

Water Quality Index of river Thamirabarani at Papanasam (upper&lower dam) region, Tamilnadu, India

S.Rajesh, NVN.Nampoothiri, S.Vanitha

Abstract: This study is done to evaluate water quality of the Thamirabarani river, by using Water Quality Index method. The water quality index of the river water was done, by analyzing the physical and chemical parameters of water samples taken at seven locations in Jan 2017 to March 2017, along the through flow path of the river. The analysis results were compared with maximum permissible limit values recommended by WHO and BIS for drinking, irrigation and aquatic life. The water quality for Dinking was assessed utilizing the WQI technique. The computed WQI values in this study are found to be between 55.65 to 23.3(for drinking), 47.1 to 14.4 (for Irrigation) and 61.2 to 15.4(for Aquatic life).The results are indicates that, for the stretch of Tamirabarani where study was conducted, the water is suited for irrigation.

Keywords: Drinking water, Physicochemical Characteristics, Pollution, Water Quality Index, Water Quality indicators, Thamirabarani river.

I. INTRODUCTION

In current decades, India has been encountering fast financial development, populace increment and urbanization. These procedures have stressed the deficiency of water assets in Tamilnadu, especially in the desolate districts of Southern Tamilnadu. Water is a significant normal asset of earth and assumes an imperative job in our life. Surface water and Groundwater are the key sources of water. The water quality of Thamirabarani River, an important domestic and potable water source of Southern Tamilnadu.

The waterway Thamirabarani is referenced as the Porunai nathi in Tamil beautiful writing. It gets thankfulness and is alluded to as the eminent one in Sanskrit news coverage references to which are as old as that of the Puranas and Legends. The river is the most important perennial river among the 33 rivers of Tamilnadu. The river Thamirabarani originates from the peak of Periyapothigai hill in the Western Ghats over Papanasam in the Ambasamudram Taluk. The river traverses Tirunelveli and Thoothukudi districts before

joining the Gulf of Mannar. The total catchment area is 4500 km².

It runs for about 120 km traversing for about 80 km including 24 km in hills in Tirunelveli district and for about 40 km in Tuticorin district. It forms a delta in Punnakayal village before outfalling into Bay of Bengal. The area of the delta is 140.93 sq.km. It has about 50 large and small islands, the largest with an area of 20 sq.km and smallest with an area of 0.1 sq.km.

The river Thamirabarani basin lies within 08^o 8' and 09^o 23' N latitude and 77^o 09' and 77^o 54' E longitude. The river basin of the Tirunelveli district includes Shenkottai, Tenkasi, Kadayanallur, Sankarankovil (Part), Veerakeralampudur, Ambasamudram, Nanguneri (Part), Tirunelveli and Palayamkottai taluks. In the Thoothukudi district Srivaikuntam and Tiruchendur Taluks (Part), are in the river basin.

Thamirabarani river basin receives rainfall through the early showers of southwest monsoon and of the later rains of the northeast monsoon. The yearly precipitation is 814.8 mm and is all around conveyed.. The dams and anicuts constructed on Thamirabarani and Manimuthar rivers provide both agriculture and power generation benefits. The Thamirabarani River affords perennial irrigation to a fairly large area on which two crops are normally raised. A few tanks and wells structure some portion of the other wellspring of water system.(G.Venkatesan et al., 2012;Krishankumar et al., 2013;Mopin –kani et al.,2014).

The current study has been conceded out to estimate the water quality characteristics of Thamirabarani river in the Papanasam (upper and lower dam) region by using water quality index which helps the common man to know the value of water.

Understanding water quality requires quantitative knowledge of physical, chemical and biological characteristics and comparing their levels with standards to support for different uses including potable and irrigation use (ICAR Bulletin, No.71, 2014). The ICAR Research Bulletin identifies the important water quality parameters to be analyzed for irrigation water.

The quality of water depends on the concentration of different constituents in it. The concentrations of constituents depend on its sources of origin and interventions through living or dead organisms in the way of its stream and there for inherently depend on the location of water. So in this study, the locations of water sampling sites are taken with a GPS and the latitude and longitude noted.

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II. STUDY AREA

A. Water Samples Sites

The water samples from Thamirabarani river were collected from seven stations. The sampling station could be considered as “source point”. The seven stations were selected considering their human activities and Hydro power generation. The location details of the sampling stations are shown in Table 1. The samples were collected from all source point at 11am.

