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Agricultural Drought Assessment In Central Dry Zone Of Agro Climatic Zones Of Karnataka Using Gis And Remote Sensing

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Abstract: **Agricultural Drought is a significantly affecting the agricultural production and major impact on economy of the country, Despite the significant technological advances since independence Indian agriculture, continues to be periodically affected by droughts. Geographical Information System (GIS) is powerful tool for retrieve the data, Data analysis and interpretation of data and also Remote sensing techniques is broadly using in assessing Agricultural drought studies. Characterization and monitoring of agricultural situation have become essential activities towards human welfare. A system for national/regional and sub regional assessment and monitoring of agricultural drought conditions through the cropping season to provide periodic information on the prevalence, severity level and persistence of agricultural drought is the utmost need of the hour. Earth Observations by satellites provide information of immense value in addressing these issues. During current kharif season 250m resolution MODIS TERRA images over Central Dry agro climatic zone were analyzed from June to October (Kharif season) and agricultural drought situation was assessed Central dry zone using satellite derived agricultural area NDVI images. The Agricultural drought, usually triggered by meteorological and hydrological droughts, occurs when soil moisture and rainfall are inadequate during the crop growing season causing extreme crop stress and wilting. Plant water demand depends on prevailing weather conditions, biological characteristics of the specific plant, and its stage of growth and the physical and biological properties of the soil. NDVI is a measure or estimate of the amount of radiation being absorbed by plants. NDVI is calculated from the visible and near-infrared light reflected by vegetation. Among the various vegetation indices that are now available, Normalised Difference Vegetation Index (NDVI) is an universally acceptable index for operational drought assessment because of its simplicity in calculation, easy interpret and its ability to partially compensate for the effects of atmosphere, illumination geometry etc [Malingreau 1986], [Jhonson, et, al., 1993].**

Keywords: **Agricultural Drought, NDVI, MODIS TERRA, Kharif Season**

I. INTRODUCTION

Agricultural drought, usually triggered by meteorological and hydrological droughts, occurs when soil moisture and rainfall are inadequate during the crop growing season causing extreme crop stress and wilting. Plant water demand depends on prevailing weather conditions, biological characteristics of the specific plant, and its stage of growth and the physical and biological properties of the soil. Agricultural drought thus arises from variable susceptibility of crops during different stages of crop development, from emergence to maturity. For more than decade agricultural drought information and monitoring system is using remotely sensed satellite data. Normalized Difference Vegetation Index NDVI) can be used to indicate deficiencies in rainfall and portray meteorological and/or agricultural drought patterns both timely and spatially, thus serving as an indicator of regional drought patterns. NDVI is a measure or estimate of the amount of radiation being absorbed by plants.

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Fig.1 indicates that healthy vegetation (left) absorbs most of the visible light that hits it, and reflects a large portion of the near-infrared light. Unhealthy or sparse vegetation (right) reflects more visible light and less near-infrared light. In the late 1970s scientists found that net photosynthesis is directly related to the amount of photo synthetically active radiation that plant absorbs. The more a plant is absorbing visible sunlight during growing season, the more it is photosynthesizing and more it is productive.

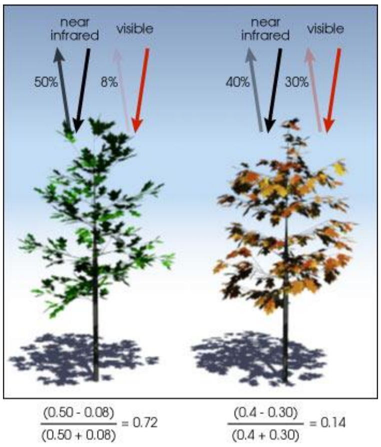

Fig.1 Normalized Differential Vegetation Index

Conversely, the less visible sunlight the plant absorbs, the less it is photosynthesizing and the less it is being productive. Thus the hypothesis behind NDVI is healthy vegetation absorbs most of the visible light that hits it, and reflects a large portion of the near-infrared light. Unhealthy or sparse vegetation reflects more visible light and less near-infrared light.

