Seasonal Variations in the Physico Chemical Parameters of River Tawi and Its Ecological Best Designated Use

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Abstract- River Tawi, the life line of the people of Jammu, provides water for the essential requirements of life to the inhabitants. However, the river is continuously subjected to tremendous anthropogenic pressure resulting in the degraded water quality. In this study, water samples from river Tawi were monitored for various physico-chemical parameters like dissolved oxygen, EC, TDS, pH, temperature, Calcium, Chloride, Magnesium, Sodium, Potassium, Nitrates and Phosphates on monthly basis for two consecutive years at four preselected stations with a view to evaluate its ecological best designated use for various purposes. The study indicates that the quality of water substantially decreases at downstream stations thereby rendering the water unfit for human use.

Index Terms- River Tawi, Physico-chemical, Anthropogenic pressure.

I. Introduction

Rivers as life giving watercourses have nurtured communities for millennia and most developmental activities are still dependent upon them. River water finds multiple applications in every sector of development like agriculture, industry, transportation, aquaculture, public water supply, etc. However, since old times, rivers have also been used for cleaning and disposal purposes. Huge loads of waste from industries; domestic sewage and agricultural practices find their way into rivers resulting in large scale deterioration of water quality. Harvesting of river waters to the point of choking off environmental flows is bound to prove ruinous in the long term even if it provides immediate benefits. Thus, there arises a need for monitoring water quality of our rivers to evaluate their production capacity, utility potential and to plan restorative measures for their conservation. (Datar and Vashistha, 1992; Das and Sinha, 1993; Agbaire and obi, 2009; *Mary etal.*, 2011 and Patel and Datar, 2014)

River Tawi, an important tributary of river Chenab and glory of Jammu division of J&K (India) is the sole source of drinking water supply to the inhabitants of Jammu. Besides, river water is also a victim of various anthropogenic pressures viz., dumping of solid waste, discharge of municipal and domestic sewage. Vehicle washing, bathing activities, sand mining, dredging, etc which have degraded its water quality (Mushtaq, 2007). Thus, present study on the water quality monitoring of river Tawi was carried out along its course in the vicinity of Jammu city with a view to evaluate its ecological best-designated use.

II. MATERIALS AND METHODS

Location and Sampling

River Tawi originates from Seoj Dhar (Bhaderwah), an upland space enclosed by the meeting of the two ridges of Dhauladhar range, a branch of Central Himalayan axis at an elevation of about 1400 ft. The river is fed by a number of streams of 1^{st} and 5^{th} order during its journey of 128 kilometers through middle and sub-Himalayas till it emerges into plains near Jammu city where it is subjected to innumerable anthropogenic pressures that effect its water quality. The flow of the river is perpetual and considerable though of much varying volume.

For the present water quality monitoring study, 4 sites were preselected along the longitudinal profile of river Tawi at a stretch of about 12-13 kms depending upon the degree of exposure of anthropogenic influences (Fig. 1). Sampling of the river water was done at these sites. Various physico-chemical parameters like temperature, pH, dissolved oxygen, carbonates, bicarbonates, calcium, magnesium and chloride were determined on the spot following A.P.H.A (1985) and Adoni (1985) whereas, for the analysis of other parameters like, BOD, nitrates, phosphates, EC, TDS, sodium and potassium water samples were brought in plastic bottles to the laboratory. The data was then statistically analyzed.

III. RESULTS AND DISCUSSION

The physico-chemical characteristics of river water exhibited a well marked seasonal and spatial variations which have been discussed as:

DO of the river water recorded a well marked variations at different stations. In upstream stations (S-I & S-II), its value ranged from 4.0- 9.6 mg/l and in downstream stations it ranged from 2.8-8.6 mg/l (Fig.4) Moreover, the maximum for DO concentration was recorded during winter months and minima during summer months. A lower temperature is known to favour greater dissolution of oxygen in water. It is well documented that DO in good quality stream / rivers is usually more than 6 ppm to promote proper growth of fish and other aquatic organisms (ANZECC, 1992). Thus, in the upstream section, DO level indicates good quality water whereas, the DO concentration falls in downstream stations at a distance of about 13 km from the S-I. This depletion of DO in the river water may be on account of the high organic load in the form of municipal and domestic sewage and other similar activities that reach the lower section thereby causing its depletion (Obasi and Balogun, 2001 and Ovrawah and Hymore, 2001). Thus, river water in this stretch is not fit for its multiple use and the present data also indicates that the water stretch recovers from the organic pollution through its self purification capacity in the downstream stations.

