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Studies on the impact of construction of barrage on the macro-benthic invertebrate faunal diversity of river Tawi

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Abstract

Present investigation deals with assessing the impact of barrage construction on macrobenthic invertebrate population of river Tawi and its comparison with the previous studies on the diversity of macrobenthic invertebrates reported from river Tawi. Dams and barrage regardless of the purpose they are made for, impede and regulate the river. This brings about changes in physical and chemical parameters along with biotic parameters of regulated river as compared to untamed rivers. The process of river degradation begins as soon as any physical disturbance is imposed upon natural course of river. Changes in river ecosystem may be temporary or permanent depending upon the severity and time duration of disturbance. In the present study, four stations on river Tawi, which flows through the centre of Jammu city were selected to study the impacts, two upstream Gujjar Nagar bridge (Station-I) & Near Mosque (Station-II), one on the site of barrage (Station-III) and one downstream the barrage ahead of Bhagwati Nagar bridge (Station-IV). Samples were collected from all the four stations on monthly basis for a period of one year (August, 2013 to July, 2014). Since the construction was still ongoing, and is still in initial stages, so no permanent standing water system had been created but repeated changes in flow regimes of river were observed, huge water diversions, disturbances to river bed (sand extraction, load carriers and tractors passing through the river, machinery for construction purposes etc.) along with pollution load from city. A river which is already dying due to pollution load and continuously decreasing water levels will definitely succumb to such disturbances especially in the stretch that flows through the city.

Keywords: barrage, macro-benthic invertebrates, degradation, flow regime.

1. Introduction

Freshwater ecosystems play a vital role in the lives of humans, providing critical provisioning services, the basis for economic services and a wide range of regulating and cultural services. In the face of development, human population growth, and increasing competition between freshwater uses and users, development must be carefully planned such that the services that freshwater ecosystems provide are maintained and that the irreplaceable ecosystems and species are not lost. Underlining these provisioning and regulating services are the supporting functions of freshwater ecosystems, which play a vital role in nutrient cycling, primary production, habitat provision and biodiversity maintenance Macro-invertebrate fauna is an essential part of aquatic ecosystem and biodiversity. Macroinvertebrate communities are most commonly used biological tool for environmental impact assessment. These communities reside in an aquatic system long enough to reflect the chronic effects of pollutants, and yet short enough to respond to relatively acute changes in water quality. The importance of macro-benthic components in the trophic dynamics of freshwater ecosystems has long been recognized. These organisms, not only regulate the aquatic productivity by occupying intermediate position in the food chain, but also by indicating environmental status in a given time (Xie *et al.*, 2008) [10]. In addition, their diversity has assumed added importance during recent years due to the ability of certain species to indicate the deterioration in the water quality caused by pollution and eutrophication (Khan, 2003; Hassan, 2008) [5, 3].

Human societies have a long history of manipulating and redesigning channel structures and flows and many of these impacts lead to changes not only in physicochemical variables but

also in aquatic biota. Barrier can be defined as any structure built into, through or over a waterway (stream, creek, river, estuary) that changes, possibly irreversibly, the physical (e.g. sedimentation, water circulation), chemical, biological or ecological (e.g. production) characteristics of that waterway. By turning originally flowing waters into stagnant reservoirs, the chemical and nutrient composition of water bodies fundamentally changes. The rate of decomposition, flow of nutrients gets disturbed. Both bed load and suspended load fundamentally shape the river and thus its flood characteristics. The alteration of sediment loads due to loss of flood pulses, over extraction of water, changing the river course or severed sediment connectivity may lead to heavily altered river characteristics. Since macro-invertebrates are inhabitants of sediments so this directly affects their abundance, density and survival.

Man-made structures on rivers which can be a barrier to fish include flumes, sluices, weirs, dams, culverts, barrages and river crossings. The nature of these structures is to alter the flow regime of a river or stream. A barrage is a type of low-head, diversion dam which consists of a number of large gates that can be opened or closed to control the amount of water passing through the structure. The gates are set between flanking piers which are responsible for supporting the water load of the pool created.

