



Evaluation of groundwater quality near the salt-pans of Kanyakumari and Tuticorin Districts, Tamilnadu, India.

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Abstract : Groundwater makes up about 20 percentage of the world's fresh water supply. It is the cheapest, more convenient and less vulnerable to pollution than surface water, because the groundwater itself provides an effective filtering medium. The degradation of groundwater quality near the salt-pans are due to intensive pumping of fresh groundwater has caused salt water to intrude into the fresh water aquifers. This phenomenon was contaminated the groundwater quality and make unfit for domestic and industrial purposes. This study explain the hydrochemical parameters of p^H , Calcium, Magnesium, Sodium, Potassium, Chloride and Sulphate in groundwater, near the salt-pans of Kanyakumari and Tuticorin districts in Tamilnadu state, India. The results of chemical analysis were correlated with drinking water specifications of Bureau of Indian standards.

Keywords : Groundwater, BIS, Sodium, Chloride, Sulphate.

Introduction:

About 80% of the earth's surface is occupied by water. The main sources of water are rain, surface water (rivers and lakes), undergroundwater (wells and springs) and sea water. Among the above sources of water, rain, surface and undergroundwater is the purest form of water whereas sea water is the most impure form. So, surface and undergroundwater are normally used for domestic and industrial purposes. Groundwater makes up about 20% of the world's fresh water supply. Groundwater is the cheapest, more convenient and less vulnerable to pollution than surface water, because the groundwater itself provides an effective filtering medium. But groundwater in a coastal tract is relatively vulnerable to contamination by sea water and salt- pan activities¹.

In recent years, the growth of industry, technology, population, municipal and industrial waste and chemical fertilizers are degraded the quality of groundwater. The interaction of groundwater with brines also increases the salinity. This phenomenon can be attributed to a variety of factors like, excessive groundwater withdrawal, sea level rise and local hydro geological conditions etc.² In case of Saline water intrusion, groundwater generally exhibits high concentration of ions and also enrichment of selective trace elements in groundwater.³

Effects of ions in groundwater :

(a) p^H :The groundwater prefer a p^H range between 6.5 to 8.5. The p^H range in groundwater is above or below the permissible limit, which affects the mucous membrane in living things, bitter taste to water, corrosion and affects the aquatic life. (b) **Sodium:** The most common sources of sodium in groundwater is underground deposits of salt, naturally occurring brackish water of some aquifers, salt water intrusion

into wells in coastal areas, decomposition of various minerals etc.⁴ Sodium is a principal chemical in body fluids, and it is not considered harmful at normal levels of intake from drinking water sources. The excessive intake of sodium at concentration above 2.5 g/day has been problematic for people with hypertension, heart disease, kidney problems, muscular twitching, cerebral and pulmonary oedema,⁵ that require them to follow a low sodium diet. **(c) Potassium:** Potassium is an essential element for human nutrition and is present in all plant and animal tissues. It acts Cofactor for many enzymes, Insulin secretion, carbohydrate metabolism and protein synthesis. The main sources of Potassium in groundwater are fertilizer application and percolation of saline water in to groundwater. The high intake of potassium above 4.7 g/day has the adverse effects of severe diarrhoea, prolonged sweating, hypokalaemia, cardiac arrhythmia, muscle weakness, nausea and vomiting.⁶ **(d) Calcium:** In salt-pans, calcium carbonate and calcium sulphate is precipitated in reservoir and condenser stages, which may leach by rain water or water bodies and mixed with groundwater aquifers. It causes the high Calcium content in groundwater near the salt-pans. Normally, calcium in drinking water may have some beneficial effects, but at very high levels of a calcium concentration can have some negative health effects and affect the absorption of other essential minerals in the body.⁷ **(e) Magnesium:** It is the important macroelements taken up by plants in considerable amounts. Magnesium is a common constituent in natural water. Higher concentration of magnesium makes the water unpalatable and act as laxative to human beings. **(f) Chloride:** Chloride in surface and groundwater from natural and anthropogenic sources, such as the use of inorganic fertilizers, land fill leachates, salt water intrusion, mineral dissolution, industrial and domestic wastes. Chloride is one of the major inorganic anion in water. In potable water, the salty taste is produced by the chloride concentrations. Chloride are required for normal cell functions in plants and animal life. High chloride may harm to growing plants, fishes and been linked to heart and kidney diseases in human. Chloride in water which increases the Electrical Conductivity of water and thus increases its corrosivity in metal.⁸ **(g) Sulphate:** As groundwater moves through the sulphate content soils and rocks, some of the sulphate is dissolved in water. Sulphate rich brine and bittern also increases the concentration of sulphate in groundwater. The high concentrations of sulphate in the water can have a laxative effect when combined with calcium and magnesium and also caused the diarrhoea and dehydration. As a safety measure, water with a sulphate level exceeding 400mg/l should not be used for domestic purpose. High sulphate levels may also be corrosive for metal and pipelines.⁹

