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Water Quality Investigation by Physicochemical Parameters of Satluj River (Himachal Pradesh, India)

NAVENDU SHARMA[1] and YOGESH KUMAR WALIA[2]*

[1]Research Scholar, Department of Chemistry, Career Point University, Kota (Rajasthan), India.
[2]Department of Chemistry, School of Basic & Applied Sciences, Career Point University, Hamirpur (Himachal Pradesh), India.
*Corresponding author E-mail : yogesh.che@cpuh.in

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ABSTRACT

Present investigation was carried out on Satluj river in Himachal Pradesh for the analysis of important physical and chemical water quality parameters during November, 2015 to February, 2016. Parameters such as turbidity, total alkalinity, pH, conductivity, magnesium hardness, biological oxygen demand (BOD), chemical oxygen demand (COD), dissolved carbon dioxide, total hardness, chloride, phosphate, nitrate and calcium were analyzed from five sampling stations i.e. First Sampling Station (SS-1) – Khab, Kinnaur, Himachal Pradesh; Second Sampling Station (SS-2) – Wangtoo, Near dam site of Karcham Wangtoo Hydroelectric Plant, Kinnaur, Himachal Pradesh; Third Sampling Station (SS-3) – Bayal at the Rampur city, Shimla, Himachal Pradesh; Fourth Sampling Station (SS-4) - Kol dam, Bilaspur, Himachal Pradesh and Fifth Sampling Station (SS-5) - Wajipur Kalan, Ludhiana, Punjab in the study area. The analyses were carried out according to APHA, 2012 procedures. The analysis of data reveals that turbidity, chemical oxygen demand, biological oxygen demand and chlorides were found to be higher than the acceptable limit prescribed by Bureau of Indian standards (BIS), WHO standards. Higher values of these parameters reveal that the pollution in Satluj river is due to siltation, domestic & municipal sewage, industrial sewage and surface run-off that effect the water quality directly or indirectly.

Keywords: Satluj river, Water Quality, Physicochemical, Sampling Station, BOD, COD, Turbidity, Chlorides.

INTRODUCTION

Water is one of the most important and abundant compounds of the ecosystem. All living organisms on the earth need water for their survival and growth[1,2]. The quality of water usually described by its physical, chemical and biological characteristics[4 ,6]. India is facing a serious problem of natural resources scarcity, especially that of water in view of population growth and economic development[3,7,12]. Most of fresh water bodies all over the world are getting polluted, thus decreasing the portability of water[5,8,9]. The river water quality is highly variable by nature due to environmental conditions such as basin lithology, vegetation and climate [5,10, 11].

The Satluj river is the easternmost tributary of the Indus river and origin is located close to Lake Rakhastal in Tibet in the vicinity of the Kailash Mountain Range. The Satluj river usually runs according to a west to southwest itinerary moving into India via the Shipki La Pass located in Himachal Pradesh after that entered in the Punjab[13]. In Satluj river, daily substantial quantity of domestic & municipal sewage etc. are discarded other than

industrial effluents, surface run-off and siltation. As no systematic study has been undertaken to assess the water quality of Satluj river with respect to physicochemical parameters. Hence it is planned to analyze the physico-chemical parameters of Satluj river water.

MATERIALS AND METHODS

In order to assess the water quality of Satluj river, five sampling stations i.e. First Sampling Station (SS-1) – Khab, Kinnaur, Himachal Pradesh; Second Sampling Station (SS-2) – Wangtoo, Near dam site of Karcham Wangtoo Hydroelectric Plant, Kinnaur, Himachal Pradesh; Third Sampling Station (SS-3) – Bayal at the Rampur city, Shimla, Himachal Pradesh; Fourth Sampling Station (SS-4) - Kol dam, Bilaspur, Himachal Pradesh and Fifth Sampling Station (SS-5) - Wajipur Kalan, Ludhiana, Punjab were selected on the basis of identified pollution problems and upon the location of points of sources of waste water discharge in the selected stretch of Satluj river. The water samples were collected during winter season in the month of November 2015 to February 2016. The pH was recorded using digital pH meter (Environmental & Scientific Instruments111E), turbidity was recorded using digital turbidity meter (Environmental & Scientific Instruments 331E), conductivity was recorded using digital conductivity meter (Environmental & Scientific Instruments 611E) and while remaining physicochemical parameters were measured by the procedures using standard methods (APHA 2012).[19]

RESULTS

The results of various physicochemical parameters recorded during present study at all the five sampling stations are presented in Tables 1, 2, 3 & 4. This study for physicochemical specifications of Satluj river water suggests that the various parameters depend upon the chemical hydrology of the study area and also on the different sites from which waste water is released. The results obtained for physicochemical properties during this study were found varied with the standard values for water quality given by World Health Organization, 2011 (WHO)[20], Bureau of Indian Standards, 2012 (BIS)[21] to classify the polluted sites as per their pollutant load.