Vegetation Indices employ this difference formula to quantify the density of plant growth on the area under study near-infrared radiation minus visible radiation divided by near-infrared radiation plus visible radiation.

II. STUDY AREA

The Karnataka State is divided into the 10 various Agro-climatic zones. Central Dry agro climatic zone of Karnataka is one of 2nd most drought prone agro climatic zone next to northern dry zone. The zone is located in the Southern part Karnataka State comprises of 5 Districts of Chitradurga (6), Davanagere (3), Tumkur (6), Hassan (1) and Chikmagalur (1) districts comprises of 17 Taluks of total geographical area of 1943830 Sq. Km, the agriculture is predominant and main occupation of rural about 65% of the area under rainfed.

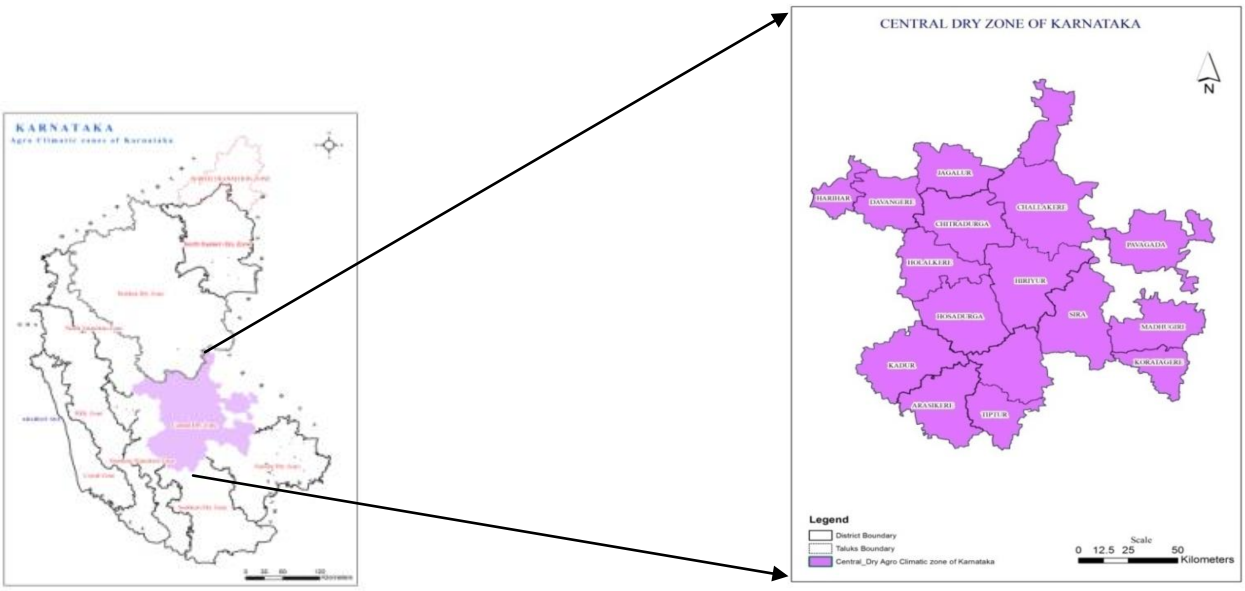

Fig.2 Study Area

Geography:

Central Dry Agro climatic zone of Karnataka is located at $13^0$56N latitude, 76^0 31' E longitudes at an altitude of 200-350m above mean sea level. It is bounded on the Central dry zone by North and south by the Southern Dry zone, on the west by Southern transition zone, east by Andrapradesh and Eastern dry zone by South East Direction.

Climate:

The climate of Central Dry agro climatic zone of Karnataka is arid to semi-arid with fairly dry and hot summer. Winter is fairly cold and sets in, in the month of November and continues till the middle of February. Summer is hot and dry which commences from mid of February and ends by the month of June with mean maximum temperature around 36^0 C. The average annual rainfall is 620 mm.

