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Research Article

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Ground water quality assessment among the selected blocks of Wayanad district, Kerala

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ABSTRACT

The present study was carried out to assess the ground water quality in various location of Sulthan Bathery block of Wayanad district. The samples were analyzed for their physico-chemical characteristics namely temperature, pH, electrical conductivity, total dissolved solids, dissolved oxygen, total alkalinity, total hardness, sodium, potassium, phosphate, sulphate, nitrate, chloride, iron. On comparing the results against water quality standards and standard values recommended by World Health Organization (WHO), Bureau of Indian Standards (BIS), US Environmental Protection Agency (US EPA) and Central Pollution Control Board (CPCB), Nitrate and Phosphate are exceeding the permissible limit in most of the groundwater samples. The aggressive application of agrochemicals might be the reason for the leaching of nutrients. The indiscriminate use of agrochemicals should be avoided and promotion of use of bio-fertilizers and bio-pesticides should be encouraged.

Key words: Ground water quality, nitrate, phosphate, fertilizers.

INTRODUCTION

Groundwater comprises 97 percent of the world's readily accessible freshwater and provides the rural, urban, industrial and irrigation water supply needs of 2 billion people around the world [1]. The groundwater reservoir of the world at about 5.0×10^{24} L, this volume is more than 2,000 times the volume of water in all the world's rivers and more than 30 times the volume contained in all the world's fresh water lakes [2].The quality of ground water is the resultant of all the processes and reactions that have acted on the water from the moment it condensed in the atmosphere to the time it is discharged by a well. The quality of ground water depends on a large number of individual hydrological, physical, chemical and biological factors ([3]. Kerala is the southernmost state of India, is very unique in the groundwater situation, than many other states in India. This part of the country is blessed with over 3000 mm of rainfall per year ([4]. Kerala is strongly dependent upon groundwater and has considerable value both for its economic and social uses and for its role in maintaining a range of ecosystems at the surface and below the ground [5]. Wayanad is an agriculture-based district in Kerala, which is noted for its pleasant climate and fertile agro-friendly soil [6]. The district is divided into three blocks - Kalpetta, Mananthawady and Sulthan Bathery. All the three blocks in the district are having similar hydrogeological conditions. The district is having 25 gramapanchayats and one municipality (Kalpetta) [7]. Mainly the ground water quality assessment is focused on the surrounding areas of Sulthan Bathery. Continuous monitoring of water quality parameters is highly crucial since the quality of groundwater is constantly changing in response to daily, seasonal and climatic factors [8]. In this study the physico-chemical groundwater quality in and around area of Sulthan Bathery is assessed, in order to ensure the safe water supply for drinking, other domestic purposes and agricultural purposes in this area.

EXPERIMENTAL SECTION

Study area

Wayanad is a small hill district in Kerala, lies between 11^0 26' 28''- 11^0 48' 22'' N latitude and 75^0 46' 38'' - 70^0 26' 11''E longitude, with an area of 2132 sq. km. The study area is mainly located on four panchayats (Noolpuzha, Nenmeni, SulthanBathery and Meenangadi) in Sulthan Bathery block. The area experiences an average rainfall of 2,500 mm per year and maximum and minimum temperature shown are 33.97^{o}C and 13.87^{o}C respectively [9]. Forest soil is mainly found in Sulthan Bathery block. They are rich in organic matter, nitrogen and humus. The pH of the soil ranges between 5.3 and 6.3 and is slightly acidic in nature. The alluvial aquifers are represented in Sulthan Bathery. In these formations groundwater occurs under phreatic condition [7].

Sample collection

A total 20 samples has been collected randomly from Sulthan Bathery block (Figure 1), between 10 am and 4 pm (Table 1). Samples were taken from the bore wells of different sampling sites at a depth of 160-380 ft height from the ground level. The different sampling location has been assigned as sample points. Water is pumped out for a fair amount of time prior to the collection. One Liter of sample was collected in clean sterile polyethylene bottle and stored properly at (4°C) for further analysis. The collection, preservation and analysis of various parameters of water samples from different sampling locations were carried out, by following the standard procedures given in the standard methods for the examination of water and wastewater [10].

