Analysis of Water Quality Index Parameters and its Seasonal Variations along the Kolong River, Assam, India

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Abstract - *The objective of the study to analyse the Water Quality Index (WQI), analysis of variations of Water Quality Index parameters along the Kolong River Nagaon, Assam. The seasonal variations of physico-chemical characteristics of Kolong River is also analyzed. Kolong River flows through the heart of the Nagaon urban area divided the town into Nagaon and Haiborgaon in Assam. In this study, river samples were collected and analyzed from seven different study sites for six different times from October 2016 to February 2017. The physico-chemical parameter of water such as Turbidity, pH, Iron, Nitrate, Fluoride, Hardness, Chloride, manganese and Bacteria were analyzed. The presence of bacteria in all the study sites was positive. For calculation of Water Quality Index and analysis of variations of Water Quality Index parameters along the River we have taken average value of the parameters. The calculation of Water Quality Index was done by using arithmetic index method. The WQI value of these samples ranges from 134.64-565.58, which shows that water in all the sites are unsuitable for drinking. Thus, river needs proper treatment to conserve this water body from future contamination and pollutions.*

Key Words: **Assam, kolong river, Nagaon, Water Quality Index, Physico- Chemical Parameters, Weighted Arithmetic Index Method.**

1. INTRODUCTION

Rivers are the most important resources in the world in general and in India in particular, great civilization developed along the bank of rivers and even today most of development has taken place in the cities located near the rivers. The rivers provide water for industries, agriculture, and aquaculture, commercial and domestic purpose. Unfortunately the same rivers are being polluted by indiscriminate disposal of sewage and industrial wastes and plethora of human activities. It affects their physicochemical characteristics and microbiological quality (Koshy and Nayar, 1999). River pollution has already acquired serious dimension in India. The quality of any surface or ground water depends upon either or both natural influences and human activities (Stark et al., 2001 and Kolawole et al., 2008). 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). Increasing numbers and amounts of industrial, agriculture and commercial chemicals discharge into the aquatic environment has led to the various deleterious effects on aquatic organisms. In some aquatic organisms, including fish, accumulate pollutants directly from contaminated water and indirectly via the food chain. Prevention of river pollution requires effective monitoring of physico-chemical and microbiological parameters (Medhi et al., 2015).

The Kolong river is a tributary of the Brahmaputra River in Assam(26.20ºN latitude and 92.94º E longitude), which divert out from the Brahmaputra river in Hatimura Region of Jakhalabandha ,Nagaon District(26.35º N latitude and 92.68º E longitude) And meet the same at Kajalichaki near Chandrapur, Guwahati, Assam. The tributary is about 250 kilometers long flows through the districts of Nagaon, Morigaon and Kamrup. On the way several streams Diju, Misa, Kapili, Digaru and others meet the Kolong River. The Kolong River flows through the heart of nagaon urban area dividing the town into Nagaon and Haiborgaon.

Unfortunately after 1950 Great Assam earthquake, there were topographical changes of river bed and its surroundings , as a result in 1969, a major part of Nagaon town itself remain under flood water for two months. In order to mitigate the flood problem an emergency scheme was taken up and completed in 1974 as at the Kolong river mouth an earthen dyke was constructed along south bank of Brahmaputra river between Hatimra and Kukurkata hill. This is known as Hatimura dyke. Although the flood problem of Kolong river basin was minimized after the construction of the dyke but the river is altered into dead stream. The people inhabiting around this river uses the partially treated water for bathing and washing clothes. The river gets polluted day by day because of the lake of current in the river and also from the human activities.

Therefore, the present investigation has been undertaken to assess and evaluate the Water Quality Index (WQI) based on physic-chemical parameters of different study sites of up and downstream course in different seasons.

2. MATERIAL AND METHOD

For the assessment of upstream and downstream river water quality the present work was divided into three parts as initial pre-field survey was carried out for identifying water collection sampling station. Secondly as field work seven study sites have been selected from up and down streams as well as from middle part of the river. Lastly collected samples were analyzed in Nagaon Public Health Engineering Department and completion of data were obtained.

2.1 Sampling Sites

The water samples were collected from seven different stations(site1:hatimura, Brahmaputra, site2:Hatimura, Kolong much, site3:Hatbor, kaliabor, site4: samouguri, site5:Gumuthagaon, Puranigudam, site6: Near A.S.T.C.,site7: Near ADP Bridge.). The samples were collected in different seasons (oct 2016-feb 2017). Water samples are collected by using plastic bottle from study sites of Kolong River. After collecting the samples the parameters like pH, turbidity, hardness etc. are analysed by proper method at Nagaon public health engineering department's laboratory.

