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Analysis of Seasonal Variation in Water Pollution Index of Nambul River, Manipur, North-East, India

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Abstract

Twenty-one water quality parameters were analysed at five sampling locations along the stretch of Nambul River covering about 20 kilometers. The main objective of the study is to bring out the water pollution index of Nambul River. The study was carried out for four seasons-monsoon, post monsoon, winter and pre monsoon on the physico-chemical and microbiological analysis like water temperature, total dissolved solid, total suspended solid, total solid, turbidity, pH, electrical conductivity, dissolved oxygen, biological oxygen demand, chemical oxygen demand, total hardness, total alkalinity, chloride, inorganic phosphate, sulphate and total coliform bacteria. Some of the mean observed parameters values are highly exceeded from the acceptable limit prescribed by Bureau of Indian Standards, World Health Organization and National Centre for Biotechnology Information. The water pollution index value ranges from 13.36 to 17.51. Major sewage drains and various anthropogenic activities near the market areas are the major polluting factors of Nambul River. A holistic approach on sewage treatment and public sensitization is needed for the conservation of the river.

Keywords: Nambul River, water quality parameters, water pollution index, pollution.

Introduction:

Water is an important asset of environment; it plays a vital role for human beings, environmental existence, and overall health by providing freshwater. Water resources play a critical role in various sectors of economy such as agriculture, livestock production, forestry, industrial activities, hydropower generation, fisheries, and other creative activities (Shweta Tyagi.et al). Nowadays, surface water quality became a critical issue in many countries: especially due to the concern that freshwater will be a scarce resource in the future, therefore, water quality monitoring program is necessary

for the protection of freshwater resources (Pesce et al.,2000). Continuous monitoring of river water quality can facilitate proper and sustainable management initiatives (American Public Health Association, 2005).

Study area:

The Nambul river originates from Kangchup Hill ranges and passes through the heart of its capital city, Imphal and finally joins Loktak lake (DOE&CC). The river lies between latitude 24º35'0" N to 24º57'0" N and longitude 93º48'30''E to 93º59'30" E (Fig 1). Its total length is about 62.70 km and its elevation is 1830 m above mean sea level (Rajkumar et al.,2016). Nambul river was once a freshwater river, but currently it is highly polluted. The main polluting factor for polluting Nambul River is dumping of garbage ang inletting of sewage from houses, hotels, shops etc. around the periphery of the river (DOE&CC). The main objective of the study is to find out the pollution load of Nambul River by using Water Pollution Index (WPI) and depict the seasonal variation of water quality and its pollution level.

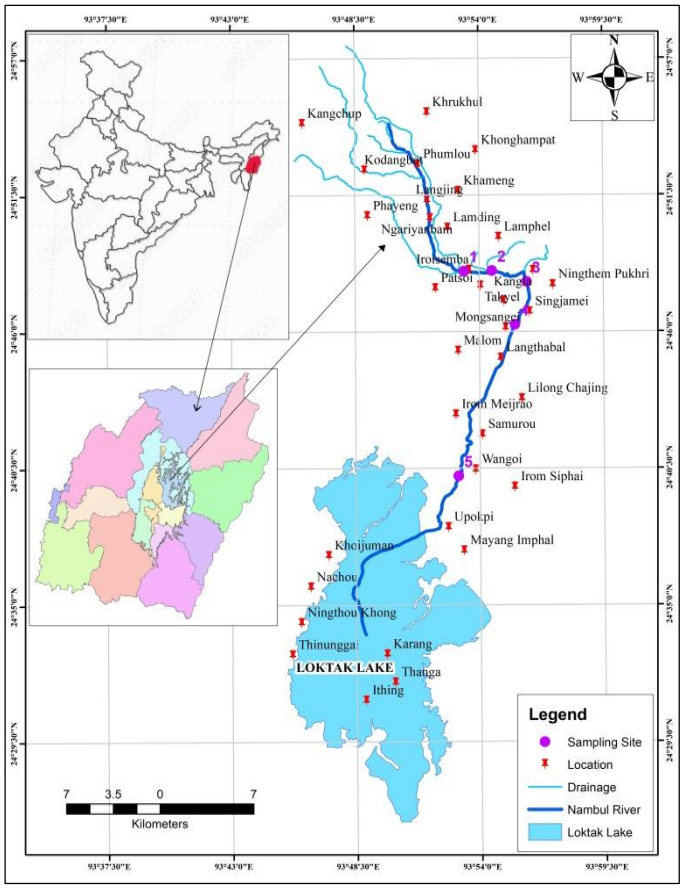

Figure 1: Map showing sampling sites of Nambul river.

