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Assessment of Water Quality Index of Nambul River, Imphal, Manipur, India

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Abstract – *The objective of the study was to calculate the Water Quality Index (WQI) of Nambul River Imphal, Manipur. Water Quality Index (WQI) of Nambul River was analysed at 7th October 2016 based on the various physiochemical parameters obtained during this period. Nambul River flows through the heart of Imphal city and drains into the Loktak Lake which is included in Ramsar site. The Water Quality of this river were severely affected while passing through Imphal city. Water samples were collected from six stations. The physico-chemical parameter of water such as water Temperature, pH, Turbidity, Dissolved Oxygen, BOD, Conductivity, Hardness, Alkalinity, COD, TDS, Chloride, Calcium and Magnesium were analysed. The calculation was done using arithmetic index method. The WQI value for these samples ranges from 103.89-115.34. The highest WQI value of 115.34 was recorded from site IV (Hump Bridge) which is in the dense populated area of Imphal city, which shows that water is unsuitable for drinking. Thus, river needs proper treatment to conserve this water body from future contamination and pollution.*

Key Words: Manipur, Nambul River, Water Quality Index, Physico-Chemical Parameters, Weighted Arithmetic Index Method.

1. 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.The indices are among the most effective ways to communicate the information on water quality. 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). Water is a chemical compound with the chemical formula H2O. Water covers 71% of the Earth's surface (CIA, 2014) and is vital for all known forms of life. Water quality refers to the chemical, physical and biological characteristics of water (Diersing and Nancy, 2009). It is a measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purpose (Johnson et al., 1997). In order to keep the health of any aquaculture system at an optimal level, certain water quality indicators or parameters must be monitored and controlled. A water quality index (WQI) summarizes large amounts of water quality data into simple terms (e.g., excellent, good, bad, etc.) for reporting to managers and the public in a consistent manner (Hulya, 2009). A water quality index provides a single number that expresses overall water quality at a certain location and time, based on several water quality parameters. WQI can be used as a tool in comparing the water quality of different sources and it gives the public a general idea of the possible problems with water in a particular region

Nambul River is one of the major river in Manipur (23.80^0N to 25.68^0N latitude and 93.03^0E to 94.78^0E 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.

Based on the importance of this freshwater body towards human livelihood, aquatic biodiversity, aquaculture, agriculture assessment of water quality index is very much required. The assessment of WQI of Nambul River based on the values of water quality index is extremely necessary because of the rise in various anthropogenic activities and also this analysis will be of great help in future planning and implementation of water management programs.

The main objectives of the current study are to assess and evaluate Water Quality Index (WQI) based on physic-

chemical parameters, to envisage the local people towards proper management and conservation policies.

2. MATERIAL AND METHOD

The present work was divided into three parts as initial pre-field survey was carried out for identifying water collection sampling stations, secondly as field field work, water samples were collected from identify sampling station and lastly collected samples were analysed in laboratory and compilation of data were obtained.

2.1 Sampling Sites

The water samples were collected from six different stations (Site 1: Iroisemba – 8 km upstream from main market; Site 2: Samusang 2.8 km upstream from main market; Site 3: Naoremthong 1.9km upstream from main market; Site 4: Hump Bridge 0 km from main market; Site 5 Heirangoithong 4 km downstream from main market; Site 6: 9 km downstream from main market). The samples were collected in different seasons (0n 7th Oct 2016) 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)

2.2 Calculation of Water Quality Index (WQI)

In this current study, Water Quality Index (WQI)was calculated by using the Weighted Arithmetic Water Quality Index which was originally proposed by Horton (1965) and developed by Brown et al (1972). The weighted arithmetic water quality index (WQI) is in the following form:

$$WQI = \sum wiqi/\sum wi$$

Where, wi= Relative weight
qi= Water quality rating
The unit weight (wi) of the various water quality parameters are inversely proportional to the recommended standards for the corresponding parameters. According to Brown et al (1972), the value of qi is calculated using the following equation:

$$qi = 100\ [(Vi - Vid)\ /(Si - Vid)]$$

Where, Vi= Observed value
Si= Standard permissible value
Vid= Ideal value
All the ideal values (Vid) are taken as zero for drinking water expect pH and dissolved oxygen (Triphaty and Sahu, 2005).