2.2 Calculating of Water Quality Index (WQI)

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

$$\mathbf{WQI = \sum w_i q_i / \sum w_i}$$

Where, w_i = Relative weight

q_i = Water quality rating

the unit weight (w_i) 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 q_i is calculated using the following equation:

$$q_i = 100\, [(V_i - V_{id}) / (S_i - V_{id})]$$

Where, V_i = Observed value

S_i = Standard permissible value

V_{id} = Ideal value

All the ideal values are taken as zero for drinking water expect pH and dissolved oxygen (Triphaty and Sahu, 2005).

For pH, the normal value is 7.0 (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} = Obseved value of pH

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 Index 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

In this current study three types of results are find out. First of all we find out the Water Quality Index of Kolong river.

Then the seasonal variation of physico-chemical characteristics of Kolong river and Along the Kolong river are find out. The samples are collected for analysis are collected in different months of 2016 and 2017. For the analysis of water Quality Index and seasonal variation along the river we taken the average observed value of the parameters for every sample collecting sites, which are shown in table 2.

Table-2: Average water parameters of Kolong River

Parameters	Sites						
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
pH	7.07	7.01	7.03	7.06	7.07	7.07	7.14
Turbidity	9.8	9.25	16	10	10.12	10.33	10.33
Iron	1.10	0.57	3.14	1.11	0.97	0.88	0.95
Nitrate	3.4	3.43	4.15	3.85	1.68	3.45	2.67
Fluoride	0.10	0.06	0.6	0.12	0.14	0.11	0.11
Hardness	66.5	90	102	72.8	83.7	73.7	73.4
Chloride	9.5	10.75	11.5	12	9.5	11.17	13.3
Manganese	0.35	0.33	0.74	0.31	0.28	0.21	0.28

The definition of Turbidity is the cloudiness or haziness of a fluid caused by suspended solids that are usually invisible to the naked eye. The measurement of Turbidity is an important test when trying to determine the quality of water. It is an aggregate optical property of the water and does not identify individual substances; it just says something is there. Turbidity of the river water ranges from 9.25 NTU to 16 NTU which is significantly high as shown in Table2. High turbidity levels recorded at Hatbor , Kaliabor of 16 NTU because at that part of the river there no flow because of the river mouth closed and due to high waste discharge and the lowest value of turbidity is recorded at Hatimura, Jakhalabandha of 9.25 NTU which is also more than permissible limit 5 NTU.

Human bodies require iron to function properly, but iron, like many substances, is toxic at high dosages. However, you could not drink enough water to consume toxic levels of iron. The Environmental Protection Agency considers iron in well water as a secondary contaminant, which means it does not have a direct impact on health. The Secondary Maximum Contaminant Level set out by the EPA is 0.3 milligrams per liter. The iron ranges from 0.57 mg/l to 3.14 mg/l. In all the sites the presence of iron is more than permissible limit but at Hatbor, jakhalabandha site the presence of iron is maximum compare to other sites.

Nitrates (NO3) are an essential source of nitrogen (N) for plants. When nitrogen fertilizers are used to enrich soils, nitrates may be carried by rain, irrigation and other surface waters through the soil into ground water. Human and animal wastes can also contribute to nitrate contamination of ground water. In Benton and Franklin Counties, agricultural practices have been linked to elevated levels of nitrates in drinking water. Although any well can become contaminated by nitrates, shallow, poorly constructed, or improperly located wells are more susceptible to contamination. Nitrate levels in drinking water can also be an indicator of overall water quality. Elevated nitrate levels may suggest the possible presence of other contaminants such as disease-causing organisms, pesticides, or other inorganic and organic compounds that could cause health problems. In this study at all sites the presence of nitrate is in permissible limit 4.5 mg/l.

Fluoride was ranges from 0.06 mg/l to 0.6 mg/l. in all the sites fluoride is in permissible limit 1.5 mg/l.

The total hardness values ranges from 66.5 mg/l to 102 mg/l. The minimum value of 66.5 mg/l at Hatimura amd maximum 102 mg/l at Hatbor, Kaliabor. Total hardness of the Kolong river increases along the downstream. Hardness values of water samples are not fit for drinking use.

