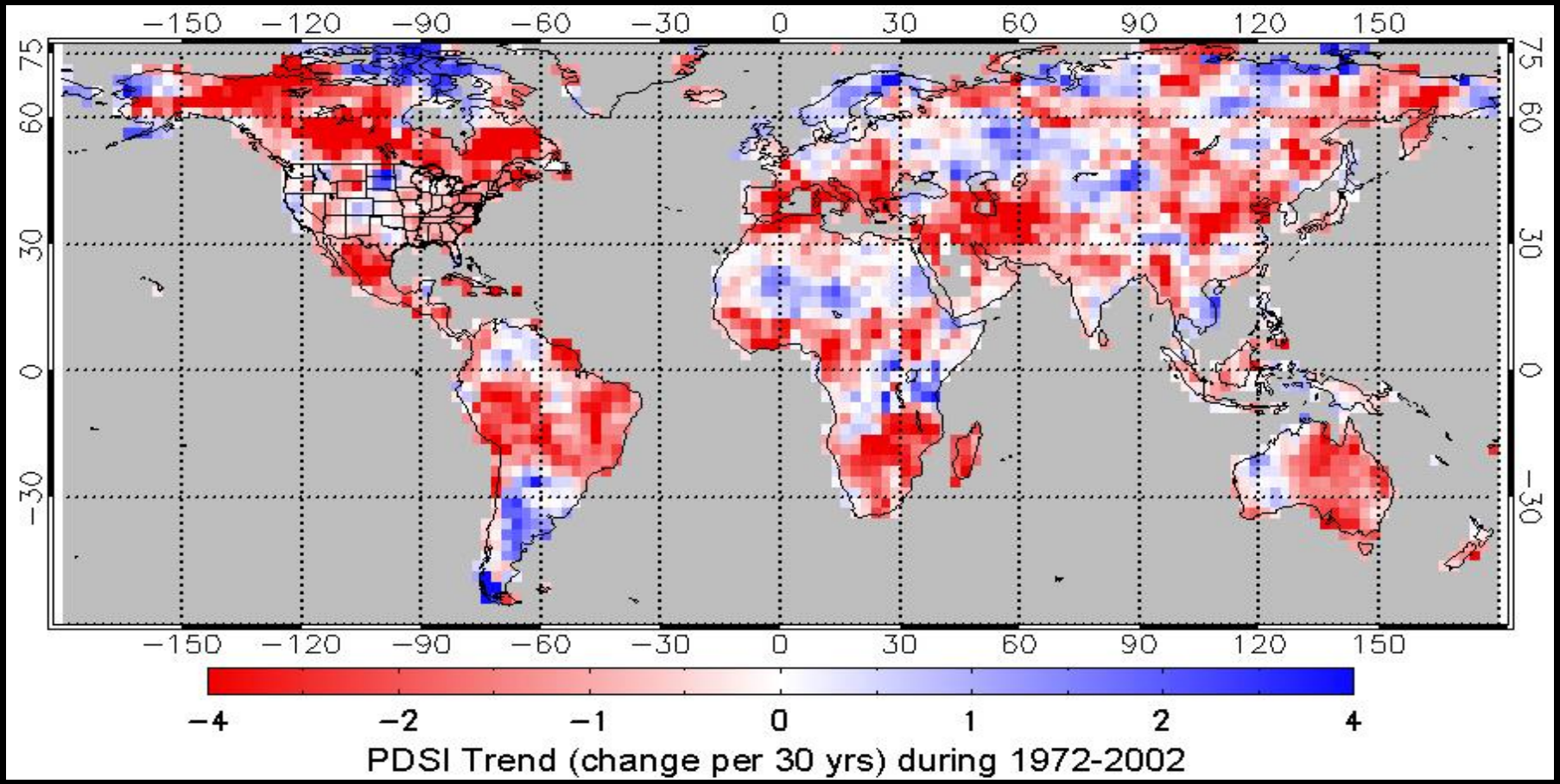
Indian Agricultural Research Institute

Drought Monitoring & Management – An Indian Experience

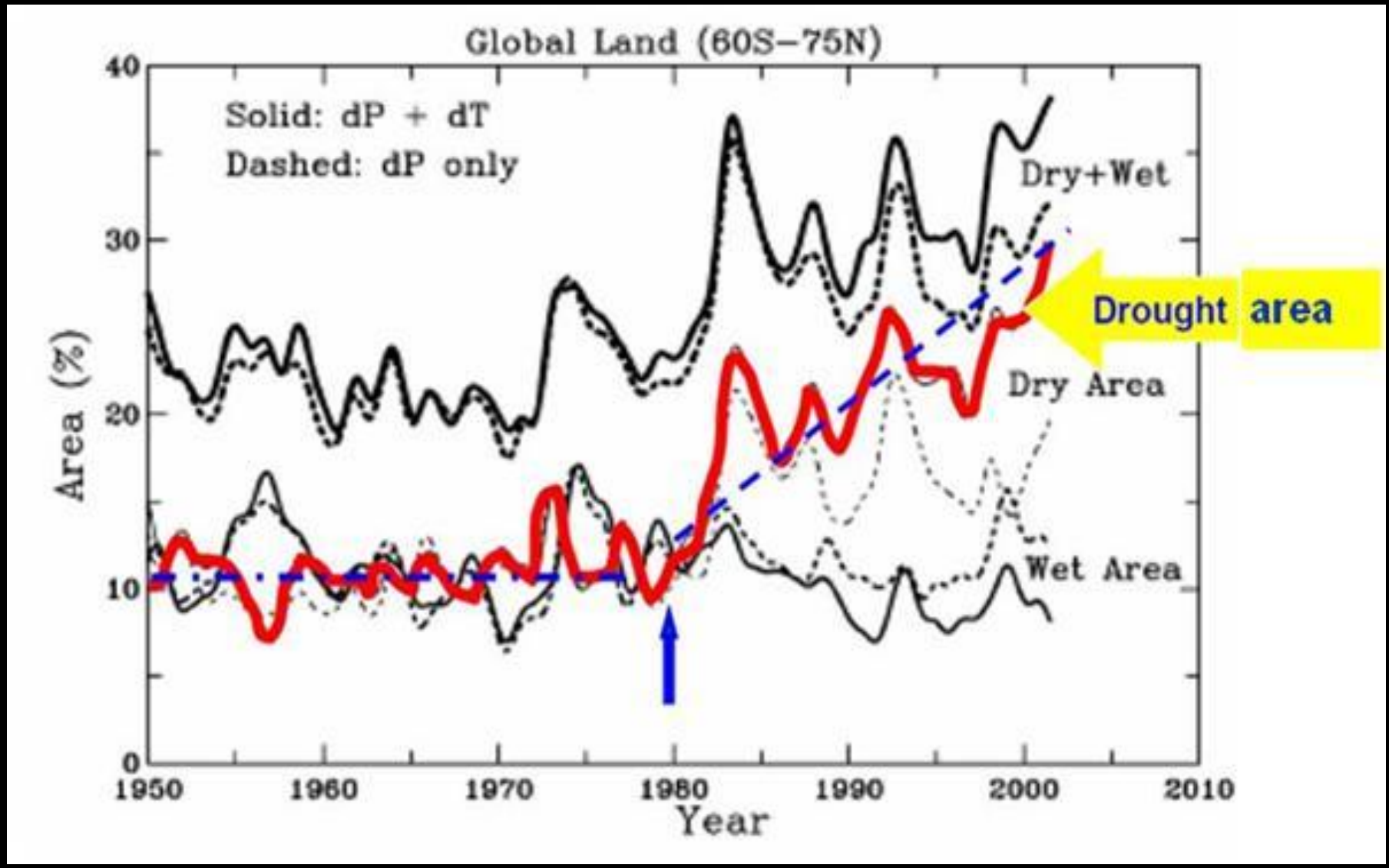
Ravinder Kaur
Project Director
Water Technology Center
Indian Agricultural Research Institute, New Delhi
Email: pd_wtc@iari.res.in

