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Physico-chemical analysis of Bansagar dam, Madhya Pradesh, India

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Abstract
The physico – chemical parameters like hardness, concentration of Mg^{2+} and Ca^{2+} ions, pH, alkalinity, TDS etc. of Bansagar dam water were studied. The results obtained by the analysis were compared with WHO and ISI standards. These results suggest the deteriorating status of the lake water. To keep it alive and usable a routine analysis of lake water is suggested by the authors at least once in a month. This will be helpful for the lake authorities to safe guard the lake water and keep its impurities levels under check. This study will also bring awareness among the people to maintain a healthy and green environment. These water bodies are very precious and there water should be saved from pollution.

Keywords: Alkalinity, pH, total dissolved solids, awareness, environment

1. Introduction
Water is the most important vital force for all life activities. Dam act as storage resources of water from ancient times. Their commercial importance is no less than industries, as it facilitates fishing, irrigation, laundry and municipal supply of drinking water. Studies on dam water parameters have been performed by many authors Deshbhratar *et al.* (2014) [2]; Dhurvey and Kashyap (2019) [3]; Kashyap (2016 & 2021) [5-6]; Manivannan *et al.* (2013) [7]; Rana (2018) [8]; Shrivastava, Kriti and Joshi (2008) [9]; Shukla and Pandey (2019) [10] and Sinha *et al.* (2014) [11] to emphasise the importance of conservation of water resources. In the present study authors have tried to analyse the water quality of Bansagar dam across the Sone River was constructed near the Deolond village in the Shahdol district. It is surrounded by Satna, Katni, and Rewa districts. The project was called "Bansagar" after Bana Bhatt, the renowned Sanskrit scholar of the 7th century, who is believed to have hailed from this region in India. Bansagar Dam is located at Latitude 24-11-30 N and Longitude 81-17-15 E. The Bansagar dam has a catchment area of 18,648 square kilometers and is supposed to provide irrigation on 249,000 hectares of land in Madhya Pradesh, 150,000 hectares in Uttar Pradesh and 94,000 hectares in Bihar. Along with irrigation, the project also generates 425 megawatt of electricity in Madhya Pradesh.

2. Material and Methods
Water samples from the Bansagar dam were collected as per standard procedures. The various Physico - chemical parameters were studied using standard methods (Dara, 2001) [1]. The results obtained were analyzed and compared with the WHO and ISI standards [4] listed in table 1. Temperature of the water samples was recorded at the sampling point. AR grade chemicals and glass distilled water was used for the preparation of the reagents. Electrical Conductivity and pH was determined using Systronics - Conductometer and Digital Systronics pH – meter respectively. The water quality parameters like Alkalinity, Total dissolved solids, Calcium and Magnesium ions, pH, Electrical Conductivity, Total, Temporary and Permanent hardness, etc. were studied and listed in Table 2.

3. Results and Discussion

Table 1: Water Quality Parameters and Their WHO & ISI Standards

S. No.	Parameters	Method	WHO Standards	ISI Standards
1.	Temp.	Thermometric	-	-
2.	pH	pH metery	7.0-8.0	6.5-8.5
3.	Electrical Conductivity	Conductivity	1400	--
4.	Total Dissolved Solid	Filtration Method	1000	500
5.	Total Hardness	EDTA titration	100	300
6.	Temporary hardness	EDTA titration	-	-
7.	Permanent hardness	EDTA titration	-	-
8.	Calcium	EDTA titration	75	75
9.	Magnesium	EDTA titration	150	30
10.	TA	Titration Method	120	200

