International Journal of Scientific Research and Management (IJSRM)
||Volume||06||Issue||10||Pages||FE-2018-111-117||2018||
Website: www.ijsrm.in ISSN (e): 2321-3418
Index Copernicus value (2015): 57.47, (2016):93.67, DOI: 10.18535/ijsrm/v6i10.fe03

Physico chemical parameters of water of some selected areas of Tamirabarani river, Tirunelveli, Tamilnadu

O.V.Sheebha Malar[1], Dr.P.Kokila[2], Dr.C.Isac Sobana Raj[3]

[1]Research Scholar, Manonmaniam Sundaranar University,
Tirunelveli, Tamil Nadu -627012, India.
[2]Department of Chemistry, Vivekananda College, Agasteeswaram,
Kanyakumari, Tamil Nadu-629701, India.
[3]Department of Chemistry and Research, Nesamony Memorial Christian College,
Marthandam, Tamil Nadu-629165, India.

Abstract:
In Tirunelveli and Thoothukudi districts Tamirabarani River is flowing continuously for 128km and drains into the Bay of Bengal at Punnaikayal village. In this present study, physico chemical parameters of some selected areas of Tamirabarani River water of Tirunelveli, was analyzed from 2013 to 2016. Seven sampling points were selected and the water samples were examined. The parameters such as chloride, sulphate, total alkalinity, calcium, magnesium and hardness were analyzed. Paper industrial waste, textile pollutants and temple waste are added to this point. These are the main sources of pollutants of Tamirabarani River. Tamirabarani is a main source of water supply to many towns which include Tirunelveli Corporation. In Tirunelveli corporation area the drinking water is not treated properly. Entire flow on the river has turbidity. The main aim of this paper is to analyze the various pollutants of Tamirabarani River by selecting seven different sites.

Keywords: Tamirabarani River, pollutants, chloride, Sulphate, total alkalinity, calcium, magnesium and hardness.

1. Introduction

In this world today all human beings are affected by one of the major problem "Environmental Pollution". Pollution has now become an individual threat to the very existence of mankind on this earth. It is now a major challenge of our times. Olden times man has been disturbing the balance of nature for comfort, wealth and ego but now nature has started to disturb the balance of nature. The endurance of human beings on this planet is based on the principle of Le-Chatelier which states that "whenever any system at equilibrium is subjected to stress, it will react in such a way so as to relieve that stress". The principle of Le-Chatelier thus operates as a conservative force to return the stressed system to an earlier less stressed one [7].

Water is essential for every living organism and is one of the most valuable natural resources on this earth. Human life is tied directly or indirectly to fresh water source such as lakes, rivers and estuaries. Human beings as well as other global and adequate life forms are sensitive to changes in the quality of the fresh water supply. Changes in quality of water such as chloride, sulphate, total alkalinity, calcium, magnesium and hardness are affect the mortality of aquatic life. The distinctiveness of both natural weathering process and anthropogenic activities can have a significant impact on water quality. Rain fall tends to dissolve and carry away minerals and contaminants found in the soil and the atmosphere [9].

Human as well as natural phenomena are responsible for bringing disturbances in the river system. People mostly depend on water for agricultural and domestic purposes. But with rapid population growth and urbanization, different activities like unplanned building and encroachment, clearing of riparian vegetation along the river banks,

disposal of waste materials in river are commonly observed in rivers [4].

Rivers are important in maintaining the soil fertility, forest and wildlife conservation activities. Therefore, river water quality monitoring program is necessary in order to safeguard public health as well as to safeguard the ecosystem [8]. Water pollution due to anthropogenic activities at river Tamirabarani has been reported in earlier studies [5], [11]- [16], [18].