Table-1: Water Sampling Site Locations

Sampling Stations	Latitude	Longitude
Kariyar dam	8°38'14"N	77°17'41"E
Sorimuthu Ayyanar Temple	8°39'18.94"N	77°20'12.75"E
Kariyar & Servalar Junction Bridge	8°40'51.09"N	77°20'47.03"E
Agasthiyar falls and three sources point	8°42'15.02"N	77°21'49.40"E
Papanasam-1(Lower dam),	8°42'30"N	77°22'5"E
Papanasam-2(Lower dam)	8°42'33"N	77°22'7"E
Papanasam-3(Lower dam)	8°42'48"N	77°22'11"E

III. METHODOLOGY AND CHARACTERISTICS ANALYSIS

A. Analytical Procedure

Surface water status is controlled by the more terrible of natural and compound status. The physico-chemical analyses and biological tests were performed using standard technical methods.

Water quality requirements for different uses of water are scientifically termed as criteria and the permissible level of contaminants in water for different uses without any negative impact on environment and society are termed as Standards. These are legally enforced levels set up by a governmental or any international agency that have been arrived at after consideration of water quality criteria and the economic, social and political consequences of possible regulatory action (ICAR Bulletin, No.7,2014).

B. Water Quality Index (WQI):

A water quality index relates a gathering of water quality parameters to a general scale and combines them into a single number in unity with a chosen method of computation. The favored utilization of WQI is to assess water quality patterns for executive purpose, although, it is not meant for an absolute measure of the level of pollution or the real water quality. The water quality index was evaluated by considering nine important physico-chemical parameters (Table 3,4&5) using ICMR (WHO) along with BIS standards by the following formula.

$$WQI = \sum W_n * Q_n$$

Where, W_n -Unit Weight(parameter weightage),

$$Q_n = 100 * \frac{(V_n - V_{i0})}{(S_n - V_{i0})}$$

Where,

Q_n - Quality Rating for the n^{th} water quality parameter.

V_n - Observed value of the n^{th} parameter for the given sample.

S_n - Standard Permissible value of the n^{th} parameter.

V_{i0} -Ideal value of n^{th} parameter in the pure water

*All the Ideal values (V_{i0}) are taken as zero for drinking water

(except for pH = 7 and dissolved oxygen = 14.6 mg/l)

$$W_n = \frac{w_n}{\sum w_n}$$

Where, W_n -Unit Weight of the Water quality parameter

w_n -weight of each parameter,

n -number of parameters

IV. RESULTS AND DISCUSSIONS

- **pH Value:** The pH value of a water source is measure of its acidity or alkalinity. The pH level is a measure of the action of the hydrogen molecule, on the grounds that the hydrogen development is a decent portrayal of the causticity or alkalinity of the water. pH ranges from 6 and 9 along the basin at various distances the permissible limit in 8.5 and desirable limit is 7 for drinking water. The pH tends to slightly decrease along the course of the river.
- **TDS:** Total dissolved solids in water are a measure of all organic and in-organic substances contained in it. The Primary application of TDS is in the study of water quality for streams, lakes and river although TDS is not considered as a primary pollutant. The Primary source for TDS in receiving waters are agricultural & residential runoff, discharge from industrial or sewage treatment plants or leaching of soil contamination. Usually higher concentration of TDS is not a health hazard. The TDS standard range from 128 to 768 mg/l. The TDS values are in the suggested range.
- **Hardness:** Hardness is the presence of minerals in water, typically Sulphates of Calcium and Magnesium. Hardness Standards were recorded between 1-60 mg/l. The level of hardness is taken as under:

Soft	: 0-50 mg/l
Moderately soft	: 50-100 mg/l
Slightly hard	: 100-150 mg/l
Moderately hard	: 150-250 mg/l.

Therefore, water quality of surface water indicating towards Soft and Moderately soft.

- **Chloride:** The chloride ion is formed when the element chlorine (a halogen) gains an electron to form an anion. Cl⁻. The salts of hydrochloric contain chloride ions and can also be called chlorides. As per IS 10500, the permissible limit for the presence of chloride content in water is 250 mg/l. but this could be extended up to 1000 mg/l. hence, the water present in the whole district has chloride value in its safe limits. Concentration of chloride was found to range from 7 to 78 mg/L.

- **Sodium:** The variation of sodium in each station is different. Its higher concentrations could be detected by its taste being salty. Sodium can be released naturally into water through mineral deposits in ground water, surface water. The Value of Sodium ranged between 0.01 to 14 mg/l.
- **Calcium:** Calcium, as the Ca^{2+} particle, is one of the major inorganic cations, or positive particles, in salt water and fresh water. The calcium is usually required for drinking water in the range of 75 to 200 mg/L.
- **Magnesium:** Magnesium is a fundamental component for the growth and development of human beings. The estimation of magnesium went somewhere in the range of 2.2 and 12 mg/L in the of waterway streaming regions
- **Potassium:** Potassium is an vital component and is present in all animal and plant tissues. The Value of Potassium ranged between 0.01 to 0.78 mg/L.
- **Dissolved oxygen (DO):** The value of DO varied from 1.2 to 2.7 mg/L. The DO in surface waters of the streaming way regions is underneath the allowable furthest reaches of 6 mg/L during every one of the seasons.
- **Bio-Chemical Oxygen Demand (BOD):** Concentration of BOD was found 0.75 to 1.42 mg/L. It represents aquatic living organism of water and impacts the rate of substance and organic responses.

