Madras Agric. J., 98 (1-3): 44-50, March 2011
https://doi.org/10.29321/MAJ.10.100240

Effect of Textile and Dye Industrial Pollution on Surface Water Quality and Soil Properties in Noyyal River Basin, Tamil Nadu

K.M. Sellamuthu*, C. Mayilswami, A. Valliammai, S. Chellamuthu
Water Technology Centre
Tamil Nadu Agricultural University, Coimbatore-641 003

Contamination of the water resources has increasingly become a serious problem in many of the States including Tamil Nadu due the domestic and industrial waste waters. Only limited studies are available to comprehend the water quality of Noyyal river basin. Hence, this study was undertaken to characterise the quality of surface waters in Noyyal river and its adjoining tanks. The Noyyal river is continuously polluted due to many industries situated on its banks of the river. Textile and dye industries are the major industries that pollute the river. Twenty water samples were collected from various points of rivers and tanks during pre and post monsoon seasons of 2006 to 2007 and analysed for chemical parameters. The E.C. and pH values varied from 0.17 to 8.70 dSm^{-1} and 5.39 to 8.63 in river water. Cations were in the order of Na>Mg>Ca>K. Around 61.5 per cent of samples found to show RSC values of >2.5 m.e L^{-1}. SAR/SCAR values indicates that most of the samples (46 %) come under medium sodium class (S_2). The EC and pH values of tank water samples varied from 0.41 to 3.13 dSm^{-1} and 8.0 to 8.5 respectively. Majority of the samples (57 per cent) found to show RSC values of <1.25 m.e L^{-1} .SAR values indicates that most of the tank water samples (71.4 %) come under Low Sodium Class (S_1). Seasonal variations in water quality parameters were also observed in river and tanks.

Key words: Industrial pollution, surface water quality, Noyyal river basin, Tamil Nadu.

The Noyyal river has a long and illustrious history as influenced by man, which is indicated by many tanks and canals. Several civilizations have flourished around its banks throughout history (The Hindu, 2003). There are 30 system tanks, 20 channels and two reservoirs in the Noyyal river basin (MSE, 2002). Contamination of the river has increasingly become a serious problem in many of the river basins of the State. River basins like Palar, Tamirabarani, Cauvery, Noyyal, Bhavani and Amaravathy face serious pollution problems due to industrial effluents. (Ministry of Textiles, 2004). In 1989, the Tamil Nadu government issued an order that banned the location of any industrial unit that discharges untreated effluent within one km of the embankment of rivers and reservoirs. The Government has also passed orders imposing total ban of setting up of any of highly polluting new industries within 5 km from the rivers. However, a great many dyeing units lie well within this distance and continue to pollute the river (Sridhar, 2005).

Noyyal river originates from the Vellingiri hills in Western Ghats and passes through the Coimbatore, Erode, Tirupur and Karur districts in Tamil Nadu and confluences with Cauvery at Kodumudi. The flow in the river is seasonal and is contributed by the North East and South West monsoon with an average annual rainfall of about 670 mm. Open wells, dug cum bore wells and bore wells are the groundwater extraction structure in the area.

The textile industry is one of the major industries in India, contributing four per cent to the gross domestic product (GDP), accounting for 20 per cent of the industrial production and 17 per cent of export earning and more than 40 million people are directly or indirectly employed in the textile and clothing sector next to the agriculture sector (Teli, 2008). The major industry in Coimbatore, Erode, Tiruppur and Karur districts of Tamil Nadu are the textile industries. Coimbatore region has been the home of knitwear production since 1925. A regional and agrarian reorganizational process have played vital role in the development of textile industry in this area where majority of the farmers and agricultural workers turned into owners and work force of textile industries (Chari, 2000).

Due to the liberalization of the Indian economy during 1990's, export opportunities were encouraged by the government and within 10 years, Tiruppur became one of the India's major total exporter of hosiery garments (Blomqvist, 1996). Up to 1997, all effluents were diverted into the Noyyal or its tributaries without any treatment (MSE, 2002). Reports show that there were 729 bleaching and

*Corresponding author email: kmsella75@yahoo.com

dyeing units in Tirupur leaving the effluents of 86 million litres per day (Dorai Kannan and Santhi Kanna, 2008). Other than dyeing and bleaching industries, municipal waste water, soap factories, electroplating industries, foundry units also let down their wastes into the Noyyal river. The pollutant loading will be still higher at present. Common Effluent Treatment Plants (CETPs) were set up during 1997. Individual Effluent Treatment Plants (IETPs) were started after CETP's but there are major problems with their functioning. The industries discharge about 100 million litres per day of effluents, which affect the surface and groundwater quality in the region (MSE, 2002). Most of the studies centered around Orathupalayam dam and Tirupur (Senthilnathan and Azeez, 1999; Kristina Furn. 2004; Nelliayat, 2005, Ramesh Mathan, 2006). Hence, this study focuses on surface water quality of representative areas of Noyyal river basin during pre and post monsoon seasons of 2006 and 2007.