Experimental:

The groundwater samples (boreholes) were collected 300 meter away from the salt-pans of Tuticorin (Tuticorin district), Puthalam and Swamithoppu (Kanyakumari district). Each sample was collected in acid – washed polyethylene bottle. Samples were analyzed in the laboratory for the physico-chemical attributes like p^H, sodium, potassium, calcium, magnesium and anions like chloride and sulphate by using the standard procedures. These parameters are tabulated in Table : 1 and 2.

Table 1 : Drinking water specifications (ISO 10,500 : 1991) Bureau of Indian standards

Characteristics	Desirable limit	Permissible limit
p ^H	6.5 to 8.5	No relaxation
Calcium (mg/L)	75	200
Magnesium (mg/L)	30	100
Sodium (mg/L)	-	200
*Potassium (mg/L)	-	100
Chloride (mg/L)	250	1000
Sulphate (mg/L)	200	400

* WHO Standards

Table 2: Hydrochemical parameters of groundwater samples .

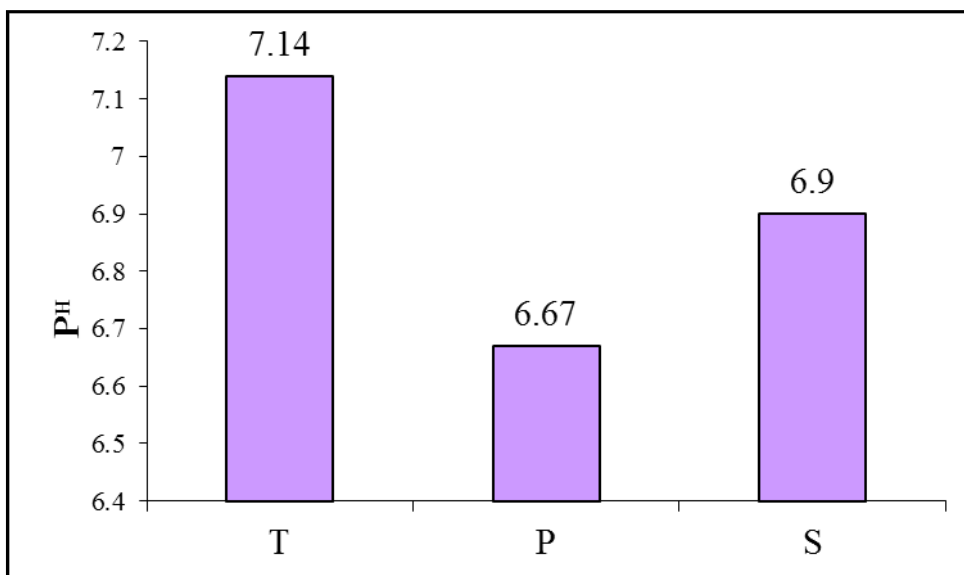
S.No	Parameters	Tuticorin Groundwater	Puthalam Groundwater	Swamithoppu Groundwater
1	p ^H	7.14	6.67	6.90
2	Calcium(mg/L)	244	216	80
3	Magnesium(mg/L)	72	64	20
4	Sodium(mg/L)	340	660	210
5	Potassium(mg/L)	40	70	20
6	Chloride(mg/L)	510	1555	204
7	Sulphate(mg/L)	3940	96	58

