Current World Environment Vol. **10**(1), 296-304 (2015)

Rapid Bioassessment of Magura *haor* (Floodplain wetland), Cachar District, Assam, India using Aquatic Insects

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http://dx.doi.org/10.12944/CWE.10.1.37

(Received: December 22, 2014; Accepted: February 02, 2015)

ABSTRACT

Investigation on the water quality of the floodplain wetland, Magura through rapid assessment survey using aquatic insects for the four seasons were done during 2013-14. Aquatic insects were collected from the two sites and were identified up to family level. All together 5 orders (Hemiptera, Coleoptera, Odonata, Ephemeroptera and Diptera) and 21 families were recorded from the wetland. 17 families from site 1 (Hemiptera- 7 families, Coleoptera- 4 families, Odonata- 3 families, Ephemeroptera- 1 family and Diptera- 2 families) and 18 families from site 2 (Hemiptera- 6 families, Coleoptera- 6 families, Odonata- 2 families, Ephemeroptera- 1 family and Diptera- 3 families) were recorded. Four family level biotic indices- SIGNAL 2, ASPT, BMWP and FBI were used to determine the status of the water quality. According to SIGNAL 2 and BMWP scores it was moderately polluted, whereas ASPT showed doubtful quality but FBI proved very good (site 1) and good water condition (site 2). This study revealed that only one biotic index cannot give proper justification of the water quality status of a wetland.

Key words: Rapid bioassessment, Aquatic insects, *haor*, Cachar.

INTRODUCTION

Rapid bioassessment survey is the quick and easy method of analyzing water quality of any water body by using benthic macroinvertebrates. Benthic macroinvertebrates are common inhabitants of freshwater systems and are also sensitive elements of aquatic biota[1]. Therefore, changes in its taxonomic richness and composition are considered sensitive tools for perceiving alterations in aquatic ecosystems[2]. Therefore, rapid procedures for assessing the biotic communities of surface waters become widely used in recent years where they allow large number of sites to examine at a low cost[3]. In general, rapid bioassessment can be defined as an evaluation of the condition of a water body using biological surveys and other direct measurements of the resident biota in surface waters[4]. Resident biota in water body are natural monitors of environmental quality and can reveal the effects of episodic as well as cumulative pollution and habitat alteration[5]. Biotic indices such as Trent Biotic index[6]; BMWP score[7], ASPT score[7], Wisconsin Biotic Index (BI) and Family Biotic Index (FBI) for macro-invertebrates are used to detect and monitor water quality and human perturbations in varying ecosystems like streams[8], rivers[9] and lakes[10].

The present study is focused on one floodplain wetland (locally called as '*haor*') named Magura in Cachar district of Assam, India. This study is aimed to establish ecological status of the wetland and classify the sampling sites with the help of different biotic indices where aquatic insects have been used as bioindicator.

MATERIALS AND METHODS

Cachar distict (25.0833° N, 92.9167° E) is the commercial district of Barak valley. Magura *haor* (N 24º36.910/ E 092º51.924/) is the floodplain wetland of River Rukni, one of the tributaries of River Barak. During monsoon its depth reached up to 150 cm. It covers an area of 1,87,146 sq.meters (Fig. 1). Major parts of the wetland get dried up during dry period and used for paddy cultivation and grazing of the cattles. The wetland is rich in macrophytes like *Eichhornia crassipes*, *Ludwigia adscendens*, *Utricularia aurea*, *Pistia* sp., *Nymphoid indicum*, and *Myriophyllum spectrum.*

Insect samples were collected seasonally during post-monsoon (2013) to monsoon (2014) from the two sites of the wetland- site 1 and site 2 in replicates. For the collection of aquatic insects "Kick method" was applied where vegetation was disturbed and a circular net (mesh size 60μm) was dragged around the vegetation for a unit of time[11-12]. Three such drags constituted one sample[13]. Collected insects were immediately sorted and preserved in 70% ethyl alcohol. They were identified upto family level using Magnus stereozoom microscope with the help of standard keys[14-20]. Different biotic indices like SIGNAL, ASPT, BMWP and FBI were used for the rapid bioassessment survey of the Magura *haor*.

