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# Remote Sensing Based Agricultural Drought Assessment in Krishnagiri District

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**Abstract:** ***Increasing temperature and altered precipitation patterns, leads to the extreme weather events like Drought which drastically affects the agricultural production. Agricultural drought is nothing but the decline in the productivity of crops due to irregularities in the rainfall as well as decrease in the soil moisture, which in turn affects the economy of the nation. As the Indian agriculture is largely dependent on the Monsoon, a slight change in it affects the production as well as the crop yield drastically. The agricultural drought monitoring, assessment as well as management can be done more accurately with the help of geospatial techniques like Remote Sensing. Krishnagiri is an important district in the part of Tamilnadu. The study area falls between North latitudes 12° 16' N & 12° 88' N and East longitude 77° 50' E & 78° 55' E (Fig. 1) and covers an area about 5143 km2It is a drought prone region and falls within the most arid band of the country. The district relies on the traditional agricultural based economy; hence the impact of drought on the agriculture not only affects the production but also the livelihood of common man. The purpose of the study is to analyze the vegetation stress in the region krishnagiri district with the calculation of NDVI values and the land surface change classification). The MODIS data is used for the calculation of NDVI as well as Land surface temperature. The Combination of (NDVI) normalized difference vegetation index and LST, provides very useful information for agricultural drought monitoring and early warning system for the farmers. By calculating the correlation between rainfall analysis and NDVI, it can be clearly noticed that they show a high negative correlation. The correlation between Rainfall analysis and NDVI is -0.635 for the -0.586 for the year 2017.The LST when correlated with the vegetation index it can be used to detect the agricultural drought of a region, as demonstrated in this work.***

**Keywords**: Remote sensing; GIS; Agricultural drought; NDVI; land use land cover map; MODIS-Drought basement map, Rainfall analysis

## 1. Introduction

Drought originates from the deficiency of precipitation over an extended period of time, resulting in a water shortage for some activity, group, or environmental sector. Based on the impact on different activities, droughts are associated with agriculture, animal husbandry and socio economic aspects of society. Agricultural drought is caused by the effect of soil moisture deficiency on the cultivation of crops in the season. Satellite remote sensing is widely used for monitoring crops and agricultural drought assessment. Information on agricultural drought is useful for in season management of crops, end of season management of crop production and assessment of crop loss. Over the last 20 years, coarse resolution satellite sensors have been used to routinely monitor vegetation and indices such as the Normalized Difference Vegetation Index (NDVI) are being used to detect the impact of moisture stress on vegetation (Tuckers and Sellers 1986, Gitelson and Merzlyak 1997). Remote sensing based agricultural drought assessment is developed on the difference in spectral response characteristics for different vegetation conditions. The reflected radiation in the wavelengths 0.60 to 0.70 um (Red) and 0.70 to 1.25 um (Near infra-red) bear close relationship to biomass, leaf area index (LAI), leaf water content and other plant canopy parameters. Out of the various vegetation indices available, Normalized Difference Vegetation Index (NDVI) is very widely used as it minimize the effect of change in illumination condition and surface topography. The NDVI is defined as the ratio of difference between the near infrared and red reflectance to their sum.

## 2. Objective

The main objective of present study is

1. To analysis the change in vegetation cover due to variation in rainfall(by using rainfall data and NDVI image)
2. Identify areas facing high drought risk by combining satellite data and thematic information

## 3. Study Area

Krishnagiri is an important district in the part of Tamilnadu. The study area falls between North latitudes 12° 16' N & 12° 88' N and East longitude 77° 50' E & 78° 55' E (Fig. 1) and covers an area about 5143 km2.Krishnagiri district is having administrative divisions of 5 taluks, 10 blocks and 626 villages. Ponnaiyar is the major river draining the district. The chief irrigation sources in the district are dug wells, tanks, canals and bore wells. Dug well irrigation is highest in Uthangarai block followed by Kaveri Pattanam. Highest canal and tank irrigation are seen in Kaveripattinam and Krishnagiri respectively. Ground water exploration through drilling was first taken up by Central Ground Water Board in Krishnagiri district between 1988 and 1990.Sites for drilling were selected based on hydrogeological, geophysical and Remote Sensing Studies. A total of 17 exploratory bore wells and 11 observation wells, ranging in depth from 107 to 300 m bgl were drilled in the district. Further, 10 bore wells were drilled in the district during 2003- 05 throughout sourcing as part of the nationwide initiative of CGWB for drought mitigation. A number of bore wells have also been drilled in the district various state Govt. agencies.

