

LIMNOLOGICAL STATUS OF RIVER SUSWA AT RAIWALA(DEHRADUN)

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ABSTRACT

The present study deals with the analysis of physico-chemical parameters of the Suswa River at Dehradun (U.K.) during the year 2010 to 2012. In the present study various physico-chemical characteristics of Suswa River viz temperature, velocity, total solids, turbidity, pH, DO, free CO₂, BOD, COD, alkalinity, chloride and sulphate were done. During the course of study only minor differences in physical and chemical parameters of study area were observed.

Keywords: *Water quality, Suswa River, Spring fed river*

INTRODUCTION

Throughout history water has been considered a natural resource critical to human survival. Being a natural resource it has been a primary concern of man throughout his existence. Human history can, in fact, be written in terms of interactions and interrelation between human and water (Biswas, 1970).

Rivers are the most important resources in the world and in India in particular. Unfortunately, the same rivers are being polluted by indiscriminate disposal of sewage and industrial wastes as a plethora of human activities. Accurate assessment of water quality, whether in relation to the requirements of intended water uses or in order to determine the impacts of an activity on the water resource depends on the results generated by specific monitoring activities which define the physical, chemical and/or biological condition of the resource.

Suswa River is a spring fed river. It originates from Ramgarh (Dehradun) and after passing a distance of approximately 36 kilometers from reserve forest and as well as from places inhabited by human beings it merges into river Ganga at Gohri range forest. The Raiwala citizens utilize the Suswa water for a variety of purposes, so at some places it receives town effluents and other wastes. These wastes change the physico-chemical characteristics of this river. Besides this, it adversely affects the ecology of fishes residing there. Immediately after crossing Raiwala, the Suswa river assimilates into the Ganga hence, it was considered desirable to examine the aquatic ecology of the Suswa at Raiwala (Dehradun).

The study on this river is scanty and keeping in view the importance of this river to local people and its ability to affect the ecological conditions of river Ganga. The present study deals with the riverine ecological factors of the river Suswa at Raiwala and determination of its suitability for different purposes in this region.

MATERIALS AND METHODS

Study area

Raiwala is a town in district Dehradun (30° 16' N latitude and 78° 00' E longitudes). The town Raiwala is situated on the right bank of the river Suswa at the foothills of the Shivalik Himalayas at an altitude of approximately

370 meters from sea level. The location of Raiwala on globe is on latitude 30° 00' N and longitude 78° 16' E. For the present study four sampling sites were selected. First site was far from the human settlement where river enter the Raiwala. Second sampling site was 2 km away from first sampling site. Third sampling site was the place where water of the river is diverted to agricultural land in various form of small channels. Fourth sampling site was 2 km from the third sampling site; here river width is very less as compared to other sampling site. No human activity was observed at this sampling site during study period.

Methodology

The samples for different parameters were analyzed with the help of the procedures described by Welch (1948), Mathur (1982), Trivedi and Goel (1984), APHA (1998).

RESULTS AND DISCUSSION

Table-1: Monthly variation in physico-chemical parameter of Suswa River at sampling site-1 (2010-2012).

S. No	Season Parameter	Summer	Monsoon	Winter	Average
1	Temperature (°C)	23.16±2.21	24.41±3.29	19.81±0.81	22.46±2.38
2	Conductivity (Siemens/cm)	0.05±0.01	0.02±0.01	0.02±0.01	0.03±0.02
3	Turbidity (JTU)	0.00±0.00	27.50±3.00	0.00±0.00	9.17±15.88
4	Total solid (mg/l)	770.00±337.06	939.58±78.71	751.04±286.29	820.21±103.81
5	Velocity (m/s)	0.27±0.07	0.30±0.07	0.23±0.05	0.27±0.04
6	pH	7.36±0.22	7.62±0.28	7.34±0.11	7.44±0.15
7	BOD (mg/l)	0.56±0.21	0.75±0.27	0.68±0.43	0.66±0.09
8	COD (mg/l)	2.40±0.22	2.90±0.07	3.40±0.57	2.90±0.50
9	DO (mg/l)	8.23±0.22	7..50	8.34±1.62	8.15±0.24
10	ORI (rH ₂)	28.58±0.26	28.50±0.16	28.14±0.22	28.41±0.23
11	ORP (Eh)	0.38±0.03	0.39±0.02	0.38±0.00	0.38±0.01
12	Free CO ₂ (mg/l)	2.67±2.26	3.55±2.08	1.76±1.16	2.66±0.89
13	Acidity (mg/l)	59.48±24.41	50.10±11.05	57.48±21.59	55.69±4.94
14	Alkalinity (mg/l)	272.50±45.48	284.37±19.50	260.21±3.04	272.36±12.08
15	Total hardness (mg/l)	240.75±22.82	234.87±14.29	244.50±9.46	240.04±4.85
16	Chlorides (mg/l)	16.74±3.51	19.75±3.55	16.44±1.95	17.64±1.83
17	Phosphates (mg/l)	0.03±0.01	0.13±0.02	0.05±0.06	0.10±0.05

