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Groundwater Quality Analysis Using Water Quality Index In Chikkaballapur District, Karnataka.

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Abstract:

Groundwater is an important natural resource and play an important role in recent years in the irrigation activities in Chikkaballapur district of Karnataka state.. Due to continuous drought situations bore well water is the main source for their irrigation needs. Groundwater is the most dependant source of water for the day to day requirement for various needs in the absence of alternate sources of water supply. Chikkaballapur district lies between North latitude 13˚ 13’ 04” to 13˚ 58’29” and East Longitude 77˚ 21’ 52” to 78˚ 12’ 31”. It is falling in Survey of India Toposheet No. 57 G/12. There are no perennial rivers in Chikkaballapur district .The district is drained by three river basins namely Palar, Ponnaiyar, and Pennar. All these rivers and their tributaries are small and carry water only during rainy season. Geologically the area is underlined by massive granites and gneisses intruded by magmatic intrusions of different dimensions. Water quality is directly related to the physical, chemical, biological and radiological property of water. These properties of water are affected because of the pollution of water due to various human activities. There are various parameters which can be assessed for measurement of quality of water but when consideration of all parameters may be generates complexity towards quality. So, development of Water Quality Index (WQI) is the quite popular method in water quality assessment. This will explain the whole story of water in single scoring number and it is calculated using different methods. It is helpful to decide appropriate treatment technique to meet the concern issue. In this paper, WQI and its development methods are discussed. The quality of irrigation water depends primarily on the presence of dissolved salts and their concentrations. Sodium Absorption Ratio (SAR), Kelly’s Ratio (KR), Magnesium Absorption Ratio (MAR), Sodium to Calcium Absorption Ratio (SCAR) and Soluble Sodium percentage. Moreover, the poor-quality water causes impairment in crop growth as high salt concentration in irrigation water results in osmotic stress and ion toxicity in plants. This may be due to over exploitation the groundwater. Fluoride and nitrates have already crossed the permissible limits in most of the groundwater samples analyzed in the study area.

Keywords: Groundwater quality, Irrigation, WQI, Groundwater Sample.

INTRIDUCTION

Groundwater is the major source of drinking water in both urban and rural areas. Besides it is an important source of water for the agricultural and industrial sector. In recent years water is becoming scarce resource and has lead to recognize that the quality of water is an important as quantity. It is well established that the chemical characteristics of the groundwater determine its usefulness for Agricultural, Industrial and domestic consumption.

Waters with high amount of different unwanted elements may prove fatal to the living beings. Water chemistry plays an important role in the groundwater quality which was poorly understood so far. It is believed that the natural variations in water chemistry are a random phenomenon. Though

it is true, that in detail, the chemistry of groundwater is exceedingly complex, much information can be gathered and various factors that affect the groundwater quality of a particular place. A water index based on some very important parameters can provide simple indication of water quality. It gives a general idea and awareness for the possible problems with the water available and used in the region. For a common man, water quality and its suitability for drinking purpose can be examined by determining its quality index. 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.

WATER QUALITY INDEX METHODS

Ramakrishnaiah et al(2009), Srinivas Rao and Nageswararao (2013), Phadatare and Gawande (2016), Shivanna et al (2016), Suman.and Bhaskar (2017) have worked on the assessment of WQI. The assessment of groundwater quality for domestic and irrigation purpose using standard laboratory procedures. All have concluded that the groundwater quality assessment carried out will help the irrigation engineers and the other stake holders in planning the conjunctive water use for agricultural activities in any area. They have opined that WQI is an important tool to determine the drinking water quality irrigation water quality in urban, rural and industrial area. Few have calculated WQI using Tiwari's method and others using Bhargava's method. From the reviewed literature it is observed that Tiwari's method is preferred by the researchers, however none of the researchers have carried out a comparative study of WQI using both the methods to arrive at the better method. Hence, in the present work it is aimed to access ground water quality in terms of water quality index by Tiwari's Method and Bhargava's Method.

