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Evaluation of water quality of river Tawi with reference to Physico-chemical parameters of district Jammu (J&K), India

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ABSTRACT

The physico-chemical parameters (pH, temperature, Free CO_2, DO, CO_3^-, HCO_3^-, Ca^{++}, Mg^{++} and Cl^-) were carried out for one year (April 2006 to March 2007) to evaluate the water quality of river Tawi (J&K). Four sampling stations (I to IV) were selected within the city limits of Jammu. Physico-chemical parameters were within the permissible limits but showed a regular trend of increase with increase of sewage contamination, as we move from Station I to IV. Contamination of river water suggests certain control measures to protect the riverine ecosystem for health, hygiene and sustainable environment.

Key words: Tawi river, Physico-chemical parameters, Sewage, Pollution.

INTRODUCTION

Water, as ubiquitous on earth as is imperative for life, seems to be loosing its ages old natural purity. Even though water is abundant, the amount of potable fresh water available is a tiny fraction of the total amount of water in the world. Rivers are the most important water resource. Unfortunately, the worldwide rivers are being polluted by indiscriminate disposable of sewage, industrial waste and plethora of human activities, which affects its physico-chemical characteristics and microbiological quality, making it unsafe for consumption.

Prevention of river pollution requires monitoring of physico-chemical parameters. So, physico-chemical parameters were taken for analysis of water quality of river Tawi. Earlier works on physico-chemical parameters of rivers from Indian waters were those of Aggarwal *et al*. (1976), Joshi & Pathak (1991), Pandey *et al*. (1992), Joshi & Bisht (1993), Chopra & Patrick (1994), Prasanakumari *et al*. (2003), Kumar *et al*. (2004) and Sanap *et al*. (2006).

Methodology

Study area

The state of J&K, situated in the extreme north India and lying at 36°58' N - 32°17' N and 80°20' E- 76°20' E, is an extensive hilly area interspersed with a host of lentic and lotic waters. Main drainage of Jammu province is effected by river Chenab. Tawi river is a major left bank tributary of river Chenab draining Jammu from Dudu in north up to Ghomanasan in south. Tawi river catchment is delineated by latitude 32° 35' N- 33° 5' and longitude 74° 35' E- 75 °45' E.

Sewage and other effluents are introduced in Tawi along its whole course, mainly at Jammu city. River Tawi is the main source of drinking water supplies for Jammu city and its outskirts. As river is being polluted day by day, it is therefore necessary to know the degree of pollution load so as to assess its potability.

Sampling sites

During the study period, four sampling stations were selected along the river Tawi (within the city limits of Jammu) viz., Station I (Har ki Pouri), Station II (Peer Kho), Station III (Gujjar Nagar) and Station IV (Bhagwati Nagar).

Sample collection

Sampling was according to the procedure recommended by American Public Health Association (APHA, 1998). Samples were collected monthly during the year (April 06-March 2007).

Physico-chemical analysis

The physical parameters determined were atmospheric temperature and water temperature. The chemical analysis performed includes pH, Free CO_2, DO, CO_3^{--}, HCO_3^-, Ca^{++}, Mg^{++} and Cl^- (ISI, 1973 and APHA, 1998).

RESULTS AND DISCUSSION

The seasonal distribution of air and water temperature is depicted in fig. 1 and 2 respectively. The mean value of air temperature at all the four (I-

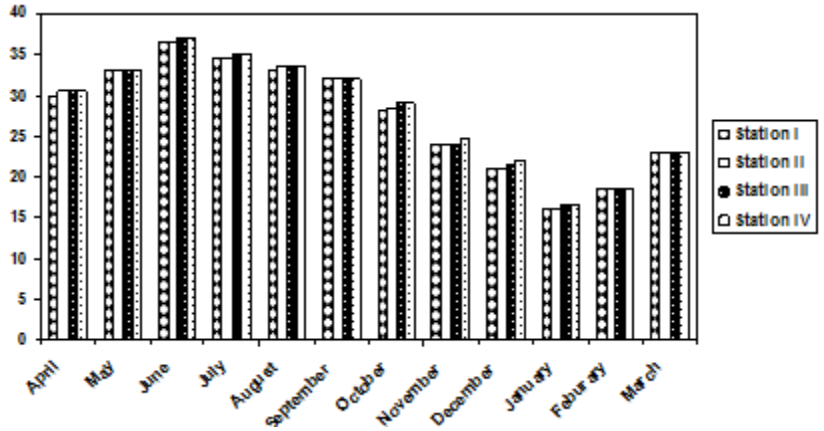

Fig. 1: Graph showing seasonal variations in Air temperature (°C) at different stations of river Tawi.

