Physicochemical characteristics of groundwater from Kumbakonam Taluk of Thanjavur District - Tamilnadu (India)

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ABSTRACT The aim of present study was to assess the quality of ground water from Kumbakonam region in Thanjavur district, and check its fitness for drinking and other purpose. An eight ground water samples were collected from various parts of Kumbakonam region. The physicochemical parameters such as calcium, magnesium, chloride was determined by titration method, sulphate, nitrate, nitrite were analyzed by spectrophotometric method, pH was determined by pH metric method and other parameters were analyzed by Indian standard method. Physicochemical parameter of ground water samples were compared with standard limits recommended by BIS. The comparative study of ground water to this region, all the collected water samples are not suitable for drinking purpose, because in this region ground water samples had excess of manganese, calcium, magnesium and iron content.

1. INTRODUCTION

Water is extremely indispensable for survival of all living organism. The quality of water is vital concern for mankind since it is directly linked with human safety. In India, most of the population is dependent on groundwater as the only source of drinking water supply. Groundwater is believed to be comparatively much clean and free from pollution than surface water [1]. But expanded discharge of industrial effluents, domestic sewage use of fertilizers and pesticides, waste deposit causes the groundwater to become polluted and creates health problems [10].

In developing countries contamination of water supplies by organic chemicals is lesser concern, because most of the health problems are found to be associated with the presence of inorganic chemicals and pathogenic organisms in drinking water. In Thanjavur region some of ground water samples was contaminated, because in the presence of excess of calcium hardness, magnesium hardness, TDS and total alkalinity [8].

The hard water is said to cause serious health problems such as urolithosis, cardiovascular disorder, kidney problems and cancer [7]. Additionally, WHO reports that excess intake of calcium is associate with kidney stones and that of magnesium leads to diarrhea and laxative effect due to change in bowel habit. Water quality of Thiruvarur region most of the areas groundwater is not suitable for drinking purpose, because in the presence of excess hardness [12; 3].

In view of the above aspects of groundwater contamination, the present study was undertaken to investigate the possible impact on the groundwater quality of some bore wells of Kumbakonam region in Thanjavur district. Thus, in this paper an attempt has been made to assess the physical and chemical properties of groundwater.

2. MATERIALS AND METHODS

2.1 Study area:

Kumbakonam is located in Thanjavur district. The studies area lies at 11° 38' N and 75° 45' E latitude. Fig – 1 showed the location of ground water samples was collected from Kumbakonam region and table – 1 are given about sampling points of Kumbakonam region.

Sampling Point	Sampling Point Number
Mangudi (East)	S1
Mangudi (West)	S2
Swamimalai (North)	S3
Swamimalai (South)	S4
Kumbakonam	S5
Baburajapuram	S6
Dharasuram	S7
Ariyapadaaiyar	S8

Water samples were collected in previously sterilized poly ethylene plastic bottles with cap. The sampling has been carried out in month of MAY - 2015. The samples in the canes (Bottle) were kept in the refrigerator. The physicochemical parameters were determined by IS analytical method. Table-2 is given about methods used for estimation of variation physicochemical parameters.

Parameters	Methods	References
pH	pH – Metric method	IS : 3025 (Part II)
Odour	Olfactory method	IS : 3025 (Part 5)
Turbidity	Nephelometric method	IS : 3025 (Part 10)
Electrical Conductivity	Conduct metric method	IS 3025 : 1964
Total Dissolved Solid	Gravimetric method	IS : 3025 (Part 16)
Total Alkalinity	Titrimetric method	IS : 3025 (Part 23)
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)
Nitrate	Chromotropic acid method	IS : 3025 (Part 34)
Nitrite	Spectrometric method	IS : 3025 (Part 34)
Phosphate	Spectrometric method	IS 3025 : 1964
Fluoride	Zirconium alizarin method	IS 3025 : 1964
Manganese	Colour comparison method	IS 3025 : 1964
Iron	1, 10, Phenanthroline method	IS : 3025 (Part 53)

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3. RESULTS AND DISCUSSION

The water samples were collected from various parts of Kumbakonam region, and were analyzed for their physicochemical characteristics. The physicochemical parameters like TDS of water samples was analyzed by gravimetric method, turbidity of the water samples was analyzed by nephelometric method, alkalinity, calcium, magnesium, chloride was estimated by titrimetric method, and other parameters were analyzed by Indian standard methods. The results were compared with BIS drinking water quality guideline. The estimated physicochemical parameters are reported in the table- 3 and table- 4.