Soil:

The soil is alluvial in origin. The soils are shallow to deep red clays in major areas shallow, well drained grey to dark grey and brown clay loam to silty clay loamy soils moderately and severely eroded. The texture of the soil is sandy loam and black. The soil is deep enough to respond well to manuring and variety of crops of the tropical and sub-tropical regions.

III. MATERIAL AND METHODOLOGY

For classification agricultural drought, the present investigation describes the historical and modern-day datasets and their characteristics used for drought assessment and reporting. This is followed by the description of satellite sensor derived vegetation indices, their derivative drought indices and thresholds for drought assessment. The MODIS (*modis.gsfc.nsds.gov*) data from 2000 to 2012 are described and the use of those for agriculture drought in central dry agro climatic zone of Karnataka. The NDVI analysis involves many processes which includes downloading cloud free data and followed by error rectification, geo referencing and masking of non agricultural area such as Water bodies and vegetation etc. The NDVI is calculated from these individual measurements as follows:

$$NDVI = \frac{NIR - VIS}{NIR + VIS}$$

Where, NDVI = Normalized Difference Vegetation Index, VIS and NIR stand for the spectral reflectance measurements acquired in the visible (red) and near-infrared regions, respectively

Calculations of NDVI for a given pixel always result in a number that ranges from minus one (-1) to plus one (+1); however, the vegetation status has been classified it is depicted in TABLE I. NDVI derived from MODIS data, seasonal NDVI progression, time series NDVI profiles, are used for assessing the agricultural drought situation at Central dry agro climatic zone of Karnataka.

Table.1 Vegetation Status for Agriculture Drought Assessment

Vegetation Status	NDVI Value
No Vegetation	0
Severely low Vegetation	0.1
Slightly low Vegetation	0.2
Moderate Vegetation	0.3
Better Vegetation	0.4
Good Vegetation	0.5
High Vegetation	>0.5

The monthly Normalized Differential vegetation index map for the Central Dry Agro climatic zones of the Karnataka overlaid are given in specific colors for the vegetation index ranges. The various colors in the NDVI map: yellow through green to violet indicate increasing green leaf area and biomass of different vegetation types. Cloud and water are represented in black and blue colors, respectively. The bare soil, fallow and other non-vegetation categories are represented in brown color.

In the present Study Eradas imagine 10.3 remote sensing software is used for NDVI analysis and to derive NDVI maps and Geographical Information System (GIS) is used draw the composite and vulnerability of Agricultural drought in Central dry agro climatic zone of Karnataka.

The composite map of vulnerability of Agricultural drought maps were derived from the aggregate score from a linear combination factor has been computed for Deficit Rainfall, NDVI and Moisture Adequacy index and was reclassified into various drought severity of Severe drought (Deficit Rainfall + NDVI + MAI) Moderate drought (NDVI + MAI and Deficit Rainfall +NDVI); and Normal which is linear combination value is 1. Then maps were overlaid to recognize the drought severity.

IV. RESULT AND DISCUSSION

During the period of 2001-2012 except the years of 2005, 2007 and 2010 are drought years in Karnataka State. The Central dry agro climatic zone is one of the drought prone agro climatic zone with average rainfall of 324 mm in kharif season.

In this paper, the drought assessment has been carried out for monitoring the drought severity in the Central Dry agro climatic zone of Karnataka. Table 2 shows Season wise average NDVI values for the year 2001-2012 for Central Dry agro climatic zone of Karnataka, which gives the drought severity of the particular month for the assessment of drought. In reference Fig.3 the NDVI pattern shows that the most severe and less vegetation is shown in the month of June, July and August months. As the rainfall increases, the vegetation vigour is increased gradually at end of Kharif season early onset and delay and failure south west monsoon plays significant role in agricultural activities. In the month of June, July, August and September month many taluk shows low to severe vegetation it is well depicted in below figure.