Methodology:

Based on the preliminary assessment, five sampling points which were polluted had been identified for the study of water pollution level. The sites are Site Ⅰ (Iroisemba); Site Ⅱ (Naoremthong); Site Ⅲ (Keishampat Junction); Site Ⅳ (Heirangoithong); and Site Ⅴ (Wangoi). At each sampling location, required field analysis were done and eventually sub- surface water sample were collected using pre-washed polyethylene bottles with distilled water for further laboratory analysis.

Table 1: Sampling and analysis site of Nambul river.

Sampling sites	Latitude	Longitude
Site 1 (Iroisemba)	24° 48’26.5” N	93°53’19.5” E
Site 2 (Naoremthong)	24°48’27.3” N	93°54’34.2” E
Site 3 (Keishampat Junction)	24°48’0.8” N	93°56’6.4” E
Site 4 (Heirangoithong)	24°46’17.2” N	93°55’34.7” E
Site 5 (Wangoi)	24°40’11.7” N	93°53’2.8” E

Sample Collection:

Water samples were collected from five points, starting from the point of entry of municipal areas till the downstream of river before draining to Loktak Lake. Sample were collected in approved polythene bottle previously soaked with nitric acid and then rinsed with distilled water. It was collected for four seasons, namely monsoon (2022), post-monsoon (2022), winter (2022 and 2023) and pre-monsoon (2023).

Sample Preservation:

Water samples were brought in laboratory for further water quality analysis and stored in cold place.

PHYSICO-CHEMICAL AND MICROBIOLOGICAL ANALYSIS:

The parameters were analysed using APHA (24^{TH} Edition, 2017) and Trivedy and Goel (1986) laboratory manual.

Table 2: Method used for Analysis

Sl. No.	Parameter	Detection Method
1.	Water Temperature	Calibrated mercury thermometer
2.	Total Solids (TS)	Trivedy and Goel Laboratory method

3.	Total dissolved Solid	Aquasol Digital TDS meter
4.	Total suspended Solids (TSS)	Difference between Total Solid and Total dissolved solids
5.	Electrical conductivity	Digital electrical conductivity meter
6.	Turbidity	Digital nephelo-turbidity meter
7.	pH	Eutech handheld pHTestr 10
8.	Free carbon dioxide	Titrimetric method at the sampling spot
9.	Dissolved Oxygen (DO)	Winkler's titrimetric method
10.	Biological Oxygen Demand (BOD)	Titrimetric method
11.	Chemical Oxygen Demand (COD)	Acid digestion at digester for two hours followed by analysis using Digital COD Analyser of Spectralab
12.	Total Hardness	Titrimetric method
13.	Calcium	
14.	Magnesium	
15.	Total Alkalinity	
16.	Chloride	
17.	Sodium	Microprocessor flame photometer
18.	Potassium	
19.	Sulphate	Turbidimetric method using doubled beam UV spectrophotometer.
20.	Inorganic phosphate	
21	Total Coliform	Most Probable Number method (MPN)

Water Pollution Index calculation (WPI):

Water Pollution Index is computed using the function by Hossain and Patra, (2020)):

WPI = $\frac{1}{n} \sum_{i=0}^{n} PL$

$PL = 1 + (Ic - Sd)/Sd$

Where,

PL represents Pollution Load,

Sd is the standard value/limit for various variables considered,

Ic is the actual value of the i^{th} parameters,

n is the number of parameters studied.

Table 3: Hossain and Patra, (2020) classified WPI

Value	Indication
< 0.5	Excellent water
0.5 - 0.75	Good water
0.75 – 1	Moderately polluted water
> 1	Highly polluted water

Results and Discussion:

Physico-chemical and microbiological parameters:

For the analysis, the sampling was done from June of 2022 to April of 2023, where we systematically categorised the seasons to monsoon, post-monsoon, winter and pre-monsoon. The mean values of twenty-one physico-chemical and microbiological parameters of Nambul River are presented in table 4, 5, 6, 7. Out of twenty-one parameters, sixteen parameters have been selected for Water Pollution Index calculation using BIS, WHO and NCBI standards for drinking water quality. The parameters are Water temperature, Total Dissolved Solid, Electrical Conductivity (EC), Turbidity, pH, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Hardness, Calcium, Magnesium, Total Alkalinity, Chloride, Inorganic Phosphate, Sulphate and Total Coliform Bacteria.