STUDY AREA:

Chickballapur is the taluk and district headquarters, it is at a distance of 56 km. from Bengaluru. The taluk geographically lies between 77^{o} 35' 58''E &77^{o} 52' 13''E East longitude and 13^{o} 19' 54''N &13^{o}39' 57''N North latitude. Chickballapur Taluk possesses an area of 644 sq.km (64400 hectares). The taluk is having a population of 1, 91,122 (as per the 2011 census). It is at a height of 917 feet with respect to mean sea level. It includes 3 hoblies and 223 villages and one town (Fig 1). Part of the taluk has clayey-loam soil. A detailed study of rainfall over the area is an essential aspect of the groundwater study. Rainfall is the source for both surface and groundwater. Its seasonal distribution, normalcy, variability and reliability will give an idea as to how the local recharge by rain would influence the groundwater body. For the present study few years' rainfall has been taken for analysis (1998 to 2017).

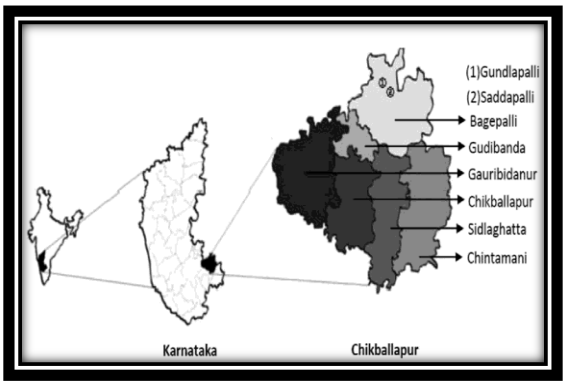

Fig. 1: Study area

METHODOLOGY

The hydro geochemistry study was undertaken by randomly collected ten groundwater samples from bore wells. Samples were collected in the study area during May (Pre Monsoon) and October (Post Monsoon) for year 2018 were drawn and analyzed as per the Indian standards. The hydrological study was undertaken by groundwater samples for different parameters. Water quality parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS),

total hardness (TH), Calcium (Ca), Magnesium (Mg), Chloride (Cl), Sodium (Na) and Potassium (K), NO3 and Fluoride etc. Groundwater is the main source of irrigation in entire study area. The most critical factor in predicting, managing, and reducing salt-affected soils is the quality of irrigation water being used. Besides affecting crop yield and soil physical conditions, irrigation water quality can affect fertility needs, irrigation system performance and longevity, and how the water can be applied. The quality of irrigation water depends primarily on the presence of dissolved salts and their concentrations. Sodium Absorption Ratio (SAR), Kelly's Ratio (KR), Magnesium Absorption Ratio (SAR), Sodium to Calcium Absorption Ratio (SCAR), Soluble Sodium percentage, and Residual Sodium Carbonate (RSC) are the most important quality criteria, which influence the water quality and its suitability for irrigation.WQI is commonly used for the detection and evaluation of water pollution and may be defined as a reflection of composite influence of different quality parameters on the overall quality of water (Horton, 1965). The quality may be good enough for drinking but not suitable for use as a coolant in an industry. It may be good for irrigating some crops but not well for irrigating some other crops..Water-quality indices aim at giving a single value to the water quality of a source on the basis of one or the other system which translates the list of constituents and their concentrations present in a sample into a single value.There are different methods for calculation of WQI, We have calculated by two different methods for Indian condition.

Table 1: WQI and Corresponding Water Quality Status by Tiwari. Method(Source: Horton, 1965**)**

Sl. No.	**WQI**	**Status**	**Possible uses**
1.	0-25	Excellent	Drinking, Irrigation and Industrial
2.	25-50	Good	Drinking, Irrigation and Industrial
3.	50-75	Fair	Drinking, Irrigation and Industrial
4.	75-100	Poor	Irrigation
5.	100-150	Very poor	Restricted use for Irrigation
6.	>150	Unfit for drinking	Proper treatment required before use.