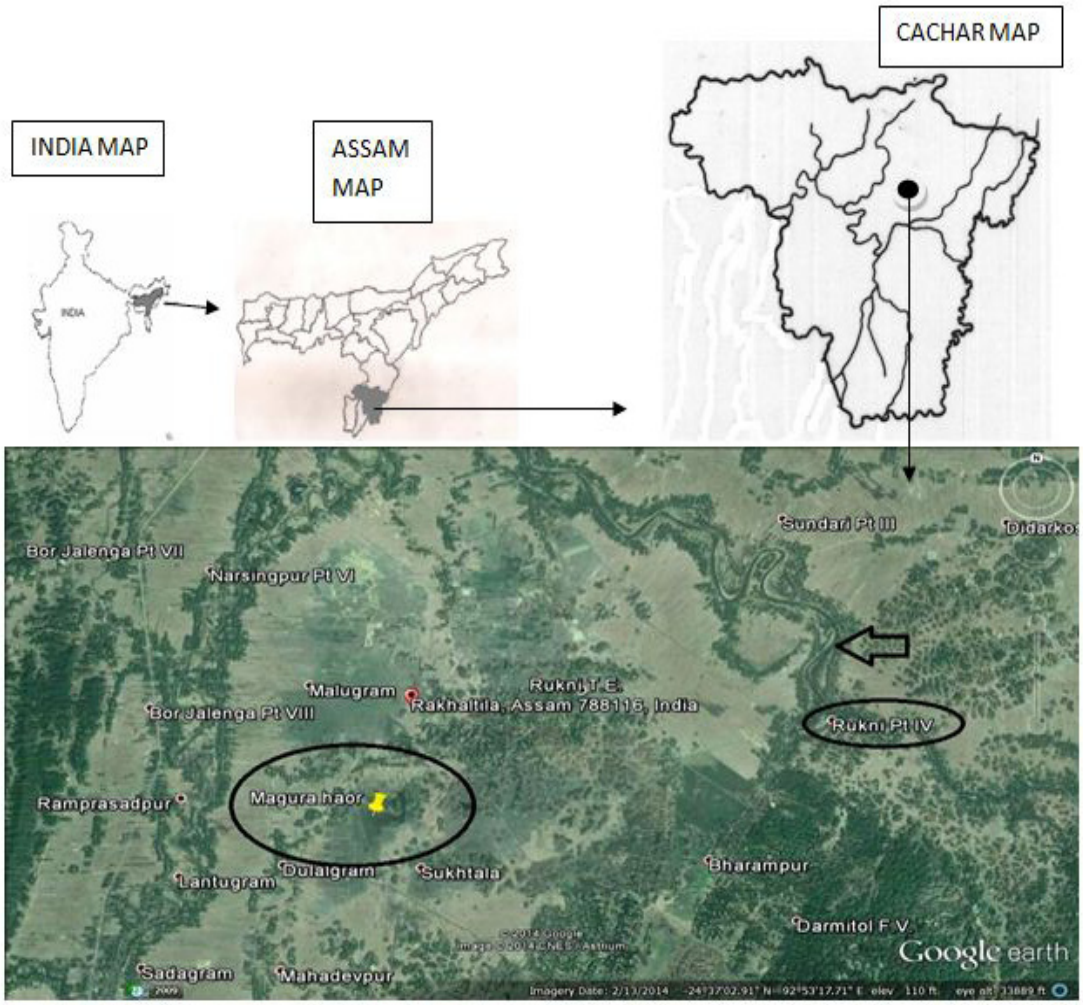

Fig. 1: Map of Cachar district, Assam showing Magura *haor* along with Rukni river. (source: Google map)

