[FRTSSDS- June 2018]
DOI: 10.5281/zenodo.1288437

ISSN 2348 – 8034
Impact Factor- 5.070

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

WATER QUALITY ASSESSMENT OF NARMADA RIVER USING BENTHIC MACROINVERTEBRATES DIVERSITY

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ABSTRACT

Benthic macro invertebrates are best indicators for Bio-assessment. The abiotic environment of the water body directly affect in the distribution, population density and diversity of the macro benthic community. Benthic fauna are especially of great significance for fisheries that they themselves act as food of bottom feeder fishes (walker et. al 1991). The present study deals with the population density and species diversity of aquatic macro invertebrate fauna. The Narmada river of Khandwa district at Omkareshwar dam in Madhya Pradesh was chosen to assess the impact of alteration of the flow regime on water quality, due to the formation of the dam. The present study involved sampling, pre-identification and identification of macro-invertebrates during 2009 and computing the % occurrence of families of various taxonomic groups and conducting physiochemical analysis of water samples collected from the selected locations. Macro-invertebrates were identified up to family level, and bio assessment at various locations has been done using NEPBIOS score system. 36 families of taxonomical group like *Ephemeroptera, Trichoptera, Plecoptera, Coleoptera, Heteroptera, Odonata, Diptera, Mollusca, Oligochaetes* etc have been found in different composition inhabiting the river. The results further show that all the locations assessed for quality using macro-invertebrates and physiochemical analysis are in the range of water quality class II (Good) during Pre-Commissioning stage of the Omkareshwar dam, while during post-commissioning stage of the Omkareshwar dam, the water quality belongs to class III (Moderately Polluted). The present study deals with the population density and species diversity of aquatic macro invertebrate fauna.

I. INTRODUCTION

Benthos is an important part of the food chain, especially for fish.
Many invertebrates feed on algae and bacteria, which are on the lower end of the food chain. Some shred and eat leaves and other organic matter that enters the water. Because of their abundance and position as “middlemen” in the aquatic food chain, benthos plays a critical role in the natural flow of energy and nutrients. As benthicin vertebrates die, they decay, leaving behind nutrients that are used by aquatic plants and other animals in the food chain. They also help in assessment of water quality. As like many types of benthos are sensitive to pollutant such as metals and organic wastes. Mayflies, stoneflies, and caddis flies are generally intolerant of pollution. If a large number of these insect types are collected in a sample, the water quality in the stream is likely to be good. If only pollution-tolerant organisms such as non-biting midges and worms are found the water is likely to be polluted. They help in water purifier. It is well known that the benthos is the best indicators of water pollution in water bodies.

II. MATERIAL AND METHOD

About Narmada river

Narmada is the fifth largest river in Indian subcontinent, Narmada a Sanskrit word means ‘one who endows with bliss’. It originates from Amarkantak and form the traditional boundary between North India and South India and flows westwards over a length of 1312 km before draining through the Gulf of Combay (Khambat) into the Arabian Sea, 50kms west of Bharuch city of Gujrat. It is one of only three major rivers in peninsular India that runs from east to west (largest west flowing river) along with the Tapti and the Mahi River. It is the only river in India that flows in a rift valley flowing west between the Satpura and Vindhya ranges.

About Omkareshwar

[FRTSSDS- June 2018] ISSN 2348 – 8034
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Omkareshwar is a famous place of pilgrimage, situated 77 km from Indore in Khandawa District, Madhya Pradesh. Shaped like the holy Hindu symbol 'OM', this scared island, on the conflux of the river Narmada, Kaveri visit by pilgrims from all over the country to seek blessing at the temple of Shri Omkar Mandhata. It's Latitude (DMS) - 22°15' 1"N and Longitude – (DMS) 76°8' 48"E.

Sampling site

- 200 m Upstream from Omkareshwar dam
- 200 m downstream in Omkareshwar dam

A sample consists of collection of 20 sub samples each of 0.25 × 0.25 m^2 taken from all microhabitat type. This procedure results in sampling of approximately 1.25 m^2 stream bottom area. Net of mesh size 500µm is used for collecting the macro invertebrates. Every large boulder or cobble in the area is picked up if it could be lifted and organisms vigorously washed by hand into the net. Finally, the substrate with smaller boulders should be distributed by kicking systematically across the area 3-4 times such that invertebrate wash D/S into the net. The organisms are then picked from the net surface & preserved immediately in 80% ethanol or 4% formaldehyde. These samples are returned to the laboratory for processing. Specimen collected are sorted & identified up to family level with the help of regional keys in the laboratory under the dissecting microscope. For identify the fauna, standard literature was consulted.

III. RESULTS AND DISCUSSION

Water samples were collected in plastic container for different physico-chemical parameters. The chemical characteristic were determined by the standard methods suggested of APHA (2002), Weltch (1998), & Golterman (1978).