Table-2: Monthly variation in physico-chemical parameter of Suswa River at sampling site-2 (2010-2012)

S. No	Season	Summer	Monsoon	Winter	Average
	Parameter				
1	Temperature ($^{\circ}\text{C}$)	23.85 \pm 2.38	24.79 \pm 0.95	19.71 \pm 1.20	22.78 \pm 2.70
2	Conductivity (Siemens/cm)	0.02 \pm 0.00	0.02 \pm 0.01	0.02 \pm 0.00	0.02 \pm 0.00
3	Turbidity (JTU)	0.00 \pm 0.00	30.00 \pm 6.00	0.00 \pm 0.00	10.00 \pm 17.32
4	Total solid (mg/l)	1000.00 \pm 0.00	937.50 \pm 408.24	687.50 \pm 478.71	875.00 \pm 165.36
5	Velocity (m/s)	0.32 \pm 0.06	0.36 \pm 0.10	0.33 \pm 0.05	0.34 \pm 0.02
6	pH	7.31 \pm 0.19	7.38 \pm 0.01	7.29 \pm 0.26	7.33 \pm 0.05
7	BOD (mg/l)	0.78 \pm 0.50	0.82 \pm 0.72	0.65 \pm 0.98	0.75 \pm 0.09
8	COD (mg/l)	3.30 \pm 0.23	3.28 \pm 0.00	2.53 \pm 0.31	3.04 \pm 0.44
9	DO (mg/l)	8.24 \pm 0.84	7.65 \pm 0.936	8.82 \pm 0.77	8.24 \pm 0.59
10	ORI (rH ₂)	28.53 \pm 0.44	28.38 \pm 0.18	27.31 \pm 0.27	28.07 \pm 0.67
11	ORP (Eh)	0.39 \pm 0.00	0.39 \pm 0.01	0.36 \pm 0.02	0.38 \pm 0.02
12	Free CO ₂ (mg/l)	2.97 \pm 0.96	4.97 \pm 1.77	1.18 \pm 0.62	3.04 \pm 1.89
13	Acidity (mg/l)	49.77 \pm 8.53	47.67 \pm 10.09	56.35 \pm 6.54	51.26 \pm 4.53
14	Alkalinity (mg/l)	254.47 \pm 33.86	287.29 \pm 52.65	258.43 \pm 3.15	266.73 \pm 17.91
15	Total hardness (mg/l)	240.85 \pm 16.38	232.25 \pm 19.02	239.89 \pm 20.54	237.66 \pm 4.71
16	Chlorides (mg/l)	18.39 \pm 5.91	22.15 \pm 5.03	17.21 \pm 1.47	19.25 \pm 2.58
17	Phosphates (mg/l)	0.04 \pm 0.01	0.10 \pm 0.00	0.06 \pm 0.02	0.07 \pm 0.03

Table-3: Monthly variation in physico-chemical parameter of Suswa River at sampling site-3 (2010-2012)

