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Original Research Paper

Water Quality Deterioration Owing to the Invasion of Low pH Groundwater in Mamam River Basin, South Kerala, India

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ABSTRACT

Aptness of groundwater in the Mamam river basin for drinking and other domestic purposes were assessed in the present work. Eighty six groundwater samples were collected in pre and post monsoon seasons and required physico-chemical attributes were determined. Results revel that most of the parameters except the pH were within the permissible limits recommended by BIS. However, abnormally low pH values were observed in the study area, as evidenced by a mean pH of 5.34 in post and 5.35 in pre monsoon seasons, indicating acidic character. Reasons for this abnormal phenomena include widespread occurrence of subsurface laterite aquifer system, presence of coconut husk retting yards, open waste dumping and extensive rubber cultivation. Consumption of this water is a definite threat to people causing gastrointestinal disorders, hyper acidity, ulcers, stomach pain and burning sensation. Besides this, pH below 6.5 can cause corrosion in pipes resulting in the release of toxic metals.

INTRODUCTION

Water is a natural resource and an absolute necessity for the survival of living beings. Groundwater is an important source of water for domestic and agricultural purposes. There has been tremendous increase in the demand for freshwater in the modern age, making qualitative and quantitative evaluation equally significant. Groundwater, being a powerful solvent, has the potential to dissolve minerals from rocks with which it draws closer contact. In addition, there are a variety of anthropogenic reasons responsible for damaging the quality of groundwater, which includes population explosion, rapid industrial development, excessive use of fertilizers and pesticides in agriculture, and improper dumping of urban waste. In the present study an attempt has been made to assess the groundwater quality in the shallow aquifer of Mamam river basin.

STUDY AREA

Mamam river basin falls in the southern part of Trivandrum district of Kerala state, and lies between latitudes N 8°35'22" to N 8°42'33" and longitudes E 76°46'30" to 76°58'12" in the Survey of India toposheet numbers D/14 NE, D/14 NW, D/14 SE and D/14 SW. Mamam river is a 5th order river which originates from the foothills of Western Ghats and flows to the Arabian Sea. The total length of main channel is 33.13 km and the total area of river basin is 130 km^2. Geologically, the basin is occupied by Archean rocks consisting of garnetiferous biotite gneiss, charnockites and khondalites. Laterite is found as cap rock above the crystallines, thereby limiting the direct exposure of crystalline rocks on the surface.

MATERIALS AND METHODS

Samples were collected from 86 open wells (Fig. 1) in both postmonsoon (August 2009) and premonsoon (May 2010) seasons. Physico-chemical parameters like pH, EC, TDS, salinity, total hardness, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, chloride, NO_3^-, SO_4^{2-}, PO_4^{3-} and HCO_3^- were measured (APHA 1995). Mean and range values of groundwater samples from postmonsoon and premonsoon seasons and their aptness for domestic use in relation to BIS standard were evaluated (BIS 1991). Arc GIS 9.3 software was used for preparation of the spatial distribution of postmonsoon pH in the study area.

RESULTS AND DISCUSSION

Mean and range values of the physico-chemical characteristics of the collected samples are given in Table 1. The mean pH of postmonsoon water sample was 5.34 ranging from 4.1 to 6.9, whereas the mean pH of premonsoon samples was 5.35 ranging from 4 to 6.9. It indicates that in most of the places pH is far below the permissible limit of 6.5-8.5 recommended by BIS. In postmonsoon, pH value range between 4 and 5 was recorded in 28 locations, while in premonsoon season pH value range between 4 and 5 was recorded at 31 locations. From this it is observed that deterioration happened in the quality of groundwater owing to the invasion of acidic groundwater. Percentage of area coming under different categories of pH range is given in Table 2. All other