Spatial and Temporal Distribution of Global Drought



- Second most geographically extensive hazard, after flood, and covers 7.5 per cent of the global land area
- Accounts for about 40% of the people impacted by all natural disasters.
- In last 30 years, an obvious drying trend has been observed across the semi-arid regions of the globe.

Drought impacted area - Global trend

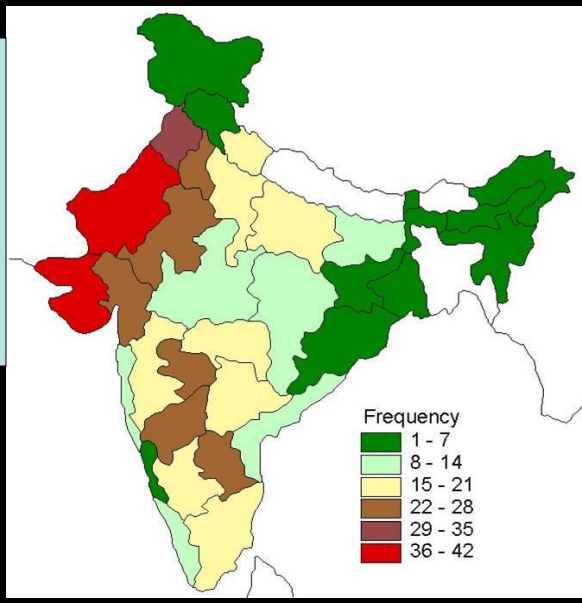


Significant increase in the drought impacted area in post - 1980's.

Drought : A Silent Threat to Indian Rural Economy

- 70% population (900 million) depend on agril.
- 68% net sown area (97 M ha) drought prone
- 50% of drought prone area severe in nature
- 1871-2012: 22 major droughts with 3 severe (1972, 87, 2002)

Geographical Area
328.7 M ha
Net Sown Area
142.2 M ha
Net Irrigated Area
55.10 Mha



Frequency of droughts in India- 1871-1999

Crop Failure

Unemployment

Cattle - starvation

Fodder shortage

Drinking water shortage

Indian Agricultural Research Institute

Government Initiatives

Criteria For Drought Declaration By Different States

- Drought is a state subject
- Declaration of drought at state level

i. Based on Large area unsown

or

ii. Wait till end of season (Oct/Nov) to realize the yield

- Memorandum of scarcity
- Verification by Central Govt.

State	Criteria for drought declaration
Andhra Pradesh	1. Block level rainfall 2. Block level crop sown area 3. Yield reduction 4. Dry spells
Karnataka	Rainfall Dry weeks
Maharashtra	Yield loss, 100 point scale
Odisha	Block level rainfall, Crop assessment
Rajasthan, UP and J & K	Yield loss criteria

No unified and standard criterion for drought declaration

Drought Declaration Process

Rainfall Deficiency / Yield loss/ Red. cropped area at Block and District level

↓

Crop Weather Watch Group

A nodal Inter-ministerial Group within the MOA responsible for all matters of drought;With experts from climate, water, crop, input supply, extension, power & R&D agencies.

↓

District Collector monitors his district

↓

State level drought is watched by State Relief Commissioner

↓

Estimation of losses

↓

Declaration

↓

Verification by Federal Teams

↓

Relief Quantum is decided

Drought Monitoring by Indian Meteorological Department

IMD carrying out meteorological drought monitoring since 1875 based on meteorological indices:

1. **Percent deviation of Rainfall from Normal**

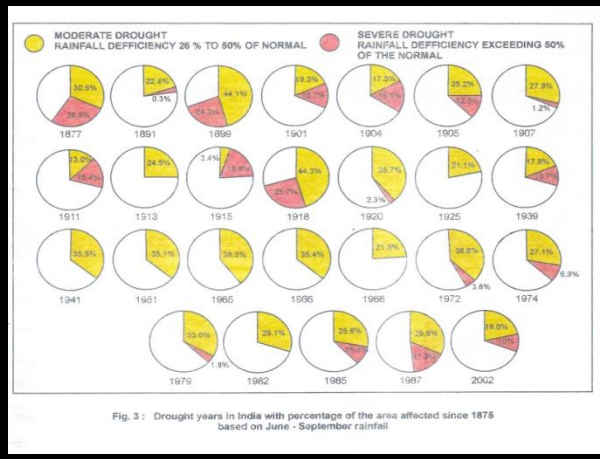
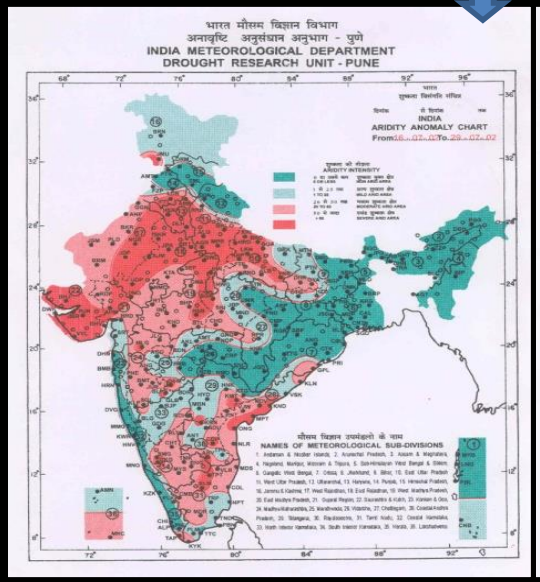
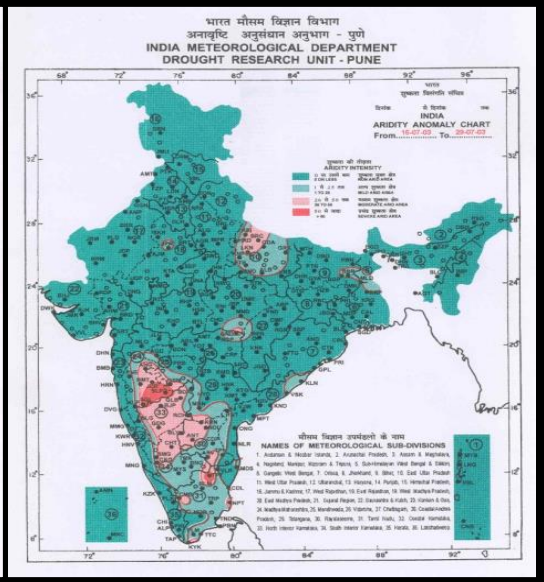


