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# Physico-chemical analysis of Tamirabarani river water in South India

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**Abstract**: The water quality of Tamirabarani river, an important domestic and potable water source of Southern India, has been assessed. The physico-chemical parameters measured at sixteen locations of the river body revealed that the riparian water pollution has not exceeded the set limit of the standards. Thus the study reassures the stake holders of the river basin its suitability for irrigation and industrial purposes and also its safe use for human consumption, of course with appropriate disinfection (in the absence of investigation on the biological parameters) throughout the stretch of the investigated points during the study period. However, the investigators reiterate the need for continued monitoring of the common property resource under strict water quality surveillance to ensure for the health and environmental safety of the river basin stakeholders.

*Keywords* : Physico chemical, Tamirabarani river, pollution, water quality, India.

## Introduction

Water the elixir, is essential for the survival of all forms of life. Even though 80% of earth's surface (80% of the total 50,000 million hectares in area) is covered by water, the fresh water supply has increasingly become a limiting factor, owing to the industrialization on one side and exploding population on the other. Acute short fall of monsoon rains, poor water shed management, lavish use of water for domestic and agricultural purposes have led to the overexploitation of the surface water sources especially from the river bodies. Many perennial rivers become ephemeral and even dried up. On the other hand, surface water bodies become the dumping source for industrial effluent and domestic wastes. As a result, the naturally existing dynamic equilibrium among the environmental segments get affected leading to the state of polluted rivers. The perennial river body the Ganges, in Northern part of India has been of great public concern (Saxena *et al*., 1978) so as the riparian water conditions in many parts of India (Shah & Ahmed, 1984; Upadya *et al*., 2005).

Water quality characteristics of aquatic environments arise from a multitude of physical, chemical and biological interactions. The water bodies – rivers, lakes and estuaries are continuously subjected to a dynamic state of change with respect to their geological age and geo chemical characteristics. This dynamic balance in the aquatic ecosystem is upset by human activities results in pollution which in turn manifests dramatically as fish kill, bad taste of drinking water, offensive odors and unchecked growth of aquatic weeds etc. Quality of water is now a great concern for environmentalists as well as the common publics in all parts of the world. The decision of World Health Organization (WHO)'s 29$^{th}$ session (May 1976) emphasizes that water for the consumers should be free from pathogenic organisms and toxic substances. In spite of vast water resources in lakes and rivers and good monsoon, India faces perennial problems of floods and droughts and high pollution of fresh water resources (De, 2000; Manivasakam, 1991; WBET, 1997). In Southern India, the Tamirabarani basin is situated between latitude 8.21' N and 9.13' N and east of longitude 77.10' E. The 40 meter Vanatheertham waterfalls are located close to the origin of the main river. The Papanasam Reservoir is 16km downstream. It is fed by both monsoons and its tributaries. It originates more than 2,000 metres above sea-level in Agasti Hill, a part of the Annamalai range on the eastern slopes of Western Ghats in the Tirunelveli district of Tamil Nadu, near the peaks of Aduppukkal Mottai, Agastya Malai and Cherumunji Mottai. It flows roughly east and enters the Gulf of Mannar of the Bay of Bengal near Palayakayal. At 130km it is a relatively short river serving as the principal source of fresh water for human need. With increasing number of industries and stakeholders of any river basin, the concern over the quality of the river has also grew up

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and hence warranted for the present investigation.

*Table 1. Sampling station in Tamirabarani River*

| Station No: | Description of location of sampling points |
|---|---|
| 1 | Bathing ghat, Agasthiar falls |
| 2 | 100m U/S of road bridge in main road to Madura coats |
| 3 | At Railway Bridge (U/S of discharge point of effluent from M/S Madura Coats near Ambasamudram) |
| 4 | D/S of Gadana river confluence |
| 5 | D/S of Pulp and Paper Industry |
| 6 | D/S of Mukkudal |
| 7 | D/S of confluence point of Pachaiyar river |
| 8 | Near Murugan Temple, Kurrukkuthurai |
| 9 | U/S of road bridge opposite to collectorate, Kokkirakulam |
| 10 | D/S of Cremation Ground, Vellakoil |
| 11 | Near drinking water supply taping point at Pottal |
| 12 | At Sivalaperi |
| 13 | At Vallanadu |
| 14 | At Srivaikundam Anicut |
| 15 | D/S of Causeway across Eral |
| 16 | Across the river at Authoor |

