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Spatial assessment of groundwater quality using water quality index for Nashik District in Maharashtra

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Abstract

Groundwater is the most important source of water for drinking, domestic, industrial and other purpose. The present study has been focused on spatial groundwater quality assessment in Nashik District. GIS based WQI was computed for spatial analysis of groundwater using 61 groundwater samples. It can help to make the policy for upgrading in groundwater quality. The WQI shows that 59% groundwater samples fall into 'excellent water' (25%) and 'good water' (34%) and can be used directly for consumption for different purposes. Remaining groundwater samples (41%) come under 'poor' to 'unfit for water drinking' categories and need to be processed before its utilization.

Keywords: Groundwater, water quality index, Nashik

Introduction

Groundwater contamination has become one of the most serious problems in the world in the last decades. Over 1.2 billion people in the world cannot have access to clean water to meet their basic needs and 2.6 billion people do not have access to basic sanitation facilities. More than 27 nations are facing water scarcity and 19 nations are considered as water stressed (WRI, 2004). In fact, there is no real water shortage, but that it is a matter of maintaining water quality, managing and distributing the sources better (Biswas and Tortajada, 2010). Imbalance between available and use of clean water, groundwater depletion and pollution, etc. are commonly identified problems in water resources management. Water quality is one of the major environmental problems in India. It depends on water recharge, precipitation, surface water, physicochemical parameters, etc. (Tiwari et al., 2017). Population growth, economic development, floods, droughts and water environment related issues, etc. have aggravated water stress in the developing countries (WHO, 2007). World Resource Institutes (WRI) reported that more than half of India's total area is facing extremely high stress of water. About 1123 billion cubic meters (BCM) usable water is available in India. Out of which, the share of ground water is only 38.55% and remaining is surface water (61.44%) (WRI, 2004). Agriculture-related problems like intensive cropping pattern, over irrigation, over use of chemical fertilizers and pesticides are observed in various watersheds. The soil erosion and water resources depletion are found to be major problems mainly in upstream areas. In such a circumstance, innovative water technologies, management systems and institutional arrangements are necessary to achieve the multiple objectives of equity, environmental integrity and economic efficiency. Therefore, the present study was focused on quality of groundwater resource in Nashik District.

Central Water Commission of India (2016) has reported that the ground water level has been decreasing in India due to unchecked exploitation and scanty and erratic rainfall. The Godavari Basin in the Nashik District has been facing the problems of ground water quality and droughts. It is one of the important natural sources for drinking, domestic, agricultural and industrial activities. The ground water is clean and less polluted compared to surface water. The quality and quantity of groundwater along the Godavari Basin has been depleting due to the increasing use of groundwater to meet the requirement of drinking water for a growing population and scanty and erratic rainfall, prolonged discharge of industrial effluents, domestic sewage, solid waste, excessive use of water and agro-chemicals i.e. herbicides, pesticides, inorganic fertilizers and organic compounds (Dinkaa, 2015). Apart from this, quality of the groundwater has impaired due to surface contamination sources, mineral dissolution, ion exchange, etc. (Tiwari, 2017). Consequently, the level and quality of groundwater has been depleting over the years and it is not sufficient to meet the needs of ever growing population in the study region. It is noticed that agriculture in the Godavari Basin of the Nashik District is more developed towards the east of the district. Excessive and injudicious use of pesticides and fertilizers has further impaired the quality of groundwater along the Godavari Basin. As a result of impure and unclean groundwater human hygiene and health has been endangered. FAO and WHO (2008) has reported that about 80% of the diseases are caused by contaminated water. The polluted water does not only lower the quality of water but also affects human health, economic development, and social wealth. Therefore, the proposed study would be devoted to assessment of groundwater quality of Godavari Basin in Nashik District for suitability of drinking purpose.

Study area

The study area lies between 19°35'00" N and 19°49'30" N latitudes and between 73°31'30" E and 73°52'15" E longitudes distributed upstream in Godavari River. The Godavari Basin covers the Tahasils of Nashik District namely Trambakeshwar, Nashik, Niphad and Yeola. River Darna is right-bank tributary of the Godavari. The Kadva is right-bank sub-tributary of the Darna and the Waki, the Unduhol and the Valdevi are left bank sub-tributaries. The Darna dam is constructed on the River Darna and The Gangapur dam is constructed on the Godavari. The rainfall varies from 3178 mm at Western boundary to 750 mm at Eastern border of Nashik District. The slope also varies from precipitous (West) to gentle (East). The deep soils are distributed on a gentle to moderate slope along the Godavari Basin at Eastern side and most of the Western areas are covered by thin and shallow soils with steep to precipitous slope. Parent rock is observed at western side of the study region. Agriculture is the main economic activity along Godavari Basin. Groundwater is the major source of irrigation, drinking and other domestic purposes.