2. Tamirabarani river

The Tamirabarani River (Porunai) is a only perennial river in south India that originates from the Agastyar koodam peak of Pothigai hills of the Western Ghats, above Papanasam in the Ambasamudram taluk. It flows through Tirunelveli and Tuticorin districts of the Tamil Nadu state of southern India into the Gulf of Mannar. It has many ancient temples along its banks. Tirunelveli district is situated between 8.05° and 9.30° of the northern latitude, and between 77.05° and 78.25° of the eastern longitude [17].Majority of the people of Tirunelveli are Hindus and worship different gods. Hinduism is one of the world's oldest religions and has over 900 million adherents. It is not a single doctrine and has no single founder or teacher.

3. Need for present study

Poor water quality may be caused by low water flow, municipal effluents and industrial discharges [10]. The Tamirabarani is a symbol of Tamil culture and civilization and an identity of the far south of India. The main source of water for the districts of Tirunelveli and Tuticorin is the only perennial river in the region and it runs through the heart of the cities. Thousands of people depend on the river for their routine activities and for satisfying their basic needs. Mixing of sewage, industrial effluents, dumping solid waste etc into the river is a worrying aspect. Local complaints and news paper reports on the cleanliness less of the river have made the subject a major issue to discuss. Although Tirunelveli authorities have taken steps to evict encroachments near the Tamirabarani river encroachments have not yet been removed from other areas and sewage being still let in to the river.

4. Materials and methods

This study was carried out from 2013 to 2016 and water samples were collected in the bottle after rinsing it in the same water 3 or 4 times. The sample was collected from seven sites of the river from centre of the width after avoiding the floating depress on the top. After the collection the bottle was tightly closed, marked and labeled. Seven different sites are (S_1) Vickramasingapuram, (S_2)Ambasamudram, (S_3) Cheranmahadevi, (S_4) Thirupudaimarthur, (S_5) Tirunelveli, (S_6) Muruppanadu and (S_7) Authoor surrounding the Tamirabarani River. All parameters were analysed in the laboratory by using standard methods, APHA 2005 [21].

5. Results and Discussion

According to the studied parameters, the water quality of the river is classified based on the national [2] and international [19] water quality criteria. The results of water quality parameters of water samples from seven stations in Tamirabarani estuarine are present in tables (1-6).

5.1. Chloride

Chloride occurs naturally in all types of water with a very low concentration. Chlorides are important in detecting the contamination of surface water by waste water. In general, high evaporation tends to increase the Chloride and Salinity at the root zone of irrigated plants, making it difficult for crops to take up water due to Osmotic pressure difference between the water outside the plants and within the plant cells.

Table 1: Variation of chloride in different sites at different seasons

Year	Season	S1	S2	S3	S4	S5	S6	S7
2013	Winter	22	20.3	60	135	134	22	35
	Summer	20	22	55	140	130	22	32
	Rainy	18	23.5	65	145	132	31	31
2014	Winter	17	21	65	152	132	25	35
	Summer	18	22	255	244.5	135	50	36
	Rainy	20	21.5	70	144	130	45	32
2015	Winter	64	40	175	28	50	50	24
	Summer	61	45	208	30.6	56	45	23
	rainy	70	50	290	32	62	49	25
2016	winter	65	42	279	29.2	51	45	24
	summer	65	44	251	257	52	47	29
	rainy	62	40	283	32.5	62	46	24

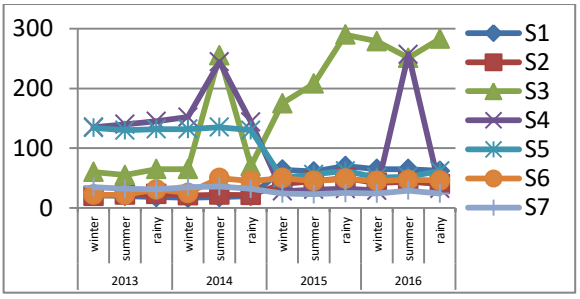

Figure 1: Variation of Chloride with time in different sites at different seasons

