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Analysis of the physico-chemical parameters of river Bohimora in the Sonitpur district of Assam and evaluation of its macro-invertebrate diversity

Angsuman Das[1], Anand Raj[2], V Gayathri snigdha[3], Khundongbam Ronalson Meitei[4],Kirandeep kaur[5]

Trainee Bioinformatician in RASA Life science Informatics[1]

National Dope Testing Laboratory (NDTL),Government of India[2]

M.Sc in Human Genetics and Molecular Biology[3]

Department of Forestry and Environmental Science, Manipur University[4]

M.Sc Zoology, Guru Nanak Dev University, Amritsar[5]

Abstract: A systematic study was conducted to evaluate the water quality status of the River Bohimora in Sonitpur District. To assess and monitor its habitability and water-usability, 15 water samples and many macro-invertebrates were collected from three sampling stations and analysed for physicochemical parameters (temperature, transparency, turbidity, TDS, pH, and DO) and diversity indices (Shannon index, Simpson index). Each parameter was compared to other studies on river water in various studies. The analytical data of various physicochemical parameters show that some parameters, such as transparency, are degrading and unfavourable to the biosphere adjacent the river's mouth. These values indicate that water samples from some sampling stations are unfit for drinking due to high TDS levels. These physiochemical findings also support the decreasing biotic indices near the river mouth. Observations were made about the possible causes of these deteriorating parameters.

Keywords: Biodiversity Index, Water quality, Physico-chemical parameters, River water

I. INTRODUCTION

Water is constantly circulating between Earth's surface (the land and oceans that make up our planet) and the atmosphere up above in a never-ending conveyor belt called the water cycle.Rivers are the main parts of the conveyor that carry water from the higher parts of Earth (the mountains and hills that we call uplands) to the lower parts (lakes and seas). Rivers are useful to humans, animals as well as to plants.

Humans use rivers for various purposes like irrigation in agriculture, as source of drinking water, for transportation, to produce electricity through hydroelectric dams, and for leisure activities like swimming and boating. Each of these uses can affect the health of a river and its surrounding ecosystems. Monitoring the health of rivers, lakes, and streams is important.Rivers play a pivotal role in assimilation properties. Apart from carrying off the industrial waste water, toxic heavy metals and chemical wastes from industries they play a vital role in creating energy. The physical and chemical properties of the river play an important in assessing various aspects of river and one can also learn about habitat in the river.

The interactions of both the physical and chemical properties of river water play an important role in composition of the river [1]. One of the major advantage of studying the physicochemical properties of the river is that one can assess the levels of pollution [2]. Through observing the physicochemical quality of river we can assess various important properties of river like the water environment, ecosystem, hydrochemistry, and ecology, and restoring water quality (Whitehead et al., 2018; Sarkar et al., 2016; Islam et al., 2019).The interaction between the physical and chemical properties of river play an important role in studying the composition, distribution, pollution and the extent of organisms present in the river. [3]. It also gives the relationship between the organism and the environment, which can further be used in determining water quality [4].

Water is constantly circulating between Earth's surface (the land and oceans that make up our planet) and the atmosphere up above in a never-ending conveyor belt called the watercycle.Rivers are the main parts of the conveyor that carry water from the higher parts of Earth (the mountains and hills that we call uplands) to the lower parts (lakes and seas). Rivers are useful to humans, animals as well as to plants.Humans use rivers for various purposes like irrigation in agriculture, as source of drinking water, for transportation, to produce electricity through hydroelectric dams, and for leisure activities like swimming and boating. Each of these uses can affect the health of a river and its surrounding ecosystems. Monitoring the health of rivers, lakes, and streams is important.

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Rivers play a pivotal role in assimilation properties. Apart from carrying off the industrial waste water, toxic heavy metals and chemical wastes from industries they play a vital role in creating energy. The physical and chemical properties of the river play an important in assessing various aspects of river and one can also learn about habitat in the river.