Physico-chemical parameters

Temperature (Brannan,UK) and pH (pH tester 1, 2, Oaklon) were recorded immediately at study site itself, due to their unstable nature to avoid unpredictable changes in characteristics as per the standard procedures. The physico-chemical parameters, such as total dissolved solids, total alkalinity, total hardness, dissolved oxygen, chloride, phosphate, nitrate, sulphate, sodium, potassium, iron, were analyzed. Sodium and potassium was analyzed using flame photometer (Elico, CL 361). UV visible spectrophotometer (Analytic Jena specord 200, Germany) was employed for sulphate, phosphate, nitrate and iron. Dissolved oxygen was estimated by Winklers' Iodometric method. Total hardness was determined by titration with EDTA and Chloride by argentometric titration using standard silver nitrate as reagent [10]. The results were compared with the standards of World Health Organization (WHO), Bureau of Indian Standards (BIS), US Environmental Protection Agency (US EPA) and Central Pollution Control Board (CPCB). Correlation analysis is used for the measurement of the strength and statistical significance of the relation between two or more water quality parameters (Sangpal*etal*. 2011). Data were analyzed by Microsoft Excel 2007 Software.

Table 1 Sampling locations with bore well depths

SAMPLE NO.	PLACES	BOREWELL DEPTH (ft)
GW_1	SulthanBathery	300
GW_2	Mathamangalam	265
GW_3	Naikatty	255
GW_4	Moolankavu	200
GW_5	Kuppadi	160
GW_6	Kambakodi	250
GW_7	Thekkumpatta	160
GW_8	Kallumukku	300
GW_9	Kalloor	160
GW_{10}	Beenachi	175
GW_{11}	Krisnagiri	275
GW_{12}	Kolagappara	250
GW_{13}	Pazhupathur	300
GW_{14}	Manichira	310
GW_{15}	Cheeral	300
GW_{16}	Pazhur	320
GW_{17}	Nambikolli	180
GW_{18}	Puthenkunnu	245
GW_{19}	Odapallam	170
GW_{20}	Thelampatta	380