For this reason, chloride and total salinity concentration at or below the drinking water standards are normally specified for waters used to irrigate salt sensitive crops. However, in the study area there is no significant change in Chloride concentration and it ranged from 17 to 290 mg/l. Chloride which have been associated with pollution as an index are found below the permissible value set at 250 mg/l in most of the study area. Chloride in excess (> 250 mg/l) imparts a salty taste to water and people who are not accustomed to high chlorides can be subjected to laxative effects. The chloride content in the rainy season of the surface water samples of S_3 showed higher than the prescribed limit may be due to the presence of septic tanks. It has been reported that more than 40 septic tanks for every 2.6 sq. km area may begin to influence adversely water quality [20]. Ironically, hundreds of septic tanks were existing in the (S3) Cheranmahadevi area.

Chloride ion usually enhances corrosive properties of water especially when such water is in contact with stainless steel materials. It also affects taste of water. Chloride ion may be present in water in combination with one or more of the cations of calcium, magnesium, iron or sodium. Chlorides of these minerals are present in water because of their high solubility in water. Chloride was estimated by Mohr's titration method. Excessive presence of chloride in water indicates sewage pollution. 12 to 306 mg/L of Cl^- is seen in aquifer water and in tube or bore well it shows a variation from 0.1 to 2.24 mg/L. In pond water ranges from 1.1 to 9.8 mg/L.

5.2. Sulphate

The permissible and excessive concentration of sulphate in drinking water is 200 and 400 mg/l, respectively, according to WHO. Sulphate is sometimes reduced by microorganisms and therefore causes foul odour.

Table 2: Variation of sulphate in different sites at different seasons

year	Season	S1	S2	S3	S4	S5	S6	S7
2013	Winter	102	158.2	190	70	40	144	25
	Summer	113	160.8	195	85	45	146	22
	Rainy	115	167	170	90	42	136	24
2014	Winter	109	168	172	75	42	100	25
	Summer	110	161	197	184	41	170	26
	Rainy	117	172	168	84	49	156	26
2015	Winter	172	157	43.9	138	120	30	95
	Summer	176	158	41	149	115	29	95
	Rainy	168	163	52	145.6	140	28	96
2016	Winter	173	150.2	45	142	152	27	98
	Summer	175	154	146	148	145	26	95
	Rainy	178	153	56	147	123	28	92

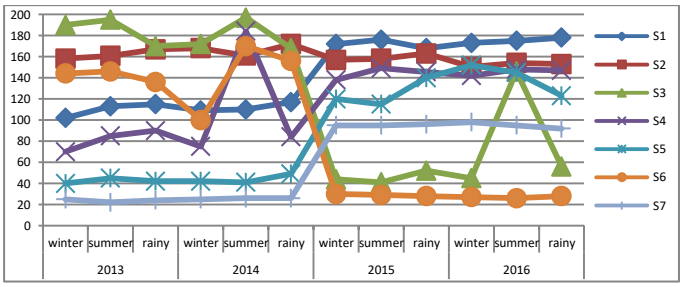

Figure 2: Variation of Sulphate with time in different sites at different seasons

The concentration of sulphate ranged between 22 mg/l to 195 mg/l in the surface water of the study area. Sulphates occur in water due to leaching from sulphate mineral and oxidation of sulphides. Sulphates are associated generally with calcium, magnesium and sodium ions. Sulphate in drinking water causes a laxative effect and gastrointestinal irritation leads to scale formation in boilers. It leads to corrosion problems under aerobic conditions. Desirable limit for drinking water is 150 mg/L. Groundwater present in igneous or metamorphic rocks contains less than 100 ppm sulphate [3]. The sulphate content of atmospheric precipitation is only about 2 ppm, but a wide range in sulphate content in groundwater is made possible through oxidation, precipitation, solution and concentration, as the water traverses through rocks. In sulphide mineralization zones, solution of other sulphide minerals like chalcopyrite, sphalerite, etc. can be induced by ferric sulphate [1]. The reaction equations are given below.

