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Chemical analysis of ground water from various parts of Thiruvarur and Nagapattinam district, Tamilnadu, India

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ABSTRACT

The present study consisted of the estimation of some heavy metals and quality of groundwater from Thiruvarur and Nagapattinam district, Tamilnadu(India). The water sample were collected from various parts of Thiruvarur and Nagapattinam region during Jun-2013. The physicochemical parameters such as Ca2+, Mg^{2+} , CT were analyzed by titration method. $SO_4^{2^-}$, Fe^{3+} , Al^{3+} , NO_3^- , NO_2^- , Cu^{2+} , Mn^{2+} , were estimated by spectrophotometric method. Colour of the water sample determined by platinum-cobalt method. TDS of the water sample determined by gravimetrically, PH was estimated by PH meter. Turbidity was estimated by nephelometric method. Data showed the variation of the investigated physicochemical parameters in sample as follows, TDS of groundwater from Thiruvarur and Nagapattinam region rang between 320mg/l - 1830mg/l and 286mg/l - 1110mg/l respectively. The Total alkalinity of ground water from Thiruvarur and Nagapattinam region for most of the chemical parameters in the drinking water sample from Thiruvarur and Nagapattinam region excess range the permissible limits of the BIS drinking water quality guideline, most of the region water quality was found unsatisfactory for drinking purpose.

Key words: Groundwater, Thiruvarur, Nagapattinam, Physicochemical parameters, Tamilnadu

INDRODUCTION

Groundwater has become major source of water supply for domestic, industrial and agricultural sectors of many countries. It is estimated that one third of the world's populations use groundwater for drinking purpose.Groundwater is regarded to be the most valuable resources needed to sustain human life, animals and plants, urbanization, discharge of industrial effluents,domestic sewage, solid dumping of waste cause the groundwater to because polluted and created health problems. According to WHO, nearly 80% of all the diseases in human beings are caused by water. Variation of groundwater quality in an area is interaction of physical and chemical parameters and anthropogenic activities [13].

chemical analysis of groundwater and study on its pollution impact in and around jammalalmadugu area of YSR, Andhrapradesh district, India. They have analyzed various Physical and Chemical parameters such as p^{H} , EC, TDS, SO₄²⁻, NO₃⁻, etc., Were determined using standard procedure. It is found that the ground water sample are suitable for drinking purpose in the sampling areas [9]. Physicochemical and Biological analysis of groundwater of rural areas of wardha city, They have analyzed DO, pH, TDS, TA,, etc. It is found that the groundwater samples are suitable for drinking and domestic purpose [2].

Generally water is polluted on all the surface of earth. All metabolic and physiological activities and life process of aquatic organisms are generally influenced by such polluted waste and hence, it is essential to study physic-chemical characterctics of groundwater [8]. Chemical analysis of ground water and study on its pollution impact in and around Papanasam and Orathanadu areas of Thanjavur district in India, they have analyzed pH , TDS, Fe³⁺, Cu²⁺, etc. It is found that the ground water sample are suitable for drinking purpose. [3].

Physicochemical analysis of groundwater samples of BICHI local government area of KANO state of Nigeria. They have analyzed various physical and chemical parameters such as P^{H} , TA, TH, Ca^{2+} , Fe^{3+} , Mg^{2+} , TDS, etc. comparison with WHO and SON Standard. It was shown that the parameters from the water samples were within WHO and SON permissible limit for groundwater which satisfy the safety limit for its use for various purposes like domestic, agricultural, and industrial purpose [4].

In this study involve the determination of Fe^{3+} , Cu^{2+} , Al^{3+} ions in drinking water sample from various part of Thiruvarur and Nagapattinam region. Some physical and chemical properties of the samples were also determined by BIS analytical method.

MATERIALS AND METHODS

Study areas

Thiruvarur is located at 10.7716[°]N, 79.6368[°]E and Nagapattinam is located at 10.7700[°]N, 79.8300[°]E.

Figure-1 Shows the location of the groundwater sample collected. Table-2(a) and 2(b) are given about sampling points of Thiruvarur and Nagapattinam District. Groundwater is major source of water used for domestic purpose. The lithology is also responsible for the quality of groundwater.