RESULTS AND DISCUSSION

Study revealed 5 orders (Hemiptera, Coleoptera, Odonata, Ephemeroptera and Diptera) and 21 families from the wetland. 17 families had been recorded from site 1, they were- Gerridae, Corixidae, Notonectidae, Hydrometridae, Pleidae, Nepidae, Belostomatidae (Order Hemiptera), Noteridae, Hydrophilidae, Chrysomelidae, Dytiscidae (Order Coleoptera), Libellulidae, Coenagrionidae, Aeshnidae (Order Odonata), Baetidae (Order Ephemeroptera), Chironomidae and Culicidae (Order Diptera) and 18 families from site 2, they were- Gerridae, Corixidae, Notonectidae, Nepidae, Hydrometridae, Veliidae (Order Hemiptera), Noteridae, Hydrophilidae, Chrysomelidae, Dytiscidae, Hydraenidae, Hydrochidae (Order Coleoptera), Libellulidae, Coenagrionidae (Order Odonata), Baetidae (Order Ephemeroptera), Chironomidae, Culicidae and Tabanidae (Order Diptera).

Table 1 showed the SIGNAL 2 scores for site 1 and site 2 for the four seasons of Magura *haor*. The SIGNAL (Stream Invertebrate Grade Number-Average level) is a family level scoring system for macroinvertebrates sample where it gives the indication of water quality from where the sample was collected[21]. In site 1, highest score was shown in monsoon while lowest score was shown in pre-monsoon. Although species richness was found more in pre-monsoon, monsoon season scored highest because of the presence of more relatively sensitive groups. In site 2, again monsoon season secured highest score and post monsoon season had lowest score. In both the sites, weight factor of Baetidae family was found highest which also has highest SIGNAL 2 sensitivity grade and highest relative abundance in monsoon season (Fig. 2), thus increasing its SIGNAL 2 score as a whole. Both the sites showed severe pollution status (i.e., < 4). Similar status of SIGNAL 2 score was also recorded from other floodplain wetlands of Cachar district[22-23]. Though it is mainly used in streams and rivers where organic pollution is less, it can also be applied in wetlands and other lentic ecosystems. But the scores would be less as some of the macroinvertebrate families that have the highest SIGNAL 2 sensitivity grades are naturally rare in wetlands[21]. Therefore we can consider this wetland under moderate water pollution.

Table 2 showed the BMWP and ASPT scores for site 1 and site 2 for the four seasons of Magura *haor.* BMWP (Biological Monitoring Working Party) is a family level scoring system which represents organisms' tolerance to pollution.