$$CuFeS_2 + 2Fe_2(SO_4)_3 \rightarrow CuSO_4 + 5FeSO_4 + 2S \quad (1)$$

$$ZnS + 4Fe_2(SO_4)_3 + 4H_2O \rightarrow ZnSO_4 + 8FeSO_4 + 4H_2SO_4 \quad (2)$$

At ordinary temperature the sulphate of calcium can be dissolved in water up to a concentration of about 1500 ppm. Water contains chiefly magnesium and sodium, but little calcium may attain sulphate concentration exceeding 100,000 ppm and even up to 200,000 ppm in certain types of magnesium brines [6]. Reduction of sulphate by bacteria and precipitation of gypsum may cause removal of sulphate in groundwater. Reduction of sulphate by bacteria is the main cause of hydrogen sulphide gas emanating from groundwater in association with lignite and coal.

5.3. Total alkalinity

Table 3: Variation of total alkalinity in different sites at different seasons

Year	Season	S1	S2	S3	S4	S5	S6	S7
2013	winter	110	120	34	282	230	98	211
	summer	112	116	32	262	230	95	210
	rainy	120	115	23	275	234	102	212
2014	winter	121	124	25	265	232	111	213
	summer	116	123	26	256	219	112	216
	rainy	114	120	28	264	222	102	220
2015	winter	35	128	172	234	160	150	98
	summer	30	125	154	236	170	145	96
	rainy	32.5	142	156	252	165	146	98
2016	winter	32	125	165	252	174	149	95
	summer	36	135	145	245	169	148	97
	rainy	42	136	139	233	152	152	102

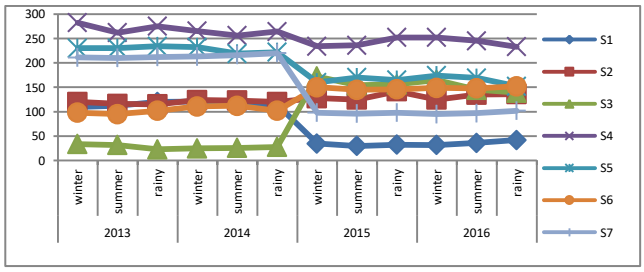

Figure 3: Variation of Total alkalinity with time in different sites at different seasons

The Alkalinity of water is a measure of its capacity to neutralize acids. Alkalinity values provide guidance in applying proper doses of chemicals in water and wastewater treatment processes particularly in coagulation, softening and operational control of anaerobic digestion. The Alkalinity in natural water is caused by bicarbonates, carbonates and hydroxides and can be ranked in order of their association with high pH values. However, bicarbonates represent the major form since they are formed in considerable amounts due to the action of carbonates with the basic materials in the soil. In the present study Phenolphthalein Alkalinity was absent in all samples and methyl orange alkalinity was ranged from 23.0 mg/l to 282 mg/l, this indicates the absence of hydroxyl and carbonate alkalinity and presence of bicarbonate. However, the desirable limit for total alkalinity is 200mg/l(BIS). The value of total alkalinity exceeded the limit in the water samples of (S4) Thirupudaimarthur, (S5) Tirunelveli, (S7) Authoor.

5.4. Hardness

In this present study, the value of hardness is measured from 53 to 347 mg/l. The highest value 347 was recorded during 2016 on summer at site S_3 and lowest value 53 was recorded on 2014 during winter at site S_2. During summer, high level of hardness is present in the water because of dry weather, quantity of water level is lessso the concentration of ion is more and also less water floating. This hardness may affect the photosynthesis and aquatic ecosystem. In rainy season, hardness is very low due to rainfall and more water floating.