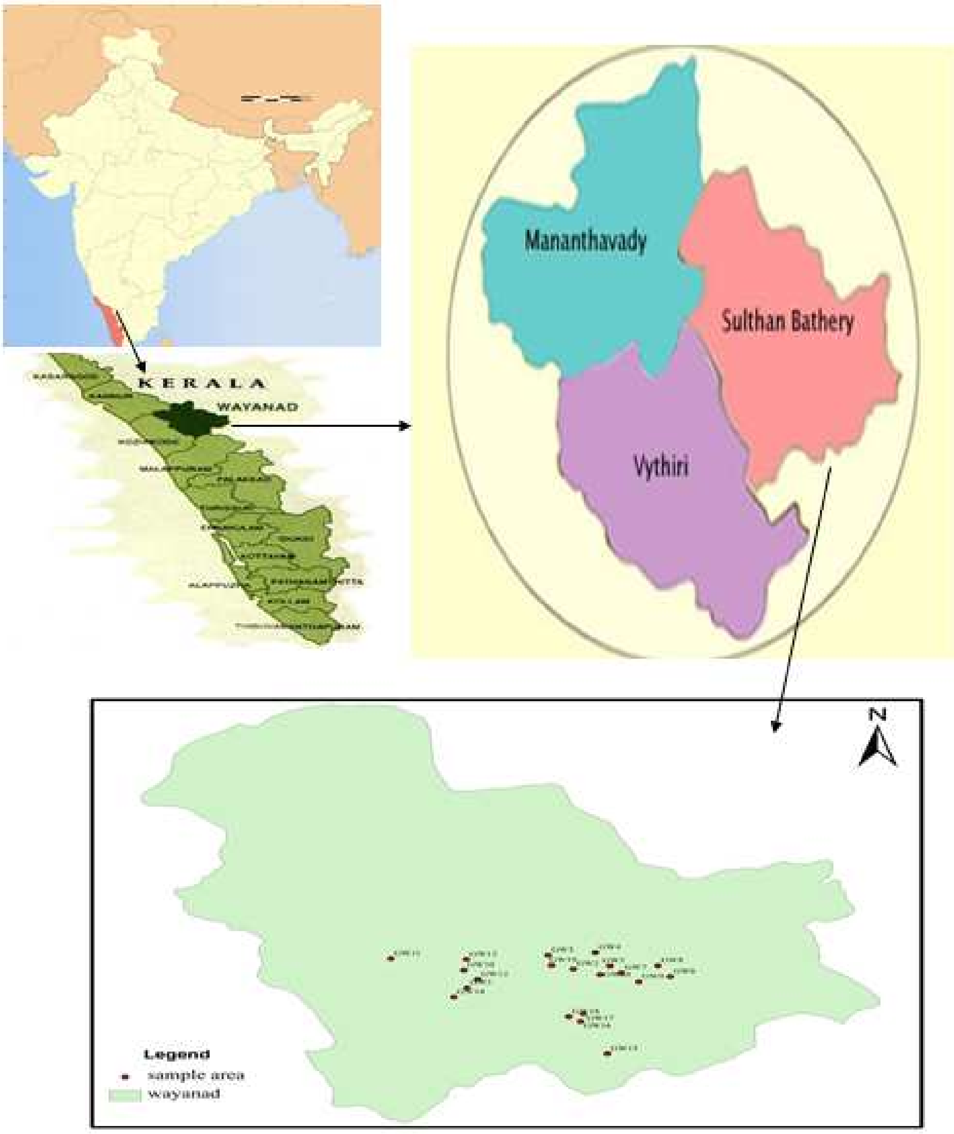

Figure 1 Location Map of Study Area with Sampling Points

RESULTS AND DISCUSSION

The experimental results of groundwater samples collected in and around area of Sulthan Bathery block were compared with the limits recommended by BIS, WHO, EPA and CPCB. Groundwater comes into intimate contact with various minerals, which are soluble in water in varying degrees. The dissolved minerals determine the property of the water for various purposes. The water from the study area of has no colour and odour.

TEMPERATURE

The temperature plays an important role in the metabolic activities of the organisms and is considered as a biologically significant factor [12]. Variation in water temperature depends on the changing climatic conditions [13]. The temperature variation in hydrosphere results in characteristic patterns of water circulation, which greatly influence the aquatic life. The raised temperature of water will stress the aquatic ecosystem by reducing the ability of the water to hold the essential dissolved gases like oxygen [14]. The permissible limit of temperature for drinking water should not exceed 5^0C above the receiving water temperature (BIS). From the table, it was found that the temperatures of water are mainly ranged from 25^0C to 27^0C (Table 2 - 3).

pH

pH is used to determine whether a solution is acidic or alkaline. Lower pH of below 4 will produce sour taste and higher than 8.5 produce bitter taste. Higher values of pH hasten the scale formation during the water heating also reduce the efficiency of disinfection process of Chlorine. Higher pH value induces the formation trihalomethanes, which will cause cancer to human beings. From the analysis it was found that the pH values of all groundwater samples are found to be in the range of 6.32 (GW_{18}) to 8.26 (GW_1) (Table 2- 3) where the majority of water samples come under slightly acidic nature. As per the WHO, US EPA, BIS and CPCB standards, the permissible limit of pH for drinking water is 6.5 - 8.5. The groundwater samples are found to be within the acceptable limit and there is no abnormal change of pH.

ELECTRICAL CONDUCTIVITY

The electrical conductivity is used to assess the source of pollution. In the coastal region, EC data will be used to assess the intrusion of salinity from the seawater to ground water. It also used to indirectly assess the inorganic content of the water. The EC values for all the groundwater samples were recorded within the range of 0.189 (GW_8) to 0.557 (GW_{12}) mS/cm (Table 2 - 3). The electrical conductance is a good indication of total dissolved solids, which is a measure of salinity that affects the taste of potable water [15]. Several factors like temperature; ionic mobility and ionic valences also influence the conductivity. The electrical conductivity values for all the groundwater samples are found within the permissible limit 1.4 mS/cm (WHO).

TOTAL DISSOLVED SOLIDS

The total dissolved solids in water are due to the presence of sodium, potassium, calcium, magnesium, manganese, carbonates, bicarbonates, chlorides, phosphate, organic matter, and other particles [16]. These dissolved minerals, gases and organic matter constitutes the unpleasant odour, taste and colour. Water with high TDS values often has a laxative sometimes the reverse effect upon people whose bodies are not adjusted to them. From the analysis it was found that the values of the total dissolved solids for all the groundwater samples shown between 166 (GW_8) to 345 (GW_9) mg/L (Table 2 - 3). The maximum permissible limits of total dissolved solids in groundwater for domestic purpose are 1000 mg/L 500mg/L, 500mg/L for WHO, BIS and US EPA respectively. The TDS values <1000 mg/L represent fresh water [17]. Based on the results, TDS values for groundwater sources were below 345 mg/L, thus considered as fresh water. The observed values for TDS at 20 locations were found within the permissible limit.

