AGRICULTURAL DROUGHT ASSESSMENT REPORT

October 2012 Assessment for 13 States with 4 States at Sub-District Level

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Department of Space, Hyderabad – 500 625
Agricultural Drought Assessment is essential for taking appropriate remedial measures for improvement of drought situation. Satellite based remote sensing data has been shown to be highly useful for crop condition assessment and drought monitoring. A very successful project called National Agricultural Drought Assessment and Monitoring System (NADAMS) had been developed by National Remote Sensing Centre (NRSC), ISRO, which envisaged use of remote sensing and meteorological data for drought assessment of 13 agriculturally important states of India. After the technology was transferred to Mahalanobis National Crop Forecast Centre (MNCFC), Department of Agriculture & Cooperation, this is the fifth report of national level agricultural drought assessment brought by MNCFC, in collaboration with NRSC. This report assesses agricultural situation of the country up to the month of October, 2012.

Composite images of coarse resolution NOAA AVHRR data (1 km) was used for 9 states namely, Bihar, Chhattisgarh, Gujarat, Madhya Pradesh, Jharkhand, Odisha, Rajasthan, Uttar Pradesh and Tamil Nadu, while moderate resolution data from Resourcesat-2, AWiFS (56m) was used for 4 states namely, Andhra Pradesh, Karnataka, Maharashtra and Haryana. Crop condition has been assessed using satellite derived Normalized Difference Vegetation Index (NDVI)/Normalized Difference Water Index (NDWI) images. Shortwave Angle Slope Index (SASI) derived from MODIS data has been used to generate Area Favorable for Crop Sowing (AFCS). These satellite derived products have been integrated with Soil Moisture Index (derived using soil water balance approach) and IMD Rainfall data (rainfall deviation, number of dry weeks) for assessment of drought situation in each district of these 13 states and further sub district level for 4 states.

Rainfall situation has improved during September month from previous month. During October, rainfall at nation level was 58 mm against 81 mm of normal. Tamil Nadu and Konkan sub-divisions have received excess rainfall, Madhya Maharashtra, Marathwada, Telangana, coastal AP, SHWB, Assam and Arunachal Pradesh sub-divisions received normal rainfall and the remaining 26 met sub-divisions received either scanty or deficit rainfall during the month. Soil Moisture Index (SMI) derived from spatial soil water balance model, up to September, showed progressive rise in the soil moisture availability during the season commensurating with the rainfall pattern. During October, SMI showed decreasing trend. NDVI has reduced slightly during first fortnight of October followed by large reduction in the 2nd fortnight, in Haryana, Rajasthan, Uttar Pradesh, Madhya Pradesh states as a result of senescence/harvesting of Kharif crops. In other states also, NDVI has slightly reduced during the month, signifying the senescing phase of crops. NDWI which represents the surface wetness has also registered declining trend during the month, in most parts of the country.

District-wise analysis for 13 states indicated “Normal” agricultural situation in 316 districts. The agricultural situation is categorized as “Mild” in 43 districts and as “Moderate” in 51 districts.
1.0 Introduction

'National Agricultural Drought Assessment and Monitoring System (NADAMS)' project, conceptualized and developed by National Remote Sensing Centre (NRSC), ISRO, Department of Space, provides near real-time information on prevalence, severity level and persistence of agricultural drought at state/district/sub-district level. Currently, it covers 13 states of India, which are predominantly agriculture based and prone to drought situation. Agricultural conditions are monitored at state/district level using daily NOAA AVHRR data for 9 states. AWiFS (Advanced Wide Field Sensor) of Resourcesat 2 (56 m resolution) is used for detailed assessment of agricultural drought at district and sub district level in four states. MODIS 250m, 1km derived NDWI, SASI datasets have also been interpreted to complement the assessment. Fortnightly/monthly report of drought condition is provided to the Government under NADAMS. From the year 2012, the NADAMS project is being implemented by the Mahalanobis National Crop Forecast Centre (MNCFC), Ministry of Agriculture, after the technology was transferred to MNCFC by NRSC.

Agricultural drought assessment with multiple indices as indicated below;

- Shortwave Angle Slope Index (SASI)
- Normalized Difference Wetness Index
- Normalized Difference Vegetation Index
- Soil Moisture Index (derived from soil water balance approach)
- IMD Rainfall data – rainfall deviation, number of dry weeks

The present report is a summary of agricultural situation during October 2012 for 13 states and contains satellite derived vegetation index images, rainfall deviations and assessment of agricultural situation.

2.0 Vegetation Index Image

Among the various vegetation indices that are now available, Normalized Difference Vegetation Index (NDVI) is most widely used for operational drought assessment because of its simplicity in calculation, easiness in interpretation and also its ability to partially compensate for the effects of atmosphere, illumination geometry etc. Normalised Difference Vegetation Index (NDVI) is derived from \( \frac{(NIR - Red)}{(NIR + Red)} \) where NIR and Red are the reflected radiation in visible and near infrared channels. Various colours in the NDVI image - Yellow through Green to Red - indicate increasing vegetation vigour. The legend of colour bars...
and the vegetation index values are provided along with the vegetation index image. Water, clouds and snow have higher reflectance in the visible region and consequently NDVI assumes negative values for these features. Bare soil and rocks exhibit similar reflectance in both visible and near IR regions and the index values are near zero. The NDVI values for vegetation generally range from 0.1 to 0.6, the higher index values being associated with greater green leaf area and biomass.