Methodology

A total twelve groundwater sample were collected from bore wells of study area (fig-1). Using pre-cleaned sterilized poly propylene plastic bottle with cap.

Necessary precaution six samples are Thiruvarur regions and six from Nagapattinam regions. The sampling has been carried out in the month of JUN-2013. The samples in the canes (Bottle) were kept in the refrigerator. Table-1 is given about methods used for estimation of various physicochemical parameters.

RESULTS AND DISCUSSION

The various physicochemical parameters of groundwater collected from Thiruvarur and Nagapattinum region and its range (concentration) are presented in table 3, 4, 5 and 6 respectively.

Hydrogen Ion Concentration (pH):

pH is an important measurement of water. Dissolved gases such as carbon dioxide, hydrogen sulphide and ammonia also affect the pH of water. pH below 6.5 starts corrosion in pipes. The pH of the groundwater in the Thiruvarur region ranges from 6.69 to 8.12 and in the Nagapattinam region the pH range from 7.08 to 8.05, (Fig -2). This two region pH value lie in the BIS desirable limits (6.5 – 8.5).

Total Dissolved Solids (TDS):

Many dissolved substance are undesirable in water. Dissolved minerals, gases and organic constituents may produce aesthetically displeasing colour, taste and odour.

The Total Dissolved Solids of Thiruvarur and Nagapattinam region groundwater range between 320 mg/l - 1830 mg/l and 286 mg/l - 1110 mg/l respectively. The TDS of groundwater sample number S1, S2, S4, S6 is high in Thiruvarur region and sample number S2, S3, S6 of TDS is high in Nagapattinam region.(Table -3 and 5) If the TDS of drinking water is more than 2000 mg/l it would result to affect gastro intestinal irritation for human beings.



Figure 2: pH Variation of the Study Area



Temperature:

The temperature is an essential factor in the determination of other parameter like pH, conductivity, etc., the temperature of the water sample was recorded in $32.0^{\circ}C - 32.8^{\circ}C$ and $32.5 - 33.0^{\circ}C$ for groundwater of Thiruvarur and Nagapattinam region respectively.(Table- 3 and 4).

Colour:

Colour in water may be due to the inorganic ions, such as iron and manganese, fine particles in suspension, plankton and industrial wastes. The colour unit value inThiruvarur and Nagapattinam region range from 0 to 0.08 HU and 0.08 - 0.16HU respectively (Table-3 and 5)

Odour and Taste:

Odour is recognized as a quality factor affecting of drinking water most organic and inorganic chemicals originating from domestic wastes and decomposition of vegetable mater contribute taste and odour to the water. All groundwater samples had agreeable odour (Table- 3 and 5).



Parameters	Method	Reference
Temperature	Thermometer	IS 3025 : 1964
pH	pH –metric	IS : 3025 (Part II)
Colour	Platinum-Cobalt method	IS: 3025 (Part 4)
Taste	Taste Rating method	IS: 3025 (Part 8)
Odour	Olfactory method	IS: 3025 (Part 5)
Turbidity	Nephelo metric method	IS: 3025 (Part 10)
Electrical Conductivity	Conduct metric	IS 3025 : 1964
Total Dissolved Solid	Gravimetric method	IS: 3025 (Part 16)
Total Alkalinity (TA)	Indicator method	IS: 3025 (Part 23)
Residual Free Chlorine	Iodometric method	IS: 3025 (Part 26)
Sulphide (H2S)	Methylene Blue-Oxalate method	IS: 3025 (Part 29)
Chloride	Argento metric method	IS: 3025 (Part 32)
Sulphate	Turbidity method	IS: 3025 (Part 24)
Calcium	EDTA Titrimetric method	IS: 3025 (Part 40)
Magnesium	EDTA Titrimetric method	IS: 3025 (Part 46)
Manganese	Colour comparison method	IS 3025 : 1964
Nitrate	Chromo tropic acid method	IS: 3025 (Part 34)
Iron	1,10-Phenanthroline method	IS: 3025 (Part 53)
Nitrite	Spectrophotometric method	IS: 3025 (Part 34)
Aluminium	Spectrophotometric method	IS: 3025 (Part 55)
Copper	Neocuprine method	IS: 3025 (Part 42)
Phosphate	Spectrophotometric method	IS 3025 : 1964