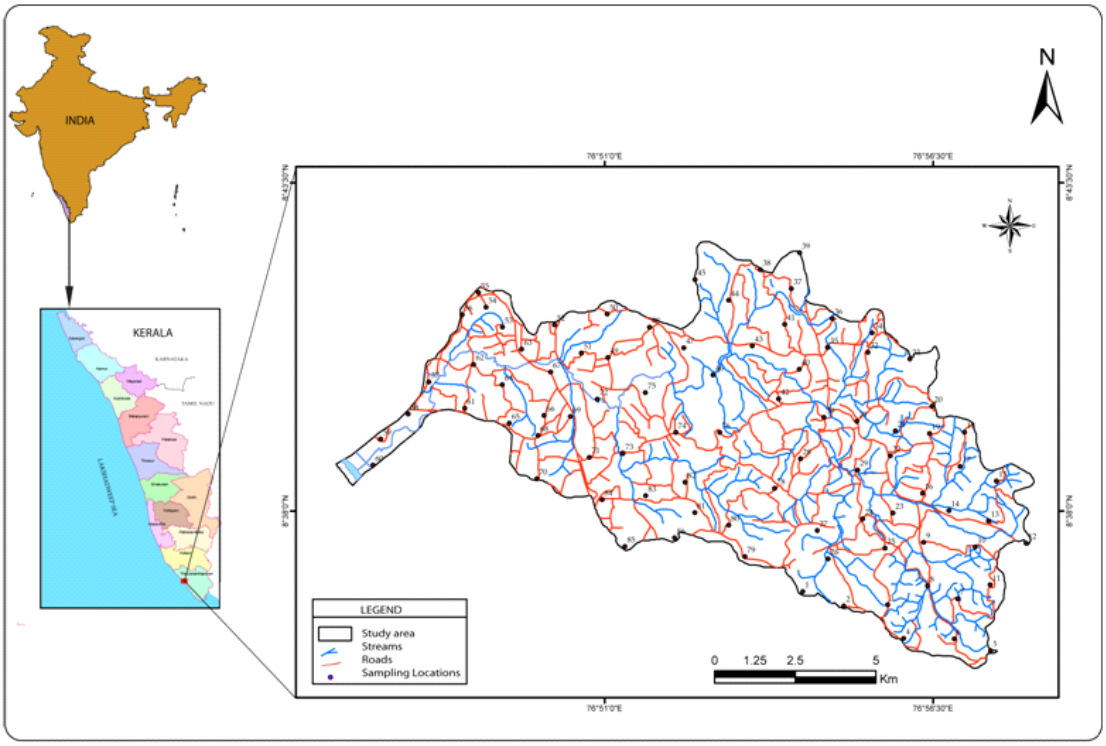

Fig. 1: Location map of the area.

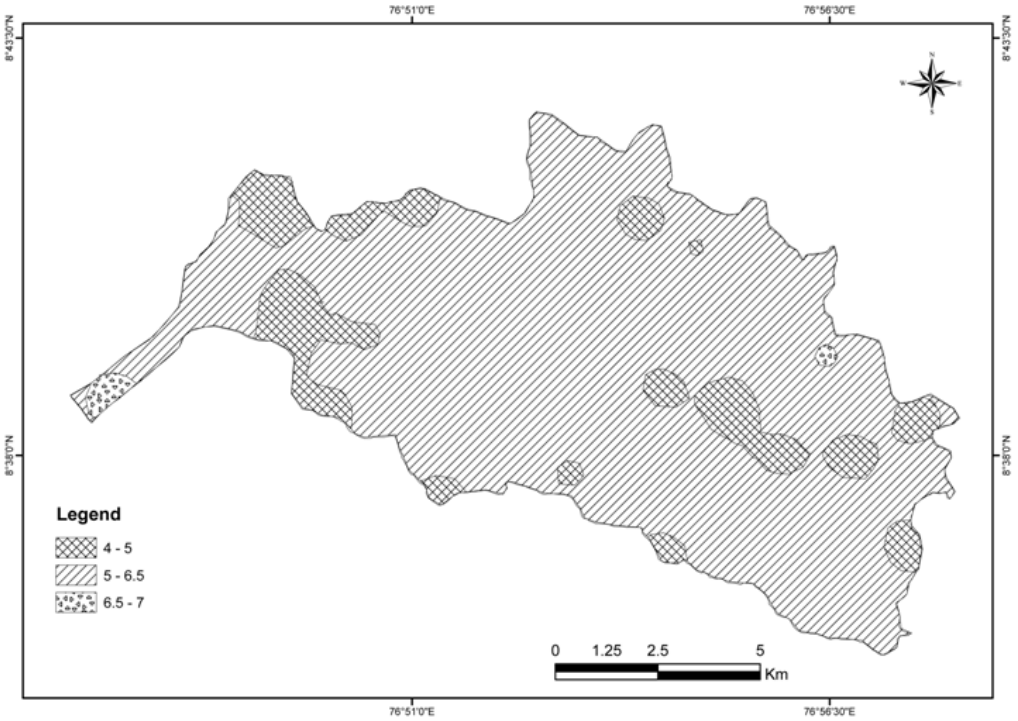

Fig. 2: Spatial variation of pH in Maman river basin.