Table 2: Parameters and Methods studied for Bansagar dam water

S. No.	Parameters	Method	S1	S2
1.	Colour	-	Colourless	Colourless
1.	Temp.	Thermometric	22°C	22°C
2.	pH	pH metery	8.0	8.2
3.	Electrical Conductivity (µs/cm	Conductivity	580	600
4.	Total Dissolved Solid (mg/l)	Filtration Method	332	332
5.	Total Hardness	EDTA titration	179	185
6.	Temporary hardness	EDTA titration	139	145
7.	Permanent hardness	EDTA titration	40	40
8.	Calcium	EDTA titration	91	96
9.	Magnesium	EDTA titration	88	89
10.	Alkalinity	Titration Method	340	345

a. Temperature
Temperature plays a significant role in all physical and biological activities. Rise in temperature of the water enhances the solubility rate of the minerals, but decreases the Solubility of oxygen and other gases. Hence it is an important parameter. Temperature of the water samples was recorded at the sampling point. It was found to be 22 °C.

b. pH
pH is defined as negative logarithm of the hydrogen ion concentration. The pH of natural water is generally between 6 and 8. It varies due to the dissolved gases, hydrolysis of salts of strong bases and weak acids or vice versa. It affects the solubility of many heavy metals as well as toxic chemicals in water. The pH of the water was found to be 8.0 and 8.2 for samples S1 and S2 respectively, which is on the higher side of the tolerance limit as stated by WHO and ISI standards. Table 2, Fig 1.

c. Electrical Conductivity (EC)
Electrical Conductivity is an estimate of the total amount of dissolved ions in water. It is a measure of electrical flow and depends upon the concentration, temperature and mobility of the ions present in the water. Inorganic materials like alkalis, nitrate, sulphate, chloride, phosphate, carbonates etc of sodium, magnesium, calcium, iron and aluminum attributes towards conductivity. The Electrical Conductivity was found to be 580 µs/cm and 600 µs/cm respectively for S1 and S2. Table 2, Fig 1.

d. Hardness
Hardness is caused due to the presence of dissolved salts of calcium and magnesium. It is expressed in the terms of calcium carbonate equivalent (ppm or mg/L). The total hardness in the water was found to be 179 mg/L for S1 and 185 mg/L for S2 sample respectively which is quite alarming. The nature of the hardness in the water was further studied as temporary and of permanent type. Bicarbonates of calcium and magnesium that leads to temporary hardness in the water was found to be 139 mg /L for S1 and 145 mg/L for S2 sample whereas, the chlorides and sulphates of calcium and magnesium that causes permanent hardness in the water was found to be 40 mg/L for both the samples S1 and S2 respectively. Table 2, Fig 1.

e. Ca^{2+} and Mg^{2+} ions
The total hardness in water is due to the presence of Calcium and Magnesium ions. Hardness in water is extremely disadvantageous for both industrial and domestic uses. sugar, paper, pharmaceutical, cement etc industries all suffer if water is hard. Potable water is also suggested to have low concentration of these ions as their deposition in the soft tissues of the living bodies may lead to various kinds of illnesses like stone formation and even cancer. The presence of Ca^{2+} ions was found to be 91 mg/L for S1 and 96 mg/L for S2 sample which is beyond the tolerance limits, whereas Mg^{2+} ions was found to be 88 mg/L for S1 and 89 mg/L for S2 sample even this was higher when compared to ISI standards. Table 2, Fig 1.

f. Total Dissolved Solids (TDS)
The total dissolved solids is the sum of all the ions like iron, calcium, magnesium, sodium, carbonates, bicarbonates, sulphates, chlorides, nitrates, phosphates, etc. present in the water. Total dissolved solids are due to the dissolution of soil, rocks, gypsum etc. The amount of TDS was found to be 332 mg/L for both S1 and S2 samples. Table 2, Fig 1.

g. Alkalinity
Alkalinity of water is the quantitative capacity of water to buffer or neutralize an acid. It is due to the presence of carbonates, bicarbonates and hydroxides anions, which

decreases H^+ ions and increases the pH of water. Irrigation of land with highly alkaline water may lead to the reduction in the yields of the crops by altering the pH of the soil. Alkalinity of the water samples was found to be 340 mg/L for S1 and 345 mg/L for S2 samples respectively, which is very high as compared to the said standards. Table 2, Fig 1.