Table-1: Methods used for estimation of various physicochemical parameters

Table-2(a) Sampling points of Thiruvarur region

Sampling place	Sampling point number
Thiruvarur	S1
Adiyakkamangalam	S2
Thiruppalakudi	S3
Thirumakkottai	S4
Koradacheri	S5
Vattar	S6

Table-2(b) Sampling points of Nagapattinam region

Sampling place	Sampling point number
Nagapattinam(Tata Nagar)	S1
Nagapattinam (Sattaiyappar south street)	S2
Nagore (New Railway Station Road)	S3
Kuthalam	S4
Mayiladuthurai	S5
Kizhvelur	S6

Table-3: Physical parameters of groundwater collected from Thiruvarur region

Parameters	S1	S2	S 3	S4	S 5	S6	BIS Desirable limit
Temperature ° C	32.2	32.6	32.4	32.3	32.8	32.0	-
Colour (HU)	BDL	0.08	BDL	BDL	BDL	BDL	2 HU
Taste	Salty	Taste less	Taste less	Salty	Taste less	Salty	Agreeable
Odour	Odour less	Agreeable					
Turbidity	00.8	00.8	00.4	1.6	00.7	1.3	2 NTU
Electrical conductivity mS/cm	1.93	1.51	0.73	4.85	1.12	3.10	-
Total Dissolved solid (mg/l)	817	635	320	1830	483	1260	500mg/l

Turbidity:

Turbidity in natural water caused by clay, plankton, organic matter, etc., the turbidity of groundwater from Thiruvarur and Nagapattinam region range between 0.4 NTU – 01.6 NTU and 0.2 NTU – 01.2 NTU respectively. The turbidity of groundwater samples was found to be within BIS permissible limit (2NTU), (Table-3 and 5).

Electrical Conductivity:

Electrical conductivity is the capacity of water to convey current and this may be due the presence of solublesalts and ionic species which act as conducting medium.

Conductivity of groundwater from Thiruvarur and Nagapattinam region range between 0.73mS/cm - 4.85 mS/cm and 0.59 mS/cm - 2.67 mS/cm respectively (Table 3 and 5)







Total Alkalinity:

Alkalinity in water is due to the presence of carbonates, bicarbonates and hydroxide. Excess alkalinity in water is harmful for irrigation which leads to soil damage and reduce crop yields. The alkalinity value in Thiruvarur region range from 108 mg/l to 486 mg/l, (Table – 4),fig (4). In this region all groundwater samples had the alkalinity concentration is high except sample number S3. The total alkalinity of groundwater from Nagapattinam region range from 166 mg/l to 368 mg/l in this region sample number S1, S2, S3 and S6 of total alkalinity is above the desirable limit (Table - 6) fig-4.

Residual Free Chlorine:

All the groundwater samples had residual free chlorine content lying below the detectable limit (Table- 4 and 6).

Chloride (Cl⁻):

Chloride is one of the major inorganic anion in water. Discharge of domestic sewage is the main source of groundwater from Thiruvarur and Nagapattinam region range between 87.97 mg/l - 339.89 mg/l and 37.98 mg/l - 313.23 mg/l respectively, (Table-4 and 6). In Thiruvarur region the chloride content of sample numberS4 and S6 is very high and the chloride content of sample number S2, S3 and S6 from Nagapattinam region is above desirable limit, Fig-5.



Fig 8: Magnesium Variation of the Study area



Fig 10: Iron Variation of the Study area



Fig 12: Phosphate Variation of the Study area



Fig 9: Nitrate Variation of Study area







Fig 13: Copper Variation of the Study area

Sulphide (H₂S):

All the groundwater samples had sulphide concentration lying well below the detectable limit (Table -4 and 6).

Sulphate (SO₄²⁻):

Drainage wastes are the main source of high sulphate concentration in water. The sulphate content of groundwater from Thiruvarur and Nagapattinam region range between 1.7 mg/l - 8.1mg/l and 1.4mg/l - 10mg/l respectively (Table - 4 and 6). The sulphate content of groundwater samples was found to be within the BIS desirable limit from both Thiruvarur and Nagapattinam region, Fig-6.