Krishnagiri is a first grade municipal town with effect from17.04.1984.Formerly it was a town panchayat and was constituted into a municipality with effect from 1.04.1965.It has an extent of 11.50 sqkm comprising of three revenue villages namely Krishnagiri, Boganpalli (Part) and Kattiganapalli (Part) The Municipal Council, comprising of 33 ward members, is headed by Chairperson. The executive wing is headed by Commissioner, who is assisted by a team of officials including Municipal engineer, Sanitary Officer and Manager. The current Municipal Council took charge in 2006.Eastern part of the district experiences hot climate and Western part has a contrasting cold climate. The average rainfall is 830 mm per annum. March - June is summer season. July - November is Rainy Season and between December - February winter prevails. The main rivers that flow across the district are Kaveri and South Pennar Kaveri enters the district from South West in Denkanikottai taluk and exists in South West direction. It forms waterfalls at Hokenakkal and joins Mettur Dam. South Pennar originates in Nandidurg of Karnataka and flows through Hosur, Krishnagiri and Uthangari Taluks. Vanniyar and Markanda rivers join this South Pennar.

The important crops of Krishnagiri district are paddy, maize, ragi, banana, sugarcane, cotton, tamarind, coconut, mango, groundnut, vegetables and flowers. The district has an excellent scope for agriculture business. Regional Agricultural Research Center of Tamil Nadu Agricultural University is functioning efficiently at Paiyur in Kaveripattinam union since 1973.This center is functioning in 18.5 hectares of land. It helps the peasants to develop and adopt the modern technique of cultivation. It has developed hybrid seeds by research which yields more tonnage and good quality.

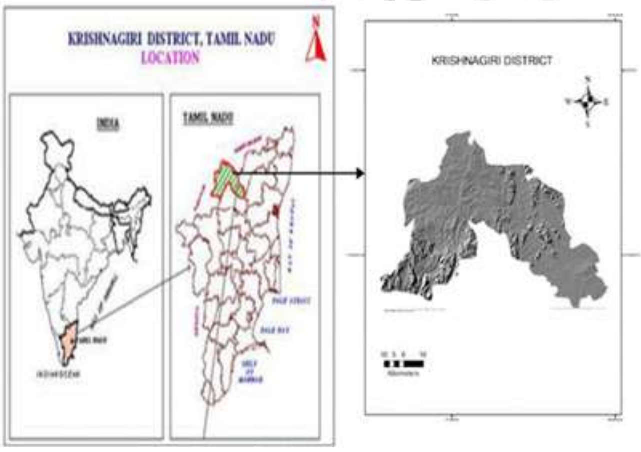



**Figure 1:** Map showing the study area

## 4. Materials and Methodology

### Data Acquisition

Data has been acquired mainly from two sources first NDVI derived from satellite source and secondary rainfall occurs from IMD data.

### Satellite Data Characteristic and Acquisition

The liss 3 sensor collect global data on a daily basics on variety of land ocean and atmospheric application. specific application requires use to detects forest detection weather analysis and vegetation classification.

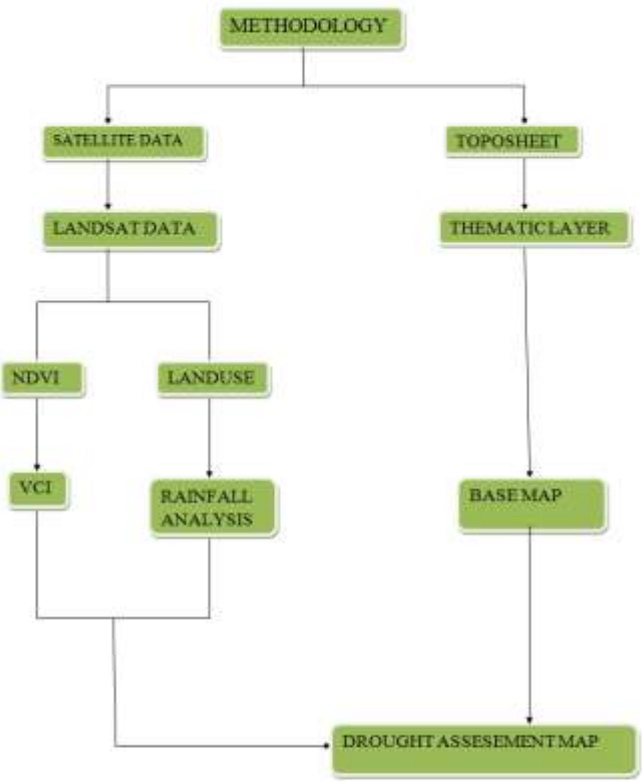
**Meteorological Data:** Meteorological data for rainfall are collected from IMD data for seasonal year and also used to derive from NDVI analysis from rainfall data was considered to be carried out various analysis.

