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Original Research Paper

Judgement of Groundwater Quality Around Trivandrum Civil Station, Kerala, India: A GIS Based Approach

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ABSTRACT

Groundwater quality determination is obligatory for assessing its appropriateness for drinking and other domestic purposes. The chemical and biological characteristics of groundwater in and around the Trivandrum civil station were studied during the pre-monsoon season of 2012 to evaluate its aptness. Forty shallow groundwater samples were collected and analysed for required parameters as per the standard procedure. The values acquired were appraised in detail and weighed against BIS standards. Results divulge that the pH values obtained were dreadfully low and fluctuate between 4.6 and 6.9 with a mean value of 5.8, indicating a clear acidic trend. Possible reasons for this atypical phenomenon include spacious incidence of lateritic aquifer, open waste dumping near the open wells, disproportionate use of fertilizers in rubber cultivation and acid washing of rubber sheets in the neighbouring areas. In addition to that the microbial contamination of groundwater was also assessed. The results show that nearly every one of the water samples is contaminated with the influx of total coliform bacteria and faecal coliform bacteria. One of the ailing effects of urbanisation is water pollution due to the invasion of bacteria into the precious groundwater resource, predominantly cramped into shallow open wells. It is decidedly obligatory to put into custom that various apposite schemes to deal with this problem so as to hoard the people from any doable menace owing to the contamination of water.

INTRODUCTION

Water is indispensable for the survival of plants, animals, and human beings. Man desires water for all familial needs like drinking and cooking. Despite the fact that, the state of Kerala obtain an average annual rainfall of 3000mm, the undulating topography of the state coupled with deforestation and sand mining show the way to a hastened draining of water into the Arabian Sea. This is manifested from the actuality that the groundwater recharging has suffered a great stress. This has resulted in a sharp decline in the groundwater levels in many localities. As a function of that coupled with other anthropogenic factors, the pollution levels in water bodies and in drinking water sources have moved up at a startling tempo. Factors like unscientific waste disposal, ill managed application of fertilizers and pesticides in agriculture, lack of alacrity to shield the rivers and other water bodies and unplanned construction of toilets in areas of towering population density have led to a sturdy deterioration of water quality. Kerala has not tolerably responded with apposite water withholding procedures to congregate the challenge of the high rate of rundown. There is an intimidating need to engender superior social awareness about the civil rights and responsibilities in the use of water and also to put in place better management practices in the utilization of this priceless reserve. Under these state of affairs, we should be keener in doing research work in the linked field. More habitually much of the researchers spotlight their attention only to the quantity of water but in real state of affairs, quality of water is also imperative as the quantity. For this reason, the present work was visualized. Trivandrum civil station is situated in the periphery of the Trivandrum city. From the time when the civil station started functioning in this area, hefty scale urbanization has happened here. This in turn might have contributed deeply towards polluting the shallow groundwater resources. Apart from that as the civil station has come up people started migrating towards this region at a generously proportioned pace. That has shaped bigger population pressure and this sequentially has resulted in increased use of water thereby affecting the quantity of water. The entire rationale affected both the quality and quantity of water intended for populace in the vicinity. For this reason, it was felt to take up this area for the current study.

STUDY AREA

The study area (Fig. 1) is located in the NW part of Trivandrum district bordering the capital city. The area is bound between parallels of north latitude 8°35'36" and east longitude 76°56'02", in the Survey of India toposheet in 1:50,000 scale. Geologically, the area is mainly composed