Materials and Methods

Study area

In Tamil Nadu, there are about 34 river basins, which are grouped into 17 major river basins (ENVIS, 2007). The major and minor rivers flowing in Tamil Nadu are the major source for surface and ground water. The Noyyal river basin is located between latitude of 10º56' and 11º19' N and longitude of 76º41' and 77º56' E. The Noyyal river originates at the Vellingiri hills in Western Ghats and passes through the Coimbatore, Erode, Tirupur and Karur district in Tamil Nadu and confluences with river Cauvery at Kodumudi. It flows over a distance of 170 kilometers with the catchment area of the river is 3510 km^2 (Sankararaaj *et al*., 2002).

Twenty water samples were collected from various points of rivers and tanks in during pre and post monsoon seasons of 2006 and 2007 and analysed for various chemical parameters. Out of 20 samples 13 points were of rivers and seven were tanks.

The water samples were analysed for quality parameters as per the standard procedure given by Richards (1969). Water quality parameters were classified for the purpose of irrigation as per standard procedures. Residual Sodium Carbonate (RSC) was classified as per Eaton (1950) and Wilcox, *et al.* (1954). Residual Sodium Bicarbonate was computed and classified based on Gupta and Gupta (1987). Salinity and sodicity classes were assessed as per Richards (1969). The results were also interpreted as per Ayers and Westcot (1994) where the quality of irrigation water interpreted based on the degree of salinity and SAR to judge infiltration problems on soils and toxicity of ions.

EC and Sodium Adsorption Ratio (SAR)

EC and SAR were classified based on salinity and sodicity classes as per Richards (1969) as follows.

$$SAR = \frac{Na^+}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}}$$

Where Na^+, Ca^{2+}, Mg^{2+} are concentrations of respective ions in m.e L^{-1}.

Sodium to calcium activity ratio (SCAR)

Classification of SAR for waters with EC >5 dSm^{-1} and Mg/Ca >1 is questionable and for higher EC waters, SAR is calculated as Na / Ca^{2+} and expressed as sodium to calcium activity ratio would perhaps better correlated with ESP of irrigated soils (Gupta and Gupta, 1987). Critical limits for SAR and SCAR remains the same.

Residual Sodium Carbonate

Residual Sodium Carbonate was calculated as per Eaton (1950) as follows.

$$RSC = (CO_3^{2-} + HCO_3^-) - (Ca^{2+} + Mg^{2+})$$

Where CO_3^{2-}, HCO_3^-, Ca^{2+}, Mg^{2+} are concentrations of respective ions in m.e L^{-1}.

Wilcox *et al.* (1954) classified the water based on RSC values as Satisfactory (<1.25 m.e L^{-1}), Marginal (1.25 - 2.5 m.e L^{-1}) and Unsatisfactory (> 2.5 m.e L^{-1}).

Residual Sodium Bicarbonate

Residual Sodium Bicarbonate was calculated as (RSBC) = HCO_3-Ca and classified as Satisfactory (< 5 m.e L^{-1}), Marginal (5-10 m.e L^{-1}) and Unsatisfactory (> 10 m.e L^{-1}) as per Gupta (1983). When rainfall is appreciable, the effective salt balance is zero. High values of EC and SAR would reduce the suggested permissible limits.

Permeability index (PI)

Permeability index or Doneen's Permeability Index was calculated as per Doneen, (1966) as follows.

$$\text{Permeability Index} = \frac{Na^+ + (HCO_3^-)^{1/2}}{Ca^{2+} + Mg^{2+} + Na^+} \times 100$$

Where HCO_3^-, Ca^{2+}, Mg^{2+}, Na^+ are concentrations of respective ions in m.e L^{-1}.

The index varies with soils having different initial permeability.

Magnesium hazard

Magnesium hazard was calculated by Mg^{2+} to Ca^{2+} ratio (Richards, 1969). If the value is <1.0, it is classified under non hazardous and the value exceeds 1.0 will cause Mg hazard.

Puri's Salt Index (PSI)

Puri (1949) established an index to interpret quality of irrigation water. The value varies from -24.5 to 0 for good waters and 0 to + ve for poor quality waters.