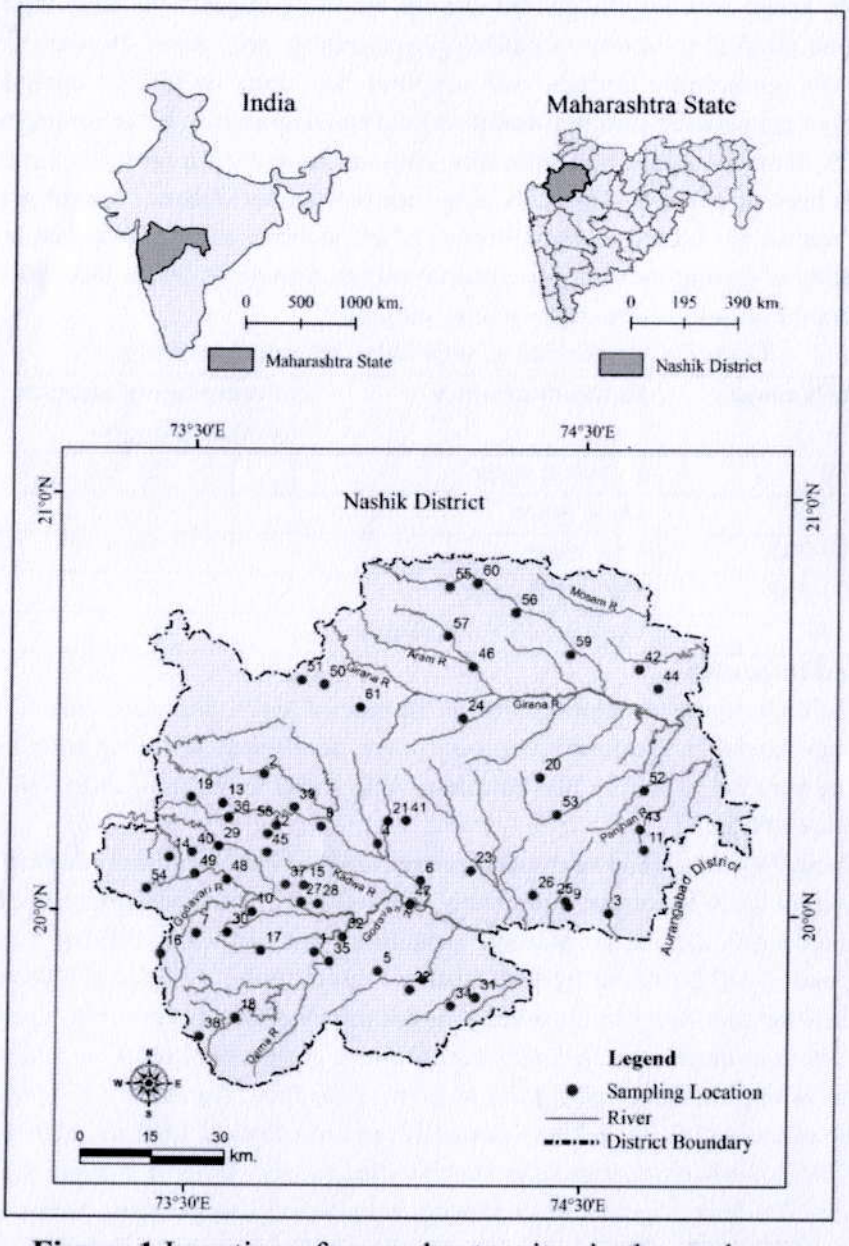

Figure 1 Location of groundwater sites in the study area

Methodology

The proposed study would pass through seven steps in order to fulfil the above mentioned objectives. 1) Data acquisition i.e. groundwater samples 2) sites selection for sample collection i.e. groundwater samples, ground information etc., 3) laboratory analyses, 4) preparation of basic maps, 5) water quality index

The entire work may be divided into the following stages. The basic information like different physical parameters including physiographic, soil, water, etc were procured from various government records and suppliers for water suitability analysis. The assessment of groundwater quality is based on field measurements of water parameters such as pH, TDS, fluoride, nitrate, iron, alkalinity, chloride, hardness and turbidity. Final output maps have been prepared in ARC GIS using interpolation techniques. Stratified random sampling method has been used for collection of groundwater samples based on land use. The suitability of groundwater has been determined based on water quality index (WQI) and multi-criterion evaluation method for drinking purposes.

Table 1: Classification of WQI range and category of water

WQI range	Category of water	Percentage of samples in this category
<50	Excellent water	25
50-100	Good water	34
100-200	Poor water	36
200-300	Very Poor water	03
>300	Unfit for drinking purpose	02

Results and Discussion

The WQI determines water quality on the basis of hydro chemical elements in water into different classes i.e. excellent water, good water, poor water, very poor water and unfit for drinking purposes (Table 1). The calculated WQI value varies from 28 to 328 with an average value 99 (Fig. 2).

About 25% of groundwater samples are classified into the class 'excellent water' and observed in the Western part of the study region (Fig.2). The concentration of all hydro chemical parameters in these groundwater samples are less and within maximum desirable limit proposed by BIS. About 34% of analyzed groundwater samples are observed in Western and Northern-East part of the study region and classified into the class 'good water' (Fig. 2). The concentration of hydro chemical is more compared to excellent water and all samples are within desirable and maximum permissible limit. Agriculture is developed in eastern site of the study region. Due to extensive use of chemical fertilizer, high TDS and TH about 36% of groundwater samples are classified in 'poor water' for drinking (Fig. 2). Only 3% and 2% land of groundwater samples is classified into the class 'very poor' and 'unfit water' for drinking. There is need to protection of groundwater from intensive use of chemical fertilizer and contamination of agro based industry.