S. No	Season	Summer	Monsoon	Winter	Average
	Parameter				
1	Temperature ($^{\circ}$ C)	23.51 \pm 2.59	25.24 \pm 0.76	19.79 \pm 0.94	22.85 \pm 2.78
2	Conductivity (Siemens/cm)	0.03 \pm 0.00	0.02 \pm 0.00	0.02 \pm 0.00	0.02 \pm 0.01
3	Turbidity (JTU)	0.00 \pm 0.00	37.50 \pm 5.0	0.00 \pm 0.00	12.50 \pm 21.65
4	Total solid (mg/l)	1000.00 \pm 408.24	1312.50 \pm 645.49	875.00 \pm 478.71	1062.50 \pm 225.35
5	Velocity (m/s)	0.28 \pm 0.04	0.32 \pm 0.06	0.32 \pm 0.04	0.31 \pm 0.02
6	pH	7.32 \pm 0.34	7.49 \pm 0.26	7.36 \pm 0.04	7.39 \pm 0.09
7	BOD (mg/l)	0.77 \pm 0.36	0.97 \pm 0.57	0.44 \pm 0.22	0.73 \pm 0.27
8	COD (mg/l)	3.25 \pm 0.19	4.06 \pm 0.16	2.35 \pm 0.20	3.22 \pm 0.86
9	DO (mg/l)	7.98 \pm 0.77	7.47 \pm 1.00	8.71 \pm 1.39	8.05 \pm 0.62
10	ORI (rH ₂)	28.05 \pm 0.15	28.00 \pm 0.36	27.99 \pm 0.30	28.01 \pm 0.03
11	ORP (Eh)	0.37 \pm 0.01	0.87 \pm 0.03	0.37 \pm 0.0	0.54 \pm 0.29
12	Free CO ₂ (mg/l)	2.86 \pm 1.11	4.88 \pm 1.50	0.77 \pm 0.01	2.84 \pm 2.06
13	Acidity (mg/l)	61.08 \pm 24.58	51.34 \pm 18.55	62.28 \pm 12.86	58.23 \pm 5.99
14	Alkalinity (mg/l)	279.79 \pm 18.55	289.25 \pm 58.93	265.43 \pm 7.99	278.16 \pm 11.99
15	Total hardness (mg/l)	244.56 \pm 16.20	245.33 \pm 10.61	245.37 \pm 11.64	245.09 \pm 0.46
16	Chlorides (mg/l)	17.63 \pm 1.97	19.36 \pm 2.56	16.56 \pm 1.39	17.85 \pm 1.41
17	Phosphates (mg/l)	0.06 \pm 4.38	0.12 \pm 0.01	0.05 \pm 0.00	0.08 \pm 0.04

Table-4: Monthly variation in physico-chemical parameter of Suswa River at sampling site-4 (2010-2012)

S.No.	Season	Summer	Monsoon	Winter	Average
	Parameter				
1	Temperature ($^{\circ}\text{C}$)	23.25 \pm 2.13	23.93 \pm 1.32	18.85 \pm 1.11	22.01 \pm 2.76
2	Conductivity (Siemens/cm)	0.03 \pm 0.01	0.02 \pm 0.01	0.02 \pm 0.00	0.02 \pm 0.01
3	Turbidity (JTU)	0.00 \pm 0.00	32.50 \pm 0.00	0.00 \pm 0.00	10.83 \pm 18.76
4	Total solid (mg/l)	1187.50 \pm 408.24	1250.00 \pm 250.00	625.00 \pm 250.00	1020.83 \pm 344.22
5	Velocity (m/s)	0.38 \pm 0.12	0.39 \pm 0.07	0.39 \pm 0.08	0.39 \pm 0.01
6	pH	7.46 \pm 0.30	7.48 \pm 0.29	7.31 \pm 0.13	7.42 \pm 0.09
7	BOD (mg/l)	0.78 \pm 0.18	0.56 \pm 0.12	0.49 \pm 0.29	0.61 \pm 0.15
8	COD (mg/l)	3.02 \pm 0.31	2.48 \pm 0.00	3.95 \pm 1.00	3.15 \pm 0.74
9	DO (mg/l)	7.94 \pm 0.29	7.63 \pm 0.62	7.62 \pm 1.47	7.73 \pm 0.18
10	ORI (rH ₂)	28.39 \pm 0.30	28.35 \pm 0.53	27.96 \pm 3.16	28.23 \pm 0.24
11	ORP (Eh)	0.36 \pm 0.01	0.38 \pm 0.02	0.35 \pm 0.01	0.36 \pm 0.02
12	Free CO ₂ (mg/l)	3.17 \pm 1.0	4.89 \pm 2.97	0.85 \pm 1.97	2.97 \pm 2.03
13	Acidity (mg/l)	62.39 \pm 28.35	51.25 \pm 16.90	66.87 \pm 8.54	60.17 \pm 8.04
14	Alkalinity (mg/l)	279.67 \pm 49.56	284.79 \pm 42.10	262.35 \pm 11.97	275.60 \pm 11.76
15	Total hardness (mg/l)	233.93 \pm 20.78	246.16 \pm 26.11	239.78 \pm 3.00	239.96 \pm 6.12
16	Chlorides (mg/l)	17.77 \pm 2.99	22.17 \pm 3.84	15.69 \pm 3.22	18.54 \pm 3.31
17	Phosphates (mg/l)	0.03 \pm 0.01	0.09 \pm 0.01	0.04 \pm 0.04	0.05 \pm 0.03

