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Drought Analysis for Agricultural Impact Through Geoinformatic Based Indices, A Case Study of Bankur District, West Bengal, India

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Abstract

Erotic and subnormal rainfall distribution or high demand of water causes the drought. According to the National Commission on Agriculture has categorized three types of drought. One of them is hydrological drought, due to the drought rural community are affected by availability of surface water, sub-surface water and ground water. This is why we can say that hydrological or agricultural drought is the silent natural threat or hazard of rural economy. Also, it impacts on crop area, crop production, environment by abnormal weather condition. In West Bengal, the few districts are drought prone. Bankura is one of them. In this paper, remote sensing based methodology prepared for identify and take management stratagem according to state label or district label. Prevention and preparedness means pre-disaster activities designed to increase the level of readiness and improvement of operational and institutional capabilities for responding to a drought.

Keywords: Drought; Hazard; Crop forecasting; NDVI; MSI; SAVI; Agricultural drought

Introduction

Drought is one of the natural hazards, due to sub- normal, erratic rainfall distribution. Drought differs from other natural hazards in many respects-most complex and least understood of all disasters [1]. Drought impacts in vicious circle, a) Immediate impact on crop growth, yield and production b) Extended impacts on environment, abnormal weather conditions such as extended winters, cold summers and floods, biological factors like plague of locusts or rodents result in famines [1]. In India drought management by National Crop Forecasting Center, Indian Council of Agriculture Research ware indices Soil water, Crop water requirement [2].

Location of Study Area

The study area geographically located between 22°38´N to 23°38´N latitude and 86°36´E to 87°46´E longitude. It has an area of 6882 square kilometers. On the north and north-east district is bounded by Burdwan district, from which it is separated by the Damodar River. On the south-east, it is bounded by Hooghly district. On the south position covered by Paschim Midnapure district and on the west side Puruliya District (Figure 1).

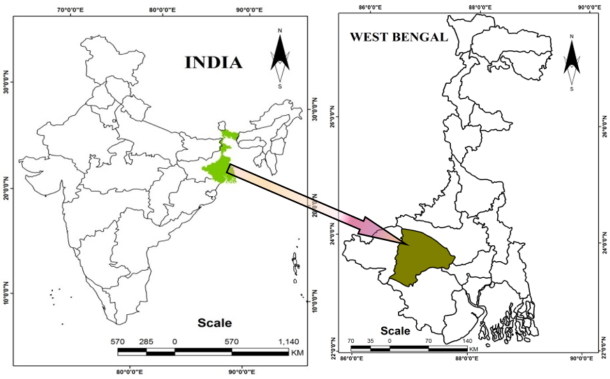

Figure 1: The study area geographically location.

Materials and Methodology

For the materials used please find the below table 1

Data Used	LANDSAT TM2000 (Path/Row 139/44) LANDSAT TM2006 LANDSAT TM2010 District Planning Map Series (D.P.M.S) Agriculture Data

Software Used	ERDAS Imaging of Leica Geosystem. PCI Geomatica. ARC GIS.

Table 1: Materials Used.

Methodology

Tasseled Cap Transformation

Normalized Difference Vegetation Index

Land Surface Water Index

Moisture Stress Index

Soil Adjusted Vegetation Index

Objectives

Land use/ Land cover of study area

Traditional Cope calendar

Tasseled cap transformation condition

Vegetation characteristic of the area

Moisture condition of the district

Physical environment setup

Relief: The areas on the east and north-east are low lying alluvial plains, similarly to predominating rice lands of Bengal. To the west the surface gradually rises, giving way to undulating country, interspersed with rocky hillocks. Much of the country is covered with jungles.

Soil: The western part of the district has bad soil and hard beds of the lateritic with scrub jungles and Sal woods. Long broken ridges with irregular patches of more recent alluvium have marks of seasonal cultivation. During the long dry season, large extents of the red soil with hardy any tree lend the country a scorched and dreary appearance. In the eastern part of the eye constantly rests on wide expanses of rice fields, green in the rains but parched and dry in summer.

Geology: The Gondwana system is represents in the northern portion of the district, south of the Damodar between Mejia and Biharinath hill. The beds covered with alluvium contain seams of coal belonging to the Raiganj system.