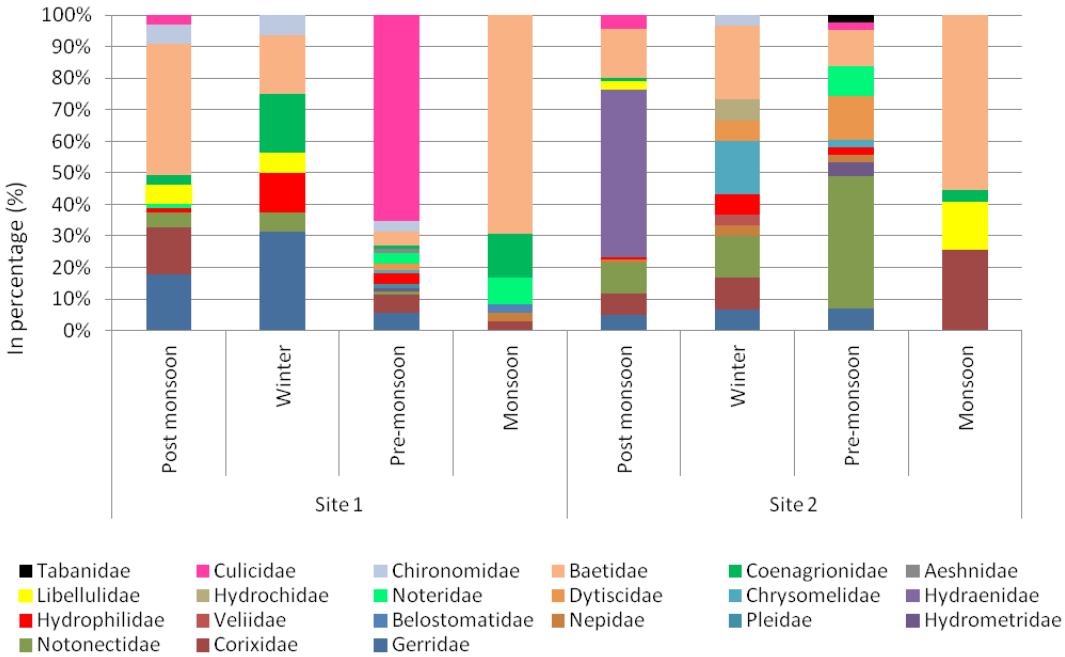

Fig. 2: Relative abundance graph of site 1 and site 2 of Magura *haor* for four seasons (2013-14)

Table 1: Seasonal variation in SIGNAL 2 scores for site 1and site 2 of Magura *haor*

Sites	Invertebrate families collected	SIGNAL 2 Sensitivity grade	Post-monsoon		Winter		Pre-monsoon		Monsoon	
			Weight factor	Grade x weight factor	Weight factor	Grade x weight factor	Weight factor	Grade x weight factor	Weight factor	Grade x weight factor
Site 1	Gerridae	4	4	16	2	8	2	8	-	-
	Corixidae	2	3	6	-	-	2	4	1	2
	Notonectidae	1	2	2	1	1	1	1	-	-
	Hydrometridae	3	-	-	-	-	1	3	-	-
	Pleidae	2	-	-	-	-	1	2	-	-
	Nepidae	3	-	-	-	-	-	-	1	3
	Belostomatidae	1	-	-	-	-	-	-	1	1
	Noteridae	4	1	4	-	-	1	4	2	8
	Hydrophilidae	2	1	2	1	2	2	4	-	-
	Chrysomelidae	2	-	-	-	-	1	2	-	-
	Dytiscidae	2	-	-	-	-	1	2	-	-
	Libellulidae	4	2	8	1	4	-	-	-	-
	Coenagrionidae	2	1	2	2	4	1	2	2	4
	Aeshnidae	4	-	-	-	-	1	4	-	-
	Baetidae	5	5	25	2	10	2	10	5	25
	Chironomidae	3	2	6	-	-	1	3	-	-
	Culicidae	1	1	1	-	-	5	5	-	-
	TOTAL		22	72	9	29	22	54	12	43
	SIGNAL SCORE		3.27	3.22	2.45	3.58				
Site 2	Gerridae	4	3	12	1	4	1	4	-	-
	Corixidae	2	3	6	2	4	-	-	3	6
	Notonectidae	1	4	4	2	2	-	-	-	-
	Nepidae	3	1	3	1	3	1	3	-	-
	Hydrometridae	3	-	-	-	-	1	3	-	-
	Veliidae	3	-	-	1	3	-	-	-	-
	Hydrophilidae	2	1	2	2	4	1	2	-	-
	Hydraenidae	3	5	15	-	-	-	-	-	-
	Noteridae	4	-	-	1	4	2	8	-	-
	Chrysomelidae	2	-	-	2	4	-	-	-	-
	Dytiscidae	2	-	-	1	2	3	6	-	-
	Hydrochidae	4	-	-	1	4	-	-	-	-
	Libellulidae	4	2	8	-	-	-	-	2	8
	Coenagrionidae	2	1	2	-	-	-	-	1	2
	Baetidae	5	4	20	3	15	2	10	4	20
	Culicidae	1	2	2	-	-	2	2	-	-
	Chironomidae	3	-	-	1	3	-	-	-	-
	Tabanidae	3	-	-	-	-	1	3	-	-
	TOTAL		26	74	18	52	14	41	10	36
	SIGNAL SCORE		2.85	2.88	2.93	3.60				

N.B: signal score = (total of grade x weight factor) / total of weight factor; Signal 2 sensitivity grade = 1-10, Signal 2 scores: healthy habitat > 6, mild pollution 5-6, moderate pollution 4-5, severe pollution < 4[21-24].