Chloride value ranges from 9.5 mg/l to 12 mg/l. The min. value 9.5 mg/l at Hatimura and the maximum is 12 mg/l at Samaguri due to highly discharge of industrial waste.

Manganese value ranges from 0.21 mg /l to 0.74 mg/l. the minimum value 0.21 mg/l at near A.S.T.C. Nagaon town and maximum at Hatbor because of the high waste discharge.

Table-3: Calculaton 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	7.07	8.5	0.1176	4.67	0.5492
	Site 2	7.01	8.5	0.1176	0.67	0.788
	Site 3	7.03	8.5	0.1176	2	0.2352
	Site 4	7.06	8.5	0.1176	4	0.4704
	Site 5	7.07	8.5	0.1176	4.67	0.5492
	Site 6	7.07	8.5	0.1176	4.67	0.5492
	Site 7	7.14	8.5	0.1176	9.33	1.097
Turbidity	Site 1	9.8	5	0.2	196	39.2
	Site 2	9.25	5	0.2	185	37
	Site 3	16	5	0.2	320	64
	Site 4	10	5	0.2	200	40
	Site 5	10.12	5	0.2	202.4	40.48
	Site 6	10.33	5	0.2	206.6	41.32
	Site 7	10.33	5	0.2	206.6	41.32
Iron	Site 1	1.10	0.3	3.33	366.67	1221.01
	Site 2	0.57	0.3	3.33	190	632.70
	Site 3	3.14	0.3	3.33	1046.67	3485.11
	Site 4	1.11	0.3	3.33	370	1232.10
	Site 5	0.97	0.3	3.33	323.33	1076.69
	Site 6	0.88	0.3	3.33	293.33	976.79
	Site 7	0.95	3	0.33	31.67	10.45
Nitrate	Site 1	3.4	4.5	0.22	75.56	16.62
	Site 2	3.43	4.5	0.22	76.22	16.77
	Site 3	4.15	4.5	0.22	92.22	20.29
	Site 4	3.85	4.5	0.22	85.56	18.82
	Site 5	1.68	4.5	0.22	37.33	8.21
	Site 6	3.45	4.5	0.22	76.67	16.87
	Site 7	2.67	4.5	0.22	59.33	13.05
Fluoride	Site 1	0.10	1.5	0.67	14.93	10
	Site 2	0.06	1.5	0.67	8.95	5.99
	Site 3	0.6	1.5	0.67	89.55	59.99
	Site 4	0.12	1.5	0.67	17.91	11.99

	Site 5	0.14	1.5	0.67	20.89	13.99
	Site 6	0.11	1.5	0.67	16.42	11
	Site 7	0.11	1.5	0.67	16.42	11
Hardness	Site 1	66.5	300	0.0033	22.17	0.0732
	Site 2	90	300	0.0033	30	0.099
	Site 3	102	300	0.0033	34	0.1122
	Site 4	72.8	300	0.0033	24.27	0.0801
	Site 5	83.7	300	0.0033	27.90	0.0920
	Site 6	73.7	300	0.0033	24.57	0.0811
	Site 7	73.4	300	0.0033	24.47	0.0807
Manganese	Site 1	0.35	0.3	3.33	116.67	388.51
	Site 2	0.33	0.3	3.33	110	366.30
	Site 3	0.74	0.3	3.33	246.67	821.41
	Site 4	0.31	0.3	3.33	103.33	344.09
	Site 5	0.28	0.3	3.33	93.33	310.79
	Site 6	0.21	0.3	3.33	70	233.10
	Site 7	0.28	0.3	3.33	93.33	310.79
Chloride	Site 1	9.5	250	0.004	3.8	0.0152
	Site 2	10.75	250	0.004	4.3	0.0172
	Site 3	11.5	250	0.004	4.6	0.0184
	Site 4	12	250	0.004	4.8	0.0192
	Site 5	9.5	250	0.004	3.8	0.0152
	Site 6	11.17	250	0.004	4.47	0.0178
	Site 7	13.33	250	0.004	5.33	0.0213