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Increasing demand of water and diseases associated with the water quality develops the need to define the quality of water of specific uses. Accurate assessment of water quality depends on the results generated by specific monitoring activities, which defines the condition of the resource. During the study period out of all the sampling site maximum temperature ($25.24\text{ }^{\circ}\text{C} \pm 0.76$) observed was at sampling site-3 during monsoon season and minimum ($18.85\text{ }^{\circ}\text{C} \pm 1.11$) at sampling site-4 during winter. The water temperature showed an upward trend from winter season to summer season followed by a downward trend from monsoon season onwards. A more or less similar trend has been observed in the river Yamuna by Chakrabarty *et al.* (1959) and in the Kallayi (John, 1976). Badola and Singh (1981) reported similar trend in river Alaknanda. The fluctuation of temperature was well within the limit for survival of fishes. Similar types of fluctuations were reported by Dwivedi *et al.* (1995) in two ponds at Patna. Site-3 ($22.85^{\circ}\text{C} \pm 2.78$) showed the maximum average value of temperature during study period.

The conductivity in this study was observed maximum ($0.05\text{ siemens/cm} \pm 0.01$) at sampling site-1 but the value of conductivity was found nearly constant for other three sampling site and that was 0.02 siemens/cm except during summer season at sampling site-3 and 4 where value of conductivity observed was 0.03 siemens/cm .

Turbidity in this study during summer and winter season remains nil at all the four sampling site but the maximum ($37.50\text{ JTU} \pm 5.00$) value of turbidity was found at sampling site-3 during monsoon season. Similar trend was found by Verma *et al.* (1984).

The value of total solid observed to be maximum ($1312.50\text{ mg/l} \pm 645.49$) at sampling site-3 during monsoon and minimum ($625.00\text{ mg/l} \pm 250.00$) at sampling site-4 during winter season. Observing the value of the entire sampling site it was found that highest ($1062.50\text{ mg/l} \pm 225.35$) average value at sampling site-3 and lowest ($820.21\text{ mg/l} \pm 103.81$) average value at sampling site-1 was observed for total solid. David (1956) and Verma and Shukla (1976) reported the similar trend for total solid in their study.

The lowest ($0.23\text{ m/s} \pm 0.05$) and highest ($0.39\text{ m/s} \pm 0.07$) velocity was observed at sampling site-1 in winter and at sampling site-4 in monsoon respectively. This observation is also supported by the work done by Kudesia and Verma (1985) and Reddy and Venkateshwarlu (1987). Highest ($0.39\text{ m/s} \pm 0.01$) and lowest ($0.27\text{ m/s} \pm 0.04$) average velocity were also found at sampling site-4 and 1 respectively. During study it was found the highest velocity of river water at all the sampling site was in monsoon.

pH represent the intensity of acidity or alkalinity of water. It plays a limiting role in the growth of flora and fauna of aquatic body. In the present study the value of pH observed to be maximum (7.62 ± 0.28) at sampling site-1 and minimum (7.29 ± 0.26) at sampling site-2 during monsoon and winter respectively. This observation was similar to the findings of Sagun and Sharma (1985), Meshram (1996). Maximum (7.44 ± 0.15) and minimum (7.33 ± 0.03) average value of pH also observed at site-1 and site-2 respectively.

During this study the highest ($0.97\text{ mg/l} \pm 0.57$) and lowest ($0.44\text{ mg/l} \pm 0.22$) value of BOD was observed at sampling site-3 in monsoon and winter respectively but the maximum ($0.75\text{ mg/l} \pm 0.09$) average BOD at sampling site-2 and minimum ($0.61\text{ mg/l} \pm 0.15$) average BOD at sampling site-4 was found. Seasonal trend found in this study was similar to the findings did by Khanna (1993), Chugh (2000).

Sampling site-3 showed the maximum ($4.06 \text{ mg/l} \pm 0.16$) and minimum ($2.35 \text{ mg/l} \pm 0.20$) value of COD during monsoon and winter respectively. Site-3 also showed the highest ($3.22 \text{ mg/l} \pm 0.86$) average value of COD but the lowest ($2.90 \text{ mg/l} \pm 0.50$) average value of COD was observed at sampling site-1.

