground to replenish aquifers, then it will create a stable water store that can be accessed via tube wells during the dry season.

Our institute, IWMI, has launched a pilot scheme in Uttar Pradesh where a village pond has been modified to channel floodwater below the surface

There's immense opportunity for smallholder farmers to save 35-40% water by adopting drip irrigation as opposed to flood irrigation

through specially built recharge wells. This will be of great use to farmers during the rabi season.

Overall, however, we will need far more water storage than schemes like this can deliver. So we should invest in more reservoir capacity. At the same time we need to protect and conserve natural water storage in rivers, lakes and wetlands. Without these ecosystems our environment will suffer. That will negatively

affect productivity of our farms and our general quality of life.

We also need to explore more high tech solutions. We work on remote sensing. The data we can now get from space satellites is remarkable. Not only can we see what is going on in our landscape in incredible detail – like a supercharged Google Earth – we can also measure how well plants are performing and even estimate how much water is underground.

By combining all this information we are able to monitor and predict water shortages and depleting soil moisture field by field, to a hitherto unimaginable degree. This will allow us to warn of impending drought well in advance of it actually happening. By passing this information on to farmers through their mobile phones, they will be able to plan far more effectively. For instance if a drought is expected, they can consider sowing crops that are less water intensive, such as pulses and oilseeds.

A recent study by IWMI of the inventory of over 1,300 farm ponds, using high-resolution satellite imagery in the tribal districts of Maharashtra (Palghar and Thane), highlights an immense opportunity for smallholder farmers to save as much as by 35-40% water by adopting drip irrigation as opposed to flood irrigation – resulting in increased crop yield, which allows farmers to sell more without increasing their inputs and results in higher incomes.

Satellite imaging can also help us provide farmers with more effective crop insurance. In the past it has been tricky to design insurance products for smallholders, since verifying claims and issuing payouts has been too time consuming to be worthwhile for private companies. If we can see the effects of flood or drought from space, however, and that can be accessed at the insurer's desk, then new possibilities open up.

We are working on just such a scheme for flood prone farmers in Bihar. Together with partners in the insurance industry and local government we have devised a new system that, for the first time, can give them financial protection from extreme events.

Adapting our water management to climate change won't be easy. Investments will need to be substantial both in infrastructure and institutions. But new thinking and new technology can help us cope with extremes and protect the most vulnerable. However, as events in Maharashtra are showing, the time to act is now.

Giriraj Amarnath specialises in water-related disaster risk management, James Clarke directs communications and marketing at the International Water Management Institute (IWMI)

गाँव कनेक्शन

India's Rural Newspaper

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

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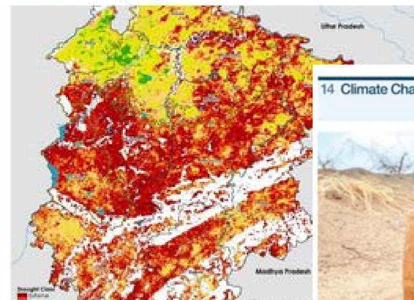

Sci Dev Net | IWMI International Water Management Institute | PRACTICAL ACTION

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

A new monitoring system will help prepare South Asia for increased drought frequency caused by a changing climate. **Amarnath Giriraj** and **James Clarke** at the International Water Management Institute (IWMI) in Sri Lanka explain how the system can be used to predict drought trends in time for communities to put climate-smart water management solutions into place.

Drought monitoring system helps strengthen resiliency to climate change

The great temples of Khajuraho in the central Indian region of Bundelkhand are a tourist magnet. Famed for their intricate – and occasionally erotic – sculptures, they are situated next to refreshing pools of water, which are remnants of a sophisticated water management system that has kept the region food secure for generations.

However, this same region is in crisis today, enduring one of the worst droughts in living memory. Many of the historic ponds and tanks have fallen into disrepair, compounding the lack of rainfall. Once an ancient kingdom, but now straddling the states of Uttar Pradesh and Madhya Pradesh, the area remains relatively underdeveloped compared to other parts of India. Consequently, many local people still rely drought conditions and with limited capacity for water storage, thousands of smallholder farmers now face hardship – and even destitution.

The current water scarcity, the most severe of this century, has parched an area the size of Israel, but experts believe that the extreme conditions could have been foreseen. A new monitoring system, developed by the Sri Lanka-based International Water Management Institute (IWMI), has been used to review satellite imagery from earlier in the year. Adopting an innovative approach to assessing drought conditions, the system could help South Asia address the more extreme weather events predicted by a changing climate.

Current methods of monitoring drought in South Asia, and India in particular, are dependent by national meteorological agencies. However, these maps do not provide the spatial resolution needed to show differences in drought severity across such vast areas.

In order to better understand and monitor drought events, the new IWMI project created a geodatabase of historical climate information as well as a decision-support tool to calculate average Standardized Precipitation Index values for specific areas. The tool and geodatabase combine rainfall data from three different sources: APHRODITE, the Asian Precipitation Highly-Resolved Observational Data Integration Towards Evaluation of Water Resources; the Tropical Rainfall Monitoring Mission; and the Global Precipitation Measurement.

The data from these multiple sources is used

Future Activities

- SADMS are increasingly being referred in the region and tested in few countries;
- IWMI will develop medium to long-term drought management framework in India in collaboration with ICAR Centres;
- Regular funding from development partners to support national stakeholders and implementation of IDMP in South Asia; Specific activities:
  - Capacity building of national partners in selected countries through GWP/CWP
  - To commission South Asia Drought Forecast System in early 2017;
  - To pilot low—cost soil moisture device for drought monitor and validation in SL;
  - Promote IDSI with insurance partner in India;
- Regional sharing and dissemination of operational drought information to the users can download at country level for subsequent analysis;
- Scaling up SADMS to SADC (7 countries) on water resource mapping, drought prediction and livelihood impacts funded by FAO


THANK YOU