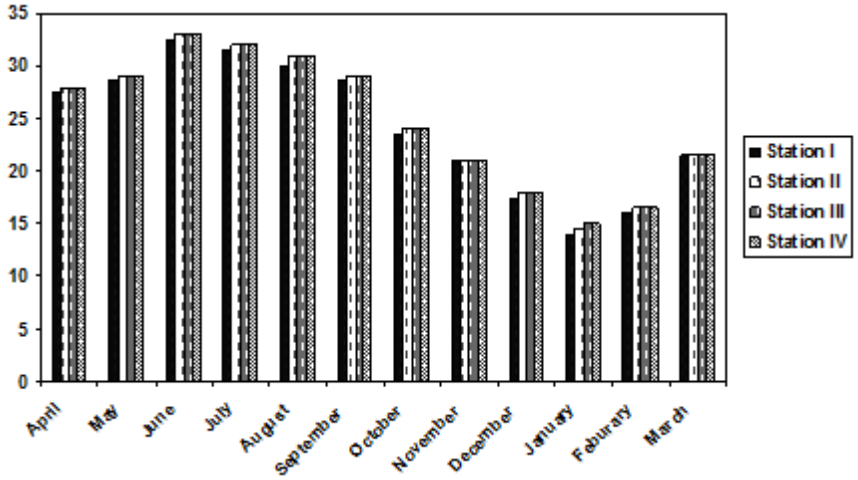

Fig. 2: Graph showing seasonal variations in Water temperature (°C) at different stations of river Tawi.

Table 1: Showing seasonal variations in Air temperature (°C) at different stations of river Tawi

Months	Station I	Station II	Station III	Station IV	Mean	± S.D.
April	30.0	30.5	30.5	30.5	30.3	± 0.21
May	33.0	33.0	33.0	33.0	33.0	± 0.00
June	36.5	36.5	37.0	37.0	36.7(Max)	± 0.25
July	34.5	34.5	35.0	35.0	34.7	± 0.25
August	33.0	33.5	33.5	33.5	33.3	± 0.21
September	32.0	32.0	32.0	32.0	32.0	± 0.00
October	28.0	28.5	29.0	29.0	28.6	± 0.41
November	24.0	24.0	24.0	24.5	24.1	± 0.21
December	21.0	21.0	21.5	22.0	21.3	± 0.41
January	16.0	16.0	16.5	16.5	16.2(Min.)	± 0.25
February	18.5	18.5	18.5	18.5	18.5	± 0.00
March	23.0	23.0	23.0	23.0	23.0	± 0.00

Station I : Har ki Pouri Station II : Peer Kho Station III : Gujjar nagar Station IV : Bhagwati nagar

Table 2: Showing seasonal variations in Water temperature (°C) at different stations of river Tawi

Months	Station I	Station II	Station III	Station IV	Mean	±S.D.
April 06	27.5	28.0	28.0	28.0	27.8	± 0.21
May	28.5	29.0	29.0	29.0	28.8	± 0.21
June	32.5	33.0	33.0	33.0	32.8(Max)	± 0.21
July	31.5	32.0	32.0	32.0	31.8	± 0.21
August	30.0	31.0	31.0	31.0	30.7	± 0.43
September	28.5	29.0	29.0	29.0	28.8	± 0.21
October	23.5	24.0	24.0	24.0	23.8	± 0.21
November	21.0	21.0	21.0	21.0	21.0	± 0.00
December	17.5	18.0	18.0	18.0	17.8	± 0.21
January 07	14.5	14.5	15.0	15.0	14.7 (Min)	± 0.25
February	16.0	16.5	16.5	16.5	16.3	± 0.21
March	21.5	21.5	21.5	22.0	21.6	± 0.21

Station I : Har ki Pouri Station II : Peer Kho Station III : Gujjar nagar Station IV : Bhagwati nagar

IV) sampling stations fluctuated between 16.2°C (Jan.) to 36.7°C (June) and that of water temperature varied from 14.7°C (Jan.) to 32.8°C in (June). Both showed highest recordings during summers and lowest during winters. A positive relation between air and water temperature was observed. Similar observations were also advocated by Dutta (1978) and Zutshi (1992).