As mentioned above river not merely flowing water on land field, they carry whole ecosystem which benefit a great range of biodiversity connected by a food-net. From different insect, water spiders and other arthropods to fishes and snails is the part of this food-net. This food-net also include the terrestrial animals like mammals (Bear), Birds (Egret, Kingfisher) etc. Rivers not only preserves them with habitat but also gives the essential nutrient, temp, pH and other physico-chemical and environmental conditions to harbour and pass the life-cycle. When these are maintained in natural condition, the river can be called as a healthy river.

Various factors determine the health of a river ecosystem (Norris and Thomas, 1999), which include discharge (flow), the physical structure of channel and riparian zone, water quality, channel management such as macrophyte cutting and dredging, level of exploitation (e.g. fishing) and the presence of physical barriers to connectivity - (Acremon and Dunbar, 2004).

But the modern lifestyle of human has a big and negative impact on natural state of rivers. As the human habitat on the planet earth expanded, each and every aspect of nature had badly affected, rivers and river system is not an exception. The sewerages from urban residence, the excretion from the industries, and the chemicals from agriculture forms changed the natural physico-chemical conditions. There are various greedy human activities that can interfere with river's flow, like quarry, mining, boring, drilling for natural gas or petroleum or making big dam for elasticity production etc. These have sometimes a vast effect but sometimes may have some small impact which is not easily observable but gradually result in a big subsequence. They should be monitored in the initial period because 70% of the fresh water in liquid form throughout country is converted into being unfit for consumption (Dwivedi, 2017). There are various method of biological and chemical tests for monitoring water quality. The method of physico-chemical assessment may be utilized or different biotic indices may be used for the purpose of water quality monitoring.

There are various biotic indices that can monitor water health of a stream efficiently. Some of them are

i / Oligo chaete Indices
ii/ Beach's Biotic Index
iii/ Hilsenhoff's Biotic Index
Iv/Shannon-Weiner Index
v/ Simpson Index etc.

Therefore the calculation of various biodiversity indices is important to assess the quality of an aquatic system. Moreover, the bio monitoring works of a riverine system is important to assess the water quality over a period of time.

Therefore the study has been conducted in Bohimora River in Sonitpur district of Assam with the following aims and objectives →

1. To evaluate certain physico-chemical parameters of the river water.
2. To assess the macro invertebrate (molluscs & arthropods) diversity of the water system.
3. Analysis of macro invertebrate species diversity using Shannon-Weiner Index (H) and Simpson index (D).

II. MATERIALS AND METHODS

The whole project was done on a small river named Bohimora which flows on northern bank of Brahmaputra in the district of Sonitpur, Assam (Sub. Div.- Tezpur, Mrhadol). Several villages are situated on the bank of this river, nammed as Balijuri, khristambasti, Pachmukh, Silbori, 2 No. Batamari, Rangachakua, Nobil, Toubhanga.

Once the river Bohimora was flows with greater strength than that of today, which was sourced from the river Dikorai But at that time both the river Dikorai and Bohimora was flooded in every monsoon. That is why the farmers from the surrounding area builded embankment on the Dikorai, due to which Echimora lost very much of its strength in 1962. From that time the river Bohimora reduced in size and amount of water also reduced. Due to this the river name became boimora which mean death during flow in Assamese. Before it was known as Boivora which means full of flow. The name Boimora was changed through time and became Bohimora. The sampling stations on this river are

1. BM-1

The first station of sampling is near to the water head or source of the river. It has been observed that a certain amount of water is flows out of ground to the surface. The local people call this as "Gogol' which is an Assamese word meaning for the place where water funnelled out from ground. The coordinates of that spot is 26.8834660 N and 92.9474091 E. The river is 3-4 m wide on that spot. The water there is so clear that the riverbed filled with thread like green algae can be seen on sun-light. But human activity like quarry, fishing made it a little polluted. The human habitats around it use water from there for washing cooking equipment, and mining sand and stones.