The temperature was found highest during summer and lowest during winter at all the preselected study stations (Fig.2) and didn't recorded much significant variations (Sujitha *etal.*, 2011). Temperature of water is known to affect pH, alkalinity and (Fig.14 and 15) DO concentration (Komal *et al.*, 2007). pH of the river Tawi also recorded significant variations both seasonal as well as temporal (Fig.3). At the upstream stations, the pH ranged 7.8-8.4 (2005) and 7.7-8.7 (2006) while the range was 7.2-9.2 and 7.1-8.6 during both the years of present study. Also, it was observed that pH recorded its maximum values during winter. Though, pH of water of river Tawi was alkaline throughout the study period but it was more alkaline at the upstream sites as compared to downstream stations. The lowering of pH at the downstream sites seems to be due to greater input of sewage (domestic as well as municipal). According to Central Pollution Control Board (CPCB, 1996), 70% of the pollution in rivers is from untreated sewage. Alkaline pH is considered to be good for promoting high primary production. The EC of water sample ranged between 40-120 umhos/cm at all the study stations during the study period (Fig.5).

The TDS concentration also showed an increasing trend along the longitudinal profile (Fig. 6). Moreover, TDS conc. was found to be higher in winter which may be attributable to low H_2O depth due to snow in higher reaches. Increase may be account of increment in municipal and domestic drainage from the city into the Tawi basin.

IV. IONIC COMPOSITION

The variations in cation composition of the river water viz., Ca^{2+}, Mg^{2+}, N^{a+} and $K^{+,}$ and Cl^- are shown in (Fig. 7,8,9,10 and 11). Ca^{2+} which is a major component of natural waters comes mainly from the rocks, seepage, drainage, waste water, etc. Ca^{2+} generally recorded its value from 8.8-56.9 mg/l at upstream stations of river Tawi but increased at downstream where it varied between 12.08-68.9 mg/l. The low calcium content in upstream indicated less solubilisation of Calcium. But the high calcium concentration at downstream stations is an indication of greater precipitation of Ca^{2+} in this zone in form of $CaCO_3$ (Raina *et al.*,1982).

Mg^{2+} is required as an essential nutrient for plants as well as for animals and a conc. of 30 ppm is recommended for drinking waters. The Mg^{2+} conc. was in the range of 5.3-42.7 mg/l in the upstream sections of river Tawi for the both the years of present study but the concentration at the downstream section of river varied between 5.3-37.9 mg/l thereby exhibiting a mixed trend of distribution (Fig. 8).

However, an inquisite study of the table Fig.8 reveals that during both the years, Mg^{2+} cation concentration was higher at the downstream (S-III). TDS value also showed downstream increment thereby indicating substantial solubilisation of Mg salts in downstream water.

The percentage of sodium ions is an important parameter in deciding the suitability of water for irrigation. The sodium levels were low (Fig. 9) in the upstream stations. Thus, water is suitable for drinking and irrigation. However, at the downstream stations the Na^+ levels were elevated to the range of 123.9 – 153.1 mg/l. Such levels of Na^+ though within the limits may prove hazardous for the crops when used for irrigation. Another essential nutrient element in natural waters is K^+. The concentration of potassium (0.9-5.5mg/l) in the upstream which elevated upto 15.3-20.1 mg/l in the downstream stations. The maximum concentration of K^+ ion was noticed during summer months (Fig.10).

