Monitoring Vegetation Canopy of Maharashtra Using Remote Sensing

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ABSTRACT

Droughts are temporary aberration from normal climatic conditions. In this paper we have highlighted the use of various indices that are currently used for monitoring vegetation canopy in India. Remote sensing applications are effective in assessing severity of agricultural drought. The Indian IRS-IC/D wide field sensor (WiFS) is a strong tool for regional drought assessment with its spatial resolution of 188m and weekly repeat coverage using AVHRR .The NDVI images of various months of Maharashtra throughout the year 2011 are analyzed in the paper also SPI map of India 2012 & SPI map of Maharashtra are used for analysis, The data ranges from 2011-2013.

Keywords: Precipitation, Resolution, Spatial, Spectral, Vegetation Canopy.

Introduction to Drought Indices

Drought indices are normally radiometric measures of vegetation condition and dynamics, exploiting the unique spectral signature of canopy elements particularly in the red and infrared region of the spectrum & are sensitive to vegetation type, growth stage, canopy cover and structure (Thenkabail, P. S. et.al. 2004.).They utilize reflectance data in two or more spectral bands thus enhancing the signal and cancelling out the effects of topography, sun angle and atmosphere.

Normalized Difference Vegetation Index (NDVI):

It was first suggested by Tucker as an index of vegetation health and density. We can say that NDVI is a simple ratio of band differences that is directly related to photosynthetic activity of plant canopies.

NDVI = (NIR-RED/NIR+RED) … (1)

Where, NIR & RED are the reflectance

NDVI is applied to provide crude estimate of vegetation health & means of monitoring changes in vegetation over time, it is most commonly used vegetation index it varies from -1 to +1 but the drawback of NDVI is that it utilizes only two bands and is not very sensitive to influences of soil

background reflectance at low vegetation covers and lagged vegetation response to developing rainfall deficits due to residual moisture stored in the soil Therefore NDVI does not reflect drought or non drought condition.

Drought Severity Index

The severity of drought may be defined as NDVI deviation from its long term means (DEVndvi). This deviation is calculated as the difference between NDVI from the current time step.

DEVndvi = NDVI I – NDVI mean m … (2)

Where NDVIi is the NDVI value for month i and NDVI mean is the long term mean for the same month m. When DEVndvi is negative it indicate below normal vegetation condition also greater the negative departure greater the magnitude of prevailing drought situation. The limitation is that the deviation does not take in to account the standard deviation and hence can be misinterpreted (Thenkabail, P. S. et. al.2004)

Vegetation Condition Index

It was first suggested by Kogan .It shows how close is the NDVI of the current month is to the minimum NDVI calculated from the long term record.

VCIj = (NDVI j - NDVImin) / (NDVImax - NDVImin)*100 … (3)

Where NDVI max &NDVI min are calculated from long term record for that current month & j is the index of the current month (week) The condition of the ground vegetation is reflected by VCI measured in percent .The VCI values around 50% reflects fair vegetation health .The VCI values below 35% reflects extreme dry conditions for particular month's low VCI values for consecutive time intervals point to drought development in the particular area. Therefore constant monitoring of land mass is necessary for drought relief planning and management.

Standard Precipitation Index (SPI)

Rainfall deviations across space and time need to be interpreted with utmost care .SPI expresses the actual rainfall as standardized departure from rainfall probability distribution function and hence the importance of this index. Computation of SPI involved fitting a gamma probability density function to a given frequency distribution of precipitation totals .The alpha and beta scale and shape parameters of gamma distribution were estimated for a suitable time scale for each year .Alpha and Beta parameters are then used for finding the cumulative probability of an observed precipitation amount which is then transformed into standardized normal distribution. Thus SPI can be said to be normalized in space and time scale (Nareshkumar M,C.S.Murthy)

Monitoring Drought of Maharashtra (2011)

In India drought conditions are monitored at district level using daily observed coarse resolution (1.1 km) NOAA-AVHRR data for the entire country and at the sub district level using better spatial resolution Indian Remote sensing Satellite (IRS) AWiFS/WiFS data.

