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Analysis of Seasonal Variations of Physico-chemical Characteristics of River Nambul Imphal, Manipur

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Abstract:
The water quality based on seasonal distribution pattern of physio-chemical characteristics of the river Nambul flowing in heart of Imphal city were analysed during different years before and after onset of rain. The physio-chemical parameter of water such as water temperature, pH, Turbidity, Dissolved Oxygen, BOD, Conductivity, Hardness, Alkalinity, COD, TDS, Chloride, Calcium and Magnesium were analysed. Water samples were collected from six sampling sites. Most of the parameters were not within the permissible value of drinking water. Turbidity was higher than normal limit and alkalinity decreased through years. BOD and COD was much lesser in upstream than the downstream. The study suggest untreated domestic, disposal from market and household to the water body causes heavy pollution in river Nambul.

Keywords: Pollution, Nambul River, Seasonal Variation, Physico-chemical properties.

I. INTRODUCTION

All biological reactions occur in water and it is the integrated system of biological metabolic reactions in an aqueous solution that is essential for the maintenance of life. Most human activities involve the use of water in one way or other. It may be noted that man's early habitation and civilization sprang up along the banks of rivers. Although the surface of our planet is nearly 71% water, only 3% of it is fresh. Of these 3% about 75% is tied up in glaciers and polar icebergs, 24% in groundwater and 1% is available in the form of fresh water in rivers, lakes and ponds suitable for human consumption (Dugan, 1972). Due to increasing industrialization on one hand and exploding population on the other, the demands of water supply have been increasing tremendously. Moreover considerable part of this limited quality of water is polluted by sewage, industrial waste and a wide range of synthetic chemicals. Fresh water which is a precious and limited vital resource needs to be protected, conserved and used wisely by man. But unfortunately such has not been the case, as the polluted lakes, rivers and streams throughout the world testify. According to the scientists of National Environmental Engineering Research Institute, Nagpur, India, about 70 % of the available water in India is polluted (Pani, 1986). Water Pollution is one of the most serious problems to humankind. It is an established fact that water quality is closely related to the surrounding environment and prevalent land use (APHA, 1992). Nambul River is one of the major River in Manipur (23.80°N to 25.68°N latitude and 93.03°E to 94.78°E longitude) with 62.70 kms length, originates from Kangchup Hill ranges in the western side at an elevation of 1830 m above mean sea level. The river flows through the thickly populated area of the city and ultimately discharges into the Loktak Lake, the largest fresh water lake in the North-Eastern Region. The potentially polluted stretch of the river is within the Imphal Municipality area for a length of about 1.45 kms and it tributary Naga River for a length of about 1 km. The people inhabiting around this river uses the partially treated water for bathing and washing purposes. The present study attempts to analyze the physico-chemical property of this river at six selected points where maximum pollution expected during April (when the water body is low prior to monsoon) and October (after monsoon) of 2014 and 2015 respectively and the results were compared with the standard value for drinking water given by BIS (IS:10500:1991).

II. MATERIALS AND METHOD

The water samples were collected from six different stations (Station 1: Iroisemba – 8 km upstream from main market; Station 2: Samushang 2.8 km upstream from main market; Station 3: Naoremthong 1.9km upstream from main market; Station 4: Hump Bridge 0 km from main market; Station 5 Heirangoithong 4 km downstream from main market; Station 6: 9 km downstream from main market). The samples were collected in different seasons (April and October of 2014-2015). Water samples were collected by using plastic bottle from study site of Nambul River. Parameter like water temperature was taken on the spot using digital thermometer. pH of water was measured by pH meter. Turbidity or transparency of water was taken by turbidity meter, total alkalinity; BOD and total hardness were determined by titration method (APHA, 2005). The Dissolved Oxygen determination was done by Wrinkler's method with Azide modification (APHA, 2005). The elements like calcium, magnesium and chloride were analysed by titration method (ALPHA, 2005)