Similar barrage is under construction on river Tawi which passes through heart of Jammu city, on the location of 4th Tawi Bridge (Bhagwati Nagar). A pondage of 14,13,000 cum (0.0011 MAF) is to be created by obstructing the flow of Tawi by way of constructing auto mechanically cum manually operated fully gated barrage of 4 meters height. The surplus water shall be allowed to flow in the Tawi River again. Thus a lotic aquatic system will be converted into a partial lentic water system which will have a profound effect on the flora and fauna of Tawi over a long range of time. River Tawi which is already under a lot of anthropogenic stress because of about 12 sewage canals entering directly into the river, garbage dumping from the banks, bridge sites, effluents from industrial and agricultural waste, religious activities etc., such a construction on river will further pile up the stress level on the river.

2. Study Area

In view of above perspectives, studies on the impact of the construction of a barrage across on the ecology of river Tawi are being made.

River Tawi, also known as "Surya Putri" passes through the heart of Jammu city and is one of the main sources of drinking water for the inhabitants of the city. It is located at a latitude 32° 35'-33° 5' N and longitude 74° 35'-74° 45' E and is one of the major left bank tributaries of River Chenab. It originates from the Himalayan glacier at Kalikundi at an altitude of nearly 4000 meters located on the south west of Bhaderwah in the Doda district of J&K state. The flow of water in the river has been decreasing in recent years as the source glacier (Kali Kundi glacier) has been retreating.

3. Methodology

The bottom soil samples from already specified four stations of river were collected using an Ekman dredge having an area of 232 cm². The soil samples collected were sieved immediately using no. 40 mesh size sieve (256 mesh per cm²). The organisms retained were segregated and their

abundance was calculated as number per square meter according to (*). Preserved samples of macrobenthic invertebrates were identified according to Ward and Whipple (1959) [8], Tonapi (1980) [7], Adoni (1985) [1] and Pennak (1978) [6]. The abundance of these organisms was calculated as number per square meter by applying the following formula.

$$N = O/A.S \times 10,000 \text{ Welch (1948) (*)}$$

Where,

N = no. of macrobenthic organisms/m².

O = no. of organisms counted.

A = area of metallic samples in square meter.

S = no. of samples taken at each stations

4. Results and Discussions

Eleven genera belonging to three phyla were reported from river Tawi during the present period of investigation. Arthropoda dominated the overall macro-benthic population at all the four stations, represented by Class insecta (Order Diptera and Coleoptera) only. Maximum contribution being from order Diptera (Chironomids). Genera reported were *Chironomus* sps., *Pentaneura* sps., *Eristalis* sps., *Tabanus* sps. (Order Diptera), *Berosus* sps and *Hydroglyphus* sps. (Order Coleoptera). Annelida was represented by two species belonging to Class Oligochaeta i.e *Tubifex* sps and *Pheretima* sps. Maximum contribution from *Tubifex* sps. Mollusca was represented by three genera belonging to class Gastropoda viz., *Physa* sps., *Lymnea* sps and sps. Maximum contribution from *Physa* sps. Macro-benthic invertebrates showed two maxima i.e in Summers and winters in accordance with the orders. Negligible or very few macroinvertebrates were reported during Monsoon season. Summer maxima of annelids can be attributed to increase in temperature, low water levels due to reduced flow and increase in the decaying organic matter content. Fall or absence of micro-invertebrates during monsoon season may be possibly due to increased water level, erosion of substratum due to flash floods which are very common during rainy season in river Tawi. Dipteran macro-invertebrate species recorded a winter maxima which may be due to lower temperature of water, comparatively higher DO, accumulation of organic matter due to slow decomposition in winters thus providing ample source of food. Numerical abundance of pollution indicator species like *Chironomus* sps., *Tubifex* sps., *Physa* sps. at all the four stations suggested that water is extremely polluted and deteriorating condition of river.

