Drought Monitoring – State of the Art & Way Forward

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Drought: A Silent Threat to Indian Rural Economy

- 70% population (900 million) depend on agriculture.
- 68% net sown area (97 M ha) drought prone.
- 50% of drought prone area severe in nature.
- 1871-2012: 22 major droughts with 5 severe.

Geographical Area
328.7 M ha

Net Sown Area
142.2 M ha

Net Irrigated Area
55.10 Mha

Crop Failure

Unemployment

Cattle - starvation

Fodder shortage

Drinking water shortage

Agriculture – The immediate victim

Frequency of droughts in India - 1871-1999
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
2. Aridity Anomaly Index (AAI)
3. Standardized Precipitation Index (SPI)
Drought Assessment from Space: National Agricultural Drought Assessment and Monitoring System (NADAMS, NRSC, India)

NDVI anomaly assessment:
1. Relative deviation
2. VCI
3. In season transformation

Agricultural drought situation

Change in crop calendar
Lag between NDVI & rainfall
Abnormal weather events such as floods

Extent of NDVI anomaly
Extent of rainfall deviation
Extent of sown area deviation

Drought warning (June, July, August)
- Normal
- Watch
- Alert

Drought declaration (Sep, Oct)
- Mild
- Moderate
- Severe

Legend:
- Normal
- Watch
- Alert
Agricultural Drought Monitoring Using NDVI and NDWI

Early Drought Detection

NDVI (2003-2002)


\[ y = 0.0017x + 0.0214 \]
\[ R^2 = 0.5837 \]

Rainfall (mm)

\[ y = 0.0022x + 0.2007 \]
\[ R^2 = 0.3608 \]

Rainfall (mm)
Hydrologic Drought Monitoring through Standardized Water Level Index

Dhar (MP)

Legend:
- <0.0 (No drought)
- >0.0 (Mild drought)
- >1.0 (Moderate drought)
- >1.5 (Severe drought)
- >2.0 (Extreme drought)
Meteorological and Biophysical Drought Indices
Drought Monitoring using Composite Indices

Meteorological Drought
- Rainfall

Hydrological Drought
- Stream Flow
- GW depth

Agricultural Drought
- ETc

Aggregated Drought Index (ADI)

Pre-monsoon ADI (1998)

Pre-monsoon ADI (1999)

Post-monsoon ADI (1998)

Post-monsoon ADI (1999)

Could satisfactorily mimic both the onset and establishment of drought conditions following 1998-monsoon failure & re-establishment of normal conds. post good 1999 monsoon
Agricultural Risk Management through Near Real Time Crop Condition Monitoring

- Specification
  - Covered 564 districts of India
  - Database: 2000-2014
  - Update: week / Fortnight
  - Automatized workflow
  - Database: MySQL
  - Web programming: PHP
  - Web server: Apache tomcat
  - Website: http://creams.iari.res.in

- Satellite derived parameters
  - NDVI -> Crop Condition Index (CCI)
  - LST (Day) -> Temperature Condition Index (TCI_D)
  - LST (Night) -> Temperature Condition Index (TCI_N)
  - Rainfall -> Standardized Precipitation Index (SPI)
  - Soil Moisture (still under development)

- Visualization
  - Country Level: as periodic & seasonal maps
  - District level: Temporal profile of parameters in current season as compared to previous year and average

Updates crop conditions at every weekly and fortnightly interval

Allows temporal comparison of each parameter in current season Vs. that in last year and over long term average
During Rabi 2013-14, the Temperature regime during day was cool while it was normal during night.

On account of favorable temperature regime during day and higher rainfall in the season, Wheat CCI very good until April 14.
# Satellite Based Pre-Harvest Wheat Yield Forecasting for Punjab and Haryana

**Satellite Sensor:** MODIS  
**Data products:** Spatio-temporal EVI, Fortnightly, Noise Filteration, Crop Phenology Derivatives, EVI Amplitude Aggregation & Regression  
**Data Period:** 2000-2014 (14 years)  
**For Forecast:** Data used up to 20-March-2014

<table>
<thead>
<tr>
<th>Target Area</th>
<th>Forecast for 2013-2014 (at 10% prediction error)</th>
<th>Change Over Previous Year</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Production (M t)</td>
<td>Yield (t/ha)</td>
</tr>
<tr>
<td>Punjab</td>
<td>16.97</td>
<td>4.84</td>
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<tr>
<td>Haryana</td>
<td>11.48</td>
<td>4.59</td>
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</tbody>
</table>

- Expected Wheat yields: 3% more over last year  
- Proposed forecast in close conformity with GAIN - forecasts  
- Validation: 2010-11
Indian Drought Monitoring & Declaration Process
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.

<table>
<thead>
<tr>
<th>State</th>
<th>Criteria for drought declaration</th>
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</thead>
<tbody>
<tr>
<td>Andhra Pradesh</td>
<td>1. Block level rainfall</td>
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<td></td>
<td>2. Block level crop sown area</td>
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<td></td>
<td>3. Yield reduction</td>
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<td></td>
<td>4. Dry spells</td>
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<tr>
<td>Karnataka</td>
<td>Rainfall</td>
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<tr>
<td></td>
<td>Dry weeks</td>
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<tr>
<td>Maharashtra</td>
<td>Yield loss</td>
</tr>
<tr>
<td>Odisha</td>
<td>Block level rainfall, Crop assessment</td>
</tr>
<tr>
<td>Rajasthan, UP and J &amp; K</td>
<td>Yield loss criteria</td>
</tr>
</tbody>
</table>
Rainfall Deficiency / Yield loss/ Red. cropped area at Block and District level

Crop Weather Watch Group

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

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.
Collaborations/Partnerships

Development of a prototype toolbox for:

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

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

Quantitative Estimation of Drought Impacts on Agriculture
THANK YOU