DISSOLVED OXYGEN

Drinking water should be rich in DO for good taste. It is an indicator of pollution load in the water. Higher values of DO will cause corrosion of iron and steel. So it is necessary to chech the DO level in the ground water in order to assess the pollution load. The DO values in the groundwater samples are observed from 4.84 to 7.75 mg/L. The highest value (7.75 mg/L) of DO is recorded at GW_{12} whereas the lowest value (4.84 mg/L) is recorded at GW_1, GW_4, GW_6, GW_8, GW_{11}, GW_{16} and GW_{18} (Table 2-3). As per BIS, dissolved oxygen level in drinking water should be 5 mg/L and usually the concentration of dissolved oxygen in clean water is 8 – 10 mg/L [18]. In this study, the DO is low in all the groundwater samples. Oxygen is generally reduced in the water due to respiration of biota, decomposition of organic matter, rise in temperature, oxygen demanding wastes and inorganic reluctant [19]. DO value below 3 mg/L is hazardous to man [20].

TOTAL ALKALINITY

Alkalinity of the water is due to presence of carbonates, bicarbonates and hydroxide salts. Large amount of alkalinity causes bitter taste in water. The alkalinity values are important for the calculation of carbonate scaling. The alkalinity values of groundwater samples were recorded between 60 (GW_6, GW_8, GW_{12}, GW_{15}, GW_{17}, GW_{18} and GW_{19}) and 200 mg/L (GW_{13}) (Table 2-3). The permissible levels of alkalinity are 200 mg/L according to BIS and 600mg/L for CPCB. All the ground water samples are found to be within the permissible level. High amount of alkalinity in water is harmful for irrigation, which leads to soil damage, and reduce crop yields [21].

TOTAL HARDNESS

Hardness defines the total polyvalent cation present in the water; the most divalent cations are calcium and magnesium. Hard water causes scaling in the pipeline or in the vessels. Soft water is corrosive and dissolves the metals. More cases of cardio vascular diseases are reported in the soft water prone areas. However the presence of calcium in the hard water is good for children growth. The hardness of the samples ranged from 56.72 (GW_{12}) to 200 mg/L (GW_1, GW_3, GW_7, GW_{13} and GW_{16}) (Tables 2 and 3). Based on the classification scheme by Driscoll (2009), the groundwater samples exhibit slightly hard to very hard nature in the study area. Hardness of the water is attributable to the presence of alkaline earths, that is, Ca^{2+} and Mg^{2+}. These ions react with soap to form precipitates [22].

SODIUM

The values of sodium for the groundwater samples are recorded in the range of 0.6 – 2.1 mg/L . The highest value of sodium is recorded GW_{19} and lowest value in GW_2 and GW_6 (Table 2- 3). From this study, it is confirmed that the value of sodium in the groundwater sample is well within the permissible limit (200 mg/L) suggested by BIS, WHO, US EPA, CPCB. High concentration of sodium ion in drinking water may cause heart problems and high sodium ion in irrigation water may cause salinity problems [23].

POTASSIUM

The potassium values for the groundwater samples are observed between 0.6 and 1.9 mg/L. The maximum value (1.9 mg/L) of potassium is observed at GW_3 and minimum value (0.6 mg/L) is observed at three samples (GW_8, GW_{11} and GW_{20}) (Table - 3). On comparison with the WHO standard value, it is found that the potassium values for all the groundwater samples are well within the maximum permissible limit (12 mg/L).

PHOSPHATE

The value of phosphate in the groundwater samples lie between 0.025 to 4.5 mg/L. The highest value (4.5 mg/L) is recorded at GW_9 and minimum value (0.025 mg/L) is recorded at GW_{12} sample (Table 2 - 3). In this study, the phosphate concentrations are found to be above the permissible limit (0.1 mg/L) of WHO, only the GW_{12} shows the concentration within the limit. Orthophosphates are generally applied to agricultural or residential cultivated land as fertilizers [10]. In some areas of Wayanad, ground water contamination due to pesticides is reported [5]. So the higher values of phosphate may be due to washing out of fertilizer, pesticides from agricultural fields and detergents used in the area.