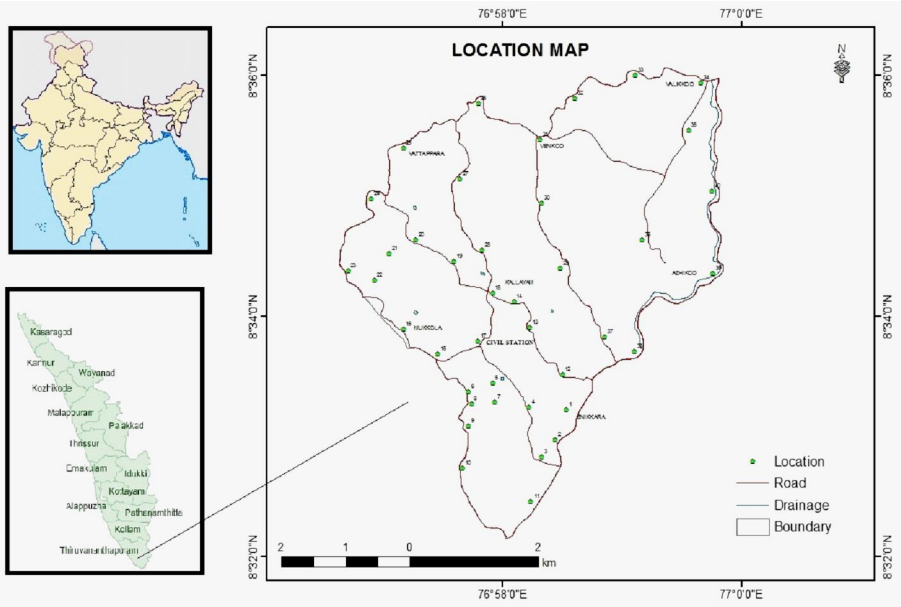

Fig. 1: The map of the study area.

of Precambrian charnockite, gneisses and young laterite. The prevailing climatic condition in the area is tropical with moderate temperature ranging from 25 to 30°C. The major locations in the study area include, Civil Station, Kallayam, Enikkara, Vazhayila, Sixthstone, Mukkola and Chellamkode.

MATERIALS AND METHODS

A total of 40 groundwater samples were collected during the pre-monsoon season and the physico-chemical parameters such as pH, EC, TDS, Na, K, Ca, Mg, HCO_3 and Cl were determined (APHA 1995). The obtained values were compared with BIS (BIS 1991) standards to understand the extent of pollution happened in this region. Microbiological analysis was also carried out in 10 locations (Trivedy & Goel 1986) to detect the presence of microorganisms in the groundwater to evaluate prospective water resource for drinking purpose. Two types of bacteria were identified, i.e. total coliform and faecal coliform following standard multiple tube fermentation and elevated temperature fermentation methods. Hydro-geochemical results were taken into a GIS platform and attributes were linked with concerned locations. The attributes were added and analysed in Arc GIS 9.3 software. Spatial analysis tools were used for the preparation of spatial variation maps. On the basis of the analytical parameters, which have got vital influence on the water quality such as pH, EC, TDS and total hardness, were considered for the preparation of water quality zonation maps by assigning suitable rank and weightage. Numerical weighted parameter rating (WPR) was used for the purpose. In this area pH is a key parameter; the spatial variation maps were integrated one over the other to find out the good groundwater quality zones, to delineate the suitable zone for domestic purpose.

RESULTS AND DISCUSSION

Quality for domestic purposes: The results of the physico-chemical analysis of groundwater are presented in Table 1. The hydrogen ion concentration (pH) during the pre-monsoon water sample varies from 4.6 to 6.9 with a mean value of 5.8, demonstrating an acidic inclination. The conductivity measurements provide an indicator of ionic concentration. The electrical conductivity (EC) values vary from 90.2µS/cm to 665µS/cm with a mean value of 275.53 µS/cm. The total dissolved ionic concentration varies between 63.8 mg/L and 472 mg/L with mean value of 188.14 mg/L.

Microbiological examination is routinely conducted to ensure safety for drinking purpose. Bacteria and other microorganisms cause blemish and if the contamination is recent they are responsible or will act as a carrier of infectious diseases (Binoj Kumar & Anet Panakkal 2012). Usage of this type of water for domestic purpose may result in new cases of contagion. Ten representative water samples (Fig. 2) were analysed for microbiological contamination. Two types of bacteria were identified which include total and faecal coliforms. The total coliform bacteria was analysed by the procedure followed by standard multiple tube fermentation method, and faecal coliform by elevated temperature fermentation method. The results are summarized in Table 2. Presence of faecal coliform is reported form all