The results for Water Pollution Index for Nambul River for monsoon, post-monsoon, winter and pre-monsoon are reflected in Fig 2.

Table 4: Mean observation value of physico-chemical and microbiological parameters during Monsoon.

		Sites						
SL NO.	**Parameters**	**1**	**2**	**3**	**4**	**5**	**Mean**	**BIS/WHO/NCBI Standard**
1.	WATER TEMPERATURE (^{0}C)	24.17	24.83	25.67	25.83	26.33	25.37	25-32
2.	TOTAL SOLID (mg/l)	316.00	255.33	290.67	278.00	250.67	278.13	-
3.	TDS (mg/l)	38.33	70.67	117.67	127.00	134.33	97.60	500
4.	TSS (mg/l)	277.67	184.67	173.00	151.00	116.33	180.53	-
5.	EC (µS/cm)	78.67	155.33	230.67	251.33	263.33	195.87	500

6.	TURBIDITY (NTU)	157.33	113.33	129.73	116.80	59.73	115.38	1
7.	pH	7.09	6.80	6.85	7.05	7.14	6.99	6.5-8.5
8.	FREE CO_2 (mg/l)	15.40	21.27	53.90	37.40	32.63	32.12	-
9.	DO (mg/l)	6.42	5.20	1.08	1.83	2.84	3.47	5
10.	BOD (mg/l)	2.54	5.06	10.54	8.71	7.30	6.83	5
11.	COD (mg/l)	6.64	10.22	27.17	28.66	23.98	19.33	10
12.	TOTAL HARDNESS (mg/l)	32.67	54.67	70.67	77.33	84.00	63.87	200
13.	CALCIUM (mg/l)	7.21	14.08	17.10	15.23	14.96	13.72	75
14.	MAGNESIUM (mg/l)	3.57	6.29	6.82	9.58	11.37	7.53	30
15.	TOTAL ALKALINITY (mg/l)	23.33	63.33	83.33	87.50	88.33	69.16	200
16.	CHLORIDE (mg/l)	29.35	34.55	49.23	48.75	46.86	41.75	250
17.	INOG.PHOSPHATE (mg/l)	0.19	0.29	0.82	0.84	0.83	0.59	0.12
18.	SULPHATE (mg/l)	31.06	22.78	23.24	20.33	15.79	22.64	200
19.	SODIUM (mg/l)	5.37	11.60	18.37	19.67	20.37	15.08	-
20.	POTASSIUM (mg/l)	1.83	2.53	5.53	5.87	4.23	4.00	-
21.	TOTAL COLIFORM (MPN/100ml)	1986.52	1550	>2400	1419.60	1550	1781.22	10

Table 5: Mean observation value of physico-chemical and microbiological parameters during post-monsoon.

		Sites						
SL NO	**Parameters**	**1**	**2**	**3**	**4**	**5**	**Mean**	**BIS/WHO/NCBI Standard**
1.	WATER TEMPERATURE (^{0}C)	20.00	20.50	21.00	21.50	21.50	20.90	25-32
2.	TOTAL SOLID (mg/l)	160.00	220.00	280.00	200.00	240.00	220.00	-
3.	TDS (mg/l)	49.00	79.00	115.00	118.00	121.00	96.40	500
4.	TSS (mg/l)	111.00	141.00	165.00	82.00	119.00	123.60	-
5.	EC (µS/cm)	100.00	158.00	231.00	236.00	244.00	193.80	500
6.	TURBIDITY (NTU)	18.00	40.00	22.00	12.00	10.00	20.40	1
7.	pH	7.80	7.20	6.90	7.10	7.20	7.24	6.5-8.5
8.	FREE CO_2 (mg/l)	6.60	13.20	28.60	19.80	17.60	17.16	-
9.	DO (mg/l)	5.90	4.30	0.40	1.60	1.50	2.74	5
10.	BOD (mg/l)	1.80	5.50	10.94	6.08	4.90	5.84	5
11.	COD (mg/l)	4.82	9.14	19.32	11.63	10.56	11.09	10
12.	TOTAL	46.00	62.00	68.00	70.00	74.00	64.00	200