IRS series (IRS 1C,IRS 1D, IRS P3) have Wide Field Sensors (WiFS) payload ,which collects data in two spectral bands : 0.62-0.68um(red) & 0.77-0.86um (near infrared)with spatial resolution of 188 m and ground swath of 810km with revisit period of 5 days .The IRS P6 (Resource Sat) has advanced WiFS (AWiFS) sensors that provide data with spectra, radiometric and spatial (56m) resolutions for better monitoring of agriculture .The combination of AWiFS /WiFS would help increase the frequency of images with one coverage in two days time which is useful to minimize cloud contamination .The crop /vegetation reflects high energy in the near Infrared band because of its canopy geometry and health of the standing crops /vegetation & absorbs high in the red band due to its biomass & photosynthesis .Using this contrasting characteristics of vegetation in near infrared and red bands, which indicates both the health and condition of the crops/vegetation, the Normalized difference is derived by the difference of these measurements and divided by their sums .The Vegetation Index is generated from each of the available satellite data irrespective of the cloud cover present .To minimize the cloud monthly time composite vegetation index is generated .The composite NDVI images are generated for each month of the monsoon for the state of Maharashtra .The seasonal progression of NDVI compared to that of normal and complementary ground data on rainfall and crop sowing progress are utilized in the assessment of agricultural drought.

Fig.1-5 depicts NDVI images of Maharashtra for the monsoon season of 2011. (http://dsc.nrsc.gov.in/DSC/Drought/NDVIimageGalleryStateTable.jsp)

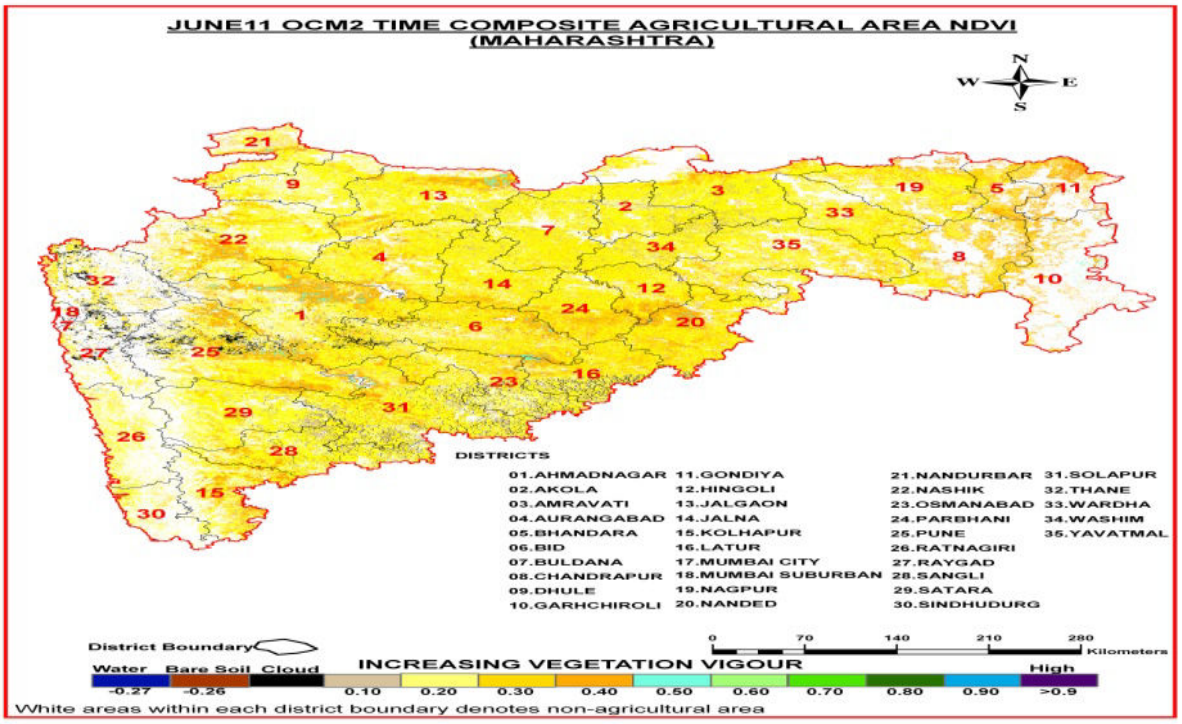

Figure-1: Composite Agricultural Area NDVI Mah (Source NADAMS)

