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# Geospatial Technology for Disaster Management – A case study of Meteorological Drought Analysis

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**Introduction:** Meteorological drought is defined usually on the basis of the degree of dryness (in comparison to some "normal" or average amount) and the duration of the dry period. Drought produces a complex web of impacts that spans many sectors of the economy and reaches well beyond the area experiencing physical drought. Direct impacts include reduced crop, rangeland, and forest productivity, increased fire hazard, reduced water levels, increased livestock and wildlife mortality rates, and damage to wildlife and fish habitat. So it's necessary to analyze the drought regime to understand and to mitigate it.

**Literature review:** The Spatial and temporal distribution of rainfall and impact of successive agricultural droughts in the state of Karnataka was carried out by Nageswara Rao et.al, (2005) using METEOSAT-5 thermal infrared (TIR) data. Regression model from spatial data was run by Wipop Paengwangthong et.al., (2006) to assess the drought risk area analysis. The model showed that the well soil drainage and rainfall are important parameters for the determination drought risk area and the technique is good enough for using with GIS. The map of agroecological units for Vellore district of Tamil Nadu was prepared by Rasheed er.al.,(2009). Vegetation drought index has been calculated using NDVI values obtained from Global Vegetation Index (GVI) of NOAA AVHRR data by Bhuiyan (2004) of Aravalli region for the years 1984-2000 together with actual ground data (rainfall, temperature, ground water level) for detailed drought analysis. Singh Ramesh (2003) carried out a study on monitoring drought over India by studying VCI and TCI of NOAA AVHRR data. Jayaseelan (2002) has described the recent trends in remote sensing applications to drought assessment and monitoring with a case study on National Agricultural Drought Assessment and Monitoring System (NADAMAS).

**Objective of the study:** To assess the drought vulnerability in Koppala district through the evaluation of Rainfall Departure Index (DI) and Dry spell using South West Monsoon Rainfall data.

 

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**Study Area:** Koppal, a district located in the northern interior of Karnataka, situated between $15^0$ 09′ 00″ to $16^0$ 03′ 30″ North Latitude and $75^0$ 47′ 30″ to $76^0$ 48′ 10″ East Longitude and has an area of 8,458 sq km. It consists of four talukas Koppal, Gangavathi, Kushtagi,Yelburga. Geographically, Koppal is a stretch of rocky terrain on one side and acres of dry land on the other where in agricultural land. The river Tungabhadhra flows along the border of Koppal and Gangavathi taluk. As the district is arid zone area and is surrounded by hills belonging to Yamini Mountain series. Soil in Koppal district is mainly of moderate fertility in nature.

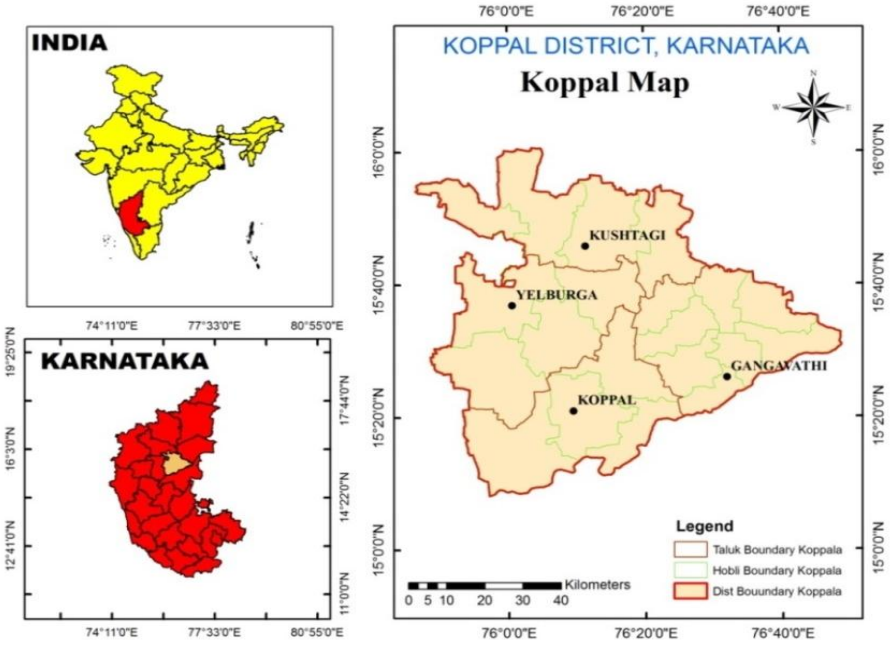
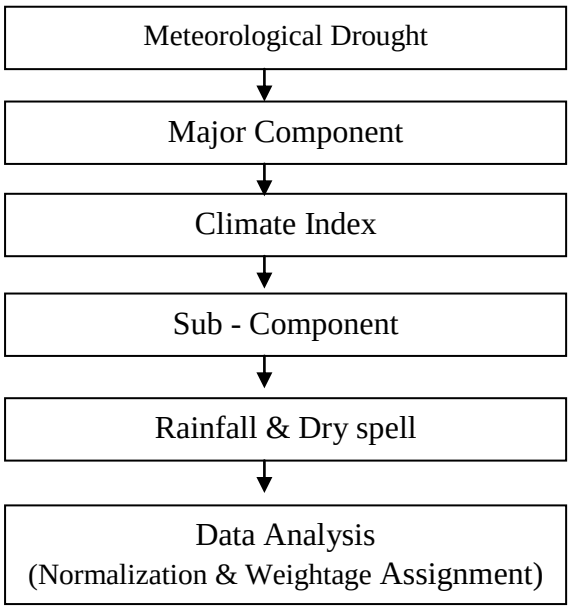