Results and Discussion

1. p^H

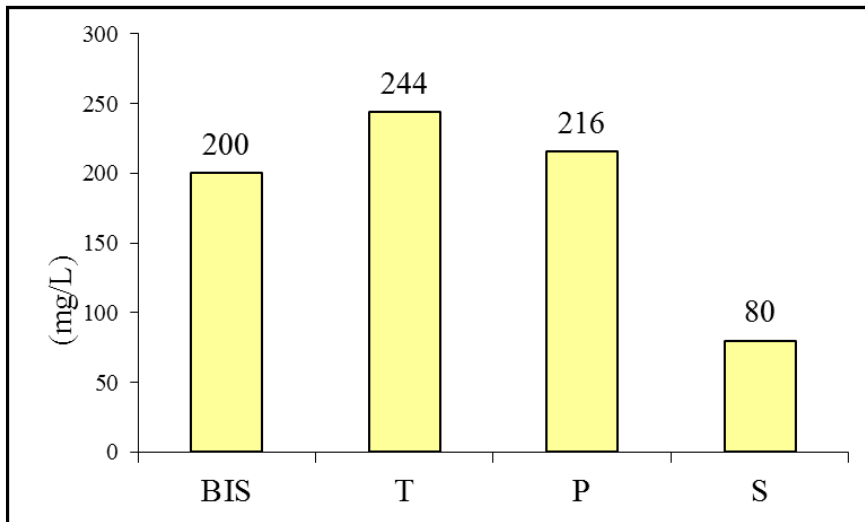
The value of P^H in the groundwater sample collected from the Tuticorin has 7.14 and Puthalam has 6.67. The value of P^H 6.90 was observed in Swamithoppu. The acceptable limit of P^H in groundwater is 6.5 to 8.5. The pH value lower than this will produce sour taste and higher value above 8.5 is bitter taste to water. In our study area, all p^H values within the desirable limit and suitable range. The maximum value of p^H was recorded at Tuticorin and minimum value at Puthalam.

1. P^H



T - Tuticorin, P -Puthalam, S – Swamithoppu

2. Calcium



T - Tuticorin, P -Puthalam, S - Swamithoppu

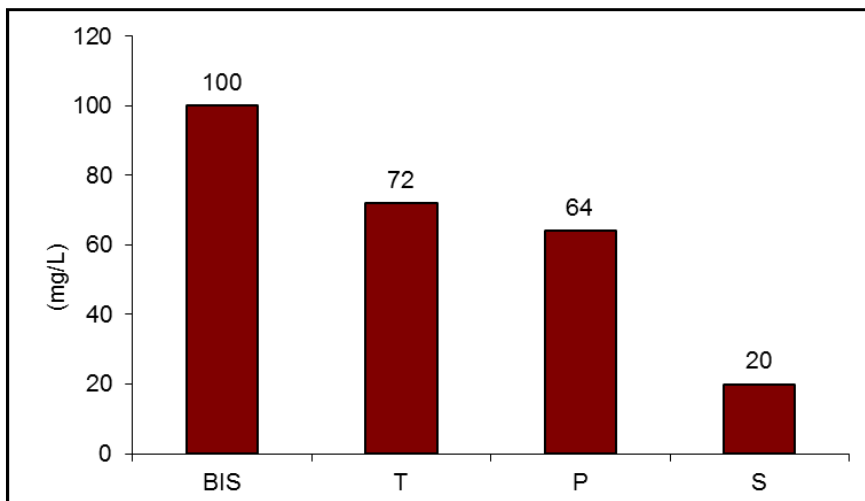
2. Calcium

The maximum allowable limit of calcium ion concentration in groundwater is 200 mg/L as per BIS classification. The sampling station of Tuticorin contains the calcium ion concentration is 244 mg/L, Puthalam has 216 mg/L and 80 mg/L was observed in Swamithoppu. The groundwater samples near the salt – pans from Tuticorin and Puthalam has higher concentration of calcium than the permissible limit of drinking water specification (BIS). This high calcium contents in groundwater are undesirable for domestic and industrial use. The calcium concentration in the groundwater sample from Swamithoppu has within the limit of Bureau of Indian standards.