2. BM-2

On this spot the algal diversity is near to zero, and arthropodan diversity is comparatively lower because the high current and slender water way and pesticides, used in a tea plantation situated just on the bank. Here human activity is highest in

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comparison to the other two spot, due to presence of a bridge and densely populated village near to it. The coordinates are 26.834234 N and 92. 9143113E.

3. BM-3

The third station is on the end or water mouth of the river. Here the water flows slowly & the width is little bit higher than the other 2 spots (approximately 7-8 m). There the coordinates are 26.7976969 N and 92.8907179 E.

Methodology

The water samples were collected from 3 sampling stations of river Bohimora (BM-1, BM-2 & BM-3). The selected parameters were studies for a period of 6 months from November 2017 to April 2018 during the winter season. For ecological study of the river, following aspects has been undertaken -

1. Studies on Physico-chemical parameters of water

(A) Physical Parameters

i) Temperature:- Water temperature was recorded by a mercury thermometer.

ii) Transparency: - Transparency was measured by Sacchi disc

iii) Turbidity: Turbidity of the river water was measured by a turbidometer.

iv) TDS: - Total dissolved solids (TDS) was determined with the help of a TDS meter.

(B) Chemical Parameters

i) Hydrogen ion concentration (pH): It was determined by an electronic pH meter.

ii) Dissolved Oxygen (DO): It was measured by the modified Winkler's method - APHA, 1998. The water samples were collected with care in bottles without bubble formation and brought in laboratory. 500 ml water samples were taken in BOD bottle and then added 5ml of manganese sulphate (Mn S04), 5ml of Alkali iodate azide (KI), the precipitates formed were dissolved by adding 4 ml off conc. sulphuric acid (H_2504). 100 ml sample was taken from this and titrated against 0.025 sodium thiosulphate. Starch is used as an indicator to estimate iodine generated and the end point is noted as the solution from blue to colourless.

DO mg /L BR X NX 1000 X 8 camount of sample taken (oud)
where, BR= Burette Reading
N = Normality of sodium this sulphate.
Free Carbondioxide (APHA, 1998) :

The method is based on the principle that free carbon dioxide in water reacts with sodium hydroxide (NaOH) to -form sodium bicarbonate (Na_2CO3) and the end point is indicated by development of prick colour using phantophthalin an indicator at pH 8.3.

To estimate CO_2 in water in 5 ml sample to 3 drops of phenlophthalin were added and the sample was titrated against 0.045 N sodium carbonate, until a pink colour was obtained. The free CO_2 was calculated using following formula

BR X NX 44 X 1000 Free CO_2 mg/4 = amount of sample taken (ml)
where,
BR = Burette reading N - Normality of Na_2 CO_2

2. Collection and Identification of Macroinvertebrates (Arthropods and Molluses) :

The macro-invertebrates from each sampling site were collected using dragging net, following the protocols of Barbour et al. (1999) and Mondaville (2002). Collected species were washed, photographed with help of a digital camera and identified as per Pennak (1989), Subba Rao (1989), Edmondson (1993), Merrit and Cummins (1996) and Subramanian and Sivaramakrishnan (2007).

3. Calculation of Diversity Index:

Macro-invertebrate species diversity was studied in the sampling sites using different indices such as Shannon Weiner index (H) and Simpson index (D) using the formula ->
Shannon Judex (H) Pi In Pi
Simpson Index (D) 1

III. RESULTS

River Bohimora which is on the Sonitpur district of Assam travels a distance of about 11 km before joining River Jia Bharali. No work has yet been conducted on this riverine system. Therefor an investigation has been needed on water quality and biodiversity.

1/ Temperature: In the present investigation the temp. were ranged from 21°C to 23°C.
2/ Transparency: The transparency on the study were ranged from 27 cm to 69 cm
3/ Turbidity: The turbidity was monitored in the range between 1.35 NTU to 11.8 NTU.