Fig. 3 : Drought years in India with percentage of the area affected since 1875 based on June - September rainfall

2. **Aridity Anomaly Index (AAI)**

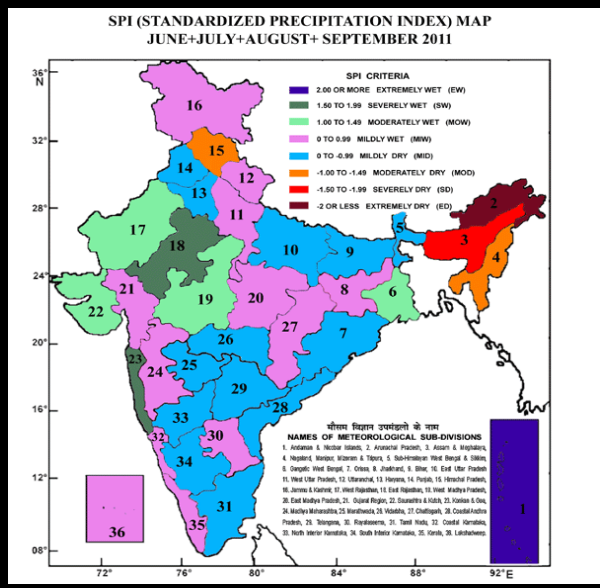


July 2002



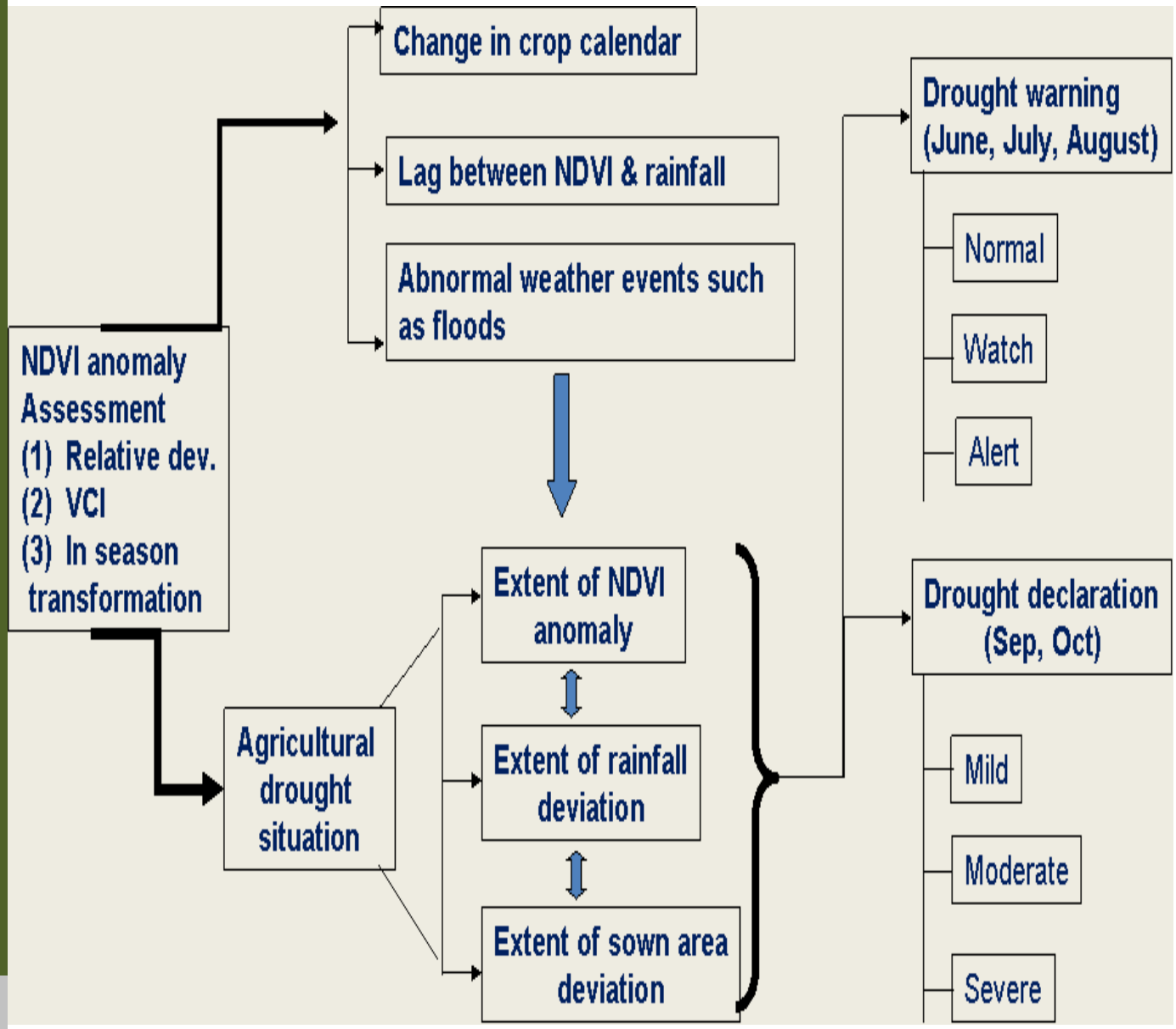
July 2003

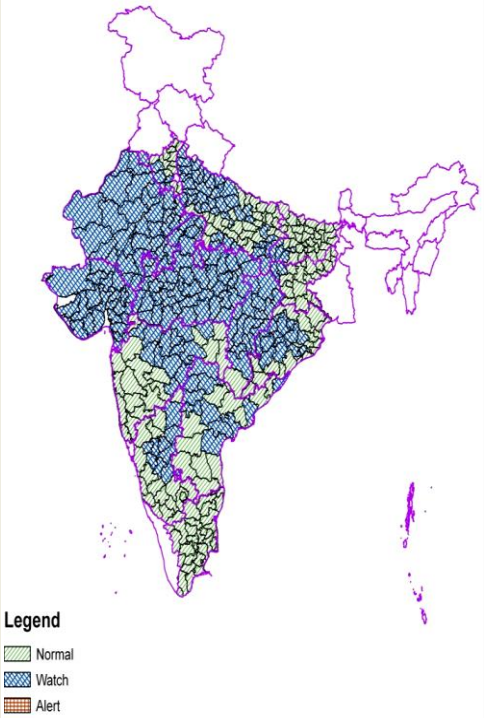
3. **Standardized Precipitation Index (SPI)**



4. **Seasonal All India Summer Monsoon Rainfall Forecast** (1st in April revised in June)

