Biological Forum – An International Journal **8**(1): 559-564(2016)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Water Quality Assessment of Gobind Sagar Lake during Rainy Season in Himachal Pradesh, India

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(Received 22 March, 2016, Accepted 19 May, 2016)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: This study was undertaken to determine the physico-chemical properties and heavy metals in water samples collected from Gobind Sagar Lake during Rainy Season in Himachal Pradesh, India. Water quality parameters and heavy metals were Water Temperature; pH; Conductivity; Total Alkalinity; Chemical Oxygen Demands; Dissolved Oxygen; Chloride; Total Hardness; Calcium Hardness; Magnesium Hardness; Dissolved Carbon Dioxide; Total Dissolved Solid; Biological Oxygen Demand; Cadmium; Copper; Chromium; Zinc; Nickel; Calcium; Lead; Manganese and Iron. The results revealed that the different conditions of Gobind Sagar Lake at different sampling stations showed fluctuations in some physico-chemical parameters and also in heavy metals. These result depicted that lake water was polluted at some of sampling stations due to bathing activities, boating activities, joining of sewage, agricultural activities and its runoff in and around the catchment area of Gobind Sagar Lake.

Key words: Water quality, physico-chemical, heavy metals, water parameters and Gobind Sagar Lake, water quality.

INTRODUCTION

Water is one of the most important natural resource available to mankind. Knowing the importance of water for sustenance of life, the need for conservation of water bodies especially the fresh water bodies is being realized everywhere in the world. Lakes, rivers and reservoirs are the most important water resources and used for several purposes (Sharma *et. al*, 2012). With continuous growth of population, rapid developments in agriculture, mining, urbanization, industrialization, hydroelectrical generation activities and motor vehicle pollution, the lake water contamination with hazardous waste is becoming common phenomenon (Shivayoginath *et. al*, 2012; CPCB, 2013 and Sharma and Walia, 2016). A high level of pollutants mainly organic matter in river water causes an increase in biological oxygen demand (Kulkarni, 1997) chemical oxygen demand, total dissolved solids and total suspended solids. They make water unsuitable for drinking, irrigation or any other uses (Hari, 1994; Sharma *et. al*, 2015).

Evaporation of water from the lake because of the increase in earth temperature, there is increase in quality of salts, heavy metals and other harmful substances, which are reliable cause of the degrade quality of the lake environment (Ho *et. al*, 2003). Due to toxic effect of metals in aquatic ecosystem, they have created a big problem; therefore it has public interest (Miller *et. al*, 2002; Censi *et. al*, 2006; Gibbs J., 1972 and Niemi *et. al*, 1990; Ashu and Praveen, 2010; Monika *et al.*, 2012).

In this regard, tremendous work has been carried out for assessing physico chemical parameters and heavy metals of various lakes throughout world (Pradhan *et. al*, 2012; Khan *et. al*, 2012; Babu and Selvanayagam, 2013 and Patel and Patel, 2012; Bhu Dayal and R.S Chauhan 2010). As no systematic study has been undertaken to assess the water quality of Gobind Sagar Lake in rainy season, hence the present investigation was undertaken.

MATERIAL AND METHOD

This study was carried out at Gobind Sagar Lake which is situated in Bilaspur District of Himachal Pradesh India. Gobind Sagar Lake is one of the largest man-made lake of India, was created by a 255 m high, straight gravity dam at Bhakra (31° 25'N and 76° 25'E) on the river Sutlej, which is a huge reservoir and is the result of Bhakra Nangal (power plant) dam. Construction of Bhakra Nangal dam was initiated in 1947 and the reservoir was formed in 1963. The lake is named after the Guru Gobind Singh, the tenth and last guru of Sikhs. It is a major landmark of Bilaspur District. This lake covers an area of 170 sq km and its length extends up to 90 km.