The distribution of pH is presented in fig. 3. The annual average of pH varied from 7.7 to 8.3. pH showed less variation and remained alkaline throughout the year. Seasonal studies of pH clearly indicate that it was in low regime during summer and rainy season and in high regime during winter season. Similar findings were also reported by Bhanja & Patra (2000) and Prasannakumari *et al*. (2003). Stationwise picture of pH shows a decreasing trend as we move from Station I (no marked sewage entry) to Station IV (sewage polluted station). Low record of pH at the pollutant mixing stations has also been reported by Saxena *et al*. (1966), Zutshi (1992) and Chopra & Patrick (1994).

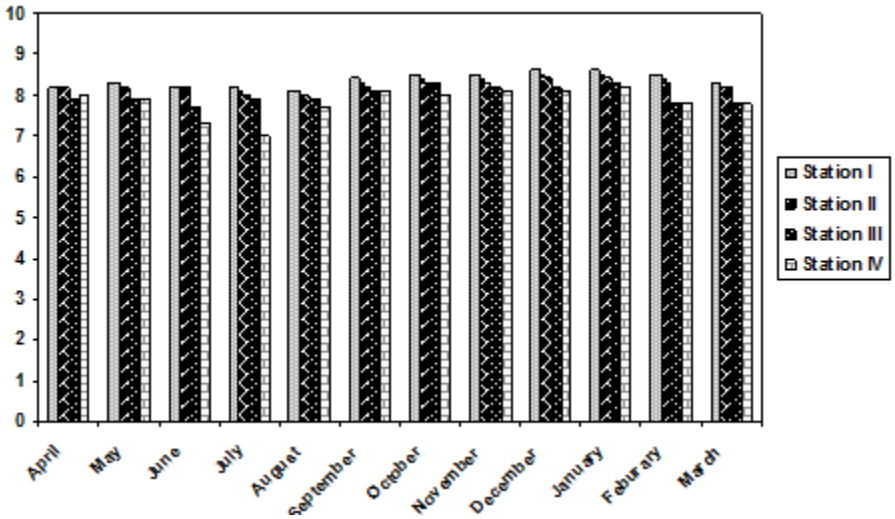

Fig. 3: Graph showing seasonal variations in pH at different stations of river Tawi.

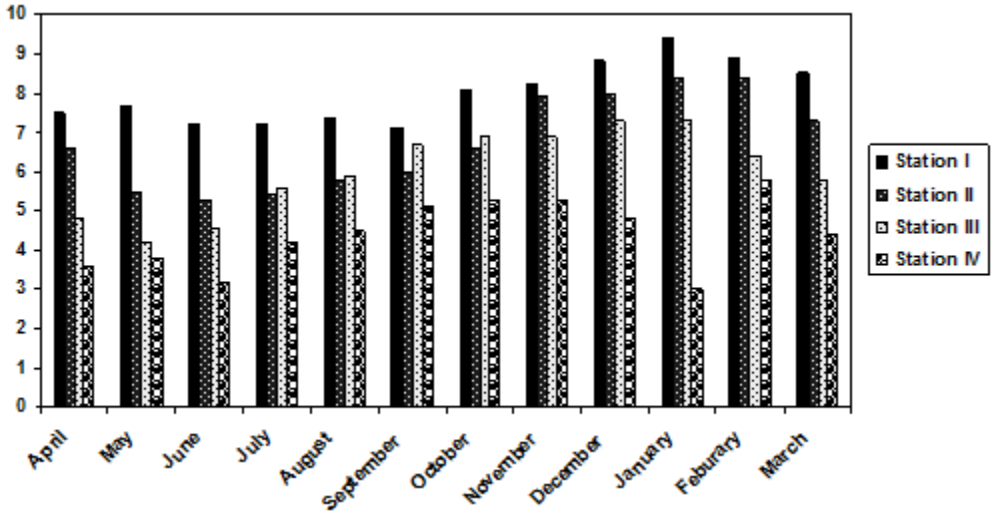

Fig. 4: Graph showing seasonal variations in Dissolved oxygen (DO) (mg/l) at different stations of river Tawi.

