

Effect of tourism on the physico-chemical parameters of stream Nalhota at Guchu Pani, District-Dehradun (India)

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Abstracts

The present paper deals with the study of the effects of tourism on the physico-chemical parameters of Stream Nalhota a spring fed stream originates from the Robber's cave (Guchu Pani) Dehradun (Uttarakhand). This site is one of the famous picnic spots in Dehradun. The Parameters studied were temperature, velocity, TS, TDS, TSS, pH, free CO₂, DO, hardness, calcium, magnesium, BOD, COD, chloride and alkalinity. The average value of all the parameters were found higher at sampling site C in comparison to sampling site A and B which may be due to higher activities of tourists and local people of near by villages. Maximum values of the studied parameters were observed during summer except DO and minimum values of these parameters obtained during winter due to less activities of localities and tourists in winter, while higher values of DO were observed during winter which may be due to super saturation of oxygen at lower ambient temperature. Nature of water of stream Nalhota with respect to pH is alkaline. The study indicates that the water quality of stream Nalhota is not suitable for drinking purpose with respect to BOD and TS.

Keywords:- TDS, Hardness, Chloride, DO, BOD

Introduction

Stream Nalhota is a spring fed stream originated from the Robber's cave (Guchu Pani) which is located at a distance of 8 km from the clock tower of Dehradun (Uttarakhand). The study site is in the Cantt. area, near a village named Guchu Pani under the panchayat of Vijaypur Gopiwala (Anarwala). Geographically the stream Nalhota and the Robber's cave are situated in the globe on longitude - 30°22'30" and latitude -78°2'30". The total length of this stream is around 1km including 600 m cave area with several natural springs and 400 m as an open area till it merges into the river Tons which in turn is the tributary of River Yamuna. This is an ultimate source of water for drinking and irrigation purpose for the people of near by villages named Guchu Pani, Vijaypur Gopiwala (Anarwala), Kotlawali, Purkal and Chandroroti. Thousands of people come here daily from April to June to enjoy this place and to have a good adventurous trekking beneath this cave. Many workers have studied the water quality of Ganga, Song and Suswa rivers which flow through the district Dehradun (Khanna and Bhutiani, 2003 and Khanna *et al.*, 2006; 2007). But no study has been conducted to assess the water quality of stream Nalhota till now. Viewing the importance of stream Nalhota for the villagers and tourists this study has been carried out.

Materials and Method

For the study of physico-chemical parameters of stream Nalhota in Uttarakhand, the water samples were collected from three sampling sites- site "A" at the starting point of Robber's cave to know the primary physico-chemical condition of the stream, site "B" at 600 m distance from site "A" where stream Nalhota

comes out from the Robber's cave and site "C" at the point where the Nalhota stream merges into the river Tons. Some of the physico-chemical parameters like TS (total solid), TDS (total dissolved solid), TSS (total suspended solid), DO (dissolved oxygen), BOD (biochemical oxygen demand), COD (chemical oxygen demand), chloride, hardness, calcium, magnesium, alkalinity and phytoplankton were observed in the laboratory. Temperature, velocity, pH, and free CO₂ were observed at the spot. Grab sampling collection method was adopted through out the study. Sampling preservation and analytical methods were adopted as per APHA (1998), Trivedi and Goel (1986), Khanna and Bhutiani (2004).

Results and Discussion

The average value of physico-chemical and biological parameters of samples analyzed from three sampling site are given in table-1 and 2 and shown in Fig. 1-9. The average values of temperature ranged between 13.33±1.69-17.00±2.00 °C. A more or less similar trend has been observed by Khanna and Bhutiani (2003) in the river Ganga at Haridwar and Iqbal *et al.* (2006) in the River Soan (Punjab), Pakistan. Velocity ranged between 0.82±0.13-1.05±0.19 m/s. Total solids, total dissolved solids and total suspended solids ranged between 1690.00±50.38-1866.00±48.63 mg/l, 203.00±7.02-292.33±9.50 mg/l, 1487.00±46.05-1573.66±40.79 mg/l respectively. The similar trend has been observed by Khanna and Bhutiani (2007) in River Suswa, Logankumar *et al.* (1989) in the river Bhavani at Sirumugai, Tamilnadu and Abbasi *et al.* (1996) in Punmurpuzha river of Kerala. pH value has been recorded between 7.50±0.00-7.83±0.16. Gasim *et al.* (2005) reported similar trend in the Bebar River, Pahang, Malaysia. Dissolved oxygen and biological oxygen demand varied between 8.91±0.46-7.56±0.26 mg/l and 2.42±0.24-3.37±0.27 mg/l respectively. The similar trend has been observed by Khanna *et al.* (2007) in Song River and Khaiwal *et al.* (2003) reported in the River Yamuna. Chemical oxygen demand was found between 2.56±0.24-3.36±0.24 mg/l. Hardness, calcium and magnesium varied between 206.00±10.27-233.66±15.08 mg/l, 86.16±4.00-104.20±4.17 mg/l and 26.62±1.54-34.44±2.25 mg/l respectively. A similar trend has been found by Singh *et al.* (2006) in the river Ganga. Kulkarni *et al.* (2002) in the Khushavati river at Quepem, Goa. Free CO₂ ranged between 0.88±0.25-1.90±0.14 mg/l. A similar trend has been found by Khanna *et al.* (2006). Chloride was found between 17.98±1.70-22.24±1.71 mg/l. Alkalinity varied between 160.00±7.05-186.66±7.60 mg/l. Khanna and Singh (2000) found similar trend in river Suswa in Raiwala.