PSI = (Total Na^+ -24.5) - ((Total Ca-calcium in $CaCO_3$) x 4.85)

Results and Discussion

Water quality of river water

The E.C. values varied between 0.17 and 8.70 dSm^{-1} among the river waters (Table 1). The highest EC value was noticed in Anaiplayam near Orathupalayam dam. Majority of the samples (69 %) are coming under very high salinity categories which will pose accumulation of salts in soils on irrigation. The pH values varied from 5.39 to 8.63 in river water. In most of the places the pH was more than 8.0 except in Mathuvarayapuram where acidic pH was noticed.

CO_3^{2-}, HCO_3^-, Cl^- and SO_4^{2-} were analysed in river water. CO_3^{2-} content in river water ranged from trace to 6.24 m.e L^{-1} and HCO_3^- content ranged from 0.28 to 13.93 m.e L^{-1}. The highest value of CO_3^{2-} and HCO_3^- were noticed at Anaipalayam few kilometers before Orathupalayam. Cl- values ranged from 1.5 to 53.6 m.e L^{-1} in river waters and the highest Cl^-content was noticed at Orathupalayam Dam. SO_4^{2-}content varied from 0.43 to 17.52 m.e L^{-1} in river waters and the highest was observed at Anaipalayam.

Table 1. Water quality parameters observed in Noyyal river (Mean values of Aug. 2006, Dec. 2006, Apr. 2007 and Sept. 2007)

Sa. No	Location	EC (dSm^{-1}) River	pH	CO3	HCO3	Cl	SO4	Na	KCa	Mg	RSC	RSBC	SAR/ SCAR	Mg/Ca	PSI	PI	m.e L-1
1	Mathampatti	0.39	8.18	0.00	1.55	1.83	0.78	1.89	0.15	1.08	1.12	-0.27	0.47	1.81	1.18	2.69	79.55
2	Neeli	0.17	7.80	0.00	0.28	1.80	0.43	0.94	0.08	0.70	0.51	-0.94	-0.43	1.18	0.75	2.41	46.03
3	Mathuvarayapuram	0.31	5.39	0.19	1.65	1.50	0.79	1.86	0.06	0.95	0.78	0.10	0.70	1.98	0.84	2.37	86.26
4	Sulur	3.21	8.55	2.50	6.06	18.11	7.82	22.09	0.96	5.21	5.70	-2.35	0.85	9.37	1.15	20.84	74.33
5	Ganesapuram	2.08	8.48	3.05	7.43	10.18	1.76	14.07	0.61	3.85	3.52	3.11	3.57	7.40	1.05	11.42	78.76
6	Somanur	3.24	8.36	2.50	7.43	22.80	2.95	25.08	0.85	3.98	5.10	0.84	3.44	12.07	1.20	24.45	81.49
7	Tirupur	7.42	8.27	4.54	11.65	47.93	12.67	64.30	2.17	5.25	4.55	6.39	6.40	13.83	0.86	51.12	91.19
8	Anaipalayam	8.70	8.63	5.69	13.93	50.40	17.52	73.48	2.21	5.01	6.36	8.25	8.92	15.07	1.31	54.54	90.60
9	Orathupalayam	8.14	8.25	5.69	12.65	53.60	14.27	71.45	1.96	4.07	8.40	5.87	8.58	17.79	2.21	57.33	88.80
10	Anjur Bridge	6.65	8.55	4.99	10.19	37.93	16.24	59.05	1.92	2.97	4.96	7.25	7.22	19.98	1.95	41.61	92.74
11	Kodumudi	5.82	8.51	6.24	9.13	31.53	12.65	50.46	1.73	2.46	4.48	8.43	6.67	22.16	1.91	34.76	92.30
12	Senapathipuram	5.44	7.81	3.47	11.28	29.25	12.25	47.25	1.19	3.84	3.61	7.30	7.44	14.30	0.90	32.40	93.11
13	Palayakottai	6.42	8.22	4.44	12.55	36.53	13.14	55.19	2.16	4.09	4.70	8.21	8.47	14.13	1.18	39.81	92.08
		Tanks															
1	Narasampathi	0.44	8.12	0.37	1.65	2.80	0.65	2.92	0.19	0.74	1.21	0.07	0.91	2.85	1.59	3.58	87.20
2	Perur Big tank	0.41	7.98	0.28	1.65	2.48	1.00	2.63	0.26	1.41	0.75	-0.23	0.24	2.33	0.50	3.44	72.52
3	Kurichi kulam	0.45	8.03	0.00	2.20	2.33	0.66	2.62	0.23	1.15	1.00	0.05	1.05	2.55	0.98	3.06	88.32
4	Sulur ST	2.40	8.41	3.33	5.78	12.65	3.28	16.90	1.95	2.47	3.55	3.08	3.31	9.71	1.52	14.40	83.61
5	Sulur BT	2.29	8.38	4.44	6.33	12.40	2.25	17.29	1.21	3.11	3.49	4.16	3.21	9.46	1.13	13.85	82.70
6	Singanallur	3.13	8.48	2.50	5.51	15.65	10.75	23.13	1.28	4.36	5.39	-1.74	1.15	10.95	1.68	18.70	77.49
7	Shyamalapuram	2.98	8.36	2.50	7.37	19.75	3.79	24.34	1.04	2.60	5.08	2.19	4.77	12.46	2.10	21.62	84.19