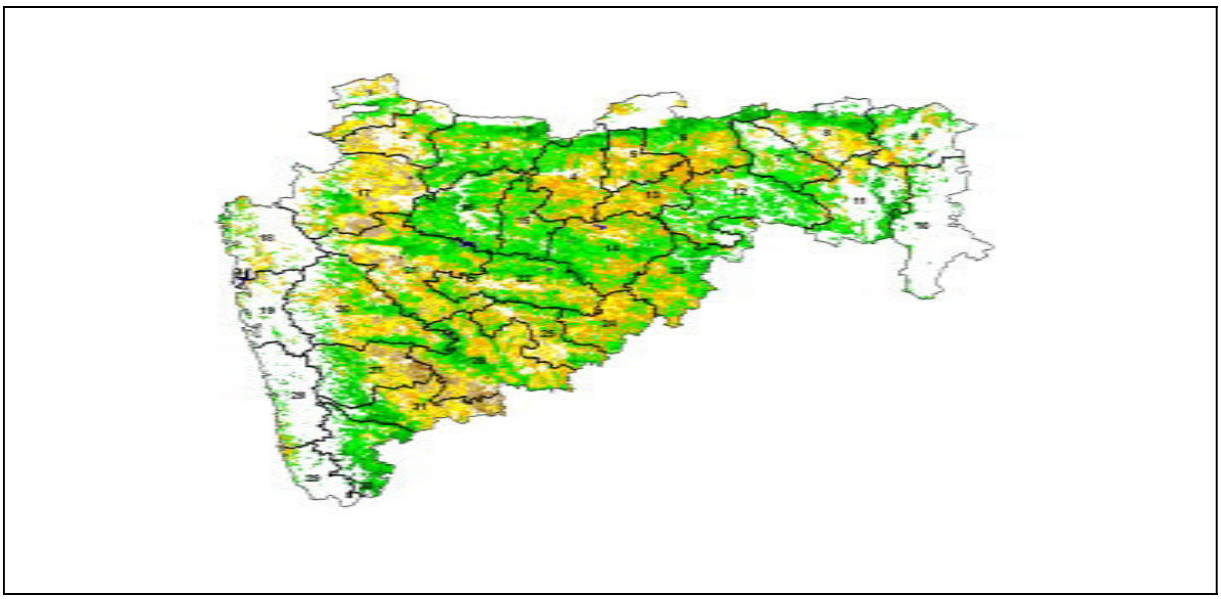

Figure-2: VCI Image 2011[june-july]

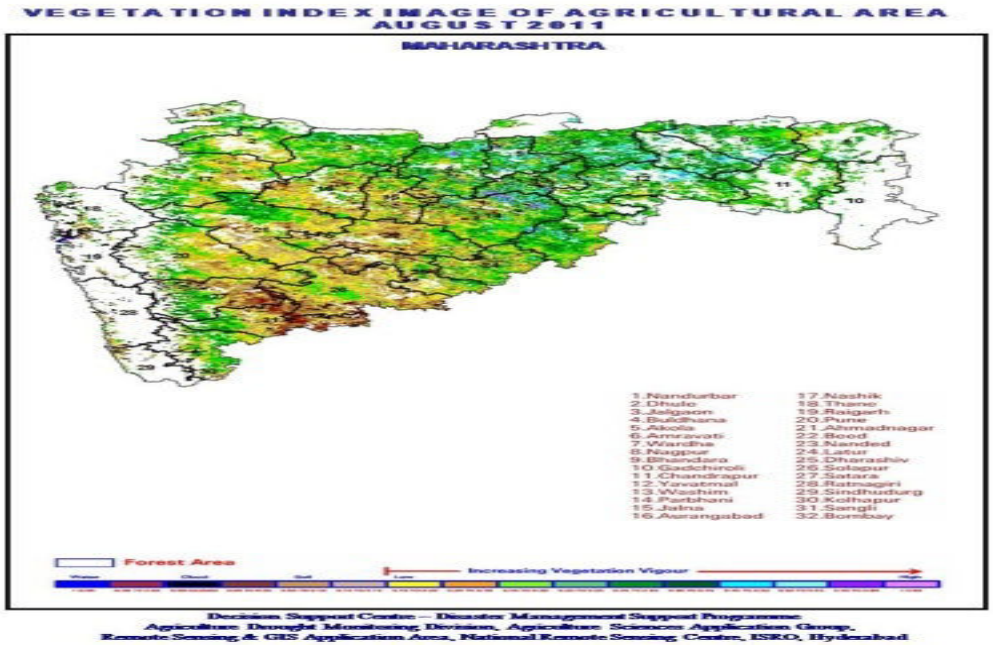

Figure-3: VCI Image [Aug 2011]