III. RESULTS AND DISCUSSION

The results for analysis of water samples collected from the six stations are shown in Tables 1,2,3,4,5 and 6 along with standard of drinking water recommended by BIS (IS:10500:1992) Temperature values ranged from 20.3-23.2°C in the monsoon and 20-23.4°C in the dry season as shown in Table 1, station 4 which lies in the heart of Imphal city found both monsoon and dry season recorded the highest value of 24°C and 23°C respectively. In addition, the results are not within

the standard acceptable levels of permissible limits. Furthermore, the temperature was highest at the point since the station 4 was the point of most polluted area along the river. Generally, many factors such as the weather condition, sampling time, and location impact on the increase or decrease of temperature by which its role effect on the percentage of dissolved oxygen, biological activities, and other parameters

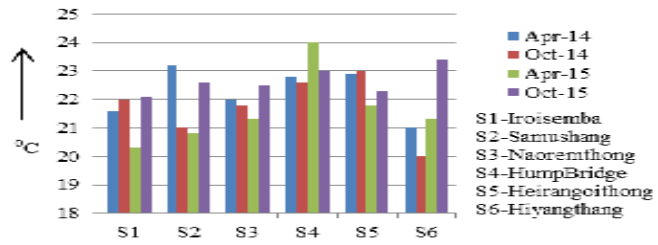

Figure.1. Temperature variation along Nambul River

pH is the indicator of acidic or alkaline condition of water status. The standard for any purpose in-terms of pH is 6.5-8.5. In the monsoon, the highest pH was obtained at the upstream with the value of 7.23 and 7.4 in downstream, whereas the lowest value was obtained at station 1 with the value of 6.4. In the dry season also almost the same value occur table 1. Moreover, statistically significant differences were not found among sampling stations. Generally, the pH concentration increase as a result of the photosynthetic algae activities that mainly consumes carbon dioxide dissolved in. Overall, the range of pH from 6.5 to 9 is appropriate for aquatic life. Therefore it is very important to maintain the aquatic ecosystem within this range because high and low pH can be destructive in nature.

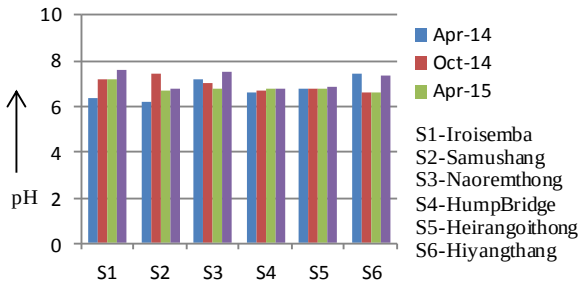

Figure. 2. pH variation along Nambul River

Turbidity values varied between 73.5 and 120 NTU during monsoon. Station 4 in the middle of the city recorded the high turbidity of 120 NTU, while the lowest value was 73.5 NTU recorded in the upstream Fig Table 1. In a similar manner, turbidity values ranged from 102 to 160 NTU during dry season, the lowest turbidity of 102 NTU was recorded station 1, while the highest value was 160 NTU at station 4 in the main market. In addition, these concentrations were not within standard permissible. However, this may be ascribed to the effluent from livestock farms, heavy precipitation, organic contamination and agriculture, and road runoff in which a high suspended matter content. Furthermore, turbidity concentrations in this study were very high at most stations where the concentration below 25 NTU is still permissible for domestic use). Overall, the excessive turbidity is generally related to possible microbiological contamination because water disinfection contained elevated turbidity is very complicated. Prevalently, turbidity is resulted from the presence of suspended particles such as silt, plankton, clay, organic matter, and other microscopic or decomposers organisms. Generally, the clarity water decreased as a result of the presence of these suspended particles that deposited in the water. This can also be the indicator of a high measured turbidity, surface runoff, and overland flow in natural waters also increase the turbidity levels in the water.

