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Seasonal Variation of Physico-chemical Parameters and Water Quality Indexing of Harike Lake

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River water is attracting the attention of government, public, Ngo's and environmentalists all more than ever before. This is in particular so as the dissolved solids percolate to underground water during recharge. All human activities tend to pollute the river waters with domestic, industrial and agriculture wastes. The underground water thus get inferior and unsuitable for drinking particularly when soluble ions get into the ground water resources. Arsenic, fluorides, nitrates in particular are found at many places above the tolerable levels. This paper deals with river water of Beas and Sutlej in Punjab are examined with the help of 16 parameter, namely 6 cations, 5 anions beside DO, BOD, TDS, pH and conductivity. Area chosen for the study was the confluence of the two main rivers of Punjab, namely Beas and Satluj at Harike in the form of Harike Lake. All the water quality parameters were estimated following standard methods and procedures. Water of the Lake has been found to be severally contaminated during 2007-08. The water is not fit for drinking and for industrial use.

INTRODUCTION

In the present study an attempt has been made to determine the physico-chemical status of Harike Lake located on the confluence of Satluj and Beas rivers. It is 66 km from Ferozpur road. The Sutlej and Beas rivers reach this site after completing almost whole of their course in India map is enclosed. Throughout their course, effluents from different cities, towns and villages get mixed with their waste. For this purpose 16 physico-chemical parameters are studied for 12 month. The water samples were collected monthly for one year from May 2007 to April 2008, to study the seasonal variation of different parameters and their water quality indexing.

Today the main reason of contamination of our water bodies is human activity (industrial, agricultural, mining and domestic). Wastes from these activities are polluting our water resources. Water quality index has been regarded as one of the most effective ways to evaluate water quality (Pradhan *et al.*, 2001; Sinha and Shrivastava, 1995; Kannan, 1991). In many studies the quality of water has been assessed on the basis of calculated water indices (Sinha *et al.*, 2004; Rajmohan et al., 2003; Singh and Ghose, 1999). The data obtained through qualitative analysis and WHO/EPA water quality standards (WHO, 1971) are used for calculating water quality indices. Here the purpose of calculating WQI is to assess the pollution of Harike Lake.

MATERIAL AND METHOD

From different sites samples were collected in 2L polythene bottles. Before sampling these bottles were rinsed with 0.1 N chromic acid and then washed thoroughly with distilled water. The samples were collected from Harike Lake (confluence of Satluj and Beas rivers) as given in table 1 once in a month for 12 month (4 seasons). Sixteen water quality physico-chemical parameters of Harike Lake were measured using standard methods and procedures of sampling and estimation (APHA, 1995; Merck, 1974). Brief descriptions of flow and mixing of effluent in both river water are given in figure

Figure 1. *Course of both rivers Satluj and Beas*

1. In table 1 all physico-chemical parameters and table 3 assigned unit weights are listed.

We have used the following equation for calculating WQI of water sample (Tiwari and Mishra, 1985: Horton, 1965).

$$Q_n = 100 \left[\frac{v_n - v_i}{v_s - v_i} \right]$$

wher v_n is actual amount of nth parameter and v_i ideal value of this parameter.

($v_i = 0$ except for pH and DO for pH $v_i = 7$ mg/L and for DO $v_i = 14.6$ mg/L)

v_s = Recommended WHO/EPA standard of corresponding parameters.

Unit weight (W_n) for various parameters is

Table 1. *Seasonwise and parameterwise values of V_n and Q_n*

Parameter	Summer		Rainy/ monsoon		Autumn		Winter	
	V_n	Q_n	V_n	Q_n	V_n	Q_n	V_n	Q_n
pH	8.33	133.33	8.27	126.67	8.47	146.67	8.42	141.67
TDS	436.67	87.33	437.33	87.47	476.67	95.33	432	86.4
Hardness	194.33	194.33	187.67	187.33	193.33	193.33	216.67	216.67
Alkalinity	87,33	87.33	95.53	95.53	115	115	105.33	105.33
Sulphate	548	274.03	448.33	672.5	603.37	301.68	570.23	268.45
Chloride	32.37	16.18	30.6	15.3	35.67	17.83	43.33	21.67
Conductance	335.67	251.75	332.67	83.17	373.33	93.33	351.67	87.92
BOD	4.45	74.16	4.57	76.11	4.7	78.35	4.48	74.72
DO	9.51	52.95	9.45	53.68	9.17	56.59	9.29	55.38
Ca	31.64	31.64	25.12	25.12	29.3	29.3	31.51	31.51
Fe	0.43	87	0.12	24	0.79	158.67	0.82	163.33
Cr	0.74	1473.33	0.42	840	0.49	980	0.64	1273.33
Zn	3.13	62.67	2.77	55.33	2.57	51.33	2.6	52
Fl	1.58	105.55	1.21	80.44	1.19	79.55	1.18	78.89
Nitrate	4.67	46.73	4.09	40.93	5.2	52	5.03	50.27
Nitrite	0.49	49	0.53	52.67	1.34	133.67	0.97	96.67

inversely proportional to recommended standards (S_n) for the corresponding parameters is given by

(S_n) for the corresponding parameter is given by

$$w_n \frac{k}{S_n}$$

Where k is constant and S_n is worldwide accepted water quality standard prescribed by WHO/EPA.