The results obtained were analyzed and compared with the WHO, BIS and ICMR standards and discussed in brief. The analysis of data reveals that turbidity, chemical oxygen demand, biological oxygen demand and chlorides were found to be higher than the permissible limit prescribed by WHO, BIS and ICMR.

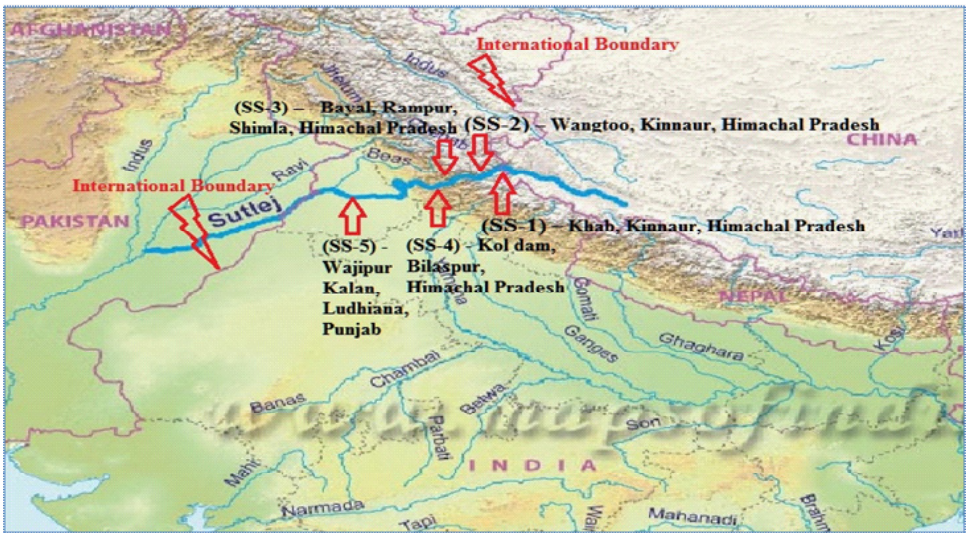

Fig. 1: location of Satluj River area showing five different water sampling stations

DISCUSSION

Water Turbidity

Turbidity for the water is an important property, which effects the light penetration. Turbidity is the measure of suspended sediment such as silt, clay, organic matter, and microscopic organisms in water sample. The average value of water Turbidity in study area of Satluj river varies from 9.25 to 298.00 NTU (Tables 1, 2, 3 & 4), which was higher than of 10 mg and 25 mg/l prescribed by BIS, 2012 and ICMR[23] respectively. The higher value especially on SS-1was due to confluence of high silt content.

Total Alkalinity

Alkalinity of water is the amount of fragile acid present in it and of the balanced cations across them.[15] In present study average value of total alkalinity varied from minimum of 89.25 mg/l at SS-3 to a maximum of 263.75 mg/l at SS-5 within the permissible limit of 600 mg/l prescribed by BIS, 2012.The high values of alkalinity were found in

Table 1: Physicochemical analysis of Satluj river during November, 2015

S.No.	Parameter	SS-1	SS-2	SS-3	SS-4	SS-5
1	Water Turbidity (as NTU)	305	35	158	10	52
2	Total Alkalinity (mg/ltr)	181	100	92	83	367
3	pH	7.74	6.65	6.71	6.34	7.17
4	Conductivity (ìmho/cm)	508	388	390	190	1368
5	Magnesium Hardness (mg/ltr)	26	21	5.3	5.3	24
6	BOD (mg/ltr)	BDL	6.2	BDL	12	41
7	COD (mg/ltr)	80	35	84	38	230
8	Dissolved Carbon Dioxide (mg/ltr)	7.9	42	35	40	60
9	Total Hardness (mg/ltr)	260	167	66	77	319
10	Chloride (mg/ltr)	7.9	14	26	13	232
11	Phosphate values (mg/ltr)	0.03	2.4	3	5	6.5
12	Nitrate values (mg/ltr)	0.99	1.8	9	2.8	28
13	Calcium Hardness (mg/ltr)	62	31	17	22	88