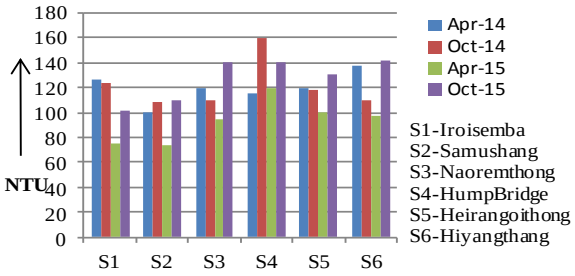

Figure.3. Turbidity variation along Nambul River

The dissolved oxygen (DO) of the water samples analysed ranged from 3.4 to 6.39 mg/L during monsoon, and from 3.6 to 7 mg/L during dry season. The lowest DO was recorded at station 6, while the highest value was at station 4 in the monsoon Table 1. In the dry season, the maximum value was at station 4, while the least value was at station 6. In addition, these results are not within the standard acceptable permissible limits, which is ranging between 4-6 mg/L. Additionally, values of DO were found to be under permissible limit at some Stations except station 4 during monsoon season whereas in dry season stations 2 and 6 were under permissible limit. The DO level found in some of the stations is adequate for the planktons to survive and to do various physiological activities. Overall, oxygen generally becomes dissolved in surface waters as a result of diffusion from the atmosphere and aquatic-plant photosynthesis. In general, dissolved oxygen is consumed by the degradation of organic matter in water. Standard for sustaining aquatic life is 4 mg/L, whereas for drinking purposes it is 6 mg/L.

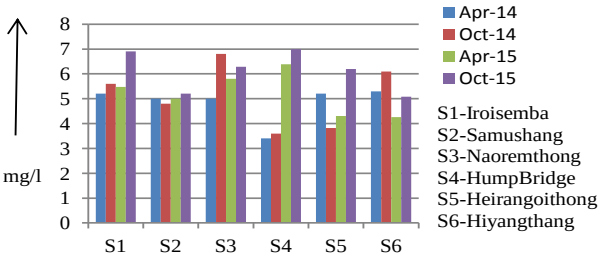

Figure. 4. D.O variation along Nambul River

The B.O.D of the river was ranging between 3.65- 10.35 mg/L in the monsoon Table 1 and from 5.14 to 7 mg/L during dry season. In the monsoon, the highest BOD was recorded in the downstream at station 6, whereas the lowest was recorded at station 1 in the upstream. Furthermore, the maximum value in the dry season was recorded at station 4, while the minimum was at station 1. Moreover, the BOD variation between stations was significantly different. Additionally, the BOD values of dry season were not within permissible limit but some points were within permissible limit like station1 and 2.The BOD concentration continuously increases because of natural plant decaying process and other contributors that increase the total nutrient in water bodies such as fertilizer, construction effluent, animal farm, and septic system. BOD

concentration is directly associated with DO concentrations. High value of BOD shows decline in DO. This phenomenon is common as identified in many previous researches

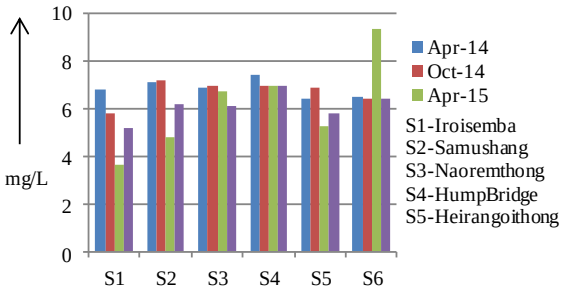

Figure. 5. B.O.D variation along Nambul River.

Table .1:Monthly variation in physico-chemical characteristics of Nambul River (Oct and April, 2014-2015).

PARAMETERS	SITE	2014		2015	
		APR	OCT	APR	OCT
TEMP	S1	21.6	22	20.3	22.1
	S2	23.2	21	20.8	22.6
	S3	22	21.8	21.3	22.5
	S4	22.8	22.6	24	23
	S5	22.8	23	21.8	22.3
	S6	21	20	21.3	23.4
pH	S1	6.4	7.2	7.23	7.62
	S2	6.2	7.4	6.72	6.8
	S3	7.2	7	6.8	7.56
	S4	6.6	6.7	6.8	6.8
	S5	6.8	6.8	6.8	6.9
	S6	7.4	6.6	6.59	7.38
TURBIDITY	S1	126	123	74.5	102
	S2	100	108	73.5	110
	S3	120	110	95.1	140
	S4	116	160	120	140
	S5	120	118	100.2	130
	S6	138	110	97.5	142
D.O	S1	5.2	5.6	5.48	6.9
	S2	5	4.8	5	5.2
	S3	5	6.8	5.8	5.89
	S4	3.4	3.6	6.39	7
	S5	5.2	3.82	4.3	6.2
	S6	5.3	6.1	3.25	5.68
B.O.D	S1	6.8	5.8	3.65	5.19
	S2	7.1	7.2	4.82	6.2
	S3	6.9	7	6.7	6.14
	S4	7.4	7	7	7
	S5	6.42	6.9	5.3	5.8
	S6	6.5	6.4	10.35	6.41
CONDUCTIVITY	S1	198	193	120	160
	S2	240	200	190	210
	S3	230	242	255	240
	S4	235	225	240	250
	S5	200	210	240	230
	S6	240	213	350	320