We consider here $\sum_{n=1}^{16} W_n = 1$

Sub indices are given by $(SI)_n = (Q_n)^{W_n}$

The overall WQI is calculated by taking geometric mean of these sub indices given by

$$WQI = \prod_{n=1}^{16} (SI)_n = \prod_{n=1}^{16} (Q_n)^{W_n}$$

or $$WQI = \text{anti}\log_{10}\left[\sum_{n=1}^{16} W_n \log_{10} Q_n\right]$$

Quality status is assigned on the basis of calculated values of water quality indices. Following assumptions are made in order to assess the extent of contamination or the quality of drinking water (Tiwari and Mishra, 1986).

WQI < 50: Fit for human consumption

WQI < 80: Moderately contaminated

WQI > 80: Excessively contaminated

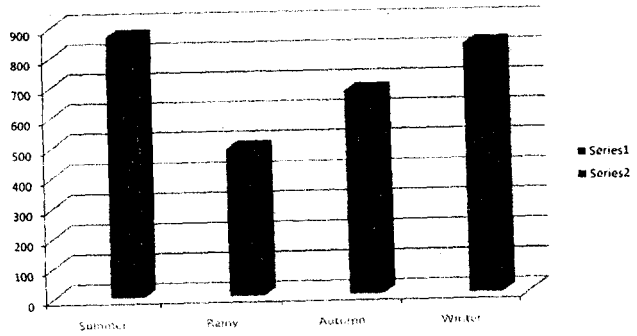
WQI > 100:Severally contaminated

RESULT AND DISCUSSION

The physico-chemical parameters with their WHO/FPA standard and assigned unit weight (W_n) with the help of equations are given on previous pages. Seasonwise and parameterwise estimated value (v_n) and calculated quality rating (Q_r) are also given in table 1 critical analysis of WQI is presented in table 2 and their comparison with standard assumption reveals facts regarding the level of contamination and seasonal variation of various parameters in Harike Lake during year (2007-2008) the course of study. The observed values of WQI are exceptionally high for all the 4 seasons (summer, rainy, autumn and winter). Water found to be severally contaminated. Values are lowest rainy season. In Punjab there is complex seasonal variability where July to September rainy season is due to monsoons

Table 2. *Values of water quality index for all seasons*

Season	WQI value
Summer	867.6508
Rainy	489.2968
Autumn	657.3613
Winter	827.6077



Statistical analysis of water quality index (WQI)

Table 3. *WHO/EPA Standards and assigned unit weights (W_n), in mg/L*

Parameter	WHO/EPA standard (V_s)	Assigned unit weight (W_n)
pH	8.00	0.0051373
TDS	500	0.0000822
Total hardness	100	0.0004099
Alkalinity	100	0.0004099
Sulphate	200	0.0002054
Chloride	200	0.0002054
Conductance	400	0.0001027
BOD	6	0.006849
DO	5	0.008219
Ca	100	0.0004099
Fe	0.5	0.082198
Cr	0.05	0.82198
Zn	5	0.00082198
Fl	1.5	0.027399
Nitrate	10	0.004109
Nitrite	1	0.041099

while in winter rains occur due to Typhoons from Persian Gulf. Due to rainy seasons although cationic and anionic species are added to lake water but due to excessive rainfall dilution occurs and we get the minimum values of WQI in rainy seasons as compared to other months. During summer season high rate of evaporation take place as temperature may go even upto 45°. Hence concentration of contaminants increases in this season.

CONCLUSION

On the basis of above results we conclude that Harike Lake water in all seasons (2007-2008) is severally contaminated and unfit for consumption. The concentration of various parameters within one and the same area may be function of time, so that frequency distribution as a function of sampling month has been done to estimate the seasonal variation of various parameters to draw more precise conclusion about the cationic and anionic species present in water of Harike Lake.

Sulphate content is useful in water quality measurements, since sulphur is a key pollutant of air (SO_x from various industries, thermal power plants, vehicle exhaust). When oxides of sulphur get mixed with water droplets in atmosphere and form sulphurous (H_2SO_3) and sulphuric (H_2SO_4) acid these are the major cause of acid rain. Similar is the case of oxides of nitrous and nitric acid. Both these acids are the main constituents of acid rain, hence contaminating our water bodies. Maximum diseases spread due to water pollution. There is a need for regular monitoring of these useful resources of water and steps should be taken to reduce the concentration of the contaminants.

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