Climate: The climate especially in the upland tracts to the west is much drier than in eastern or southern Bengal. From the beginning March to early June, hot westerly winds prevail, the thermometer in the shade rising to around 45°C. The monsoon months June to September are comparatively pleasant. The total average rainfall is 1400 mm, the bulk of the rain coming in the months of June to September winters are pleasant with temperatures dropping down to below 27°C.

Agriculture: The agro-climatic condition of the district is suitable for plantation and horticultural crops. The district with dry climate condition and vast wasteland has great potential for undertaking plantation and horticultural activities, both traditional and non-traditional plantation, like mango, guava, cashew nut, jackfruit, banana, papaya etc can be grown in large scale.

The economy of Bankura District is predominantly a grain. Moreover, the crop pattern is tilted heavily towards paddy cultivation using traditional agricultural practices, unconductive topography very small size of the land holding, poor irrigation coverage, low water retention capacity of soil etc., offer of farm mechanization in agriculture is low also due to lack of awareness among farmers. Farm mechanization is limited to eastern alluvial tract among comparatively prosperous farmers. On the other hand, response to crop diversification is poor and the pace of change of cropping pattern is low.

Drainage: The Drainage of the district is mainly controlled by Damodar, Dwarakeswar and the Kangsabati river along with their tributaries. Damodar (89.6 Km.) river rises in hilly country of Palamau District of Chhotonagpurand before it touches the Bankura District, it receives the water of many smaller hill streams including those of the Barakar, its Principal tributary. The Dwarakeswar flows approximately through the middle of the district and divides it into two halves. It rises in the adjoining Purulia district, flows in a south-easterly course and enters Bankura District. The Silabati (56 Km.), popularly known as silai is the largest tributary of Dwarakeswar, The Joypanda (43.45 Km) is the Principal tributary of the Silabati. The Kangsabati on the Kasai is the third largest river in the district, which rises in the hilly terrain of Jhalda block in the adjoining district of Purulia and enters Bankura district in Khatra block. After 56 Km flow enters Paschim Midnapur district. The rivers play an important role of the districts irrigation. All the rivers are seasonal; hence the district is drought prone.

Land use/ Land cover: Total area of the district is 688200 hectares out of which forest area is 119214.4 hectares and high land and medium land are 176915 hectares and 150611 hectares respectively of the total forest area 20712.4 hectares (11.7%) fall under open forest and 57084.09 hectares (32.7%) fall under degraded forest. The huge land area may be put to productive use by undertaking plantation and other activities which may generate gainful employment. There lies scope for activities under micro watershed which may be put to productive use when agriculture and other allied activities may be well become much remunerative. Land development activities based on watershed development can be taken up in many areas of the districts. Land utilization pattern reveals that only 59.5% of total land is under cultivation. In order to increase agriculture productivity in this limited cultivable area scientific approach for land development, soil conservation and watershed management, besides adoption of dry land agriculture are very much needed.

Results and Discussion

Impact on land use

In Bankura total area is 688200 hectares of which forest area is 11921 hectares and highland and medium land are 176915 and 150611 hectares respectively. To analysis the Bankura district by using satellite image I mainly found nine types of land use and land cover type. They are Upland with very dense forest, Upland with dense forest, Upland

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with open forest, Upland with forest, Agriculture, river, water-body, wet land marshy land etc. If analysis the area of every land use and land cover in the year 2000, 2006, 2010 we are able to know the areal changes. The area of Upland with very dense forest is gradually increases. In the year 2000 the area is 7978.32 hectares and in the year 2006 the area is 13492.5 hectares. So, the area is increase 5514.18 hectares. In the year 2010 the area is 62613.1 hectares. So, the area is increasing 49120.6 hectares.