Conductivity depends on the number of ions present in water. In the monsoon, conductivity varied from 120 and 350 µs/cm, and the lowest value of conductivity was observed at station 1 i.e. at upstream, while the highest was at station 6 i.e. at downstream Table 1. Likewise, the variation of conductivity during dry season was from 160 to 320 µs/cm, and the maximum value of conductivity was observed at station 6, whereas the minimum was at station 1 , so the conductivity was found to be within the 2000 µs/cm. Conductance increases along the downstream of the river. Conductance values for the dry season are higher than that for the monsoon. Normally, conductivity in the water was affected by the inorganic dissolved solids such as calcium, chloride, aluminium cation, nitrate, iron magnesium, and sodium. On the other hand, organic compounds such as oil, alcohol, phenol, and sugar that can influence the water conductivity as well as the temperature also have an effect on the conductivity.. Generally, most of the freshwaters conductivity is ranging from 10 to 1000 µS/cm. Nevertheless, the concentration can exceed about 1000 µS/cm in the water that receiving pollution.

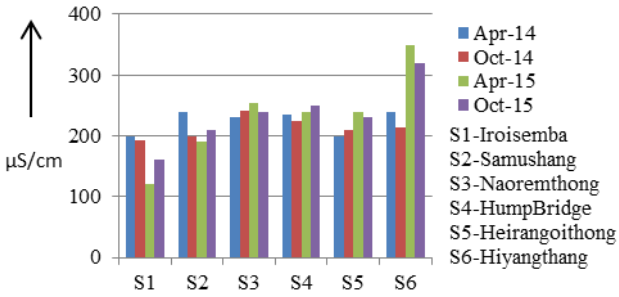

Figure. 6. Conductivity variation along Nambul River

The total hardness (TH) values ranged between minimum 64 mg/L at station1 and maximum 110 mg/L at station 6 during monsoon Table 2, whereas in dry season, they ranged between minimum 76 mg/L at station 1 and maximum 122 mg/L at station 6.Total hardness of the Nambul River increases along the downstream. Hardness values of water samples are not fit for drinking use. Hardness values for the dry season are higher than that for the monsoon. Moreover, the concentration of hardness in all stations did not pose any water quality problems because the hardness concentration was within the permissible limit which is 300 mg/L. Generally, total hardness is a function of the geology of the area with which the surface water is associated. Hardness has no known adverse influences health; nevertheless, some evidence has been given to point out its impact on heart diseases.

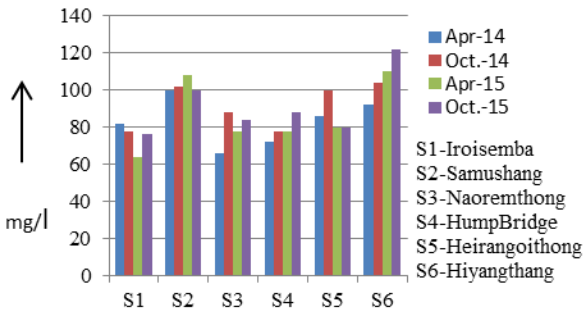

Figure. 7. Total Hardness variation along Nambul River

Alkalinity refers to the capability of water to neutralize acid. Alkalinity ranges from 60mg/l to 110mg/l in monsoon season, in dry season it ranges from 74mg/l to 135mg/l the values are high in dry season as compared to monsoon season and the values are higher in downstream as shown in table 2 this indicates the absence of Hydroxyl and Carbonate and presence of Bicarbonate in water.