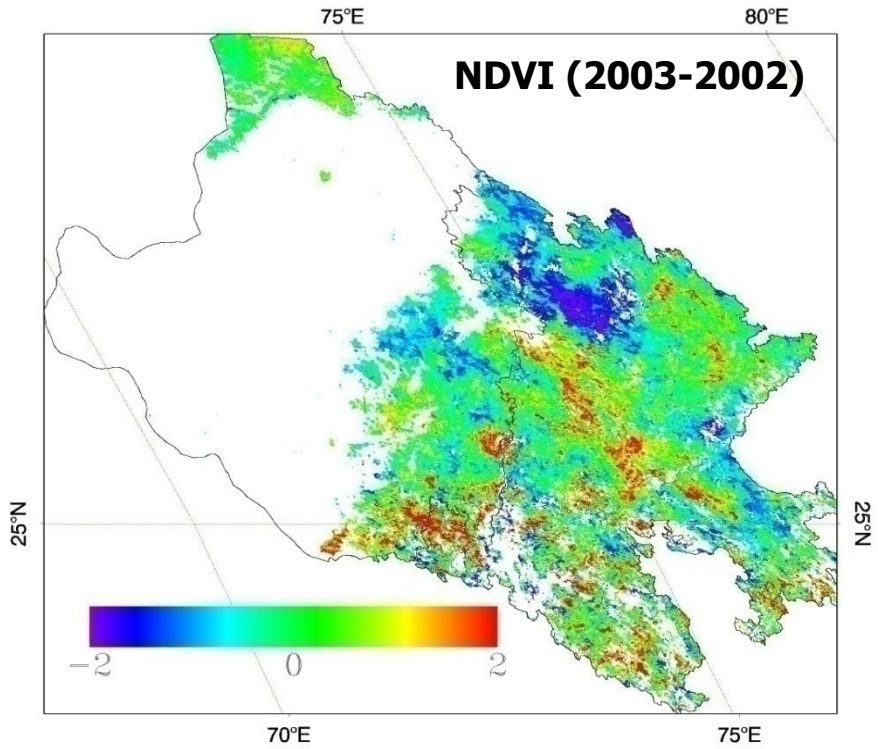
Drought Assessment from Space : National Agricultural Drought Assessment and Monitoring System (NADAMS, NRSC, India)