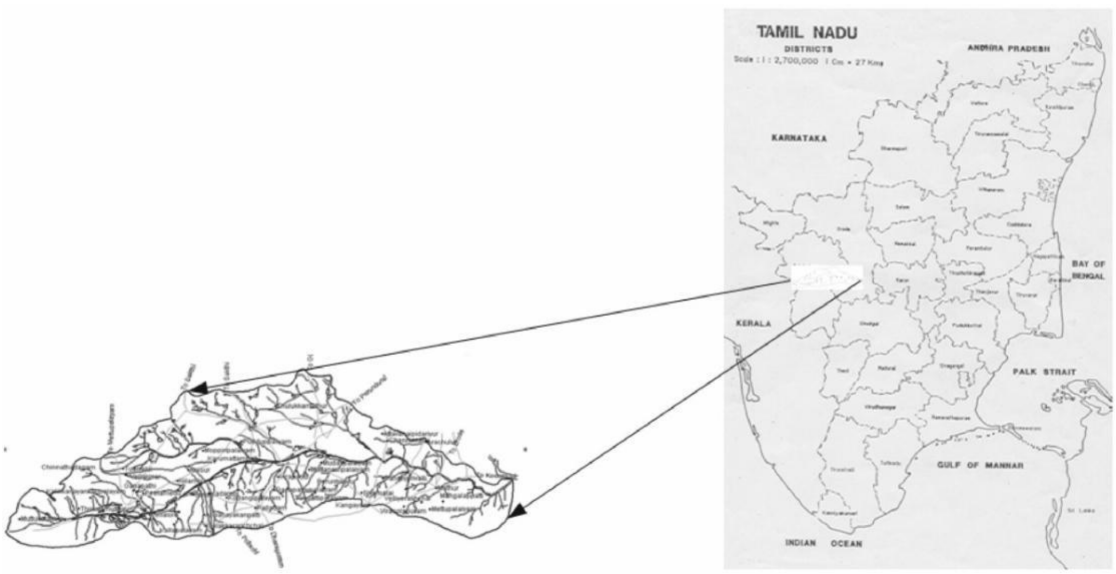

Fig 1 . Locations of water samples collected in Noyyal river basin

Cations were in the order of $Na^+ > Mg^{2+} > Ca^{2+} > K^+$. Na^+ concentration varied from 0.94 to 73.48 m.e L^{-1} in river waters. K^+ content varied from 0.06 to 2.21 m.e L^{-1} in river waters. Ca^{2+} and Mg^{2+} concentration varied from 0.7 to 5.25 m.e L^{-1} and 0.51 to 8.4 m.e L^{-1}, respectively. The highest value of Na^+, Ca^{2+}, Mg^{2+} were noticed at Anaipalayam, Tiruppur and Orathupalayam dam, respectively.

Table 2. Classification of river water based on EC and SAR / SCAR values

EC (dSm^{-1})	Category	No of samples	Frequency (%)	SAR /SCAR	Category	No.of samples	Frequency
<0.25	Low Salinity Class (C_1)	1	7.7	<10	Low Sodium Class (S_1)	5	38.5
0.25-0.75	Medium Salinity Class (C_2)	2	15.4	10-18	Medium Sodium Class (S_2)	6	46.1
0.75-2.25	High Salinity Class (C_3)	1	7.7	18-26	High Sodium Class (S_3)	2	15.4
>2.25	Very High Salinity Class (C_4)	9	69.2	>26	Very High Sodium Class (S_4)	Nil	Nil

Classification of river waters for irrigation purpose

The results indicated that the values of RSC varies from -2.3 to 8.4 m.e L^{-1} and RSBC varies from -0.4 to 8.9 m.e L^{-1}. Majority of the samples (61.5 per cent) found to show RSC values of >2.5 m.e L^{-1} which suggest that these waters will pose considerable influence on soil properties on irrigation and 54 per cent of samples exhibit moderate problem on soil with respect to RSBC values (5-10 m.e L^{-1}).

