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Urban Impacts on the Water Quality of River Jhelum

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ABSTRACT

The present investigation was undertaken from April to December, 2002 for a period of nine months. A stretch of about 33km of the river Jhelum in the valley of Kashmir was studied within the Srinagar city proper and before the river enters the city. The investigation mainly deals with the general water chemistry in relation to dominant periphytic species present at the five sampling stations, with emphasis on the study of the impacts of effluents, sewage and domestic wastes coming from Srinagar municipal area through various sources and entering directly into the river without any treatment. The comparatively low dissolved oxygen content, high nutrient level besides the presence of pollution tolerant periphytic species at various sampling stations within the urban area is an indication of nutrient enrichment and hence higher degree of organic pollution of these sampling stations in comparison to the other sampling stations lying outside the city.

Keywords: Freshwater, river Jhelum, hydrochemistry, pollution, periphyton.

INTRODUCTION

Though the pollution, leading to deterioration, of aquatic ecosystems is as old as human civilization yet the industrialization and urbanization coupled with modernization are considered to be the main contributors towards the pollution of these ecosystems all over the globe. The freshwater ecosystems of the valley of Kashmir also face the same threat of pollution especially those located at relatively low elevations, in the close vicinity of human settlements. Among these the river Jhelum, locally known as VYATH, the principal drainage system of the valley, is one good example. Although, there has not been much of the development with regard to industrialization in the valley yet unfortunately over the last two decades mushroom growth of human settlements, commercial establishments, dunga boats and residential houseboats have come along the river shores, resulting in dumping of huge quantities of sewage, effluents, human excrement and municipal garbage into the river without any treatment (Fig. 1 & 2).

Limnological studies on the river Jhelum were initiated by Vass *et al.* (1977) and since then few more contributions have appeared (Raina *et. al.*, 1982; Sunder, 1983; V, Raina, 1985; Pandit *et al.*, 2002 and Rather, 2002). The present investigation is therefore, an addition to the existing literature and is further aimed to study the impacts of urbanization by monitoring the hydrochemistry in relation to the presence of dominant periphytic organisms at five different sampling stations.

Fig. 1. River Jhelum near Zero Bridge, Srinagar showing signs of sevefe pollution as indicated by the development of noxious algal blooms

Fig. 2. A view of Dhobi Ghat on River Jhelum

STUDY AREA

For the present investigation a stretch of 33km of the river starting from Kakapora to Qammerwari was undertaken. The five sampling stations were Kakapora (SI), Pampore (SII), Zero Bridge (SIII), Fatehkadal (SIV), and Qammerwari (SV) (Fig. 3), of which Kakapora falls in a rural area where the river is facing very little anthropogenic pressures. In contrast, Pampore lies in the semi-urban area whereas the other three stations are located within the Srinagar municipal area, being subjected to increasing human perturbations as the river proceeds.

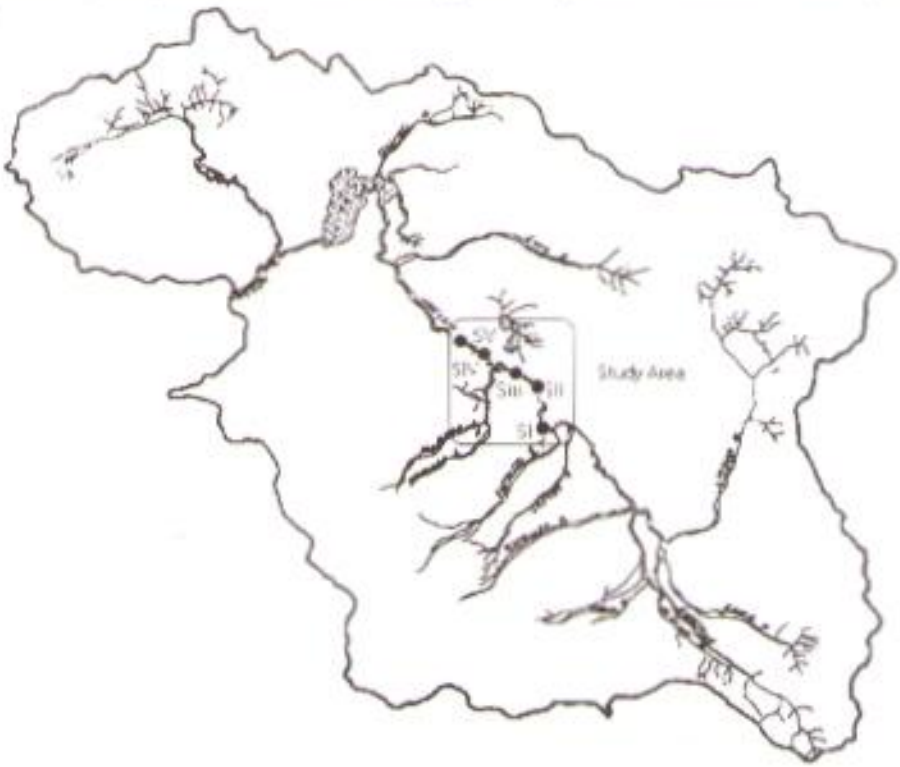

Fig 3 : Location of sampling station in River Jhelum

MATERIAL AND METHODS

For the present limnological study of the river Jhelum, the water samples were collected on monthly basis between 9.00 – 13.00 hr from five sampling stations (I, II, III, IV and V) during the year 2002, in one litre polyethylene bottles. Determination of water temperature, water depth and current velocity was done on spot.