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

WQI(site1)=**Σ**wiqi/**Σ**wi=1675.97/7.87=212.96

WQI (site2) = **Σ**wiqi/**Σ**wi=1059.67/7.87=134.64

WQI (site3) = **Σ**wiqi/**Σ**wi=4451.16/7.87=565.58

WQI (site4) = **Σ**wiqi/**Σ**wi=1647.57/7.87=209.35

WQI (site5) = **Σ**wiqi/**Σ**wi=1450.81/7.87=184.35

WQI (site6) = **Σ**wiqi/**Σ**wi=1279.73/7.87=162.60

WQI (site7) = **Σ**wiqi/**Σ**wi=1431.87/7.87=181.94

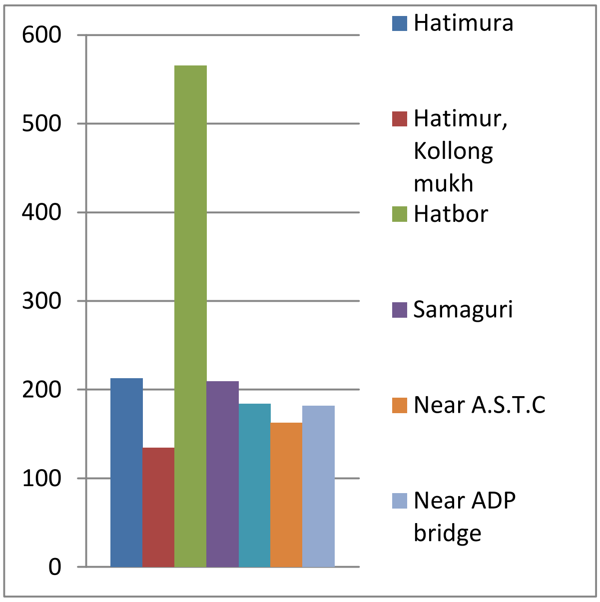


Figure 1: Graphical presentation of WQI

3.1 Analysis Of Variations Of Water Quality Index Parameters Along The Kolong River

pH- The pH of water range from 7.01 to 7.14. The max. pH value is recorded at near ADP Bridge of 7.14 and the min. value is recorded at Hatimura, Kolong much of 7.01. The mean pH values along the Kolong river water value is 7.06 that means the water is acidic in nature which is not under permissible limit. The difference in the pH values is depend upon the source of contamination and growth of algae, affect the pH level to higher.

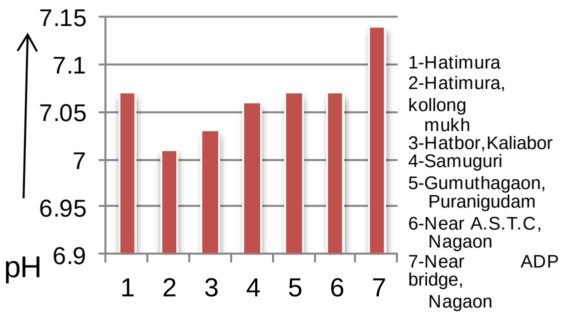


Figure 2: pH variation along the river

TURBIDITY- Turbidity of the river water ranged from 9.25 NTU to 16 NTU which is significantly high shown in figure. High turbidity levels recorded at Hatbor of 16 NTU due to high waste discharge and the lowest value of turbidity is recorded at Hatimura, Kolong mukh of 9.25 NTU which is located at the initial sampling point, and the mean turbidity level is 10.83 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.

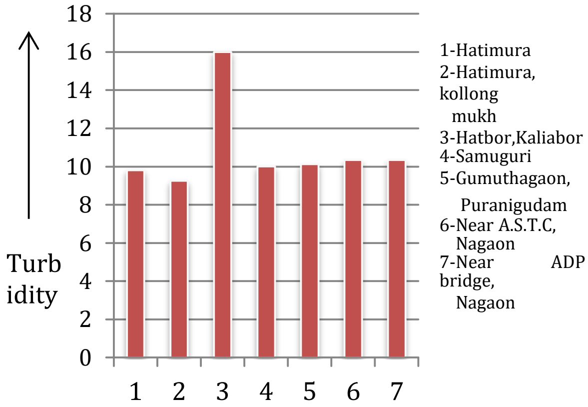


Figure 3: Turbidity variation along the river

Iron- The iron value ranges from 0.57 mg/l to 3.14 mg/l which is the maximum value comparing to the other sites. Presence of iron at Hatbor site is maximum. The mean iron value along the river is 1.25 mg/l which is not within permissible limit.