	HARDNESS (mg/l)							
13.	CALCIUM (mg/l)	12.82	13.62	14.42	16.03	16.03	14.58	75
14.	MAGNESIUM (mg/l)	3.40	6.80	7.80	7.31	8.30	6.72	30
15.	TOTAL ALKALINITY (mg/l)	15.00	20.00	15.00	17.50	15.00	16.50	200
16.	CHLORIDE (mg/l)	38.34	44.02	59.64	58.22	55.38	51.12	250
17.	INOG.PHOSPHATE (mg/l)	0.05	0.15	0.42	0.20	0.18	0.20	0.12
18.	SULPHATE (mg/l)	2.00	2.83	2.93	3.76	2.00	2.70	200
19.	SODIUM (mg/l)	6.90	13.70	17.00	18.30	19.40	15.06	-
20.	POTASSIUM (mg/l)	1.80	3.70	4.70	5.20	5.70	4.22	-
21.	TOTAL COLIFORM (MPN/100ml)	≥2400	≥2400	≥2400	≥2400	1031.7	2126.34	10

Table 6: Mean observation value of physico-chemical and microbiological parameters during Winter.

		Sites						
SL NO.	**Parameters**	**1**	**2**	**3**	**4**	**5**	**Mean**	**BIS/WHO/NCBI Standard**
1.	WATER TEMPERATURE (^{0}C)	18.00	19.00	19.00	19.00	19.50	18.90	25-32
2.	TOTAL SOLID (mg/l)	110.00	170.00	180.00	260.00	230.00	190.00	-
3.	TDS (mg/l)	51.00	64.00	137.00	161.00	162.00	115.00	500
4.	TSS (mg/l)	59.00	106.00	43.00	109.00	68.00	77.00	-
5.	EC (µS/cm)	102.00	130.00	275.00	322.00	323.00	230.40	500
6.	TURBIDITY (NTU)	24.00	31.20	17.80	27.40	9.80	22.04	1
7.	pH	7.75	7.30	7.15	7.35	7.65	7.44	6.5-8.5
8.	FREE CO_2 (mg/l)	4.40	27.50	46.20	31.90	19.80	25.96	-
9.	DO (mg/l)	7.81	5.07	1.43	1.02	3.86	3.84	5
10.	BOD (mg/l)	3.80	4.41	23.72	21.89	8.51	12.47	5
11.	COD (mg/l)	6.67	9.37	28.43	30.93	20.00	19.08	10
12.	TOTAL HARDNESS	52.00	59.00	94.00	99.00	113.00	83.40	200

	(mg/l)							
13.	CALCIUM (mg/l)	14.03	12.83	18.03	20.44	22.85	17.64	75
14.	MAGNESIUM (mg/l)	4.15	6.58	11.95	11.70	13.66	9.61	30
15.	TOTAL ALKALINITY (mg/l)	67.50	77.50	165.00	116.60	192.50	123.82	200
16.	CHLORIDE (mg/l)	38.34	44.73	68.16	72.42	75.97	59.92	250
17.	INOG.PHOSPHATE (mg/l)	0.03	0.17	1.01	1.14	0.84	0.64	0.12
18.	SULPHATE (mg/l)	9.05	7.42	10.02	15.12	8.96	10.11	200
19.	SODIUM (mg/l)	5.60	11.50	21.35	30.55	23.00	18.40	-
20.	POTASSIUM (mg/l)	0.45	3.40	6.60	7.30	2.55	4.06	-
21.	TOTAL COLIFORM (MPN/100ml)	1950.00	1448.23	≥2400	≥2400	1550	1949.65	10

Table 7: Mean observation value of physico-chemical and microbiological parameters during Pre-monsoon.