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4/ Total dissolved solids (TDS): In the 3 sampling stations the maximums TDS was found as 700 mg/L and minimum TDS was 30 mg/L.
5/ Hydrogen ion concentration (PH): In case of hydrogen ion the most concentrated site was BM-3 with a pH level of 8.5 and least concentrated site was BM-2 with pH level of 7.
6/ Dissolved Oxygen (DO): In the river Bohimora the dissolved oxygen was ranged from 6.2 mg/L to 9.8 mg/L
7/ Free carbon dioxide: The minimum free CO_2 conc. was found to be 13.8 mg/L in BM-2 site where as maximum CO_2 was found to be 102.96 mg/L in BM-3 sampling site.

Distribution of macro-invertebrate fauna of river Bohimora

BM-1

On the BM-1 site of Bohimora river 6 species of arthropods are found, those are - Isonychia sp., Caenis sp., Lacotrophes sp., Microneta sp., Notonecta sp. and Stenopsyche sp. These are included in 6 different family of 3 order. (Table 1 and Figure 2)

BM-2

On the BM-2 site of Bohimora river 4 species of arthropods are found, those are - Isonychia sp., Caenis sp, Notonecta sp., and Macrobrachium sp. which are included in 4 different family of 4 order. An another species of molluse also found on this spot that is Brotia sp. of Pacly-chilidae. (Table 1 and Figure 2)

BM-3

On the BM-3 site 6 species of arthropods and 2 species of molluscs are found. The arthropods are Caenis sp., Diplonychus sp., hacotrephes Sp., Notonecta sp., Hydaticus sp. and Macrobrachium sp. These are included in 6 families of 3 orders. The molluscs that are found on this spot are Gyrulus convexiusculus cond, Bellamya bengalensis. (Table 1 and Figure 2)

Distribution of macroinvertebrate fauna of river Behimora.

Anthropode
Macroinvertibrate sp.
Trong chia 2P,
Caenis SP
Diplonychus sp.
Lacotrophes sp.
Microneta sp.
Notonesta 2p.
Stenopsyche sp.
Hydaticus sp.
Macrobrachnum
Molluses
Family
Iso my chidae
Caenidae
Belostomatidae
Nepidae
Notonestidae
Stenopsychidae
Dytiscidae
Palaemonidae
Planorbidac
Viviparidae
Pachychilidae

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Distribution of macroinvertebrate fauna of river Bohimora:

S.N.	Macroinvertibrate sp.	Family	Order	Site
	Arthropods			
1.	Isonychia sp.	Isonychidae	Ephemeroptera	BM-1 & BM-2
2.	Caenis sp.	Caenidae	Ephemeroptera	BM-1, BM-2 & BM-3
3.	Diplonychus sp.	Belostomatidae	Ephemeroptera	BM-3
4	Lacotrephes sp.	Nepidae	Hemiptera	BM-1 & BM-2
5.	Microneta sp.	Notonectidae	Hemiptera	BM-1
6.	Notonecta sp.	Notonectidae	Hemiptera	BM-1, BM-2 & BM-3
7.	Stenopsyche sp.	Stenopsychidae	Trichoptera	BM-1
8.	Hydaticus sp.	Dytiscidae	Coleoptera	BM-3
9.	Macrobrachium sp.	Palaemonidae	Decapoda	BM-2 & BM-3
	Molluscs			
10.	Gyraulus convexiusculus	Planorbidae	—	BM-3
11.	Bellamya bengalensis	Viviparidae	Archilaeniglossa	BM-3
12.	Bretia sp.	Pachychilidae	—	BM-2 & BM-3