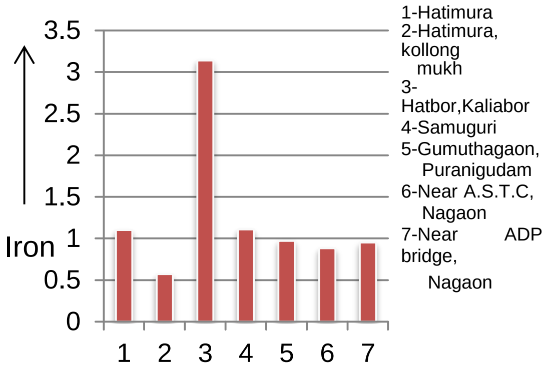


Figure 4: variation of iron value along the river

NITRATE- The nitrate value ranges from 1.68 mg/l to 4.15 mg/l. the mean value of nitrate is 3.23 mg/l which is under permissible limit 4.5 mg/l.

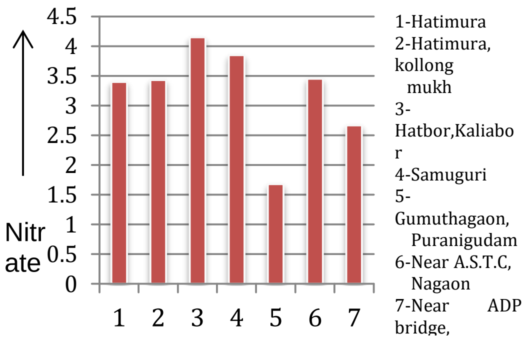


Figure 5: variation of nitrate value along the river.

FLUORIDE- Fluoride was ranges from 0.06 mg/l to 0.6 mg/l. in all the sites fluoride is in permissible limit 1.5 mg/l.

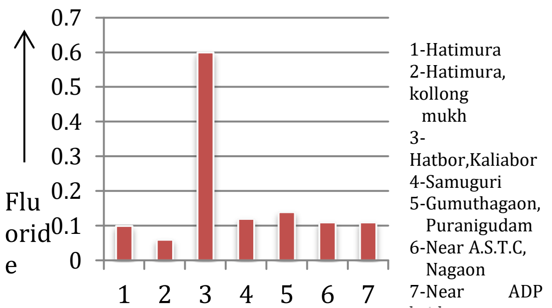


Figure 6: variation of fluoride value along the river

HARDNESS- The total hardness values ranges from 66.5 mg/l to 102 mg/l. The minimum value of 66.5 mg/l at Hatimura amd maximum 102 mg/l at Hatbor, Kaliabor. Total hardness of the Kolong river increases along the downstream.

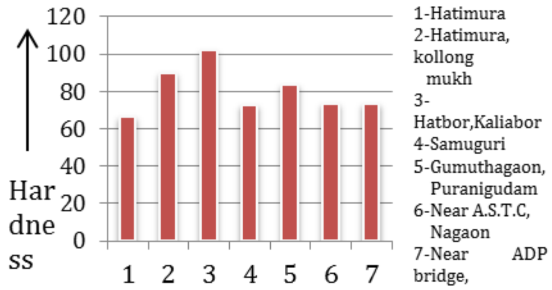


Figure 7: Hardness of water variation along the river.

CHLORIDE- Chloride value ranges from 9.5 mg/l to 12 mg/l. The min. value 9.5 mg/l at Hatimura and the maximum is 12 mg/l at Samaguri due to highly discharge of industrial waste.

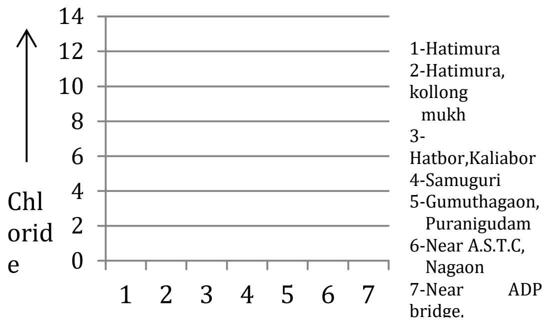
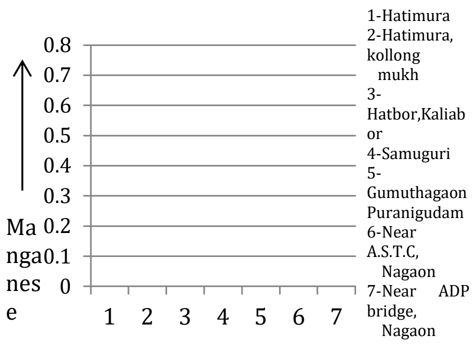


Figure 8: variation of Chloride value along the river.