In inland water, excess of Cl^- is taken as an index of pollution. Higher values of Cl^- in fresh water may be due to sewage discharges, contamination from reflux leachates discharge of effluents from chemical industries, irrigation drainage, organic decomposition and use of soaps and detergents. The mean values of chloride exhibited a monsoon increment on account of the greater influx from catchments area due to rains. Higher values of Chloride noticed in the downstream stations was on account of the greater exposure to the aforesaid anthropogenic pressures (Fig.11).

Nitrates in river water promotes high primary productivity and an excess of NO_3 in surface water is taken as a warning for algal blooms (Sujitha *et al.* 2011). However, the NO_3 levels were quite low, varying from 0.06-0.71 mg/l during both the years of present study (Fig.12).

Moreover, the Phosphate is present in natural waters as soluble phosphates and organic phosphates. The concentration of available phosphate was low in the upstream water, ranging from 0.012-0.053 (mg/l).

The phosphates increased in the range (0.024-0.321) mg/l was high enough to cause eutrophication. Agricultural runoff containing phosphates fertilizers as well as waste water containing detergents etc, tend to increase PO_4^{3-} pollution in the downstream section of river Tawi. (Fig.13).

Table: Drinking water quality standards as recommended by USPH, WHO and BIS

Parameters	USPH standards	WHO standards	BIS standards
Colour	Colourless	-	5
Odour	Odourless	-	Unobjectionable
Taste	Tasteless	-	Agreeable
pH	6.8-8.5	6.5-9.2	6.5-8.5
DO	4.0-6.0	-	3.0
TDS	500	500	500
CI	250	500	250

SO_4	250	250	200
NO_3	<10	45	45
F	1.5	0.5	1.0
PO_4	0.1	-	-
Ca	100	100	75
Mg	30	150	30
COD	4.0	10	-

V. CONCLUSION

Based on the parameter values of pH, EC, TDS, Na, Po_4, DO and the maximum permissible limits for the parameters. It may be concluded that in the upstream of river Tawi water is suitable for drinking, bathing, fisheries, irrigation etc. following the water quality criteria for various designated best use as outlined by ADSORBS (1982).

However, the increased values of the above discussed parameters at downstream stations gave an indication of degraded H_2O quality brought about by anthropocentric interferences thereby rendering the water unfit for drinking, bathing, etc.

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Fig-1

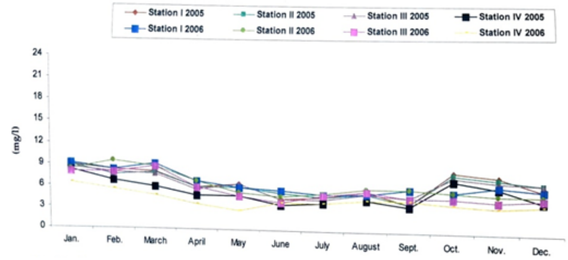

Fig-4 Seasonal variations in the dissolved oxygen (mg/l) at the study stations of river Tawi (Jan., 2005 – Dec., 2006).

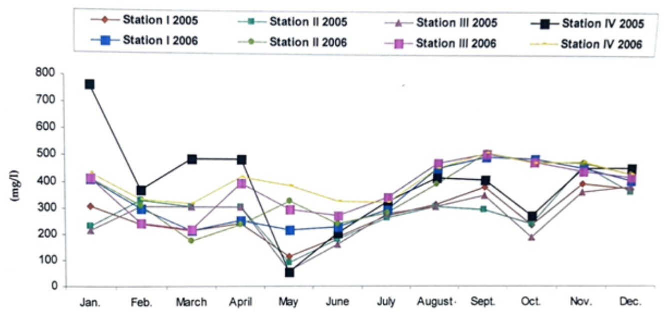

Fig-15 Seasonal variations in the bicarbonate (mg/l) at the study stations of river Tawi (Jan., 2005 – Dec., 2006).