Table 1: Mean and range values of physico-chemical characteristics of graoundwater samples.

Parameter	Statistics	Season		BIS Standard	
		Post mon	Premonsoon	Highest Desirable	Maximum Permissible
pH	Range	4.1-6.9	4-6.9	6.5-8.5	No relaxation
	Mean	5.34	5.35		
EC	Range	29-750	30-2777	-	-
	Mean	204	199		
TDS	Range	1.5-391	20-1565	500	2000
	Mean	122	124		
Salinity	Range	0.02-0.46	0.01-1.75	-	-
	Mean	0.10	0.24		
Total hardness	Range	15-195	6-286	300	600
	Mean	42	40		
Ca^{2+}	Range	2-54	2-168	-	200
	Mean	7.4	20		
Mg^{2+}	Range	1.1-15.7	0-29.6	-	-
	Mean	5.9	10.6		
Na^{+}	Range	0-100	4-140	75	200
	Mean	29	27		
K^{+}	Range	0-12	0-14	30	100
	Mean	3.5	4.6		
Cl^{-}	Range	24.6-196.8	7-150	250	1000
	Mean	64.7	32.7		
NO_3^{-}	Range	0.3-11	0.2-5.3	45	100
	Mean	5.7	2.3		
SO_4^{2-}	Range	1.9-40.4	0-25	200	400
	Mean	6.3	3.8		
PO_4^{2-}	Range	0-0.40	0-0.09	-	5
	Mean	0.0324	0.018		
HCO_3^{-}	Range	0-205	0-174	-	-
	Mean	27.4	30.4		

The values are in mg/L except pH, EC (μS) and salinity (ppt).

Table 2: Percentage of area coming under different ranges of pH.

pH range	Percentage of area	
	Postmonsoon	Premonsoon
4-4.5	15	20
4.5-5	17	17
5-5.5	31	25
5.5-6	20	20
6-6.5	14	15
6.5-7	3	3

parameters except the pH lie within the desirable limits of BIS standards for drinking water.

The striking observation is that the groundwater samples obtained from the shallow aquifers of Mamam river basin are highly acidic. Spatial variation of pH map (Fig. 2) reveals that very low pH values concentrated mainly in two highly urbanized areas namely Attingal and Venjaramood. There are many reasons for the extremely low pH values in the area. The main aquifer in the study area is laterite, water getting percolated through laterite mostly show low pH values. It may be due to the leaching of ferric constituents from laterites that mix with groundwater to form ferric chloride, which is an acidic species. Several coir retting yards are working in the study area. Lower pH is expected at coir retting yards (Sarthre et al. 2002). Huge deposits of clay are found in the study area mainly in the south western part which is being actively mined in recent years. The clay contain pyrite, which can break down to produce limonite and sulphuric acid (Evans 1997). Rubber is the main plantation in the study area and accumulation of layers of rubber plant leaves and their decaying produce humic acid which along with acid released by the treatment of rubber, enters into the shallow aquifer system. Open waste dumping is a common phenomenon in the urban pockets of the study area. Leachate produced from these areas may intrude into the groundwater system. All these factors may be responsible for the acidic nature of water in the study area.

CONCLUSION

It is evident from the study that there occurs a grave problem of groundwater pollution due to mixing of acidic groundwater. The matter of serious concern is that the low pH can cause gastrointestinal disorders, hyperacidity, ulcers,

stomach pain and burning sensation in people who consume this water. In addition to this pH below 6.5 can cause corrosion in pipes, thereby releasing toxic metals like Zn, Pb, Cd, Cu, etc. Proper water treatment mechanism is essential to nullify the impact of acidic pH. It could be possible by alkali neutralization method or diluting groundwater with rain water by adopting different rain water harvesting methods.

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