Table 3: Showing seasonal variations in pH at different stations of river Tawi

Months	Station I	Station II	Station III	Station IV	Mean	± S.D.
April 06	8.2	8.2	7.9	8.0	8.0	± 0.12
May	8.3	8.2	7.9	7.9	8.0	± 0.17
June	8.2	8.2	7.7	7.3	7.8	± 0.37
July	8.2	8.0	7.9	7.0	7.7 (Min)	± 0.46
August	8.1	8.0	7.9	7.7	7.9	± 0.14
September	8.4	8.2	8.1	8.1	8.2	± 0.12
October	8.5	8.3	8.3	8.0	8.2	± 0.17
November	8.5	8.3	8.2	8.1	8.2	± 0.14
December	8.6	8.4	8.2	8.1	8.3 (Max)	± 0.19
January 07	8.6	8.4	8.3	8.2	8.3 (Max)	± 0.14
February	8.5	8.3	7.8	7.8	8.1	± 0.30
March	8.3	8.2	7.8	7.8	8.0	± 0.22

Station I : Har ki Pouri Station II : Peer Kho Station III : Gujjar nagar Station IV : Bhagwati nagar

Table 4: Showing seasonal variations in Dissolved oxygen (DO) (mg/l) at different stations of river Tawi

Months	Station I	Station II	Station III	Station IV	Mean	± S.D.
April 06	7.5	6.6	4.8	3.6	5.6	± 1.52
May	7.7	5.5	4.2	3.8	5.3	± 1.52
June	7.2	5.3	4.6	3.2	5.0 (Min)	± 1.44
July	7.2	5.4	5.6	4.2	5.6	± 1.06
August	7.4	5.8	5.9	4.5	5.9	± 1.02
September	7.1	6.0	6.7	5.1	6.2	± 0.75
October	8.1	6.6	6.9	5.3	6.7	± 0.99
November	8.2	7.9	6.9	5.3	7.0	± 1.42
December	8.8	8.0	7.3	4.8	7.2	± 2.13
January 07	9.4	8.4	7.3	3.0	7.0	± 3.48
February	8.9	8.4	6.4	5.8	7.3 (Max)	± 1.62
March	8.5	7.3	5.8	4.4	6.5	± 1.54

Station I : Har ki Pouri Station II : Peer Kho Station III : Gujjar nagar Station IV : Bhagwati nagar

Seasonal data on the dissolved oxygen (DO) is depicted in fig. 4. Annual average recorded a minimum of 5.0 mg/l (June) and maximum of 7.3 mg/l (Feb.) at the selected sampling stations. In the present study, DO showed highest records during winters and lowest value during summers. Higher values of DO can be attributed to low temperature which permits higher retention of air, thereby causing rise in oxygen level during winter months and rise in temperature lowers the oxygen retention capacity of water, resulting in low values of DO during summer. The results are in agreement with Joshi *et al*. (1993), Kataria *et al*. (1995), Parashar *et al*. (2003) and Thilaga *et al*. (2004).Data revealed low DO level at sewage mixing stations (Station III & IV) as compared to less polluted stations (Station I& II). Similar observations were also suggested by Khanna *et al*. (1997).

The annual data of FCO_2 is presented in fig. 5. The annual averages ranged between 0.05 mg/l (May) to 2.72 mg/l (Jan.) in the study stations. An inverse relationship between DO and FCO_2 was recorded. FCO_2 exhibit an increasing trend from Station I to Station IV, which may be due to addition of faecal matter and domestic sewage. Present observation gets support from the findings of Welch (1952) and Dutta (1978).

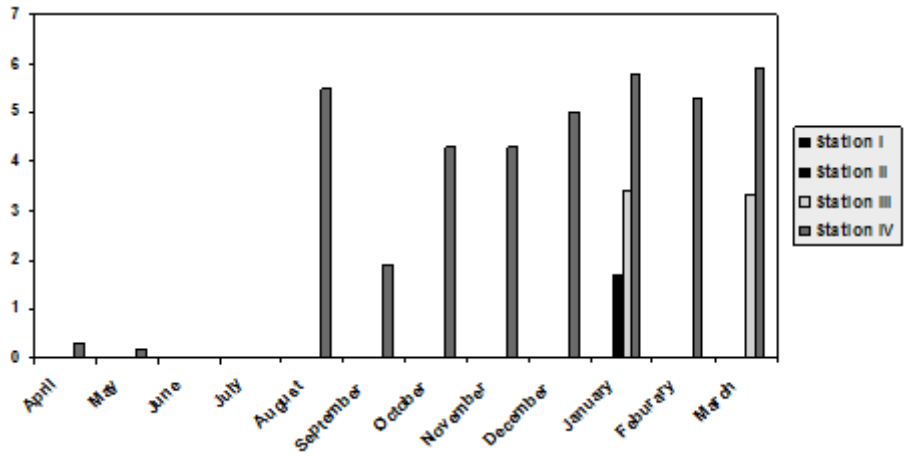

Fig. 5: Graph showing seasonal variations in Free carbon-dioxide (FCO_2) (mg/l) at different stations of river Tawi.