SULPHATE

The sulphate values for the groundwater samples are exhibited between 30 (GW_{11}) mg/L (Table 3) and 58.5 (GW_7 and GW_9) mg/L (Table 2). The sulphate values for all the groundwater samples are well within the permissible limit (200mg/L) of WHO, (400mg/L) BIS, (250mg/L) US EPA and (400mg/L) CPCB and high concentration of sulphate may cause gastro-intestinal irritation particularly, when magnesium and sodium ions are present in drinking water [24]. The addition of sulphate to the groundwater is due to leaching from fertilizers and municipal waste [25]. The sulphate values of all the groundwater samples do not pose any water quality problem in the area.

CHLORIDE

Chloride associates with sodium exert a salty taste. It can also corrode the concrete. Magnesium chloride produces hydrochloric acid when the water is heated which is also a corrosive nature. Chloride determination in natural water will useful for the selection of water supply to the human beings. The value of chloride for all the groundwater samples is ranged from 49.63 (GW_1, GW_8, GW_{17} and GW_{20}) to 85.08 (GW_7) mg/L (Table 2-3). All samples show chloride values within the acceptable limit (250 mg/L) recommended by WHO, US EPA, BIS, CPCB. The limits of chloride have been laid down primarily from taste point of view. None of the samples exceeded the maximum permissible limit of 1000 mg/L.

NITRATE

The values of nitrate in all the groundwater samples were found between 0.09 mg/L and 20.37 mg/L. According to WHO and BIS, the acceptable limit of nitrate is 10 mg/L and 45mg/L respectively. The presence of nitrate in drinking water has adverse effects on health above 50 mg/L [26]. The four samples (GW_4, GW_6, GW_9 and GW_{10}) exceeds the limit of nitrate 10 mg/L (WHO) in groundwater (Table 2), which may be due to the leaching of nitrate with the percolating water by excess application of fertilizes. Nitrate is highly soluble and not readily degraded under aerobic condition [27] and the elevated concentrations (> 5 mg/L) of nitrate in waters are an indication that the waters are at the risk of pollution [28]. Penetration of nitrate into the subsurface is due to the usage of fertilizers for plantations and by the discharge of domestic waste. If nitrate could be readily leached from agricultural land to the underlying groundwater, then it seemed likely that, with intensification of pesticide use [27]. In this area, fifty per cent of samples are at the risk. High nitrogen leaching from soils can occur, where irrigation is excessive and not carefully controlled. Controlling the loading will, eventually, reduce pollution to acceptable levels [27]. Prevention is the best method to safeguard water sources against nitrate contamination.

IRON

The concentration of iron in the ground water of the surrounding areas of Sulthan Bathery town ranges from 0.02 mg/L (GW_6, GW_{11} and GW_{16}) to 0.1 mg/L (GW_3, GW_9, GW_{10}, GW_{14} and GW_{18}) (Table 2-3). The acceptable limit of iron according to WHO, BIS and US EPA are 0.1 mg/L, 0.3 mg/L and 0.3mg/L respectively. High concentrations of iron generally cause inky flavor, bitter and astringent taste to water. It can also discolour clothes, plumbing fixtures and cause scaling which encrusts pipes. In the present study the iron was within the permissible limit.

From the analysis, it is concluded that the groundwater, in and around areas of Sulthan Bathery, is mostly contaminated with phosphate and also the localized contamination of nitrate is seen due to the excess application of agrochemicals. Human activities have done much to alter the distribution of nutrients in the environment. Application of manure and chemical fertilizers to crops results in local abundance of nutrients, which is the desired outcome. But over-application can result in local excesses of nutrients, which can reach groundwater. Hence, more care should be taken to avoid contamination and overexploitation of groundwater.