For pH, the ideal value is 7.0 9 (for natural/pure water) and a permissible value is 8.5 (for polluted water). Therefore, the quality rating for pH is calculated from the following equation:

$$q_{pH} = 100\ [(V_{pH} - 7.0/(8.5-7.0)]$$

Where, V_{pH}= observed value of pH

For dissolved oxygen, the ideal value is 14.6 mg/L and the standard permissible value for drinking water is 5 mg/L. Therefore, its quality rating is calculated from the following equation:

$$q_{DO} = 100\ [(V_{DO} - 14.6)/(5.0-14.6)]$$

Where, V_{DO} =observed value of dissolved oxygen.

Table 1 below shows a classification of water quality, based on its quality index of Brown et al (1972), Chatterji and Raziuddin (2002) etc.

Table 1 Classification of Water Quality based on weighted arithmetic WQI method

WQI	STATUS
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very Poor
Above 100	Unsuitable for Drinking

3. RESULTS AND DISCUSSIONS

The temperature of Nambul river water during October 2016 varied from 22.2^{0}C to 21.3^{0}C. As shown in Table2 and the min. temperature was recorded at Naoremthong and the max. Temperature was recorded at Iroisemba and Heirangoithong. The mean temperature values are 21.81^{0}C which is not under the permissible limits for drinking purpose. As the temperature depends upon weather temperature the temperature during sampling was 23^{0}C.

The pH of water range from 7.45 to 7.16 as shown in Table2. The maximum pH value is recorded at Iroisemba of 6.45 and the min. value is recorded at Naoremthong and Hump Bridge of 7.16. The mean pH values along the Nambul river water value is 7.27 that means the water is acidic in nature which is not under permissible limit. The difference in the pH values is depending upon the source of contamination and growth of algae, affect the ph level to higher. Most probably the effluents discharge from cafeteria can affect the level of pH as some organic matters are acidic

TABLE 2: Water Parameters of Nambul River

Parameters	Sites					
	S1	S2	S3	S4	S5	S6
Temp.	22.2	21.4	21.3	22	22.2	21.8
pH	7.45	7.3	7.16	7.13	7.14	7.18
Turbidity	110	119	122	130	117	127
D.O	4.5	4.7	5.6	4.9	5.2	5.1
B.O.D	5.3	6.8	6.5	7	6.5	6.2
Conductivity	170	119	232	230	220	250
Hardness	75	105	85	82	92	115
Alkalinity	90	80	102	95	102	132
C.O.D	7.2	12.2	8.1	8.2	10.1	12.2
T.D.S	124	108	123	145	135	180
Chloride	16.4	18.4	23.2	27	22.4	30.6
Calcium	16.7	18	17.2	18	17.2	20.2
Magnesium	6.4	7.2	8.2	9.5	8.7	13.3

Turbidity of the river water ranged from 110 NTU to 130 NTU which is significantly high shown in Table2. High turbidity levels recorded at Hump Bridge of 130 NTU due to high waste discharge and the lowest value of turbidity is recorded at Iroisemba of 110 NTU which is located at the initial sampling point, and the mean turbidity level is 120.833 NTU. Which is not under the permissible limits, But turbidity level is low at initial sampling point because of low erosion of the land and low waste discharge. Generally, turbidity increased towards the river mouth due to high suspended particle.

Dissolved oxygen range from 4.5mg/L to 5.6mg/L shown in figure 4.7. The highest DO level is 5.6mg/L at Naoremthong while the lowest is 4.5mg/L at Iroisemba. The mean DO is 5mg/L which means it is not under permissible value. The low DO is probably caused by the cafeteria discharges. Cafeteria discharges contain organic matters cause high BOD levels. The microorganism will need to use oxygen to oxide the organic matter.

Biochemical oxygen demand range from 5.3mg/L to 7mg/L during our period shown in figure 4.3. The highest value is7mg/L at Hump Bridge and the lowest is 5.3mg/L at Iroisemba. The mean B.O.D is 6.38mg/L which is not under permissible value. At hump bridge the effluent like garbage dump and industrial discharge into the river. The effluent will be oxidizing by the microorganism which uses more oxygen that cause low DO. At the upstream of river (i.e Iroisemba) BOD levels is low because most probably the areas are less developed than the areas in downstream. Therefore more oxygen indicated high DO where the microorganisms have less organic matter to oxidize.

