RESEARCH ARTICLE OPEN ACCESS

# Drought Vulnerability Detection And Mapping In Thrissur District, A Part Of Southern Western Ghats, India- Using Geoinformatics

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**ABSTRACT**
Drought is an insidious phenomenon. Unlike rapid onset disasters, it tightens its grip over time, gradually destroying an area. In most cases, drought can last for many years .The impacts of drought vary from lack of adequate drinking water, loss of vegetation, loss of farmland, loss of livestock and loss of life due to famine or dehydration. Drought can be divided into four categories of meteorological, hydrological, agricultural and socio-economic. In this study the vulnerability of drought in Thrissur district is investigated by providing vulnerability maps which demonstrates spatial characteristics of drought vulnerability. Thrissur is also called as “cultural capital of Kerala”, south India. The modern technology used in present system for drought prone area identification is remote sensing and geographic information system. Drought is one of the climatic, natural disasters, having an impact on both the economy and the society, with its long-standing problems. Drought by nature is a result of inter-related parameters. The study is based on the concept that the severity of the drought is a function of rainfall, hydrological and physical aspects of the landscape, leading to meteorological, hydrological and physical drought. In the present study a Geographic Information Systems (GIS) and remote sensing -based tool for drought vulnerability assessment at a micro level has been developed. The result of this study can be used for preparedness planning and for allocating resources for facing droughts in this region.
**Key words:** Drought, Geographic Information System, Remote Sensing, Vulnerability Maps

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Date Of Submission:16-11-2018 Date Of Acceptance:30-11-2018

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## I. INTRODUCTION

Drought is considered by many to be the most complex but least understood of all natural hazards, affecting more people than any other hazard (Abdel Aziz Belal ,2014). Drought risk is a product of a region’s exposure to the natural hazard and its vulnerability to extended periods of water shortage (Nishadi,2015). drought is a normal, recurring feature of climate ; it occurs in virtually all climatic regimes. Drought occurs on high as well as low rain fall areas. Drought is a temporary phenomenon, in contrast to aridity, which is a permanent feature of the climatic and is restricted to low rainfall areas. Drought is a phenomenon occurred by reduction in the amount of precipitation over time, usually a season or more in length; other climatic factors are also associated with it in many regions which aggravate the severity of the event. It also related to the timing, effectiveness of the rains. Thus, each drought year is unique in its climatic characteristics and impacts (somya rajawat, 2016). Technology of GIS-MCE can combine multiple source information associating with agriculture meteorological drought risk and achieve measurable result. Satellite remote sensing provides a synoptic view of the land and a spatial context for measuring drought Impacts, which have proved to be a valuable source of spatially continuous data with improved information for monitoring vegetation dynamics(Elham Asrari et al, 2014). GIS is an information system that is designed to work with data referenced by spatial or geographic coordinates. GIS combined with MCE (Multi-Criteria Evaluation) can achieve measurable evaluation of drought risk. Karamouz et al, 2015, introduced Technologies for evaluating agriculture meteorological drought risk with GIS-MCE. The results indicated that technology of GIS-MCE can combine multiple source information associating with agriculture meteorological drought risk and achieve measurable result. Satellite remote sensing provides a synoptic view of the land and a spatial context for measuring drought Impacts, which have proved to be a valuable source of spatially continuous data with improved information for monitoring vegetation dynamics. Ganesh et al, 2018 used the newly developed LULC methodology to determine the effects of drought in specific classes with great precision.

According to Jerrod et al, 2016, Earth observation satellites could prove useful for the assessment and evaluation of drought effects in forest ecosystems. The objective of his study were to briefly review the existing sources of remote sensing data and their potential to detect drought damage; to review the remote sensing applications and studies carried out during the last two decades aiming at detecting and quantifying disturbances caused by various stress factors, and especially those causing effects similar to drought. If nations and regions are to make progress in reducing the serious consequences of drought, they must improve their understanding of the hazard and the factors that influence vulnerability. integrated drought information system that incorporate climate, soil, and water supply factors such as precipitation, temperature, soil moisture, snow pack, reservoir and lake levels, ground water levels, and stream flow. All drought prone nations should develop national drought policies and preparedness plans that place emphasis on risk management rather than following the traditional approach of crisis management, where the emphasis is on reactive, emergency response measures. Crisis management decreases self-reliance and increase dependence on government and donors. India is predominantly an agrarian country as more than 70% of its population is dependent on agriculture. Due to the vagaries of rainfall more than 68% of the net sown area in the country is drought prone, out of which 50% is severe in nature. The country experiences drought every 2 to 3 years in one part or other (Jeyaseelan et al., 2001). The nation experienced phenomenal drought condition in the years 1972, 1979 and 1989 (C.S.E, 2001). UNICEF reported that 'an estimated 130 million people – 15 percent of the population – in more than 70,000 villages and 230 urban centres were at risk due to severe drought and resultant crop failure in India during years 1998-2000 (Subin, 2015). The prime aim of this study was to develop a method for geospatial prognosis of drought hazards using satellite remote sensing and ground-based information through the application of geographic information system (GIS).