Table 2 Physico-Chemical Characteristics of Groundwater Samples from Sulthan Bathery Block

PARAMETERS	GW_1	GW_2	GW_3	GW_4	GW_5	GW_6	GW_7	GW_8	GW_9	GW_{10}	BIS	WHO	EPA	CPCB
Temp (°C)	27	26	25	25	25	25	25	25	25	25	-	-	-	-
pH	8.26	6.95	8.18	6.59	6.53	6.98	6.78	6.74	6.90	7.07	6.5-8.5	6.5-8.5	6.5-8.5	65-8.5
EC, mS/cm	0.373	0.262	0.301	0.315	0.266	0.302	0.406	0.189	0.415	0.295	-	1.4	-	-
TDS, mg/L	322	192	258	268	210	186	336	166	345	244	500	1000	500	-
DO, mg/L	4.84	6.46	5.18	4.84	5.17	4.84	5.49	4.84	6.46	5.76				
Total Alkalinity, mg/L of $CaCO_3$	180	80	140	120	80	60	140	60	180	120	200	-	-	600
Total hardness, mg/L of $CaCO_3$	200	80	200	160	140	140	200	120	140	100	300	500	-	600
Sodium, mg/L	0.8	0.6	0.8	1.4	1.1	0.6	1.2	0.8	1.2	1.1	-	200	-	-
Potassium, mg/L	0.8	0.8	1.9	1.5	1.1	1	1.6	0.6	1.2	1.5	-	12	-	-
Phosphate, mg/L	3.25	2.5	3.5	1.25	1.3	0.5	0.25	0.5	4.5	0.5	-	0.1	-	-
Sulphate, mg/L	39	30.5	33	36	39	32.5	58.5	30.5	58.5	30.5	200	400	250	400
Nitrate, mg/L of NO_3	5.76	4.43	5.31	20.37	5.31	12.40	7.08	9.3	12.4	17.27	45	10	10	100
Chloride, mg/L	49.63	63.81	63.81	70.9	70.9	70.9	85.08	49.63	70.9	63.81	250	250	250	1000
Iron, mg/L	0.04	0.07	0.1	0.05	0.04	0.02	0.06	0.09	0.1	0.1	0.3	0.1	0.3	-

Table 3 Physico-Chemical Characteristics of Ground Water Samples from Sulthan Bathery Block

PARAMETERS	GW_{11}	GW_{12}	GW_{13}	GW_{14}	GW_{15}	GW_{16}	GW_{17}	GW_{18}	GW_{19}	GW_{20}	BIS	WHO	EPA	CPCB
Temp (°C)	26	25	25	25	25	26	25	25	26	25	-	-	-	-
pH	7.7	6.64	7.62	6.81	6.59	6.92	6.62	6.32	6.57	7.69	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
EC,mS/cm	0.350	0.557	0.511	0.315	0.315	0.396	0.373	0.315	0.295	0.373	-	1.4	-	-
TDS,mg/L	195	340	315	197	197	251	232	197	176	232	500	1000	500	-
DO, mg/L	4.84	7.75	5.17	5.81	6.94	4.84	5.76	4.84	5.49	6.3				
Total Alkalinity,mg/L of$CaCO_3$	80	60	200	80	60	120	60	60	60	120	200	-	-	600
Total hardness, mg/L of $CaCO_3$	140	56.72	200	120	150	200	150	150	100	140	300	500	-	600
Sodium,mg/L	1.1	0.8	1.2	1.2	0.8	1.4	1.2	2	2.1	0.8	-	200	-	-
Potassium,mg/L	0.6	1.4	1.5	1	1.1	0.8	0.8	1.2	1.4	0.6	-	12	-	-
Phosphate,mg/L	0.5	0.025	1	1.5	0.25	0.25	1.5	1.25	1.5	0.5	-	0.1	-	-
Sulphate,mg/L	30	30.5	31	38	40	36.5	38	38.5	38.5	40	200	400	250	400
Nitrate,mg/L	0.09	9.3	0.9	3.1	1.329	9.3	3.54	3.54	3.54	8.86	45	10	10	100
Chloride,mg/L	70.9	63.81	63.81	56.72	56.72	70.9	49.63	63.81	56.72	49.63	250	250	250	1000
Iron,mg/L	0.02	0.07	0.09	0.1	0.09	0.02	0.04	0.1	0.06	0.05	0.3	0.1	0.3	-