As conductivity range from 170-250 along the river. As conductivity increase along the downstream of river shown in figure 4.8. The highest value is 250 at Hiyangthang and the lowest value is 170 at Iroisemba which is upstream of the river. The mean conductivity is 219.5; conductivity in the water was affected by the inorganic dissolved solids such as calcium, chloride, aluminium cation, nitrate, iron magnesium, and sodium. 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.

The total hardness values ranged between 75 mg/L-115mg/L shown in figure 4.4. The min. value of 75 mg/L at Iroisemba and maximum 122 mg/L at Hump Bridge. The mean values is 92.33mg/L which is not . Total hardness of the Nambul River increases along the downstream. Hardness values of water samples are not fit for drinking use. It is caused due to the present of dissolved bicarbonate mineral like calcium bicarbonate and magnesium bicarbonate.

Alkalinity was ranged from 90mg/l to 132mg/l, the minimum value is 90mg/L at Iroisemba and maximum value is 132mg/L at Hiyangthang shown in figure 4.5. The mean value is 100.16mg/L. this indicates the absence of Hydroxyl and Carbonate and presence of Bicarbonate in water.

The COD level is range between 7.2mg/L-12.2mg/L shown in figure 4.9. The lowest COD level is at Iroisemba with 7.2 mg/L while the highest COD level is at Hiyangthang with 12.2 mg/L and the mean value is 9mg/L. As COD level is low at the downstream of River. Because maybe the areas are not as developed so less effluent is flowed into the river. The activities along River increase throughout the year. This is due to the effluents discharge from cafeterias and faculties that make microorganism to use the more oxygen to oxidize organic matter.

Total dissolved solids (TDS) have range of108mg/L-180mg/L shown in figure 4.10. The lowest TDS level is at Samushang of 108mg/L while the highest is at Hiyangthang of 180mg/L. the mean value is 135.83mg/L. Due to dissolve solids come fromsite constructions can cause erosion as dust and sand can be delivered into the river, the TSS level is quite high compare to other data. The effluents from cafeterias and hostels increase the sediments in the river, runoff water can increased TDS level as it carries organic and inorganic substance to the river.

Chloride value range from 16.4mg/L-27mg/L shown in figure 4.11. the minimum value is 16.4mg/L at Iroisemba and the maximum is 27mg/L at Hump Bridge. Mean value is 23mg/L it is due to highly discharge of industrial waste

The concentration of calcium varied from 16.7mg/l to 20.21mg/L shown in figure 4.12 the minimum value is 16.7mg/L at Iroisemba and maximum value is 20.21mg/L at Hiyangthang. The mean value is 17.88mg/L. 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.

Magnesium also occurs in all kind of natural waters with calcium shown in figure 4.13. Its value range from is 6.4mg/L to 13.3mg/L. The minimum value is 6.4 mg/L at Iroisemba and maximum value is 13.3mg/L, its mean value is 8.88mg/L. Magnesium is essential for all organisms and is not toxic under normal circumstances. 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

Table 3: Calculation of Water Quality Index

Parameters	Sites	Observed values (V_i)	Standard value (S_i)	Unit weight (W_i)	Quality rating (q_i)	Weighted value (W_iq_i)
pH	Site 1	7.45	8.5	0.1176	30	3.528
	Site 2	7.3	8.5	0.1176	20	2.352
	Site 3	7.16	8.5	0.1176	10.66	1.25
	Site 4	7.13	8.5	0.1176	8.67	1.02
	Site 5	7.14	8.5	0.1176	9.33	1.09
	Site 6	7.18	8.5	0.1176	12	1.41
Turbidity	Site 1	110	25	0.04	440	17.6
	Site 2	119	25	0.04	476	19.04
	Site 3	122	25	0.04	488	19.52
	Site 4	130	25	0.04	520	20.8
	Site 5	117	25	0.04	468	18.72
	Site6	127	25	0.04	508	20.32
D.O	Site 1	4.5	5	0.2	105.1	21.042
	Site 2	4.7	5	0.2	103.13	20.63
	Site 3	5.6	5	0.2	93.75	18.75
	Site 4	4.9	5	0.2	101.04	20.208
	Site 5	5.2	5	0.2	97.91	19.58
	Site 6	5.1	5	0.2	98.95	19.79
B.O.D	Site 1	5.3	5	0.2	106	21.2
	Site 2	6.8	5	0.2	136	27.2
	Site 3	6.5	5	0.2	130	26
	Site 4	7	5	0.2	140	28
	Site 5	6.5	5	0.2	130	26
	Site 6	6.2	5	0.2	124	24.8
Conductivity	Site 1	170	250	0.004	68	0.272
	Site 2	119	250	0.004	47.6	0.1904
	Site 3	232	250	0.004	92.8	0.3712
	Site 4	230	250	0.004	92	0.368
	Site 5	220	250	0.004	88	0.352
	Site 6	250	250	0.004	100	0.4
Hardness	Site 1	75	300	0.0033	25	0.0825
	Site 2	105	300	0.0033	35	0.1155

