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Water Quality Assessment of River Dikhow, Assam, India Using Biological Water Quality Criteria

Bristi Dutta[1], Debojit Baruah[2] and S.P. Biswas[3]
Department of Zoology, S.P.P. College, Namti, Sivsagar, Assam, India
bristiduttaborah@gmail.com

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Abstract

An assessment has been made on the water quality of the tail race of River Dikhow - a southern tributary of the mighty river Brahmaputra, Assam, India, following Biological Water Quality Criteria. During the study, the study period (Jan'2013 to Dec'2013) was divided into four seasons-pre-monsoon, monsoon, post-monsoon and winte . March to May is considered as pre-monsoon, Jun to August is considered as monsoon, September to October is considered as post-monsoon and December to February is considered as winter seasons. Studied area was demarcated into five stations, viz station I, station II, station III, station IV and station V. Samples of macro invertebrates were collected monthly and identified following standard methods. A total of thirteen (13) species of three (3) phyla (Annelida, Mollusca, Arthropoda) were recorded during the study. Biological Water Quality Criteria which is based on saprobic and diversity score, showed slight pollution in station V and moderate pollution in station I,II,III and IV. But the extent of pollution in station III was found to be greater as compared to the other stations.

Keywords: Biological Water Quality Criteria, River Dikhow, Macroinvertebrates, Saprobic score, Diversity score.

Introduction

River is an open system and receives runoff from its drainage which carries both suspended and dissolved materials into the stream. As a river is a running water ecosystem, they are the most impacted ecosystem on the Earth as they have been the prime sources for human settlement and are variously heavily exploited such as water electricity generation, waste disposal etc[1]. As Aquatic organisms often considered not only react to physical and chemical changes in their environment, but also they can detect such changes and have important roles in cleansing and detoxifying their environment[2], these organisms have been used to monitor the water quality of a river. Biomonitoring, or biological monitoring, can be defined as "the systematic use of living organisms or their responses to determine the condition or changes of the environment"[3-5]. Since streams and rivers are among the most endangered ecosystems worldwide[6,7], it is high time to monitor their rate of changes and proper evaluation through comprehensive methodological approaches[8]. Bio monitoring technology is more valuable than conventional chemical methods to quantify the degradation level of river ecosystems [9]. Among various aquatic organisms, the macro-invertebrates I,e the benthic fauna of a river have been considered as the most suitable biological tool for the evaluation of water quality of an aquatic ecosystem like river [10]. Benthic macro invertebrates have a sedentary and long life span , sensitive community response like thermal pollution toxic pollution etc[11]. They are regarded as the most informative bio indicators of water pollution. Macro invertebrates are used most frequently in bio monitoring programs as their responses to organic and inorganic pollution have been extensively documented[12,13].

The studied site was the tail race of Dikhow River- a Southern tributary of the mighty River Brahmaputra. River Dikhow is a crucial river which has been utilized by the local people for various purposes and hence various anthropogenic activities affect it's water quality. Thus the major objective of this study is to identify and use the fresh water macroinvertebrates in the tail race of the River Dikhow, Assam, India to assess the biological water quality using Biological Water Quality Criteria (BWQC) developed by Central Pollution Control Board, New Delhi.

Materials and Methods

Study Area: Dikhow River is a southern tributary of the mighty river Brahmaputra. Its total length is 330 km originating from the Naga Hills. The studied part of the river is of 65 km. stretch, which was demarcated into five stations longitudinally (Figure-1) viz. station I, station II, station III, station IV and station V.

Study period: The study period was for one year that is from January'2013 to December '2013, which was divided into four seasons – pre-monsoon, monsoon, post-monsoon and winter. March to May is considered as pre-monsoon, Jun to August is considered as monsoon, September to October is considered as post-monsoon and December to February is considered as winter seasons.