Sample analysis: Sampling stations of the lake were selected on the basis of the identified pollution problems to assess the overall status of the lake. To analyze the water of the lake, water samples were collected from three different stations of the lake first sampling station (S1) was Kundrour Bridge (Kundrour), second sampling station (S2) was Bathing Ghat (Luhnu), and third sampling station (S3) was ACC Cement Factory Pump House (Daiher). Water Samples for the analysis of water parameters [temperature, pH, dissolved oxygen (DO), chemical oxygen demand (COD), biological oxygen demand (BOD), chloride, total alkalinity, total hardness, carbon dioxide, total dissolved solid, lead, copper, iron, chromium, cadmium, nickel and manganese] were preserved and transported to research laboratory. For the preservation and the analysis of water samples of the lake water, the standard methods (Trivedy and Goel, 1986; APHA, 2012) were followed. The water samples were collected during the months from July to October 2014 at 10:30 a.m. The samples for analysis were collected in satirized bottles. Almost care was taken, so that no bubbling should observe during sampling, which avoids influence of the dissolved oxygen. The water temperature was recorded at the sample stations. The chemicals used were of A. R. grade and was used without further purification. The pH of water samples of the lake water was measured with the help of instrument pH Meter (Elico LI-120) with a glass electrode. The COD of the sample was measured by Open Reflux Method. Dissolved oxygen and BOD determined by Wrinkle's Azide Modification Titrimetric Method. Total Hardness was measured by EDTA Titrimetric Method. Chloride was measured by Argentometric Method. Alkalinity and Carbon dioxide of the water sample was measured by Titration Method. TDS of the sample was measured by drying it at 180°C. The metals of water sample were determined by Flame Atomic Absorption Spectroscopy (Shimadju AA-6300).

RESULTS

The observed values for the analysis of physico-chemical parameters and heavy metals [Water Temperature; pH; Conductivity; Total Alkalinity; Chemical Oxygen Demands; Dissolved Oxygen; Chloride; Total Hardness; Calcium Hardness; Magnesium Hardness; Dissolved Carbon Dioxide; Total Dissolved Solid; Biological Oxygen Demand; Cadmium; Copper; Chromium; Zinc; Nickel; Calcium; Lead; Manganese and Iron] are shown in Table 1, Table 2 and presented by graphs in Fig.1. The results obtained were analyzed, compared with the WHO (World Health Organization), CPCB (Central Pollution Board), ICMR (Indian Council of medical research) standards and discussed in brief, which had played a conclusive role in deciding the status of water quality of lake under study.

DISCUSSION

Water qualities provide the primary assessment of the pollution status and it can be determined through assessment of water quality parameters.

1. Temperature: Temperature is one of the most important parameters which influence water quality. The temperature of the water samples varied from minimum 17.9°C to maximum 26.5°C in rainy season. Low value of temperature was because of strong wind and rain (Prabhu *et. al*, 2008, Rajkumar *et. al*, 2009).

2. pH: Study shows that pH value was varied from 3.77 to 6.67. It is found a slight acidic of water. It is because of addition of domestic sewerages from houses and also due to agricultural wastes. The low value may be due to its consumption by phytoplankton (Rajaram *et. al*, 2005, Bragadeeswaran *et. al*, 2007).

3. Dissolved Oxygen (DO): Dissolved Oxygen of water body gives direct and indirect information e.g., stratification, bacterial activity, photosynthesis etc. (Premlata Vikal, 2009). In present study the Dissolved Oxygen was ranged between 2.1 mg/l to 3.2 mg/l. The results show that these values are below the prescribed limit.

4. Biochemical Oxygen Demand (BOD): Biochemical Oxygen Demand is the amount of oxygen required by organisms to stabilize biological decomposable organic matter in water. In present study the Biochemical Oxygen Demand was ranged between 0.11 mg/l to 0.7 mg/l. It was found that these values are below the maximum permissible limit.

5. Chloride: The chloride value of the lake water varied between 65.3 mg/l to 195 mg/l. It was found that they are below the maximum permissible limit.

Table1: Physico-chemical analysis at different sampling stations of Gobind Sagar Lake.