Comparing the availability of macro-invertebrate species in all four stations, Station I & IV reported highest number while Station- III reported the lowest number. Low number of benthic macroinvertebrates at Station-III is attributed to disturbed flow regime of river at the station due to construction of barrage. Physical disturbance to river bed due to dredging, sand extraction, bulldozers, tractors and trucks supplying construction material along with various machines like stone crushers etc being used and repetitively diverging the water course during dry season at this station. High number of macroinvertebrates at Station I & IV is attributed to many sewage canals entering the river near these stations, garbage and other organic waste at these stations. If we compare the previous reports on macro-invertebrate quantity and quality with present one, a

decrement in quality and an increase in quantity of macro-invertebrates was observed. Another characteristic was disappearance of pollution sensitive orders like Ephemeroptera etc and dominance of pollution tolerant genera from Order Diptera, Annelida and Mollusca which clearly indicates deteriorating trophic status of river due to new construction and pollution load.

Due to decrease in water level of river Tawi and subsequent slowing down of river water because of ongoing construction, along with changes in flow regime, accumulation of wastes in the river has occurred, further decreasing the water quality, thus providing ideal conditions for pollution tolerant species to thrive.

Table 1: Quantitative Data of Macro-Invertebrates from All Four Stations of River Tawi during the Study Period Aug, 2013 to July, 2014.

S. No	Macro-invertebrate Gxenera/Fauna	ST-I Org/m2	ST-II Org/m2	ST-III Org/m2	ST-IV Org/m2
1.	Annelida				
	A. Oligochaeta				
	a. <i>Tubifex sp.</i>	548	112	128	400
	b. <i>Pheretima sp.</i>	0	16	0	4
2.	Arthropoda				
	A. Diptera				
	a. <i>Chironomus sp.</i>	3700	2896	648	3220
	b. <i>Pentaneura sp.</i>	608	408	200	612
	c. <i>Eristalis sp.</i>	4	0	8	0
	d. <i>Tabanus sp.</i>	0	8	0	0
	B. Coleoptera				
	a. <i>Berosus sp.</i>	4	4	0	4
	b. <i>Hydroglyphus sp.</i>	4	8	0	4
3.	Mollusca				
	A. Gastropoda				
	a. <i>Physa sp.</i>	276	8	84	48
	b. <i>Lymnaea sp.</i>	0	8	8	8
	c. <i>Gyraulus sp.</i>	0	12	8	0

Table 2: A Comparison of Previous Studies on Macro-Invertebrate Fauna of River Tawi with Present One

S. No.	Macro-benthic fauna reported from River Tawi (Phyla)	Sawhney N. (2005-06)	Chowdhary S. (2007-08)	Present (2013-14)
1.	Annelida	2 Classes, 6 Genera	1 Class, 3 Genera	1 Class, 2 Genera
2.	Arthropoda	2 Classes, 7 Orders, 12 Genera	1 Class, 4 Orders, 13 Genera	1 Class, 2 Orders, 11 Genera
3.	Mollusca	1 Class, 4 Genera	1 Class, 4 Genera	1 Class, 3 Genera

5. Conclusion

On the basis of above studies, it can be safely concluded that construction of barrage has altered the physical as well the biological aspects of river. Since the project is still ongoing so more damage can be in the waiting. Qualitative and quantitative distribution of benthic macro-invertebrates clearly indicated deteriorating water and sediment quality of already polluted and under stress river Tawi, the process which has been hastened by the construction of barrage and disturbance to river bed. Thus, this barrage is definitely not in favour of health of river Tawi which is already under a lot of stress.

A sustainable approach is needed on the part of people and Govt. in order to save this river along with its flora and fauna. Effective Pollution control measures and minimal disturbance to natural flow regime of river will go a long way protecting this river.

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