Table 2

Table -2

✡ Calculation of diversity index

Table 3: The BM-1 was sampled and following specimens were collected :-

Order	Description	No. of individual	n/N	P_i	P_i^2	$\ln P_i$	$P_i \ln P_i$
Ephemeroptera	Brown with 2 pairs of leg	1	1/18	0.055	0.003	-2.900	-0.159
Ephemeroptera	Brown in colour	3	3/18	0.166	0.027	-1.795	-0.297
Hemiptera	Brown in colour with a pair big foreleg	3	3/18	0.166	0.027	-1.795	-0.297
Hemiptera	Light brown and leaf like body	2	2/18	0.111	0.012	-2.198	-0.244
Hemiptera	White in colour with two long legs	5	5/18	0.277	0.076	-1.283	-1.283
Stenopsyche	Long, white larval body.	1	1/18	0.055	0.003	-2.900	-0.159

$N = 15$ $\quad \Sigma P_i^2 = 0.143$ $\quad \Sigma P_i \ln P_i = -2.439$

Shannon Index (H) $= -(-2.439) = 2.439$

Simpson Index (D) $= \frac{1}{0.143} = 6.993$

Table-3

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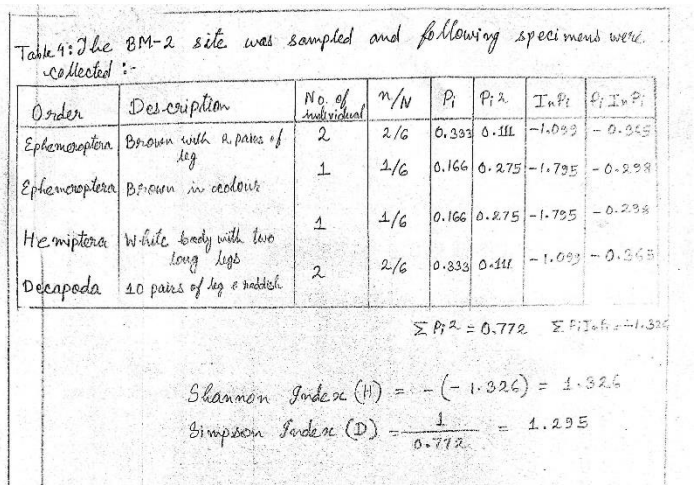

Table 4: The BM-2 site was sampled and following specimens were collected :-

Order	Description	No. of individual	n/N	P_i	P_i^2	$\ln P_i$	$P_i \ln P_i$
Ephemeroptera	Brown with 6 pairs of leg	2	2/6	0.333	0.111	-1.099	-0.365
Ephemeroptera	Brown in colour	1	1/6	0.166	0.275	-1.795	-0.298
Hemiptera	White body with two long legs	1	1/6	0.166	0.275	-1.795	-0.298
Decapoda	10 pairs of leg & reddish	2	2/6	0.333	0.111	-1.099	-0.365

$\Sigma P_i^2 = 0.772$ $\Sigma P_i \ln P_i = -1.326$

Shannon Index (H) = $-(-1.326) = 1.326$

Simpson Index (D) = $\frac{1}{0.772} = 1.295$

Table-4

BM-1

Different diversity indices off the BM-1 stimpling site of river. Bohimora are given below.
Shannon Index (H) = 2.439 = 6.993
Simpsom Index

BM-2

Different diversity indices of the BM-2 sampling site are,
Shannon Index (H) = 1.326. Simpson Index (D) = 1.295
Diversity indices of BM-3 site are,
Shannon Index (H) = 1.668.
Simpson Index (D) = 0.271

The above observation mentioned in the Table 2,3 & 4 show that the Shannon Index of river Bohimora is ranged between 1.326 to 2.439 and the Simpson Index is ranged between 0.2.71 to 6.993. Therefore it is found that shannon index (H) and Simpson index (D) is highest at BM-1 at 2.439 and 6.993. respectively. Therefore sector BM-1 has got highest species diversity.

DISCUSSION

""We never know the worth of water till the well is dry" (T. Fuller). Inland water biodiversity underpins the provision of most goods and services that freshwater ecosystem provide to people. They are diverse and include not only direct used for food, fibre and medicine but also benefits such as pollution and nutrient absorption and recycling.