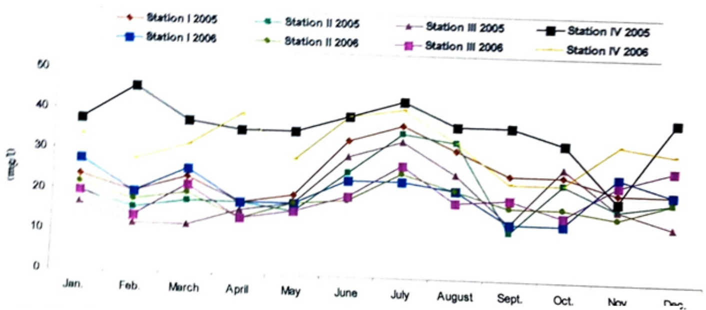

Fig-11 Seasonal variations in the chloride (mg/l) at the study stations of river Tawi (Jan., 2005 – Dec., 2006).

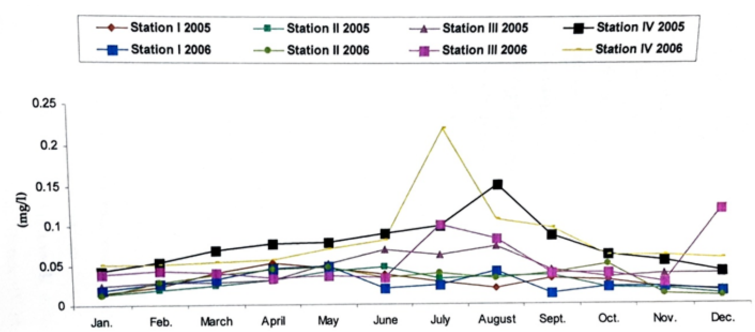

Fig-13 Seasonal variations in the phosphates (mg/l) at the study stations of river Tawi (Jan., 2005 – Dec., 2006).

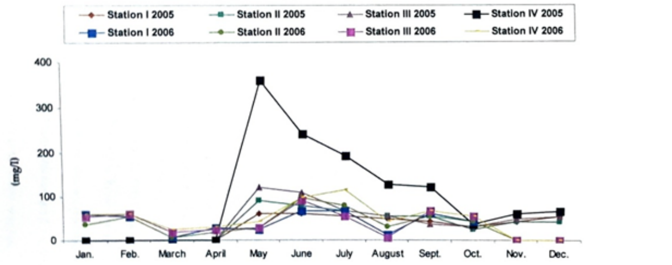

Fig-14 Seasonal variations in the carbonate (mg/l) at the study stations of River Tawi (Jan., 2005 – Dec., 2006).

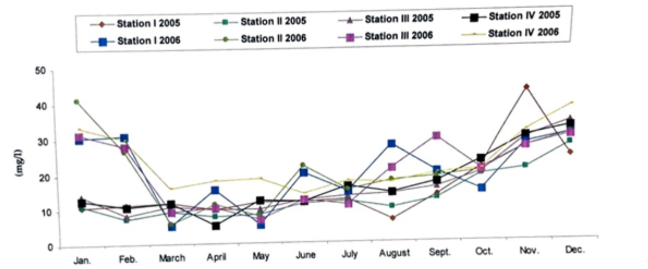

Fig-8 Seasonal variations in the magnesium (mg/l) at the study stations of river Tawi (Jan., 2005 – Dec., 2006).

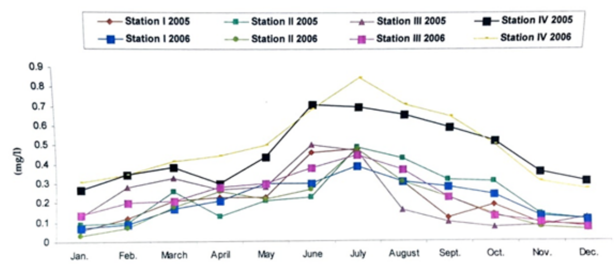

Fig-12 Seasonal variations in the nitrates (mg/l) at the study stations of river Tawi (Jan., 2005 – Dec., 2006).