	Site 3	85	300	0.0033	28.33	0.094
	Site 4	82	300	0.0033	27.33	0.0901
	Site 5	92	300	0.0033	30.67	0.1012
	Site 6	115	300	0.0033	38.33	0.1265
Alkalinity	Site 1	90	200	0.005	45	0.225
	Site 2	80	200	0.005	40	0.2
	Site 3	102	200	0.005	51	0.255
	Site 4	95	200	0.005	47.5	0.238
	Site 5	102	200	0.005	51	0.255
	Site 6	132	200	0.005	66	0.33
C.O.D	Site 1	7.2	250	0.004	2.88	0.0115
	Site 2	12.2	250	0.004	4.88	0.0195
	Site 3	8.1	250	0.004	3.24	0.0129
	Site 4	8.2	250	0.004	3.28	0.0131
	Site 5	10.1	250	0.004	4.04	0.0162
	Site 6	12.2	250	0.004	4.88	0.0195
T.D.S	Site 1	124	500	0.002	24.8	0.0496
	Site 2	108	500	0.002	21.6	0.0432
	Site 3	123	500	0.002	24.6	0.0492
	Site 4	145	500	0.002	29	0.058

	Site 5	135	500	0.002	27	0.054
	Site 6	180	500	0.002	36	0.072
Chloride	Site 1	16.4	250	0.004	6.56	0.0263
	Site 2	18.4	250	0.004	7.36	0.0295
	Site 3	23.2	250	0.004	9.28	0.0371
	Site 4	27	250	0.004	10.8	0.0432
	Site 5	22.4	250	0.004	8.96	0.0359
	Site 6	30.6	250	0.004	12.24	0.0489
Calcium	Site 1	16.7	75	0.013	22.27	0.2895
	Site 2	18	75	0.013	24	0.312
	Site 3	17.2	75	0.013	22.93	0.2981
	Site 4	18	75	0.013	24	0.312
	Site 5	17.2	75	0.013	22.93	0.2981
	Site 6	20.2	75	0.013	26.93	0.35
Magnesium	Site 1	6.4	30	0.033	21.33	0.704
	Site 2	7.2	30	0.033	24	0.792
	Site 3	8.2	30	0.033	27.33	0.9029
	Site 4	9.5	30	0.033	31.67	1.045
	Site 5	8.7	30	0.033	29	0.957
	Site 6	13.3	30	0.033	44.33	1.463

The Water Quality Index (WQI) of the Nambul River was then calculated using the weighted arithmetic index formula as follows:

WQI (site1) = ∑wiqi/∑wi = 65.0304/0.6259 = 103.89
WQI (site2) = 70.9241/0.6259 = 113.32
WQI (site3) = 67.5404/0.6259 = 107.91
WQI (site4) = 72.1954/0.6259 = 115.34
WQI (site5) =67.4594/ 0.6259 = 107.99
WQI (site6) =69.1299/0.6259 = 110.45