		Sites						
SL NO.	**Parameters**	**1**	**2**	**3**	**4**	**5**	**Mean**	**BIS/WHO/NCBI Standard**
1.	WATER TEMPERATURE (^{0} C)	19.00	18.00	20.00	21.50	19.00	19.50	25-32
2.	TOTAL SOLID (mg/l)	370.00	480.00	550.00	460.00	540.00	480.00	-
3.	TDS (mg/l)	311.00	433.00	503.00	431.50	499.00	435.50	500
4.	TSS (mg/l)	59.00	47.00	47.00	28.50	41.00	44.50	-
5.	EC (μS/cm)	645.00	868.00	1029.00	862.00	993.00	879.40	500
6.	TURBIDITY (NTU)	72.80	25.20	22.60	21.60	22.40	32.92	1
7.	pH	7.95	7.25	7.25	7.45	7.35	7.45	6.5-8.5
8.	FREE CO_2 (mg/l)	16.50	94.60	106.70	57.20	68.20	68.64	-
9.	DO (mg/l)	10.34	1.42	0.00	0.51	1.62	2.78	5
10.	BOD (mg/l)	12.37	17.94	29.80	29.80	18.55	21.69	5
11.	COD (mg/l)	31.55	33.88	42.25	34.64	35.10	35.48	10
12.	TOTAL HARDNESS	162.00	113.00	173.00	164.00	162.00	154.80	200

	(mg/l)							
13.	CALCIUM (mg/l)	28.06	26.45	36.07	31.66	40.88	32.62	75
14.	MAGNESIUM (mg/l)	22.41	11.45	19.98	20.71	14.62	17.83	30
15.	TOTAL ALKALINITY (mg/l)	235.75	370.00	454.00	367.50	420.00	369.45	200
16.	CHLORIDE (mg/l)	124.25	129.93	138.45	120.21	132.06	128.98	250
17.	INOG.PHOSPHATE(mg/l)	0.57	1.82	2.88	2.72	2.04	2.01	0.12
18.	SULPHATE (mg/l)	21.66	23.52	33.86	31.64	22.04	26.54	200
19.	SODIUM (mg/l)	28.80	35.90	40.30	36.20	49.65	38.17	-
20.	POTASSIUM (mg/l)	15.30	18.05	23.75	20.25	24.70	20.41	-
21.	TOTAL COLIFORM (MPN/100ml)	≥2400	≥2400	≥2400	≥2400	≥2400	≥2400	10

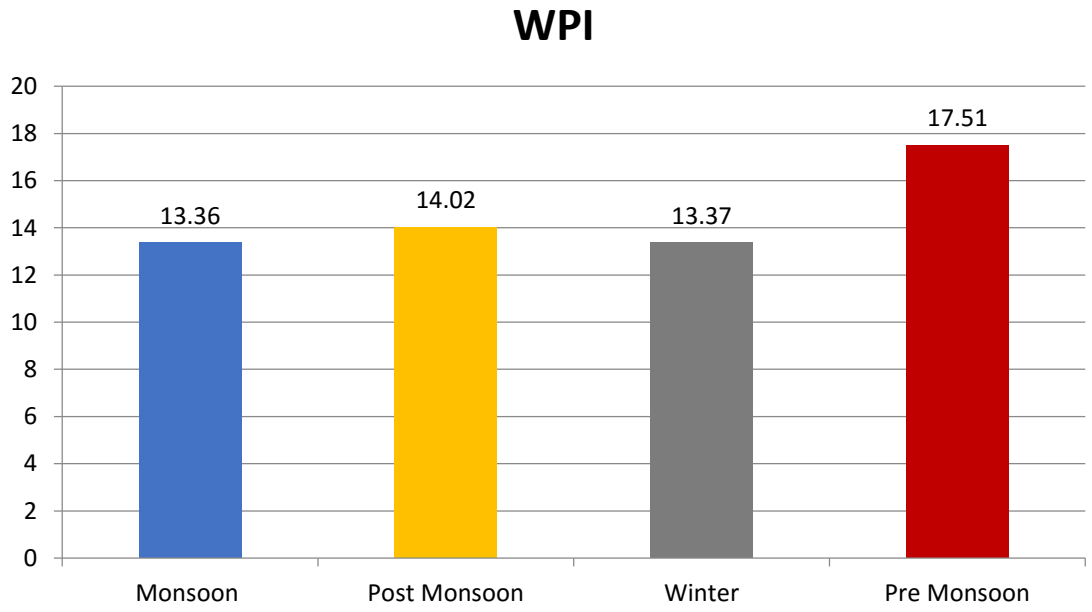

Figure 2: Overall mean Water Pollution Index of Nambul river.