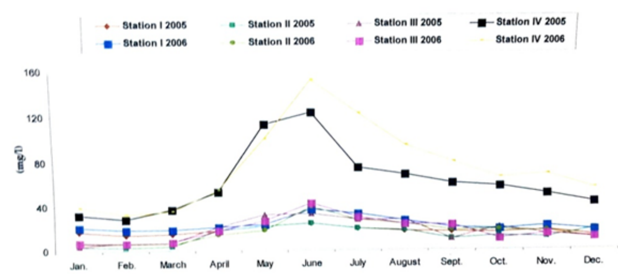

Fig-9 Seasonal variations in the sodium (mg/l) at the study stations of river Tawi (Jan., 2005 – Dec., 2006).

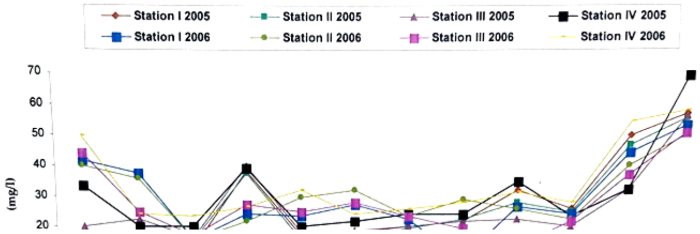

Fig-10 Seasonal variations in the potassium (mg/l) at the study stations of river Tawi (Jan., 2005 – Dec., 2006).

Fig-5 Sea

Fig-7 Seasonal variations in the calcium (mg/l) at the study stations of river Tawi (Jan., 2005 – Dec., 2006).

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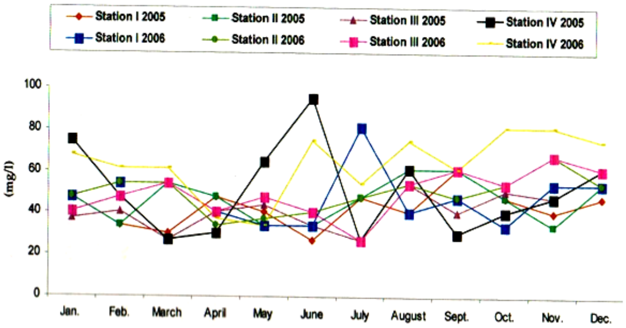

Fig-6 Seasonal variations in the total dissolved solids (mg/l) at the study stations of river Tawi (Jan., 2005 – Dec., 2006).

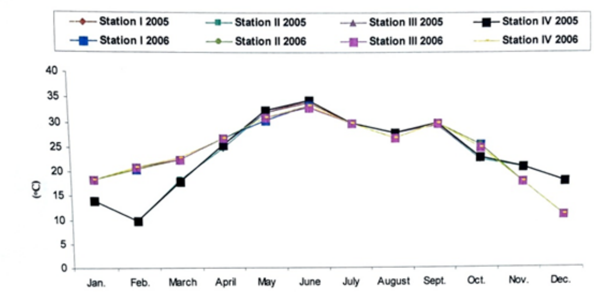

Fig-2 Seasonal variations in the water temperature (ºC) at the study stations of river Tawi (Jan., 2005 – Dec., 2006).

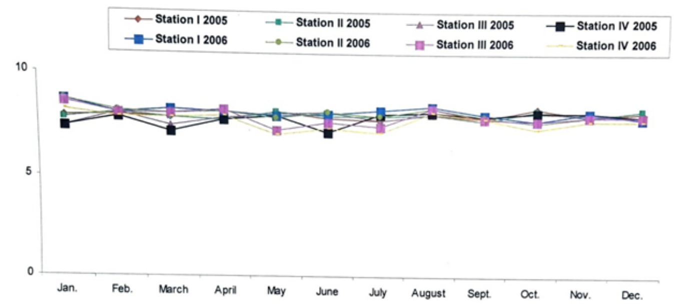

Fig-3 Seasonal variations in the pH at the study stations of river Tawi (Jan., 2005 – Dec., 2006).