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IMPACT OF SOLID WASTE DISPOSAL ON WATER QUALITY IN THE SELECTED STATIONS OF THAMIRAPARANI RIVER BASIN AT KANYAKUMARI DISTRICT,TAMILNADU

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ABSTRACT

Water is very important for survival of all form of life on the earth. At present various types of organic and inorganic pollutants emerged out from solid wastes are discharged into the fresh water bodies. Therefore, quality of the fresh water is severely affected. The present investigation was planned to access water quality of Thamiraparani river stretch near Kuzhithurai, Kappucadu, Thangapattinam at Kanyakumari district. Water sampling was done from January, 2021 to December, 2021 to study the impact of solid waste dumping in the vicinity of the river at selective locations such as Kuzhithurai (Station I), Kappucadu (Station II) and Thangapattinam (Station III). The quality of the water was accessed in terms of physico-chemical parameters. All the selected parameters such as pH 8.35, turbidity (NTU) 14.5, conductivity 1262.25µS/cm^3, alkalinity 507.5 mg/l, total hardness 550.5 mg/l, total dissolved solids 1274.25 mg/l, chlorides 447 mg/l, BOD 375.75 mg/l and COD 472.5 mg/l were maximum at station I when compared to the other stations. This result reveals that water could be unfit for drinking purpose.

Key words: Water quality, Pollutants, Solid waste.

Introduction

The urban and industrial areas in both developed and developing countries faces severe problem in safe disposal of solid waste from the environment (Joseph, 2002). Huge amount of solid waste is generated daily due to the increasing trend of industrialization, urbanization and rapid growth of population (Ololade *et al*., 2009). The solid waste management encompasses three phases such as collection, transportation and disposal of waste (Vincent Kodzo Nartey, 2012). In the past, very less amount of solid wastes was collected from the cities to distant places for dumping and the nature decomposes the wastes. But, today, the increasing amount of solid waste, inadequate space, limited capacity of nature to reduce unwanted emissions and decomposition causes threat to human health (Dhere, 2008). The uncontrolled open dumping is commonly prevalent in and around the vicinity of the river banks witnessed an associated harmful impact on the fresh water ecosystem (Sarkar *et al*., 2007). The infiltration of river water into the solid waste dumpsites and squeezing of the waste due to self weight produces black coloured liquor called leachate (Eshanthini and Padmini, 2015). It contains organic and inorganic substances such as calcium, magnesium, sodium, potassium, ammonium, iron, manganese, chloride, sulphate, bicarbonate, lipid, protein, organic carbon etc (Aiyesanmi and Imoisi, 2011). The compositions of leachate varied and are classified based on the type of solid waste and a climatic condition prevails in the dumping sites (Rajkumar, 2010). The leachate was oozing out from solid waste dumpsites discharged into the river causes severe pollution in the water (Khanbilvardi *et al*., 1992). Recently, surface water samples from solid waste dumping sites at Erode city, Tamilnadu were analyzed and detected that the observed water samples were unsuitable for drinking due to contamination from leachates [9]. Therefore, the present study has been carried out with the objective of assessing the variation of water quality due to the disposal of solid waste in the selected stations of Thamiraparani river at Kanyakumari district.

Materials and methods

Water samples were collected monthly from 3 different experimental stations at Thamiraparani river in the vicinity of solid waste dumping site for a period of one year from January 2021 to December 2021. The mean values of each seasons such as spring (January to March), summer (April to June), autumn (July to September), winter (October to December) and annual mean values were calculated.

Station I – Kuzhithurai**:** This station is surrounded by industrial and residential area. The banks of river contain solid waste dumping site and house hold sewage also discharged into this river from western and northern side of Kuzhithurai town.

Station II – Kappucadu**:** This station is situated just 5 Km distance from southern side of Kuzhithurai. This station is surrounded by small scale industries and residential area. The banks of river contain solid waste dumping site and sewage also discharged into this river.

Station III –Thangapattinam **:** This station is situated just 7 Km distance from southern side of Kappucadu village. This station is surrounded by coir retting ponds, coconut plantations and residential area. The banks of river contain solid waste dumping site and domestic sewage discharged into this river.

The samples were analyzed for the physico-chemical parameters of water such as pH, turbidity, conductivity, Total Hardness (TH), Total Dissolved Solids (TDS), chlorides, Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). The analysis of the physico-chemical parameters have been carried out following the standard methods as described in APHA, 2005. Statistical analysis was carried out by using software Microsoft Excel. Correlation analysis measures the closeness of the chosen parameters.