Table 2: Physicochemical analysis of Satluj river during December, 2015

S.No.	Parameter	SS-1	SS-2	SS-3	SS-4	SS-5
1	Water Turbidity (as NTU)	295	21	163	15	76
2	Total Alkalinity (mg/ltr)	184	149	11	121	345
3	pH	7.69	6.54	6.66	6.33	7.11
4	Conductivity (?mho/cm)	556	402	395	200	986
5	Magnesium Hardness (mg/ltr)	28	28	27	5	27.7
6	BOD (mg/ltr)	1.5	7.4	7.1	16	15
7	COD (mg/ltr)	76	26	38	32	158
8	Dissolved Carbon Dioxide (mg/ltr)	7.5	25	15	26	45
9	Total Hardness (mg/ltr)	270	198	220	110	312
10	Chloride (mg/ltr)	8.4	16.6	25	18	189
11	Phosphate values (mg/ltr)	0.02	1.34	0.02	3.88	5.45
12	Nitrate values (mg/ltr)	0.44	0.8	0.6	0.45	18
13	Calcium Hardness (mg/ltr)	68	26	36	34	78

SS-1, SS-2 and SS-5. The high value of alkalinity indicates the presence of weak and strong base such as carbonates, bicarbonates and hydroxides in the water body.

pH

pH is used for evaluating the acid-base balance present in water. pH is correlated with electrical conductance and total alkalinity. The higher value of pH recommend that carbon dioxide, carbonate-bicarbonate equilibrium is affected more due to change in physico-chemical condition.[14] In the present study pH varied from neutral to alkaline i.e. 6.22 to 7.74 maximum at SS-1 and minimum at SS-4. It is found that river water is slightly acidic; it may be due to addition of domestic, municipal sewerages and also agricultural wastes. The results show that these values are below the maximum permissible limit.

Conductivity

The conductivity is numerical expression of water's ability to conduct electric current and depends on the concentration of ions in solution.

Table 3: Physicochemical analysis of Satluj river during January, 2016

S.No.	Parameter	SS-1	SS-2	SS-3	SS-4	SS-5
1	Water Turbidity (as NTU)	290	5	174	6	80
2	Total Alkalinity (mg/ltr)	196	191	156	126	178
3	pH	7.79	6.36	6.57	6.12	6.92
4	Conductivity (?mho/cm)	607	368	327	227	903
5	Magnesium Hardness (mg/ltr)	28	34	32	3	21
6	BOD (mg/ltr)	BDL	8	8	18	1.9
7	COD (mg/ltr)	80	35	84	38	230
8	Dissolved Carbon Dioxide (mg/ltr)	7	6	6	1.2	27
9	Total Hardness (mg/ltr)	280	240	280	120	245
10	Chloride (mg/ltr)	9.6	19	9.6	21	126
11	Phosphate values (mg/ltr)	0.01	0.01	0.01	0.02	2.16
12	Nitrate values (mg/ltr)	0.102	2.73	0.1	0.85	17
13	Calcium Hardness (mg/ltr)	72	18	42	36	62

Table 4: Physicochemical analysis of Satluj river during February, 2016

S.No.	Parameter	SS-1	SS-2	SS-3	SS-4	SS-5
1	Water Turbidity (as NTU)	302	11	176	6	65
2	Total Alkalinity (mg/ltr)	173	154	98	91	165
3	pH	7.77	6.89	6.69	6.12	6.99
4	Conductivity (?mho/cm)	443	267	287	210	398
5	Magnesium Hardness (mg/ltr)	18	27	28	2	16
6	BOD (mg/ltr)	1.2	9	8	16	1.8
7	COD (mg/ltr)	80	35	84	38	230
8	Dissolved Carbon Dioxide (mg/ltr)	6.8	6	5.6	2.1	29
9	Total Hardness (mg/ltr)	278	220	245	102	188
10	Chloride (mg/ltr)	9.6	19	9.6	21	126
11	Phosphate values (mg/ltr)	0.01	BDL	0.01	0.02	2.11
12	Nitrate values (mg/ltr)	0.2	0.9	0.1	0.63	14
13	Calcium Hardness (mg/ltr)	70	26	44	40	57

Conductivity measurement is an excellent indicator of TDS, which is a measure of salinity that affects the taste of potable water. In present study, the average value of conductivity of Satluj river water varies from 206.75 to 913.75 ìmho/cm minimum at SS-4, and maximum at SS-1. It was seen that the maximum conductivity at SS-1 which can be attributed to excess silts.