Parameters	S1	S2	S3	S4	S5	S6	BIS Desirable limit
pH	8.12	7.69	6.69	6.92	7.43	7.81	6.5 - 8.5
Total Alkalinity	486	378	108	208	294	458	200 mg/l
Residual Free Chlorine	BDL	BDL	BDL	BDL	BDL	BDL	0.2mg/l
Sulphide(H ₂ S)	BDL	BDL	BDL	BDL	BDL	BDL	0.05mg/l
Chloride(Cl ⁻)	174.94	130.95	87.97	339.89	93.97	319.9	200mg/l
Sulphate(SO ₄)	2.8	8.1	1.7	3.3	2.7	6.9	200mg/l
Calcium	90.38	87.31	57.31	138.27	64.92	92.18	75mg/l
Magnesium	9.73	23.12	8.76	6.08	22.39	40.16	30mg/1
Manganese	BDL	BDL	BDL	BDL	BDL	0.2	0.1mg/l
Nitrate(NO ₃)	2.55	2.46	2.47	3.44	3.21	4.65	45mg/l
Iron(Fe ³⁺)	0.53	0.32	0.54	0.45	0.35	0.24	0.1mg/l
Nitrite(NO ₂ ⁻)	0.002	0.0025	0.0009	0.0118	0.0011	0.0027	0.02mg/l
Aluminium(Al ³⁺)	0.024	0.027	0.031	0.028	0.029	0.022	0.03mg/l
Phosphate	0.16	0.44	0.55	1.16	0.3	1.11	-
Copper	0.001	0.48	BDL	BDL	0.001	0.01	0.05mg/l

Table-4: Chemical parameters of groundwater collected from Thiruvarur region

All the values are expressed in mg/l, except pH.

BDL – Below the Detection Limit.

Table-5: Physical parameters of groundwater collected from Nagapattinam region

Parameters	S1	S2	S3	S4	S5	S6	BIS Desirable limit
Temperature °C	32.5	32.7	33.2	32.7	32.9	33.0	-
Colour (HU)	0.16	BDL	0.08	0.08	BDL	BDL	2 HU
Taste	Taste less	Salty	Salty	Taste less	Taste less	Salty	Agreeable
Odour	Odour less	Agreeable					
Turbidity	00.6	01.1	01.2	00.3	00.2	00.9	2 NTU
Electrical conductivity mS/cm	0.93	2.63	2.67	0.59	0.61	2.28	-
Total Dissolved solid (mg/l)	408	1070	1110	286	328	937	500mg/l

Table-6: Chemical parameters of groundwater collected from Nagapattinam region

Parameters	S1	S2	S 3	S4	S5	S6	BIS Desirable limit
Ph	7.46	8.05	7.83	7.13	7.42	7.08	6.5 - 8.5
Total Alkalinity	212	368	316	182	166	274	200 mg/l
Residual Free Chlorine	BDL	BDL	BDL	BDL	BDL	BDL	0.2mg/l
Sulphide(H ₂ S)	BDL	BDL	BDL	BDL	BDL	BDL	0.05mg/l
Chloride(Cl ⁻)	89.97	309	313.23	37.98	103.3	221.59	200mg/l
Sulphate(SO ₄)	6.6	10	4.8	1.4	4.2	1.5	200mg/l
Calcium	53.7	105.21	108.21	50.50	40.48	89.17	75mg/l
Magnesium	12.65	28.59	33.46	09.00	03.16	14.60	30mg/1
Manganese	BDL	BDL	0.2	BDL	0.2	BDL	0.1mg/l
Nitrate(NO ₃ ⁻)	2.25	7.75	3.09	2.81	2.48	2.59	45mg/l
Iron(Fe ³⁺)	0.36	0.30	0.28	0.32	0.31	0.37	0.1mg/l
Nitrite(NO ₂ ⁻)	0.0029	0.0018	0.0015	0.0015	0.0020	0.1	0.02mg/l
Aluminium(Al ³⁺)	0.025	0.030	0.024	0.022	0.026	0.023	0.03mg/l
Phosphate	0.94	0.5	0.11	0.16	0.27	1.05	-
Copper	0.043	0.011	BDL	0.013	0.001	0.003	0.05mg/l

All the values are expressed in mg/l, except pH. BDL – Below the Detection Limit.