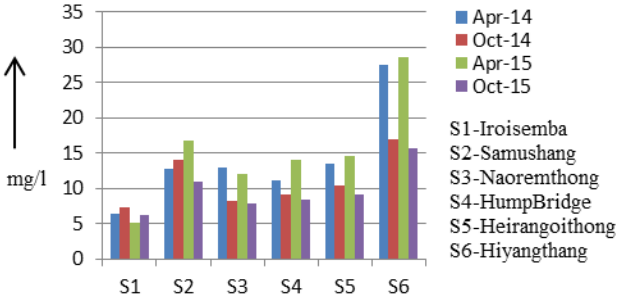

Figure. 8. Alkalinity variation along Nambul River

C.O.D is other important parameter of water quality assessment. COD concentrations of water samples were fluctuating between minimum 5.23 mg/L at station 1 and maximum 28.64 mg/L at station 6 in the monsoon Table 2, whereas in dry season, they were fluctuating between minimum 6.23 mg/L at station 1 and maximum 15.68 mg/L at station 6. In addition, these results are within the standard permissible limits which is 250 mg/L or less .Generally, the lower COD level indicates a low level of pollution, while the high level of COD points out the high level of pollution of water in the study area. Moreover, a wide usage of chemical and organic fertilizer and discharge of sewage affect COD level, while the high COD pointing to a deterioration of the water quality is attributed to the discharge of municipal effluent.

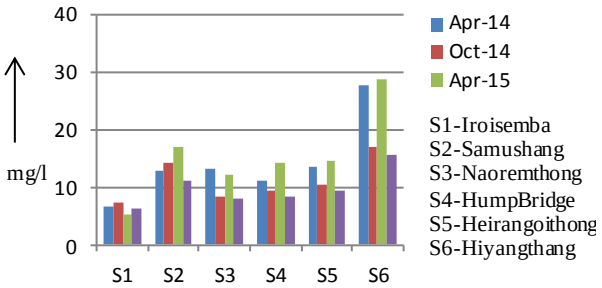

Figure. 9. C.O.D variation along Nambul River

The values of TDS in the monsoon season are ranging from 80 to 150 mg/L. The highest value obtained was 150 mg/L recorded at station 4, and the lowest value obtained was 80 mg/L at station 1Table 2. In addition, the TDS concentrations in the dry season ranged from 110 to 200 mg/L. The highest concentration was 200 mg/L recorded at station 6, and the lowest concentration was 110 mg/L at station 2. Moreover, It was noticed that upstream stations have lower TDS values compared to the downstream ones because anthropogenic and land use activities were much less at upstream stations. Besides, TDS results are within permissible limits .The high TDS concentration in the rivers is attributed to presence extreme anthropogenic activities along the river course and runoff with high suspended matter.

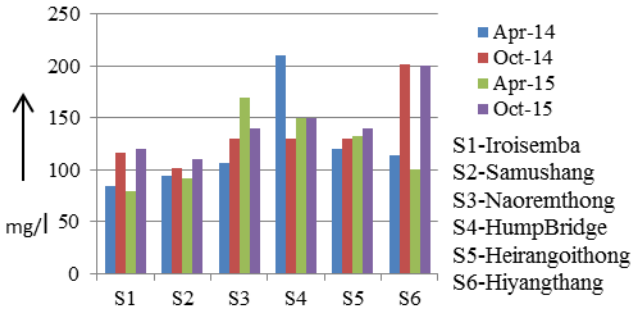

Figure. 10 . T.D.S variation along Nambul River

Table.2. Monthly variation in physico-chemical characteristics of Nambul River (Oct and April, 2014-2015).