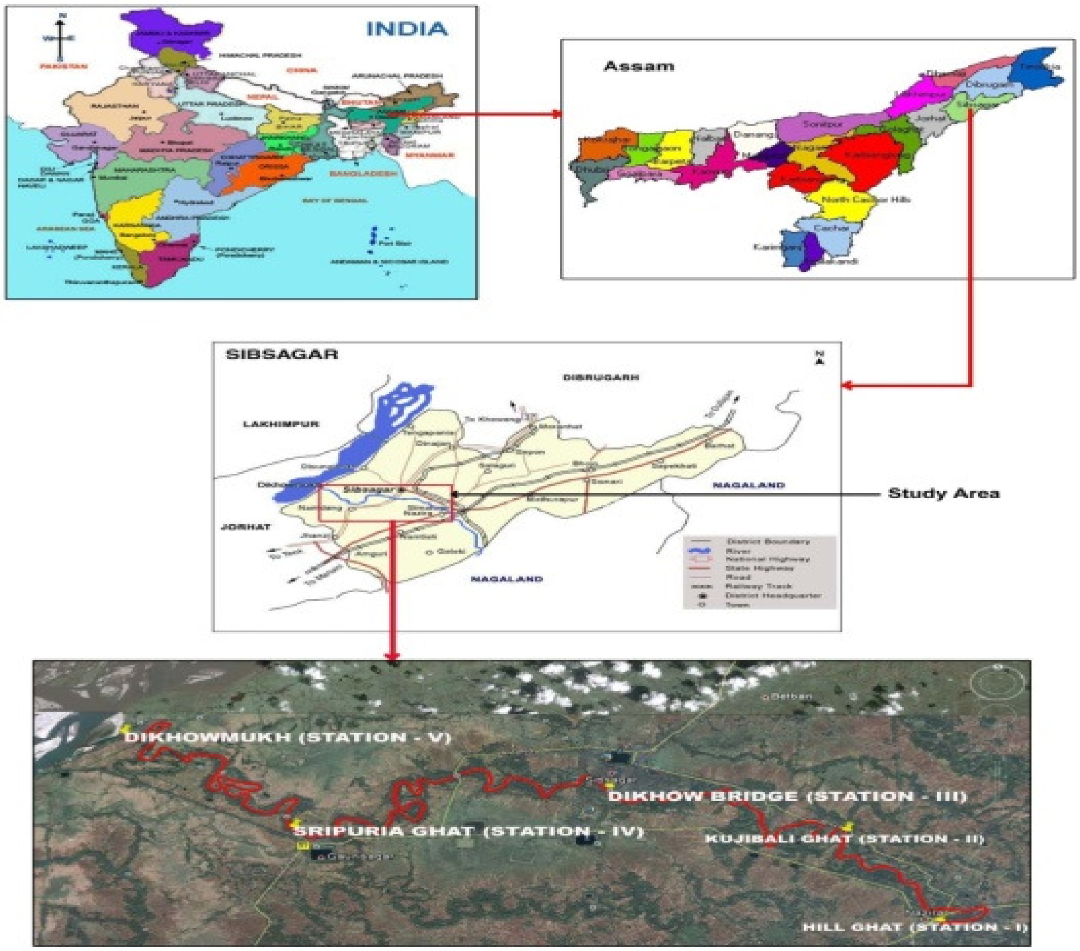

Figure-1
Location Map of the Study Area

Macro invertebrate Sampling: Macro invertebrate samples were collected seasonally following the SASS5 protocol[14]. Macroinvertebrate sampling was done using a net (30 X 30 cm frame with mesh size 1000 µm). Collected macroinvertebrates were tipped into a white tray that was half filled with river water. Families of macroinvertebrates present were identified by the river side, recorded on a sheet, preserved in 70% ethanol for further identification and sorting. Identification was done by using identification keys described by various researchers[15-17].