3.0 Spatial Vegetation Status

The agricultural crop condition is monitored based on the NDVI information derived from satellite data. The vegetation index images of the country after overlaying the forest area mask and agricultural vegetation condition map for June 2011 and 2010 are shown in Plates.

After precluding the forest area, district wise average vegetation index statistics are generated. The district wise vegetation status during the current season is assessed based on the seasonal NDVI progression.

4.0 Surface Wetness Indicators

Shortwave Infrared (SWIR) band is sensitive to moisture available in soil as well as in crop canopy. In the beginning of the cropping season, soil background is dominant hence SWIR is sensitive to soil moisture in the top 1-2 cm. As the crop progresses, SWIR becomes sensitive to leaf moisture content. SWIR band provides only surface wetness information. When the crop is grown-up, SWIR response is only from canopy and not from the underlying soil. NDWI using SWIR can complement NDVI for drought assessment particularly in the beginning of the cropping season. NDWI is derived as under;

$$\text{NDWI} = \frac{(\text{NIR} - \text{SWIR})}{(\text{NIR} + \text{SWIR})}$$

where Near Infra Red and SWIR are the reflected energy in these two spectral bands. Higher values of NDWI signify more surface wetness.

5.0 Shortwave Angle Slope Index (SASI)

SASI images were generated using 8-day composites of MODIS 500 m images of NIR, SWIR 1 and SWIR 2 bands. SASI is highly sensitive to rainfall and hence indirectly associated with crop sown area. SASI variations in the season which represent dynamics of surface moisture were used for assessing the Area Favourable for Crop Sowing (AFCS) from time to time. General threshold values of SASI specific to soil texture that indicate favorable situation for crop sowings were identified. Based on SASI thresholds, discrimination of the Area Favourable Crop Sowing (AFCS) was done on weekly basis for each state. The AFCS weekly values are useful to assess the intensity of early season/sowing period agricultural drought...
intensity in terms of timeliness in the commencement of sowings, extent of delay or reduction in crop sowings.

6.0 Soil Moisture Index from Soil Water Balance Model

The soil water balance (SWB) model is a convenient way of estimating the soil moisture over a large area with considerable reliability. A simple book keeping – bucket type – water tight model was developed to derive the top 30cm profile soil moisture. This model considers the initial root depth of 30 cm throughout the season to capture the soil water scenario for crops sown and germinating during any part of the cropping season. The soil water balance in the upper layer is governed by daily values of rainfall, runoff, evapotranspiration (ET) and drainage to the second layer. When the upper layer saturates in excess of Field Capacity (FC) due to rainfall, the excess water percolates to the lower passive root zone and are instantaneously redistributed in that zone. The excess soil water in the passive zone moves out as deep percolation. Since the upper 30 cm is considered for the soil water assessment the lower limit of soil water is the residual water content of the soil as the upper layer is exposed to the atmosphere and subjected to upward flux due to the direct solar radiation. The climatic, soil and crop parameter are the main inputs for the SWB. The daily near real time TRMM 3B42RT spatial rainfall product and the daily global potential evapotranspiration data are used as the rainfall and climatic input, respectively. The soil information was derived from the 1: 0.5 million scale NBSS&LUP soil map. Since this model does not take into account the irrigation applied from various sources, the results of the model should be considered over rainfed areas alone. The Soil Moisture Index (SMI) derived is defined as the proportion of the difference between the current soil moisture and the permanent wilting point to the field capacity and the permanent wilting point. The index values range from 0 to 100 with 0 indicating extreme dry condition and 100 extreme wet conditions.

7.0 Rainfall Status (Data Source: IMD, New Delhi, www.imd.gov.in)

During October, rainfall at nation level was 58 mm against 81 mm of normal. Tamil Nadu and Konkan sub-divisions have received excess rainfall, Madhya Maharashtra, Marathwada, Telangana, coastal AP, SHWB, Assam and Arunachal Pradesh sub-divisions received normal rainfall and the remaining 26 met sub-divisions received either scanty or deficit rainfall during the month.

Rainfall situation has improved during September month from previous month. Total season’s rainfall (June to September 2012) was 820 mm against 887 mm of normal, deficit by 8% at country level, as per IMD reports. There are 22 met sub-divisions with normal rainfall, 13 subdivisions with deficit rainfall and 1 sub-division with excess rainfall in 2012. In the southwest monsoon period of the year 2011, there were only 3 met sub-divisions with deficit rainfall with all other sub-divisions recording either normal or excess rainfall.
8.0 Highlights of Agricultural Situation – October 2012

- Rainfall situation has improved during September, reducing the extent of deficiency. Deficit rainfall was recorded in many meteorological sub-divisions namely, South Interior Karnataka, North Interior Karnataka, Madhya Maharashtra, Marathwada, Gujarat region, Saurashtra, West UP, Haryana.

- **Soil Moisture Index (SMI)** derived from spatial soil water balance model, up to September, showed progressive rise in the soil moisture availability during the season commensurating with the rainfall pattern. During October, SMI showed decreasing trend.