Table 3. Classification of river water based on RSC and RSBC

RSC (m.e.L-1)	No. of Samples	Frequency (%)	RSBC (m.e.L-1)	No. of Samples	Frequency (%)
<1.25	5	38.5	<5	6	46.2
1.25-2.5	Nil	Nil	5-10	7	53.8
>2.5	8	61.5	>10	Nil	Nil

Presence of Na^+ salts and their concentration in water decide the quality of irrigation water. The classification of irrigation water with respect to SAR is based on the abundance of exchangeable Na^+ particularly on the physical condition of the soils. Waters with EC >5 dSm^{-1} and Mg/Ca >1 are classified based on sodium to calcium activity ratio (SCAR) as per Gupta and Gupta, (1987) instead of SAR. The limits are same, for both SAR and SCAR. SAR or SCAR values indicates that most of the samples (46 %) come under Medium sodium class (S2) followed by Low sodium class (S_1) with 38.5 per cent and 15.0 per cent come under High sodium class (S_3). High sodium class water will exhibit sodicity in soils on irrigation.

Seasonal change was clearly noticed in river samples (Fig.2). In most of the samples, the EC was high during August followed by April. Normally

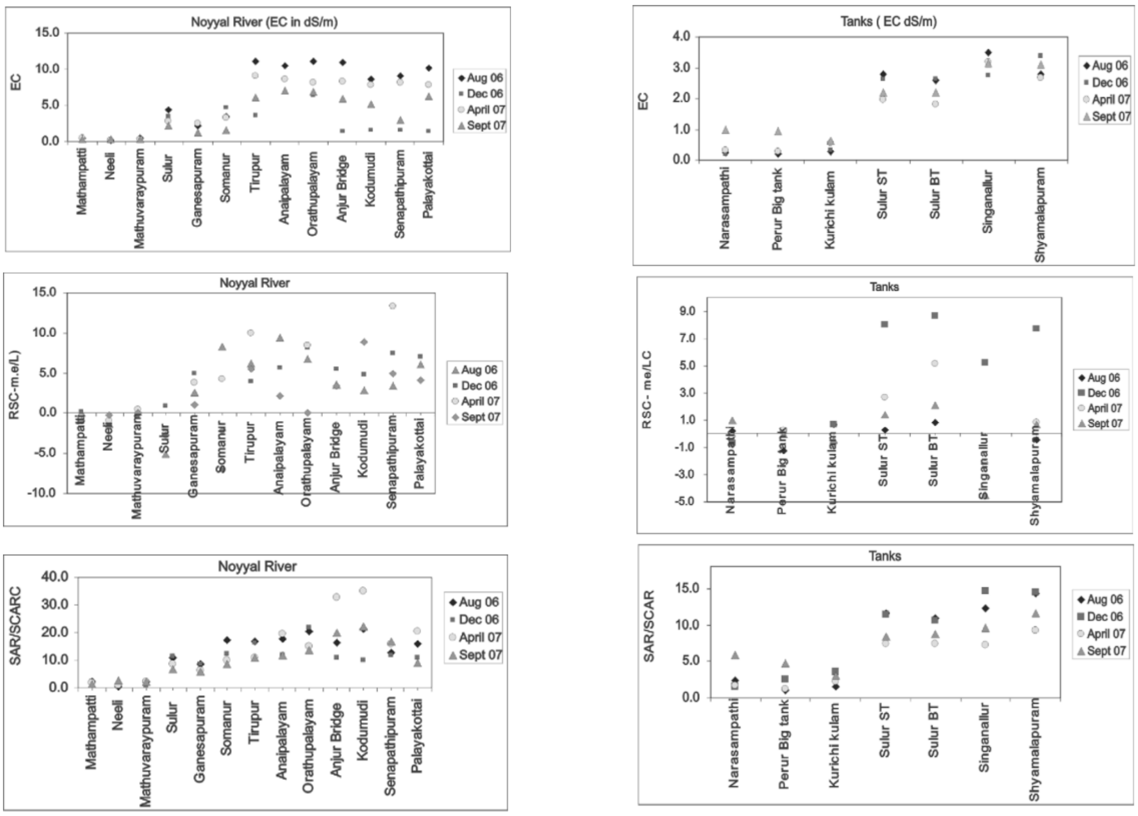

Fig. 2. Seasonal change in EC, RSC and SAR/SCAR in Noyyal river and tank water

Table 4. Classification of tank water based on EC and SAR/ SCAR values

EC (dSm^{-1})	Category	No of samples	Frequency (%)	SAR /SCAR	Category	No.of samples	Frequency
<0.25	Low Salinity Class (C_1)	Nil	Nil	<10	Low Sodium Class (S_1)	5	71.4
0.25-0.75	Medium Salinity Class (C_2)	3	42.9	10-18	Medium Sodium Class (S_2)	2	28.6
0.75-2.25	High Salinity Class (C_3)	Nil	Nil	18-26	High Sodium Class (S_3)	Nil	Nil
>2.25	Very High Salinity Class (C_4)	4	47.1	>26	Very High Sodium Class (S_4)	Nil	Nil

the EC should be high in river water during summer, due to high evaporation. But the data shows that EC was high during August, it may be due to high amount of discharged polluted water during this period. RSC and RSBC (Data not given in graph) were high during April in majority of the samples. SAR/SCAR was high during April followed by August and December. The data shows that during summer, sodium accumulation is high when compared to monsoons. During rainy period, leaching of sodium is possible. Hence, less sodium accumulation have seen in river water samples. It shows that sampling in a single event will not represent the actual pollution intensity.

Table 5. Classification of tank water based on RSC and RSBC

RSC (m.e.L-1)	No. of Samples	Frequency (%)	RSBC (m.e.L-1)	No. of Samples	Frequency (%)
<1.25	4	57.1	<5	7	100
1.25-2.5	1	14.3	5-10	Nil	Nil
>2.5	2	28.6	>10	Nil	Nil