Densities and Abundance of Macroinvertebrates: The densities of abundant species were analyzed for each of the sampling Stations using the formula:

$D = n/ A$,

Where: D= Density, n= total number of macroinvertebrates sampled, A= area of sampling unit

Biological Water Quality Criteria (BWQC): Central pollution Control Board [18] has derived a Biological Water Quality Criteria (BWQC) for the evaluation of water quality of aquatic ecosystems like rivers [19]. This criteria is based on two values namely saprobic score values and diversity score values. Saprobic score gives us a quantitative proportion of macroinvertebrate benthic fauna up to family level. On the basis of the preference for saprobic water quality, the families of macroinvertebrates are classified on a score scale ranging between 1 to 10. The saprobic scores of all the families are to produce Bio-Monitoring Working Party (BMWP) index.

The families which are more sensitive to pollution have been assigned scores of 10 while the most pollution tolerant families have been assigned scores of 1 and 2.

The diversity score can be obtained by dividing the total number of different animals or runs by total number of animals encountered. The diversity score value ranges between 0 and 1. Sequentially encountered individuals are compared pair-wise in this system. First observed animal is scored as 1 run. Next observed one which is different from the last, is considered as a new run.

Saprobic score values = Grand total multiplied score / Grand total number of families encountered

Diversity score values = Number of runs / Number of organisms

According to the range of saprobic scores (between 1 and 10) in combination with the range of diversity scores (between 0 qnd 1) , the water quality level of an aquatic ecosystem has been classified into five different categories and displayed in table 1. The abnormal combination of saprobic score and diversity score indicates sudden change in environment conditions.

Result and Discussion

Macroinvertebrates composition: Macroinvertebrate taxa of the tailrace of Dikhow River are presented in Table: 2. A total of thirteen (13) species (*Rhynchobdella sp, Physella sp, Soletelina sp, Gammarus sp, Fenneropeneus sp, Isotomus sp, Caenius sp, Gomphus sp, Lethocerus sp, Hydrophylus sp, Chaobarus sp, Chironomus sp)* of benthic invertebrates' fauna belonging to three (3) phyla (Annelida, Mollusca, Arthropoda), were recorded from the studied stations.

The highest population of macroinvertebrates is contributed by Physidae family of class Gastropoda of Phylum Mollusca (Figure-2), followed by family Pannidae of class crustacea. Pannidae is followed by family Anomidae (Figure-2) of class Bivalvia, followed by population of family Hirudinidae of class Hirudinea (Figure-2). Family chaoboridae of class Insecta followed Hirudinidae. Chaoboridae is followed by family chironomidae of class insect (Figure-2). Family Gomphidae, Belostometidae and caennidae of class insect contributed with very low population compared to above mentioned families. Family gammaridae of class Crustacea, nepidae and isotomidae of class insecta showed lowest population during the study period (Figure-2).

Biological Water Quality criteria: Biological Water Quality Criteria (BWQC), based on the range of saprobic and diversity values of the benthic macro invertebrate families were displayed for the five sampling stations in Table-3. In station I, lower saprobic value was seen during pre monsoon season (5.38) , followed by winter (5.39) and post-monsoon (5.42) as compared to that of monsoon. Diversity score also comparatively lower in post-monsoon season (0.35). In station II, lower saprobic values were seen during pre-monsoon, post-monsoon and winter seasons (5.5 in each) as compared to monsoon (6). Diversity score also decreased from post monsoon (0.42) and pre-monsoon (0.40). In Station III, saprobic score was found to be lower in pre-monsoon (3.96) followed by winter (4) and post-monsoon (4.55). Diversity score also comparatively higher in monsoon (0.42) and lower in pre-monsoon (0.32). In Station IV, lower saprobic score was recorded during pre-monsoon and winter (5), followed by post-monsoon season (5.32). Diversity score also higher during monsoon (0.51) and lower during winter (0.45). In station V, saprobic score was comparatively lower winter (6.4) and higher in monsoon (6.8). Diversity score was also lower in winter (0.56) and higher in monsoon (6.8).