Table 2: Seasonal variation in BMWP and ASPT scores for site 1and site 2 of Magura *haor*

Sites	Invertebrate families collected	BMWP SCORE			
		Post- monsoon	Winter	Pre- monsoon	Monsoon
Site 1	Gerridae	5	5	5	-
	Corixidae	5	-	5	5
	Notonectidae	5	5	5	-
	Hydrometridae	-	-	5	-
	Pleidae	-	-	5	-
	Nepidae	-	-	-	5
	Belostomatidae	-	-	-	5
	Noteridae	5	-	5	5
	Hydrophilidae	-	5	5	-
	Chrysomelidae	5	5	5	-
	Dytiscidae	-	-	5	-
	Libellulidae	-	8	-	-
	Coenagrionidae	6	6	6	6
	Aeshnidae	-	-	8	-
	Baetidae	4	4	4	4
	Chironomidae	2	-	2	-
	Culicidae	1	-	1	-
	TOTAL	38	38	66	30
	ASPT SCORE	4.22	5.42	4.71	5.00
Site 2	Gerridae	5	5	5	-
	Corixidae	5	5	-	5
	Notonectidae	5	5	-	-
	Nepidae	5	5	5	-
	Hydrometridae	-	-	5	-
	Veliidae	-	5	-	-
	Hydrophilidae	5	5	5	-
	Hydraenidae	5	-	-	-
	Noteridae	-	5	5	-
	Chrysomelidae	-	5	-	-
	Dytiscidae	-	5	5	-
	Hydrochidae	-	5	-	-
	Libellulidae	8	-	-	8
	Coenagrionidae	6	-	-	6
	Baetidae	4	4	4	4
	Chironomidae	-	2	-	-
	Culicidae	1	-	1	-
	Tabanidae	-	-	2	-
	TOTAL	49	56	37	23
	ASPT SCORE	4.9	4.66	4.11	5.75

N.B: BMWP score = 0-10 very poor, 11-40 poor, 41-70 moderate, 71-100 good, >100 very good ; ASPT score = total of BMWP score / total number of families represented; >6 clean water, 5-6 doubtful quality, 4-5 probable moderate pollution, <4 probable severe pollution[25]

Table 3: Seasonal variation in Family Biotic Index (FBI) for site 1 and site 2 of Magura *haor*

Sites	Invertebrate families collected	Post- monsoon			Winter			Pre- monsoon			Monsoon		
		Number of Organisms (A)	Tolerance Value (B)	A x B	Number ofOrganisms (A)	Tolerance Value (B)	A x B	Number ofOrganisms (A)	Tolerance Value (B)	A x B	Number ofOrganisms (A)	Tolerance Value (B)	A x B
Site 1	Corixidae	10	5	50	-	-	-	5	5	25	1	5	5
	Hydrophilidae	-	-	-	2	5	10	3	5	15	-	-	-
	Dytiscidae	-	-	-	-	-	-	2	5	10	-	-	-
	Libellulidae	-	-	-	1	9	9	-	-	-	-	-	-
	Coenagrionidae	2	9	18	3	9	27	1	9	9	5	9	45
	Aeshnidae	-	-	-	-	-	-	1	3	3	-	-	-
	Baetidae	28	4	64	3	4	12	4	4	16	25	4	100
	Chironomidae	4	6	24	-	-	-	3	6	18	-	-	-
	TOTAL	44		156	9		58	19		96	31		150
	FBI Index	2.88	6.44	5.05	4.83								
Site 2	Corixidae	8	5	40	3	5	15	-	-	-	7	5	35
	Hydrophilidae	1	5	5	2	5	10	1	5	5	-	-	-
	Dytiscidae	-	-	-	2	5	10	6	5	30	-	-	-
	Libellulidae	3	9	27	-	-	-	-	-	-	4	9	36
	Coenagrionidae	1	9	9	-	-	-	-	-	-	1	9	9
	Baetidae	19	4	76	7	4	28	5	4	20	15	4	60
	Chironomidae	-	-	-	1	6	6	-	-	-	-	-	-
	TOTAL	32		157	15		69	12		55	27		140
	FBI Index	4.91	4.60	4.58	5.18								