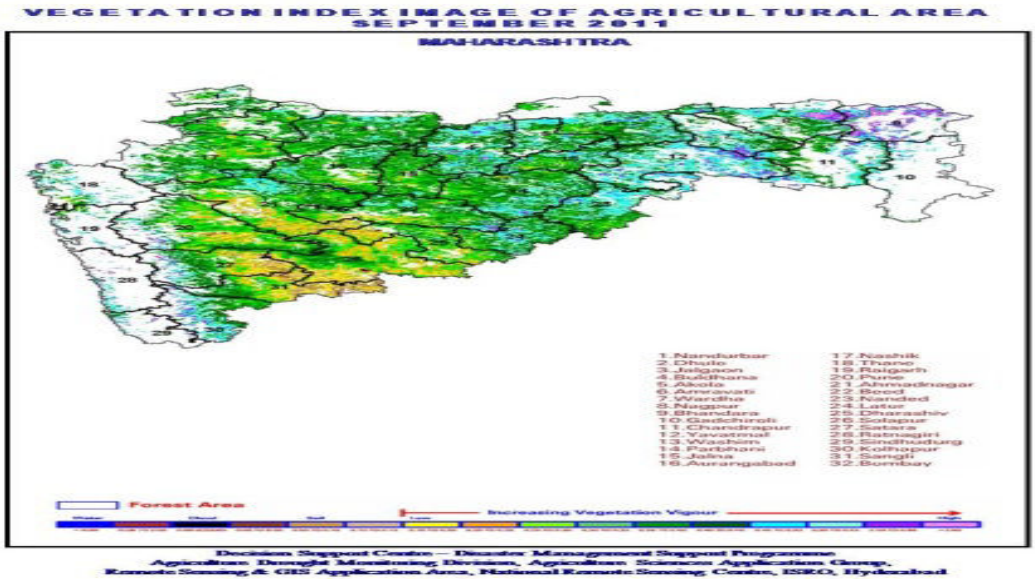

Figure-4: VCI Image[sep 2011]

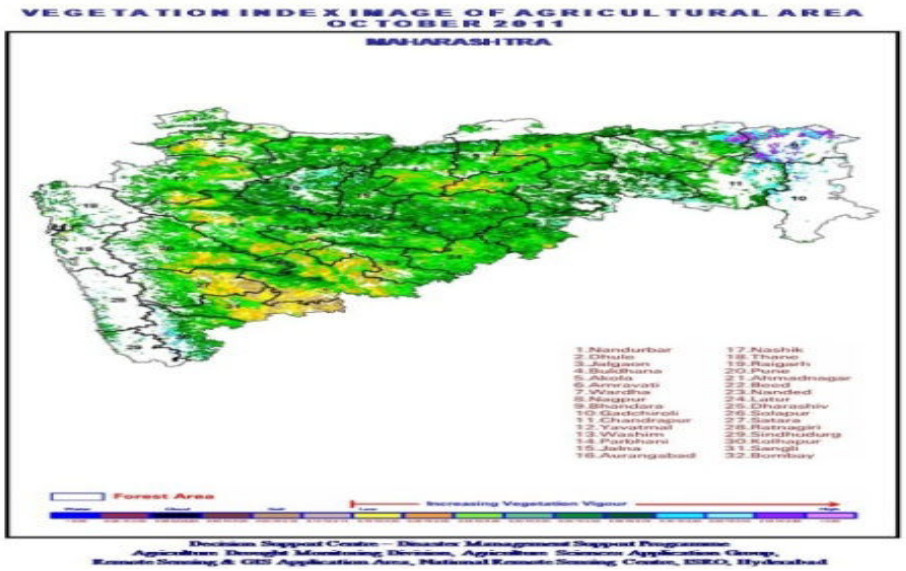

Figure-5: VCI Image[Oct 2011]

Now let us examine the cumulative SPI map of India & SPI map for month of Sep 2012. Fig. 6 -7 below.