The samples for different parameters were analysed in the laboratory within 24 hours with

the help of standard methods described by Golterman and Clymo (1969), Trivedy (1987) and ÁPHA (1998).

Periphytons were collected by scraping submerged stones, sticks, pilings and other available substrate. Samples were preserved in 4% formalin and identification was done with the help of standard works (Edmondson, 1992; APHA, 1998).

RESULTS

Physico-chemical characteristics of water

The seasonal fluctuations for various physico-chemical characteristics of river water are depicted in Table 1

Table 1 : Seasonal fluctuations in physico-chemical characteristics of the river water at different sampling stations

Parameters	Unit	Station	Seasons			
			Spring	Summer	Autumn	Winter
Speed	$kmhr^{-1}$	I	2.80	2.84	2.48	2.40
		II	2.15	2.61	2.20	2.18
		III	2.22	2.50	2.22	2.21
		IV	2.30	2.51	2.88	2.79
		V	2.12	2.44	2.22	2.20
Depth	m	I	2.98	3.70	2.81	2.20
		II	3.70	3.95	3.40	2.95
		III	2.81	3.70	2.87	2.40
		IV	2.89	3.58	2.51	2.24
		V	2.80	2.88	2.10	2.62
Water Temperature	°C	I	14.8	24.0	15.1	8.0
		II	15.1	24.2	15.5	8.6
		III	15.4	27.0	15.9	9.3
		IV	15.7	27.1	16.2	9.6
		V	16.0	27.5	16.4	9.8
pH		I	7.77	7.89	7.83	7.92
		II	7.84	7.80	7.89	7.97
		III	8.06	8.17	8.02	8.10
		IV	8.12	8.21	8.06	8.14
		V	8.15	8.29	8.33	8.17

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contd. table 1

DO	mgl^{-1}	I	7.80	6.40	7.97	8.89
		II	7.58	6.26	7.70	8.63
		III	7.10	5.92	7.50	7.89
		IV	6.94	5.51	6.70	7.20
		V	6.19	5.18	6.00	6.94
Alkalinity	mgl^{-1}	I	83	118	130	128
		II	86	123	136	124
		III	91	130	141	152
		IV	117	136	157	168
		V	132	141	161	175
Conductivity	μScm^{-1}	I	268	286	302	359
		II	270	294	320	397
		III	289	297	334	428
		IV	291	301	359	448
		V	301	309	391	451
Free CO_2	mgl^{-1}	I	4.6	7.3	5.1	4.0
		II	5.0	9.9	5.6	4.0
		III	6.3	11.3	6.0	6.0
		IV	7.3	14.0	6.9	6.6
		V	9.6	14.6	7.2	8.3
Chloride	mgl^{-1}	I	12.0	24.0	23.0	21.0
		II	13.0	25.0	27.0	25.0
		III	16.0	31.0	40.0	32.0
		IV	15.0	33.0	41.0	25.0
		V	17.0	34.0	42.5	27.0
Ca^{2+}	mgl^{-1}	I	23.1	31.2	39.6	34.2
		II	25.3	33.0	41.0	36.2
		III	27.0	38.0	43.1	39.3
		IV	28.3	38.9	43.8	40.8
		V	32.1	42.1	47.2	44.1
Mg^{2+}	mgl^{-1}	I	2.3	3.0	4.0	6.0
		II	2.8	3.9	4.4	6.4
		III	4.0	5.0	4.9	8.7
		IV	3.9	5.8	5.2	10.0
		V	4.9	6.2	5.8	12.3

Speed and depth River Jhelum is a slow flowing perennial river with average velocity of 2.41 km hr^{-1}. The average depth recorded at the sampling stations I-V were 2.9, 3.5, 3.0,

2.8 and 2.6m respectively.

Water temperature The surface water temperature followed a trend similar to air temperature exhibiting its maximum (27.5°C) in summer at station V and minimum (8.0 °C) in winter at station I.

Dissolved Oxygen In consonance with the general fact that the lotic systems containing relatively higher concentration of DO under natural conditions the present investigation revealed the DO content ranging from 5.18 mgl^{-1} to 8.98 mgl^{-1}.The maximum value was recorded during winter at station I and minimum during summer at station V. The DO however, showed an inverse relationship with water temperature throughout the study period.

pH The pH of the river water was on the alkaline side throughout the study period and varied between 7.77 to 8.33. The highest value was recorded in autumn at station V and lowest in spring at station I.