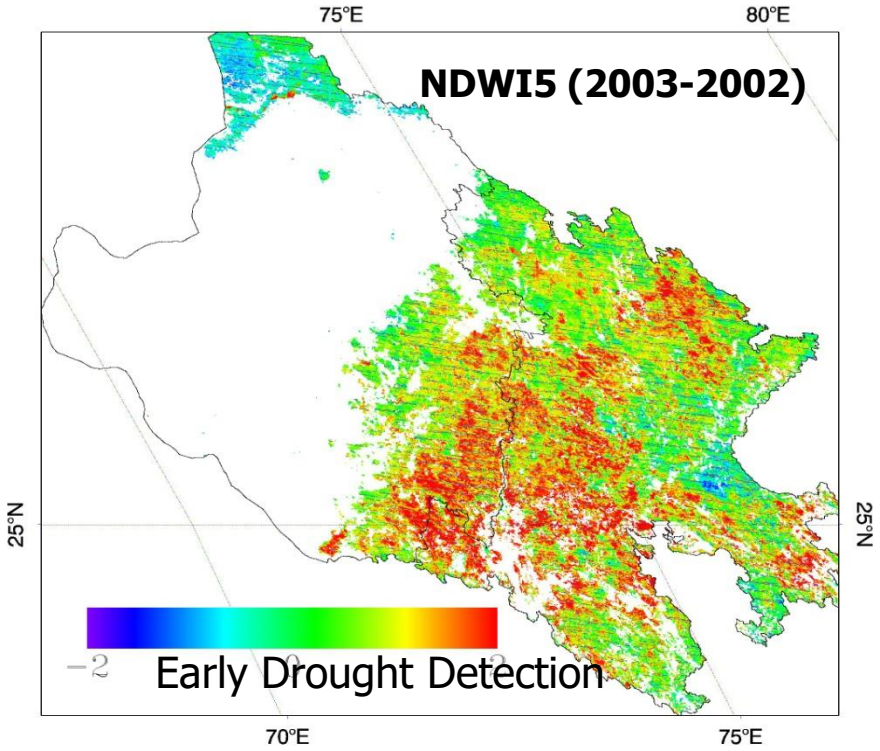


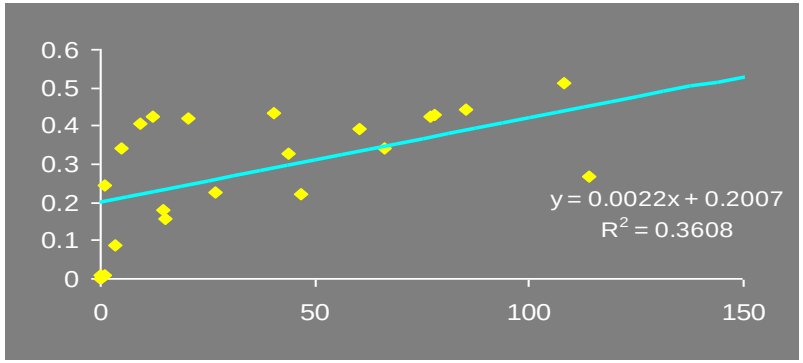


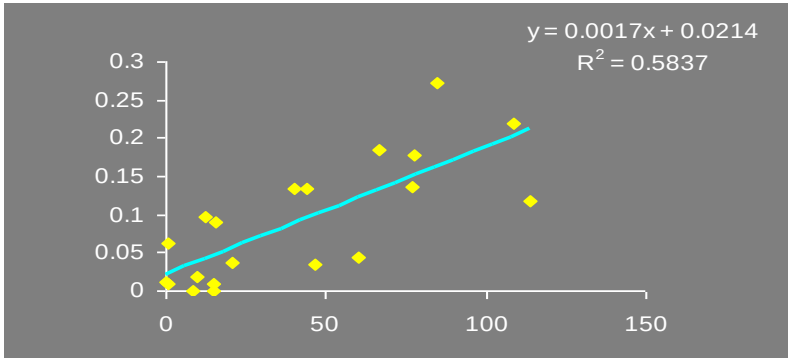
Our University- Initiatives

Agricultural Drought Monitoring Using NDVI and NDWI

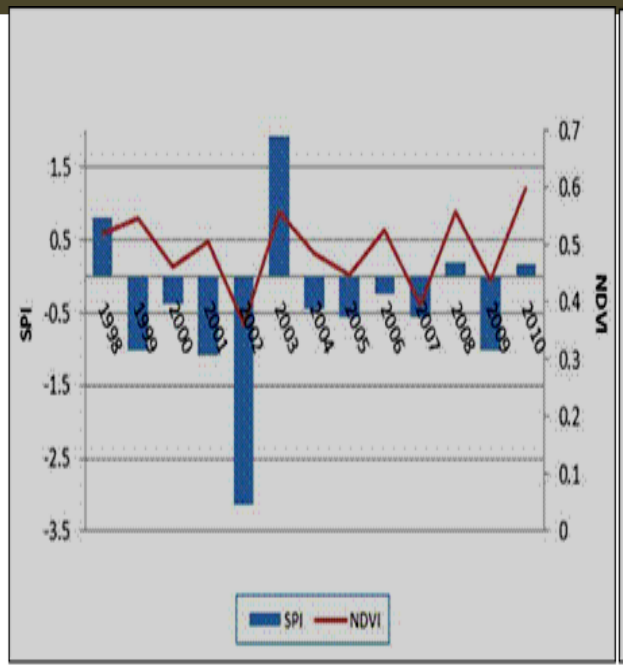


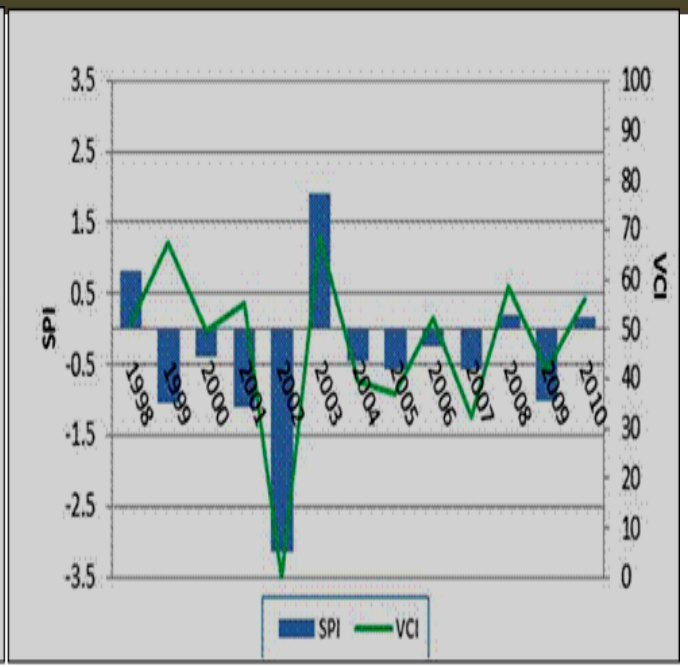


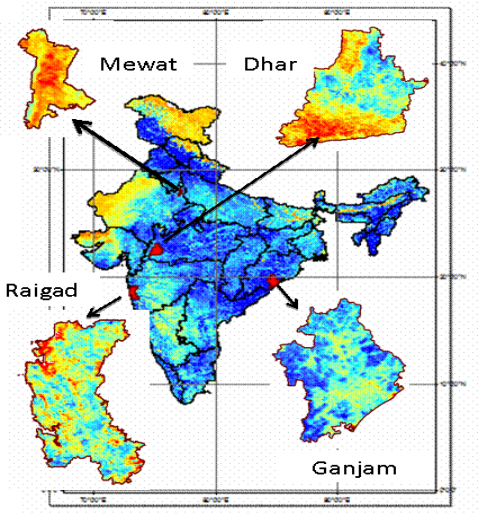




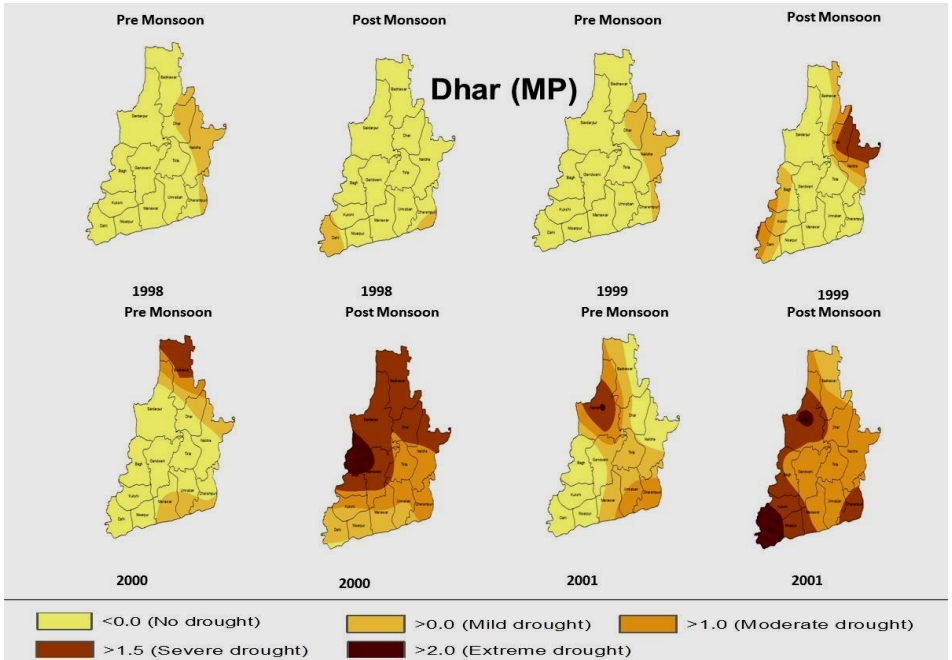
Meteorological and Hydrologic Drought Monitoring