The maximum ($8.71 \text{ mg/l} \pm 1.39$) and minimum ($7.47 \text{ mg/l} \pm 1.00$) value of DO on comparing the observation of all sampling site was found in winter and monsoon season respectively at sampling site-3. Similar trend of DO was also observed by Badola and Singh (1981) for river Alaknanda, Khanna (1993) and Chugh (2000) for the river Ganga. Highest ($8.24 \text{ mg/l} \pm 0.59$) average value of DO was recorded for sampling site-2 and lowest ($7.73 \text{ mg/l} \pm 0.18$) at sampling site-4 out of all the four sampling site. Highest value of DO was recorded for river Cauvery by Somashekar (1984) and for Kosi River by Bhatt *et al.* (1984). For any particular sampling site value of DO was lowest in monsoon and highest in winter except sampling site-4 where highest DO was observed in summer.

Oxidation reduction index showed its maximum ($28.58 \text{ rH}_2 \pm 0.26$) and minimum ($27.31 \text{ rH}_2 \pm 0.27$) values in summer season at sampling site-1 and in winter season at sampling site-2. Gautam (1990) found the similar result during his study. Site-1 showed the maximum ($28.41 \text{ rH}_2 \pm 0.23$) and site-3 showed the minimum ($28.01 \text{ rH}_2 \pm 0.03$) average value of oxidation reduction index.

Oxidation reduction potential showed its maximum ($0.87 \text{ Eh} \pm 0.03$) and minimum ($0.35 \text{ Eh} \pm 0.01$) values in monsoon season at sampling site-3 and in winter season at sampling site-4. Gautam (1990) found the similar result during his study. Site-3 showed the maximum ($0.54 \text{ Eh} \pm 0.29$) and site-4 showed the minimum ($0.36 \text{ Eh} \pm 0.02$) average value of oxidation reduction potential.

Free CO_2 showed a regular trend of increasing from winter to monsoon at all the four sampling site. Comparing all the observation it was found that the value of CO_2 found was maximum ($4.97 \text{ mg/l} \pm 1.77$) in monsoon at sampling site-2 and minimum ($0.77 \text{ mg/l} \pm 0.01$) in winter at sampling site-3. Average value of CO_2 was maximum ($3.04 \text{ mg/l} \pm 1.89$) at sampling site-2 and minimum ($2.66 \text{ mg/l} \pm 0.89$) at sampling site-1. Seasonal trend observed in this study was similar to the findings of Pahwa and Mehrotra (1966), Chakrabarty *et al.* (1959).

Maximum ($66.87 \text{ mg/l} \pm 8.54$) and minimum ($47.67 \text{ mg/l} \pm 10.09$) value of acidity were observed at sampling site-4 and 2 respectively during the study period. The maximum value during winter season and minimum value during monsoon season were observed. On comparing the average value of acidity we found that sampling site-2 showed the minimum

($51.26 \text{ mg/l} \pm 4.53$) and sampling site-4 showed the maximum ($60.17 \text{ mg/l} \pm 8.04$) values.

Alkalinity is the measure of carbonate and bi-carbonate. It showed variation in its value from maximum ($289.25 \text{ mg/l} \pm 58.93$) to minimum ($254.47 \text{ mg/l} \pm 33.86$) which were observed at sampling site-3 and 2 respectively. The maximum value of alkalinity was observed in monsoon season and minimum value of alkalinity in summer season. This observation is similar to the findings of Venkateshwarlu and Jayanti (1968) for the river Sabarmati.

The value of total hardness is governed by the contents of calcium and magnesium salts, largely combined with bicarbonate, carbonate, sulphate and chloride. The maximum ($246.16 \text{ mg/l} \pm 26.11$) and minimum

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(232.25 mg/l \pm 19.02) value of total hardness was observed at sampling site-4 and 2 respectively during the study period. The maximum and minimum values were observed in monsoon. The maximum (245.37 mg/l \pm 11.64) and minimum (237.66 mg/l \pm 4.71) average value of total hardness were observed at sampling site-3 and 2 respectively.

Chloride in the water occurs as salt of sodium and calcium. The concentration of chloride vary from maximum (22.17 mg/l \pm 3.84) at sampling site-4 to minimum (15.69 mg/l \pm 3.22) at sampling site-4 during monsoon and winter season respectively. But the average value was maximum (19.25 mg/l \pm 2.58) at sampling site-2 and minimum (17.64 mg/l \pm 1.83) at sampling site-1.

Phosphate showed maximum (0.13 mg/l \pm 0.02) value at site-1 during monsoon season and minimum (0.03 mg/l \pm 0.01) at site-1 and 4 during summer season. Maximum (0.10 mg/l \pm 0.05) and minimum (0.05 mg/l \pm 0.03) value of phosphate were observed at sampling site-1 and 4 respectively.

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