Parameter	Months	S1 (Sampling Station 1)	S2 (Sampling Station 2)	S3 (Sampling Station 3)
Water temperature	July, 2014	26	26.5	25.8
	August, 2014	25.5	26	25.9
	September, 2014	24	24	24
	October, 2014	18.2	18	17.9
pH	July, 2014	5.95	6.67	5.1
	August, 2014	5.32	5.48	5.42
	September, 2014	5.15	4.98	5.05
	October, 2014	3.77	4.37	4.49
Total Alkalinity	July, 2014	31	141	30
	August, 2014	28	138	24
	September, 2014	19	125	18
	October, 2014	12	115	12
Chloride	July, 2014	89	72	195
	August, 2014	82	69	120
	September, 2014	75	67	91.56
	October, 2014	71	65.3	87.43
Dissolved Oxygen	July, 2014	2.2	3.2	2.1
	August, 2014	2.2	3.2	2.3
	September, 2014	2.3	3.2	2.4
	October, 2014	2.3	3.1	2.5
Biological Oxygen Demand	July, 2014	0.3	0.7	0.3
	August, 2014	0.288	0.659	0.276
	September, 2014	0.211	0.543	0.117
	October, 2014	0.205	0.542	0.11
Chemical Oxygen Demand	July, 2014	1.921	0.085	0.095
	August, 2014	1.825	0.072	0.083
	September, 2014	1.734	0.0687	0.0721
	October, 2014	1.673	0.567	0.0633
Dissolved Carbon dioxide	July, 2014	4.6	3.2	3.4
	August, 2014	5.2	4.1	4.3
	September, 2014	3.6	2.9	2.9
	October, 2014	4	3	2.9
Total Hardness	July, 2014	45.3	82.5	50.1
	August, 2014	48.7	85.6	53.8
	September, 2014	48.3	85.4	53.4
	October, 2014	48.1	65.2	53.2
Calcium Hardness	July, 2014	31.5	55.4	35.4
	August, 2014	32.6	59.3	37.3
	September, 2014	31.3	55.1	36.3
	October, 2014	27.9	39.9	32.4
Magnesium Hardness	July, 2014	13.8	27.1	14.7
	August, 2014	16.1	26.3	16.5
	September, 2014	17	30.3	17.1
	October, 2014	20.2	25.3	20.8
Total Dissolved solids	July, 2014	105	192	120
	August, 2014	104	189	112
	September, 2014	101	185	102
	October, 2014	98.6	183	95
Conductivity	July, 2014	139.4	110.2	122.2
	August, 2014	144.3	92.5	110.5
	September, 2014	100.1	83.5	80.1
	October, 2014	100.1	67.9	70.5

Table 2: Concentrations of Heavy Metals for Gobind Sagar Lake.

Seasons	Sampling Stations	Lead (Pb)	Cadmium (Cd)	Nickel (Ni)	Iron (Fe)	Zinc (Zn)	Calcium (Ca)	Copper (Cu)	Chro-mium (Cr)	Manganese (Mn)
Rainy	S1	0.71	BDL	BDL	5.23	0.44	26.45	BDL	BDL	BDL
	S2	0.93	BDL	0.12	2.09	0.51	21.53	BDL	BDL	BDL
	S3	0.52	BDL	0.35	4.38	0.47	25.51	0.255	BDL	5.3

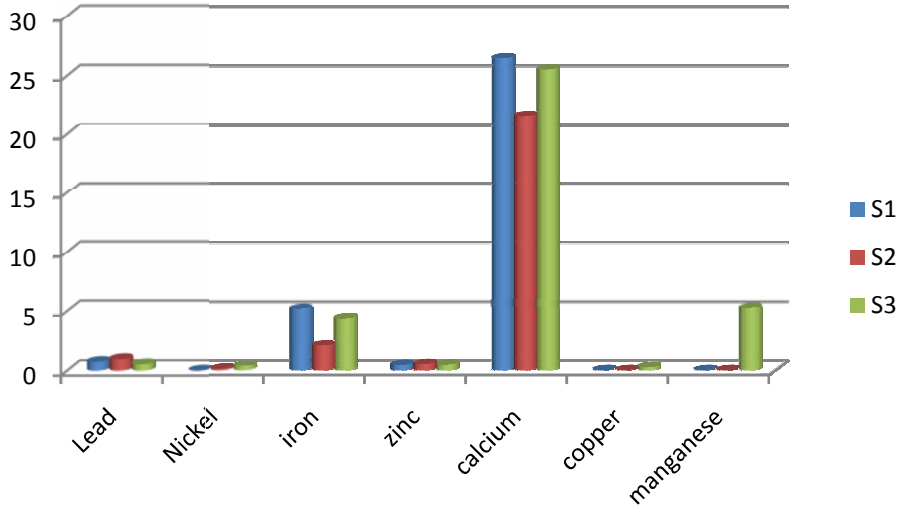

Fig. 1. Heavy Metal analysis at different sampling statiosns of Gobind Sagar Lake at Rainy Season.

6. Total Alkalinity: The alkalinity of water ranged from a minimum value 12 mg/l to a maximum value 141 mg/l. It was found below the maximum permissible limit.