### Processing of Satellite Data

### Software Used

The following GIS software package are used for data analysis

- ARCGIS 10.5
- ERADAS IMAGINGE




## 5. Result and Discussion

### 4.1 Land Use Classification

Krishnagiri is a first grade municipal town with effect from17.04.1984.Formerly it was a town panchayat and was constituted into a municipality with effect from 1.04.1965.It has an extent of 11.50 sq. km comprising of three revenue villages namely Krishnagiri, Boganpalli (Part) and Kattiganapalli (Part) The Municipal Council, comprising of 33 ward members, is headed by Chairperson. The executive wing is headed by Commissioner, who is assisted by a team of officials including Municipal engineer, Sanitary Officer and

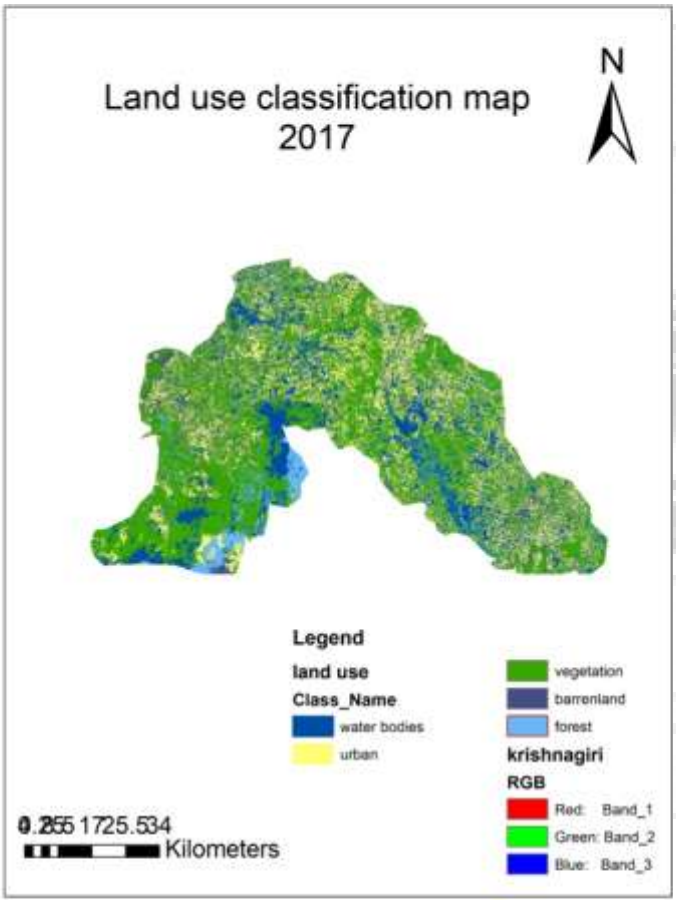
Manager. The current Municipal Council took charge in 2006.

Population in Krishnagiri town has not registered a steady decline during last four decades although it increased in absolute terms throughout the period. As per the last census 2001 population was 64, 587 with floating population of approximately 10, 000 daily. Decreasing population growth rate in last four decades can be attributed to general migration in search of employment and lesser opportunities for meaningful employment to residents of the town.

The present administrative area of Krishnagiri town extends over an area of 1150 hectares. However, in the master plan 2000, it is mentioned that the municipal area is 9.78 sq km and the land use pattern in the master plan has been given accordingly. The total developed area of the town is 347 hectares out of the town area of 9.78 sq km.

