Surface Water Quality with respect to Municipal Solid Waste Disposal within the Imphal Municipality Area, Manipur

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Abstract -Unscientific disposal of municipal solid wastes from different sources pollutes the environment. The present paper tries to find out the pollution level of surface water of river Nambul and surface water quality at the very vicinity of the disposal site at Lamphelpat. River Nambul is one of the important rivers passing through the heart of the Imphal municipality. Three sampling sites have been taken along this river one at the entrance of the municipality (upstream), at the middle and the other at the outgoing of the municipality (downstream). The fourth site is near the solid waste disposal site. The parameters taken for the analysis using the standard methods are air temperature, water temperature, transparency, conductivity, pH, TDS, alkalinity, hardness, calcium, magnesium, chloride, dissolved oxygen and BOD. The study has been carried out on monthly basis during April, 2010 to March, 2012.

Index Terms- Imphal municipality, Lamphelpat, Nambul, Pollution, Solid waste and Surface water

I. INTRODUCTION

Urban society produces garbage and other solid waste every day. In the past, men thought the environment had an infinite capacity to devour his waste without any ill effects. More recently, however, man's health and welfare are being affected by environmental pollution. These pollutants are substances present naturally in the environment but when released in significant amount by humans, become toxic [1]. Different workers detected higher levels of organic and inorganic pollutants and heavy metals in surface and underground water and water in the vicinity of solid waste landfills [2-5]. In non-arid regions, infiltrations of water through landfill have caused water table molding. This causes leachate to flow downward and outward from the land fill. Downward flow pollutes ground water while outward flow causes leachate springs at the periphery of the landfills or seepage into streams or other surface-water [6].

The urban centers of the developing world are ill equipped to handle the increasing amounts of municipal solid waste. Health and environment get jeopardized when urban infrastructure is unable to cope with increasing amounts of wastes [7]. It is reported that urban centers of India produce 120,000t of solid waste per day and in almost all the cities, unscientific disposal of solid waste has created environmental pollution [8]. Recently 43 ground water samples and 7 surface water samples from waste dumping sites at Erode city, Tamilnadu were analyzed and found that the analyzed water samples are 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 with respect to the disposal of urban municipal solid waste in Imphal municipality, Manipur.

II. MATERIALS AND METHODS

The Imphal municipality area covers parts from the districts of Imphal East and West. The districts of Imphal East and West occupy an area of 1, 22,800 hectares, which is situated at the central part of the Manipur valley and has five districts all around it. This Municipality extends over an area of 34.48 sq. km. and geographically, it is situated at $24^{o}48.8'$ N and $93^{o}57'$ E. It has twenty-seven (27) wards and a total population of 219467 (2001 census).

The sampling of water was carried out monthly from the month of April, 2010 to March, 2012. Three sampling points are selected from the river Nambul which is one of the important rivers passing through the heart of the city. Site-1, Iroisemba near bridge, represents the point of entrance of river within the municipal areas. Here direct dumping of waste and other sewage discharge are very less. Site-2, Hump bridge (Thong Nambonbi), represents the middle point of the river within the municipal areas. This site is in the heart of the city. Dumping of municipal wastes from the houses, markets and other shops and business establishments and sewage discharges are done into the river. Site-3, Heirangoithong, represents the exit point of the river from the municipal areas. Here also haphazard dumping of municipal wastes and discharge of sewages are done. Site-4, the very vicinity of Lamphelpat temporary disposal site, represents the stagnant water.

The water samples were collected in 1litre plastic bottles after thoroughly cleaning with distilled water every month. Some parameters like Air and Water temperature, Conductivity, pH, Total dissolved solids and Dissolved oxygen is recorded and analyzed on the spot immediately after the samples have been collected. The analyses of the other remaining parameters have been carried out in the laboratory. The analysis of the physico-chemical parameters have been carried out following the standard methods as described in APHA [10] and Trivedy and Goel (1984) [11].

III. RESULTS AND DISCUSSION

The variation in the physico-chemical parameters of water in the four different sites i.e. site-1, site-2, site-3 (along the river Nambul) and site-4 at the very vicinity of Lamphelpat disposal site are given in the Table-1.

The mean air temperatures at the sites 1, 2, 3 and 4 are 26.08 ± 5.09° C, 27.04 ± 5.22° C, 24.67 ± 5.12° C and 23.75 ± 5.50° C respectively. The water temperature at site 1, 2, 3, and 4 are 21.88 ± 4.88, 22.54 ± 5.74, 22.21 ± 4.94, 23.54 ± 5.62 respectively. The water temperature at the sites 2, 3 and 4 are higher than that of site-1. After the river enters within the municipal area, several human activities like dumping of waste from the domestic, commercial and other sources is done into this river. This higher value of temperature may be due to reaction of chemicals and discharged into water bodies [12]. The mean transparency value at the study sites 1, 2, 3 and 4 are 18.5 ± 8.59, 15.5 ± 8.30, 17.58 ± 9.53 and 18.94 ± 6.1 respectively. During the study period the transparency ranges from 5 cm to 33.7 cm. The mean transparency was highest at site-4 i.e. 18.94 ± 6.1 and the lowest was at site-2 i.e. 15.5 ± 8.30. The lowest at site-2 may be because of the discharge of sewages and other waste materials in addition to other human activities.