Maximum values of the studied parameters were observed during summer except DO and minimum values of these parameters obtained during winter, while higher value of DO was observed during winter which may be due to super saturation of oxygen at lower ambient temperature and less activities of localities and tourists in winter. After winter period as temperature of the environment rises activities of tourists are also increased which gradually deteriorates the water quality of stream Nalhota. The values of studied parameters are obtained higher at sampling site C than sampling site B which in turn has higher values of studied parameters than sampling site A which may be due to the higher bathing and washing activities of tourists and localities on site C and also due to the small sewage drains of village Guchu pani at this sampling site. The value of studied parameter of site B was obtained higher than site A, because there are many bathing point for tourists and small restaurants at this site. Water quality of stream Nalhota with respect to pH is alkaline. The value of BOD as well as COD was recorded highest at site C in all the season while the average value of both the parameters was obtained highest in the month of June due to higher activities of tourists in summer tourism. The average value of pH, DO, COD, alkalinity, Hardness and Chloride were obtained with in the prescribed tolerance limits of drinking purpose (BIS-

1991) where the average values of BOD (2.42 ± 0.24 - 3.37 ± 0.27 mg/l) and TS (690.00 ± 50.38 - 1866.00 ± 48.63) mg/l was observed beyond the standard limits. The observed value of BOD beyond the standard limits clearly indicates the presence of bacteria, which may cause diseases like gastroenteritis, dysentery, cholera and other fatal diseases. Indian standards of drinking water (BIS-1991) are given in table-3.

The correlation coefficients among the different parameters are presented in table-3. The analysis show the high degree positive correlation between temperature and TS, temperature and TDS, temperature and Hardness, temperature and calcium, temperature and BOD, temperature and COD, velocity and TS, velocity and TDS, velocity and CO_2 , velocity and Hardness, velocity and Calcium, velocity and Magnesium, velocity and BOD, velocity and COD, TS and TSS, TS and TDS, TS and CO_2 , TS and Hardness, TS and Calcium, TS and Magnesium, TS and BOD, TS and COD, TS and Chloride, TS and Alkalinity. TSS and TDS, TSS and CO_2 , TSS and Hardness, TSS and Calcium, TSS and Magnesium, TSS and BOD, TSS and COD, TSS and Chloride, TSS and Alkalinity, TDS and CO_2 , TDS and Hardness, TDS and Calcium, TDS and Magnesium, TDS and BOD, TDS and COD, TDS and Chloride, pH and Hardness, pH and Calcium, CO_2 and DO, Hardness and Calcium, Hardness and Magnesium, Hardness and BOD, Hardness and COD, Hardness and Chloride, Hardness and Alkalinity, Calcium and Magnesium, Calcium and BOD, Calcium and COD, Calcium and Chloride, Magnesium and BOD, Magnesium and COD, Magnesium and Chloride, Magnesium and Alkalinity, BOD and COD, BOD and Chloride, BOD and Alkalinity, COD and Chloride, COD and Alkalinity, Chloride and Alkalinity.

The analysis show the high degree negative correlation between temperature and DO, Velocity and DO, TS and DO, TDS and DO, TSS and DO, pH and DO, pH and CO_2 , CO_2 and Hardness, CO_2 and Biological Oxygen Demand, CO_2 and Chemical Oxygen Demand, CO_2 and Chloride, CO_2 and Calcium, CO_2 and Magnesium, CO_2 and Alkalinity, DO and Biological Oxygen Demand, DO and Chemical Oxygen Demand, DO and Chloride, DO and Hardness, DO and Calcium, DO and Magnesium and DO and Alkalinity. The statistical analysis of present study shows the correlation coefficient among the parameters was negative 23 times and positive 73 times. This study indicated that positive correlation dominated in the present stream.