(A) Physico-chemical parameters:- Following physico-chemical parameters were analyzed.

Table 01

S.No.	Parameters	U/S	D/S
1	pH	8.2	8.1
2	Conductivity	366	225
3	Turbidity	1.42	1.28
4	Dissolved Oxygen	9.09	8.25
5	Alkalinity	141	89
6	Hardness	201	102
7	Chloride	13.4	7.2
8	Phosphate	940	1150
9	BOD	3	3.9
10	TDS	0.22	0.12
	NSF Index	III	III
	NSF value	69	68
	WQI	50-70	50-70

On the basis of these parameters, the Water quality can be determined using NSF water quality index.

NSF water quality index

The National Sanitation Foundation, water quality index (NSFWQI) has long been used for the development of standards, product testing and certification services in the areas of public health, safety and protection of the environment. Calculate a mathematical a single value from multiple test results. The index tells about the status of water quality of a given water body is scaled from 0 to 100 to rate the quality of the water, with 100 being the highest possible score representing excellent water quality and 0-25 as the bad quality (Table 02).

Table 02 : NSF WQI scale.

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Range	*WQI Quality*	*WQ Class*
91-100	Excellent water quality	I
71-90	Good water quality	II
51-70	Medium or average water quality	III
26-50	Poor water quality	IV
0-25	Bad water quality	V

The range using NSF water quality index for the site u/s is 69, which is indicative of moderately polluted water quality (Class III).

The range using NSF water quality index for the site D/S is 68, which is indicative of moderately polluted water quality (Class III).

Biological Parameters:
The common and dominant families of macroinvertebrates of each group encountered are given in (Table 03) NEPBIOS score has been calculated using NEPBIOS.

The water quality assessment on the basis of macroinvertebrates families is based on the NEPBIOS biotic index system which is based on indices or score system is only when local reference communities are properly scored

Taking this fact into account the Nepalese taxa were scored, the **Average score per taxon** (ASPT) calculated and a different biotic score method for Nepal developed under the name **Nepalese Biotic Score** abbreviated as NEPBIOS. The calculation of the water quality on the basis of the presence of the macroinvertebrates families has been done on the basis of NEPBIOS (Table 04) using the Pre-classification sheet.

Table 03 : Occurrence of benthic macro invertebrate's community

Texanomic Group	*Family*	Upstream			Downstream		
		No. of individual	% of abundance	NEPBIOS	No. of individual	% of abundance	NEPBIOS
	Thiridae	346	46.82	4	526	74.50	4
Mollusca	*Planorbidae*	52	7.03	4	36	5.09	4
	Lymnaeidae	138	18.67	5	77	10.90	5
	Viviparidae	44	5.95	6	28	3.96	6
	Ephemerellidae	33	4.46	7			
Ephemeroptera	*Ephemeredae*	11	1.48	6	2	0.28	6
	Heptogeniidae	1	0.13	7			
	Leptophlebiidae	3	0.40	7	1	0.14	7
Odonta	*Gamphidae*	2	0.27	4	6	0.84	4
	Scirtidae				2	0.28	6
Colleptera	*Elmidae*	10	1.35	8			
	Psephenidae	3	0.40	8			
	Ecnomidae	3	0.40	-			

	Hydropsychidae				13	1.84	6
Trichoptera	*Glossosomatidae*				1	0.14	7
	Psychomyiidae	1	0.13	6			
	Goeridae	2	0.27	9			
	Hydroptillidae	7	0.94	6			
	Lapidostomatidae	2	0.27	10			
	Ceratopogonidae				4	0.56	0
	Chironomidae				8	1.13	1
	Limoniidae	5	0.67	8			
Diptera	*Tabanidae*				1	0.14	0
	Ephydridae				1	0.14	0
	Simuliidae	9	1.21	7			
Hemiptera	*Corixidae*	25	3.38	4			
Placoptera	*Perlidae*	3	0.40	8			
Crustacea	*Palaemonidae*	33	4.46	4			
Annelida	*Oligochaetes*	6	0.81	-			

Three procedures were followed in scoring the taxa.
(1) Numerical Procedure: This procedure follows the following formula:

Guide Score = SI/STot × 10 + SI-II/STot × 8.57 + SII/STot × 7.14 + SII-III/STot × 5.71 + SIII/STot × 4.28 + SIII-IV/STot × 2.85 + SIV/STot × 1.43
where,SI, SI-II, SII, SII-III, SIII, SIII-IV, SIV are the total number of sites representing the pollutional classes I, I-II, II, II-III, III, III-IV, IV. respectively
Stot= SI+SI-II+SII+SII-III+SIII+SIII-IV+SIV
1.43 is the score interval with 10 as maximum

(2) Professional judgements:
Step-I: Based on the reference made to the scores that has previously been assigned by different authors in their respective country of origin, and the range of pollutional class represented by each taxon in the rivers of Nepal.
Step-II: Based on the distribution pattern of each taxon (family level) in response to pollutional level. The comparison of family (taxon) distribution with the distribution of observed water quality classes was carried out to see if any family with the same ecological distribution are differently scored. If so whether or not the reasons are matching. Once NEPBIOS/ASPT is calculated, reference is made to the transformation (table 05) for Interpretation of on the water quality of the particular site investigated

Table 04: Nepalese Biotic Scores (NEPBIOS) assigned to the Macroinvertebrates.