**Land Use Pattern of the District**

| Land Use pattern | Geographical area | Forest area | Land Under non agriculture use | Permanent pasture | Cultivable Waste land | Land Use Tree crops | Barren land | Current flow | Other flow |
|---|---|---|---|---|---|---|---|---|---|
| Area (ha) | 514.3 | 202.4 | 42.2 | 8.2 | 4.0 | 9.7 | 24.3 | 35.6 | 9.4 |




### 4.2 NDVI Classification

Normalized Difference Vegetation Index he NDVI values are calculated for 2017were represented in. A minimum NDVI value of -0.4 and a maximum value of 0.668966 were observed. The result of NDVI shows high vegetated area in northern part and less vegetated area in southern part. Similarly, a minimum NDVI value of -0.065911 and a maximum of 0.452611 were observed in 2017year data. The NDVI results show high vegetated area in eastern part and less vegetated area in north western part.

**Image Pre-processing**

a) Layer Stacking: The layer stacking of bands was performed on the Erdas Imagine 14 software.
b) Mosaicking the layer stacked image tiles were mosaicked and then clipped with study area shape file.
c) Image rectification was done to correct distortions resulting from the image acquisition process.
d) Projection: The image downloaded is in Universal Transverse Mercator projection and it is reprojected to Geographic WGS 84, spheroid and datum Everest.

**Image classification was performed through supervised classification using maximum likelihood classifier, which includes following steps:**

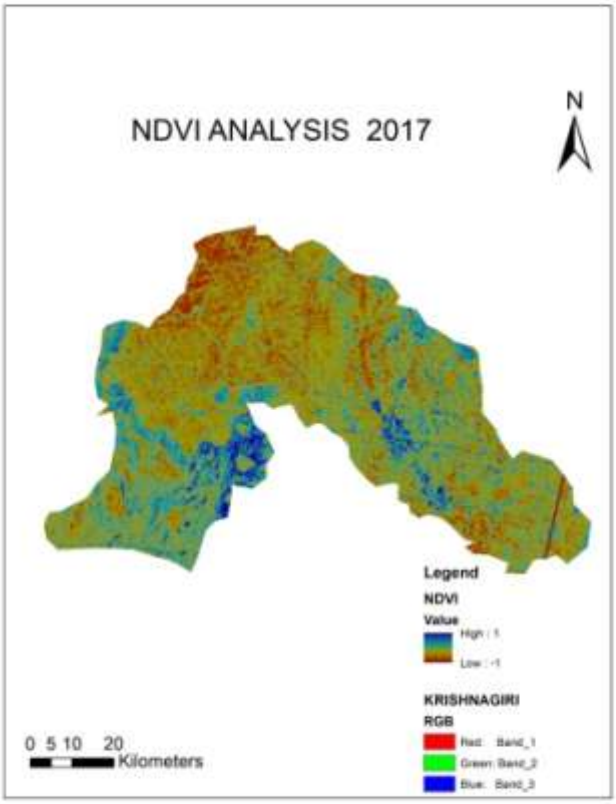
a) Selection of signature of different features (training sites) by digitization of selected area on the image. Selection of signature was based on field knowledge and existing literature and map.
b) Obtained signatures act as an input for digital image classification. On the basis of given signature, the whole study area was classified into four classes.
c) Based on the quality of results, training samples were refined until a satisfactory result was obtained.
d) Classified images were recorded to respective classes (i.e. Forest, wetland vegetation, river, agricultural field) e) The normalized difference vegetation index was calculated on ERDAS Imagine14.0 for the year 2014 and 2017 of land sat image.

The results of both the years were also compared, which show significant changes in land use/land cover over a period of time in the study area.

The pressure of increasing population and unplanned land use practices has great impact over natural land cover. The large vegetation cover has been converted into crop land, settlement and the natural wetlands are under the threat of dryness. The concern about the change in LULC has got attention after realizing the impact of change on climate and ecosystem of the area. In present study, two images (2014and 2017) have been classified on the basis of normalized difference vegetation index (NDVI), a vegetation index calculated by

$$\text{NDVI} = \frac{(\text{NIR - Red})}{(\text{NIR + Red})}$$

- NDVI is an index based on spectral reflectance of the ground surface feature. Each feature has its own characteristic reflectance varying according to the wavelength
- The decrease in NDVI value indicates the change in land use of the area mainly due to the loss of forest area because of agricultural expansion and human encroachment.
- The upper part of the area having higher NDVI value belongs to the reserve forest and vegetative land
- The lower values of NDVI were found in the rivers and wetland regions of the study area.