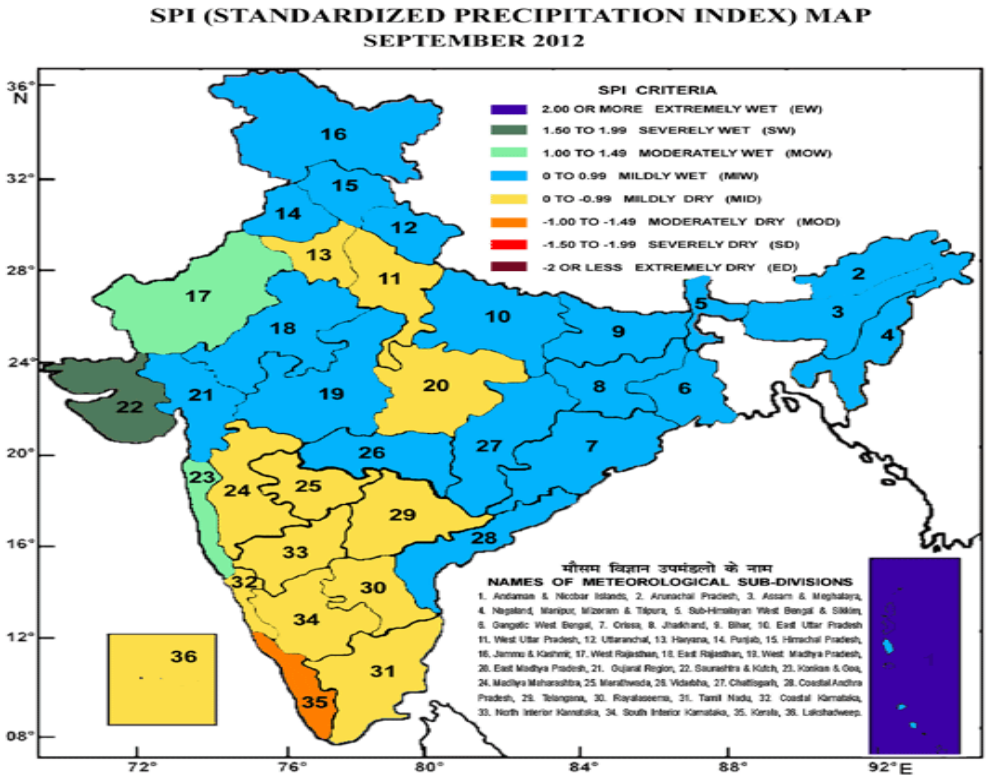

Figure-6: SPI Map [Sep 2012]

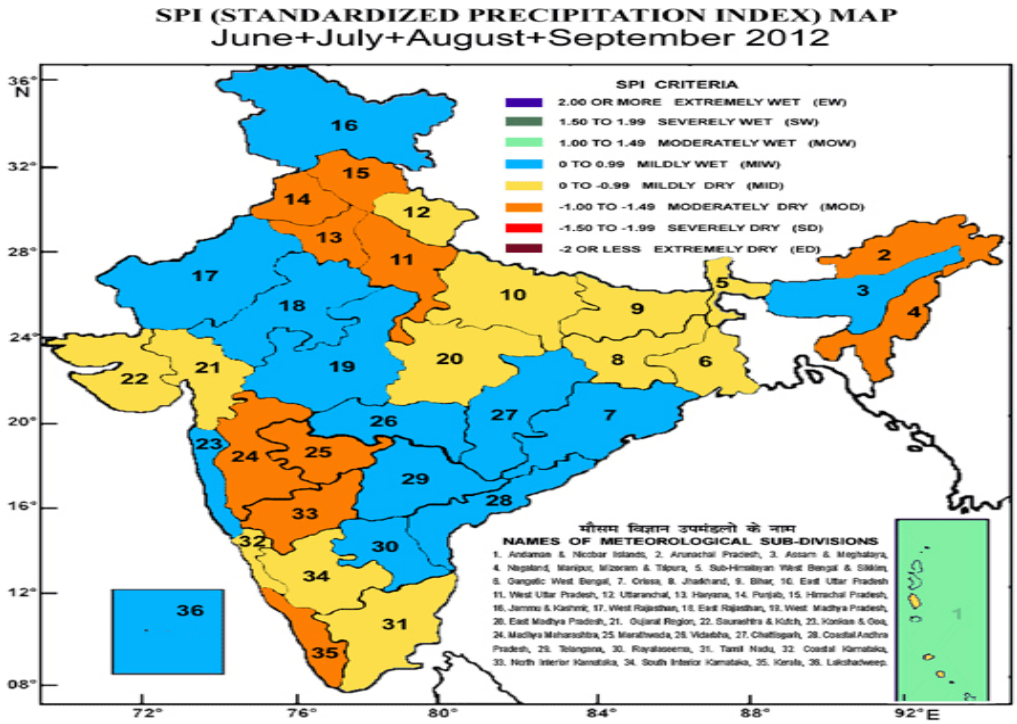

Figure-7: Cumulative SPI Map 2012

It is observed that in 2012 year the SPI of India shows that there is considerable scanty precipitation in State of Maharashtra also the Cumulative SPI map of Maharashtra from Jan 2013 to Feb 2013(www.nrsc.gov.in)(Indian meteorological dept New Delhi, Lodhi road.) as shown in Fig. 8 below.

