WATER QUALITY ASSESSMENT OF GAMBHIR RIVER USING BIOTIC INDICES

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Abstract: Benthic macro invertebrate species play a vital role in aquatic ecosystem and therefore can be used to access an ecosystems health. By assessing indicator species of benthic macro invertebrate community, it is possible to determine water quality. This paper presents the water quality of Gambhir River by applying EPT Index, Biotic Index (HBI), and Chironomidae Index (CHIRn). Based on the all the three Index values in the monitoring stations of the river, the first station has a better water quality than the second and third stations.

Key words: Biotic Index, EPT, Macro invertebrates, Species richness, Tolerance value.

Introduction: Rivers provide habitat to many plants and animals. These habitats consist of benthic and aquatic components or biological communities. Macro benthic organisms occupy the bottom of water body and their distribution is determined by a number of factors such as physical nature of the substratum, depth and nutritive content of the water body.

These organisms also circulate the preferred nutrition for numerous fish species.

Water quality represents the biological conditions of any community and macro invertebrates are ideal indicator organisms as various taxa are associated with different levels of water quality. Water pollution influences the benthic macro invertebrate distribution and the possibility fulfilling their life cycle (Siligardi, M.et.al-2000).

Since some macro invertebrates show significant tolerance to particular pollution levels and because they can be easily analyzed both qualitatively and quantitatively, they were the subject of this study. Different species of macro invertebrates have been characterized by the US Environmental Protection Agency (EPA) as sensitive, moderately tolerant, or pollution tolerant species. This characterization was the basis for the development of variety of Biotic Indices, including the Epemeroptera, Plecopter and Trichoptera Index (EPT), Hilsenhoff Biotic Index (HBI) and Chironomidae Index (CHIRn).

Methods and Materials: The main objective of this study is to biologically assess the water quality of Gambhir River using benthic invertebrate indicator species.

Study Area: Present study was carried out in Dam site, Down stream site and Barwai site of Gambhir River near Ujjain city of Madhya Pradesh during March, 2012 to February, 2013. Water of Gambhir River is the main source of drinking water for the inhabitants of Ujjain city. Besides this, river water is also used for irrigation, recreation and fishing.

Methods: Macro invertebrates were collected using gill net at each site, and then preserved in 5% formalin, then sorted and identified up to genus level using available keys provided by J.G. Needhem and P.R. Neddhem (1962) and G.T. Tonapi (1980).

Density represents the number of organisms per meter square. It was calculated by using the below mentioned formula from Adoni et al. (1985).

$$\textbf{Individuals/m}^2 = \frac{N}{a} \times 10{,}000$$

Where,

N = Average number/sample

a = Area of the sampler (m^2).

Result was expressed as number of total benthic macro invertebrate organisms/m^2.

Biotic Indices are comparison of the abundance of taxa and their tolerance to environmental stress. This widely used index can indicate organic and nutrient pollution. Organisms or family is assigned a water tolerance value from 0 to 10 (tolerance value increase as water quality decreases) values were taken from Hilsenhoff (1987) but were modified using latter data from Bode et al (1996 and 2002).

EPT, HBI and CHIRn Indices were used in standard accepted method to determine the relative quality of each stream.

1. **ETP Index** is defined as number of Ephemeroptera (E), Plecoptera (P) and Trichoptera (T) compared to the total number of organisms:

$$\textbf{\% EPT index} = \frac{E+T+P}{N} \times 100$$

2. **The HBI** or Familial Biotic Index (FBI) is a measure of the macro invertebrate assemblage tolerance towards organic (nutrient) enrichment. (PSU, 2003). HBI is as follows:

$$\textbf{HBI} = \frac{\text{SUM (No. in each family)} \times \text{Tolerance value for each family}}{\text{Total no. of organism (N)}}$$

3. **Chironomidae Index** (CHIRn) is the total number of organisms in the family divided by the total number of organisms (N) in the sample:

$$\% \textbf{ CHIRn} = \frac{CHIRn}{N} \times 100$$

Result and Discussion: During the study period average 236 individuals were collected. From these individuals 96 were found in the first monitoring station (Dam site), 54 in the second (Down stream) and 86 in the third station (Barwai site).

The highest percentage of individuals was found in the first station 40.67% (i.e. Dam site) and lowest in the second 22.88% (i.e. Down stream). The highest density of benthic invertebrates is an indicator of good conditions of the ecosystem.

Among the macro invertebrates, Ephemeroptera, Plecoptera and Trichoptera (EPT) are very important in assessing water quality as they show low tolerance towards environmental changes, that they occur in clean and well oxygenated waters (Wallace et.al. 1996; Voeiz et.al. 2001; EEA. 20096-107, 2007). It means EPT group is very sensitive to water pollution (Table-1)**.**

In this study the Dam sites EPT index was 31.35, indicating "high species diversity, low pollution and clean water", were as calculated values of EPT for Down stream and Barwai sites were 22.22 and 18.60 respectively (Table-4). The values for second and third study sites were substantially lower than first site's score and potentially indicative of "good and medium polluted waters".

Thus based on the EPT value, the first site was classified in different bio-class (i.e.good water) compared to the two other sites. The second and third sites have not shown considerable difference in EPT values, and classified in the same bio class (i.e. medium impact).

The difference in EPT value is influenced by the different climate conditions in the first station (Wallace, 1996).

In this study based on the S.W.R.C. HBI values, HBI values of Dam site showed "Better" or "Good" water quality (Somers et al, 1998) as it falls between 3.76-5.0. Where as, HBI for Down stream and Barwai sites were 5.01 and 5.36 respectively (Table-4) which qualifies it as "medium impact" on water quality with "Some organic pollution probable" (Table-2).

Table 1: Water quality classification based on EPT Value (Bode et. al., 1997)

EPT Value	< 2	2-5	5-10	>10
Water quality	Polluted	Clean	Good	Very good

Table 2: Biological classification based on Hilsenhoff Biotic Index Value (Somers et al, 1998)

HBI value S.W.R.C.	< 3.75	3.76-5.00	5.1-6.5	6.6-10
Water quality	Very good	Good	Medium impact	Poor

Table 3: Water quality classification on the basis of Chironomidae Index(Yandora, 1997):

Chironomidae index	20-30%	50-65%	65% & above
Water quality	No impact	Poor water quality	Percentage of heavy metals

Table 4: HBI value, EPT values and Chironomidae value of Gambhir River:

Station	EPT	HBI	CHIRn	Biological classification of water quality
Dam site 1	31.35	4.31	20.83	Good
Down stream 2	22.22	5.01	42.59	Medium impact
Barwai 3	18.60	5.36	41.86	Medium impact

In the study Chironomidae Index values were found 20.83%, 42.59% and 41.86% for Dam site, Down stream and Bawai sites respectively (Table-4). Values in excess of 50% (Table-3) can be indicative or poor water quality (Yandora, 1997). In this study Chironomidae Index was found below 50%, indicating "no pollution or medium impact" of water pollution in all the three study sites.

Conclusion: From all the calculations and analysis of the data collected in Gambhir River we may conclude that the water of the river is still of good quality, with very low pollution. Our data on macro invertebrate biotic indices indicates that the second and third site has a lower water quality than of first site. Eutrophication, domestic sewage and drainage are apparently contributing to the lower water quality of site second and third.

Future periodical and continuous monitoring in Gambhir River stations is recommended as the areas surrounding the river are rapidly changing and shifting of the land uses. Increase of the number of monitoring stations is recommended in future.

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