PARAMETERS	SITE	2014		2015	
		APR	OCT	APR	OCT
HARDNESS	S1	82	78	64	76
	S2	100	102	108	100
	S3	66	88	78	84
	S4	72	78	78	88
	S5	86	100	80	80
	S6	92	104	110	122
ALKALINITY	S1	68	74	60	75
	S2	75	80	62	74
	S3	80	90	85	95
	S4	82	90	85	92
	S5	82	90	90	97
	S6	108	132	110	135
C.O.D	S1	6.4	7.4	5.23	6.23
	S2	12.8	14	16.8	11
	S3	13	8.3	12.13	7.89
	S4	11.2	9.2	14	8.34
	S5	13.5	10.4	14.6	9.2
	S6	27.5	17	28.64	15.68
T.D.S	S1	84.6	116	80	120
	S2	94	102	92	110
	S3	107	130	170	140
	S4	210	130	150	150
	S5	120	130	132	140
	S6	114	202	100	200
CALCIUM	S1	16.5	20.4	15.23	19.24
	S2	14.4	21	18.6	20
	S3	22.4	21.2	20.04	18.44
	S4	22.4	23.4	20	20.02
	S5	20.5	15.4	21.6	18.6
	S6	26.4	22.8	22.44	27.25
MAGNESIUM	S1	7.5	6.7	6.33	6.83
	S2	8.4	7.8	8.8	7.2
	S3	8.2	10.1	6.82	8.77
	S4	6.9	10	7.5	9.24
	S5	6.2	9	7.8	9.1
	S6	16.9	14.9	13.15	13.15

Calcium is an important constituent present in natural water. It is also one of the main cations contributing to hardness in water. Permissible limit for calcium content in water is less than 75mg/l. The concentration of calcium in Station 1 varied from 15.23mg/l to 20.4mg/l; 22.44mg/l to 27.25mg/l in Station 6 during monsoon and dry seasons respectively and also the minimum and maximum value. Calcium concentration was found least during monsoon and maximum during winter this is due to the fact that Calcium is present in various construction materials, such as cement, brick lime and concrete. It is present in batteries, and is applied in plaster as calcium sulphate.

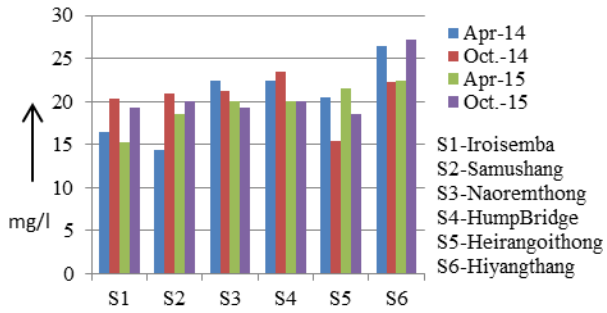

Figure. 11. Calcium variation along Nambul River

Magnesium is essential for all organisms and is not toxic under normal circumstances. The value of Magnesium ranged between 6.33mg/L to 16.9mg/L in monsoon and 6.7mg/L to 13.15mg/L in dry season. Deficiencies of magnesium are much more common than problems concerned with toxicity. Magnesium is a key plant nutrient and is essential for photosynthesis in plants, where it forms the active site in the chlorophyll enzyme molecule.

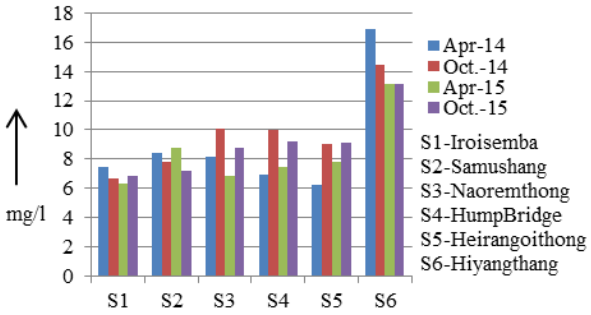

Figure. 12. Magnesium variation along Nambul River

IV. CONCLUSION

The seasonal distribution pattern of different parameters were found to be influenced by different environmental factors. Thus the main pollutants added to the river system comes from domestic waste/refuge, sewage, animal excreta and hospital waste. Approximately 85 tons of waste of waste is being generated from the city of Imphal everyday which contributes towards the degradation of the river water quality. Thus it is suggested that proper waste management should be taken up. Ultimately Nambul Rivers discharge into the Loktak Lake, the pollution of this River will also affects the water quality of Loktak Lake.

V. ACKNOWLEDGEMENT

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