3. Magnesium

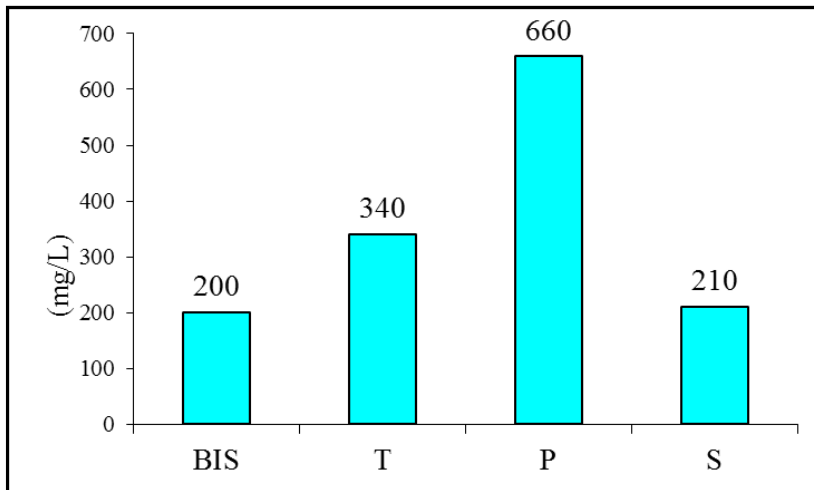
The maximum allowable limit of magnesium ion concentration in groundwater is 100 mg/L as per BIS classification. The Magnesium concentration in Tuticorin groundwater has 72 mg/L, Puthalam has 64 mg/L and 20 mg/L was observed in Swamithoppu. The groundwater samples from the Tuticorin, Puthalam and Swamithoppu has the Magnesium concentration is within the permissible limit of BIS. But, the value of Magnesium in Swamithoppu groundwater sample has lesser than the desirable limit of BIS.

3. Magnesium



T - Tuticorin, P -Puthalam, S - Swamithoppu

4. Sodium



T - Tuticorin, P -Puthalam, S - Swamithoppu

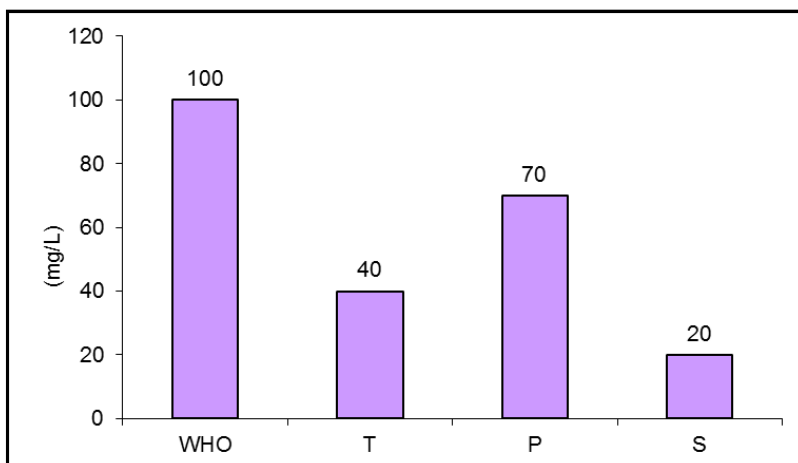
4. Sodium

The sodium concentration ranging from 210 to 660 mg/L. The maximum permissible limit of sodium in groundwater is 200 mg/L as per BIS classification. All the groundwater samples have sodium concentration much above the permissible limit of BIS. The maximum value of sodium concentration was observed in Puthalam ie, 660 mg/L and minimum value was 210 mg/L at Swamithoppu. Higher concentrations of sodium in the groundwater samples of Puthalam and Tuticorin (340 mg/L) are may be attributed to salt- water intrusion from salt – pans or sea.