The area of upland with dense forest in the year 2000 is 19908 hectares. In the year 2006, it is 32476.5 hectares. So, the area is increase 1256.8 hectares. But in the year 2010 the area is 7441.56. So, the area is decrease 25034.94 hectares. The area of upland with open forest in the year 2000 is 213682 hectares. In the year 2006, it is 11747.4 hectares. So, the area is decrease 212507.6 hectares. But in the year 2010 the area is 138219. So, the area is increase 1264716 hectares. The area of upland with forest in the year 2000 is 19846 hectares. In the year 2006, it is 43339.8 hectares. So, the area is increase 23493.8 hectares and in the year 2010 the area is 5262.57. So, the area is increase 922.77 hectares. So, the area is gradually increased. The area of agriculture in the year 2000 is 42546.3 hectares. In the year 2006, it is 6339.24 hectares. So, the area is decreasing 36207.06 hectares and in the year 2010 the area is 21899.6. So, the area is increase 15560.36 hectares. The area of river in the year 2000 is 23408.1 hectares. In the year 2006, it is 58867.6 hectares. So, the area is increase 3545.95 hectares and in the year 2010 the area is 48520.4. So, the area is decrease 10347.2 hectares. The area of water body in the year 2000 is 805.95 hectares. In the year 2006, it is 247.32 hectares. So, the area is decrease 558.63 hectares and in the year 2010 the area is 1138.77. So, the area is increase 891.45 hectares. The area of wet land in the year 2000 is 201795.7 hectares. In the year 2006, it is 363459 hectares. So, the area is increase 161663.3 hectares and in the year 2010 the area is 244874. So, the area is decreasing 118585 hectares (Figure 2).

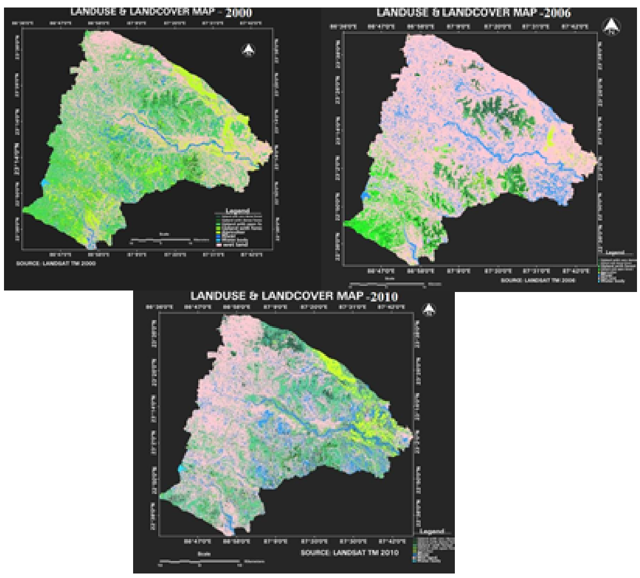

Figure 2: Land use and land cover in the year 2000, 2006, 2010.

Impact on crop calendar

From crop calendar we see the increase or decrease of crops [3] at a glance. The production of rice in the year 2000-01 is 993.4 tones. The year 2001-2002 it is increase and the production is 1222.4 tones. But the year 2002-03 it is decrease and the production is 867 tones. The year 2004-05 it also decreases and the production is 458 tones. The production of wheat in the year 2000-01 is 21.1 tones. The year 2001-2002 it is increase and the production is 24.0 tones. But the year 2002-03 it is decreases and the production is 19.6 tones. The year 2004-05 it also decreases and the production is 14.6 tones. The production of maize in the year 2000-01 is 0.7 tones. The year 2001-2002 it is increase and the production is 1.0 tone. But the year 2002-03 it is decreases and the production is 0.1 tones. The year 2004-05 it also increases and the production is 1.1 tones. The production of bajra in the year 2000-2005 is same and the production is 0.2. The production of maize in the year 2000-01 is 0.1 tones the year 2001-2002 it is increase and the production is 0.1 tones. But the year 2003-03 it is decreases and the production is 0.1 tones. The year 2004-05 it also decreases and the production is 0.1 tones. The production of small millet in the year 2000-01 is 0.3 tones. The year 2001-2002 it is same and the production is 0.3 tones. But the year 2002-03 it is decrees and the production is 0.2 tones. The year 2004-05 it also decrees and the production is 0.1 tones. The production of arhar in the year 2000-01 is 0.3 tones the year 2001-2002 it is decrease and the production is 0.2 tones. But the year 2002-03 it is increase and the production is 0.5 tones. The year 2004-05 it also same and the production is 0.5 tone. The production of mung in the year 2000-01 is 0.2 tones. The year 2001-2002 it is decrease and the production is 0.24 tones. But the year 2002-03 it is same and the production is 0.2 tone. The year 2004-05 it also same and the production is 0.2 tones. The production of mustard in the year 2000-01 is 12.9 tones. The year 2001-2002 it is decrease and the production is 9.7 tones. But the year 2002-03 it is decrease and the production is 9.3 tones. The year 2004-05 it also decreases and the production is 6.9 tones. The production of Jute in the year 2000-01 is 6.9 tones the year 2001-2002 it is decrease and the production is 2.4 tones. But the year 2002-03 it is decrease and the production is 0.2 tones. The year 2004-05 it also increases and the production is 5.2 tones. The production of potato in the year 2000-01 is 571.3 tones. The year 2001-2002 it is decrease and the production is 522.9 tones. But the year 2002-03 it is decrease and the production is 370.7 tones. The year 2004-05 it also increases and the production is 539.0 tones. The production of dry chilies in the year 2000-01 is 1.2 tones in the year 2001-2002 it is increase and the production is 1.5 tones. But the year 2002-03 it is decrease and the production is 1.1 tones. The year 2004-05 it also increases and the production is 1.4 tones. To discuss Bankura's drought with the help of different index based divided the whole Bankura district in 8 divisions. They are North, North-east, North-west, south, South-east and South-west. Also divided the indexes in 4 categories 1 category the value of the image is highest and the 4 category the value of the image is lowest. Here is a brief discussion about all indexes.