The calculated of WQI(Drinking, Irrigation, Aquatic) of 7-stations are given in Tables 3-5. The water quality index and its rating for drinking, irrigation and aquatic life purposes are given in Table 6. WQI of surface water of flowing path areas of Thamirabarani River, status of water quality at different sites are given in Table 7. The WQI is a useful method to assess the water quality of surface water.

Table- 6: Water Quality Index Scale for Drinking , Irrigation& Aquatic life

S.No	Range	Quality
1	0-25	Excellent
2	26-45	Good
3	51-75	Moderately Polluted
4	76-100	Very Poor
5	100 and above	Unsuitable for Drinking,Irrigation, Aquatic life

V. CONCLUSION

In this study, the water quality of the Thamirabarani River and its suitability of drinking, irrigation, and aquatic life were evaluated. To evaluate water quality of the Thamirabarani River, 7 source points were determined and 11 water quality parameters were selected for monitoring and analysis. Water quality parameters pH, EC, TDS, HCO_3 , Cl,

SO_4 , Mg, Ca, K, DO, BOD, COD, and Na were used to calculate WQI values to evaluate the river water quality. The results indicate that the river water varied, to drinking, irrigation and aquatic life. The computed WQI values are between 23.3 to 52.65 for drinking, 14.4 to 47.1 for Irrigation, and 15.4 to 61.2 for Aquatic life. The water quality index classification shows that table 7.WQI values and Classes are shown on the satellite image in Figure 1. The size of the circle is proportional to the WQI value. As the size increases water quality decreases for a specific purpose. It can be visualized that the WQI is higher in locations Kariayar dam(1) and Papanasam3(6). This can be attributed to pollution due to tourism and bathing/cleaning effects. On other locations, the Tamirabarani is in a relatively “Good” quality class. Hence it is recommended that the “Good” and “Excellent” quality is preserved along the Tamirabarani by suitable conservation and pollution prevention options. Other places of moderate and serve pollution may be required to be treated and further pollution prevented. The water nature of surface water, particularly stream water, must be checked occasionally. It is basic practice to decide the nature of waterway waters during the summer and winter seasons.

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Table-2: Physico –Chemical recommended Standards for Drinking Water, Irrigation water and Aquatic life by BIS

S.No	Parameter	Standard range Drinking water	Weightage(w_n) drinking water	Standard range Irrigation water	Weightage(w_n) Irrigation water	Standard range aquatic life	Weightage(w_n) aquatic life	Methods of Analysis
1	pH	6.5-8.5	6	6.5-8.5	4	6.5-8.5	6	Electrometric Method
2	Electrical Conductivity	50-300	4	0.7-3.0	4	20-50	4	Nephelometric Method
3	Total Dissolved Solids(mg/l)	500-2000	4	500-1000	2	500-1200	4	Gravimetric Method
4	Total Hardness as CaCO_3 (mg/l)	200-600	2	-	-	-	-	EDTA Method
5	Magnesium(mg/l)	30-100	2	1-5	2	-	-	AAS Method
6	Sodium(mg/l)	50-200	3	-	-	-	-	AAS Method
7	Potassium(mg/l)	0-.3	2	.1-2	1	-	-	AAS Method
8	Calcium(mg/l)	75-200	2	5-20	1	-	-	AAS Method
9	Dissolved Oxygen(mg/l)	6	4	-	-	4-14.6	7	Winklers Titrimetric Method
10	Chloride(mg/l)	250-1000	3	5-30	1	250-600	3	Mohr Method
11	Biological Oxygen Demand(mg/l)	5	4	-	-	-	-	Oxygen difference method
12	SAR(mg/l)	-	-	5-15	4	5-26	4	AAS Method
13	Carbonate(mg/l)	-	-	0-.1	1	-	-	EDTA Method
14	Bicarbonate(mg/l)	-	-	8-10	1	-	-	EDTA Method
15	Sulphate(mg/l)	-	-	5-20	1	-	-	Gravimetric Method
Σw_n			36		22		32	

Water Quality Index of river Thamirabarani at Papanasam (upper&lower dam) region, Tamilnadu, India
 Table-3: Physico-Chemical Characteristics for Drinking water analysis of Thamirabarani @ Papanasam upper and lower dam