5. Potassium

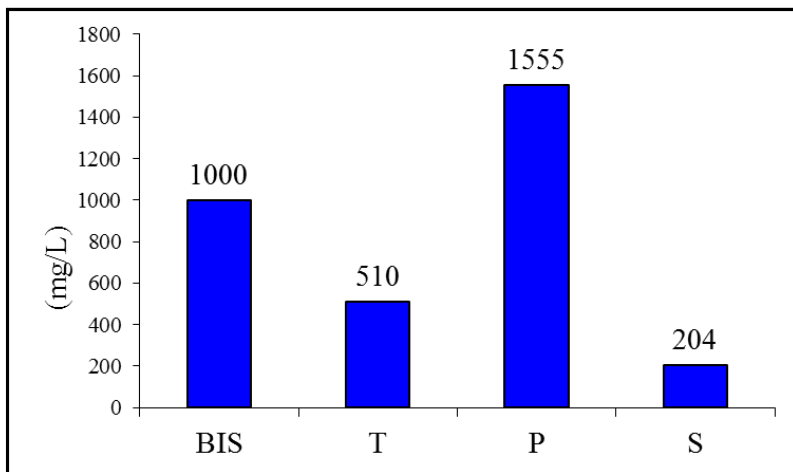
Natural water normally contain low concentration of Potassium. The high values of Potassium should be looked upon with some suspicion as these may indicate pollution. The Bureau of Indian standards, lay down any limits for Potassium content in drinking water. But, the World Health Organisation (WHO 1993) drinking and public health standards express the permissible limit of Potassium in drinking water is 100 mg/L. In our study area, the Potassium content in groundwater has been found in the range of 20 mg/L to 70 mg/L. The maximum Potassium content in the groundwater was 70mg/L at Puthalam, Tuticorin has 40 mg/L and the minimum value was recorded at Swamithoppu i.e, 20 mg/L.This result may indicate that, Potassium concentration in groundwater is within the permissible limit of drinking water standards.

5. Potassium



T - Tuticorin, P -Puthalam, S - Swamithoppu

6. Chloride

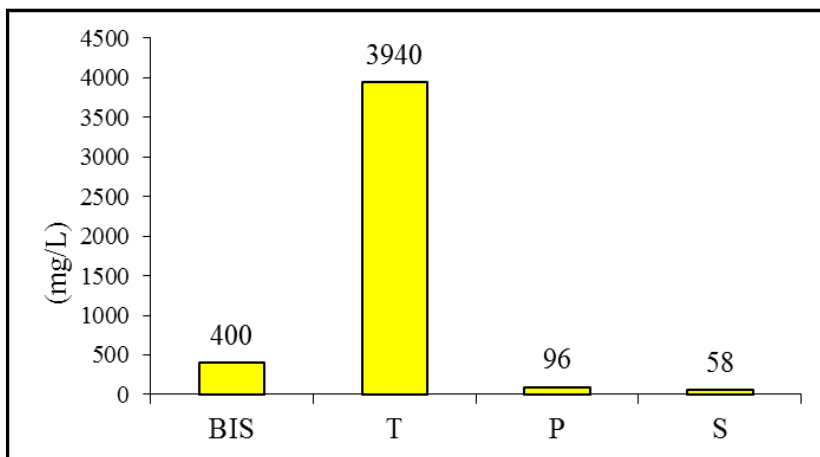


T - Tuticorin, P -Puthalam, S – Swamithoppu

6.Chloride

Chloride concentration ranging from 204 to 1555 mg/L respectively. The maximum allowable limit of chloride is 1000 mg/L as per BIS classification. The chlorinity of the Puthalam groundwater was 1555 mg/L, Tuticorin has 510 mg/L and the minimum value of chloride found in Swamithoppu ie, 204 mg/L. The groundwater samples of Tuticorin and Swamithoppu have chloride content within the permissible limit and hence safe for domestic purposes. But, Puthalam have high chloride content than the permissible limits of BIS. Thus high levels of Sodium and Chloride ions in the groundwater of Puthalam may indicate a significant effect of salt water intrusion from salt – pans or sea.

7.Sulphate



T - Tuticorin, P -Puthalam, S - Swamithoppu

7. Sulphate

The maximum permissible limit of sulphate concentration in groundwater is 400 mg/L as per BIS classification. In our study area, the sulphate value ranges from 58 to 3940 mg/L. The maximum value of sulphate concentration was observed in Tuticorin i.e, 3940 mg/L and the minimum value was 58 mg/L at Swamithoppu. The poor quality water with sulphate value greater than 400mg/L was observed in Tuticorin groundwater. This poor quality may be due to the marine sediments and industrial activities.

Conclusion:

The major cations such as calcium and sodium were high in the groundwater samples of Tuticorin and Puthalam. The concentration of chloride ion was high in Puthalam and sulphate ion was high in Tuticorin. From the results, we conclude that all the parameters in the groundwater samples of Swamithoppu has been within the limit of BIS. This investigation indicates that among the three groundwater samples, the Swamithoppu groundwater was of better quality than Puthalam and Tuticorin groundwater.

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