Water temperature is one of the important parameters that influences the physical, chemical and biological properties of a water system. Higher the temperature lower is the dissolved oxygen. So, water temperature plays an important role in the quality of water and aquatic life forms of the river (Laishram, et al., 2022). The highest mean water temperature of 26.33 ^{0}C was recorded during monsoon season at Site Ⅴ.

Total solids are the solid or suspended or dissolved particles in a solution. It is an

aggregation of total dissolved solids and total suspended solids (Trivedy and Goel, 1986.). The highest mean value of 550 mg/L of total solid was found during pre-monsoon at Site Ⅲ. Soil erosions, catchment run-off, major drains and sewages are the possible factors for higher total solids in river system.

Total dissolved solids consist of calcium, chlorides, nitrate, phosphorus, iron, sulphur, and other ions particles that will pass through a filter with pores of around 2 microns in size (EPA). During pre-monsoon, Site Ⅲ has the highest mean TDS value of 503.00 mg/L. Higher TDS value more than 500 mg/L shows the water is polluted.

Total suspended solid includes silt and clay particles, plankton, algae, fine organic debris, and other particulate matter. These are particles that will not pass through a 2-micron filter (EPA). The highest TSS mean value of 277 mg/L is found during monsoon season at Site Ⅰ.

EC during pre-monsoon season at Site Ⅲ had the highest mean value of 1029.00 µS/cm, it is because of the stagnation of water, where the ions concentration is high.

The determination of turbidity is interfered by the presence of debris and other rapidly settleable matter (Trivedy and Goel, 1984). Highest turbidity mean value of 157.33 NTU was found during monsoon because of the high siltation rate and soil erosion in the catchment areas. Turbidity value for all the sites in every season exceeds the standard limit laid down by BIS/WHO.

pH is an important factor which determines the water quality since it affects other chemical reactions such as solubility and metal toxicity (Fakayode, et al. 2005). The pH of the river was varied between the ranges of 6.80 to 7.14 during monsoon, 6.90 to 7.80 during post monsoon, 7.15 to 7.75 during winter and 7.25 to 7.95 during pre-monsoon season.

Free carbon dioxide was found maximum mean value of 106.70 mg/L at Site Ⅲ, it indicates the higher level of pollution with higher microbial population.

Dissolved oxygen is one of the most important indicators of water quality and the DO level in natural water is determined by the physical, chemical, and biochemical activities in the water bodies. It is introduced into the water as a by-product of aquatic plant photosynthesis and atmospheric wind interaction with the water. The solubility level of oxygen is related to pressure and temperature. In a freshwater system with 1 atm pressure, at, DO reaches approximately 14.6, 9.1, 8.3, and 7.0 mg/L at 0 °C, 20°C, 25°C, and 35 °C, respectively (Himanshu Patel and R.T. Vashi, 2015). DO level of Site Ⅲ had the lowest value in all seasons except winter season. This site is polluted heavily by Naga Nalla and other diffused drains.

Biochemical Oxygen Demand is the measure of the degradable organic material present in a water sample, and can be defined as the amount of oxygen required by the micro-organisms in stabilizing the biologically degradable organic matter under aerobic condition (Trivedy and Goel, 1984). Organic material that is discharged into natural waters causes a rapid increase in the growth of micro-organisms that deplete the oxygen required for other aquatic life (Laishram et al.,2022). BOD value of 29.80 mg/L was

the highest mean value found at Site Ⅲ during pre-monsoon.

Chemical Oxygen Demand (COD) is defined as the amount of a specified oxidant that reacts with the sample under controlled conditions (APHA.2017). Site Ⅲ had the highest COD mean value of 42.25 mg/L during pre-monsoon season.

Total hardness of water is due to the concentration of calcium carbonate and magnesium with other polyvalent ions of some other metals like iron, zinc, aluminium and manganese, etc. (Trivedy and Goel, 1986). Lowest total mean hardness value of 32.67 mg/L was found at site Ⅰ during monsoon and highest value of 173.00 mg/l was found at site Ⅲ during pre-monsoon season.

During pre-monsoon, calcium had the highest mean value of 40.88 mg/l at Site Ⅴ, but it is within the standard limit.

Magnesium takes a major role in hardness of water. During pre-monsoon, Site Ⅳ had the highest magnesium mean value of 20.71 mg/L.