BDL – Below the Detection Limit.

Calcium(Ca^{2+}):

The calcium content was recorded in 57.31 mg/l - 138 mg/l and 40.48 mg/l - 108.21 mg/l for groundwater of thiruvarur and nagapattinam region respectively (Table – 4 and 6), fig-7.

Magnesium (Mg²⁺):

The magnesium was recorded in 6.08 mg/l - 40.16 mg/l and 3.16 mg/l - 33.46 mg/l for groundwater of Thiruvarur and Nagapattinam regions respectively. The magnesium content of sample number S6 from Thiruvarur region is above the desirable limit and the sample number S3 from Nagapattinam region groundwater to reach desirable limit (Table 4 and 6) Fig- 8.

Manganese (Mn²⁺):

The manganese content of all the groundwater sample bellow the detectable limit except sample number S6 from Thiruvarur region and sample number S3 and S5 from Nagapattinam region is above the desirable limit (Taable-4 and 6).

Nitrate (NO₃⁻):

This is highest oxidized form of nitrogen. Low quantity of nitrate present in surface water, but may attain high level in some groundwater. The nitrate was recorded in 2.46 mg/l - 4.65 mg/l and 2.25 mg/l - 7.75 mg/l for groundwater of Thiruvarur and Nagapattinam region respectively. The nitrate of groundwater sample was found to be within the BIS permissible limit (45 mg/l) (Table-4 and 6) fig-9.

Iron (**Fe**³⁺):

Iron is an essential element in human nutrition. Iron usually exits in ferrous and ferric forms. Generally the region range between 0.24 mg/l - 0.54 mg/l and 0.28 mg/l - 0.37 mg/l respectively.

The iron content of all groundwater samples from both the regions is more than BIS permissible limit. (Table -4 and 6) Iron variation of the study area shown in the fig -10.

Nitrite (NO₂⁻):

Nitrite in water is due to incomplete oxidation of organic matter containing nitrogen. The nitrite content of groundwater from Thiruvarur and Nagapattinam region range between 0.0009 mg/l - 0.0029 mg/l and 0.0015 mg/l - 0.1 mg/l respectively (Table-4 and 6). The nitrite content of groundwater in Thiruvarur regions is well within the desirable limit of BIS (0.02 mg/l) but the sample number S6 from Nagapattinam region nitrite content of groundwater is more than desirable limit of BIS drinking water quality guideline.

Aluminium (Al³⁺):

The aluminium content of groundwater from Thiruvarur and Nagapattinam regions range between 0.022 mg/l - 0.03 mg/l and 0.022 mg/l - 0.030 mg/l respectively. The aluminium concentration of groundwater was found to be within the desirable limit from both Thiruvarur and Nagapattinam region (Table -4 and 6) fig-11.

Phosphate:

Phosphate content naturally occurs as inorganic (or) organic phosphate form. Domestic sewage, agricultural effluent and detergents are the main source of phosphate in water. Phosphate was recorded in 0.16mg/l - 1.16mg/l and 0.1mg/l - 1.05mg/l for groundwater of Thiruvarur and Nagapattinam regions respectively, (Table-4 and 6) Fig-12.

Copper:

The copper content of groundwater from Thiruvarur and Nagapattinam region range between 0 - 0.048 mg/l and 0 - 0.043 mg/l respectively (Table-4 and 6). The copper content of groundwater was found to be within the BIS desirable limit from both Thiruvarur and Nagapattinam region respectively, fig-13.

CONCLUSION

In conclusion, the concentration of the investigated major ions in the drinking water samples from various part of Thiruvarur and Nagapattinam region, Tamilnadu (India). In most of the groundwater samples of TDS, TA, Ca²⁺, Fe³⁺ are high from both Thiruvarur and Nagapattinam regions. The estimated parameters were compared with BIS drinking water quality guideline. The physicochemical analysis of water samples concluded that the water quality of

these two regions most of the areas groundwater is not suitable for drinking purpose. The human beings of that two region are suffering with various diseases like gastro intestinal irritations and skin irritation. Rainwater harvesting is one of the solution to minimize the heavy metals concentration in drinking water.

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