## Materials and methods

The water samples were made as grab samples from the river Tamirabarani at sixteen different points (Fig.1) from Karaiyar to Authoor on 20th May 2007 to 23rd May 2007. The samples were collected in polyethylene cans of one-liter capacity and analyzed as per the standard method for various chemical constituents. The description of sampling sites is provided in Table 1.

Fig.1
Not to be scaled


All reagents were of analytical grade and solutions were made of distilled water. Various water quality parameters like pH, Turbidity, Total Dissolved Solids, Specific Conductance, Total Alkalinity, Chloride, Fluoride, Sulphate, Total Hardness, Dissolved oxygen, Biochemical Oxygen Demand, Nitrate and Phosphate were determined using standard analytical methods (APHA, 1992; Jeffery *et al*., 1991; Trivedi & Goel, 1984; Vijayaram *et al*., 1990). The instruments used were calibrated before use for observing readings. The repeated measurements were made to ensure precision and accuracy of results.

## Results and discussion

The physico-chemical tests were conducted employing standard scientific methods so as to minimize the determinate errors. Assessment of the water samples for pollution is made by comparison of the assessed values of all the physico-chemical parameters with the corresponding standards prescribed for drinking water by various organizations IS, ICMR and WHO as displayed in Table 2. Following are some of the observations revealed from the study of the various water quality parameters (Table 3).

The pH values of the samples varied between 7.0 and 7.4. The World Health Organization (WHO, 1984) prescribed the limiting value of pH as between 7.0-8.5 for a

*Table 2. Comparison of water quality standards (domestic & drinking water)*

| Parameters | IS | | ICMR | | WHO | |
|---|---|---|---|---|---|---|
| | (P) | (E) | (P) | (E) | (P) | (E) |
| pH | 6.5-8.5 | 6.5-9.2 | 7.0-8.5 | 6.5-9.2 | 7.0-8.5 | 6.5-9.2 |
| SC (μmho/cm) | 300* | - | - | - | - | - |
| Turbidity (NTU) | 5 | 25 | 5 | 25 | 5 | 25 |
| TDS | 500 | - | 500 | - | 500 | 1500 |
| Total Alkalinity | 600 | - | 120 | - | - | - |
| Total Hardness | 300 | 600 | 300 | 600 | 500 | - |
| Chloride | 250 | 1000 | 250 | 1000 | 200 | 600 |
| Sulphate | 150 | 400 | 200 | 400 | 200 | 400 |
| DO | 3 | - | >5 | - | 4-6* | |
| BOD | - | - | <5 | - | 6.0 | |
| Nitrate | 45 | - | 45* | - | - | - |
| Fluoride | 1.0 | - | 1.0 | - | 1.0-1.5 | |

All units except pH, specific conductance and turbidity are in mg/l
SC- Specific conductance; P – Permissible; E – Excessive; IS – Indian Standard
ICMR- Indian Council for Medical research; WHO – World Health Organization
* United States Public Health Drinking Water Standard

sample of water to be used for industrial, agricultural and domestic purposes.

The magnificent parameter of river pollution is turbidity, as is well established by many studies already, the values of this parameter form the range (2-5/NTU) which is well within the standard limit (WHO, 1984). It reveals that the river pollution is well within the safe level.

The specific conductance of the water samples ranged from 80 to 350 μmho/cm and was within the standard limit of 300 μmho/cm except station16. Thus the water has very low electrical conductivity, implying the presence of reduced level of ionic species. However, the conductance of water increases at station 16, which might be due to enrichment of organic conducting species from soaps and detergents of the bathing places (Gopalsami *et al*., 2003; Vijayaram *et al*., 1990).