3.1. Appearance:

Colour of water may be due to the presence of fine particles in suspension (or) due to certain mineral matter in solution. The entire collected sample had slightly yellow colour, (Table- 3).

3.2. Odour:

Organic and inorganic chemicals originating from domestic wastes and by decomposition of vegetables matter contributes odour to the water. Entire collected ground water samples had odour less nature, (Table- 3).

3.3. Turbidity:

Turbidity in natural water is caused by clay, organic matter, phytoplankton etc., and the turbidity of ground water samples from Kumbakonam region ranged from 10 NTU to 55 NTU, the data are shown in table- 3.

3.4. Electrical Conductivity:

Electrical conductivity is the capacity of water to convey current and this may be due to the presence of soluble salts and ionic species which act as conducting medium. Conductivity of the samples ranged between 550 $\mu\text{S}/\text{cm}$ to 1790 $\mu\text{S}/\text{cm}$. The data are given in table- 3, (Fig- 2).

3.5. Total Dissolved Solids:

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 Kumbakonam region ground water range between 385 mg/l to 1253 mg/l. The TDS of ground water sample number S1, S3, S5, S6, S7 and S8 is high in Kumbakonam region, (Table - 3), (Fig - 3). If the TDS of drinking water is more than 2000 mg/l, would result to affect gastro intestinal irritation to human beings.

3.6. Hydrogen ion concentration (pH):

pH is the measure of capacity (or) alkalinity natural water is alkaline due to the presence of carbonates. The desirable pH range for drinking water is 6.5 to 8.5. The water samples had pH ranged from 6.8 to 7.2. All the samples pH lying with in BIS permissible limit, showing that all the samples were almost neutral and harmless, (Table- 4), (Fig- 4).

3.7. Alkalinity:

Alkalinity in water is due to the presence of carbonates, bicarbonates and hydroxides. Bicarbonates are the major contributors since they are included from the basic materials in the soil. Alkalinity is also a measure of water to absorb H^+ ions. Total alkalinity of the samples was found to range from 212 mg/l to 460 mg/l, (Table- 4), (Fig- 5). The entire collected ground water samples had total alkalinity lying above the BIS desirable limit.

3.8. Calcium:

The calcium hardness was recorded in 32 mg/l to 128 mg/l. Ground water sample number S7 and S8 were exceeding the BIS limit. Excess calcium hardness of ground water samples causing kidney problem, urolithosis, to human beings. The data are given in table- 4 and fig- 6.

3.9. Magnesium:

The magnesium hardness was recorded in 21 mg/l to 55 mg/l. The magnesium content of sample numbers S1, S3, S5, S6, S7 and S8 from Kumbakonam region is above the BIS desirable limit, (Table- 4), (Fig- 7).

3.10. Iron:

Irons usually exist in ferrous and ferric forms. Generally, the ferric form is predominant in natural water. Excess iron causes stripping of clothes. The samples had iron levels ranged between 0.30 mg/l to 1.47 mg/l, (Table- 4), (Fig- 8). The entire ground water samples of Kumbakonam region iron content is above the BIS desirable limit.

3.11. Manganese;

Manganese was recorded in 0.33 mg/l to 3.36 mg/l. All the ground water samples of Kumbakonam region the manganese content level is high compare than BIS desirable limit, (Table- 4), (Fig - 9). Generally the manganese is non – toxic to animals. However, when exceed 100 ppm it cause toxicity to human body and produces fever, muscular fatigue.

3.12. Nitrite:

Nitrite in water is due to incomplete oxidation of organic matter containing nitrogen. Nitrites should never be present in drinking water. Nitrite of the samples was found to range from 0.09 mg/l to 1.65 mg/l. The nitrite content of ground water sample number S1, S3 and S4 had high concentration compare than BIS desirable limit. High concentration of nitrites may cause blue-baby syndrome in children, (Table- 4), (Fig- 10)

3.13. Nitrate:

This is the highest oxidized form of Nitrogen. Biological oxidation of nitrogenous substance from sewage is the main source of nitrate. All the samples were found to have nitrate concentration ranging from 1mg/l to 8 mg/l. All the water samples had nitrate content lying within the BIS limit, (Table- 4), (Fig- 11).