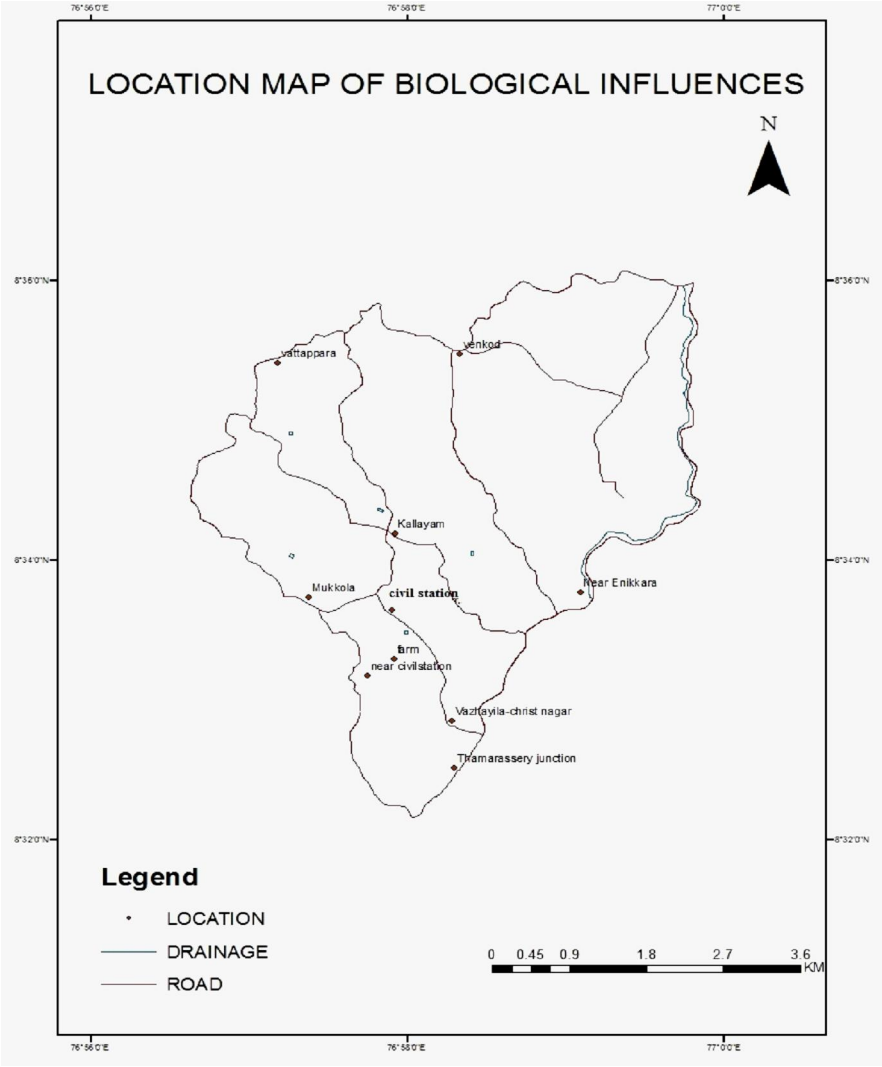

Fig. 2: Location map of the stations for collection of samples for bacterial studies.

locations except one place i.e., Vazhayila Christ Nagar. The highest value of total and faecal coliform is obtained from Thamarassery junction and also the Civil Station.

Delineation of groundwater quality zones based on water suitability for drinking and domestic purposes was also endeavoured. Groundwater quality zone maps were prepared based on convinced parameters such as pH, EC, TDS and total hardness, which could principally influence the quality of groundwater. The map (Fig. 3) divulge that only 8% of the water falls in very good category.

Abnormal pH values were observed in the groundwater samples in copious parts of the study area which spell out an acidic trend. The cause for the acidic pH might be the presence of lateritic aquifer (Binoj Kumar & Divya 2012) which act as the foremost water providing unit for the most part of the study area. Apart from that, the rubber plantation is the major vegetation grown in several parts of the study area, where large scale application of fertilizers is taking place and this can be another reason for low pH (Anseena Beegom & Binoj Kumar). Such water is not good for drinking purpose in the existing form. There is an imperative need for some kind of acid neutralizing treatment to craft the water appropriate for domestic purpose. Microbiological analysis carried out for open well samples shows the presence of total coliform and faecal coliform bacteria. Hence, the water samples are not suitable for both drinking and other domestic purposes. The biological pollution is due to the proximity between the well and the septic tanks. Most of the septic tanks in the area were found to be not constructed methodically. Groundwater quality zone maps were prepared based on certain parameters which possibly

Table: 1: Mean and range values of open well water samples.