Fig.1: Location map of study area.

**Methodology:**



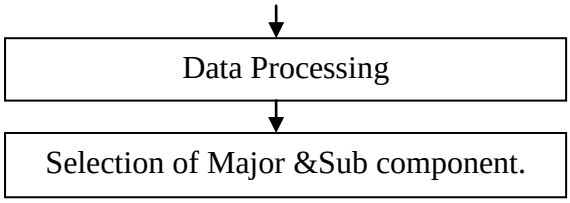



Fig.2: Flow chart of methodology.

**Data and Methods:**

Meteorological data: Precipitation and Normal potential evapotranspiration concerned to Rainfall for and daily rainfall data from all the 20 rain gauge stations of the district years ranging from 1989 to 2018 has been obtained from Karnataka State Natural Disaster Monitoring Center. Rainfall departure index was derived. Microsoft Excel Software is used for data arrangement, statistical analysis and for estimation of Departure Index. Geospatial analysis was carried out by using ArcGIS 10.1 software.

**Drought Vulnerability Analysis**

For the assessment of drought it requires the calculation of certain parameters in order to generate information, on the basis of which vulnerable areas can be prioritized. These parameters are basically those factors which are directly proportional to the cause of drought. To analysis the drought vulnerability the meteorological parameters used in this study is:

**Rainfall Deficiency Index:** The rainfall deviation (RFdev) which is expressed in percentage terms is calculated as below:

RFdev = (RFi-RFn) / RFn) * 100

Where RFi is current rainfall for a comparable period (in mm) and RFn is the normal rainfall (at least 30 years average) for the same period (in mm).30 years of rainfall data is given for all talukas of Koppala district.

Percentage departure is calculated as

$$\% \text{ Departure} = \text{Actual rainfall} - \frac{\text{Normal rainfall} * 100}{\text{Normal rainfall}}$$

Normal rainfall is average of 30 years seasonal rainfall

**Dry spell:** A dry spell is a short period, usually 4weeks (up to 3weeks in case of light soils), of low rainfall or rainfall. Thus, consecutive 3-4 weeks after the due date for the onset of Monsoon with rainfall less than 50% of the normal in each of the weeks is defined as a Dry spell. This indicator is important in that it quantifies the extent of intra-season rainfall variation which is so critical for the health of the crops and maintenance of soil and hydrological regime.