Table 2:WQI and Corresponding Water Quality Status by Bhargava Method**.**

Sl. No	**WQI**	**Status**	**Possible Usages**
1	<50	Excellent	Drinking, Irrigation & Industrial
2	50-100	Good Water	Domestic, Irrigation & Industrial
3	100-200	Poor Water	Irrigation & Industrial
4	200-300	Very Poor Water	Restricted Use for Irrigation
5	>300	Unfit for drinking	Proper treatment required before use

RESULTS AND DISCUSSION:

The current study was designed to investigate the conditions of groundwater contamination in the study area. The hydro-geochemistry was undertaken by randomly collecting twelve groundwater samples from bore wells. Samples from bore well for confined aquifer of the study area during May (Pre Monsoon) and October (Post Monsoon) for year 2018 were drawn and analyzed as per the Indian standards. The parameters analysedare (pH), Electrical conductivity (EC), Total dissolved Solids (TDS) total hardness (TH). The major cations such as Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K), Iron (Fe), Chloride (Cl), Sulphate (SO_4), Fluoride (F) and Nitrate (NO_3

Irrigation Water Quality

Groundwater is the main source of irrigation in entire study area. The most critical factor in predicting, managing, and reducing salt-affected soils is the quality of irrigation water being used. Besides affecting crop yield and soil physical conditions, irrigation water quality can affect fertility needs, irrigation system performance, and how the water can be applied. The quality of irrigation water depends primarily on the presence of dissolved salts and their concentrations. Sodium Absorption Ratio (SAR), Kelly's Ratio (KR), Magnesium Absorption Ratio (SAR), Sodium to Calcium Absorption Ratio (SCAR), Soluble Sodium percentage, are the most important quality criteria, which influence the water quality and its suitability for irrigation.Irrigation water quality is generally judged by some determining factors such as Sodium absorption ratio (SAR), soluble Sodium percentage (SSP), and electrical conductance (EC). Along with the above indicators, some additional indices to categorize the groundwater for irrigation like Kelly's ratio (KR) and total hardness (TH) were studied

Water Quality Index:

Water-quality indices aim at giving a single value to the water quality of a source on the basis of one or the other system which translates the list of constituents and their concentrations present in a sample into a single value. One can then compare different samples for quality on the basis of the index value of each sample. Accurate information on the quality of water is inevitable to form a public policy and to implement the water quality improvement programmers. Water quality index (WQI) provides information about water quality in a single value.

An attempt has been made to calculate the water quality index of the study area based on hydro chemical data. From the hydro chemical data the WQI is calculated using different methods It is observed that station no.2 and 6 are found to be excellent water that can be used for domestic, irrigation and industrial purpose. Sample no.8 is found to be fair water that can be used for only irrigation and industrial purpose and is hazardous to the domestic purpose and remaining samples are found to be good water that water can also used for the domestic, irrigation and industrial purpose during pre monsoon season of 2018 (Fig.2 and 3) . Due to the rainfall and agricultural variation in the post monsoon season most of the stations namely 1, 5, 7 samples are found to be fair water that can be used for irrigation and industrial purpose and remaining samples found to be good water that can be used for domestic, irrigation and industrial purpose only. The water quality status by Bhargava's method, the sample no. 1, 5, 7, found to be fair water that can be used for domestic, irrigation and industrial purpose and remaining samples found to be good water that water can used for the domestic, irrigation and industrial purpose during pre monsoon season of 2018. Due to the rainfall and agricultural variation in the post monsoon season most of the samples like 2, 3, 4, 6 and 7 found to be good water that can be used for domestic, irrigation and industrial purpose and remaining samples found to be poor water that can be used for irrigation and industrial purpose.