Temperature is a vital parameter for growth of biodiversity and physico-chemical behaviour of biotic component of aquatic ecosystem. The water tempr. showed a balance in all the 3 sampling site. The tempr. that were detected is healthy for a habitat which is ranged between 21-23°c. This can be easily balanced to human body tempr. and healthy to consume.

pH of a water body is also a very important character of water quality. The standard pHfor fresh water to be healthy is below 8 (according to WHO). The pH of Bohimora River was ranged from 1 to 8.5 which is a sign of over pollution.

According to WHO, 1993, the standard permissible limit for TDS is 1000 mg/L. Water at a TDS level of 5000 mg/L is unsuitable for flora and fauna to grow and taste unpleasant to drink. The current study showed a TDS range of 90 to 700 mg/L that is under desirable condition.

The turbidity of any water sample is the reduction of transparency due to the presence of particulate matter such as clay or salt, finely divided organic matter, or salt, Plankton and other microscopic organisms. In the present investigation the turbidity range was between 1.35 NTU and 4.18 NTU which is greater than normal and indicates a significant pollution rate.

Barman and Gupta (2015) researched on Bakumari shcom of chakrashila Wildilife Sanctuary, Assam and find out the DO was ranged between 6.63 to 12.17 which was a little bit lower to the current study found in Bohimara river that was 4.2-6.2 and depicts a certain amount of pollution

Barman & Gupta (2015) studied the Free Co_2 level too which awas in the range of 5.86 to 10.56. But the free CO_2 level of river Bohimora is in the range of 45.5 to 102.96 mg/L which is far greater than the former one, that depicts high pollution rate.

Gogoi and Gupta (2017) have also researched on the Brahmaputra river and find out that order Hemiptera are most abundant on it. In the river 'Bohimora' too the most abundant group of arthropod is Hemiptera. In coleoptera order they

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found 5 family, those are Noteridae, Dyropidae, Dylisidae, Elmidae and Hydrophilidae. But the current study found only family from the order coleoptera that is Dytiscidae. They found only 1 family from the order Ephemeropterar in Brahmaputra where as in Behimora 3 family has been found, those are Isomychidae, Caenidae and Belostomatidae. In the current study another 2 order of arthropoda was found which are Trichoptera and Decapada in place of then Gogoi and Gupta had found Odonata

Kardong et al. (2016) studied the diversity of molluscs in Muguri beel in Tinsukia District. They found 30 species of 9 families which are included in 5 different order, in bohimora 3 species of 8 family has been found.

One of most important aspect of river is the diversity of fauna on it. Different program from USA and Europe that the benthic macro-invertebrates are most useful in monitoring fresh water ecosystem. Shannon-Weiner index and Simpson index are some of the mostly used indices to monitor diversity of river all around the globe.

In river Brahmaputra Gogoi and Gupta (2017) found the Shannon index in the range between 0.376 to 0.943 which is not similar result of the current study which ranges from 2.439 to 1.326. The result that shows greater than 1 indicates a fair ecosystem.

Ghosh and Biswas (2015) measured simpson index in Chariganga lake in eastern india and found in the range of 0.53-0.69 which is far lower than the current study that showed in the range between 0.271 to 6.993 that is an indicator of more diverse ecosystem.

CONCLUSION

This was a little attempt to examine and evaluate the parameters related to the biosphere of the river Bohimora. Though it was a trial to approach each and every possible aspect of the topic, as natural it was neither perfect nor complete. There were many physio-chemical parameters that can affect the biology of a river which were remained untouched and must be taken into consideration in a future work. eg. Electrical conductivity, concentration of ions and metals, Total hardness, Biological oxygen demand, Nitrates conc. etc.

The monitoring of the water quality is not enough, but the assessment of the reasons for poor state should be done in a future research which should also include the overall solution of the problem.At last it can be concluded that the attempt was successful to monitor the water quality and biodiversity state of river 'Bohimara' though various aspects are remained in this field to study.

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