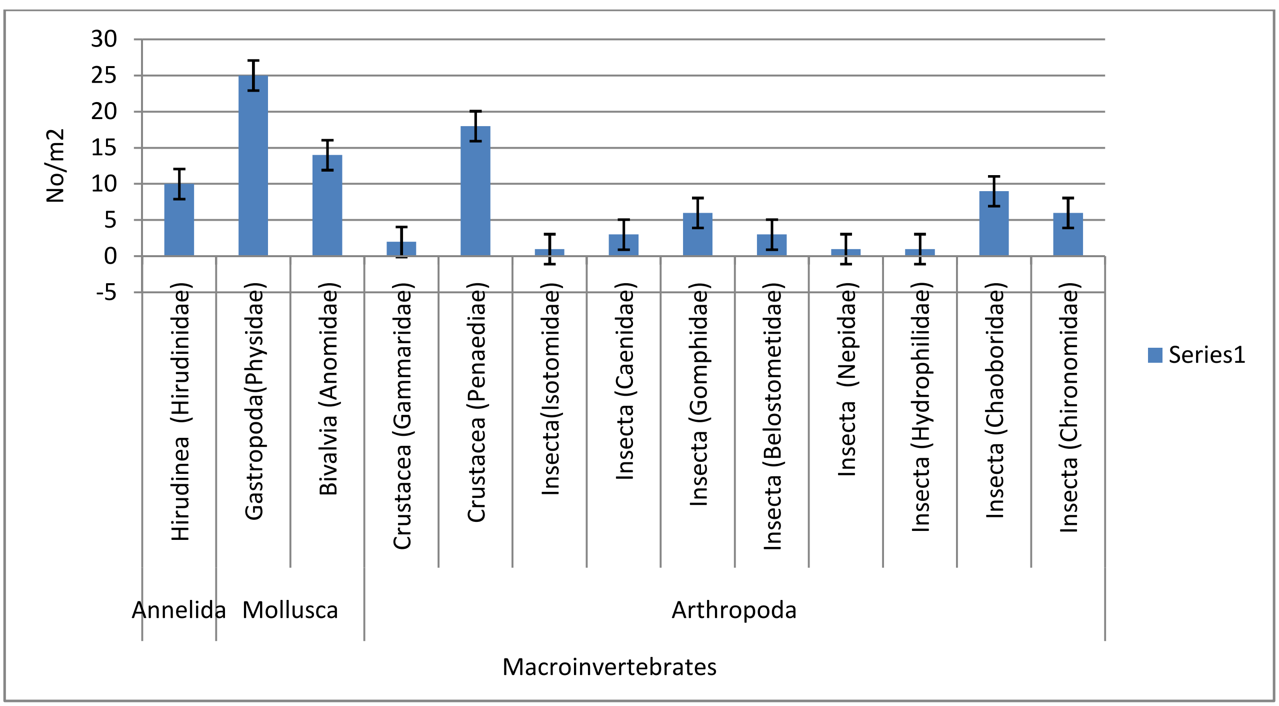

Figure-2
Population densities of macroinvertebrates during the study period

Thus, in the present study it was reported that in station V, the saprobic scores were comparatively higher than the rest stations (Table-3). The diversity scores were also comparatively higher in this station (Table-3). The water quality in all the seasons in this station was found to be slightly polluted: but in other four stations, the water quality was moderately polluted. However, slight pollution was seen during monsoon in station II and IV. The range of pollution in station I and III was found to be higher as compared to other stations. This may be as a result of various anthropogenic factors and local land uses. Besides, these stations can be influenced by the discharge of domestic effluent and by community bathing. Interestingly during pre monsoon, from the study, it can be said that station II, IV and V are less influenced by the human activities when compared to station I and III. Due to the increase in flow of the stream during monsoon, pollution level seems to decrease slightly (Table-3) and water quality improved and impact of monsoon pilgrimage became evident only during post monsoon where water again became moderately polluted [21]. Abundance of pollution tolerant species of benthic fauna is a clear indication of organic contamination and the enrichment of organic matter in the river[20,21]. It has been noticed that in all the stations, the trend of water quality was same, that is only slight improvement during monsoon seasons, and back to same condition at post monsoon which may be due to a higher flow rate and flooding nature of the river during monsoon, as all were seen to be flood prone areas.