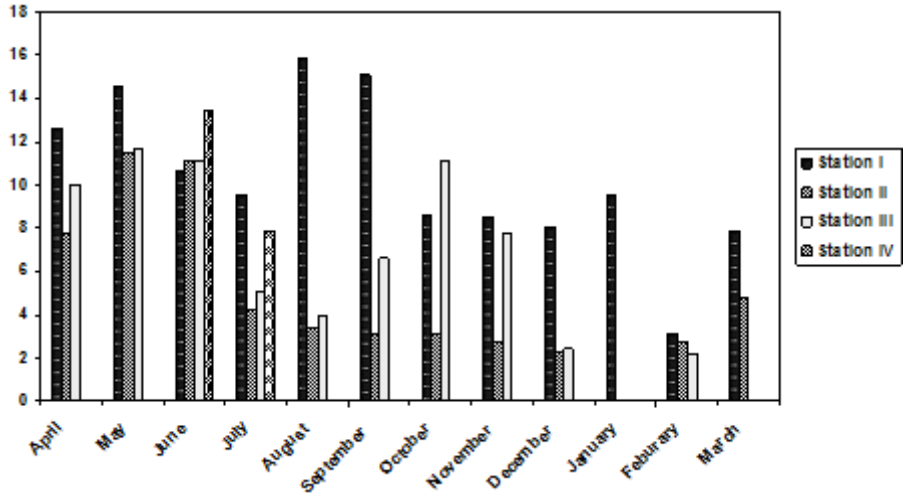

Fig. 6: Graph showing seasonal variations in Carbonates (mg/l) at different stations of river Tawi.

Table 5: Showing seasonal variations in Free carbon-dioxide (FCO_2) (mg/l) at different stations of river Tawi

Months	Station I	Station II	Station III	Station IV	Mean	± S.D.
April 06	Nil	Nil	Nil	0.3	0.07	± 0.12
May	Nil	Nil	Nil	0.2	0.05(Min)	± 0.08
June	Nil	Nil	Nil	Nil	0.00	± 0.00
July	Nil	Nil	Nil	Nil	0.00	± 0.00
August	Nil	Nil	Nil	5.5	1.37	± 2.38
September	Nil	Nil	Nil	1.9	0.47	± 0.82
October	Nil	Nil	Nil	4.3	1.07	± 1.86
November	Nil	Nil	Nil	4.3	1.07	± 1.86
December	Nil	Nil	Nil	5.0	1.25	± 2.16
January 07	Nil	1.7	3.4	5.8	2.72(Max)	± 2.14
February	Nil	Nil	Nil	5.3	1.32	± 2.29
March	Nil	Nil	3.3	5.9	2.30	± 2.47

Station I : Har ki Pouri Station II : Peer Kho Station III : Gujjar nagar Station IV : Bhagwati nagar

Table 6: Showing seasonal variations in Carbonates (mg/l) at different stations of river Tawi

Months	Station I	Station II	Station III	Station IV	Mean	± S.D.
April 06	12.6	7.7	10.0	Nil	7.5	± 4.70
May	14.5	11.5	11.6	Nil	9.4	± 5.55
June	10.6	11.1	11.1	13.4	11.5(Max)	± 1.08
July	9.6	4.2	5.0	7.9	6.6	± 2.17
August	15.9	3.4	3.9	Nil	5.8	± 6.02
September	15.1	3.1	6.6	Nil	6.2	± 5.64
October	8.6	3.1	11.1	Nil	5.7	± 4.38
November	8.5	2.7	7.8	Nil	4.7	± 3.54
December	8.1	2.3	2.4	Nil	3.2	± 2.98
January 07	9.6	Nil	Nil	Nil	2.4	± 4.15
February	3.1	2.7	2.2	Nil	2.0 (Min)	± 3.46
March	7.9	4.8	Nil	Nil	3.1	± 3.35

Station I : Har ki Pouri Station II : Peer Kho Station III : Gujjar nagar Station IV : Bhagwati nagar

In the presently selected stations (I-IV), the mean value of carbonate varied from 2.0 mg/l (Feb.) to 11.5 mg/l (June) - Fig. 6 and bicarbonate showed a mean fluctuation between 171.3 mg/l (Aug.) to 273.1 mg/l (Jan.) – Fig. 7. An inverse relation was noticed between FCO_2 and carbonates at Station IV. The high values of carbonates and bicarbonates recorded at Station IV may be due to addition of more sewage at this particular site. The results are in accordance with the findings of Singh & Rai (2003) who also suggested high conc. of sewage as the cause of high alkalinity.