## II. MATERIALS AND METHODS

Drought vulnerability was assessed by eighteen parameters like, contour, drainage density, elevation, geomorphology, land use, spatial distribution of rain fall, rock group, rock type, soil depth, soil drainage, soil slope, soil texture, spatial distribution of water level, drainage network, spatial distribution of temperature, road network, tin, and watershed.The different sources of data used are include National Aeronautic Space Agency (NASA) operates a series of Landsat satellites which carries sensors like MSS, TM, ETM, ETM+ etc. and collect global data. Landsat ETM data is used for deriving NDVI of the study area. The images are downloaded from Global Land Cover Facility (GLCF). The area falls under two tiles, which are mosaicked in Erdas Imagine. Geomorphology map, Soil map, Land use land cover map, Rocks and minerals map, Geohydrology map prepared by Geological Survey of India were also used for the identification of potential ground water zone and drought prone areas. Slope and elevation of the study area are generated from Shuttle Radar Topographic Mission (SRTM) data. The tiles are downloaded from Global Land Cover Facility (GLCF).Meteorological data was collected from the meteorological department. Ground water level of an area is important in determining the most available area of ground water and an indicator to drought. If the depth to ground water level (DGWL) is less, then the availability of ground water is high. But when the DGWL is high it may be an indicator of drought. Drought may result in the reduction of ground water level.

The Survey of India toposheet and Landsat ETM+ satellite image were used for the preparation of all the thematic layers. These layers were used for the identification of ground water potential zone and drought prone areas. Various thematic maps like geomorphology, depth to water level, slope, rainfall, drainage density, landuse/landcover, NDVI, geohydrology, soils and rocks & minerals were prepared. The weighted overlay analysis technique was employed to determine the drought prone area and potential groundwater zone identification. The weightages of individual themes and feature score were fixed and added to the layers depending upon their suitability to hold groundwater and potential and to cause drought. Higher values of the scores indicate higher possibilities for groundwater availability and drought proneness. Spatial Analyst extension of ArcGIS 10.3 was used for converting the features to raster and also for final analysis. In this method, the total weights of the final integrated map were derived as sum or product of the weights assigned to the different layers according to their suitability. The following numerical weighting scheme was used to assess the relative drought hazard potential of each factor. Each class of seven hazard factor map has been assigned a relative weight as 1, 2, 3… with 1 being considered least significant in regard to drought hazard and highest number being considered most significant. The choice of weights was based on an informed assumption on relative contribution of each class to drought hazard. The given weights were normalized for each map so that difference in the number of classes in all maps can be brought to same scale with value of weights in the range of 0 less than 1. For normalization, weights of each class were recalculated by dividing the class weight by cumulative weight of all the classes. All the maps in the polygon (vector) format were converted into raster format with a grid cell size of 25 m. The grid cell size of 25 m was selected for deriving output map with the high spatial accuracy as the drought scenario changes at short spatial dimension in undulating plateau terrain.

The weighted maps were cumulated by spatial join in GIS using the parameters selected for each types of drought. As all the weighted maps in GIS database were co-registered with their respective cell coordinates, weights of individual cell in all input maps were joined by adding their normalized values in the attribute table. A high numeric value within each category was assumed to be indicative of a geographic area that is likely to be more susceptible to drought. The resulting map was reclassified into five classes, identifying geographic areas with 'very low', 'low', 'moderate', 'high', and very high hazard using natural break method. Finally, the village vise drought vulnerability condition has been assessed by superimposing the village map over the drought prone area maps.