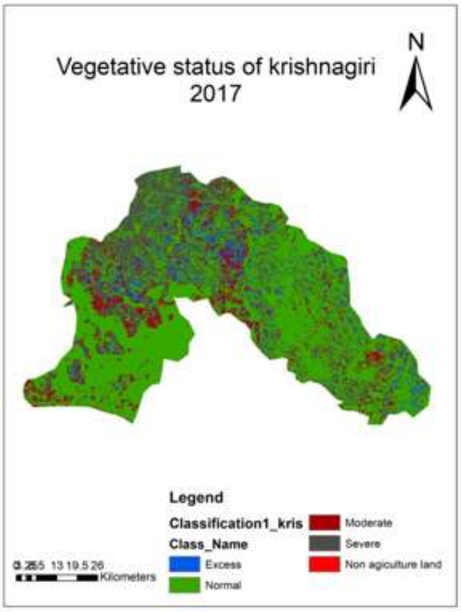

### 4.3 Vegetation Analysis

**Vegetation** is often considered to be the best single surrogate for habitat and ecosystems. Vegetation science has thus played an increasing role in wildlife and natural lands conservation and management over the years and is now among the principal tools involved in wild lands management and planning.

- Developing and maintaining a standardized vegetation classification system for krishnagiri.
- Implementing and updating best methods of vegetation assessment including sampling, analyzing, reporting, and mapping vegetation at multiple scales.
- Training resource professionals on these techniques and coordinating with other agencies and organizations to ensure a state wide, standardized approach toward collecting, reporting, and interpreting vegetation data
- Developing best practices for using these data for long-range conservation and management of natural lands in the state.
- Conducting integrated vegetation assessments throughout the state in areas with high conservation and management interest to the Department of Fish and Game and other agencies..
- Archiving and distributing quality vegetation data.
- Coordinating with other state, federal, and local agencies and organizations involved in vegetation assessment.
- Integrating standard vegetation classification systems with species distributions to encourage unified habitat assessments and conservation efforts.

Krishnagiri does not have any commercially exploitable mineral resources; however the adjacent places do have a good amount of high quality Granite mineral, which are in demand in western countries as well. The soils of the town are generally mixed or black loam, black sand, red sand, red ferruginous, or gravel in nature. The black loam is considered most fertile. It absorbs moisture from atmosphere and retains it. Considerable stretches of good loams and black clays are equal to loam in productivity. The main crops in and around the town are Paddy, Maize, Raggi, Banana, Sugarcane, Cotton, Tamarind, Coconut, Mango, Groundnut, Vegetables and Flowers. The town serves as the marketing hub for trading of agricultural produce from neighboring villages. Krishnagiri is famous for mangoes and the transactions do take place in the market during May to July, after procuring from surrounding areas. The mango markets are located at Dharmaraja Koil Street, Car stand Street, South Mada Street, Ambedkar Nagar main road, and at Salem road. The town has a weekly and a daily market to serve the commercial needs for trading of agricultural produce.

| Major field crop cultivated | Karif season | | Rabi season | | Total |
|---|---|---|---|---|---|
| | irrigated | rainfed | irrigated | rainfed | 60.4 |
| Finger millet | 0.1 | 58.6 | 0.4 | 0.4 | |
| Horse gram | | | | | |
| Paddy | 15.6 | | | 12.6 | 27.8 |
| Ground nut | 0.7 | 12.8 | 0.1 | 0.2 | 13.3 |
| Sugarcane | | | | | 3.0 |




## 4.4 Rainfall analysis

Net Recharge (R)