S. No.	Macroinvertebrates	Score
1.	Capniidae, Ephemerellidae (*Drunella sp.*), Epiophlebiidae, Helicopsychidae, Helodidae (Scirtidae), Heptageniidae (*Epeorus rhithralis),* Heptageniidae (*Rhithrogena nepalensis),* Leuctridae, Peltoperlidae, Perlidae (*Acroneuria* spp.), Perlidae (*Calicneuria* spp.), Siphlonuridae, Taeniopterygidae, Uenoidae.	**10**
2.	Athericidae, Chloroperlidae, Goeridae, Leptophlebiidae (*Habrophlebiodes* sp.), Limnocentropodidae, Neoephemeridae, Perlodidae, Polycentropodidae.	**9**

ISSN 2348 – 8034
Impact Factor- 5.070

3.	*Baetidae (Centroptilumsp.),* Brachycentridae, Chironomidae (Diamesinae), Elmidae, Euphaeidae, Glossosomatidae, Heptageniidae (*Epeorus bispinosus*), Heptageniidae (*Iron psi*), Heptageniidae (*Rhithrogena spp.),* Hydrobiosidae, Lepidostomatidae, Limnephilidae, Nemouridae, Perlidae, Philopotamidae, Psephenidae, Rhyacophilidae, Stenopsychidae.	**8**
4.	Aphelocheiridae, *Baetidae (Cloedodes sp.),* Baetidae *(Baetiella spp.),* Baetidae (*Baetis spp.),* Baetidae *(Baetiella ausobskyi), Baetidae (Baetis sp.1),* Corydalidae, Ephemerellidae, Ephemerellidae (*Cincticostella sp.*), Ephemeridae, Gammaridae, Gyrinidae, Heptageniidae, Heptageniidae (*Cinygmina* sp.), Heptageniidae (*Notacanthurus cristatus*), Hydraenidae, Leptophlebiidae, Limoniidae, Pleuroceridae, Psychomyiidae, Salifidae (*Barbronia sp.*), Simuliidae, Tipulidae.	**7**
5.	Aeshnidae, Baetidae (*Baetis sp.5), Baetidae (Baetis sp.4),* Caenidae, Ceratopogonidae, Ecnomidae, Ephemerellidae (*Torleya nepalica),* Heptageniidae (*Electrogena* sp.), Hydrometridae, Hydropsychidae, Hydroptilidae, Potamidae, Scirtidae, Viviparidae.	**6**
6.	Baetidae *(Baetis sp.2),* Baetidae *(Baetis sp.3),* Bithyniidae, Chlorocyphidae, Coenagrionidae, Corduliidae, Dryopidae, Hydrophilidae, Leptophlebiidae (*Euthraulus spp.),* Lymnaeidae, Odontoceridae, Protoneuridae, Sphaeriidae, Unionidae.	**5**
7.	Calopterygidae, Chironomidae (*Microtendipes* sp.), Chironomidae (*Polypedilum* sp.), Corbiculidae, Dytiscidae, Gerridae, Glossiphoniidae, Micronectidae, Naucoridae, Nepidae, Palaemonidae, Planorbidae, Ranatridae, Salifidae (*Barbronia weberi*), Thiaridae.	**4**
08.	Corixidae, Libellulidae, Lumbricidae, Noteridae, Notonectidae, Salifidae	**3**
09.	Culicidae, Physidae, Tubificidae	**2**
10.	Chironomidae *[Chironomus* group *riparius (=thummi)* and group *plumosus]*	**1**

Table 05: Water quality scores based on NEPBIOS Score system

NEPBIOS/ASPT	WATER QUALITY
8.00-10.00	I
7.00-7.99	I-II
5.50-6.99	II
4.00-5.49	II-III
2.50-3.99	III
1.01-2.49	III-IV
1.00	IV

On the basis of NEPBIOS Score System the species present in the samples of the site at Omkareshwar dam on Narmada River U/S due to stagnant water shows the water quality of river belongs to class III and the D/S due to Holi dip & contamination of sewage water shows the water quality of the river belongs to class III

IV. CONCLUSION

1. On the basis of our study Benthic macro invertebrates are best indicator of water quality.
2. The result shows that the physio chemical analysis of water & NSF WQI U/S & D/S of Omkareshwar Dam is class III (moderately polluted) & the NEPBIOS Score System is also shows the range of water quality class III (moderately polluted). Both results are same that means Benthic Macro invertebrates show the water quality as well.

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