Tasseled cap transformation

The tasseled cap transformation developed by Kauth and Thomas is a means for highlighting the most important phenomena of crop development in a way that allows discrimination of special crops, and crops from other vegetative cover. Its basis originally lies in an observation of crop trajectories in band 6 versus band 5 and band 5 verses band 4 subspaces. Kauth and Thomas to consider the development of a linear transformation that would be useful in crop discrimination. Three major orthogonal directions of significance in agriculture can be identified. The first is the principal diagonal along which soils are distributed [4]. This was chosen by Kauth and Thomas as the first axis in the tasseled cap transformation. The development of green biomass as crops move towards maturity appears to occur orthogonal to the soil major axis. This direction was then chosen as the second axis, with the intention of providing a greenness indicator. Consequently, choosing a third axis orthogonal to the soil line and greenness axis will give a yellow measure. Finally, a fourth axis is required to account for data variance not substantially associated with differences in soil brightness or vegetative greenness or yellowness. The formulas are,

SBI: 0.33183 × TM1+0.33121 × TM2+0.55177 × TM3+0.42514 × TM4+0.48087 × TM5+0.25252 × TM7

GVI: 0.24717 × TM1-0.16263 × TM2-0.040639 × TM3+0.85468 × TM4+0.05493 × TM5-0.11749 × TM7

WI: 0.13929 × TM1+0.22490 × TM2+0.40359 × TM3+0.25178 × TM4-0.70133 × TM5-0.45732 × TM7

The upper north-east part of the Bankura district the value of SBI 2002, 2006 is 3, 3. The middle part of north-east the value is 3, 2 respectively. The lower part of north-east the value is 4, 3. The upper north-west value is 3, 3. The middle part of north-west the value is 3, 3. The lower part of north-west the value is 3, 2. The upper south-east portion the values are 1, 1. The middle south-east the value is 3, 3.The lower south-east value is 4, 3. The upper south-west portion the value is 3, 2. The middle south-west portion the value is 4, 3. The lower south-west portion the value is 3, 2 respectively. I can show this in Table 2. In this table row represent year and column represent class.

Class	2000	2006	2010
Class-I	471.815-598.063	216.438-271.160	259.842-318.038
Class-II	345.566-471.815	161.709-216.438	201.645-259.842
Class-III	219.317-345.560	106.981-161.709	143.449-201.645
Class-IV	93.068-219.317	52.253-106.981	85.252-143.449

Table 2: The values of SBI.