N.B.: FBI Index= (Total of AxB)/(Total of A); 0.00-3.75= Excellent, 3.76-4.25= Very good, 4.26-5.00= Good, 5.01-5.75= Fair, 5.76-6.50= Fairly poor, 6.51-7.25= Poor, 7.26-10.00= very poor[26]

The greater their tolerance towards pollution, lower the BMWP score[27]. In site 1, BMWP score was found highest in pre-monsoon season and lowest in monsoon. The highest score reflected moderate condition of water according to BMWP grade. In site 2, winter had highest score and had moderate condition and monsoon had lowest score and had poor water condition. Overall we can say, according to BMWP score this wetland was moderately polluted. Similar studies at other parts of the world also revealed moderate pollution according to BMWP score[28-29]. ASPT (Average Score Per Taxon) is also a family level scoring system for the average tolerance level of all the taxa within the community and was calculated by dividing the BMWP by the number of families represented in the sample[30]. In case of ASPT score, for site 1 winter season had highest score and in site 2 monsoon season had highest score. Both the highest scores came under doubtful quality. Previous studies also revealed doubtful quality for ASPT score[22-23].

Table 3 represented the Family Biotic Index (FBI) for site 1 and site 2 for the four seasons of Magura *haor.* FBI is a family biotic index which provides a single tolerance value which is the average of the tolerance values of all species within the benthic arthropod community. The Biotic Index was subsequently modified to the family-level with tolerance values ranging from 0 (very intolerant) to 10 (highly tolerant) based on their tolerance to organic pollution thus creating FBI[26]. FBI is different from the other two scores in the interpretation of tolerance status. In this lower the score more clean is the system. In site 1, post-monsoon season had the lowest score (2.88) and so it came under 'very good' condition and in site 2 pre-monsoon had lowest score (4.58) which had a 'good' water condition. Thus, both the sites represented less pollution condition according to FBI.

Figure 2 showed relative abundance graph of the wetland of site 1 and site 2. In site 1 Baetidae was found most abundant in Monsoon followed by Culicidae in Pre-monsoon whereas in site 2 most abundant families were Hydraenidae in Post-monsoon and Baetidae in Monsoon followed by Notonectidae in Pre-monsoon. Family Baetidae was recorded as most abundant family in both the sites of this wetland. Though the family Baetidae belongs to order Ephemeroptera which is a part of EPT sensitive group, occurrence of insects belonging to this family indicate moderate pollution condition of water[31-33]. During dry period intensive farming practices carried out by the inhabitants might have contributed to the deterioration of water quality. A study on aquatic insects of one oxbow lake of South Assam also revealed similar result[34].

CONCLUSION

This study confirmed that rapid bio-assessment survey can be a very useful tool in the determination of water quality of a system. Different biotic indices used in this study revealed that the system is moderately polluted although according to FBI it is in good or very good condition. We found that use of only one biotic index cannot give proper justification of the water quality of a system. There is need to analyze several indices which can lead to a conclusive remark. Therefore, it can be concluded that although the wetland had some impact of pollution, it is still under condition of reviving to its original state if intervention is made in time. The need of the hour is environmental awareness among the inhabitants regarding water quality and its possible consequences.

ACKNOWLEDGEMENT

The first author would like to thank the Head, Department of Ecology and Environmental Science, Assam University, Silchar for providing laboratory facilities and the funding agency, Department of Science and Technology (DST) INSPIRE fellowship for carrying out the Ph.D research work.

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