STATISTICAL ANALYSIS

In statistics, correlation is a broad class of statistical relationship between two or more variables. Hence, the correlation study is useful to find a predictable relationship, which can be exploited in practice. It is used for the measurement of the strength and statistical significance of the relation between two or more water quality parameters [11]. The values of correlation coefficients are listed in Table 4. The negative correlation was found in 26 cases between pH and DO, pH and K^+, pH and Na^+, pH and SO_4^{2-} , pH and $NO_3^{-,}$ pH and Cl^-, pH and Iron, EC and PO_4^{3-} , EC and NO^{3-} , EC and iron, TDS and Na^+, DO and TA, DO and TH, DO and Na^+, DO and PO_4^{3-} , DO and NO_3^- , DO and Cl^-, TA and Na^+, TH and NO_3^- ,TH and Iron, Na^+ and PO_4^{3-} , Na^+ and NO_3^- , PO_4^{3-} and NO_3^- , PO_4^{3-} and Cl^-, NO_3^- and Iron, Cl^- and Iron. Fairly high degree of correlation (0.75-0.9) found between EC and TDS and moderate degree of correlation (0.5-0.75) found between pH and TA, TDS and TA, TA and TH. The low degree of correlation (0.25-0.5) found between pH and TDS, EC and DO, pH and TH, pH and PO_4^{3-}, EC and TA, EC and K^+, TDS and TH, TDS and K^+, TDS and SO_4^{2-}, TDS and PO_4^{3-}, TDS and Cl^-, DO and Iron, TA and K^+, TA and SO_4^{2-}, TH and SO_4^{2-} , Na^+ and K^+, K^+ and Iron , PO_4^{3-} and SO_4^{2-} , PO_4^{3-} and Iron, SO_4^{2-} and Cl^-.

Table 4 Correlation Matrix for Different Water Quality Parameters

	pH	**EC**	**TDS**	**DO**	**TA**	**TH**	**Na^+**	**K^+**	**PO_4^{3-}**	**SO_4^{2-}**	**NO^{3-}**	**Cl^-**	**Fe**
pH	1												
EC	0.146338	1											
TDS	0.294113	0.786014	1										
DO	-0.1944	0.364112	0.2498	1									
TA	0.604625	0.412947	0.737569	-0.16023	1								
TH	0.427439	0.149466	0.331834	-0.57425	0.612617	1							
Na^+	-0.43305	0.043492	-0.08935	-0.29969	-0.06992	0.078977	1						
K^+	-0.02989	0.286866	0.431012	0.074394	0.306339	0.158973	0.255685	1					
PO_4^{3-}	0.343146	-0.05654	0.273436	-0.02362	0.46941	0.168746	-0.0235	0.1515	1				
SO_4^{2-}	-0.1924	0.174584	0.45474	0.137714	0.350968	0.315464	0.232831	0.1653	0.31087873	1			
NO^{3-}	-0.15255	-0.08862	0.242575	-0.03669	0.160083	-0.12987	-0.08496	0.2145	-0.0210971	0.066073	1		
Cl^-	-0.18216	0.244207	0.315453	-0.14729	0.193834	0.207493	0.129414	0.434	-0.098548	0.348138	0.240038	1	
Fe	-0.10085	-0.04102	0.090672	0.325167	0.142485	-0.17223	0.088317	0.4546	0.28280112	0.096122	-0.03184	-0.172765	1

CONCLUSION

Water quality is often degraded due to agricultural, industrial and human activities. Wayanad has a population of about 7.86 lakh, of which 90% depend upon agriculture for sustenance. In the present study, an attempt has made to analyze the physico-chemical characterization of groundwater samples taken from Sulthan Bathery town, Wayanad district. Twenty groundwater samples were collected from different parts of Sulthan Bathery town and analyzed for Temperature , pH, EC, TDS, TH, TA, Cl^-, Na^+, K^+, NO_3^-, SO_4^{2-}, PO_4^{3-}, DO and Fe using standard procedures. The values of all the groundwater samples are compared with the standard permissible value of WHO, US EPA, BIS and CPCB. This study reveals that the agriculture activities, geological formation and local environmental conditions control the groundwater quality. The groundwater samples could generally be classified as fresh and moderately hard to very hard nature. Nitrate and Phosphate, are exceeding the permissible limit in most of the groundwater samples, which may be due to intensive usage of fertilizers and pesticides. The bore well depths in the study area are mostly in the range of 200-300 ft. So the leaching out of these nutrients verifies the aggressive application of agrochemicals. The accumulation of these pollutants can be dangerous for both aquatic and human life. Suitable measures have to be taken to minimize the load of salts in the soil, so that the fertility could be maintained and better yield may be obtained. All other parameters are within the limit of standard organizations. Monitoring the groundwater quality periodically with integrated land use patterns will prevent the further contamination.

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