The upper north-east part of the Bankura district the value of GVI 2002, 2006, 2010 is 4, 3 and 2. The middle part of north-east the value is 4, 2 and 3 respectively. The lower part of north-east the value is 3, 2 and 2. The upper north-west value is 4, 3 and 3. The middle part of north-west the value is 4, 3, and 3. The lower part of north-west the value is 4, 3 and 2. The upper south-east portion the values are 3, 3 and 2. The middle south-east the value is 4, 2 and 3. The lower south-east value is 3, 2 and 2. The upper south-west portion the value is 3, 2 and 2. The middle south-west portion the value is 4, 4 and 4. The lower south-west portion the value is 4, 2 and 2 respectively. I can show this in Table 3. In this table row represent year and column represent class.

Class	2000	2006	2010
Class-I	158.647-207.120	64.0860-83.8230	79.6655-102.0361
Class-II	110.174-158.647	44.3490-64.0860	57.2948-79.6655
Class-III	61.701-110.174	24.6120-44.3490	34.9247-57.2948
Class-IV	13.228-61.701	4.8750-24.6120	12.5535-34.9247

Table 3: The values of GVI.

The upper north-east part of the Bankura district the value of Wetness Index 2002, 2006, 2010 is 2, 2 and 2. The middle part of north-east the value is 1, 2 and 3 respectively. The lower part of north-east the value is 2, 2 and 2. The upper north-west value 2, 2 and 1. The middle part of north-west the value is 2, 2, and 1. The lower part of north-west the value is 3, 2 and 1. The upper south-east portion the values are 2, 2 and 1. The middle south-east the value is 3, 2 and 1. The lower south-east value is 2, 2 and 1. The upper south-west portion the value is 2, 2 and 1. The middle south-west portion the value is 1, 1 and 1. The lower south-west portion the value is 3, 2 and 1 respectively. I can show this in Table 4. In this table row represent year and column represent class.

Class	2000	2006	2010
Class-I	29.128-86.005	16.080-68.645	-14.651-53.094
Class-II	-27.748-29.128	-36.485-16.080	-83.237- -14.651
Class-III	-84.624—27.748	-89.050--36.485	-151.822- -83.237
Class-IV	-141.501—84.624	-141.615—89.050	-220.407- -151.822

Table 4: The values of Wetness Index.

Normalized difference vegetation index

The Normalized Difference Vegetation Index (NDVI) is a simple numerical indicator that can be used to analyze remote sensing measurements, typically but not necessarily from a space platform, and assess whether the target being observed contains live green vegetation or not [5].

Live green plants absorb solar radiation in the Photo synthetically Active Radiation (PAR) spectral region, which they use as a source of energy in the process of photosynthesis. Leaf cells have also evolved to scatter (i.e., reflect and transmit) solar radiation in the near-infrared spectral region (which carries approximately half of the total incoming solar energy), because the energy level per photon in that domain (wavelengths longer than about 700 nanometers) is not sufficient to be useful to synthesize organic molecules. A strong absorption at these wavelengths would only result in over-heating the plant and possibly damaging the tissues. Hence, live green plants appear relatively dark in the PAR and relatively bright in the near-infrared. By contrast, clouds and snow tend to be rather bright in the red (as well as other visible wavelengths) and quite dark in the near-infrared. The pigment in plant leaves, chlorophyll, strongly absorbs visible light (from 0.4 to 0.7 µm) for use in photosynthesis. The cell structure of the leaves, on the other hand, strongly reflects near-infrared light (from 0.7 to 1.1 µm). The more leaves a plant has, the more these wavelengths of light are affected, respectively. Since early instruments of Earth Observation, such as NASA's ERTS and NOAA's AVHRR, acquired data in visible and near-infrared, it was natural to exploit the strong differences in plant reflectance to determine their spatial distribution in these satellite images [6]. The NDVI is calculated from these individual measurements as follows:

NDVI: (IR-R)/(IR+R)

This spectral reflectance is themselves ratios of the reflected over the incoming radiation in each spectral band individually; hence they take on values between 0.0 and 1.0. By design, the NDVI itself thus varies between -1.0 and +1.0. It should be noted that NDVI is functionally, but not linearly, equivalent to the simple infrared/red ratio. The advantage of NDVI over a simple infrared/red ratio is therefore generally limited to any possible linearity of its functional relationship with vegetation properties (e.g., biomass). The simple ratio (unlike NDVI) is always positive, which may have practical advantages, but it also has a mathematically infinite range (0 to infinity), which can be a practical disadvantage as compared to NDVI. Also in this regard, note that the VIS term in the numerator of NDVI only scales the result, thereby creating negative values. NDVI is functionally and linearly equivalent to the ratio (IR-R)/(IR+R), which ranges from 0 to 1 and is thus never negative nor limitless in range. But the most important concept in the understanding of the NDVI algebraic formula is that, despite its name, it is a transformation of a spectral ratio (IR/R), and it has no functional relationship to a spectral difference (IR-R).