Results and discussion

The variation in the physico-chemical parameters of water in the three different stations such as I, II and III at the vicinity of solid waste disposal site were given in the table-1, 2 and 3.

pH is very important in water quality assessment which influences many biological and chemical processes within a fresh water body (Chapman, 1996). The pH values recorded were alkaline and showed variations among the stations. The seasonal mean pH value was minimum 7.4 at station II in winter and maximum 8.9 at station I in summer with an annual mean of 8.35 ± 0.519, 8.1 ± 0.496 and 8.15 ± 0.465 in station I, II and III respectively (Table 1 to 3). Similar variations of pH of the river water at different stations were reported by Gupta *et al*., 2011 in Chambal river.

Turbidity in water is formed by suspended and colloidal matter such as sand, silt, clay and finely divided organic matter. The mean seasonal values of turbidity ranged from 10 NTU in summer at station I to 18 NTU in winter at station I and III with annual mean of 14.5 ± 3.0, 13.5 ± 2.06 and 13.75 ± 3.5 in station I, II and III respectively (Table 1 to 3). All the values showed above were higher than the WHO value of 5 NTU. The high turbidity value could be due to solid waste dumpsites close to the water bodies and the indiscriminate disposal of waste into the water bodies. Values 10 NTU showed visible turbidity and significant risk of infectious disease transmission due to infectious agents and chemicals absorbed onto particulate matter (Vincent Kodzo Nartey *et al*.,2012)

The mean seasonal values of conductivity (EC) ranges from 1015 µS/cm^3 in spring at station II to 1388 µS/cm^3 in winter at station I with an annual mean of 1262.25 ± 106.38 µS/cm^3, 1085.25 ± 81.93 µS/cm^3, 1210.5 ± 85.27 µS/cm^3 in station I, II and III respectively. This values were exceeded the conductivity limits prescribed by WHO standards in all experimental stations and it renders the water unsuitable for domestic consumption. The increased conductivity values could be due to the discharge of effluent from the solid wastes into river. The reported changes in conductivity of river water depend on the mineral composition of water and mixing of domestic water into the fresh water bodies (Desmukh and Ambore, 2006). Thus the significant increasing conductivity could be an indicator of presence of various ions in the selected experimental stations of Thamiraparani river.

During the study period , the mean seasonal values of alkalinity ranges from 438 mg/ml in spring at station II to 541 mg/ml in summer at station I with an annual mean of 507.5 ± 24.93 mg/ml, 475.25 ± 45.87 mg/ml, 486.5 ± 28.17 mg/ml in station I, II and III respectively. There was a fluctuation of alkalinity values near the solid waste dumping site from station I to station III during different seasons of a year. Higher values can be supported by the value reported from Surface water quality with respect to municipal solid waste disposal within the Imphal municipal area, Manipur (Raghumani Singh, Mithra Dey, 2014) and Jagadeshappa *et al*. (2011) from the two Wetlands of Tiptur Taluk, Karnataka.

The mean seasonal TH value was minimum 472 mg/ml in winter at station II and maximum 588mg/ml in summer at station I with an annual mean of 550.5 ± 33.11 mg/ml, 502.75 ± 29.23 mg/ml and 531.25 ± 28.32 mg/ml in station I, II and III respectively. The higher values of hardness were recorded in all the experimental stations. The high hardness in the selected stations of river water may be because of the discharge of untreated solid waste effluents (Trivedy and Goel, 1986).

The mean seasonal value of TDS showed variation between 1010 mg/ml in spring at station II and 1348 mg/ml in winter at station I with annual mean of 1274.25 ± 65.13 mg/ml, 1113 ± 82.28 mg/ml and 1192.5 ± 81.349 mg/ml in station I, II and III respectively. Comparatively similar values were reported from the vicinity of the solid waste dumping sites of Karimganj district, Assam, India (Dibakar *et al*., 2012). TDS values of water in the selected stations may be higher due to run off from solid garbage dump and other wastages (Mehari Muuz, 2013).

The mean seasonal values of BOD ranges from 291 mg/ml in spring at station II to 403 mg/ml in winter at station I with an annual mean of 375.75 ± 21.31 mg/ml, 317.5 ± 25.199 mg/ml and 349 ± 34.99 mg/ml in station I, II and III respectively. The high concentration of BOD indicates the presence of organic effluent discharged into the water bodies from the solid waste dump site (Vincent Kodzo Nartey *et al*., 2012). Moreover, the uptake of dissolved oxygen by the microbial population for the oxidative breakdown of these wastes results into high BOD (Akuffo, 1998).

The mean seasonal chloride concentration across the experimental sites ranges from 367 mg/l during winter at station II to 499 mg/l during summer at station I with annual mean value of 447 ± 34.35 mg/ml, 391.75 ± 21.74 mg/ml and 426.5 ± 45.449 mg/ml in station I, II and III respectively. The results were similar to the findings of river water recorded at Godawari in which effluents from solid waste raises the chloride value in river (Sanap *et al*., 2006). Sanjoy Meitei and Rakesh, 2013 reported that the higher value of chloride in surface water might be due to surface runoff of water through solid waste dump sites.