Table 1: Physico-chemical parameters of Nambul River and Lamphelpat disposal site during April 2010 to March 2012. The values are Means for the different month ± SD and Range.

Parameter	Nambul River			Disposal site
	SITE -1	SITE -2	SITE -3	SITE -4
Air Temperature (°C)	26.08 ± 5.09 (14-33)	27.04 ± 5.22 (15-33)	24.67 ± 5.12 (14-30)	23.75 ± 5.50 (11-30)
Water Temperature(°C)	21.88 ± 4.88 (12-27)	22.54 ± 5.74 (12-36)	22.21 ± 4.94 (13-27)	23.54 ± 5.62 (12-31)
Transparency (cm)	18.5 ± 8.59 (5.6-33.6)	15.5 ± 8.30 (5.1-29.4)	17.58 ± 9.53 (5-33.7)	18.94 ± 6.1 (11.2-29.8)
Conductivity (µmho/cm)	129.58 ± 30 (80-180)	196.25 ± 72.04 (80-310)	242.5 ± 97.59 (90-450)	605 ± 158.64 (240-820)
pH	7.09 ± 0.52 (6.29-8.56)	6.77 ± 0.46 (6.3-7.62)	6.79 ± 0.48 (6.23-7.7)	6.99 ± 0.5 (6.27-7.8)
TDS (ppm)	42.5 ± 12.25 (20-60)	66.25 ± 33.47 (20-160)	93.33 ± 54.83 (20-280)	1055.42 ± 589.24 (70-1920)
Alkalinity (mg/l)	86.25 ± 21.17 (50-120)	99.58 ± 33.72 (55-170)	111.04 ± 38.16 (55-190)	240.83 ± 140.95 (35-485)
Hardness (mg/l)	35.75 ± 10.96 (18-54)	41.5 ± 12.94 (18-60)	47.5 ± 21.11 (18-110)	192.29 ± 64.28 (43-292)
Calcium (mg/l)	9.15 ± 5.12 (1.6-20.04)	9.92 ± 5.94 (0.8-20.04)	11.86 ± 6.05 (1.6-20.04)	26.95 ± 13.09 (7.21-59.32)
Magnesium (mg/l)	3.31 ± 2.15 (0-7.8)	4.43 ± 2.50 (0.97-10.72)	4.61 ± 3.46 (1.46-16.57)	30.98 ± 14.21 (3.9-55.06)
Chloride (mg/l)	9.11 ± 3.7 (2.84-17.04)	12.60 ± 6.23 (2.84-24.14)	16.63 ± 10.30 (2.84-41.18)	71 ± 30.57 (17.04-147.68)
DO (mg/l)	4.78 ± 1.17 (3.04-6.89)	3.71 ± 1.40 (1.62-5.47)	3.28 ± 1.4 (1.01-7.09)	5.46 ± 3.55 (2.23-19.86)
BOD (mg/l)	1.74 ± 0.91 (0.61-3.65)	5.02 ± 2.49 (0.91-8.83)	4.89 ± 2.54 (0.91-9.14)	5.43 ± 2.73 (0.91-9.74)

Conductivity, the capacity to conduct electric current in a solution ranges from 80 µmho/cm to 820 µmho/cm during the study period. The mean values at the study sites 1, 2, 3 and 4 are 129.58 ± 30, 196.25 ± 72.04, 242.5 ± 97.59 and 605 ± 158.64 respectively. The conductivity gradually increases from sites 1 to 3 along the river. But the highest mean conductivity value was observed at site-4. The higher value of conductivity may be because of the discharge of runoff from the unsegregated waste dumped. The value is comparable with that reported from the two Wetlands of Tiptur Taluk, Karnataka (560.67µmho/cm in Bajgur and 265.25µmho/cm in Sugur) [13]. The highest value of conductivity (1940 µmho/cm) was reported from the Cauvery River, Tamil Nadu [14].

The average pH value at site-1 is 7.09 ± 0.52 and at site 2, 3 and 4 are 6.77 ± 0.46, 6.79 ± 0.48 and 6.99 ± 0.5 respectively. The pH value during the study period ranges from 6.23 to 8.56 across the study sites. The pH value at the sites 2, 3 and 4 shows slight acidic nature. It may be because of the waste dumping. This was in support of the values reported from the Brahmani River, Orissa [15].The observed minimum value of pH are slightly lower than the desirable value prescribed by BIS, Bureau of Indian Standard (6.5-8.5)

for drinking water and maximum values in all sites are within the desirable limit except in site-1.