The TDS content of water samples collected at the selected stations ranged between 700-161 mg/l, which is well below the set limit value of 500 mg/l (WHO, 1984) acceptable for potable use except at station 16. The steady increase in TDS and conductance indicated that water is contaminated i.e. due to the discharge of effluents to the river from various industries like Madura coats, Sun paper mill, and Government automobile workshops and pilgrimage places. This led to the increase of the organic and inorganic materials in the water gradually as the river flow from station 1 to 16. The determination of total solids indicates a wide range of variation. The tolerance limit prescribed in the progress report of the committee on Water Quality Tolerance for industrial use is only 50 mg/l. In all samples analyzed the total solids is found to be greater than 50 mg/l.

All the water samples showed zero phenolphthalein alkalinity and have methyl orange alkalinity only. It indicates the alkalinity of the samples which are due to bicarbonate and not due to carbonate and hydroxide ions.

The concentrations of chloride ion showed variation between 9.67 and 62.33 mg/l. The prescribed minimum tolerance limit for chloride in drinking water is 200 mg/l (WHO, 1984). In all the tested places throughout the course of the river the presence of chloride ions is within the limit. Thus, indicating the lesser degree of pollution that maks the river water suitable for domestic and industrial purposes.

The estimation of fluoride ion content shows a variant value between 0.1 and 1.3 mg/l. The World Health Organization (WHO, 1984) sets the threshold value for fluoride ion content in domestic water as 1 to 1.5 mg/l which would prevent dental caries. The chemical analysis for sulphate ions in the water samples revealed its negligible presence.

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*Table 3. Water quality of Tamirabarani River*

| Station No: | pH | Specific Conductance µmho/cm | TDS (mg/L) | Turbidity (NTU) | Total Alkalinity (mg/l) | Chloride (mg/l) | Fluoride (mg/l) | Total Hardness (mg/l) | DO (mg/l) | BOD (mg/l) | Nitrate (mg/L) | Phosphate (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7.0 | 80 | 161 | 2.1 | 24.99 | 19.75 | 0.1 | 32 | 5.62 | 1.75 | 3.7 | 0.23 |
| 2 | 7.2 | 90 | 185 | 2.3 | 26.18 | 9.67 | 0.2 | 26 | 5.07 | 1.10 | 3.5 | 0.41 |
| 3 | 7.4 | 110 | 225 | 4.5 | 35.22 | 13.3 | 0.8 | 58 | 5.51 | 1.,64 | 2.8 | 0.37 |
| 4 | 7.2 | 200 | 410 | 2.2 | 23.80 | 17.42 | 0.9 | 54 | 5.20 | 1.15 | 3.0 | 0.29 |
| 5 | 7.3 | 95 | 195 | 4.7 | 50.64 | 23.25 | 0.5 | 52 | 5.46 | 1.59 | 2.0 | 0.43 |
| 6 | 7.1 | 175 | 350 | 3.4 | 28.24 | 14.0 | 0.2 | 50 | 5.37 | 1.40 | 2.5 | 0.32 |
| 7 | 7.4 | 120 | 248 | 3.8 | 11.21 | 14.89 | 0.4 | 18 | 6.45 | 0.74 | 4.0 | 0.39 |
| 8 | 7.5 | 145 | 295 | 2.5 | 41.21 | 19.33 | Negligible | 34 | 5.23 | 1.19 | 4.5 | 0.18 |
| 9 | 7.1 | 220 | 450 | 3.1 | 43.32 | 16.22 | Negligible | 73 | 5.71 | 1.89 | 4.8 | 0.45 |
| 10 | 7.2 | 215 | 435 | 2.0 | 48.24 | 17.25 | Negligible | 48 | 5.89 | 2.21 | 6.0 | 0.28 |
| 11 | 7.0 | 140 | 285 | 3.2 | 44.56 | 20.58 | 0.1 | 53 | 5.02 | 1.01 | 3.6 | 0.24 |
| 12 | 7.1 | 180 | 360 | 2.7 | 24.39 | 21.02 | 0.1 | 52 | 5.35 | 1.38 | 3.2 | 0.33 |
| 13 | 7.2 | 185 | 374 | 3.4 | 29.67 | 12.53 | 0.1 | 64 | 5.11 | 1.35 | 4.5 | 0.20 |
| 14 | 7.0 | 190 | 389 | 3.0 | 30.54 | 16.97 | 0.2 | 67 | 5.86 | 2.27 | 5.9 | 0.19 |
| 15 | 7.1 | 230 | 460 | 3.7 | 38.23 | 52.72 | 0.8 | 120 | 2.42 | 5.90 | 2.7 | 0.35 |
| 16 | 7.2 | 350 | 700 | 2.9 | 62.81 | 62.33 | 1.3 | 160 | 5.45 | 1.71 | 5.5 | 0.39 |