3.14. Chlorides:

Discharge of domestic sewage is the main source of chloride in water. The chloride content estimated in the samples ranged between 44 mg/l – 284 mg/l, (Table- 4), (Fig- 12). The ground water sample number S1, S7 and S8 have high concentration of chloride ions. An excess of chloride ion react with organic matter in water and produces cancer – causing compounds.

3.15. Fluoride:

Industrial waste is the main source of fluoride. The fluoride content was recorded in 0.1 mg/l to 0.2 mg/l. An entire ground water samples had fluoride content lying well below the detectable limit, (Table- 4), (Fig- 13).

3.16. Sulphate:

Sulphate occurs naturally in all kinds of water. Drainage wastes are the main source of high sulphate concentration. Excess sodium and magnesium sulphate may cause cathartic action. The samples had sulphate levels ranged between 3 mg/l to 75 mg/l. Entire collected ground water samples lying within BIS limit, (Table- 4), (Fig- 14).

3.17. Phosphate:

Generally phosphate occurs in natural water as inorganic (or) organic phosphates. Domestic sewage, agricultural effluents and detergents are the main source of phosphate in water. Excess phosphate may lead to growth of unwanted algae. The sample had phosphate content ranged from 0.03 mg/l to 0.86 mg/l, (Table- 4), (Fig- 15).

TABLE – 3: Physical parameters of ground water collected from Kumbakonam region.

Parameters	S1	S2	S3	S4	S5	S6	S7	S8	BIS Desirable limit
Appearance	Slightly Yellow	Slightly Yellow	Slightly Yellow	Slightly Yellow	Slightly Yellow	Slightly Yellow	Slightly Yellow	Slightly Yellow	-
Odour	Odour less	Odour less	Odour less	Odour less	Odour less	Odour less	Odour less	Odour less	Agreeable
Turbidity	20	50	35	30	10	45	45	55	2 NTU
EC	1280	550	725	690	780	735	1790	1770	-
TDS	896	385	508	483	546	515	1253	1239	500 mg/l

TDS = Total Dissolved Solids, EC = Electrical Conductance.

TABLE – 4: Chemical parameters of ground water collected from Kumbakonam region.

Parameters	S1	S2	S3	S4	S5	S6	S7	S8	BIS Desirable limit
pH	6.9	6.9	7	7	7.2	7.1	6.8	6.9	6.5 – 8.5
Alkalinity	340	212	320	280	280	236	460	380	200 mg/l
Ca ²⁺	61	32	32	43	48	40	128	104	75 mg/l
Mg ²⁺	55	23	29	21	38	29	48	40	30 mg/l
Fe ³⁺	0.30	1.47	0.64	0.59	0.30	0.75	0.96	1.25	0.3 mg/l
Mn ²⁺	2.63	0.74	0.36	0.68	0.92	0.33	3.36	1.97	0.1 mg/l
NO ₂ ⁻	0.09	BDL	0.45	1.65	BDL	BDL	BDL	BDL	0.02 mg/l
NO ₃ ⁻	7	4	4	2	1	5	7	8	45 mg/l
Cl ⁻	152	52	44	52	64	72	284	240	200 mg/l
F ⁻	0.2	0.1	0.1	0.2	0.1	0.2	BDL	BDL	1.0 mg/l
SO ₄ ²⁻	72	5	3	4	38	31	39	75	200 mg/l
PO ₄ ³⁻	0.03	1.20	1.20	0.04	0.08	0.39	0.86	0.78	-

FIGURES

Fig- 2: EC Variation of the Study area.

Fig- 3: TDS Variation of the Study area.

Fig- 4: pH Variation of the Study area.

Fig- 5: Total Alkalinity Variation of the Study area.

Fig- 6: Calcium Variation of the Study area

Fig- 7: Magnesium Variation of the Study area

Fig- 8: Iron Variation of the Study area **Fig- 9: Manganese Variation of the Study area** **Fig- 10: Nitrite Variation of the Study area** **Fig- 11: Nitrate Variation of the Study area** **Fig-12: Chloride Variation of the Study area** **Fig- 13: Fluoride Variation of the Study area**

Fig- 14: Sulphate Variation of the Study area

Fig- 15: Phosphate Variation of the Study area

CONCLUSION

The physicochemical analysis of water samples concluded that the water quality of Kumbakonam region most of the areas groundwater is not suitable for drinking purpose, because in the region ground water had excess of TDS, manganese, chloride and iron. So human being of that region is suffering with various diseases such as 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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