MANGANESE- Manganese value ranges from 0.21 mg /l to 0.74 mg/l. the minimum value 0.21 mg/l at near A.S.T.C. Nagaon town and maximum at Hatbor because of the high waste



discharge.

Figure 9: variation of manganese value along the river.

3.2. Seasonal variation of physico-chemical parameters of Kolong River.

From figure 10 to 17 shows the seasonal variations of different parameters.

pH- pH value in all the sites are within the permissible limit.

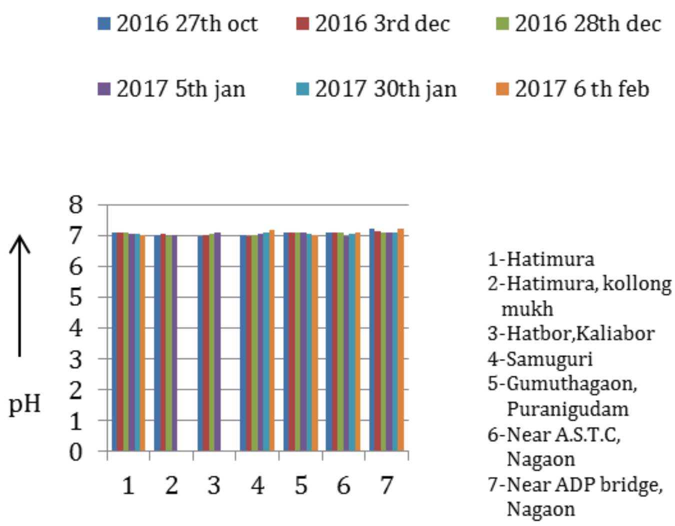


Figure 10: pH for seasonally variation

Turbidity- High turbidity levels recorded at Hatbor due to high waste discharge

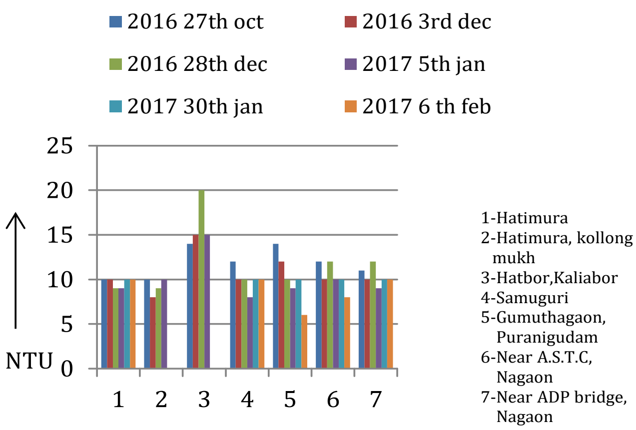


Figure 11: Turbidity for seasonally variation

Iron- The iron value is also more in the site 3, Hatbor.

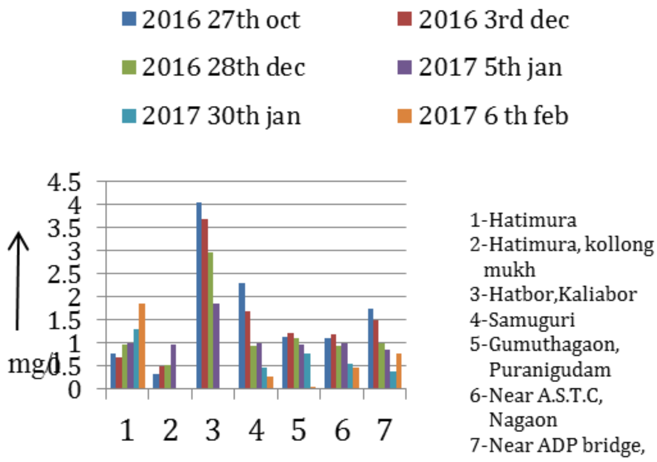


Figure 12 : Iron for seasonally variation.

Nitrate- The presence of Nitrate in all the sites are with in permissible limit. But the maximum nitrate value is recorded at the site 3, Hatbor Kaliabor.