S.No	Parameters	Karaiyar Dam @0KM	Sorimuthuayyanar Temple @3.07KM	Bridge @6.8KM	Agasthiyar Falls @10.35KM	Papanasam 1 @ 11.14KM	Papanasam 2 @ 11.24KM	Papanasam 3 @ 11.87KM
1	pH	8.16	7.6	6.75	7.6	6.48	6.1	7.35
2	EC	110	80	120	60	20	20	50
3	Chlorides as Cl in (mg/l)	7.1	14.2	17.75	10.65	35.5	42.6	78.1
4	Total Dissolved Solids in (mg/l)	704	512	768	384	128	128	32
5	Total Hardness as CaCO ₃ in (mg/l)	60	60	60	40	12	1	24
6	Magnesium as Mg in (mg/l)	7.2	2.4	4.8	3.6	12	9.6	10.15
7	Sodium as Na in (mg/l)	2.3	0.1	6.9	0.01	0.01	14.95	20.5
8	Potassium as K in (mg/l)	0.67	0.01	0.01	0.01	0.78	0.78	0.02
9	Calcium as Ca in (mg/l)	4.8	4.8	4.8	3.2	9.6	0.4	15.2
10	DO in (mg/l)	1.62	1.54	2.17	1.69	1.3	1.2	1.7
11	BOD in (mg/l)	1.34	0.75	1.42	1.3	1.06	0.96	1.2
12	WQI	52.65	26.6	27.09	26.67	44.20	48.02	23.22

Table-4: Physico-Chemical Characteristics for Irrigation water analysis of Thamirabarani @

Papanasam upper and lower dam

S.No	Parameters	Karaiyar Dam @0KM	Sorimuthuayyanar Temple @3.07KM	Bridge @6.8KM	Agasthiyar Falls @10.35KM	Papanasam 1 @ 11.14KM	Papanasam 2 @ 11.24KM	Papanasam 3 @ 11.87KM
1	pH	8.16	7.6	6.75	7.6	6.48	6.1	7.35
2	EC	0.11	0.08	0.12	0.6	0.2	20	50
3	Total Dissolved Solids	704	512	768	384	128	42.6	78.1
4	SAR	3	2	3	4	5	128	32
5	CO ₃ ⁻²	0.01	0.01	0.01	0.01	0.01	1	24
6	HCO ₃ ⁻	0.7	0.5	0.8	0.4	1.3	9.6	10.15
7	Chlorides as Cl	0.2	0.4	0.5	0.3	1	14.95	20.5
8	SO ₄	0.01	0.01	0.1	0.01	0.01	0.78	0.02
9	Magnesium as Mg	0.6	0.2	0.4	0.3	1	0.4	15.2
10	Pottassium as K	0.67	0.01	0.01	0.01	0.78	1.2	1.7
11	Calcium as Ca	0.24	4.8	4.8	3.2	9.6	0.96	1.2
12	WQI	47.71	22.5	14.40	22.26	22.32	48.00	23.23

Table-5: Physico-Chemical Characteristics for Aquatic life analysis of Thamirabarani @

Papanasam upper and lower dam

Water Quality Index of river Thamirabarani at Papanasam (upper&lower dam) region, Tamilnadu, India

S.No	Parameters	Karaiyar Dam @0KM	Sorimuthuayyanar Temple @3.07KM	Bridge @6.8KM	Agasthiyar Falls @10.35KM	Papanasam 1 @ 11.14KM	Papanasam 2 @ 11.24KM	Papanasam 3 @ 11.87KM
1	pH	8.16	7.6	6.75	7.6	6.48	6.1	7.35
2	Ec	110	80	120	60	20	20	50
3	Chlorides as Cl	7.1	14.2	17.75	10.65	35.5	42.6	78.1
4	Total Dissolved Solids	704	512	768	384	128	128	32
5	SAR	3	2	3	4	5	5.3	4.5
6	DO	1.62	1.54	2.17	1.69	1.3	1.2	1.7
7	BOD	1.34	0.75	1.42	1.3	1.06	0.96	1.2
8	WQI	61.23	35.8	1.42	29.58	33.12	15.40	21.9

Table-7: WQI for drinking, irrigation and aquatic life

S.No	Place	Distance in Km	WQI for Drinking purpose	WQI for Irrigation purpose	WQI for Aquatic life
1	Karaiyar Dam	0	52.65(MP)	47.1(MP)	61.2(MP)
2	Sorimuthuayyanar Temple	3.07	26.6(G)	22.5(E)	35.8(G)
3	Bridge	6.81	27.1(G)	14.4(E)	55.5(MP)
4	Agasthiyar Falls	10.35	26.67(G)	22.2(E)	29.6(G)
5	Papanasam 1	11.14	44.2(G)	22.34(E)	33.1(G)
6	Papanasam 2	11.24	48.02(MP)	34.61(G)	15.4(E)
7	Papanasam 3	11.87	23.3(E)	17.92(E)	21.9(E)

E=Excellent, G=Good, MP=Moderately Polluted



Fig 1: Tamirabarani River-Papanasam WQI image