- The **Area Favourable for Crop Sowing/ Crop sown area (AFCS)**, has been derived from (1) SASI data integrated with ground data on cropping pattern, soils and irrigation support and (2) Spatial Soil Water Balance model. AFCS reflects the agricultural area with significant surface wetness and hence favorable for crop sowing activity.

- **AFCS at the end of July**
  There was a significant increase in AFCS or area sown from 44 M ha in June to 87 M ha in July. The AFCS has increased significantly in July from previous month in Andhra Pradesh, Karnataka, Maharashtra, Orissa, Chhattisgarh, Uttar Pradesh and Madhya Pradesh states. The unfavorable area for crop sowing is 22 M ha, and is mostly located in Gujarat, Rajasthan and Haryana and in the northern and central Karnataka and in coastal region and Rayalseema regions of Andhra Pradesh indicating the continued unfavorable seasonal conditions in July 2012. About 2.5 M ha of this unfavorable area corresponds to rice crop and is mostly located in Rajasthan, Haryana, Karnataka, Tamil Nadu and Uttar Pradesh states.

- **AFCS at the end of August**
  With the occurrence of significant rainfall, the crop sown area has increased 97.7 M ha in August from 87 M ha in July. The unfavorable area is 10.9 M ha at nation level, of which about 7 M ha is located in 3 states namely Karnataka, Gujarat and Rajasthan. In these 3 states, the unfavorable area represents considerable proportion of Kharif crop area. In Andhra Pradesh state, about 1 M ha is yet to be sown with crops. In the remaining states, the unfavorable area is less than 10 percent of potential Kharif area. Thus, the overall agricultural situation in the country, with respect to crop sown area, indicates “Alert” situation in 3 states – Karnataka, Gujarat and Rajasthan with significant reduction in sown area and with less scope for (a) further raise in crop area and (b) late sown crop area reaching normal crop growth progression.

- **AFCS at the end of September**
  AFCS has increased to 106 M ha against a normal of 109 M ha, thus covering 97% of normal area. The unfavorable area was 3 M ha, mostly located in Karnataka, Gujarat and Rajasthan states.
NDVI has reduced slightly during first fortnight of October followed by large reduction in the 2nd fortnight, in Haryana, Rajasthan, Uttar Pradesh, Madhya Pradesh states as a result of senescence/harvesting of Kharif crops. In other states also, NDVI has slightly reduced during the month, signifying the senescing phase of crops.

NDWI which represents the surface wetness has also registered declining trend during the month, in most parts of the country.

Seasonal profiles of NDVI and NDWI from June to October indicate normal agricultural situation in many parts of the country - Chhattisgarh, Orissa, Madhya Pradesh, Jharkhand, Uttar Pradesh, Bihar, Tamil Nadu, Northern half of Andhra Pradesh, West coast of Karnataka, Vidarbha region of Maharashtra, Eastern Rajasthan and Eastern Gujarat.

Less than normal NDVI and NDWI and reduced rate of transformation from June to October, signifying delayed crop sowing/reduced crop area/poor crop growth are observed in southern parts of Andhra Pradesh, northern and southern Karnataka, Marathwada and Madhya Maharashtra regions of Maharashtra, West Gujarat, Southern Haryana and Western Rajasthan.

In many parts of Karnataka state, Marathwada and Madhya Maharashtra regions of Maharashtra, West Gujarat, Southern Haryana, Western Rajasthan and in parts of Andhra Pradesh, the extent of crop sown area and/or the vigor of already sown crops is significantly less than that of Kharif 2011 or Kharif 2010 indicating agricultural drought situation.

District-wise analysis in 13 states by the end of October 2012 (as shown in Table 1 below) indicate the number of districts under different categories of agricultural situation.
**Table 1:** Number of districts under different categories of agricultural situation in 13 states, October 2012

<table>
<thead>
<tr>
<th>State</th>
<th>Normal</th>
<th>Mild</th>
<th>Moderate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andhra Pradesh</td>
<td>13</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Bihar</td>
<td>31</td>
<td>6</td>
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</tr>
<tr>
<td>Chhattisgarh</td>
<td>15</td>
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<td>0</td>
</tr>
<tr>
<td>Gujarat</td>
<td>13</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Haryana</td>
<td>8</td>
<td>5</td>
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<tr>
<td>Jharkhand</td>
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<td>0</td>
</tr>
<tr>
<td>Karnataka</td>
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<td>7</td>
<td>15</td>
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<td>10</td>
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<td>Madhya Pradesh</td>
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</tr>
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<td>Odisha</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Rajasthan</td>
<td>24</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>20</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Uttar Pradesh</td>
<td>69</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>316</strong></td>
<td><strong>43</strong></td>
<td><strong>51</strong></td>
</tr>
</tbody>
</table>

- “Moderate agricultural drought” category districts/Taluks are characterised by one or more of the attributes – more than a month delayed sowing time, more than 25% reduction in crop area, poor greenness/moisture levels of crop vegetation, significant reduction in crop yield, lack of adequate irrigation infra-structure, reduced rate of increase in crop greenness/moisture during the season.

- “Mild agricultural drought” category districts are characterised by slightly reduced crop sown area or slightly reduced greenness of crops leading to slight reduction in crop yield.