Most of the samples exhibited magnesium toxicity. Out of 13 samples 9 samples (69.23 %) found to show Mg/Ca ratio of >1. Water polluted due to dye industry in general shows magnesium toxicity. Potential salinity values varied from 2.41 to 57.33. All the samples showed positive values. The positive values indicate free Na^+ ions present in the river water. Continuous irrigation with the water with free s Na+ will lead to Na+ accumulation in soils. Permeability Index is used to assess probable influence of water quality on physical properties of soils. It is the most important single soil physical property reflecting soil texture and soil structure, as well as chemical characteristics. High level of HCO_3^-in waters will affect the permeability of soils. Permeability index varied from 46.03 to 93.11 and most of the samples will pose permeability hazard if irrigated.

Water quality of tank waters

The analytical values of the quality parameters pertaining to tank waters are given in Table 1. The EC values of tank water samples varied between 0.41 and 3.13 dSm^{-1}. The highest EC value was noticed in Singanallur tank. Forty seven per cent of samples come under very high salinity category (C_4) and 43 per cent under medium salinity category (C_2). Upon irrigation, these waters will pose salinity to soils or recharge the wells with salt load. The pH values varied from 8.0 to 8.5 in tank waters.

CO_3^{2-}, HCO_3^-, Cl^- and SO_4^{2-} were analysed in the tank waters. CO_3^{2-}content in tank water samples ranged from traces to 4.44 m.e L^{-1}. HCO_3^- ranged from 1.65 to 7.37 m.e L^{-1}. Cl^- and SO_4^{2-} concentration ranged from 2.33 to 19.75 m.e L^{-1} and 0.65 to 10.75 m.e L^{-1} in tank waters respectively. The highest concentration of CO_3^{2-} and HCO_3^- were noticed in Sulur big tank. The highest concentration of Cl^- and SO_4^{2-} were recorded in Shyamalapuram tank and Singanallur tank respectively. Na^+ and K^+ concentration varied from 2.62 to 24.34 m.e L^{-1} and 0.7 to 4.4 m.e L^{-1} respectively in tank waters. Ca^{2+} and Mg^{2+} content were observed from 0.74 to 4.36 m.e L^{-1} and 0.75 to 5.39 m.e L^{-1} respectively.

Table 6. Classification of EC and pH (USDA, 2002)

Descriptive Term	EC range (dSm^{-1})	No. of Samples	Frequency %	Descriptive Term	pH range	No. of Samples	Frequency (%)
Non-Saline	0 < 2	33	100.0	Slightly Acid	6.1 to 6.5	0	0.0
Very Slightly Saline	2 to < 4	0	0.0	Neutral	6.6 to 7.3	5	15.2
Slightly Saline	4 to < 8	0	0.0	Slightly Alkaline	7.4 to 7.8	9	27.3
Moderately Saline	8 to < 16	0	0.0	Moderately Alkaline	7.9 to 8.4	17	51.5
Strongly Saline	$\geq$ 16	0	0.0	Strongly Alkaline	8.5 to 9.0	2	6.1