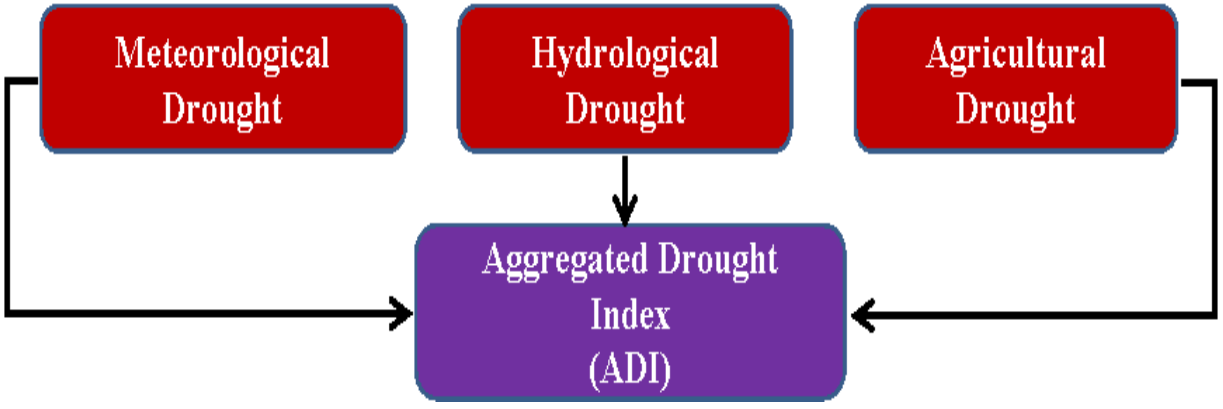




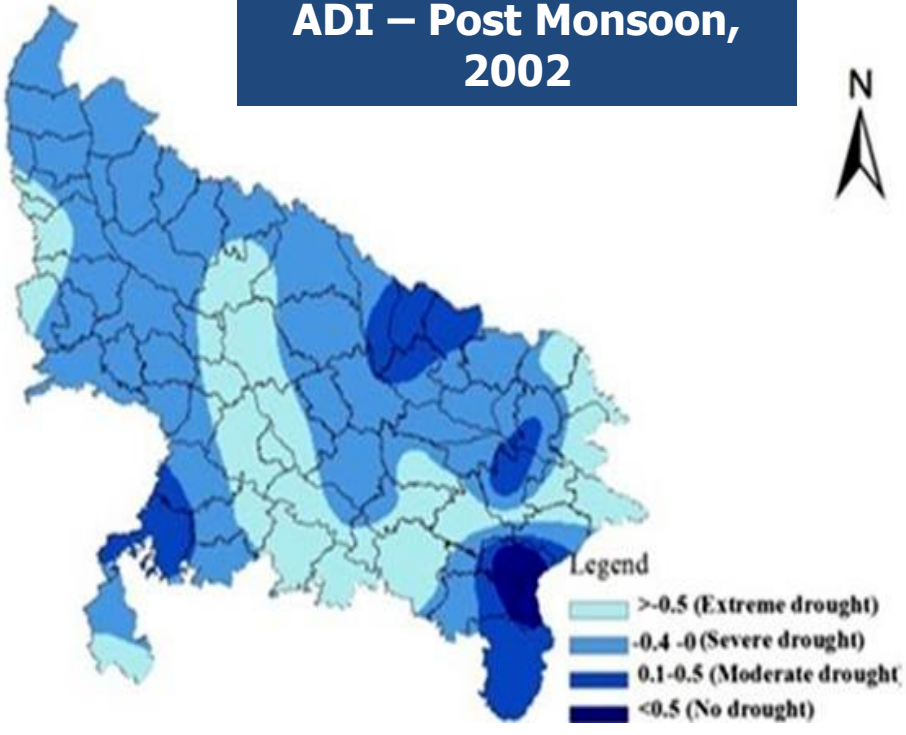
Standardized Water Level Index - Hydrologic Drought



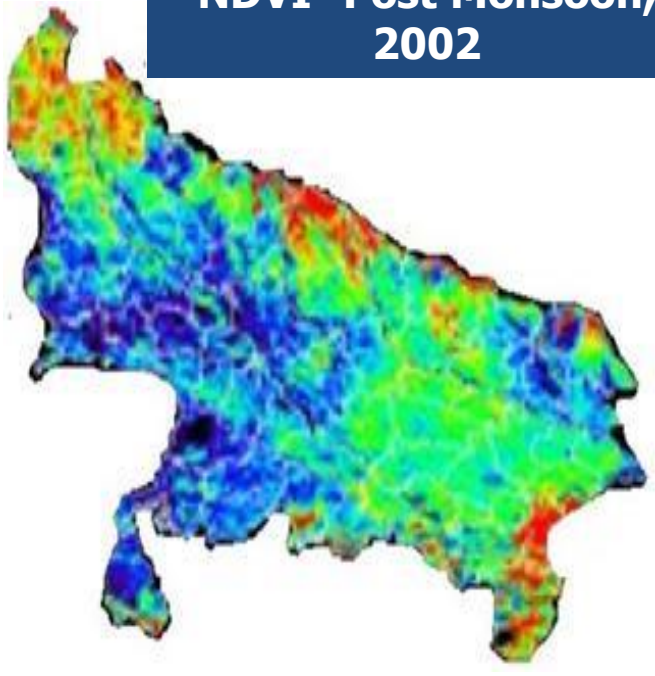
Drought Monitoring Using Composite Indices