- The agricultural situation has not worsened from September to October in the country. The trends of different crop indices are normal in many states indicating progressive improvement in agricultural situation from June. At the end of October month, Normal agricultural situation is evident in **316 districts** followed by Mild agricultural drought in **43 districts** and moderate agricultural drought in **51 districts**.

- **Gujarat, Karnataka and Maharashtra** are the states of concern, with significant number districts under “Moderate drought”, followed by Haryana, Rajasthan and Andhra Pradesh states.

- **Sub-district level assessment:** In four states namely, Andhra Pradesh, Karnataka, Maharashtra and Haryana, agricultural drought assessment has been done at sub-district level; using Resourcesat AWIFS derived indices along with other indices. The number of Blocks/Mandals/Taluks under different categories of agricultural situation –
Normal, Mild and Moderate drought – in each district of these four states is furnished in the Table 3 to 6.

- In Andhra Pradesh state, the agricultural situation has slightly improved from previous month. 164 Mandals are categorised under “Moderate drought” class followed by 203 Mandals in “Mild drought” class and 731 Mandals in “Normal” class.

- In Haryana, 40 blocks are categorised under “Moderate agricultural drought” class followed by 27 blocks under “Mild agricultural drought” class and 54 blocks in “Normal” class. The “Moderate agricultural drought” class blocks mostly correspond to southern part of the state - Hisar, Bhiwani, Mahendragarh, Rewari, Jajjar and Mewat districts.

- In Karnataka, 68 Taluks are categorised under “Moderate agricultural drought” class followed by 53 Taluks under “Mild agricultural drought” class and 55 Taluks under “Normal” class. The Taluks under Moderate drought class are distributed all over the state except in the west coast region.

- In Maharashtra, 73 Taluks are categorised under “Moderate agricultural drought” class followed by 60 Taluks under “Mild agricultural drought” class and 221 Taluks under “Normal” class. The Taluks under Moderate drought are distributed mostly in Madhya Maharashtra and Marathwada regions of the state.

- Summary tables showing district level categories of agricultural situation in 13 states and sub-district level categorisation in 4 states are furnished hereunder Table 2 – 6.

- Poor crop growth in parts of Karnataka, Gujarat, Maharashtra, Andhra Pradesh Rajasthan and Haryana may result in the reduction of crop yield.
Table 2: Summary of September 2012 Agricultural Drought Assessment is shown below:

<table>
<thead>
<tr>
<th>State</th>
<th>Agricultural drought situation up to October 2012</th>
</tr>
</thead>
</table>
| Andhra Pradesh   | **Normal**: (13 districts) Adilabad, Karimnagar, Khammam, Medak, Nellore, Nizamabad, Rangareddy, Srikakulam, Visakhapatnam, Vizianagaram West Godavari, Krishna and Warangal  
                    **Mild**: (5 districts) Chittoor, East Godavari, Mahaboobnagar, Guntur and Nalgonda.  
                    **Moderate**: (4 districts) Anantpur, Kurnool, Kadapa and Prakasam |
| Bihar            | **Normal**: (31 districts) Paschim Champaran, Kishanganj, Bhabhua, Rhotas, Aurangabad, Purbi Champaran, Sitamarhi, Madhubani, Muzaffarpur, Sheikhpura, Khagaria, Madhepura, Sheohar, Supaul, Araria, Darbhanga, Gopalganj, Nalanda Sheikhpura, Patna, Bhojpur, Jahanabad, Gaya, Purnia, Luckeesarai, Samastipur, Saharsa, Siwan, Saran, Vaishali, Nawada and Buxar  
                    **Mild**: (6 districts) Begusarai, Bhagalpur, Banka, Munger, Katihar, and Jamui |
| Chhattisgarh     | **Normal**: (15 districts) Koriya, Surguja, Jashpur, Raigarh, Korba, Bilaspur, Jangir, Raipur, Durg, Kawardha, Rajnandgaon, Dhamtari, Kanker, Bastar and Dantewada |
| Gujarat          | **Normal**: (13 districts) Mehsana, Sabar Kantha, Dahod, Panchmahal, Kheda, Gandhi Nagar, The Dangs, Anand, Valsad, Vadodara, Surat, Narmada and Navsari  
                    **Mild**: (3 districts) Banas Kantha, Patan, and Ahmedabad  
                    **Moderate**: (9 districts) Kachchh, Surendranagar, Rajkot, Jamnagar, Junagadh, Porbander, Amreli, Bharuch and Bhavnagar |
| Haryana          | **Normal**: (8 districts) Ambala, Kurukshetra, Panchkula, Panipat, Yamunanagar, Karnal, Kaithal and Fatehabad  
                    **Mild**: (5 districts) Sonipat, Jind, Rhotak, Sirsa and Gurgaon  
                    **Moderate**: (7 districts) Bhiwani, Hisar, Jhajjar, Mahendragarh, Rewari, Faridabad and Mewat |
| Jharkhand        | **Normal**: (22 districts) Koderma, Gumla, Garhwa, Palamau, Chatra, Jamtara, Pakaur, Latehar, East Singhbhum, Saraikela Kharsawan, Giridih, Deoghar, Sahibganj, Dumka, Dhanbad, Hazaribagh, Lohardaga, West Singhbhum, Ranchi, Godda, Bokaro and Simdega |
| Karnataka        | **Normal**: (8 districts) Bidar, Chikmagalur, D. Kannada, Kodagu, U. Kannada, Yadigir, Shimoga and Udupi  
                    **Mild**: (7 districts) Belgaum, Bangalore-U, Bangalore-R, Davangere, Kolar, Ramanagara and Mandya  
                    **Moderate**: (15 districts) Bagalkot, Mysore, Chickballapur, Chamarajanagara, Chitradurga, Haveri, Hassan, Tumkur, Bellary, Bijapur, Dharwad, Gadag, Gulberg, Koppal and Raichur |
<table>
<thead>
<tr>
<th>State</th>
<th>Normal: (N districts)</th>
<th>Mild: (M districts)</th>
<th>Moderate: (M districts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maharashtra</td>
<td>Akola, Amaravati, Bhandara, Buldana, Chandrapur, Dhule, Gadchiroli, Gondia, Kolhapur, Latur, Nagpur, Nandurbar, Rayagad, Ratnagiri, Thane, Wasim, Sindhudurg and Wardha</td>
<td>Hingoli, Nanded, Nashik, Yavatmal and Parbhani</td>
<td>Sangli, Osmanabad, Satara, Aurangabad, Beed, Jalna, Jalgaon, Ahamadnagar, Solapur and Pune</td>
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<tr>
<td>Madhya Pradesh</td>
<td>Katni, Damoh, Jabalpur, Mandla, Seoni, Chhindwara, Betul, Hoshangabad, Harda, Morena, Bhind, Datia, Gwalior, Sheopur, Shivpuri, Tikamgarh, Chhatarpur, Panna, Rewa, Sidhi, Shahdol, Vidisha, Bhopal, Rajgarh, Shajapur, Ujjain, Ratlam, Mandsaur, Indore, Dewas, Sehore, Raisen, Narsimhapur, East Nimar, West Nimar, Badwani, Guna, Satna, Sagar, Neemach, Dhar, Umaria, Balaghat, Dindori and Jhabua</td>
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<td></td>
</tr>
<tr>
<td>Orissa</td>
<td>Sundargarh, Jharsuguda, Sambalpur, Angul, Dhenkanal, Cuttack, Puri, Khurda, Nayagarh, Ganjam, Phulbani, Boudh, Sonepur, Mayurbhanj, Bargarh, Nawapara, Kalahandi, Malkangiri, Keonjhar, Deogarh, Bolangir, Rayagada, Gajapati, Koraput, Jagatsinghpur, Jajpur, Kendrapada, Balasore, Bhadrak and Nowrangapur</td>
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<td>Rajasthan</td>
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<td>Bikaner and Ganganagar</td>
<td>Churu, Nagaur, Jodhpur, Jaiselmer, Barmer and Jalore</td>
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<tr>
<td>Tamil Nadu</td>
<td>Chennai, Thiruvallur, Vellore, Viluppuram, Tiruvannamalai, Nilgiris, Kanchipuram, Salem, Teni, Coimbatore, Dharmapuri, Erode, Namakkal, Pudukkottai, Sivaganga, Madurai, Cuddalore, Dindigul, Nagappattinam, and Kanyakumari</td>
<td>Tiruchirapalli, Perambalur, Ariyalur, Karur, Ramanathapuram, Thiruvarur, Thanjavur, Virudunagar, Tuticorin and Tirunelveli</td>
<td></td>
</tr>
</tbody>
</table>
Table 3: Number of Mandals under different classes of agricultural situation in Andhra Pradesh state - October 2012

<table>
<thead>
<tr>
<th>District</th>
<th>Normal</th>
<th>Mild</th>
<th>Moderate</th>
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<tbody>
<tr>
<td>Adilabad</td>
<td>52</td>
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<td>0</td>
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<tr>
<td>Anantpur</td>
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<td>12</td>
<td>51</td>
</tr>
<tr>
<td>Chittoor</td>
<td>31</td>
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<td>17</td>
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<tr>
<td>Kadapa</td>
<td>6</td>
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<td>0</td>
</tr>
<tr>
<td>West Godavari</td>
<td>46</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>731</strong></td>
<td><strong>203</strong></td>
<td><strong>164</strong></td>
</tr>
</tbody>
</table>

(Details list of Mandals under different classes of agricultural situation in Appendix-I)
Table 4: Number of Blocks under different classes of agricultural situation in Haryana state – October 2012

<table>
<thead>
<tr>
<th>District</th>
<th>Normal</th>
<th>Mild</th>
<th>Moderate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panchkula</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ambala</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Yamunanagar</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Kurukshetra</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Karnal</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Panipat</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sonipat</td>
<td>3</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Kaithal</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Jind</td>
<td>1</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Hisar</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Fatehabad</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sirsa</td>
<td>3</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Rhotak</td>
<td>0</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Bhiwani</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Jhajjar</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Mahendragarh</td>
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<td>0</td>
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<tr>
<td>Rewari</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Mewat</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Gurgaon</td>
<td>0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Faridabad</td>
<td>0</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>54</strong></td>
<td><strong>27</strong></td>
<td><strong>40</strong></td>
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(Details list of Blocks under different classes of agricultural situation in Appendix-II)
Table 5: Number of Talukas under different classes of agricultural situation in Karnataka state - October 2012