In general, if there is much more reflected radiation in near-infrared wavelengths than in visible wavelengths, then the vegetation in that pixel is likely to be dense and may contain some type of forest. Subsequent work has shown that the NDVI is directly related to the photosynthetic capacity and hence energy absorption of plant canopies.

Negative values of NDVI (values approaching -1) correspond to water. Values close to zero (-0.1 to 0.1) generally correspond to barren areas of rock, sand, or snow. Lastly, low, positive values represent shrub and grassland (approximately 0.2 to 0.4), while high values indicate temperate and tropical rainforests (values approaching 1).

The upper north-east part of the Bankura district the value of Normalized Difference Vegetation Index in 2002, 2006, 2010 is 1, 2 and 1. The middle part of north-east the value is 3, 1 and 3 respectively. The lower part of north-east the value is 2, 3 and 3. The upper north-west value 3, 3 and 3. The middle part of north-west the value is 3, 2, and 2. The lower part of north-west the value is 4, 3 and 3. The upper south-east portion the values are 3, 3 and 3. The middle south-east the value is 2, 2 and 2. The lower south-east value is 3, 1 and 3. The upper south-west portion the value is 3, 1 and 2. The middle south-west portion the value is 4, 4 and 4. The lower south-west portion the value is 3, 2 and 3 respectively. I can show this in Table 5. In this table row represent year and column represent class.

Class	2000	2006	2010
Class-I	0.076-0.346	0.346-0.575	0.306-0.496
Class-II	-0.104- 0.076	0.118-0.346	0.115-0.306
Class-III	-0.283- -0.104	-0.111- 0.118	-0.076-0.115
Class-IV	-0.553- -0.283	-0.340- - 0.111	-0.267- -0.076

Table 5: The values of Normalized Difference Vegetation Index.

Land surface water index

For more than 20 years the Normalized Difference Vegetation Index (NDVI) has been widely used to monitor vegetation stress. It takes advantage of the differential reflection of green vegetation in the visible and near-infrared (NIR) portions of the spectrum and provides information on the vegetation condition. The Land Surface Water Index (LSWI) uses the shortwave infrared (SWIR) and the NIR regions of the electromagnetic spectrum. There is strong light absorption by liquid water in the SWIR, and the LSWI is known to be sensitive to the total amount of liquid water in vegetation and its soil background [7]. In this study, we investigated the LSWI characteristics relative to conventional NDVI-based drought assessment, particularly in the early crop season. The area chosen for the study was the state of Andhra Pradesh located in the Indian peninsular. The Moderate Resolution Imaging Spectro radiometer (MODIS) Vegetation Index (VI) product from the Aqua satellite was used in the study. The analysis was carried out for the years 2002 (deficit year) and 2005 (normal year) using the NDVI from the MODIS VI product and deriving the LSWI using the NIR and SWIR reflectance available with the MODIS VI product. The response of LSWI to rainfall, observed in the rate of increase in LSWI in the subsequent fortnights, shows that this index could be used to monitor the increase in soil and vegetation liquid water content, especially during the early part of the season. The relationship between the cumulative rainfall and the current fortnight LSWI is stronger in the low rainfall region (<500 mm), while the one-fortnight lagged LSWI had a stronger relationship in the high rainfall region (>500 mm). The relationship between LSWI and the cumulative rainfall for the entire state was mixed in 2002 and 2005. The strength of the relationship was weak in the high rainfall region. When LSWI was regressed directly with NDVI for three LSWI ranges, it was observed that the NDVI with the one-fortnight lag had a strong relationship with the LSWI in most of the categories. The formula of the Land Surface Water index is LSWI: (TM4-TM7)/(TM4+TM7)

