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RESEARCH ARTICLE

INTEGRATED WATER MANAGEMENT STRATEGIES THROUGH DROUGHT HAZARD MAPPING AND WATER QUALITY MODELLING USING GEOINFORMATICS

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ABSTRACT

Drought is one the climatic as well as natural disasters common all over the world. Droughts have disastrous impact on the economy and can affect the largest segment of the society. 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)-based tool for drought vulnerability assessment at a microlevel has been developed. Groundwater is an integral part of the environment, and hence cannot be looked upon in isolation. There has been a lack of adequate attention to water conservation, efficiency in water use, water re-use, groundwater recharge, and ecosystem sustainability. In the present study an attempt has been made to unleash the power of GIS as an integrating tool for accurate representation and analysis of groundwater quality data. The study area was chosen mainly to know the groundwater quality in Palakkad district. The power of GIS is used for the preparation of ground water quality index of the study area. The present study aims to identify the drought hazard prone areas of different time period and also predict the drought vulnerable area to the next season using the present data and mathematical models. The drought vulnerable area and water quality index map is used for the public for the better management of water resources and drought management.

INTRODUCTION

Drought is a recurring natural phenomenon that has overwhelmed civilization through out the history. It affects the ecosystem and all the sectors of society from agriculture to transportation and event to modern industries. Drought has long been accepted as one of the most dangerous cause of human misery (Wilhite, 2000). It has today become the worst natural disaster that annually claims billions of dollars of loss for the affected community. Its ability to cause widespread misery is actually increasing day by day. Drought hazard is known as a "creeping hazard**"** (Coppola, 2007) and results in serious economic, social, and environmental impacts. Drought is a normal part of climate; an extreme climatic event, often described as a natural hazard (Wilhite, 2000). Dynamic nature of drought with complex phenomenon having multiple effects from a major challenge in planning, monitoring, predicting, assessing impacts and offering solutions to drought hit areas. Because of these complexities, high quality data and improved tools to capture the spatial and temporal dimensions of drought various satellite platforms and the technology available for analysis such as geographic information system and other integrative tools like global positioning systems are needed. Satellite derived drought indicators calculated from satellite-derived surface parameters have been widely used to study droughts. Normalized Difference Vegetation Index (NDVI), Vegetation Condition Index (VCI), and Temperature Condition Index (TCI) are some of the extensively used vegetation indices (Zhao, 2008).

The chemical composition of groundwater is a measure of its suitability as a source of water for human and animal consumption, irrigation, and for industrial and other purposes. The groundwater resources are under great risk due to the drastic increases in population, modern land use applications (agricultural and industrial) and demands for water supply, which endanger both water quality and quantity (Babiker, 2007). The definition of water quality is therefore not objective, but is socially defined depending on the desired use of water. Different uses require different standards of water quality. Therefore, assessing and monitoring the quality of groundwater is important to ensure sustainable and safe use of these resources for the various purposes. Many researches in India and abroad have assessed the groundwater quality to find its suitability for drinking and irrigation purposes (Melian,1999; Hrkal, 2001; Srinivas, 2005; Babiker, 2007.). When water comes down to the earth as rain it begins its journey in a highly pure form but as it falls through the air it

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begins dissolving gases and entrapping particulate matter present in the air. The nature and concentration of the constituents that the water acquired determine the quality of water (Reza, 2010).

METHODOLOGY

The present study adopt GIS and field based methodology and it include collection of spatial data layers, field varification, analysis and satellite data interpretation. The different layers used for the analysis of drought hazard map include landuse and NDVI (Normalised Difference Vegetation Index) prepared from LISS IV satellite image (may 2010), Geology map, soil map, Geomorphology map, Rainfall map (Rainfall data is spatialy interpolated by using geostatistical analyst and prepare rainfall map),Depth to ground water map (depth to ground water level are analysed in the field in different stations and the data are interpolated using Inverse distance function of Spatial analyst extention of Arc GIS),drainage density map, Geohydrology map , rocks & minerals and slope map was prepared. These different layers are used for the analysis. Weighted overlay analysis technique was employed to determine the drought prone area. The weight ages of individual themes and feature score were fixed and added to the layers depending upon their role to cause drought. Higher values of scores indicate higher possibilities .Spatial Analyst extension of ArcGIS 9.3 was used for converting the features to raster and also for final analysis.