Seasonal change was clearly noticed in tank water samples (Fig.2). Sulur, Singanallur and Shymalapuram tanks exhibited EC values >2.25 dSm^{-1}, since all the industrial and urban waste water drained into Sulur tanks followed by other tanks. Fluctuation in EC values were noticed among the different periods of observation but values were high during August, followed by September and December. The pollution load in the tanks not only due to textile industries but also due urban and other industriial pollutants of the city. RSC, RSBC (Data not given in graph) and SAR/ SCAR values were high during December in majority of the samples. The discharge of polluted water in the river and tank water mainly depends on the quantity of polluted water discharged to the river, quantity and intensity of rain fall and evaporation. The ions present in the

Table 7. Available nutrient status and organic carbon

Status	N		P		K		O.C	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Low	29	87.9	0	0.0	0	0.0	20	60.6
Medium	4	12.1	16	48.5	3	9.1	13	39.4
High	0	0.0	17	51.5	30	90.9	0	0.0

samples during different seasons may also depend upon the nature of the chemical used during that period for processing. Though there are complications in arriving conclusions, it indicates the complexity of issues in assessing the pollution load.

Classification of tank waters for irrigation purpose

The water quality parameters were classified based on RSC, RSBC, SAR/SCAR, potential salinity and permeability index (Table 1, 4 and 5). The results indicated that the values of RSC vary from - 1.74 to 4.16 m.e L^{-1} and RSBC vary from -0.24 to 4.77 m.e L-1. Around 57 per cent of samples found to show RSC values of <1.25 m.e L^{-1} and 28.6 per cent under >2.5 m.e L^{-1} category. The water with >2.5 m.e L^{-1} will pose considerable influence on soil properties on irrigation. There is no harm due to RSBC among the water sample collected. Presence of Na^+ salts and their concentration in water decide the quality of irrigation water. The classification of irrigation water with respect to SAR / SCAR is based on the abundance of exchangeable Na^+ particularly on the physical condition of the soils. SAR values indicates that most of the samples come (71.4 %) under Low Sodium Class (S_1) followed by Medium Sodium Class (S_2) with 28.6 per cent.

Most of the samples exhibited potential for Mg^{2+} toxicity. Out of seven tank samples, five samples were found to show Mg^{2+}/Ca^{2+} ratio of >1. Potential salinity values ranged from 3.06 to 21.62. All the samples showed positive values. It indicates free Na^+ ions in the water and continuous irrigation with the water will lead to sodium accumulation in soils. Use of high level of HCO_3^- water for irrigation will affect the permeability of soils. Permeability index varied from 72.52 to 88.32. Most of the samples will pose permeability hazard if irrigated.

Survey of soil samples and their properties

Thirty three surface soil samples were collected from fields near by where water samples have drawn. EC values ranged from 0.05 to 1.55 dSm-1. Since most of the sampled wells are not irrigated with polluted water, all the soil samples exhibited nonsaline status. The pH values of the soils ranged between 6.95 and 8.91 and 52 per cent of soil is classified under moderately alkaline followed by slightly alkaline (27 %). Organic carbon content of the soils varied between 5.14 and 9.43 mg kg-1 and most of the soils (60.6%) come under low organic carbon status. Available N, P and K varied from 143 to 323, 12.4 to 32.6 and 243 to 743 kg ha^{-1}, respectively. Nutrient status found to be low in N (87.9 %) , medium in P (51.5%) and high in K (90.9 %). Most of the polluted wells near the Noyyal river are abandoned and currently not used for irrigation. Hence there was no drastic impact on soil properties like EC or pH.

Conclusions

The Noyyal river is continuously polluted due to many industries located on its banks particularly Textile and dye industries which are in large numbers. The results indicate that pollutant load of the river starts from Sulur and continuously increase up to Anaipalayam just before Orathupalayam dam. The water samples are charecterised by high salinity and alkaline pH. Cations were in the order of Na>Mg>Ca>K. Most of the samples (61.5 per cent) exhibited RSC values of >2.5 m.e L^{-1}. Medium sodium class (S_2) found to dominate (46 %) in the river water samples. As Noyyal passes through many tanks nearby Coimbatore, samples were also collected from tanks. Forty seven per cent of tank samples come under very high salinity category (C_4) and there is less carbonate and sodium hazard in water samples collected nearby Coimbatore along the Noyyal river. Seasonal variations in water quality parameters were also observed in river and tanks. Since, most of the wells nearby the polluted zone of Noyyal river are abandoned and well waters are not used for irrigation, the soils samples did not exhibit much influence pollution on soil properties.