<table>
<thead>
<tr>
<th>District</th>
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<th>Mild</th>
<th>Moderate</th>
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</thead>
<tbody>
<tr>
<td>Bagalkot</td>
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<td>3</td>
</tr>
<tr>
<td>Bangalore rural</td>
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<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Bangalore urban</td>
<td>0</td>
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<td>2</td>
</tr>
<tr>
<td>Belgaum</td>
<td>3</td>
<td>5</td>
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</tr>
<tr>
<td>Bellary</td>
<td>0</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Bidar</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bijapur</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Chamarajanagara</td>
<td>0</td>
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<td>3</td>
</tr>
<tr>
<td>Chickballapur</td>
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<tr>
<td>Chikmagalur</td>
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<tr>
<td>Chitradurga</td>
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<tr>
<td>D. Kannada</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Davangere</td>
<td>0</td>
<td>4</td>
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<tr>
<td>Dharwad</td>
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<tr>
<td>Gadag</td>
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<td>Gulberga</td>
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<tr>
<td>Hassan</td>
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<td>Haveri</td>
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<td>2</td>
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</tr>
<tr>
<td>Koppal</td>
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<td>Mandya</td>
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<td>Mysore</td>
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<td>Uttara Kannada</td>
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<tr>
<td>Yadgir</td>
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<td>1</td>
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<tr>
<td><strong>Total</strong></td>
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<td><strong>53</strong></td>
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</table>

(Details list of Talukas under different classes of agricultural situation in Appendix-III)
Table 6: Number of Talukas under different classes of agricultural situation in Maharashtra state – October 2012

<table>
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<th>District</th>
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<th>Moderate</th>
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<tr>
<td>Akola</td>
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<td>0</td>
</tr>
<tr>
<td>Amravati</td>
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<td>0</td>
</tr>
<tr>
<td>Aurangabad</td>
<td>0</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Beed</td>
<td>5</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Bhandara</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Buldana</td>
<td>11</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Chandrapur</td>
<td>14</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dhule</td>
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<td>2</td>
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<tr>
<td>Gadchiroli</td>
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<td>Gondia</td>
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<td>0</td>
</tr>
<tr>
<td>Hingoli</td>
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<td>1</td>
</tr>
<tr>
<td>Jalgaon</td>
<td>7</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Jalna</td>
<td>1</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Kolhapur</td>
<td>11</td>
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<td>0</td>
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<td>Latur</td>
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<td>0</td>
</tr>
<tr>
<td>Nanded</td>
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<td>6</td>
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</tr>
<tr>
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<td>Nasik</td>
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<td>Osmanabad</td>
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<td>Parbhani</td>
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<td>6</td>
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<tr>
<td>Pune</td>
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<td>Raigad</td>
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<td>Ratnagiri</td>
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<td>0</td>
</tr>
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<td>Sangli</td>
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</tr>
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<td>Satara</td>
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<td>Sindhurg</td>
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<td>Solapur</td>
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<tr>
<td>Thane</td>
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<tr>
<td>Wardha</td>
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<tr>
<td>Washim</td>
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<td>0</td>
</tr>
<tr>
<td>Yeotmal</td>
<td>7</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>221</strong></td>
<td><strong>60</strong></td>
<td><strong>73</strong></td>
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</table>

*(Details list of Talukas under different classes of agricultural situation in Appendix-IV)*
# List of Colour Plates