The various physico-chemicals attributes of water samples such as pH, Electrical Conductivity (EC), Total Hardness (TH), Calcium (Ca), Magnesium (Mg), Carbonates (CO3), Bicarbonates (HCO3), Sodium (Na), Potassium (K), Chloride (Cl), Nitrate (NO3), Sulphates (SO_4), Flouride (F) etc were collected from CGWB. The different locations of sampling stations with its corresponding physico-chemical analysis values were imported into GIS as point layer. All the three years of data are imported like this. The spatial distribution of each water quality parameters are generated by using the 'Inverse Distance Weighted' tool in the spatial analyst toolbox of Arc. Map. This spatial distribution of the selected water quality parameters are used to generate water quality index (WQI) of the study area. Water quality index (WQI) is defined as a technique of rating that provides the composite influence of individual water quality parameter on the overall quality of water. WQI turns the complex water quality data into information that is understandable and usable by public. The BIS and WHO standards for drinking have been considered for calculation of WQI. The calculation of WQI is with the help of raster calculator (Kavitha *et al*., 2010)

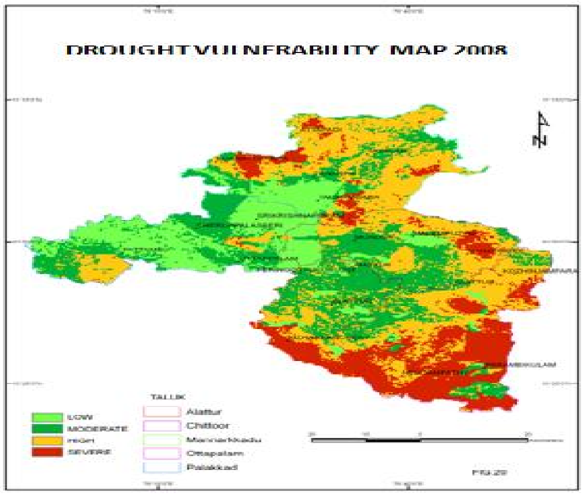
The Water Quality Index (WQI) is calculated as follows:

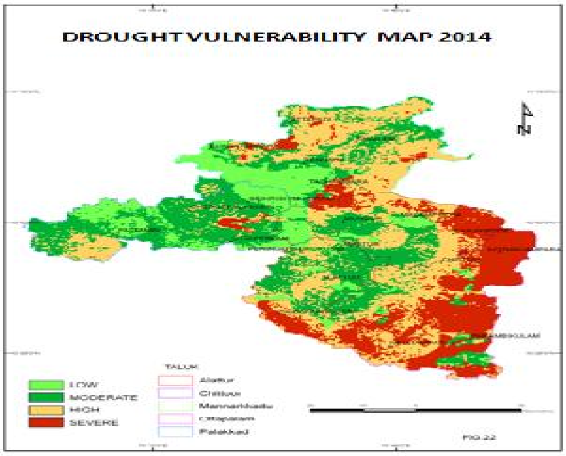
$$WQI= \sum^{n}_{i=1} (Qi\ Wi) / \sum_{i=1} Wi$$