Alkalinity The total alkalinity at all the sites was entirely due to bicarbonates. The bicarbonate alkalinity was highest in winter (175mgl^{-1}) at station V and lowest in spring (83mgl^{-1}) at station I.

Conductivity Conductivity measurement is an excellent measure of total dissolved salts in water. It fluctuated between a low of 268 µS at station I during spring to a high of 451µs at station V during winter. The winter high may be attributed to the recharge of the river by spring water mainly Verinag.

Free CO_2 The free CO_2 value ranged from 4.0 mgl^{-1} to 14.6mgl^{-1} as against DO content maximum free CO_2 content was recorded at station V in warmer months while as minimum was registered at sampling station I in winter months.

Chloride Chloride in water is generally due to the salts of sodium, potassium and calcium. In the present study the chloride content ranged between 12.0 to 42.5 mgl^{-1}, being highest in autumn at station V and lowest in spring at station I.

Ca^{2+} and Mg^{2+} The Ca^{2+} content varied between a low of 23.3 to a high of 47.2 mgl^{-1} and Mg^{2+} fluctuated from 2.3mgl^{-1} to 12.3mgl^{-1} Both the cations reached the maximum levels at station V during winter, and were minimum during spring months at station –I.

II - Periphyton

In the present investigation the dominant periphytic genera, totaling 13, were identified at

all the five stations. Of these 3 belonged to Chlorophyceae, 7 to Bacillariophyceae and 3 to Cyanophyceae. The presence or the absence of these species at the five sampling stations gives an idea of the dominance of pollution indication species (Table 2).

Table 2. The composition of various periphytic algae at various sampling stations

S. No.	Group	Name of Species	STATIONS				
			S-I	S-II	S-III	S-IV	S-V
1.	Chlorophyceae	Ulothrix	D	D	+	+	+
		Chlorella	-	D	+	+	-
		Spirogyra	-	-	D	D	+
2.	Bacillariophyceae	Diatoma	+	+	-	-	-
		Synedra	-	+	D	-	-
		Cymbella	-	-	D	D	D
		Navicula	-	-	D	+	D
		Fragilaria	-	-	-	+	-
		Gomphonema	+	-	-	-	-
		Amphora	-	-	-	-	+
3.	Cyanophyceae	Oscillatoria	-	-	D	D	D
		Anabaena	-	-	-	D	D
		Spirulina	-	-	D	D	D

D = Dominant, + = Presence, - = Absence

DISCUSSION

The River Jhelum, the principal drainage system of the Kashmir Valley with an average depth of 3-4m and average rate of flow of water of (2-4m hr^{-1}) is getting heavily polluted within the limits of Srinagar municipal area. In the Srinagar city, where, there is no proper sewerage system, the drains carry the raw sewage directly or indirectly into the river. In addition to 55 dewatering units run by UEED discharge their flow into the river, further domestic wastes thrown by approximately 560 houseboats, dunga boats residing in the river, plus 525-575 cubic meters of solid waste coming from human habitation are dumped directly into the river daily. All these inputs result in the deterioration of water quality plus subsequent pollution of the river (Khalid Bashir, 2001). However, as the river proceeds from rural to the urban area, there is a gradual decrease in the water depth, which is attributed to the input of silt and garbage into the river system. The water temperature does not show much variation from station I to station V because of thorough mixing of water. Difference of nearly 2-3mgl^{-1} of D.O content between station I and V almost in every season is an indication of heavy organic

load at lower reaches, which is in agreement with the earlier studies of Butcher, 1947. The high value of free CO_2 content downstream is indicative of high degree of pollution (Todda, 1970; Cole, 1979) which subsequently influences the amount of D.O and hence the presence of pollution tolerant periphyton showing a gradual increase from station I to station V. The high chloride content at urban station is an indication of inorganic pollution owing its origin to the sewage wastes carrying detergents, sewerage from human settlements. These findings are in agreement with those of Paramsivam and Srinivasan (1981). Similarly high values of Ca^{2+} and Mg^{2+} were recorded at station V as compared to other stations in every season, there by indicating the hardness of water to be high at this station, a fact also observed by Rai (1974) who also attributed it to the inflow of sewage effluents. Again, comparing the data on alkalinity, conductivity and pH of river water from station I to V, it was observed that the stations downstream, shows marked gradual increase in their corresponding values again confirming the pollution pressures on the river in the proper Srinagar city.

Changes in physico-chemical environment influence the flora and fauna which together constitute the biotic component of the ecosystem concerned. The presence and absence of a species gives a fair idea of the trophic status of a water body. The periphytic species like *Navicula, Synedra, Oscillatoria and Anabaena,* known to inhabit polluted water (Palmer, 1977) were abundantly present at lower station which again confirms the deterioration of water quality of the river in the Srinagar city proper.

The present limnological data when compared with those of earlier investigations (Raina *et al.*, 1982; Sunder, 1983) shows that the river is getting polluted at an accelerated rate with the passage of time which may be attributed to heavy urban impacts.

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