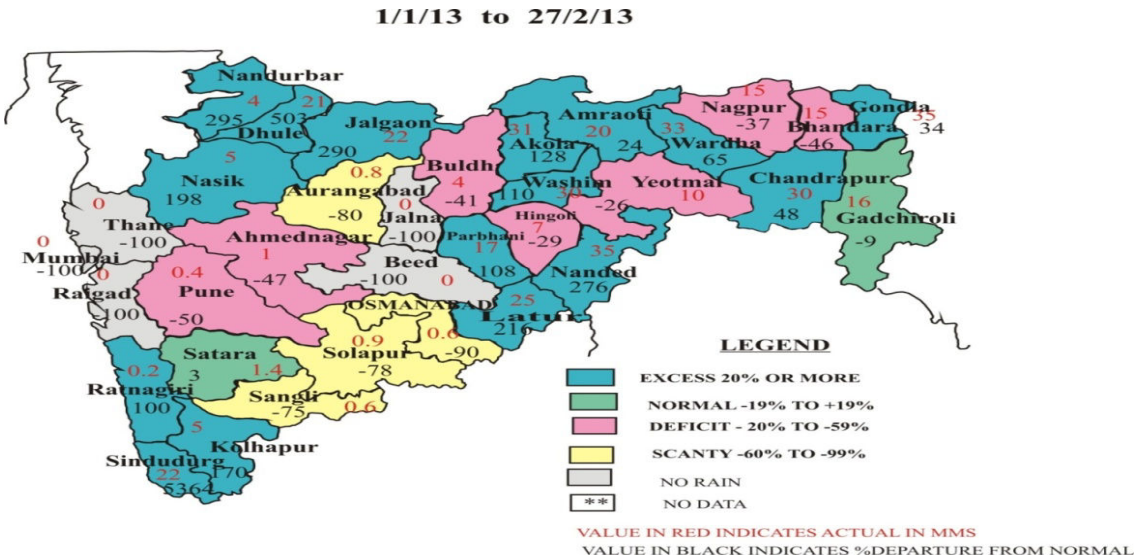

Figure-.8: Cumulative SPI map of Maharashtra from Jan 2013 to Feb 2013

(Source www.nrsc.gov.in)

It shows that in some areas of Maharashtra the rainfall is scanty and drought situation is prevailing.

Analysis & Observation

1. A month by month [June - Nov 2011] spatial distribution in the study area during year 2011 is illustrated in fig 1-5 where areas in different shades of yellow are drought affected and areas in different shades of blue and green are those with healthy and normal vegetation most of the pixels in the area have persistent shades of yellow in the month of June, July indicative of delayed northwest monsoon and in the further months the areas of Marathwada are constantly in shade of yellow which indicates dry condition in the year of 2011 for Marathwada region in particular.
2. The vegetation vigor in the Maharashtra is ranging on the band scale from 0.20 i.e. lowest and only few parts of Maharashtra have high vegetation vigour [fig 2-5].
3. The SPI image [September] of India and cumulative SPI [June+July+Aug+Sep] of India shows that the dry conditions are increasing and there is considerable amount of change in rainfall ,agricultural area in Maharashtra further when SPI of only one month i.e. September is considered the regions Marathwada & Vidharbha and whole coastal Andhrapradesh [fig.6.] are seen as most affected whereas when complete monsoon analysis is done then only Marathwada , Vidharbha and some parts of Andhrapradesh are seen as most affected by low rainfall and dry conditions .
4. The recent image of Maharashtra fig-8 shows that consequently third year the dry conditions are going to prevail giving rise to undoubtedly drought condition in the region.

Conclusion

The main aim of this study is to create awareness about developing the regional drought monitoring system and use the data analysis for the development of DSS so that the drought can be contained considering the spread and frequency of droughts in the region and lack of ground data and technical capacity in the state also, at regional level such a system could play an invaluable role in the preparedness of the drought. Preparing DSS will help farmers plan their crop sowing and govts to provide necessary water supply and modern methods for irrigation so that Agricultural drought if not completely controlled can be contained to measure and loss can be minimized.

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