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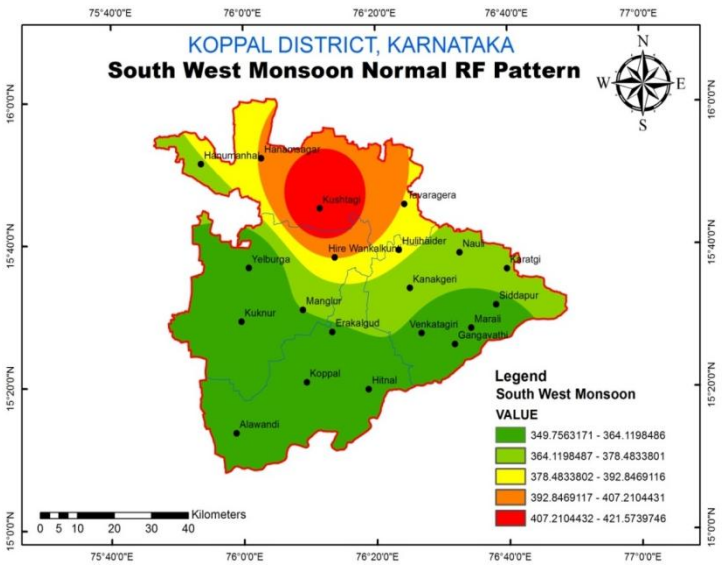
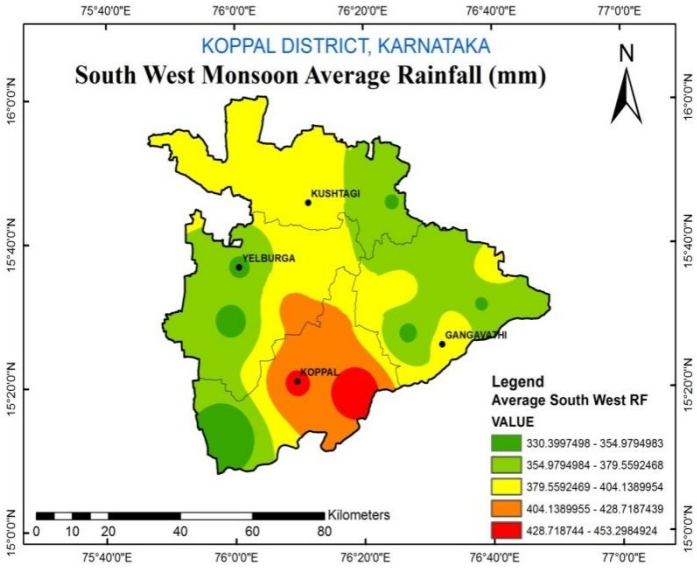
**Results and Discussion**

The South-West Monsoon rainfall varies between 350 to 420mm. It contributes 74% of the normal annual rainfall of the district. Its onset normally takes place by the first week of June over the state. The Kharif agricultural production in the state heavily depends on the timeline, quantum and distribution of the South – West monsoon rainfall.

**Rainfall Deficiency:** A departure in percentage for the rainfall is calculated from its long-term averages (average rainfall) and actual rainfall and should be considered as a basis for declaring the Drought. Rainfall Deviation: The rainfall deviation (RFdev) which is expressed in percentage terms is calculated as the departure is calculate using the formula,

RFdev = {(REI-RFn) /RFn} * 100.




Where RFI is the Current rainfall for a comparable period (in mm). RFn is the Normal rainfall (at least 30 years average) for the same period (in mm). The IMD classification of rainfall deviation is given in table.

Fig. 3: South West Monsoon Normal Rainfall.

Fig.4 : Average Rainfall of South West Monsoon.

**Weekly Percentage Departure (Dry Spell):**

Weekly Percentage departure is the percentage deviation of actual rainfall with normal rainfall.

To calculate percentage departure, weekly data of study area is taken for calculation, which is collected by TRG stations.

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Departure of rainfall (%) = ((AR-NR)/NR)*100.

Where, AR= Actual Rainfall

NR= Normal Rainfall

Normal rainfall is calculated by obtaining an average amount of rainfall that had occurred in that hobli in past 55 years. If the departure value of the week is less than the threshold value then the week is considered as dry week, if in an area the dry week persist for four or more consecutive dry weeks in kharif season and six or more consecutive weeks in rabi season, then the area falls under dry area or prone to drought.

**Weighted Overlay Analysis**

**Thematic Layers for GIS Analysis**

 

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In this analysis, four layers were used those are Dry spell, Rainfall of SW Monsoon, Landuse Landcover and Soil. The weightages were assigned with respect to their behavior and ranks were assigned to their feature/category with respect their influence on the study area for the identification of suitable drought Prone Area. The various thematic maps are converted into raster form. Therefore, each parameter is assigned a weightage depending on its influence on the Climatic Condition. Therefore, higher weightages are given to Dry Spell and Rainfall. On the other hand, when the influence of slope and in the area is comparatively less, lower weightages are given to these them. After assigning the Weightages to the themes and features, all the thematic layers were converted to raster format using spatial analyst tool of Arc GIS software.