Table 3: Correlation matrix of physico-chemical characteristics of Bansagar dam

	Temperature	pH	Elct. conductivity	Total Dissolved Solid	Total hardness	Temporary hardness	Permanent hard.	Calcium	Magnesium	Alakalinity
Temp.	1									
pH	0.22	1								
Electrical Conductivity (µs/cm	-0.11	0.69**	1							
Total Dissolved Solid (mg/l)	0.71*	0.10	-0.36	1						
Total Hardness	-0.88*	-0.34	0.29	-0.92*	1					
Temporary hard.	-0.04	0.77*	0.49**	0.36	-0.06	1				
Permanent hard.	0.80*	0.54**	0.05	0.65*	-0.94*	0.19	1			
Calcium	0.69*	-0.18	-0.67*	0.78*	-0.71*	-0.43**	0.40	1		
Magnesium	-0.46**	-0.51**	-0.35	-0.08	0.57**	-0.35	-0.57**	0.06	1	
Alkalinity	-0.41**	-0.73*	-0.29	0.26	0.58**	-0.49**	-0.76*	-0.02	0.71*	1

* = $P<0.01$; ** = $P<0.05$

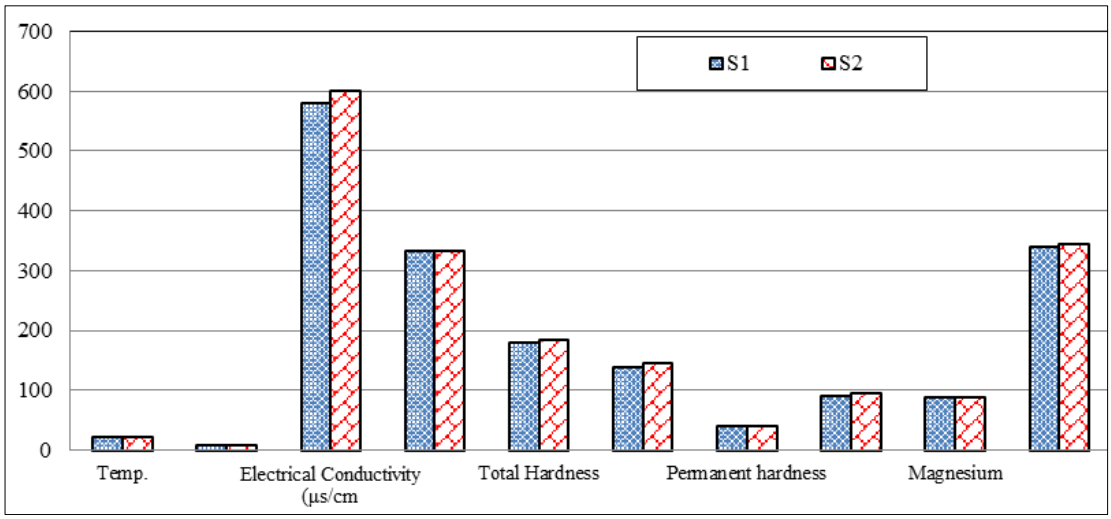

Fig 1: Graphics analysis of physical and chemical parameters recorded at Bansagar dam during Jan. 2020 to Dec. 2020

4. Conclusion

Bansagar dam is a percolation lake. It is a great tourist attraction from India and abroad. It is an abode for many animals. It supplies water to many industries, to the city for urban use and for irrigation. The results obtained from the present study are not very enthusiastic. High pH and alkalinity of the water as well as high amount of total hardness in the lake water makes the water highly prohibited for drinking and irrigation purposes. It is even not recommended for industries due to excessive hardness. The main reasons for its deterioration may be improper town planning and development, dumping of garbage and sewage in the soil of the catchment area of the lake and improper or leaky underground drainage system. Unplanned tourism activities and cultural misuse is yet another big threat to the lake. Hence the authors suggest having a well managed and well built shoreline. This will prevent illegal trespassing and misuse of the lake water. Visitors entering into the park and museum should be educated properly, through hoardings and documentaries about the prestigious ancestral heritage of the lake so that they should not spoil the sanctity and serenity of the lake. Frequent cleaning of the surrounding areas of the lake is also important and should not be overlooked.

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