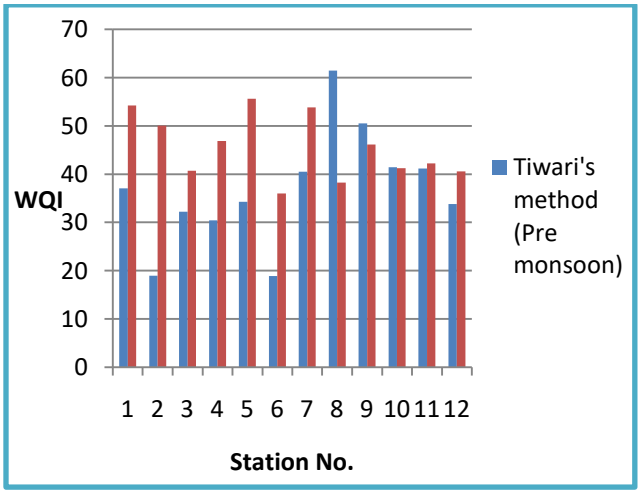

Fig. 2. Pre monsoon and post monsoon results by Tiwari's method for 2018

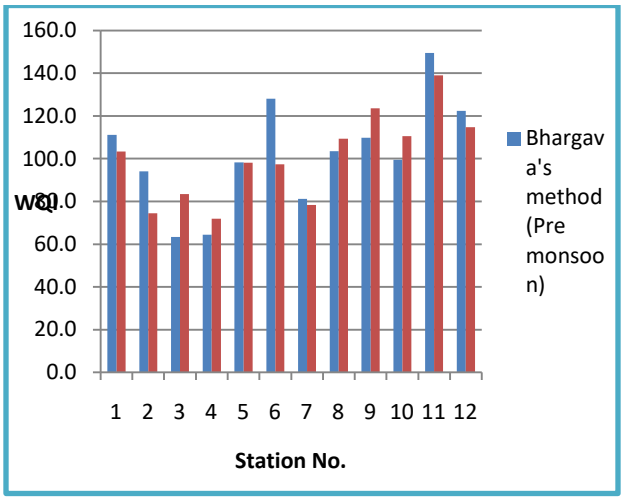

Fig. 3:. Pre monsoon and post monsoon results by Bhargava's method for 2018

CONCLUSION

In the present study the evaluation of the quality of water has been done using different laboratory procedure by computing Water Quality Index (WQI) using different methods namely, WQI by Tiwari and Mishra (1985), and WQI by Bhargava method (1983). Based upon the analysis of the results carried out, the following conclusions have been drawn:

Assessing the quality of water for drinking and irrigation purpose it is observed that during pre monsoon period station 8 (Chikkaballapur Town) is not found to be fit for domestic purpose during 2018 as per Tiwari's method whereas other stations are found to be fit for drinking purpose during pre monsoon period.

Assessing the quality of water for drinking and irrigation purpose it is observed that during post monsoon period station 1, 5 and 7 (Arur, GundlaMandikallu and Bandammanahalli) is not found to be fit for domestic purpose during 2018(Tiwari's method) whereas other stations are found to be fit for drinking purpose during post monsoon period.

Assessing the quality of water for drinking and irrigation purpose it is observed that during pre monsoon period station 1, 6, 8, 9, 11, 12, (Arur, Chikkaballapur, Chikkaballapur Town, Patrenahalli, Gaviganahalli and Agalgurki) is not found to be fit for domestic purpose during 2018 as per Bhargava's method were as other stations are found to be fit for drinking purpose during pre monsoon period.

Assessing the quality of water for drinking and irrigation purpose it is observed that during post monsoon period stations 1, 8-12, (Arur, Chikkaballapur Town, Patrenahalli, Kolavanahalli, Gaviganahalli and Agalgurki) is found to be not fit for domestic purpose during 2018 and remaining stations are fit for the drinking purpose during post monsoon 2018 as per Bhargava's method.

From irrigation point of view as per Bhargava's method and Tiwari's method all 12 stations are suitable during pre monsoon period and post monsoon period.

In the present study the Water quality index is calculated by Tiwari's method shows better result than the Bhragava's method because in Tiwari's method all parameters consider as 0 for ideal values and pH is considered as 7, it is suitable for every area were as in Bhargava's method rating should be given for the each parameter, that is depends upon the area.A maximum weight of 5 was assigned to nitrate, total dissolved solids, chloride, fluoride and sulphate considering that these often influence groundwater quality. Sulphate has given the minimum weight of 1 as the two rarely play a significant role in groundwater quality. Hence the results found by

Tiwari's method show better than the Bhragava's method.

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