Chloride is one of the most important indicators of pollution. Chlorides are present in sewage, sewage effluents and farm drainage. It showed a mean fluctuation between 11.3 mg/l (July) and 27.7 mg/l (Oct.) – Fig. 8. Monsoon fall in chloride concentration is due to dilution effect caused by direct rainfall and inundation of water from catchment area, which corroborate with the earlier observations of Kumar (1990) and Sharma (2004). Rise in chloride was noticed at Station III & IV, which can be attributed to increased pollution level due to addition of sewage at these stations. Similar observations have also put forth by Zutshi (1992) and Chopra & Rehman (1995).

Mean annual variation of calcium content in the selected study area (I-IV) varied from 34.4 mg/l (Mar.) to 50.5 mg/l (Oct.) - Fig. 9 and mean value of magnesium varied from 7.8 mg/l (May) to 23.3 mg/l (Oct.) - Fig. 10. Stationwise, both cations showed their highest recording at Station III & IV

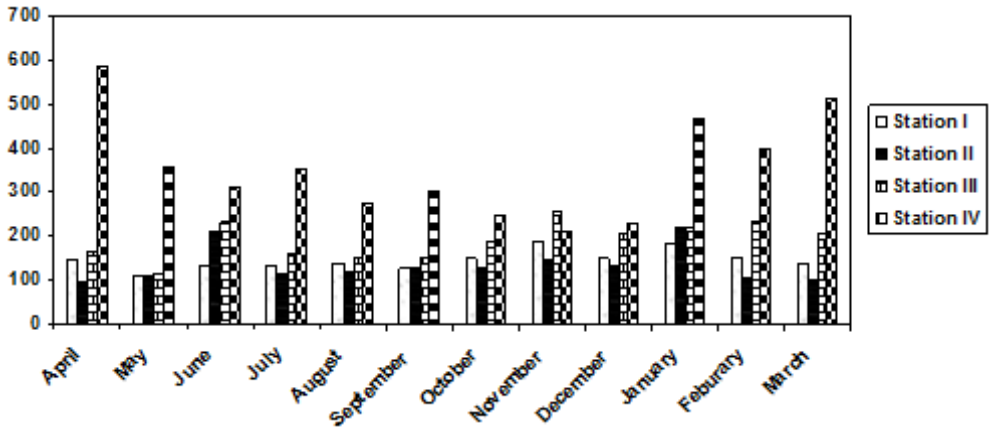

Fig. 7: Graph showing seasonal variations in Bicarbonates (mg/l) at different stations of river Tawi.

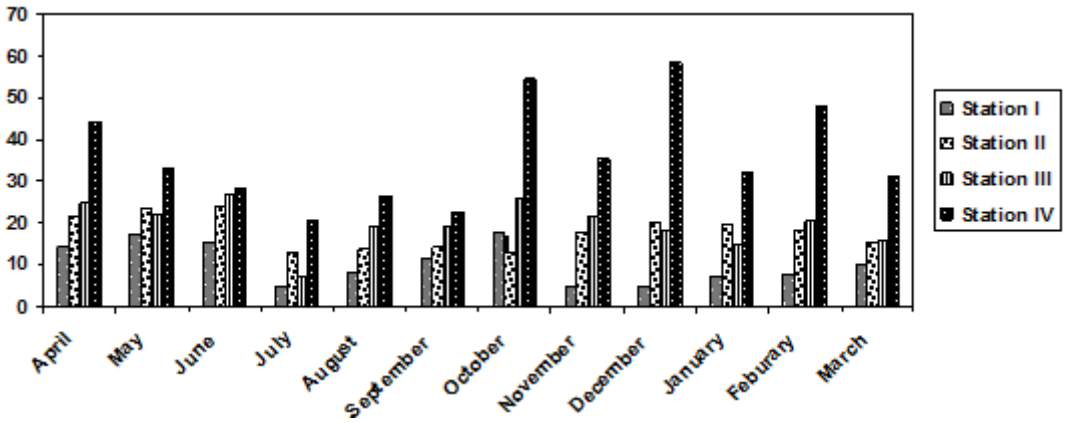

Fig. 8: Graph showing seasonal variations in Chloride (mg/l) at different stations of river Tawi