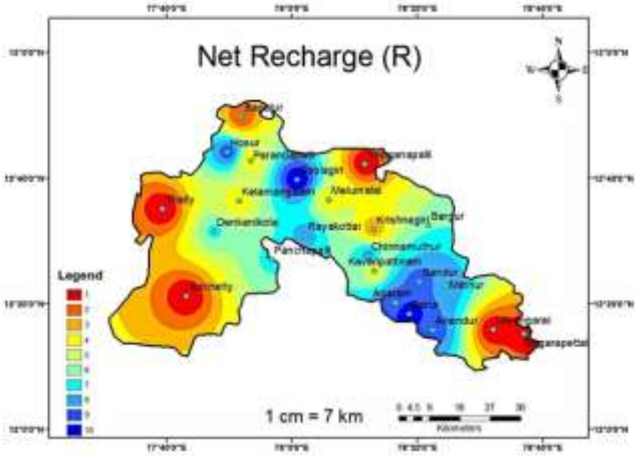
Net recharge represents the amount of water that infiltrates into the ground and reaches the water table. The map incorporates available features like slope, soil permeability and rainfall, which are important for the calculation of recharge component. A digital elevation model (DEM) of the study area was used to identify the slope % and soil permeability was calculated from soil type, average rainfall of the study area was used as a recharge index and the finalized recharge value was calculated and the ratings were assigned as presented in Table.

| Slop | | Rainfall (mm/year) | | Soil premeablity | |
|---|---|---|---|---|---|
| range | Rating | range | rating | range | rating |
| <18 | 8 | <440 | 1 | High | 8 |
| 19-36 | 6 | 440-540 | 3 | Low | 4 |
| 37-54 | 4 | 540-640 | 5 | | |
| 55-77 | 2 | 640-740 | 7 | | |
| >73 | 1 | >740 | 9 | | |

The net recharge is the amount of water from precipitation and artificial sources available to migrate down to the GW. Recharge water is, therefore, a significant vehicle for percolating and transporting contaminants within the vadose zone to the saturated zone. It carries the solid and liquid contaminants to the water table and also increases the water table.

Urban and built-up areas, open plots, and barren land were assigned a rating of 1 (Table) because it is the zone of highest runoff due to impervious surface areas. Water bodies and wetlands were assigned a rating of 8.An area with high Ground water recharge is at high risk because of the permeable pathway from the surface to the water table. So high recharge rates were assigned to these areas. Net recharge was then calculated using the following equation:

**Net recharge = (Rainfall - Evaporation) × Recharge rate.** The recharge values observed in the study area ranges from 1 to 10.The ratings assigned to net




| Range | Rating |
|---|---|
| 0-6 | 1 |
| 6-12 | 2 |
| 12-18 | 3 |
| 18-24 | 4 |
| 24-30 | 5 |
| 30-36 | 6 |
| 36-42 | 7 |
| 42-48 | 8 |
| 48-58 | 9 |
| 58-64 | 10 |

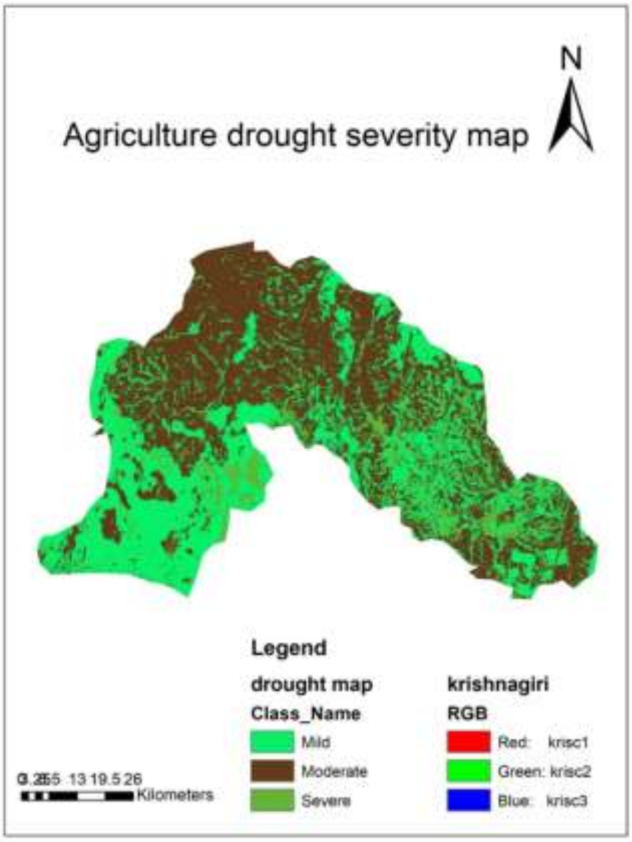
## 4.5 Drought Assessment Risk Map

The various methods of drought severity assessment were applied to all the eight taluks of the study area in meteorological, hydrological and agricultural contexts. The results are discussed and compared to select a better suited one for the study area in each of the three aspects of drought. Also, wherever possible, improvements to the existing methods are proposed and illustrated.