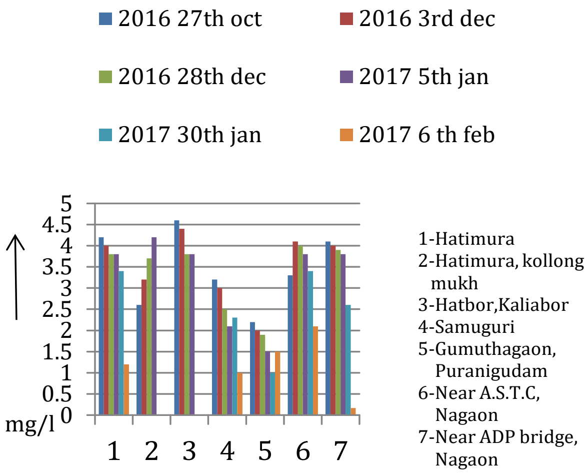


Figure 13: Nitrate for seasonally variation.

Fluoride- The presence of fluoride in water in all the sites are also in permissible limit.

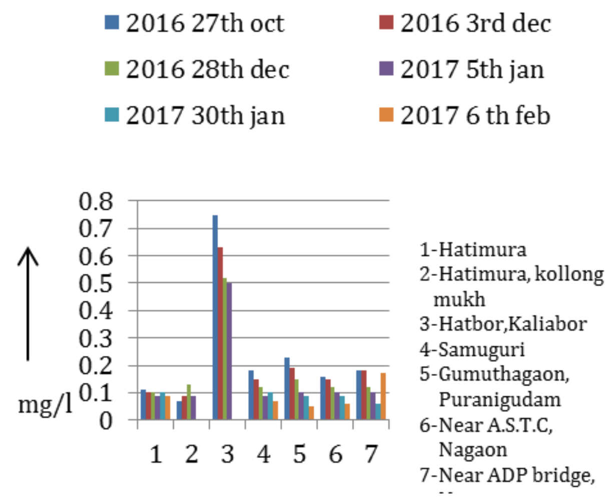


Figure 14: Fluoride for seasonally variation

Hardness-The Total hardness of the Kolong river increases along the downstream.

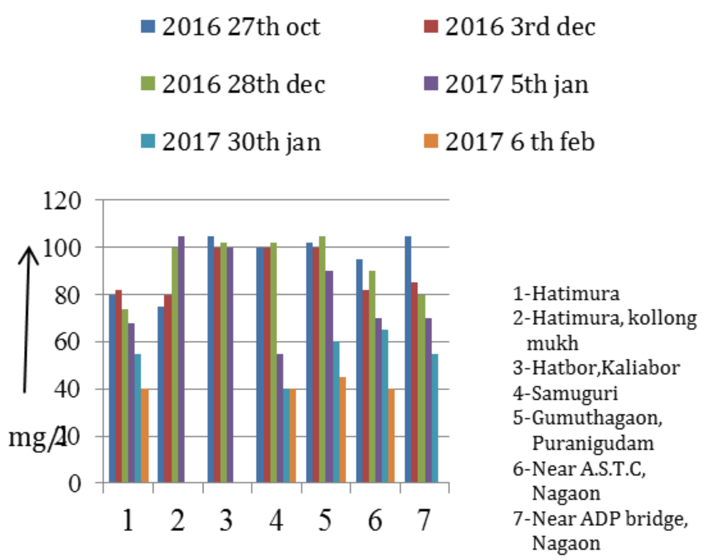


Figure 15: Hardness for seasonal variation

Chloride- The maximum Chloride value is at Samaguri due to highly discharge of industrial waste.

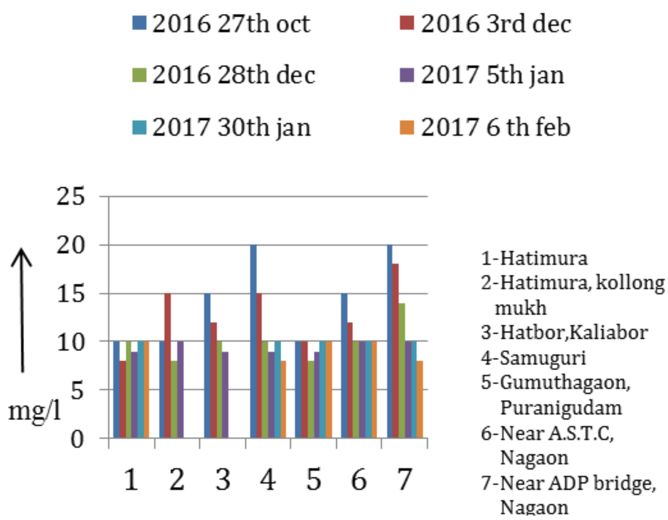


Figure 16: Chloride for seasonal variation

Manganese- The value of manganese is maximum at Hatbor because of the high waste discharge.