## III. RESULT AND DISCUSSION

Thrissur is one of the important historical cities of Kerala, which is known as the cultural capital of Kerala. The district has an area of 3032 sq.km and is located in the central part of the State. Based on the acquired information from several literature and availability of data, drought hazard map was generated by the integration of different thematic layers like drainage density, geomorphology, land use, spatial distribution of rainfall, rock group, rock type, soil depth, soil drainage, soil slope, soil texture, spatial distribution of ground water level, drainage net work, spatial distribution of temperature and water shed map.

Drought condition in the Thrissur district is reduced by different service such as canal irrigation and opening of dam. People use this water for their farm land, ground or the area where water is needed in a large amount. Which help to replenish the ground water and maintains the moisture content in the soil.

The result of the study shows that GIS and remote sensing could be successfully employed in identification of drought vulnerable areas in Thrissur. The general trend observed in the present study is increase in the drought risk area due to the decrease in the forest cover. The drought vulnerability scenario developed by combining all the seven criterias indicated that very high and high chances of drought vulnerability is more pronounced near to hilly without vegetation regions. Areas under low drought hazard are mainly found over ultisol soil, situated over regions with relatively higher slope (> 33 degree) in the vicinity of forest areas that receive higher rainfall (2,600-2,700mm)

The rain shadow effect in the eastern side is due to the high and steep hills on the Western region and over lower slope areas (< 26 degree) with low and moderate drainage density and, inceptisol type of soil, landuse type in this region is agriculture. Geomorphologically, the areas over planation and structural cum denudational hills are under high drought hazard, whereas over linear structural hills, very high drought hazard exists.

## IV. CONCLUSION

Drought is considered by many to be the most complex but least understood of all natural hazards, affecting more people than any other. It is a normal feature of climate and its recurrence is inevitable.

Drought differs from other natural hazards in several ways. First, drought is a slow-onset, creeping natural hazard. Its effects often accumulate slowly over a considerable period of time and may linger for years after the termination of the drought event. Second, the absence of a precise and universally accepted definition of drought adds to the confusion about whether a drought exists and, if it does, its degree of severity. Third, the impacts of drought are non structural and typically are spread over a larger geographical area than are damages resulting from other natural hazards. Drought results from a deficiency of precipitation from statistically normal (long-term average) amounts that, when extended over a season or especially over a longer period of time, is insufficient to meet the demands of human activities. All types of drought originate from a deficiency of precipitation those results in water shortages for some activity (such as crop production) or for some group (such as farmers). The maximum temperature ranges from 29.3 to 36.2$^0$C whereas the minimum from 22.1 to 24.9$^0$C. The average annual maximum temperature is 32.30$^0$C and minimum temperature 23.3$^0$C. Generally March and April months are the hottest and November, December, January and February months are the coldest.

The present study using Remote Sensing and GIS techniques has helped in identifying drought vulnerable area which is classified into Very high, high, Moderate and Low. Such a zonation assumes importance in planning strategies for effective management of the water resources. In this study integrated Remote Sensing and GIS can be used as a powerful and an effective tool for planning in local and government organizations.

GIS can play a key role in documenting natural condition, documenting the impacts on resources, exposing conflicts, and the revealing cause effect relationship. The ecological degradation of the area had begun since the colonial government's intervention through its forest policies and it became acute since it had been integrated with the Kerala state in 1957 The major activity that destroyed the eco-system of a deep forest into a desert like landscape is the conversion of forest into arable land by settlers. Deforestation and the introduction of non-eco friendly agriculture practices have degraded the vegetation cover almost beyond regeneration. With the loss of vegetation, subsequent massive soil erosion changed the local climate and made rainfall erratic. The reason for introducing the chance of drought is not due to the natural causes but due to the immoral activities that had taken place and changes in the life style of modern humans causing a widespread disaster in the study area. It’s a great shame to human society that we are exploiting our mother earth for our selfish needs.

## ACKNOWLEDGEMENT

We express our sincere gratitude to INDIAN COUNCIL OF SOCIAL SCIENCE RESEARCH (ICSSR), New Delhi for the financial support for the project

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Subin K. Jose "Drought Vulnerability Detection And Mapping In Thrissur District, A Part Of Southern Western Ghats, India- Using Geoinformatics "International Journal of Engineering Research and Applications (IJERA) , vol. 8, no.11, 2018, pp 32-35