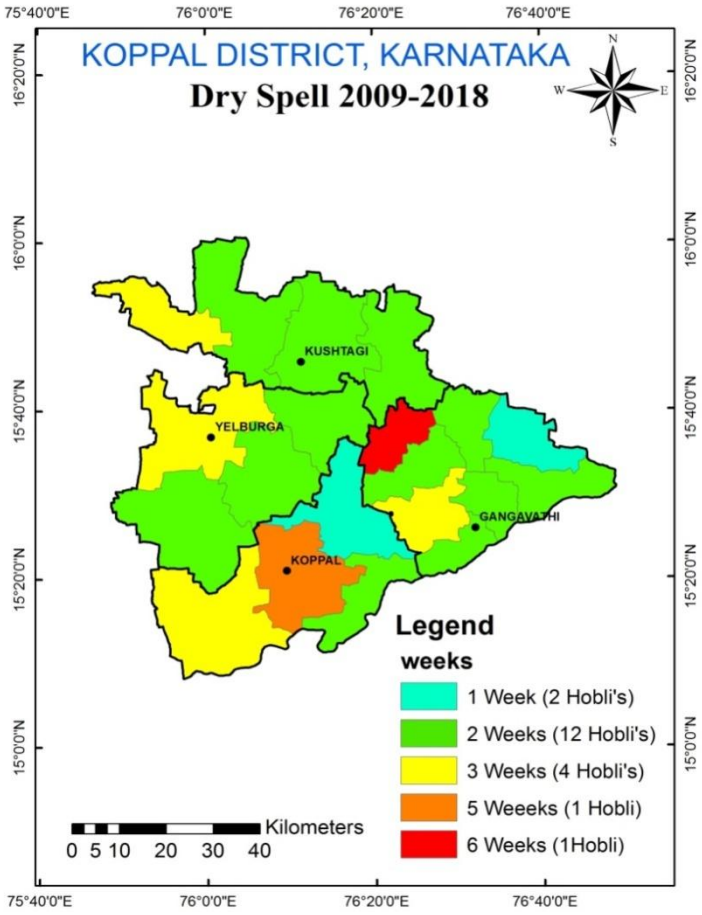


Fig.5.1: Dry Spell Map 2009-2018

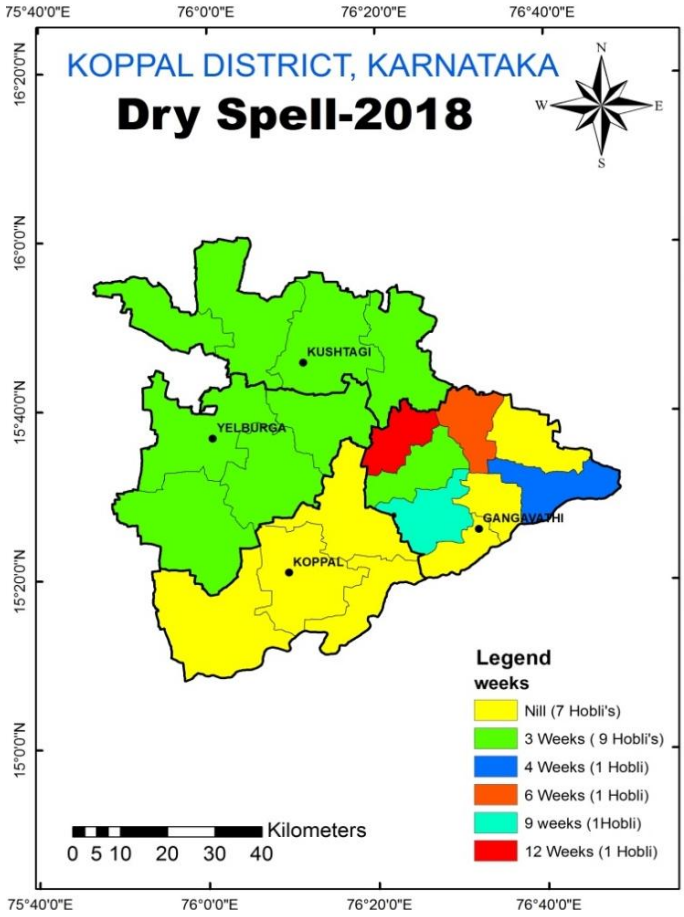


Fig.5: Dry Spell Map of 2018.

Further, different units of each theme were assigned knowledge-based hierarchy of ranking from 1 to 5. On the basis of their significance with reference to prospects 1 denoted poor prospects and 5 denoted excellent prospect of drought prone area.

**Meteorological Drought Map**

 

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This map (Fig. 6) is showing Composite drought index vulnerability taluk is in the study area. So Kustagi, Yealburga taluk's are Mild drought areas. Gangavati taluk is Moderate drought area. In the Koppal taluk is Moderate drought identified except Alawandi hobli (Red shaded region in the SW part of Fig. 6), it is a drought-affected area in the Koppal taluk. The map shows that the majority of area (72%) comes under Mild drought class, 14% of area is under No drought class, 19% of area comes under Moderate drought class, 4% of area is under Extreme drought class and 1% of area comes under severe drought class.