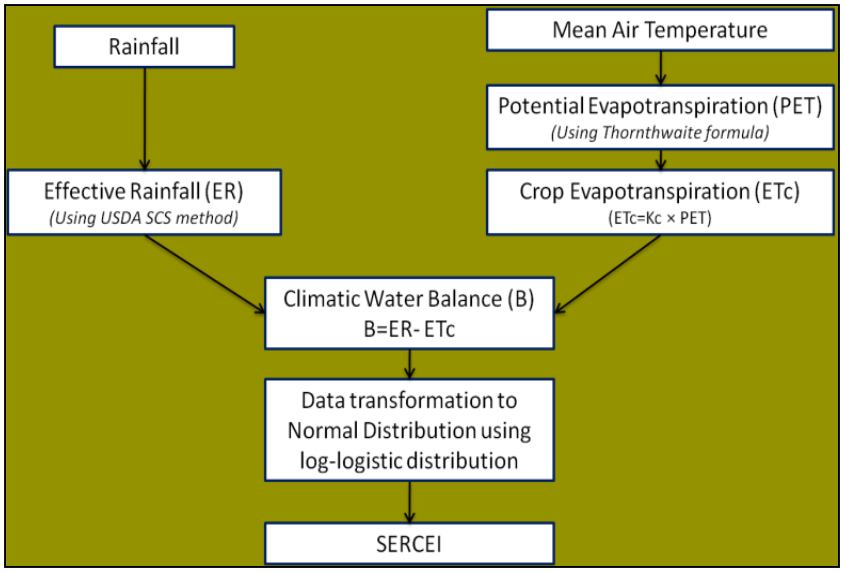
ADI – Post Monsoon, 2002

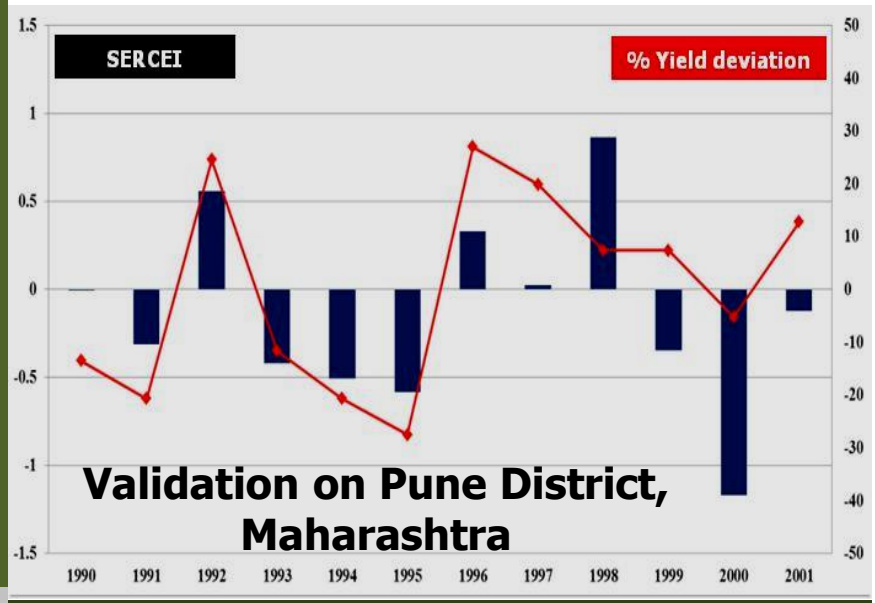


NDVI- Post Monsoon, 2002



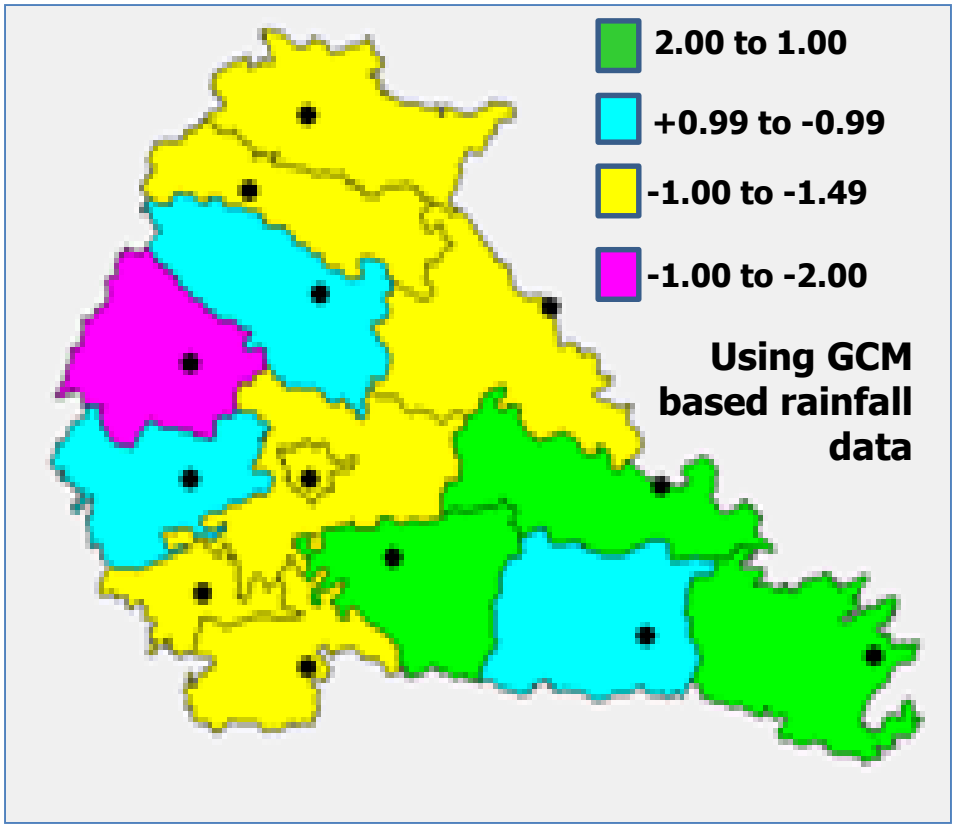
Drought Monitoring Using Composite Indices





SERCEI correlated well with yield deviations

SERCEI Based Drought Scenario - 2015 for Pune, Maharastra



Agricultural Drought Vulnerability Mapping

Drought vulnerability essential to :

Design area specific crop contingency/ mitigation plans and

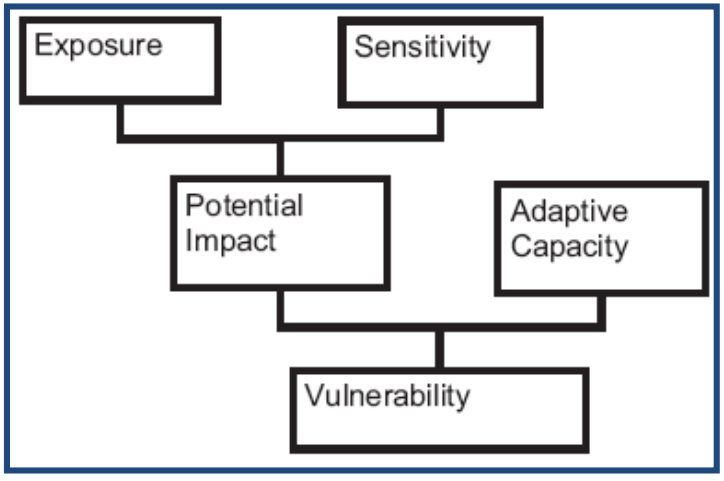
Devising drought declaration criteria

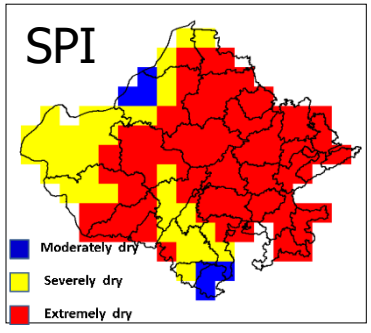
- **Exposure**:
  Frequency & Intensity of Standardized Precipitation Index (**SPI**), monthly rainfall 1951-2006.

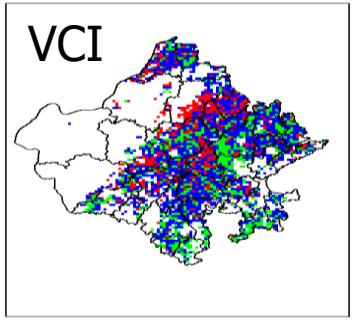
- **Sensitivity:**
  Frequency & Intensity of Vegetation Condition Index (**VCI**), Fortnightly AVHRR Satellite data 1982-2003.
  Water Holding Capacity of Soil, NBSS&LUP soil map
  Land-use, satellite derived

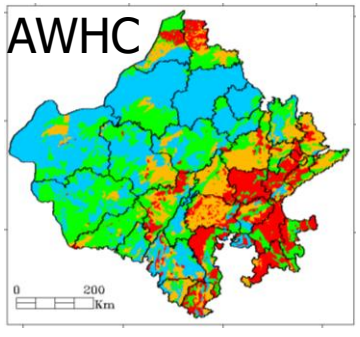
- **Adaptive Capacity:**
  Percent irrigation in grid

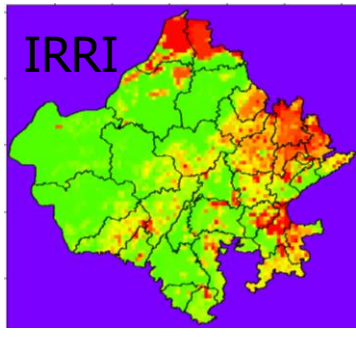
- **Composing**:
  Multi-criteria Evaluation was used to derive relative weights











Our Drought Mitigation & Adaptation Efforts

Mitigation & Adaptation Strategies

- **Renovation of Soil/ Water Conservation Structures & Community Ponds**
- **Laser leveling**
- **Laying of underground pipeline**
- **Sprinkler**
- **Rain gun**
- **Drip irrigation systems**

Mewat - One of the most backward regions in the country

ISSUES OF CONCERN

Long dry spells during monsoon

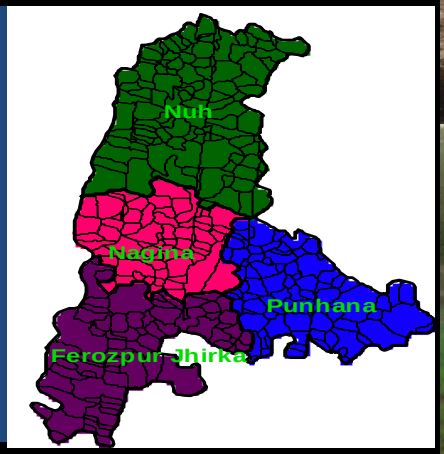
Limited water availability during non monsoon period

Heavy Pumping of Wells

Poor Water Quality

In-efficient water conveyance and application

Traditional un-controlled flood irrigation



Impact of Water Saving Interventions

Dist.	Water Saving Technologies	Water Saved/ha /season (Cu. m)	Time Saved per irrigation (hr)	GHG Gas Emission Reduction (Kg CO_2 /ha)
Nuh	Laser leveling	578	5-6	100.5
	Sprinkler Raingun	693	6-7	121
	Underground Pipeline	500	3-4	60
Taoru	Laser leveling	576	5-6	100.5
	Sprinkler Raingun	693	6-7	111
	Underground Pipeline	432	3-4	60