Table-1: Average value of physical parameters of stream Nalhota from January to June 2008

Month Parameter	January	February	March	April	May	June	Average
Temperature (°C)	13.33 ±1.69	14.33 ±2.72	13.66 ±2.33	14.00 ±2.51	16.00 ±1.52	17.00 ±2.00	14.72 ±0.59
Velocity (m/sec)	0.82 ±0.13	0.83 ±0.13	0.88 ±0.13	0.92 ±0.13	0.93 ±0.14	1.05 ±0.19	0.90 ±0.03
Total solid (mg/l)	1690.00 ±50.38	1720.00 ±45.00	1745.66 ±52.35	1779.66 ±43.64	1820.33 ±46.24	1866.00 ±48.63	1770.18 ±26.77
TDS (mg/l)	203.00 ±7.02	222.33 ±10.73	241.00 ±9.02	257.00 ±11.85	280.66 ±12.01	292.33 ±9.50	249.38 ±13.99
TSS (mg/l)	1487.00 ±46.05	1497.66 ±34.72	1504.66 ±46.72	1522.66 ±35.41	1539.66 ±46.84	1573.66 ±40.79	1520.88 ±13.07

Table-2: Average value of chemical parameters of stream Nalhota from January to June 2008

Month Parameter	January	February	March	April	May	June	Average
pH	7.50 ±0.00	7.66 ±0.16	7.66 ±0.16	7.66 ±0.16	7.66 ±0.16	7.83 ±0.16	7.66 ±0.04
Free CO ₂ (mg/l)	0.88 ±0.25	1.17 ±0.14	1.46 ±0.14	1.61 ±0.14	1.61 ±0.14	1.90 ±0.14	1.43 ±0.14
D.O. (mg/l)	8.91 ±0.46	8.51 ±0.46	8.23 ±0.35	7.96 ±0.35	7.83 ±0.35	7.56 ±0.26	8.16 ±0.10
Hardness (mg/l)	206.00 ±10.27	211.33 ±9.62	214.66 ±10.46	217.33 ±9.96	222.00 ±11.72	230.66 ±15.08	216.99 ±3.52
Calcium (mg/l)	86.16 ±4.00	88.83 ±4.04	90.17 ±4.00	94.18 ±4.17	96.18 ±1.62	104.20 ±4.17	93.28 ±2.64
Magnesium(mg/l)	26.62 ±1.54	27.27 ±1.48	29.23 ±2.06	30.53 ±1.31	32.32 ±2.18	34.44 ±2.25	30.06 ±1.22
B.O.D. (mg/l)	2.42 ±0.24	2.56 ±0.35	2.83 ±0.46	2.97 ±0.26	3.24 ±0.23	3.37 ±0.27	2.89 ±0.15
C.O.D. (mg/l)	2.56 ±0.24	2.72 ±0.27	2.88 ±0.24	3.04 ±0.24	3.20 ±0.24	3.36 ±0.24	2.96 ±0.11
Chloride (mg/l)	17.98 ±1.70	19.40 ±1.70	19.88 ±1.69	21.30 ±1.69	21.77 ±1.70	22.24 ±1.71	20.42 ±0.66
Alkalinity (mg/l)	160.00 ±7.05	170.00 ±7.07	178.33 ±7.05	180.00 ±7.00	186.66 ±7.90	186.66 ±7.60	176.94 ±12.68

Table-3: Standard limits of drinking water in terms of physico-chemical parameters

Parameters	Desirable limit
pH	6.5-8.5
TS (mg/l)	500
DO (mg/l)	>6.0
BOD	2.0
Hardness (mg/l)	300.0
Calcium hardness (mg/l)	75.0-200.0
Magnesium hardness (mg/l)	30.0-100.0
Alkalinity (mg/l)	<200.0
Chloride (mg/l)	250.0

Table-4: Correlation matrix of physico-chemical parameters of stream Nalhota during January to June 2008

	Temperature	Velocity	TS	TSS	TDS	pH	CO ₂	DO	Hardness	Calcium	Magnesium	BOD	COD	Chloride	Alkalinity
Temperature		0.86	0.91	0.87	0.93	0.80	0.76	-0.81	0.91	0.91	0.88	0.86	0.87	0.81	0.76
Velocity			0.96	0.92	0.98	0.81	0.92	-0.92	0.97	0.98	0.97	0.93	0.94	0.89	0.83
TS				0.98	0.98	0.85	0.94	-0.97	0.99	0.98	0.99	0.98	0.99	0.96	0.92
TSS					0.95	0.82	0.96	-0.96	0.97	0.94	0.98	0.99	0.99	0.98	0.96
TDS						0.86	0.91	-0.93	0.98	0.99	0.98	0.95	0.96	0.91	0.85
pH							-0.89	-0.86	0.90	0.88	0.82	0.80	0.84	0.82	0.80
CO ₂								0.94	-0.98	-0.97	-0.96	-0.95	-0.96	-0.93	-0.89
DO									-0.96	-0.93	-0.96	-0.97	-0.98	-0.99	-0.97
Hardness										0.98	0.98	0.96	0.98	0.94	0.90
Calcium											0.97	0.94	0.96	0.91	0.85
Magnesium												0.99	0.99	0.95	0.91
BOD													0.99	0.97	0.95
COD														0.98	0.95
Chloride															0.96
Alkalinity															