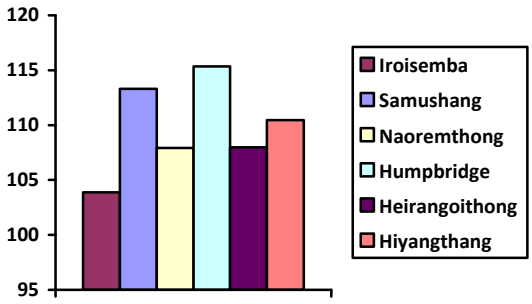

Figure 1: Graphical presentation of WQI

4. CONCLUSIONS

The objective of the study was to calculate the Water Quality Index (WQI) of Nambul River Imphal, Manipur in order to assess its suitability for drinking purposes. The water quality index (WQI) of 103.89, 113.32, 107.91, 115.34, 107.99 and 110.45 were obtained for Site1, Site2, Site3, Site4, Site5 and Site6 respectively. And from which Site4 (Hump Bridge) is found to have highest value. The obtained value is a clear indication that water from Nambul River is unsuitable for drinking purposes and must therefore be treated before use to avoid water related diseases. And it is also need for regular monitoring of water quality in order to detect the changes in physicochemical parameters. 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.

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REFERENCES

[1] Waribam Suraj Devi, Kh. Rajmani Singh and N.Sony Meitei(2015). "*Assessment of Water Quality Index of Nambol River, Manipur, India* ".Universal Journal of Environmental Research and Technology eISSN 2249 0256 Volume 5, Issue 3: 165-172M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

[2] Govindraj S, Selvaraj D, Kuppuraj RM, Rangaswamy M (2009). *Water quality in select regions of Cauvery Delta River basin, Southern India, with emphasis on monsoonal variation*. Environmental Monitoring and Assessment, In press (DOI:10.1007/s10061-009-1013-7).

[3] Babu, K.N., D. Padmalal, R. Sreeja and S. Sreebha, (2003), *Water Quality Variation of Bharatapuzha River, South West Cost of India*: Problems and Solutions. In: Environments Pollution, Singh, V.P. and R.N. Yadava, (Eds). Allied Pub. Pvt. Ltd., New Delhi, India, pp 29-43

[4] Nasrollahzadeh C, Vardi A . (2002*). Tajan River water quality study of quality index curves*, Proceedings of the Sixth International River Engineering Conference. Volume II. Ahvaz, Chamran University, p 903.

[5] Almeida, C. A., Quintar, S., Gonzalez. P., and Mallea, M. A. (2007): Influence of urbanization and tourist activities on the water quality of the Portero de los Funes River (San Luis – Argentina). Environment Monitoring and Assessment, 133: 459 –465

[6] Mini, I. and Radhika. C. G. and Ganga Devi, J. (2003): Hydrological studies on a lotic ecosystem, Vamanapuram River, Thiruvananthapuram, Kerala, South India. Poll. Res., 22(4) 617-626.

[7] 2. Th. Alexander Singh, N.Sanamacha Meetei, and L. Bijen Meitei(2013)."Seasonal Variation of Some Physico-chemical Characteristics of Three Major Riversin Imphal, Manipur: A Comparative Evaluation

[8] Naz, S. (2014): A study for prediction of water quality of non-reserved ponds of Bhilai - Durg regions for various purpose. Online Int. Interdisciplinary Res. J. 4: 276-288.

[9] Lok Siew Chin(2012) "River Water Quality Profile In University Technology Malaysia Campus" .Thesis for Bachelor of Civil Engineering.

[10] Khwakaram, A. I., Majid, S. N. and. Sharma, N. Y. (2012): Determination of Water Quality Index (WQI) for Qalyasan stream in Sulaiman city, Kurdistan region of Iraq. Int. J. Plant and Animal Environ. Sci., 2(4), pp. 148 – 157.

[11] Singh, P. and Balasingh, R. (2011): Limnological studies of Kodaikanal Lake (Dindugal District), in special reference to phytoplankton diversity. Ian. J. Fund. Appl. L. Sci., 1(3): 112-118.

[12] R. K. Horton, An index number for rating water quality, Journal of Water Pollution Control Federation, 37 (3), 1965, pp 300-306.

[13] P. B. Jagadeeswari and K. Ramesh, Water Quality Index for Assessment of Water Quality in South Chennai Coastal Aquifer, Tamil Nadu, India, International Journal of Chem. Tech Research, 4 (4), 2012, pp 1582-1588.

[14] APHA, (2005). Standard Methods for the Examination of Water and Waste Water, 21th ed. American Public Health Association, Washington, D.C.