The upper north-east part of the Bankura district the value of Land Surface Water Index 2002, 2006, 2010 is 1, 1 and 1. The middle part of north-east the value is 3, 2 and 1 respectively. The lower part of north-east the value is 4, 2 and 3. The upper north-west value 3, 2 and 2. The middle part of north-west the value is 3, 1, and 2. The lower part of north-west the value is 4, 3 and 3. The upper south-east portion the values are 3, 2 and 3. The middle south-east the value is 3, 2 and 2. The lower south-east value is 4, 2 and 3. The upper south-west portion the value is 4, 2 and 3. The middle south-west portion the value is 3, 1 and 2. The lower south-west portion the value is 2, 2 and 2 respectively. I can show this in Table 6. In this table row represent year and column represent class.

Class	2000	2006	2010
Class-I	0.359-0.619	0.0401-0.730	0.294-0.597
Class-II	-0.099-0.359	0.072-0.0401	-0.009-0.294
Class-III	-0.161- -0.099	-0.257-0.072	-0.311- -0.009
Class-IV	-0.421- -0.161	-0.587- -0.257	-0.614- -0.311

Table 6: The values of Land Surface Water Index.

Moisture stress index

The Moisture Stress Index for corn and soybean crops is a measure of the effects of drought and catastrophic wetness on national crop yield and is calculated through the use of a drought index (the Palmer Z Index) and annual average crop productivity values within each U.S. climate division. Moisture stress, either a lack or an abundance of soil moisture during critical phases of the crop growth and development cycle, affects US average crop yield, particularly when moisture stress occurs in the most highly productive crop growing areas. Soil moisture conditions in July and August were found to be the best indicators of average crop yield for corn and soybeans, and as such, are used in creating the Moisture Stress Index [8].

The occurrence of drought during some months of the year would not be expected to impact crop productivity, the index was initially calculated for all months of the year. In cases when no climate division within the crop growing region has a Z index value less than or equal to -2 or a value greater than or equal to +5, the Moisture Stress Index equals zero. For months in which one or more climate division within the crop growing region has Z index values greater than or equal to +5, the Stress Index value for the month is calculated using a weighted average, with the average crop productivity values in the affected climate divisions as weights. For example, if severe to catastrophic drought or catastrophic wetness occurred during a particular month in X number of climate divisions that account for 20% of the crop growing region's productivity, the value of the Index would be 20 for that month. Not surprisingly the largest Moisture Stress Index values result when widespread drought or catastrophic wetness occurs in the most productive areas of the crop growing region. Moisture Stress Index, which considers drought and wetness, indices based solely on drought and another based solely on wetness were calculated. An index based solely on the effect that drought conditions have on crop yield was calculated (a Drought Stress Index) as well as an index based only on the effect that wetness (a Wetness Stress Index) has on crop yield was also calculated. In all cases, the effect of varying levels of drought and wetness severity was evaluated by using a variety of minimum drought and wetness thresholds (e.g., Z Index less than or equal to -2, -3 etc. and Z Index greater than or equal to 2.5, 3.5, etc.). The formula of moister stress index is –

MSI: (TM5)/(TM4)

The upper north-east part of the Bankura district the value of Moisture Stress Index in 2002, 2006, 2010 is 4, 4 and 4. The middle part of north-east the value is 2, 3 and 3 respectively. The lower part of north-east the value is 4, 3 and 3. The upper north-west value 2, 3 and 3. The middle part of north-west the value is 2, 3, and 3. The lower part of north-west the value is 1, 3 and 3. The upper south-east portion the values are 2, 4 and 4. The middle south-east the value is 2, 4 and 4. The lower south-east value is 2, 4 and 4. The upper south-west portion the value is 3, 3 and 2. The middle south-west portion the value is 4, 4 and 4. The lower south-west portion the value is 2, 3 and 3 respectively. I can show this in Table 7. In this table row represent year and column represent class.

Class	2000	2006	2010
Class-I	2.21-2.81	3.10-4.02	3.15-4.07
Class-II	1.61-2.21	2.17-3.10	2.22-3.15
Class-III	-1.01-1.61	1.24-2.17	1.29-2.22
Class-IV	0.40-1.01	0.31-1.24	0.36-1.29

Table 7: The values of Moisture Stress Index.