Table-1
Biological Water Quality Criteria (BWQC)

Range of Saprobic Score	Range of Diversity Score	Water Quality	Water Quality Class	Indicator colour
7 and more	0.2-1.0	Clean	A	Blue
6-7	0.5-1.0	Slight Pollution	B	Light blue
3-6	0.3-0.9	Moderate Pollution	C	Green
2-5	0.4-less	Heavy Pollution	D	Orange
0-2	0-0.2	Severe Pollution	E	Red

Table-2
Macroinvertebrate taxa of the tailrace of Dikhow River

Taxa	Class	Family	Species	Density					Mean±SD
				I	II	III	IV	V	
Annelida	Hirudinea	Hirudinidae	*Rhynchobdella* sp	20	10	4	10	5	10±5.67
Mollusca	Gastropoda	Physidae	*Physella* sp.	15	30	30	25	25	25±5.47
	Bivalvia	Margaretiferidae	*Margaretiferous* sp	5	10	7	10	40	14±12.94
Arthropoda	Crustacea	Gammaridae	*Gammarus* sp.	1	5	0	2	0	2±1.86
		Penaediae	*Fenneropenae Indicus*	20	10	20	24	15	18±4.83
	Insecta	Isotomidae	*Isotomurus* sp	0	0	1	0	0	0
		Caenidae	*Caenius* sp	0	5	6	3	2	3±2.13
		Gomphidae	*Gomphus* sp	1	1	3	1	1	1±2
		Belostometidae	*Lethocerus* sp	2	2	4	5	2	3±1.26
		Nepidae	--------------	0	0	1	1	1	1±0.51
		Hydrophilidae	*Hydrophilus* sp.	1	2	3	0	1	1±0.51
		Chaoboridae	*Chaobarus* sp	15	11	9	6	2	9±4.4
		Chironomidae	*Chironomus* sp	5	10	6	9	2	6±2.87

Table-3
Biological water quality of the tail race of Dikhow River

Stations	Seasons	Saprobic Score	Diversity Score	Water Quality	Water Quality Class
I	Pre-monsoon	5.38	0.39	Moderate pollution	C
	Monsoon	5.55	0.42	Moderate pollution	C
	Post-monsoon	5.42	0.35	Moderate pollution	C
	Winter	5.39	0.39	Moderate pollution	C
II	Pre-monsoon	5.5	0.40	Moderate pollution	C
	Monsoon	6	0.52	Slight pollution	B
	Post-monsoon	5.5	0.42	Moderate pollution	C
	Winter	5.5	0.42	Moderate pollution	C
III	Pre-monsoon	3.96	0.32	Moderate pollution	C
	Monsoon	4.96	0.42	Moderate pollution	C
	Post-monsoon	4.55	0.325	Moderate pollution	C
	Winter	4	0.35	Moderate pollution	C
IV	Pre-monsoon	5	0.48	Moderate pollution	C
	Monsoon	5.32	0.51	Slight pollution	B
	Post-monsoon	5.30	0.48	Moderate pollution	C
	Winter	5	0.45	Moderate pollution	B
V	Pre-monsoon	6.5	0.55	Slight pollution	B
	Monsoon	6.8	0.71	Slight pollution	B
	Post-monsoon	6.5	0.65	Slight pollution	B
	Winter	6.4	0.56	slight pollution	B

Conclusion

Various anthropogenic activities are showing its impacts on the water quality of the tail race of Dikhow River. The range of pollution in sampling stations I and III was found to be higher as compared to other sampling stations. Urban and suburban runoff including pesticides, fertilizers, human excreta, ash (released due to burning of dead bodies), harmful farming wastes, toxic industrial wastes and other rubbish contribute to the water pollution in station I and III. But the influence was found to be greater in station III. This is a prime resource of water for all of the surrounding communities and being used by humans for so long has changed this noble river in various ways.

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