Drought Contingency Planning - 2012

Jun/Jul Rainfall: 30mm
(210 mm normal)

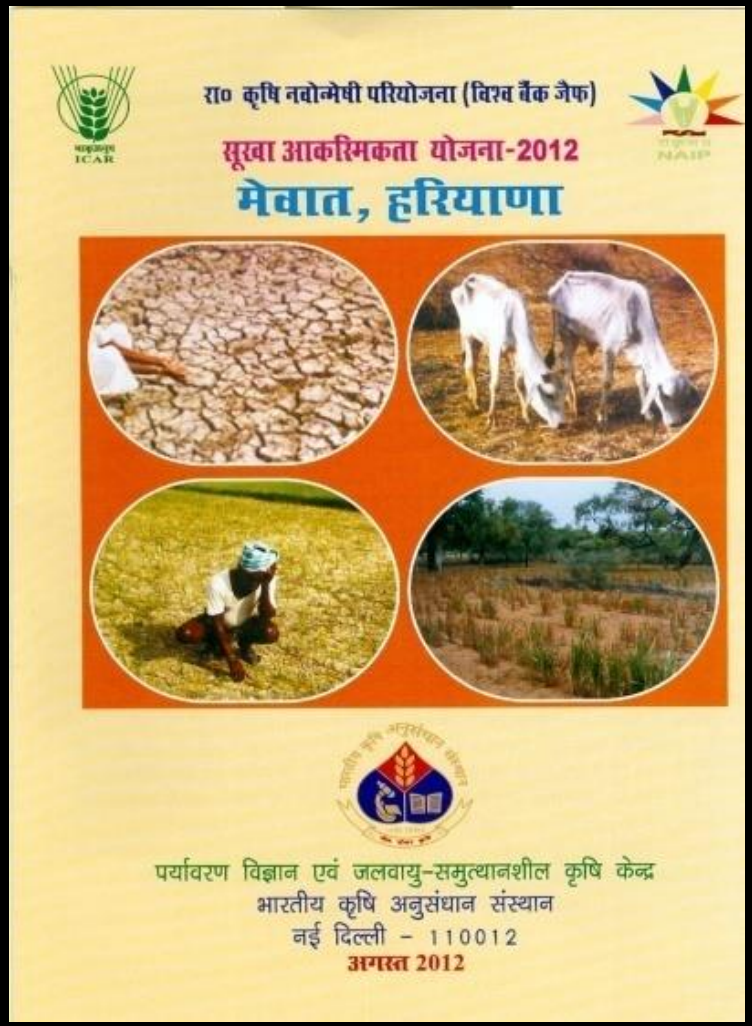
Cumulative Rainfall deficit: > 80%
(Up to 15 Aug 2012)

SPI : -1.50 to -1.99

Late Aug.: Vegetable Crops (Okra/Cowpea/Chilli)+ Plant Protection support

Sept.: Early Mustard + Vegetables (Brinjal/ Tomato/Cauliflower) + Late Wheat

Oct: Fallow (Deep Ploughing + Levelling), for those who couldn't take Mustard by Mid. Oct.



Impact of Contingency Plan – Vegetable Crop Intervention (Rainy Season)

Okra	Pusa A-4	New Introduction	Rs.45,000 (US 670)
Chilli	Pusa Sadabahar	60 beneficiaries	Rs. 60,000(US 1000)
Cow pea	Pusa Sukomal	New Introduction	Rs. 40,000 (US 597)

Rs. 20-25 thousand (or US300 - 370)/ha higher over Pearl Millet

Impact of Contingency Plan – Vegetable Crop Intervention (Early Winter)

Crop	Varieties/ Hybrids	Seed	No. of benefi-ciaries	Yield (t/ha)	Income (Rs/ha)
Brinjal	Pusa Hybrid -5 Pusa Hybrid -6 Pusa Hybrid -9 Pusa Uttam Nun-707	2500g	30	40.0-45.0	70,000 – 75,000
Bottle gourd	Pusa Naveen	500g	16	32.5- 45	61000-80000
	Mahyco No.8	500g		40.0 - 45	75000 - 80000
	Sungrow Vidhya	500g		33.0	63000 **(US 940)**
Tomato	Himsohna US 2853 Pusa Hybrid-8 Others(Dev)	700g	20	35 – 65.0	1,00,000 – 1,50,000 **(US 2300)**

•Farmers raising Vegetable in furrow system in Mewat

•Brinjal- 40.0-45.0 t/ha

•Profit Rs. 70,000 – 75,000/ha

Bottle guard -30.0-35.0 t/ha

&

Profit Rs. 61,000 – 75,000/ha

•Tomato : 35.0 t- 65.0 t/ha &

•Profit : Rs. 1,00,000 – 1,50,000/ha

The Bumper Harvest of Brinjal

Pusa hybrids early & tasty
While Private hybrids late

Impact of Contingency Plan – Early Mustard + Late Wheat Intervention (Winter Season)

Special early sown (Sept 2nd week) mustard (Cv. PM 25 & 28) introduced to enhance productivity / unit areas during post rainy season in Mewat

Adaptation of early mustard (Cv. PM 25 & 28) followed by Late wheat (WR 544) / Summer Vegetables in Mewat

mKRISHI® services for strengthening of adaptation initiative

Public-Private Partnership with TCS

Impact of Other Livelihood Improving Strategies – Livestock Intervention

<u>Interventions</u>

Periodic de-worming/ Medication

Provisioning of Mineral Mixture and dietary supplements for 5 months

Promoting Multi-cut Fodder Sorghum – 450 Households

<u>Impacts</u>

✓16% increased milk yield/day/head (Control – 7.38 lit/d and project intervention - 8.57 lit/d)

✓Household income Increase by Rs. 8,000/animal/lactation period

Impact of Other Livelihood Improving Strategies

- **Establishment of stitching and tailoring centre**
- Assignments of school dress in process
- Linkage with NGO for market integration
- Training also organized in another cluster of villages

UNL Team visit to villages in Mewat district

Collaborations/Partnerships

MOU between IARI and The University of Nebraska/ Daugherty Water for Food Institute

Development of a prototype toolbox for :

Near real time drought monitoring and early warning based on composite indices.

Quantitative Estimation of Drought Impacts on Agriculture

Sensor operated precision-irrigation / fertigation systems for cropping systems of drought prone areas

Deciphering gene networks/ allelic variations for genetic engineering of drought tolerant target crops


THANK YOU

Indian Drought Monitoring Process

- South west monsoon contributes 80 % of total rainfall in India during four months *i.e.* June to September.
- Drought recognized with a rainfall deficiency of more than 20%.
- Meteorologically, ± 19% deviation of rainfall from the long-term mean is considered 'normal' in India. Deficiency in the range 20–59% represents 'moderate' drought, and more than 60% is 'severe' drought.
- A year is considered to be a DROUGHT YEAR when the area affected by moderate and severe drought, either individually or together, is 20- 40% of the total area of the country.
- When the spatial coverage of drought is more than 40% it is called as ALL INDIA SEVERE DROUGHT YEAR.