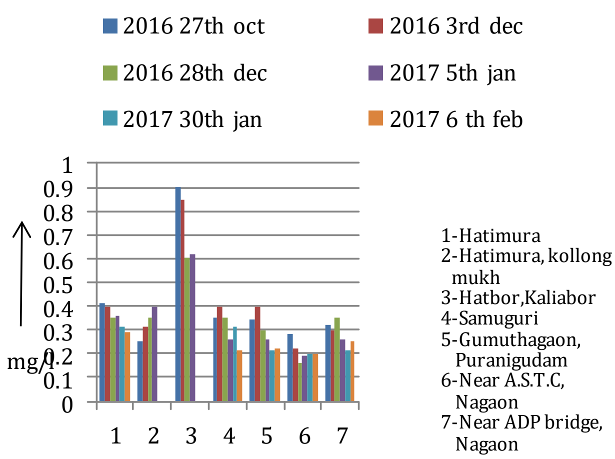


Figure 17: Manganese for seasonal variation

4. CONCLUSIONS

From the above study, it is revealed that, there are variations in water quality in different seasons in a same site. Again there are also variations in water quality in different study sites along the river. The water quality index (WQI) of 134.64, 565.58. 209.35, 184.35, 162.60 and 181.94 were obtained for site1, site2, site3, site4, site5, site6 and site7 respectively. And from which site3 (Hatbor) is found to have highest value. This clearly indicates that water from Kolong River is unsuitable for drinking purpose and must therefore be treated before use to avoid related diseases. As compare to the other sites, at site3 (Hatibor) the values of parameters are maximum because there is no flow in the river at that point due to the river Mouth closure and also due to high waste discharge. The Kolong River also needs regular monitoring of water quality in order to detect the changes in physic-chemical parameters.

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REFERENCES

[1] APHA, (2005). Standard Methods for the Examination of Water and Waste Water, 21th ed. American Public Health Association, Washington, D.C. M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

[2] Kolawole, O. M., T. B. Ajibola and O. O. Osuolale (2008). Bacteriological Investigation of a wastewater discharge run-off stream in Ilorin, Nigeria. J. Appl. Environ. Sci., 4 : 33–37.

[3] Koshy, M. and T. V. Nayar (1999). Water quality aspects of River Pamba. Pollut. Res., 18 : 501–510.

[4] Stark, J. R., P. E. Hanson, R. M. Goldstein, J. D. Fallon, A. L. Fong, K. E. Lee, S. E. Kroening and W. J. Andrews (2001). Water Quality in the Upper Mississippi River Basin, Minnesota, Wisconsin, South Dakota, Iowa, and North Dakota, 1995–98. United States Geological Survey; Reston, VA, USA: 2001.

[5] Bora Minakshi and Goswami Dulal c. Study for restoration using field survey and geoinformatics of the Kolong river, Assam, India.

[6] Medhi K.K. et al.,(2015), An Assessment Of Physico-Chemical Water Quality Of Kolong River, Nagaon District (Assam), North East India. Plant Archives Vol. 15 No. 2, 2015 pp. 1093-1096.

[7] Sing Raj Kumar Bronson et al., Assessment of Water Quality Index of Nambul River, Imphal, Manipur, India , International Research Journal of Engineering and Technology (IRJET), Dec 2016.

[8] Shikhar Firmal(2009)"A Study on the Water Quality of NIT Rourkel",BTech thesis NIT Rourkela pg(9-24).

[9] 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".

[10] Trivedy R.K. and Goel P.K., Chemical and biological methods for water pollution studies, 2nd Edn., Environ. Pub. Karad, India.,1-2, (1986).

[11] Agarkar S. V. and A. M. Garode., Evolution of physicochemical and microbiological parameters of Vyazadi reservoir water, Ind. Hydrobiol., 3(1), 3-5, (2000).

[12] United Nations Environment Programme Global Environment Monitoring System/Water Programme (2000). Water Quality for Ecosystem and Human Health. National Water Research Institute; Burlington, ON, Canada: 2000.

[13] Hammer, M. J. (2004). Water and Wastewater Technology. 5th ed. Practice-Hall Inc.; Upper Saddle River, NJ, USA: pp. 139–141.