Total alkalinity of water body is a measure of its capacity to neutralise acid to a designated pH (APHA, 2005). Site III during pre-monsoon had the highest total alkalinity mean value of 454.00 mg/L and the values for all the sites were beyond the standard value given by WHO and BIS. Such high in alkalinity may be high concentration of domestic sewage and consumption of fertilizers in agriculture (Waribam et al, 2015).

Chloride is one of the major inorganic anions, or negative ions, in saltwater and freshwater, sources may be from septic tank effluent, animal waste, water softener regeneration, chlorinated drinking water, and potash fertilizer. The highest chloride mean value of 138.45 mg/L was found during pre-monsoon at Site Ⅲ. This higher chloride value is due to high domestic sewage discharge in the river system.

In river water, sodium is mainly deposited due to natural salt deposits, sewage and fertilizer run-off. Sodium content of mean value 49.65 mg/L was found highest during pre-monsoon at Site Ⅴ, it is due to the lean river water volume where the salt concentrations are high.

Potassium is the fourth naturally occurring cation in fresh water ecosystem and is always found lesser value than sodium, calcium and magnesium (Siddiqi, 2007). Municipal and industrial sewage discharges and agricultural runoff are the familiar sources of potassium in river water (Skowron et al., 2018). The highest mean value of potassium 24.70 mg/L was found during pre-monsoon at Site Ⅴ.

Sulphate can be naturally occurring from breakdown of leaves, organisms that fall into a stream or the result of municipal, agriculture and industrial discharges (Patricio A, et al, 2009).

The highest mean value of sulphate 33.86 mg/l was found during pre-monsoon

at Site Ⅲ.

Inorganic phosphate is one of a major component of phosphorus and is an essential

nutrient for plants and animals, but excessive phosphorus in surface water can cause explosive growth of aquatic plants and algae (EPA). The highest mean inorganic phosphate value of 2.88 mg/L was found at Site Ⅲ during pre-monsoon. In almost all seasons and sites the inorganic phosphates exceed the standard value laid down by BIS/WHO. Higher inorganic phosphates triggered the process of eutrophication, eventually it leads to lower dissolved oxygen, higher BOD, COD and loss of aquatic lives.

Total Coliform bacteria are discharged from the human intestine and their presence indicates the possibility of the presence of pathogenic organisms. The coliform group comprises all the facultative and aerobic gram-negative, non-spore-forming rod-shaped bacteria that ferment lactose with gas formation within 48 hours at 37^{o}C (Trivedy and Goel, 1984). In every site and season, the mean total coliform bacteria exceed the standard limit and during pre-monsoon, total coliform was found at the maximum value. This clearly shows the river water is highly contaminated with micro-biological waste.

The annual mean Water Pollution Index value for Nambul River

is 13.36, 14.02, 13.37 and 17.51

for monsoon, post-monsoon, winter and pre-monsoon respectively. WPI in every site and season have exceeded the value of 1 and it clearly indicates the river is highly polluted.

Figure 3: Nambul river at Site 1 (Iroisemba)

Figure 4: Nambul river at Site Ⅱ (Naoremthong)

Figuire 5: Nambul river at Site Ⅲ (Keishampat Junction)

Figure 6: Nambul river at Site Ⅲ (Keishampat Junction)

Figure 7: Blackish water of Nambul river during pre-monsoon at Site Ⅳ (Heirangoithong)

Figure 8: Nambul river during monsoon at Hiyangthang

Figure 9: Nambul river during lean season of pre monsoon at Site Ⅴ (Wangoi)

Conclusion:

The Water Pollution Index of Nambul River was calculated to assess the pollution level of the river. This was carried out using various physico – chemical and microbiological parameter. Application of WPI is useful in evaluating the seasonal pollution level and to know the status of the river. The index clearly revealed the degree of pollution level of Nambul River and can be confirmed that it has been deteriorating from the past. The state government has taken a project called "Nambul River Rejuvenation" with the objective of its restoration and thus set up a sewage treatment plant of 16 MLD at

Heirangoithong Maibam Leikai at the adjacent to the Nambul river to minimize the pollution load, collecting sewage from municipal areas around the heart of Imphal city it will be functional soon.

Further sensitization and participation of public in mitigation process to develop a strategy to protect Nambul River with a holistic approach with government is necessary to restore the water quality and to bring its natural regeneration capacity.

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