Parameter		Values	BIS Standards	
			Highest Desirable	Maximum Permissible
pH	Range	4.6-6.9	6.5-8.5	No relaxation
	Mean	5.8		
EC (µs/cm)	Range	90.2-665	-	-
	Mean	275.53		
TDS (mg/L)	Range	63.8-472	500	2000
	Mean	188.14		
Salinity (ppt)	Range	0.0561-0.304	-	-
	Mean	0.1429		
HCO_3^- (mg/L)	Range	05-55	-	-
	Mean	21.5		
Th (mg/L)	Range	10-135	300	600
	Mean	19.62		
Ca^{2+} (mg/L)	Range	5.01-90.18	75	200
	Mean	12.29		
Mg^{2+} (mg/L)	Range	0-13.365	30	100
	Mean	5.644		
Na^+ (mg/L)	Range	05-57	-	200
	Mean	24.8		
K^+ (mg/L)	Range	1-30	-	-
	Mean	5.775		
Cl^-(mg/L)	Range	10.65-113.6	250	1000
	Mean	48.10		

Table 2: Microbiological evaluation of groundwater.

No	Sample location	Total coliform MPN/100mL Desirable limit : 0 Permissible limit :10	Faecal coliform MPN/100mL 0 0
1	Vazhayila Christ Nagar	300	NIL
2	Vazhayila Mariya Nagar	50	50
3	Farm near Civil Station	≥1600	≥1600
4	Civil Station	≥1600	1600
5	Thamarassery junction	≥1600	≥1600
6	Mukkola market	≥1600	≥1600
7	Kallayam	500	500
8	Vattapara	500	300
9	Vengod	≥1600	900
10	Near Enikkara	≥1600	≥1600

will basically influence the quality of groundwater. The map (Fig. 3) shows that 44% of study area falls in moderate category, 48% falls under good category and a minuscule 8% only falls in very good category. That gives a clear visualization of probable risk for people who live in those areas with tainted groundwater for their every day consumption.

CONCLUSION

Whichever area is undergoing hefty urbanization do have diverse groundwater problems. Present study too point towards such a tendency. Here, both the physico-chemical as well as biological pollution has come to pass. This

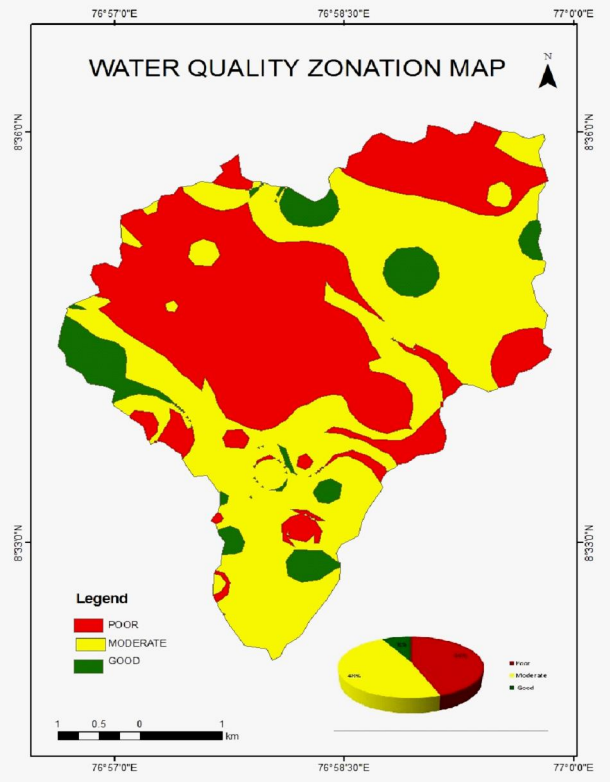

Fig. 3: Water quality zonation map.

pollution is together by the natural ways like the presence of lateritic aquifer and also the anthropogenic means like glut application of fertilizers, acid washing, etc. The biological pollution is predominantly due to the irrational construction of toilet units in close proximity to the drinking water wells. So it is of the essence to develop a water management plan to tackle this problem and save people from contiguous diseases.

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