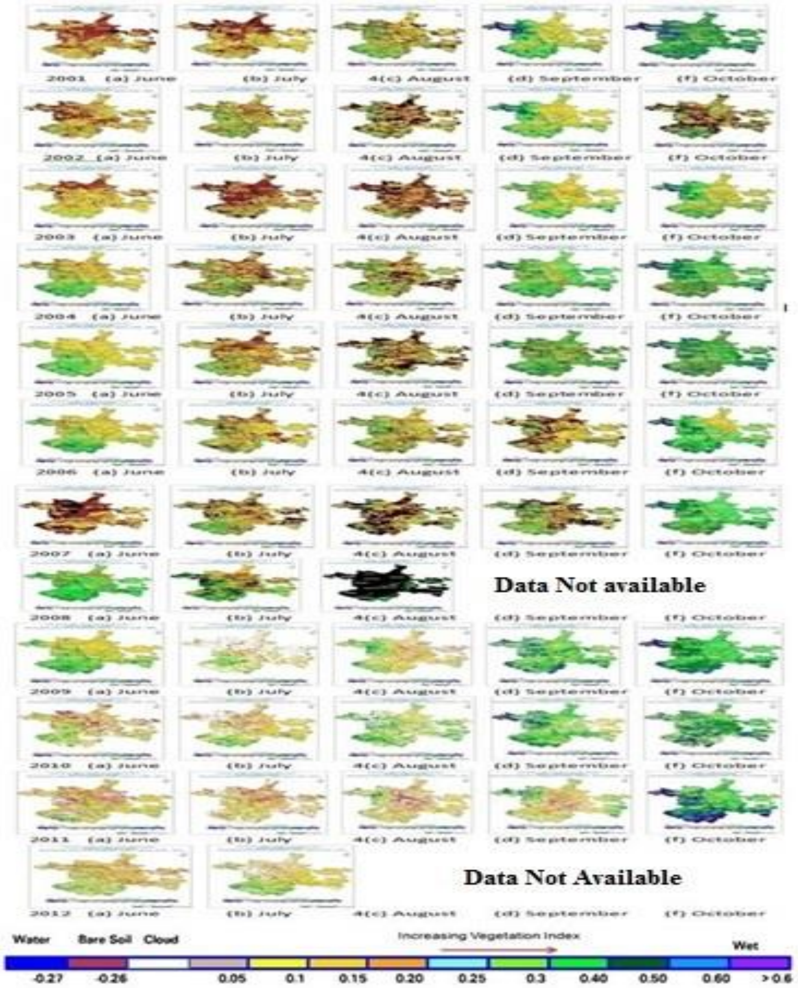

Fig.3 Agricultural Drought Pattern in Central Dry Zone 2001-2012

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Rainfall significantly impact on agricultural production in this due late onset, delay and early withdrawn of rainfall in South west monsoon causes meteorological, hydrological finally Agriculture drought is prominent in this zone.

In south west monsoon in the month of June, July months in the year 2001-2012 recorded significantly less vegetation to moderate vegetation in the months of June to September. The vegetation Status and vigour vegetation can well depicted in the figure -3 and the average NDVI values for Vegetation status in the TABLE 2.

Table.2 month-wise Average NDVI Value for Central Agro Climatic zone of Karnataka

ACZ	JUNE	JULY	AUG	SEPT	OCT
2001	0.0	0.1	0.2	0.4	0.5
2002	0.2	0.2	0.2	0.3	0.4
2003	0.1	0.1	0.2	0.4	0.4
2004	0.2	0.2	0.3	0.4	0.5
2005	0.2	0.1	0.3	0.4	0.5
2006	0.2	0.2	0.2	0.3	0.4
2007	0.2	0.2	0.3	0.4	0.4
2008	0.2	0.2	0.3	0.3	0.3
2009	0.3	0.2	0.3	0.5	0.5
2010	0.3	0.2	0.4	0.5	0.5
2011	0.2	0.2	0.2	0.4	0.5
2012	0.1	0.1	0.2	0.3	0.4

During the year 2001-2012 in Central Dry zone shows that there is very slow progress in vegetation during the year 2001-2012. The zone records severely low vegetation to moderate vegetation form the month of June to October (South West Monsoon season). In many years in the NDVI pattern in the month of June, July and August shows severe- low vegetation. The graph for the NDVI status is during 2001 to 2012 is given Fig.4 below.