The total hardness value lies between 160 and 18 mg/l in the present study. The maximum limit of total hardness for drinking water is 300mg/l ( WHO, 1984). The hardness of the riparian water lies within the prescribed standard. Hence the whole stretch of the river water can be used for drinking (in the absence of biological suitability test, suitable precautions needed) as well as irrigation purposes with a single exception at station16. This may be due to the addition of calcium and magnesium salts from detergents and soaps.

The investigation of dissolved oxygen revealed that the value lies between 6.45 to 2.42 mg/l. The tolerance limit for inland surface waters used as raw water and bathing ghat is 3 mg/l. At all places, except station 15, water has higher DO value than the limit prescribed. DO content satisfies the public water supply needs.

The highest dissolved oxygen content 6.45 was recorded at station 7. Higher solubility due to lesser hardness in combination with the prevalence of primary production might result in the higher value of DO at station 7. This may be due to reflection of high level of photosynthetic activity of hydrilla plants in this site. The lowest dissolved oxygen content 2.42 mg/l was recorded at station15.The decrease in dissolved oxygen content may be due to the inflow of field water into the river in smaller quantities and probably with microbial activity.

The Biochemical oxygen Demand value ranged from 0.74 to 5.90 mg/l. The phenomenon of eutrophication resulting from sewage load was seen in station15 from the high BOD. Eutrophication permits the blooming of phytoplankton.

Nitrate is observed in the river water of Tamirabarani in the range of 2.0 to 6.0 mg/l. Nitrate is toxic and it has been reported that consumption of water with high levels of nitrate causes infantile methemoglobinemia and death (WHO, 1978). Since this parameter is not present at a higher level in any of the selected stations, it does not pose a threat to the health of human beings.

Phosphate concentration in water samples varied from the 0.43 to 0.18 mg/l. Phosphate is non-poisonous at the present concentration and thus poses no threat to aquatic lives and health of human beings.

The values of all the thirteen parameters measured for the sixteen water samples are too low to reach the standard values and in many cases they are far low, bringing about clearly the no pollution or less pollution state of the river water. This is contradiction to what one can usually expect about the waters with many industries along the side, because the work of Water Quality Index of Indian Rivers (25 major rivers) has pointed out that almost all the rivers are considered polluted and unfit for human consumption without treatment. Perhaps the reason may be:

a) The effluent from industrial units has a depressive level of contamination both in quantity and quality.
b) All the major and medium industries have established Effluent Treatment Plant in their factories, which were subsequently revamped due to stringent legislations with an investment of about Rs.600 to Rs.700 lakhs during the years 1998 to 2004.
c) Even in the case of extensively contaminated effluents, they may get settled as sludge by the considerable quantum and flow of water.

The study provides first hand information based on preliminary investigation. A continuous monitoring of the riparian water covering all the seasons over a period time is necessary for fresh water source management. Since the water body serves as potable source as well as for other human needs, periodic monitoring will be helpful to reassure the publics and safeguard the precious common property resource from improper exploitation.

## Conclusion

The present study reveals that the Tamirabarani river water is palatable, suitable for industrial and civic purposes and potable (additional tests on biological parameters are needed) if appropriate disinfection methods are followed.

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