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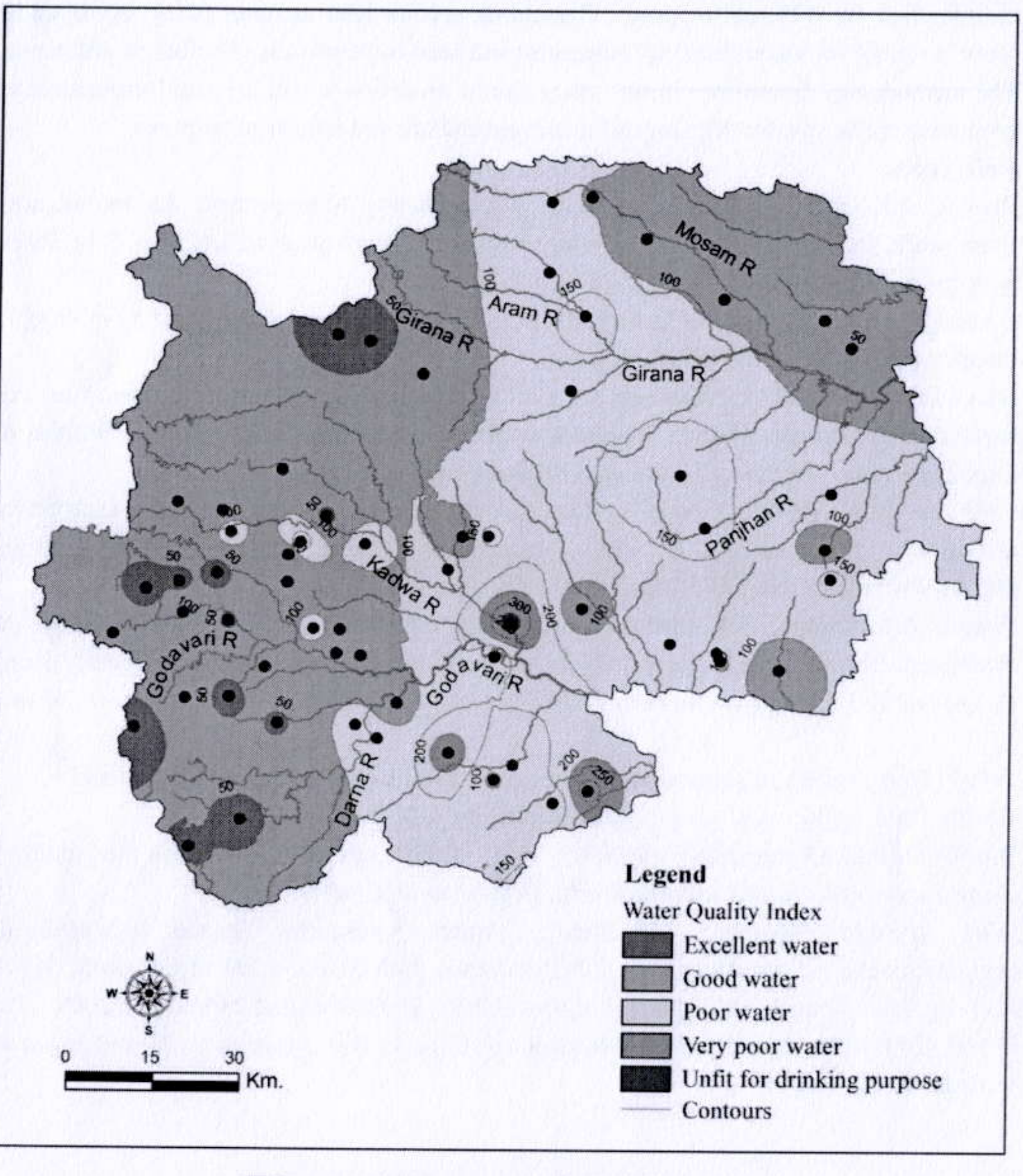

Figure 2 Water quality index map

Conclusions:

The WQI is useful for determination of groundwater quality for different purposes i.e. drinking, agriculture, etc. Twelve parameters i.e. pH, Total dissolved solids (TDS), Total hardness (TH), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Sodium (Na^{+}), Bicarbonate (HCO_3^-), Chloride (Cl^-), Sulphate (SO_4^{2-}), Nitrate (NO_3^-), Potassium (K^+) and Fluoride (F^-) were selected for groundwater quality analysis. The WQI shows that 59% groundwater samples fall into 'excellent water' (25%) and 'good water' (34%) and can be used directly for consumption for different purposes. Remaining groundwater samples (41%) come under 'poor' to 'unfit for water drinking' categories and need to be processed before its utilization. The methodology formulated in this study can be an efficient tool for rapid assessment of groundwater analysis for drinking, domestic, agriculture and industrial purposes.

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