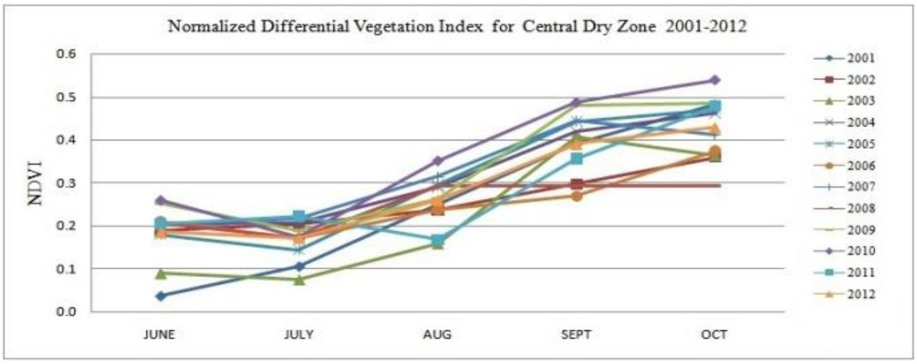

Fig.4 Vegetation Status from June – October during 2001-2012

Identification of Agricultural Drought Vulnerable Taluks in Central Dry Agro climatic Zones Of Karnataka 2001-2012

To identify the drought vulnerable areas in the state, the NDVI maps of severely low vegetation (0.1), slightly low vegetation (0.2), moderate vegetation (0.3), better vegetation (0.4), good vegetation (0.5), high vegetation (0.6) , and excess vegetation (0.7) are studied in detail.

First and foremost the areas which are showing severely low vegetation picked up for the study, same areas are compared in other categories of vegetation status where the percentage of vegetation gradually diminuted as the vegetation growth increases from June to September (South west monsoon) Season 2000 -20012, the same area experienced every high percentage of low vegetation and low percentage of high vegetation such area is identified as the drought vulnerable area for that particular taluk. Also studied the areas where in vegetation status is very low during the study period. By adopting the same methodology following areas are identified as the drought vulnerable area for the south west monsoon season.

The identification of drought vulnerable areas for the entire season is identified by taking same methodology. The spatial distribution of such area maps are given in Fig.5 below.

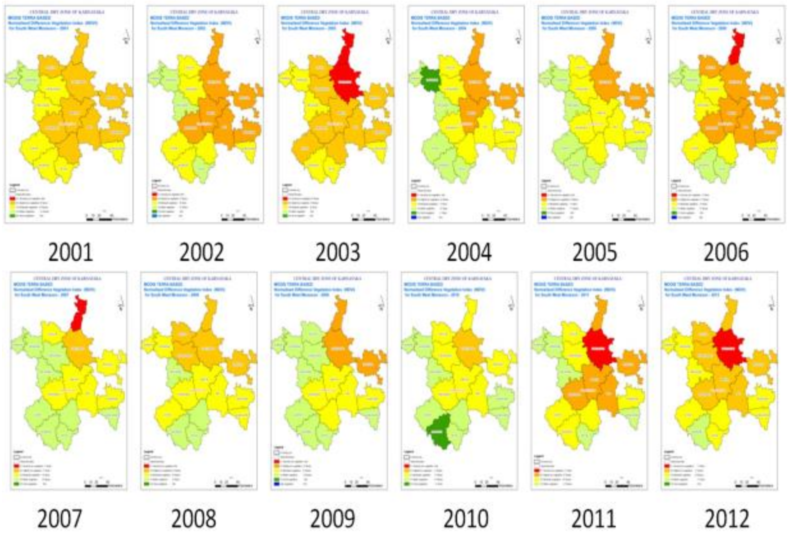

Fig.5 Agricultural Drought vulnerable areas in the Central Dry Zone based on Average NDVI Pattern in South West Monsoon 2001 -2012