Table 4: Seasonal variation of Hardness at station 1-7

Year	season	S1	S2	S3	S4	S5	S6	S7
2013	winter	98	56	66	189	275	115	120
	summer	102	59	66	145	270	120	126
	rainy	118	57	78	190	265	140	125
2014	winter	110	59	75	190	260	100	124
	summer	104	56	320	312	255	110	124
	rainy	107	53	78	170	258	115	125
2015	winter	80	142	99.6	120	80	140	185
	summer	83	140	94	113	84	135	180
	rainy	83	138	120	111	94	136	185
2016	winter	86	136	97	112	73	135	187
	summer	86	135	347	330	87	136	185
	rainy	83	143	117	107	110	136	187

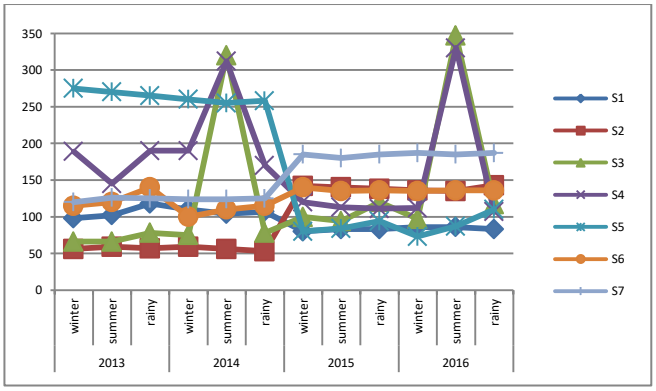

Figure 4: Seasonal variation of hardness at station 1- 7

5. Calcium

Carbonate rocks are the chief source of calcium in natural water and on global scale they contribute 80% or more of the calcium in streams. Normally Silicate minerals are not soluble in water. But weathering breaks them down into soluble calcium products and clay minerals. Silicate mineral groups like plagioclase, pyroxene and amphibole among igneous and metamorphic rocks and limestone, dolomite and gypsum among sedimentary rocks are the main source of calcium in ground water.

Table 5: Variation of calcium in different sites at different seasons

year	Season	S1	S2	S3	S4	S5	S6	S7
2013	Winter	28	15	20	80	28	12	32
	summer	34	16	19	79	32	14	32
	Rainy	28	17	20	72	34	16	31
2014	Winter	23	12	16.4	70	27	13	30
	summer	26	14	75	67	29	7	32
	Rainy	32	16	15	72	24	10	32
2015	Winter	18	16.2	40	19	21	35	36
	summer	20	16	28	33	20.5	36	35
	Rainy	16.5	14.9	32	29	21.5	34	30
2016	Winter	19	18	24	35	14	32	42
	summer	20	15.6	72	76	16	35	42
	Rainy	15	15	28	24	33	36	46

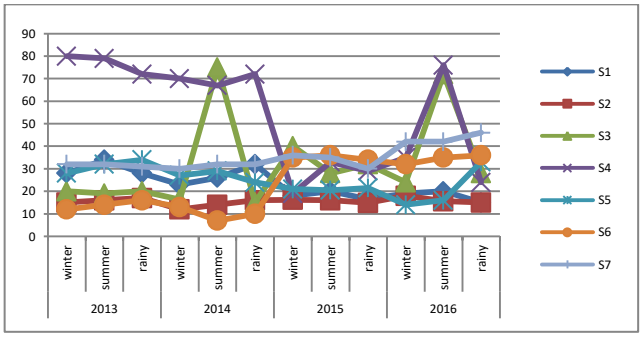

Figure 5: Variation of Calcium with time in different sites at different seasons

The carbonates and sulphates of calcium however, are soluble in water. Due to its abundance in most of the rocks and its solubility, calcium is present almost everywhere in groundwater. In the presence of water containing carbon dioxide in dissolved form calcium carbonate is quite soluble, the reaction being broadly as given in equation.