The mean seasonal COD value was minimum 388 mg/ml in spring at station II and maximum 518mg/ml in winter at station I with an annual mean of 472.5 ± 43.71 mg/ml, 431 ± 33.85 mg/ml and 462 ± 36.83 mg/ml in station I, II and III respectively. The presence COD in the river water indicates high organic strength of the effluent passed out from solid wastes and the decomposition of organic matter (Bendz *et al*.,1997).

The correlation coefficient of physico-chemical parameters of Thamiraparani river at station I, II and III were analyzed. In station I and III all the parameters of water tested exhibit significant positive and correlation and negative correlation (Table 4 and 6). But in station II, the pH of water showed significant positive correlation with alkalinity, TH and chlorides and negative correlation with turbidity, conductivity, TDS, BOD and COD; turbidity recorded significant positive correlation with conductivity, TDS, BOD and COD and insignificant correlation with alkalinity, TH and chlorides; Conductivity showed significant positive correlation with TDS, BOD and COD and negative correlation with TH and chlorides and insignificant correlation with alkalinity; alkalinity recorded significant positive correlation with TH and chlorides and insignificant correlation with TDS, BOD and COD; TH showed significant positive correlation with chlorides and negative correlation with TDS, BOD and COD; Chlorides recorded negative correlation with BOD and COD; and BOD showed significant positive correlation with COD (Table 4 to 6). Similar correlation coefficient of physico-chemical parameters water were recorded by Trivedi *et al*., 2009 in Ganga river and Hema and Subramani, 2012 in Cauvery river.

Table 1 : Physico-chemical parameters of Thamiraparani river (Station I – Kuzhithurai)

S.No	Parameters	Seasons				Mean and SD
		I	II	III	IV	
1	pH	8.6	8.9	8.2	7.7	8.35 ± 0.519
2	Turbidity (NTU)	12	12	16	18	14.5 ± 3.0
3	Conductivity (µS/cm^3)	1208	1147	1306	1388	1262.25 ± 106.38
4	Alkalinity (mg/l)	509	541	498	482	507.5 ± 24.93
5	TH (mg/l)	563	588	547	509	550.5 ± 33.11
6	TDS (mg/l)	1201	1243	1305	1348	1274.25 ± 65.13
7	Chlorides (mg/l)	445	499	424	429	447 ± 34.35
8	BOD (mg/l)	369	352	379	403	375.75 ± 21.31
9	COD (mg/l)	443	428	501	518	472.5 ± 43.71

Seasons: I – Spring, II – Summer, III – Autumn, IV – Winter

Table 2: Physico-chemical parameters of Thamiraparani river (Station II – Kappucadu)

S.No	Parameters	Seasons				Mean and SD
		I	II	III	IV	
1	pH	8.4	8.5	8.1	7.4	8.1 ± 0.496
2	Turbidity (NTU)	11	14	13	16	13.5 ± 2.06
3	Conductivity (µS/cm^3)	1015	1027	1121	1188	1085.25 ± 81.93
4	Alkalinity (mg/l)	438	539	478	446	475.25 ± 45.87

5	TH (mg/l)	507	541	491	472	502.75 ± 29.23
6	TDS (mg/l)	1010	1093	1145	1204	1113 ± 82.28
7	Chlorides (mg/l)	396	419	385	367	391.75 ± 21.74
8	BOD (mg/l)	291	304	327	348	317.5 ± 25.199
9	COD (mg/l)	388	431	449	467	431 ± 33.85

Seasons: I – Spring, II – Summer, III – Autumn, IV – Winter

Table 3: Physico-chemical parameters of Thamiraparani river

(Station III - Thangapattinam)

S.No	Parameters	Seasons				Mean and SD
		I	II	III	IV	
1	pH	8.3	8.7	8.0	7.6	8.15 ± 0.465
2	Turbidity (NTU)	12	10	15	18	13.75 ± 3.5
3	Conductivity (µS/cm^3)	1196	1098	1253	1295	1210.5 ± 85.27
4	Alkalinity (mg/l)	494	523	468	461	486.5 ± 28.17
5	TH (mg/l)	540	565	522	498	531.25 ± 28.32
6	TDS (mg/l)	1103	1158	1216	1293	1192.5 ± 81.349
7	Chlorides (mg/l)	439	485	398	384	426.5 ± 45.449
8	BOD (mg/l)	304	341	366	385	349 ± 34.99
9	COD (mg/l)	416	450	483	499	462 ± 36.83