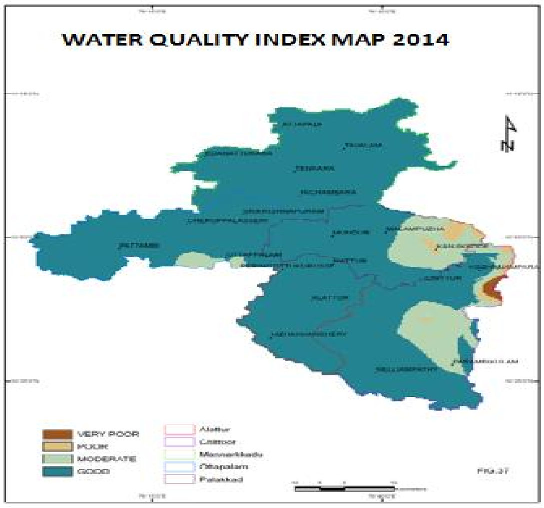
Where, Qi is the sub index of i^{th} parameter. Wi is the unit weightage for i^{th} parameter, n is the number of parameters considered. Spatial distribution of each parameter generated. All such maps were integrated and generate water quality index map of the study area for three years

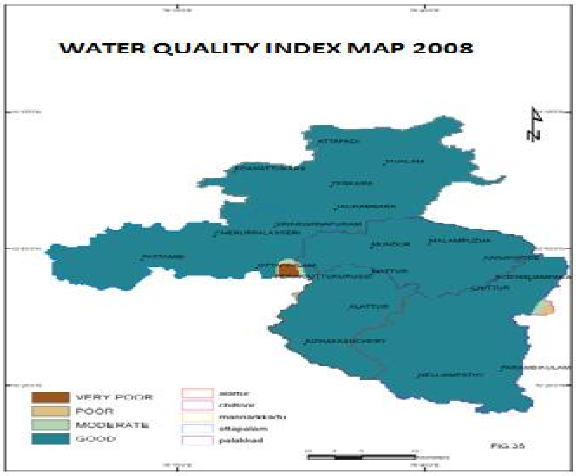
RESULT AND DISCUSSION

The drought severity maps of 2008 and 2014 are generated which gives a clear understanding of the spatial changes of drought and its extreme link towards the water level depth and rainfall. The drought severity maps of 2008, and 2014 are represented in the figure. Careful analysis of the three year drought analysis shows an increasing pattern of drought in the district.









This may be due to the changing climatic parameters, land use pattern and human exploitation. The analysis this drought vulnerable maps help to identify the drought hit areas in the district. The map shows four different classes as low, moderate, high and severe. The reason for the increase in drought is mainly the changing cropping pattern, Over dependence in groundwater for domestic, industrial and irrigation purposes also exacerbate the drought condition in the district. The temperature in the region is also ever increasing.

The values of selected parameters of groundwater quality data in pre, during, and post monsoon seasons and BIS and WHO water quality standards were used for calculating water quality indices. Quality status is assigned on the basis of calculated values of water quality indices to include the collective role of various physicochemical parameters on the overall quality of drinking water. WQI computations were made from the equations. The spatial distribution of the WQI map generated for the study area during 2008 and 2014 are shown the figure. The Water quality map show four classes like very poor, poor, moderate and good quality areas. The analysis of the of WQI map shows that in 2014 water quality of the district are comparatively not suitable than in 2008. This may be due to the climatic as well as human activities.

CONCLUSION

Water is a finite and vulnerable resources essential for the sustain of life, development and the environment. The increasing demand on water creates conflicts all around the world. The integrated water resource management is one of the widely accepted approaches which cater efficient, equitable and sustainable development and management of water resources. As the drought is dynamic in nature, which builds over a time, timely and reliable information is essential for effective drought monitoring and management. Satellite remote sensing provides multi-spectral, multi spatial and multi temporal data useful for drought monitoring, assessment and management.

The present study is a comprehensive evaluation and integrated analysis of drought, which has been carried out by using satellite based remote sensing and GIS techniques. Adverse climatic conditions may further convert these high drought prone areas to severe drought areas. Some action plans comprising of drought proofing works, employment generation programmes and social security programs were discussed for managing the drought prone areas. GIS based methodological framework developed as part of this study can be effectively used elsewhere in groundwater quality monitoring and their management. Spatial interpolation maps are used for the water quality monitoring process of the area and it is useful for the decision makers to take better decision for the water quality management. The present water quality index map and water quality data will serve as a baseline data for the future development and management of water use strategies in the area.

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