$CaCO_3 + H_2O + CO_2 \rightarrow Ca(HCO_3)_2$

Calcium carbonate continues to dissolve as long as there is carbonic acid in the water, but precipitation of calcium carbonate may occur once the acid is used up. The causes for the precipitation of calcium carbonate from water are evaporation, increase in temperature, decrease in pressure and pH beyond 8.2. Calcium cations (Ca^{2+}) and calcium salts are among the most commonly encountered substances in natural waters, ranging from zero to several hundred milligrams per liter depending on the source. Calcium often is the most abundant cation in river water. Calcium leads to poor lathering, deterioration of clothes, incrustation in pipes and scale formation. The Calcium content in the study area ranges from 32 to 78.4 mg/L in aquifer,13 to 78.7mg/L in tube well and from 5.1 to 12.20 mg/L in pond water. The concentration of Calcium varied from 7 to 80 mg/l. All the samples were within the permissible limit i.e.75 mg/l for Calcium (ICMR) in all seasons except the samples of(S_4) Thirupudaimaruthur.

5.6. Magnesium

Magnesium leads to poor lathering, deterioration of clothes, incrustation in pipes and laxative effect as sulphate. The concentration of Magnesium varied from 9.0 to 65.0 mg/ l. Mica from intensive weathering of 71 mafia rocks and from pyroxene and amphiboles give rise to silicates. All the samples were within the permissible limit. i.e. 50 mg/l for Magnesium (ICMR) in all seasons except the samples of Tirunelveli(S_5).

Table 6: Variation of magnesium in different sites at different seasons

Year	Season	S1	S2	S3	S4	S5	S6	S7
2013	Winter	15	9.9	11	26	60	25	21
	Summer	18	10	11	16	58	26	22.8
	Rainy	21	9	16	28	57	30	22.8
2014	Winter	21	9	14.2	29	59	21	22.8
	Summer	19	10	30	32	60	25	22.3
	Rainy	18	10	15	23	65	27	22.5
2015	Winter	15	30	14	24	14	25.5	36
	Summer	15	30	18	19	15	24	35
	Rainy	16	28	21	19	18	24	37.6
2016	Winter	16	28	18	18	14	25	35
	Summer	16	29	34	38	17	24	34.7
	Rainy	16.5	31	22	20	19	24	34

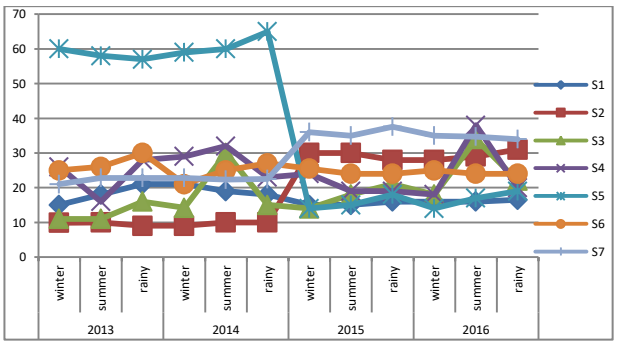

Figure 6: Variation of Magnesium with time in different sites at different seasons

In aquifer Mg varies from 0.5 to 9.5 mg/L but in tube or bore well it is from 0.7 to 5.2 mg/L, while in

pond water it is of 0.65 to 5.6 mg/L. In groundwater the magnesium is derived part from silicates and part from magnesium calcite or dolomite. The weathering of igneous and metamorphic rocks gives rise to soluble carbonates, clay and silica. In the presence of carbonic acid in water magnesium carbonate is converted into more soluble, bicarbonate.

6. Conclusion

The primary production varied from season to season with the load of nutrient in addition to phytoplankton species. Water quality parameters affected the primary production in different seasons; The physicochemical characteristics of river water in the study area suggested that Tamirabarani River is contaminated by various effluents. If proper measures are taken for the treatment of sewage before discharge and restrictions are put on various anthropogenic activities upstream, the estuary would remain healthy in the long run. Organic enrichment and higher bacteriological content of the river system determines the quality of the river water. In conclusion, water quality of the upstream areas of the river Tamirabarani was worsening because of higher cations and anions of the study area when compared with the water quality standards WHO [19], BIS [2], and Indian Council of Medical Research. When the salt concentration is increased, it is difficult for plants to extract water. Chlorides are more toxic to some plants. Hardness is due to presence of Calcium, Magnesium, Bicarbonate and Chloride ions.