7. Total Hardness: Total hardness determine the effect of dissolved minerals commonly Ca and Mg (Sharma and Walia, 2016). The study reveals that total hardness of water samples varied between 45.3 mg/l to 85.6 mg/l.

8. Calcium Hardness: Calcium Hardness in Gobind Sagar Lake varies from 27.9 mg/l to 59.3 mg/l. It was found below the maximum permissible limit. Deviations were arisen because of different environmental problems at different sampling station of the lake (Sharma and Walia, 2015).

9. Magnesium Hardness: Magnesium Hardness was observed between 13.8 mg/l and 27.1 mg/l. It was found that they are below the maximum permissible limit.

10. Conductivity: Conductivity of Gobind Sagar Lake varies from 67.9µmho/cm to 144.3 µmho/cm. It was found that they are below the maximum permissible limit.

11. Chemical Oxygen Demand (COD): Chemical Oxygen Demand is the measure of organic material contamination in water. Chemical Oxygen Demand Chemical Oxygen Demand of Gobind Sagar Lake was ranges from 0.0633 mg/l to 1.921 mg/l. It was found that they are below the maximum permissible limit.

12. **Dissolved Carbon Dioxide:** Dissolved CO_2 of Gobind Sagar Lake water ranges from 2.9 mg/l to 5.2 mg/l. It was found that they are below the maximum permissible limit.

13. Total dissolved solid (TDS): TDS give the cations and anions concentrations of the water. TDS of the lake varies from 95 mg/l to 192 mg/l. It was found that values are below the maximum permissible limit.

14. Lead: Lead in Gobind Sagar Lake varies from 0.52 mg/l to 0.93 mg/l, minimum value is at S3 and maximum value is at S2.The study shows that lead concentration was high and was found above the maximum permissible limit. High value is because of atmospheric contribution of lead which is originating from leaded gas, petrol or industrial processes. This is due to atmospheric input of lead originating from its use in the leaded gasoline or industrial processes.

It is also introduced into the environment from variety of sources such as solders, electrodes, batteries, newsprint and pigments in paints. The main contribution is from the combustion of lead containing coal.

15. Copper: The concentration of Copper in natural waters is generally very low. In Gobind Sagar Lake Copper concentration was 0.255mg/l at S3 but at S1 and S2, it was below detection limit. The study shows that copper concentration of water sample in lake water is found below the maximum permissible limit.

16. Iron: Iron is a rich element in the earth's crust, but in natural water system it exists normally in minor concentrations. Iron content in Gobind Sagar Lake varies from 2.09 mg/l to 5.23 mg/l, minimum value is at S2 and maximum value is at S1. The study shows that iron concentration of water sample in Gobind Sagar Lake water is above the maximum permissible limit. The most common sources of iron in lake water are naturally occurring, for example from weathering of iron bearing minerals and rocks, Industrial effluent (cement factory and latex factory near Gobind Sagar lake), sewage inlets and landfill leachate may also contribute iron to lake water.

17. Chromium: The chromium concentration in surface waters is usually very low. The study shows that chromium in Gobind Sagar Lake was below detection limit in all three sampling station.

18. Cadmium: Cadmium concentration in Gobind Sagar Lake was below detection limit in all three sampling station.

19. Nickel: Nickel in Gobind Sagar Lake varies from 0.12 mg/l to 0.35 mg/l, minimum value is at S2 and maximum value is at S3. The study shows that nickel concentration of water sample in lake water is below the maximum permissible limit.

20. Manganese: Manganese in Gobind Sagar Lake was 5.3 mg/l at S3 and was below detection limit at S1and S2. The results show that manganese concentration in lake water is above the maximum permissible limit. Manganese in lake water results from weathering of manganese bearing minerals and rocks, sewage inlets and landfill leachate.

21. Zinc: Zinc concentration in Gobind Sagar Lake varies from 0.44 mg/l to 0.51 mg/l, minimum value is at S1 and maximum value is at S2. The study results show that concentration of zinc in the water sample of lake water is within the permissible limit.

22. Calcium: Calcium in Gobind Sagar Lake was in between 21.53 mg/l and 26.45, minimum value was recorded at S2 and maximum value was recorded at S1. The results show that concentration of calcium in lake water is within the permissible limit.

ACKNOWLEDGEMENT

I am grateful to Career Point University, Hamirpur and CSIR- Institute of Himalayan Bioresource Technology, Palampur Himachal Pradesh, for providing necessary laboratory facilities.

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