Acknowledgement

The authors gratefully acknowledge Directorate of Water Technology Centre for Eastern Region Bhubaneshwar, Indian Council of Agricultural Research for the financial assistance and the anonymous reviewer who improved the quality of this manuscript.

References

Ayers, R.S. and Westcot, D.W. 1994. Water quality for agriculture. FAO Irrigation and drainage paper. Food and Agriculture Organization of the United Nations, Rome. 197p.

Blomqvist, A. 1996. Food and Fashion: Water management and Collective Action among Irrigation Farmers and Textile Industrialists in South India. Ph.D. Thesis submitted to The Tema Institute, Department of Water and Environmental Studies, Faculty of Arts and Sciences, Linköping University. 220p.

Chari, S. 2000. The Agrarian Origins of the knitwear industrial cluster in Tiruppur, India. World Development **28** : 579-599.

Doneen, L.D. 1966. Water quality requirement for agriculture. Proc. National symposium on quality standards for natural waters. University of Michigan, Ann. Report. 213-218p.

Dorai Kannan and Santhi Kanna. 2008. Industrial pollution and economic compensation : A Study of Down Stream Villages in Noyyal River, Tirupur, Tamil Nadu, South India. M.Sc Thesis submitted to Linköping University, The Tema Institute, Department of Water and Environmental Studies. 53p.

Eaton, F.M. 1950. Significance of carbonates in irrigation waters. *Soil Sci.,* **69**: 123-133.

ENVIS. 2007. Water Resources of Tamil Nadu. In: Environment Information System, News Letter on State of Environment Supported by Ministry of Environment and Forests, Government of India. **4** : 1-8p.

Gupta, I.C. 1983. Concept of residual sodium. carbonate in irrigated waters in relation to sodic hazard in irrigated soils. *Curr. Agric.* **7**: 97-113

Gupta, S.K. and Gupta, I.C. 1987. Management of saline soils and waters. Oxford and IBH Publishing and Co, New Delhi. 339p.

Kristina Furn. 2004. Effects of dyeing and bleaching industries on the area around the Orathupalayam Dam in Southern India. Thesis for Minor Field Study submitted to Tryckt hos Institutionen för geovetenskaper, Uppsala Universitet, Uppsala. 98p.

Ministry of Textiles. 2004. Government of India, Annual Report 2003-2004, 21-22p.

MSE (Madras School of Economics). 2002. Environmental impact of industrial effluents in Noyyal river basin-Final report. Submitted to: Water Resources research fund institute for water studies, Chennai, India.

Nelliayat, P. 2005. Industrial growth and environmental degradation: A case study of industrial pollution in Tiruppur, Ph.D. Thesis submitted to University of Madras, Chennai.

Puri A.N. 1949. Soils - their physical chemistry, Rein-hold Publishing and Co. 550p.

Ramesh Mathan. 2006. Physico-chemical studies of water quality of the Noyyal river, Tamil Nadu, South India. *Chinese J. Geochem*. **25**: 138p.

Richards, L.A. 1969. Diagnosis and improvement of Saline and Alkali Soils. United States Salinity Laboratory Staff. Agriculture Handbook No. 60. U.S. Government Printing Office, Washington, D.C.166p.

Sankararaaj, L., Subramanian, T.P., Siddhamalai, A. and Farooq Ahmed, N. 2002. Quality of soil and water for agriculture in Noyyal river basin, Tamil Nadu. Soil Survey and Land Use Organization, Tamil Nadu Department of Agriculture, Coimbatore.

Senthilnathan, S. and Azeez, P. A. 1999. Influence of dyeing and bleaching industries on ground water of Tirupur, Tamilnadu, India. Bull. Environ. Contam. Toxicol. **62**: 330-335.

Sridhar, V. 2005. Tirupur's crisis. http://www.frontlineonnet.com/fl2217/stories/20050826004311600.htm.

Teli, M.D. 2008. Textile coloration industry in India. Color. Technol., **124**: 1-13.

The Hindu. 2003-05-19. A glorious system in Peril. www.hinduonnet.com.

USDA. 2002. Field Book for Describing and Sampling Soils, National Soil Survey Center Natural Resources Conservation Service, U.S. Department of Agriculture. p. 2-72.

Wilcox, L.V., G.Y.Blair, and C.A Bower. 1954. Effect of bicarbonate on suitability of water for irrigation. *Soil Sci*. **77**: 259-266p.

Received: August 22, 2010; Accepted: February 20, 2011