Central Dry zone is frequently affected severe agricultural drought in many taluks. The zone shows that severely low vegetation to good vegetation in the south west monsoon season. During the year 2001-2012 in the zone identified as more than 1-2 taluks are severe drought, 5-7 taluks low drought and 4-5 taluks are moderate drought condition. In the year 2001-2003 and 2006 there is more number taluks are drought affected and 2011-2012 more than 5 taluks are affected by sever-low drought condition. The rainfall in the south west monsoon is significantly implies the occurrence of drought in this zone. Taluks of Challakere, Chitradurga, Hiriyur, Hosadurga, Holalkere, Jagalur, Molkalmuru, Arasikere, Kadur, Madhugiri, Pavagada, Koratagere, C.N.Halli, Sira, Tiptur are identified as drought prone taluks. The Average South West Monsoon NDVI Pattern is well depicted in the Fig.N given below.

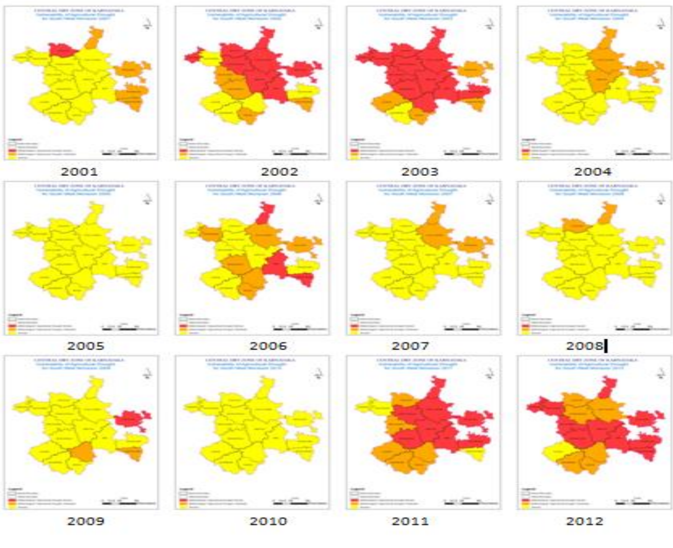

Fig. N Vulnerability of Agricultural drought in central Dry agro climatic zone of Karnataka

V. CONCLUSION

The Central dry zone Agro Climatic zones of Karantaka comprises of 17 taluks of is one of 6 Districts. Central dry zone is one of the highest areas under rain fed and drought prone. Agriculture is predominant about 66 percent of the workforce is dependent on agriculture. Further, 70 per cent of population is still living in rural areas and are completely depending on agriculture for their livelihood. Agriculture production in the Central dry zone is spread over three seasons namely, Kharif seasons (June to ctober) which account for nearly 70% of annual food grain production respectively. Some of the important crops grown are Cereals like rice, Jowar, Bajra, Maize, Wheat, pulses like Tur, Bengalgram, Horsegram, Blackgram, Greengram, Cowpea etc; oil seeds like sugarcane, cotton and tobacco. During the year 2001-2012 in the zone identified as more than 1-2 taluks are severe drought, 5-10 taluks low drought and 5-7 taluks are moderate drought condition. In the year 200-2003 there is more number taluks are drought affected and in 2006, 2011-2012 more than 5 taluks are affected by sever-low drought condition. The rainfall in the south west monsoon is significantly implies the occurrence of drought in this zone. Taluks of Challakere, Chitradurga, Hiriyur, Hosadurga, Holalkere, Jagalur, Molkalmuru, Arasikere, Kadur, Madhugiri, Pavagada, Koratagere, C.N.Halli, Sira, Tiptur are identified as drought prone taluks.

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