<table>
<thead>
<tr>
<th>Plate No.</th>
<th>Title</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Agricultural Drought assessment October 2012</td>
</tr>
<tr>
<td>2</td>
<td>Area Favorable for Crop Sowing/ crop sown area (AFCS) derived from SASI and water balance methodology, kharif 2012</td>
</tr>
<tr>
<td>3</td>
<td>Fortnightly Agricultural area NDVI of NOAA AVHRR (1 km * 1km), October 2012</td>
</tr>
<tr>
<td>4</td>
<td>Monthly progression of Agricultural area NDVI of NOAA AVHRR (1 km * 1km), 2012</td>
</tr>
<tr>
<td>5</td>
<td>Comparison of Agricultural area NDVI of NOAA AVHRR (1 km * 1km) October 2012, 2011 and 2010</td>
</tr>
<tr>
<td>6</td>
<td>Comparison of August month Agricultural area NDVI of NOAA AVHRR (1 km * 1km), August and September months of different years</td>
</tr>
<tr>
<td>7</td>
<td>Comparison of Agricultural area NDVI of NOAA AVHRR (1 km * 1km), June &amp; July of different years</td>
</tr>
<tr>
<td>8</td>
<td>MODIS (250 m) NDWI during October 2012 showing surface moisture status</td>
</tr>
<tr>
<td>9</td>
<td>MODIS (250 m) NDWI during September, August, July and June 2012 and 2010 showing surface moisture status</td>
</tr>
<tr>
<td>10</td>
<td>NDVI and NDWI Deviation Map for October 2012</td>
</tr>
<tr>
<td>11</td>
<td>NDVI and NDWI Deviation Map for September, August, July and June 2012</td>
</tr>
<tr>
<td>12</td>
<td>Percent Deviation of NDWI and NDVI - October 2012</td>
</tr>
<tr>
<td>13</td>
<td>Percent Deviation of NDWI and NDVI for September, August, July and June 2012</td>
</tr>
<tr>
<td>14</td>
<td>IMD – Sub-division-wise rainfall and its deviations, October 2012</td>
</tr>
<tr>
<td>15</td>
<td>IMD – Sub-division-wise rainfall and its deviations, October 2012</td>
</tr>
<tr>
<td>16</td>
<td>IMD – Sub-division-wise rainfall and its deviations, September 2012</td>
</tr>
<tr>
<td>17</td>
<td>IMD – Sub-division-wise rainfall and its deviations, June to August 2012</td>
</tr>
<tr>
<td>18</td>
<td>District wise rainfall deviations</td>
</tr>
<tr>
<td>19</td>
<td>District wise weekly rainfall deviations October 2012</td>
</tr>
<tr>
<td>20</td>
<td>District wise weekly rainfall deviations September 2012</td>
</tr>
<tr>
<td>21</td>
<td>District wise weekly rainfall deviations June, July and August 2012</td>
</tr>
<tr>
<td>22</td>
<td>District wise weekly rainfall deviations June, July, August 2011</td>
</tr>
<tr>
<td>23</td>
<td>AWiFS derived Agricultural Area NDVI and NDWI – Andhra Pradesh</td>
</tr>
<tr>
<td>24</td>
<td>Agricultural Drought Assessment - Andhra Pradesh</td>
</tr>
<tr>
<td>25</td>
<td>Agricultural Drought Assessment- Bihar</td>
</tr>
<tr>
<td>26</td>
<td>Agricultural Drought Assessment - Chhattisgarh</td>
</tr>
<tr>
<td>27</td>
<td>Agricultural Drought Assessment - Gujarat</td>
</tr>
<tr>
<td>28</td>
<td>AWiFS derived Agriculture area NDVI and NDWI - Haryana</td>
</tr>
<tr>
<td>29</td>
<td>Agricultural Drought Assessment - Haryana</td>
</tr>
<tr>
<td>30</td>
<td>AWiFS derived Agriculture area NDVI and NDWI – Karnataka</td>
</tr>
<tr>
<td>31</td>
<td>Agricultural Drought Assessment - Karnataka</td>
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<tr>
<td></td>
<td>Title</td>
</tr>
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<td>---</td>
<td>----------------------------------------------------------------------</td>
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<tr>
<td>32</td>
<td>Agricultural Drought Assessment - Jharkhand</td>
</tr>
<tr>
<td>33</td>
<td>AWiFS derived Agricultural Area NDVI and NDWI - Maharashtra</td>
</tr>
<tr>
<td>34</td>
<td>Agricultural Drought Assessment - Maharashtra</td>
</tr>
<tr>
<td>35</td>
<td>Agricultural Drought Assessment - Madhya Pradesh</td>
</tr>
<tr>
<td>36</td>
<td>Agricultural Drought Assessment - Orissa</td>
</tr>
<tr>
<td>37</td>
<td>Agricultural Drought Assessment - Rajasthan</td>
</tr>
<tr>
<td>38</td>
<td>Agricultural Drought Assessment - Tamil Nadu</td>
</tr>
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<td>Agricultural Drought Assessment – Uttar Pradesh</td>
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Plate 1: Agricultural Drought assessment: October 2012

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<th>State</th>
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<th>Moderate drought</th>
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<td>Andhra Pradesh</td>
<td>13</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Bihar</td>
<td>31</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Chhattisgarh</td>
<td>15</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Gujarat</td>
<td>13</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Haryana</td>
<td>8</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Jharkhand</td>
<td>22</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Karnataka</td>
<td>8</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>18</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Madhya Pradesh</td>
<td>45</td>
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<td>0</td>
</tr>
<tr>
<td>Odisha</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Rajasthan</td>
<td>24</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>20</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Uttar Pradesh</td>
<td>69</td>
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</tr>
<tr>
<td><strong>Total</strong></td>
<td>316</td>
<td>43</td>
<td>51</td>
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Legend
- Normal
- Mild Drought
- Moderate Drought
- Severe Drought
Plate 2: Area Favorable for Crop Sowing/crop sown area (AFCS) derived from SASI and water balance methodology, kharif 2012

<table>
<thead>
<tr>
<th>States</th>
<th>Kharif potential Area (M ha)</th>
<th>AFCS (M ha)</th>
<th>% Kharif Area</th>
<th>Unfavourable (M ha)</th>
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<tr>
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<td>Chhattisgarh</td>
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<td>Gujarat</td>
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<td>Uttar Pradesh</td>
<td>9.3</td>
<td>9.3</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Sub-Total</td>
<td>94.5</td>
<td>91.7</td>
<td>97</td>
<td>2.9</td>
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<tr>
<td>All India</td>
<td>108.6</td>
<td>105.5</td>
<td>97</td>
<td>3.1</td>
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Plate 3: Fortnightly Agricultural area NDVI of NOAA AVHRR (1 km * 1km), October, 2012
Plate 4: Monthly progression of Agricultural area NDVI of NOAA AVHRR (1 km * 1km), 2012

- June 2012
- July 2012
- August 2012
- September 2012
- October 2012

Legend:
- Forest Area
- Increasing Vegetation Vigour

Agricultural Drought Assessment Report - October, 2012
Plate 5: Comparison of Agricultural area NDVI of NOAA AVHRR (1 km * 1km) October 2012, 2011 and 2010
Plate 6: Comparison of Agricultural area NDVI of NOAA AVHRR (1 km * 1km), August & September months of different years

- September 2012
- September 2011
- September 2010
- August 2012
- August 2011
- August 2010
Plate 7: Comparison of Agricultural area NDVI of NOAA AVHRR (1 km * 1km), June & July of different years.