Table 7: Showing seasonal variations in Bicarbonates (mg/l) at different stations of river Tawi

Month of the year	Station I	Station II	Station III	Station IV	Mean	± S.D.
April 06	147.2	98.1	164.8	588.2	249.5	± 197.02
May	111.1	111.3	116.9	359.3	174.6	± 106.63
June	133.6	211.8	232.4	311.4	222.3	± 63.28
July	136.3	116.4	162.2	352.9	191.9	± 94.33
August	138.2	121.1	149.7	276.5	171.3 (Min)	± 61.54
September	127.5	126.2	152.2	302.6	177.1	± 73.17
October	152.2	126.8	189.5	246.7	178.8	± 45.10
November	188.9	145.7	258.2	212.3	201.2	± 40.63
December	148.9	133.0	207.2	227.7	179.2	± 39.33
January 07	186.2	218.9	219.7	467.7	273.1 (Max)	± 113.14
February	149.9	102.8	236.9	398.2	221.9	± 112.55
March	141.1	99.0	209.4	512.9	240.6	± 162.07

Station I : Har ki Pouri Station II : Peer Kho Station III : Gujjar nagar Station IV : Bhagwati nagar

Table 8: Showing seasonal variations in Chloride (mg/l) at different stations of river Tawi

Months	Station I	Station II	Station III	Station IV	Mean	± S.D.
April 06	14.0	21.9	24.6	44.5	26.2	± 11.23
May	17.2	23.3	22.1	33.2	23.9	± 5.80
June	15.6	23.9	26.9	28.4	23.7	± 4.94
July	4.8	12.8	7.3	20.6	11.3 (Min)	± 6.06
August	8.1	13.9	19.2	26.4	16.9	± 6.74
September	11.3	14.0	18.9	22.6	16.7	± 4.36
October	17.6	12.9	25.9	54.7	27.7(Max)	±16.22
November	4.9	17.9	21.8	35.4	20.0	± 10.87
December	4.7	19.8	18.3	58.7	25.3	± 20.11
January 07	6.9	19.6	14.8	31.9	18.3	± 9.06
February	7.4	18.1	20.2	47.8	23.3	± 14.91
March	10.2	15.7	16.1	31.2	18.3	± 7.80

Station I : Har ki Pouri Station II : Peer Kho Station III : Gujjar nagar Station IV : Bhagwati nagar

Table 9: Showing seasonal variations in Calcium (mg/l) at different stations of river Tawi

Months	Station I	Station II	Station III	Station IV	Mean	± S.D.
April 06	27.6	28.0	32.3	58.0	36.4	±12.56
May	37.6	28.0	39.4	46.4	37.8	± 6.56
June	45.3	19.6	44.6	57.5	41.7	± 13.77
July	39.9	23.9	54.1	31.7	37.4	± 11.17
August	42.0	22.4	34.9	64.8	41.0	± 15.41
September	35.1	34.6	55.1	75.8	50.1	± 16.96
October	33.1	38.7	43.1	87.1	50.5(Max)	± 21.42
November	28.9	37.2	38.9	75.8	45.2	± 18.06
December	28.0	37.8	34.7	76.8	44.3	± 19.08
January 07	26.0	38.0	31.9	80.4	44.0	± 21.39
February	23.2	33.5	30.2	67.6	38.6	± 17.13
March	22.1	23.9	28.1	63.8	34.4(Min)	± 17.07

Station I : Har ki Pouri Station II : Peer Kho Station III : Gujjar nagar Station IV : Bhagwati nagar

Table 10: Showing seasonal variations in Magnesium (mg/l) at different stations of river Tawi

Months	Station I	Station II	Station III	Station IV	Mean	± S.D.
April 06	6.9	5.1	8.7	15.8	9.1	± 4.05
May	6.9	5.2	3.5	15.6	7.8 (Min)	± 4.66
June	10.0	12.1	12.2	17.8	13.0	± 2.89
July	16.2	11.0	13.8	9.2	12.5	± 2.66
August	13.0	15.7	6.6	26.2	15.3	± 7.06
September	12.3	21.0	14.5	22.3	17.5	± 4.22
October	14.2	27.5	16.2	35.3	23.3(Max)	± 8.58
November	12.7	19.0	16.9	22.8	17.8	± 3.64
December	13.9	12.2	12.2	33.2	17.8	± 8.87
January 07	7.7	6.1	6.2	19.6	9.9	± 5.63
February	8.5	6.0	7.2	21.2	10.7	±6.11
March	5.2	5.1	4.9	20.0	8.8	± 6.46