Agricultural drought occurs when soil moisture and rainfall are inadequate during the growing season to support healthy crop growth to maturity and cause extreme crop stress and wilt. Many previous works in this aspect focused their attention mainly on micro-implications of Agronomy of crops and not in quantification of water deficiency during the period of Agricultural drought. Rama Prasad method, as described in the previous chapter, was applied here in this study.

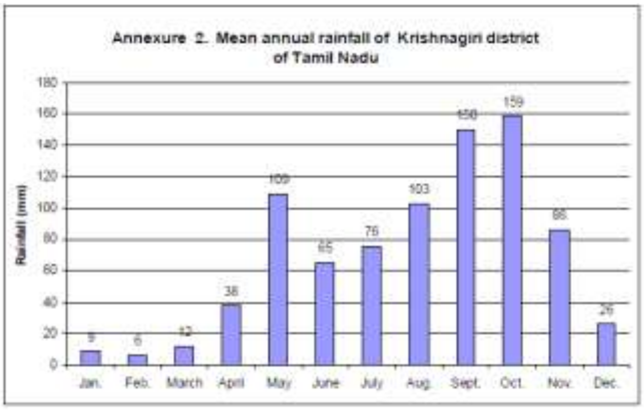
Agricultural drought severity assessment was carried out for all the eight taluks of the study area. In the case of Krishnagiri taluk, the stream flow component is added as additional input other 54 than rainfall. The cumulative deficits over all the months of each water year were calculated and their plottings with crop yields were prepared, which are presented in. The trend lines fitted to these plotted points show an encouraging positive trend with increased crop yields for the reduced cumulative deficits. From these graphs, the normal yield is calculated to be the long term average value. Depending upon the level of the crop yield of the particular time period with respect to the normal yield and the max yield for the particular taluk, the drought severity levels are assigned as per.

Also, as a measure of quantification of the drought severity levels, the coefficients of 1, 2, 3 and 4 are assigned for incipient, mild, moderate and severe droughts, which are presented in Table 4.9.Rama Prasad's approach fairly satisfies the definition of agricultural drought. It also has the carry over effect. The plottings of cumulative deficit with crop yields, presented in Appendix 6, show a good trend indicating its suitability for assessing the agricultural drought situation.




| Year | Annual rainfall | Drought assement by IMD |
|---|---|---|
| 2008 | 835.1 | 18.39 |
| 2009 | 768.8 | 8.3 |
| 2010 | 882.8 | 25.16 |
| 2011 | 738.3 | 4.67 |
| 2012 | 739.8 | 4.88 |
| 2013 | 781.7 | 10.83 |
| 2014 | 514.4 | -27.07 |
| 2015 | 571.8 | -18.93 |
| 2016 | 684.5 | -2.95 |
| 2017 | 536.1 | -23.99 |

IMD also leads to no drought, mild, moderate or severe using the annual values of rainfall. Here, the percentage deviation of rainfall from long term mean rainfall is taken as the drought quantification. IMD method takes into account only the rainfall of a particular time period, completely neglecting the antecedent conditions. Hence, a time period maybe assessed to be under severe drought even when the previous time periods received copious rainfalls.




## 6. Conclusion

From the above study area it is conclude that the seasonal analysis of NDVI land use land cover and rainfall distribution of the specific through imd dataIn this paper the (land use classification map), resulting from the Normalized Difference Vegetation Index (NDVI), and the vegetation status map derived from Land Surface Temperature (LST), were combined to produce a d map for 2017The drought regions Drought assessment map were highlighted and they cover the Anandur, Kallavi, Samalpatti, Karappattu and Singarapettai villages. From the study it is found that the villages are under threat and has to be prepared for mitigation to reduce the impacts of agricultural drought. This study concludes that real time satellite data can be well utilized for regional level agricultural vulnerability detection for early warning of agricultural drought.

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