- July 2012
- July 2011
- July 2010
- June 2012
- June 2011
- June 2010

Legend:
- Forest Area
- Water
- Cloud
- Soil
- Increasing Vegetation Vigour
- Low
- High

Agricultural Drought Assessment Report - October, 2012
Plate 8: MODIS (250 m) NDWI during October 2012 showing surface moisture status.

1\textsuperscript{ST} fortnight
October, 2012

2\textsuperscript{ND} fortnight
October, 2012

October, 2012

1\textsuperscript{ST} fortnight
October, 2010

2\textsuperscript{ND} fortnight
October 2010

October, 2010
Plate 9: MODIS (250 m) NDWI during September, August, July and June 2012 and 2010 showing surface moisture status.
Plate 10: NDVI and NDWI Deviation Map for October 2012
(derived from MODIS data)
Plate 11: NDWI and NDVI Deviation Map for September, August, July and June 2012
(derived from MODIS data)

NDVI Deviation w.r.t. 2010

<table>
<thead>
<tr>
<th>Month</th>
<th>September 2012</th>
<th>August 2012</th>
<th>July 2012</th>
<th>June 2012</th>
</tr>
</thead>
</table>

NDWI Deviation w.r.t. 2010

<table>
<thead>
<tr>
<th>Month</th>
<th>September 2012</th>
<th>August 2012</th>
<th>July 2012</th>
<th>June 2012</th>
</tr>
</thead>
</table>

Legend:
- Green: ++0%
- Yellow: +10% to 0%
- Orange: +20% to -10%
- Red: <20%
- White: Non-Agriculture
- Black: Cloud
Plate 12: Percent Deviation of NDWI and NDVI - October 2012

Deviation w.r.t. October 2010 (derived from MODIS data)

NDVI deviation October 2012

NDWI deviation October 2012

% Agricultural area
Plate 13: Percent Deviation of NDWI and NDVI for September, August, July and June 2012

(derived from MODIS data)

Deviation w.r.t. 2010

Agricultural Drought Assessment Report - October, 2012
Plate 14: IMD – Sub-division-wise rainfall and its deviations, October 2012
Plate 15: IMD – Sub-division-wise rainfall and its deviations, October 2012

RAINFALL (mm.) FOR THE PERIOD
01.10.2012 TO 31.10.2012

CATEGORYWISE NO. OF SUBDIVISIONS
01.10.2012 01.10.2012 01.10.2011
TO TO TO
EXCESS 2 3 1
NORMAL 8 11 5
DEFICIENT 12 9 7
SCANTY 14 13 21
NO RAIN 0 0 2

All India Area Weighted Rainfall (mm.)
Actual Normal % Departure
58.3 80.6 -28

LEGEND:
- EXCESS (±20% OR MORE)
- NORMAL (±19% TO -19%)
- DEFICIENT (20% TO -59%)
- SCANTY (±50% TO -99%)
- NO RAIN (-100%)
Plate 16: IMD – Sub-division-wise rainfall and its deviations, September 2012

(Source: www.imd.gov.in)
Plate 17: IMD – Sub-division-wise rainfall and its deviations, June to September 2012

Source: www.imd.gov.in
Plate 18: District wise rainfall deviations

Legend
- EXCESS (+20% OR MORE)
- NORMAL (+19% TO -19%)
- DEFICIENT2 (-40% TO -59%)
- DEFICIENT1 (-20% TO -39%)
- SCANTY (-60% TO -99%)
- NO RAIN (-100%)
- NO DATA

(Data Source: www.imd.gov.in)
Plate 19: District wise weekly rainfall deviations October 2012

Legend
EXCESS (+20% OR MORE)
NORMAL (+19% TO -19%)
DEFICIENT2 (-40% TO -59%)
DEFICIENT1 (-20% TO -39%)
NORMAL ( +19% TO -19%)
EXCESS (+20% OR MORE)
NO RAIN (-100%)
NO DATA
Plate 20: District wise weekly rainfall deviations September 2012

(Source of data: www.imd.gov.in)

Legend
- EXCESS (+20% OR MORE)
- NORMAL (+19% TO -19%)
- DEFICIENT2 (-40% TO -59%)
- DEFICIENT1 (-20% TO -39%)
- SCANTY (-60% TO -99%)
- NO RAIN (-100%)
- NO DATA
Plate 21: District wise weekly rainfall deviations June, July and August 2012

Legend
- NO RAIN (-100%)
- SCANTY (-60% TO -99%)
- DEFICIENT2 (-40% TO -59%)
- DEFICIENT1 (-20% TO -39%)
- NORMAL (+19% TO -19%)
- EXCESS (+20% OR MORE)

(Source of data: www.imd.gov.in)
Plate 22: District wise weekly rainfall deviations June, July, August 2011

(Source of data: www.imd.gov.in)