Station I : Har ki Pouri Station II : Peer Kho Station III : Gujjar nagar Station IV : Bhagwati nagar

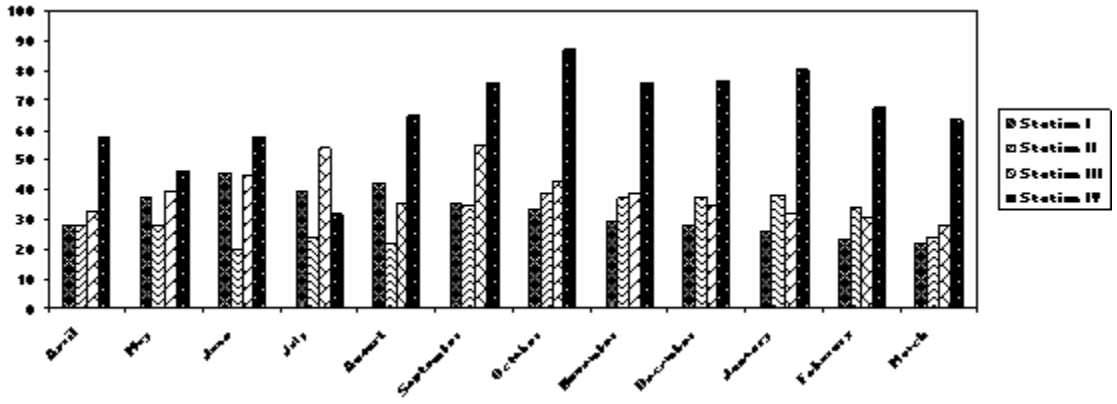

Fig. 9: Graph showing seasonal variations in Calcium (mg/l) at different stations of river Tawi.

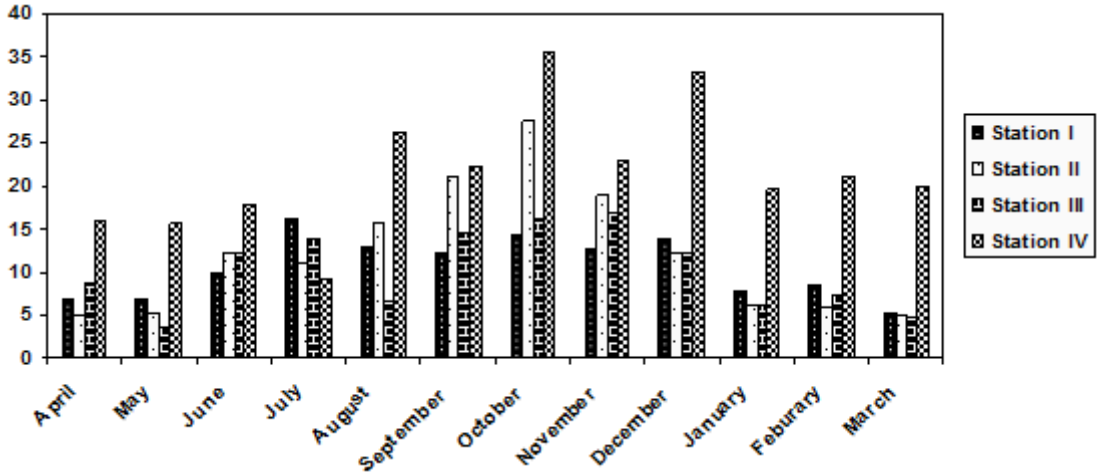

Fig. 10: Graph showing seasonal variations in Magnesium (mg/l) at different stations of river Tawi.

which could be attributed to entry of sewage from adjoining areas and also due to pollution of other sorts (Bhanja and Patra, 2000).

CONCLUSION

In the present investigation on river Tawi (J&K), all physico-chemical parameters were within permissible limits but show a regular trend of increase as we move from Station I to IV. Raised values of certain parameters like alkalinity, chlorides and low values of pH & DO at some stations indicate pollution at river water. To protect this water ecosystem, there should be proper management and planning of deposition of municipal sewage and domestic wastage for health hygiene and sustainable environment.

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