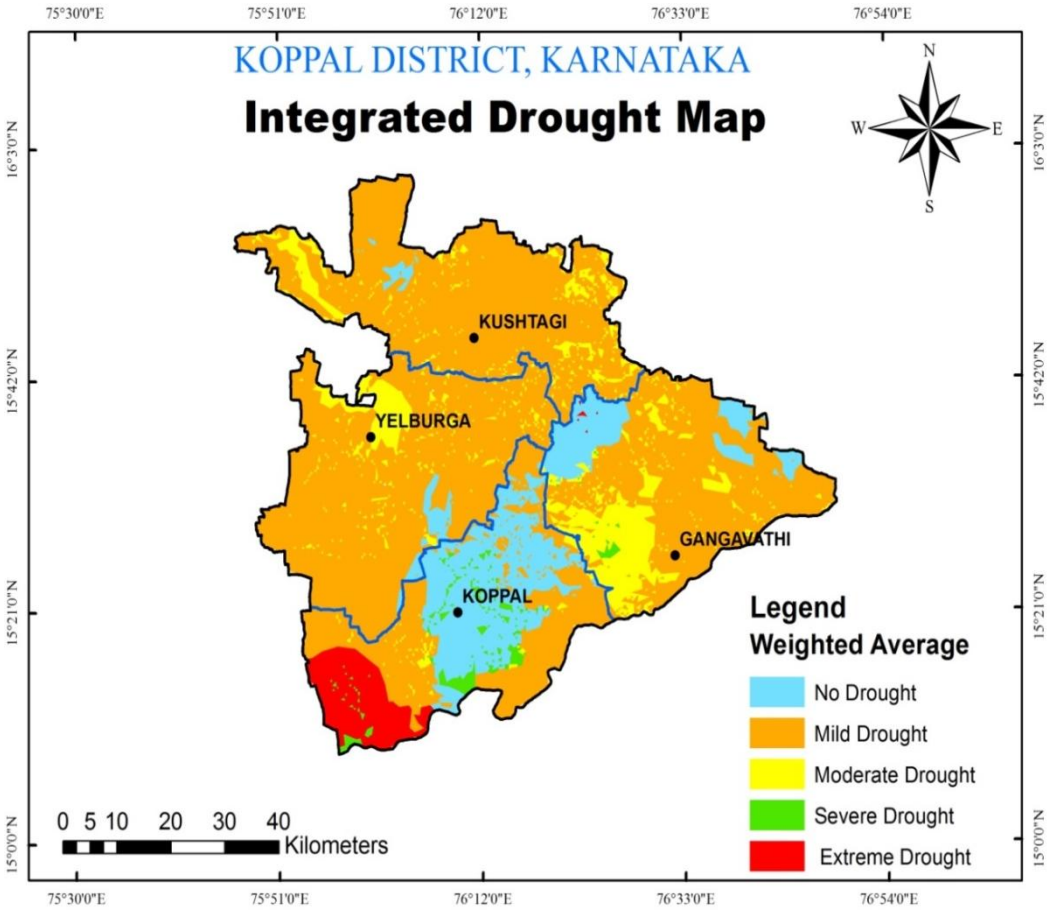


Fig 6: Meteorological drought map.

| Drought Class | Area in sq. Km | % of Area |
|---|---|---|
| No Drought | 798 | 14% |
| Mild Drought | 399 | 72% |
| Moderate Drought | 500 | 9% |
| Severe Drought | 60 | 1% |

 

| | | |
|---|---|---|
| Extreme Drought | 224 | 4% |

Table 1: Meteorological drought table

## Conclusion

Some part of Koppal district has sufficient water availability for agriculture and domestic purpose. Under this study, components and subcomponents / indicators that are relevant to drought were considered over a period and analysed to develop the composite index of drought. Out of three fundamental types of drought, study focused on the meteorological drought. For this analysis Rainfall and Dry spell of south-west monsoon is used. In four taluk's of three taluk's are under Mild drought class, (Gangavati,Yalburga, Kustagi) and 12 hobli's are under Mild drought class, four hobl's are Moderate drought class, three hobli's are under No drought class, one hobli's is under Extreme drought class i.e, Alawandi hobli. From this analysis it is clear that Koppal district is not prone to meteorological drought except one hobli. Normal rainfall is 612.8 (mm) in the area, so this area so much area's receive a sufficient rainfall. Yalburga taluk receive the lowest rainfall of 560.4 mm. whereas Koppal taluk receive the highest rainfall 665.9 mm in the district.

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