The mean value of the TDS at site-1 is 42.5 ± 12.25 and at sites 2 and 3 are 66.25 ± 33.47 and 93.33 ± 54.83 respectively, whereas at site-4 it was 1055.42 ± 589.24. The TDS values varied from 20 ppm to 1920 ppm in all the sites during the study period. The value of TDS gradually increases from site-1 to site-3 along the river Nambul. The values can be comparable with that reported from the vicinity of the municipality dumping sites of Karimganj district, Assam, India [16]. The maximum value in the present study was observed at site-4 which is comparable with the value of 1324 mg/l reported from the Cauvery River, Tamil Nadu [14]. TDS value may be higher due to run off from many bathing ghats, municipality solid garbage dump and other wastages [17].

During the study period the mean alkalinity value at the different sites 1, 2, 3 and 4 are 86.25 ± 21.17, 99.58 ± 33.72, 111.04 ± 38.16 and 240.83 ± 140.95 respectively. The value ranges from 35 mg/l to 485 mg/l across the sites. There is gradual increase in the values from site-1 to site-3 along the river and the highest value was observed at the site-4, the very vicinity of municipal waste dumping yard. The minimum values are comparable with the value (32-64 mg/l) reported from Thengapattanam estuary, Tamilnadu, India [18]. Higher values can be supported by the value (112-148 mg/l) reported from river Chambal in Kota city area, Rajasthan, India [19] and Jagadeshappa et al. (2011) from the two Wetlands of Tiptur Taluk, Karnataka [13]. It is also supported by the values (13-246 mg/l) reported from Ganga River, Kanpur [20]. The observed mean value at site-4 exceeds the desirable range prescribed by BIS (200mg/l).

The mean hardness values are 35.75 ± 10.96, 41.5 ± 12.94, 47.5 ± 21.11 and 192.29 ± 64.28 respectively for sites 1, 2, 3, and 4. Hardness values ranges from 18 mg/l to 292 mg/l during the study period. The higher value of hardness is observed at site-3 and the highest at site-4. The high hardness in river water may be because of the discharge of untreated domestic wastes and industrial effluents [21]. The mean value of calcium at the study sites 1, 2, 3 and 4 are 9.15 ± 5.12, 9.92 ± 5.94, 11.86 ± 6.05 and 26.95 ± 13.09 respectively. Calcium concentration varied from 0.8 mg/l to 59.32 mg/l in the study sites during the study period. There is gradual increase in the mean value from site-1 to site-3 along the river and it was maximum at site-4, the disposal site. The mean value of magnesium at the sites 1, 2, 3 and 4 are 3.31 ± 2.15, 4.43 ± 2.50, 4.61 ± 3.46 and 30.98 ± 14.21 respectively. Magnesium ranges from 0 mg/l to 55.06 mg/l during the study period. The highest value at site-4 may be because of the runoff from the dump site. The observed value of magnesium at site-4 is slightly greater than the desirable value prescribed by BIS.

The mean chloride value at the sites 1, 2, 3 and 4 are 9.11 ± 3.7, 12.60 ± 6.23, 16.63 ± 10.30 and 71 ± 30.57 respectively. Chloride concentration from across the sites ranges from 2.84 mg/l to 147.68 mg/l. The value is gradually increasing from site-1 to site-3 and the highest value is observed at site-4. The finding is similar with that reported in [22] which state that municipal sewage and domestic waste in river water raises the chloride value. Reference [23] reported that the greater value of chloride in surface water might be due to natural processes like passage of water through natural salt formations in the earth or it may be an indication of pollution from domestic waste.

The mean dissolved oxygen value at site-1, site-2, site-3 and site-4 are 4.78 ± 1.17, 3.71 ± 1.40, 3.28 ± 1.4 and 5.46 ± 3.55 respectively. The dissolved oxygen value ranges from 1.01 mg/l to 19.86 mg/l across the study sites during the study period. The mean value of biological oxygen demand, the indicator of bi-oxidisable inorganic and organic substances at the study site-1, site-2, site-3 and site-4 are 1.74 ± 0.91, 5.02 ± 2.49, 4.89 ± 2.54, and 5.43 ± 2.73 respectively. The BOD value varied from 0.61 mg/l to 9.74 mg/l across the study sites during the study period. The lowest value of BOD at site-1 indicates least organic pollutants while the higher value at sites 2 and 4 indicate the water is moderately polluted by organic wastes. The result is comparable with that reported (1.26-2.81 mg/l) from the Dhamra estuary [24] and (1.20-12.20 mg/l) reported from the river Chambal in Kota city area, Rajasthan [19].

IV. CONCLUSION

From the study of the physico-chemical parameters of water it can be concluded that disposal of solid waste in water bodies leads to pollution of water quality. It also shows that there are differences in the values of parameter between the waste disposal area and non disposal area. It also can be concluded that proper management of the municipal solid waste should be practiced to minimize harmful effect on river which is also used for drinking and other domestic work by people living along the course of river. The public should be given proper awareness regarding the haphazard dumping of solid waste into water bodies and their health impact. Illegal open dumping is hazardous and pollute both land and water (lotic as well as lentic). Considering the impact of pollutants on public health it is essential to prevent pollution of River Nambul as well as water bodies near the disposal site and develop scientific management of solid waste, segregation at source etc. so that aquatic system pollution may be avoided.

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