Reference

[1] A. Bateman, "Economic Mineral Deposits", Asia Publishing, New York, pp.788, 1960.

[2] BIS (Bureau of Indian Standards), 2012. "specification for drinking water" IS 10500:2012, New Delhi, India.

[3] Davis, Dewiest "Hydrology", John Wiley, New York, pp.463, 1966.

[4] Gyawali, "The improvement of water quality monitoring system on U-Tapao river basin, Thailand", TIChF International Conference (Paper Code es103),2011.

[5] S.Hema, S.Muthalagi "Mass balance approach for assessment of pollution load in the Tamiraparani river", Int. J. Chem. Tech. Res, 1(2), 385-389, 2009.

[6] J.D. Hem, "Study and interpretation of the chemical characteristics of natural water", USGS Water Supply Paper, 1473, pp. 363, 1970.

[7] Horne, Ralph Albert, 1978."The chemistry of our environment."

[8] PR Kannel, et al. "Application of water quality indeces and dissolved oxygen as indicators for river classification and urban impact assessment". Environmental Monitoring and Assessment; 132: 93-110, 2007.

[9] B. Lawrence, "Eutrophication status of Thamirabarani River at Kuzhithurai", Journal of Basic and Applied Science, 4(3) p(168-173), 2010.

[10] E.O. Lawson. "Physico-chemical parameters and heavy metal contents of water from the mangroves swamps of logos lagoon, logos, Nigeria", advances in biological research, 5(1)08-21, 2011.

[11] A.G. Murugesan, Environmental status of the perennial river Tamirabarani with special reference to domestic and industrial pollution. In Proceedings of Workshop on enhancing the public awareness on the ecological and environmental status of the river basins 2000; 15-20.

[12] A.G Murugesan, et al. "Water Quality Profile of the Perennial River Tamirabarani". Indian Journal of Environmental Protection 1994; 14(8): 567-572.

[13] A. G. Murugesan, K. Mophin Kani "Determination of water quality deterioration using coliforms as pollution indicators at river Tamirabarani", Tamil Nadu, India. Journal of Basic and Applied Biology, 4(1and2): 209-215, 2010.

[14] A. G. Murugesan, K. Mophin Kani "Evaluation and classification of water quality of Perennial river Tamirabarani through aggregation of water quality index". International Journal of Environmental Protection 2011; 1(5); 24-33.

[15] A.G Murugesan, et al. "Toxic impact of Environmental Pollutants on Freshwater Habitats" - An overview. Ecology of polluted waters (Ed. Arvind Kumar) Ashish Publishing Corp, New Delhi, India 2002; 1207-1218.

[16] A.G Murugesan, et al. "Pollution status of perennial river Tamirabarani with special reference to sewage mixing and coliform bacteria". Management of sustainable environment 2004; 187-195.

[17] A. J. Stuart, Tinnevelly District Manual, Madras, 1871, p. 1.

[18] S. Umamaheswari “Water quality assessment of River Thamirabarani at Ambasamudram”. Journal of Ecotoxicology and Environmental Monitoring, 14(4):273-276, 2004.
[19] WHO. “Guidelines for drinking water quality”, 3rd ed. Geneva: WHO 2004.
[20] C. Subba Rao, N.V. Subba Rao., Groundwater quality in a residential colony, Indian journal of environmental health, 37(4), pp 295-300, (1995).
[21] APHA (2005) Standard methods for the examination of water and waste water 21st edition, American Public Health Association, Washington, Dc.,USA.