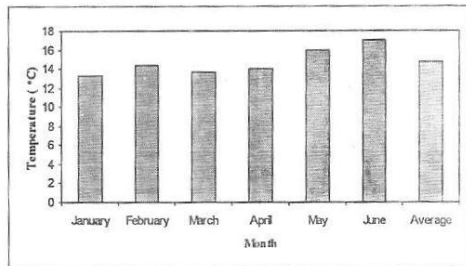


Fig. 1: Showing monthly fluctuation in water temperature (°C) of stream Nalhota

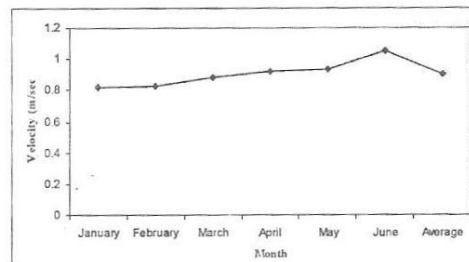


Fig. 2: Showing monthly fluctuation in water velocity (m/sec) of stream Nalhota

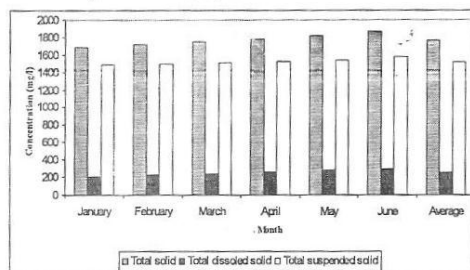


Fig. 3: Showing monthly fluctuation in total solid, TDS and TSS (mg/l) of stream Nalhota

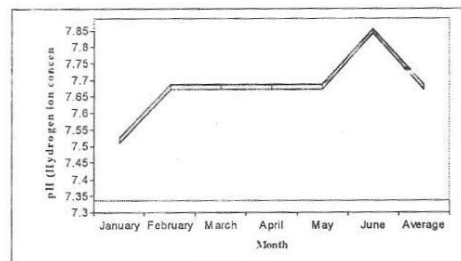


Fig. 4: Showing monthly fluctuation in pH of stream Nalhota

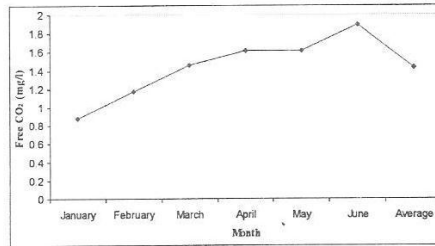


Fig. 5: Showing monthly fluctuation in free CO₂ (mg/l) of stream Nalhota

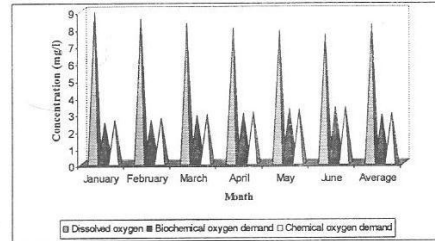


Fig. 6: Showing monthly fluctuation in DO, BOD, COD (mg/l) of stream Nalhota

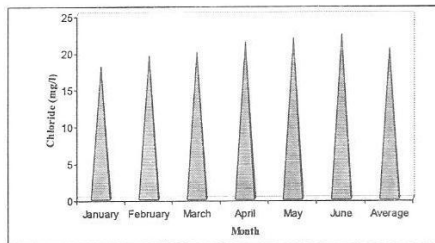


Fig. 7: Showing monthly fluctuation in chloride (mg/l) of stream Nalhota

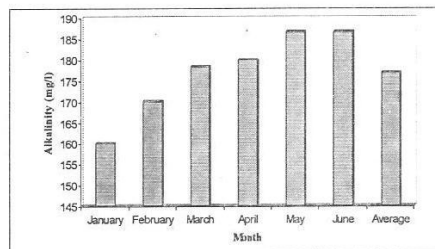


Fig. 8: Showing monthly fluctuation in alkalinity (mg/l) of stream Nalhota

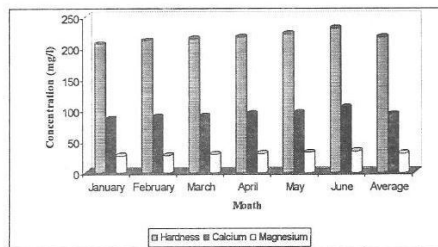


Fig. 9: Showing monthly fluctuation in hardness, calcium and magnesium (mg/l) of stream Nalhota

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