Magnesium Hardness

Magnesium hardness contributes both carbonate and non carbonate hardness to water.[3] The average value of magnesium in study area of Satluj river varies from 3.82 to 27.50 mg/l, minimum is at SS-4, and maximum is at SS-2, which was within the permissible limit of 100 mg/l prescribed by BIS, 2012.

Biochemical Oxygen Demand (BOD)

BOD test help to measure the amount of biodegradable organic material of water sample.[3] In the present study the BOD of water sample was varied between 7.65 to 15.50 mg/l with minimum at SS-2 and maximum at SS-4. The unpolluted water has BOD value of 3 mg/l or less and polluted water has BOD value higher than 25mg/l. The value of BOD in the present study was highest in SS-4 which indicates that the river is polluted.

Chemical Oxygen Demand (COD)

Chemical Oxygen Demand is amount of oxygen required for the oxidation of oxidizable organic matter.[3] Chemical Oxygen Demand of river varies from 34.25 to 121.75 mg/l, minimum is at SS-2 and maximum is at SS-5. A trend of increasing COD level was observed at SS-1, SS-3 and SS-5 showing the population load and activities caused by the mixing of sewage water, garbage dumping and industrial discharges. This increase in COD indicates that the pollution may increase and hence need exercise for monitoring and control.

Dissolved Carbon Dioxide (CO_2)

Dissolved Carbon dioxide is the end product of organic carbon degradation in almost all aquatic environments and its variation is often a measure of net ecosystem metabolism.[16 & 17] Dissolved CO_2 of Satluj river varies from 7.30 to 40.25 mg/l, minimum is at SS-1, and maximum is at SS-5.

Total Hardness

Total hardness of the water expresses the role of dissolved minerals specially in terms of Calcium and Magnesium which determines the suitability of water for various purposes such as domestic, industrial, drinking etc. and applied to the presence of bicarbonates, sulphates, chlorides and nitrates of both calcium and Magnesium.[18] The observation of total hardness reveals that Hardness of the river water fluctuated between 102.25 to 272.00 mg/l with minimum at SS-4 and Maximum at SS-1. The results indicate that the Satluj river is hard based on water hardness classification showing their less suitability for drinking and industrial purposes.

Chloride

Chloride in river water are mainly due to the presence of sediments, sewage and industrial effluents. In present study the values of chloride varied between 8.75 to 150.75 mg/l with minimum at SS-1 and Maximum at SS-5. BIS, 2012 prescribed the permissible limit of chloride is as 250 mg/l. Chloride concentration in Satluj river water are within prescribed limit.

Phosphate

The main sources which increase the phosphorous load in river water are use of fertilizers, use of detergents and domestic sewage.[22] The value of Phosphate in water of river varies from 0.01 to 4.05 mg/l, minimum is at SS-1, and maximum is at SS-5. The BIS, 2012 suggested the limit of phosphate is 0.1 mg/l. The higher value at SS-5 may be due to addition of domestic, municipal sewerages and also agricultural wastes.

Nitrate

The value of nitrate in water of river varies from 0.43 to 19.25 mg/l, minimum is at SS-1, and maximum is at SS-5, which was within the acceptable limit prescribed by BIS, 2012 and WHO, 2011 respectively. Basic source of nitrates is nitrogen which is constituent of proteins, chlorophyll and many other biological compounds.[5]

Calcium

Calcium is mainly the micronutrient which present in an aquatic environment. The hardness of the river water is of chief significance

in connection with the discharge of the sewage and industrial pollutants, as shown by variations in the concentration of the hardness of the water. Calcium causes both carbonate and non carbonate hardness of water.[3] The average value of calcium in study area of Satluj river varies from 25.25 to 71.25 mg/l, minimum is at SS-2, and maximum is at SS5-, which was within the acceptable limit. This concentration of calcium in river water may be due to occurrence of highly soluble halides, gypsum and easily weathered surface rocks.

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