Seasons: I – Spring, II – Summer, III – Autumn, IV – Winter

Table 4 : Correlation coefficient of physico-chemical parameters of Thamiraparani river (Station I – Kuzhithurai)

Parameters	pH	Turbidity (NTU)	Conductivity (µS/cm3)	Alkalinity (mg/l)	TH (mg/l)	TDS (mg/l)	Chlorides (mg/l)	BOD (mg/l)	COD (mg/l)
pH	1								
Turbidity (NTU)	-0.9623**	1							
Conductivity (µS/cm^3)	-0.9965**	0.9708**	1						
Alkalinity (mg/l)	0.9468**	-0.8512**	-0.9506**	1					
TH (mg/l)	0.9927**	-0.9243**	-0.9812**	0.9553**	1				
TDS (mg/l)	-0.8672**	0.9647**	0.8753**	-0.6834*	-0.8121**	1			
Chlorides (mg/l)	0.8076**	-0.7196*	-0.8349**	0.9404**	0.8031**	-0.5234*	1		
BOD (mg/l)	-0.9918**	0.9201**	0.9809**	-0.9607**	-0.9998**	0.8035**	-0.8134**	1	
COD (mg/l)	-0.9641**	0.9836**	0.9818**	-0.9071**	-0.9268**	0.9112**	-0.8278**	0.9261**	1

** Correlation is significant at the 0.01 level, * Correlation is significant at the 0.05 level

Table 5: Correlation coefficient of physico-chemical parameters of Thamiraparani river (Station II – Kappucadu)

Parameters	pH	Turbidity (NTU)	Conductivity (µS/cm3)	Alkalinity (mg/l)	TH (mg/l)	TDS (mg/l)	Chlorides (mg/l)	BOD (mg/l)	COD (mg/l)
pH	1.0000								
Turbidity (NTU)	-0.7488*	1.0000							
Conductivity (µS/cm^3)	-0.9527*	0.8264*	1.0000						
Alkalinity (mg/l)	0.5091*	0.1877	-0.3550	1.0000					
TH (mg/l)	0.8746*	-0.4106	-0.8496*	0.7820*	1.0000				
TDS (mg/l)	-0.8368*	0.9648*	0.9342*	-0.0011	-0.6064*	1.0000			
Chlorides (mg/l)	0.9104*	-0.4628	-0.8737*	0.7632*	0.9964*	-0.6428*	1.0000		
BOD (mg/l)	-0.9242*	0.9015*	0.9883*	-0.2132	-0.7594*	0.9772*	-0.7905*	1.0000	
COD (mg/l)	-0.7553*	0.9731*	0.8815*	0.1284	-0.5055*	0.9908*	-0.5411*	0.9410*	1.0000

** Correlation is significant at the 0.01 level, * Correlation is significant at the 0.05 level

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Table 6: Correlation coefficient of physico-chemical parameters of Thamiraparani river (Station III - Thangapattinam)

Parameters	pH	Turbidity (NTU)	Conductivity (µS/cm3)	Alkalinity (mg/l)	TH (mg/l)	TDS (mg/l)	Chlorides (mg/l)	BOD (mg/l)	COD (mg/l)
pH	1.0000								
Turbidity (NTU)	-0.9923*	1.0000							
Conductivity (µS/cm^3)	-0.9817*	0.9600*	1.0000						
Alkalinity (mg/l)	0.9659*	-0.9516*	-0.9930*	1.0000					
TH (mg/l)	0.9999*	-0.9911*	-0.9836*	0.9677*	1.0000				
TDS (mg/l)	-0.8028*	0.8693*	0.7050*	-0.7168*	-0.7966*	1.0000			
Chlorides (mg/l)	0.9722*	-0.9587*	-0.9947*	0.9997*	0.9737*	-0.7283*	1.0000		
BOD (mg/l)	-0.6855*	0.7702*	0.5939*	-0.6296*	-0.6786*	0.9743*	-0.6382*	1.0000	
COD (mg/l)	-0.7194*	0.7990*	0.6406*	-0.6794*	-0.7132*	0.9726*	-0.6866*	0.9969*	1.0000

** Correlation is significant at the 0.01 level, * Correlation is significant at the 0.05 level

Conclusion

The study revealed that the major pollutants into the Thamiraparani river could be due to discharge of organic effluent. The sources of these pollutants into these water bodies are through runoffs from the solid waste dump sites and the indiscriminate refuse disposal which had contributed to elevated levels of the pollutants. Farming along the banks of these water bodies had led to eroded materials accumulating in them. This was resulted in the occurrence of large quantities of dissolved solids and ultimately high turbidities. The discharge of organic waste including domestic and animal waste either directly or indirectly through runoffs, into the water systems has resulted in high BOD and COD level in the water bodies. Thus the water renders unsuitable for domestic consumption.

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