Soil adjusted vegetation index

In areas where vegetation cover is low (i.e.,<40%) and the soil surface is exposed, the reflectance of light in the red and near-infrared spectra can influence vegetation index values [6]. This is especially problematic when comparisons are being made across different soil types that may reflect different amounts of light in the red and near-infrared wavelengths (i.e., soils with different brightness values). The soil adjusted vegetation index was developed as a modification of Normalized Difference Vegetation Index to correct for the influences of soil brightness when vegetation cover is low.

The SAVI is structured similar to the NDVI between with the addition of a "soil brightness correction factors". The utility of SAVI for minimizing the soil "noise" inherent in the NDVI has been corroborated in several studies. SAVI: (NIR-RED) × (1+L)/(NIR+RED +L)

Where NIR is the reflectance value of the near-infrared band, red is reflectance of the red band and L is the soil brightness correction factor. The value of L varies the amount or cover of green vegetation, in very high vegetation regions, L=0; and in areas with no green vegetation, L=1. Generally, and L=0.5 works well in most situation, and is the default value is used, when L=0 then SAVI=NDVI.

The upper north-east part of the Bankura district the value of Soil Adjusted Vegetation Index in 2002, 2006, 2010 is 1, 2 and 2. The middle part of north-east the value is 2, 2 and 1 respectively. The lower part of north-east the value is 3, 2 and 2. The upper north-west value 3, 3 and 3. The middle part of north-west the value is 3, 2, and 1. The lower part of north-west the value is 2, 1 and 1. The upper south-east portion the values are 3, 3 and 3. The middle south-east the value is 3, 2 and 1. The lower south-east value is 3, 2 and 2. The upper south-west portion the value is 3, 2 and 2. The middle south-west portion the value is 4, 4 and 4. The lower south-west portion the value is 2, 2 and 1 respectively. I can show this in Table 8. In this table row represent year and column represent class.

Class	2000	2006	2010
Class-I	0.182-0.518	0.517-0.859	0.524-0.866
Class-II	-0.154- 0.182	0.176-0.517	0.183-0.524
Class-III	-0.490- -0.154	-0.160- 0.176	-0.167- 0.183
Class-IV	-0.825- -0.490	-0.507- -0.160	-0.514- -0.167

Table 8: The values of Soil Adjusted Vegetation Index.

Conclusion

The deficit from normal availability of water for a short period is usually defined as drought. It disturbs the sustainability of a region. It can be discriminated from aridity as it is a sustained state of water shortage to which life and economic activity is to be adjusted. Drought measuring primary elements are precipitation, run off; surface storage soil moister, ground water etc. The time span of drought phenomenon may be extended from year to month and also week. Drought is one of the short term extreme events. There is no operational practice to forecast the drought [9].

Now recent day we can measures the drought by using Remote Sensing as a technique. The G.I.S. database is an effective tool for emergency responders to access information in terms of crucial parameters for the disaster affected areas. The crucial parameters include location of the public facilities, communication links and transportation network at National, State and District levels. The GIS database available with different agencies of the Government is being upgraded and the gaps are proposed to be bridged. The database will provide multi layered maps on district wise. Three maps taken in conjunction with the satellite images available for a particular area will enable the district administration as well as State governments to carry out hazard zonation and vulnerability assessment, as well as co-ordinate response after a disaster. Drought is one type of main natural disaster in West Bengal. Bankura is one of the most important drought-prone districts in West Bengal. So, drought declaration is the primary responsibility of the state. Forecasting of arrival dates of monsoon and rainfall deviation with respect to normal by IMD. States also monitor rainfall and gather information from Remote Sensing Agencies.

Meteorologically ± 19% deviation of rainfall from long term mean is considered normal in India. Rainfall deficiency 20-59% a moderate drought. More than 60% represent serve drought [9].

States have set rules for declaring hydrological drought. Such as Annawari Procedure of estimating losses used in Gujrat, in Maharashtra Paiswari System.

Prevention and preparedness means pre-disaster activities designed to increase the level of readiness and improvement of operational and institutional capabilities for responding to a drought. Drought Management in the India context is the delineation of drought prone areas. At the block level, the following indicators are generally used.

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