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Studies on the Physico-chemical parameters and correlation coefficient of Govindgarh Lake, Rewa (M.P.)

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Abstract

Present investigations were carried out on the studies on the physico-chemical parameters and correlation coefficient of Govindgarh Lake, Rewa (M.P.). Monthly changes in physicochemical parameters such as Water temperature, Turbidity, pH, Alkalinity, Total Hardness, Chloride, Dissolved Oxygen (DO), Bio-chemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) were analyzed for a period of two years from July 2018 to June 2020. The results indicated that physico-chemical parameters of the water were within the permissible limits and can be used for domestic and irrigation. Correlation coefficient indicates showed positive and negative relationship.

Keywords: Physicochemical parameters, freshwater, correlation coefficient, Govindgarh Lake

1. Introductions

Water is an essential component of the environment and it sustains life on the earth. All organisms depend on water for their survival (Smitha, *et al.* 2007) ^[1]. Freshwater bodies are important wetlands located in and around human habitations as they are generally semi natural ecosystems constructed by man in landscape suitable for water stagnation (Yadav, *et al.* 2013) ^[2]. The quality of drinking water is essential for life. Contaminants such as bacteria, viruses, heavy metals, nitrates and salt have polluted water supplies as a result of inadequate treatment and disposal of waste from humans, livestock, industrial discharges, domestic discharge and extensive use of limited water resources (Onwughara, *et al.* 2013) ^[3]. The physical and chemical properties of freshwater body are characterized by the climatic, geochemical, geomorphological and pollution conditions. Various physico-chemical parameters were studied to analyse the water quality of the lake. The pollution of this lake is a matter of great concern, since it has reached an alarming level due to inflow of large volume sewage and solid wastes. The lake receives a large amount of raw sewage from its densely populated habitation. The water body is a eutrophic lake where the amount of nutrient is very high and oxygen depletion is prominent (Varughese *et al.*, 2004) ^[4]. Anaerobic conditions predominate throughout extensive areas of highly eutrophic lakes observed by Hutchinson (1975) ^[5]. Hypolimnion is often observed with the phenomenon of frequent oxygen depletion with the consequent increase in BOD, COD reported by Pani and Misra (2000) ^[6].

The purpose of the present study is to observe water quality of Govindgarh Lake by physico-chemical procedures and to determine the changes in water quality parameters by seasons and to find the relationship between different Physico-chemical parameters.

2. Materials and Methods

The Govindgarh lake is one of the unique water body in India and located in south of Rewa, district in Madhya Pradesh at a distance of 20 kms. From Rewa, with a longitude 24°20'25" and latitude 81°15'20". The lake is connected with all weather Rewa-Shahdol and Satna-Sidhi road. The lake was formed by impounding of small nalla originating from Kaimore hill. With a view to storing rain water, the Maharaja of Rewa at that time built a bandh across the nalla to form a tank in the year 1958.

Four different sites were selected for collection of samples. The samples were collected in sterilized polythene bottles of one liters capacity. Monitoring was done during July 2018 to June 2020 in rainy season (July to October), winter season (November to February) and summer season (March to June).

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For unstable parameters like Water temperature, Turbidity, pH, Alkalinity, Total Hardness, Chloride, Dissolved Oxygen (DO), Bio-chemical Oxygen Demand and Chemical Oxygen Demand were measured on the station. Samples were brought to the laboratory for analysis of other physico-chemical parameters like sodium, total alkalinity, total hardness, calcium, magnesium, chlorides, sulphate, nitrate, phosphate and Biochemical Oxygen Demand (BOD) were analyzed according to the standard methods described in the literature (APHA, 1989; WHO, 1998; Botkin and Keller, 1995) [7-9].

2.1 Statistical analysis

The correlation between various physico-chemical parameters of water samples were analyzed statistically conducting Pearson correlation analysis with the help of SPSS software (20.0).

3. Results and Discussion

Physico-chemical parameters (Mean \pm S.D) of Govindgarh lake obtained during the present investigation (July 2018 to June 2020), is presented in Table 1.

3.1 Water Temperature

Seasonal variance of water temperature was recorded between 22.83 ± 1.897 and 33.72 ± 0.134 ($^{\circ}\text{C}$). Temperature was minimum in winter season and maximum in rainy season. Analysis of variance for water temperature between seasons ($F = -0.55$) not significant and between sampling stations ($F = 0.13$) not significant ($p < 0.05$ level) (Table 1). Temperature varies according to the seasons and several authors recorded the temperature range of various Indian reservoirs. Water temperature shows high significant positive relationship ($p < 0.01$ level) with Turbidity ($r = 0.363$), Total Hardness ($r = 0.012$), Chloride ($r = 0.170$) and COD ($r = 0.210$) whereas pH ($r = -0.199$), Alkalinity ($r = -0.398$), Dissolved oxygen ($r = -0.222$) and BOD ($r = -0.097$) were show negative relationship ($p < 0.05$ level) (Table 2). These observations are in line with those of the study reported by Salla and Ghosh (2014) [10] who reported 31.5°C temperature at Lower Lake of Bhopal during pre monsoon, 29.5°C monsoon temperature and 28°C post monsoon temperature. Similar observed Shukla and Mishra (2017) [20] ecological study of Govindgarh lake.

3.2 Turbidity

Seasonal variance of Turbidity was recorded between 56.19 ± 34.663 and 234.41 ± 54.324 (NTU). Turbidity was minimum in summer season and maximum in rainy season. Analysis of variance for turbidity between seasons ($F = 6.51$) significant and between sampling stations ($F = -0.11$) not significant ($p < 0.05$ level) (Table 1). Turbidity shows high significant positive relationship ($p < 0.01$ level) with Water temperature ($r = 0.363$), Alkalinity ($r = 0.129$), Total Hardness ($r = 0.417$) and Chloride ($r = 0.745$) whereas pH ($r = -0.668$), Dissolved oxygen ($r = -0.424$), BOD ($r = -0.707$) and ($r = -0.647$) were show negative relationship ($p < 0.05$ level) (Table 2). Ramana *et al.* (2007) [11] reported higher turbidity is unacceptable for bathing, industrial and other purposes. Borkar and Tembhe (2018) [12] observed the highest turbidity $49\text{cm} \pm 2.12$ from Sarangpani Lake, $45\text{cm} \pm 1.21$ for Lower Lake, $43\text{cm} \pm 1.42$ for Upper Lake, $37\text{cm} \pm 2.01$ for Shahpura Lake and $32\text{cm} \pm 3.16$ for Kolar Lake.

3.3 Hydrogen-Ion-Concentration (pH)

Seasonal variance of pH was recorded between 8.05 ± 0.188 and 8.66 ± 0.760 . pH was minimum in rainy season and maximum in summer season. Analysis of variance for pH between seasons ($F = 10.07$) significant and between sampling stations ($F = -0.72$) not significant ($p < 0.05$ level) (Table 1). However, pH shows high significant positive relationship ($p < 0.01$ level) with Dissolved oxygen ($r = 0.165$), BOD ($r = -0.503$) and COD ($r = 0.461$) whereas Water temperature ($r = -0.199$), Turbidity ($r = -0.668$), Alkalinity ($r = -0.294$), Total Hardness ($r = -0.316$) and Chloride ($r = -0.454$) were show negative relationship ($p < 0.05$ level) (Table 2). Similar trends in fluctuation of pH values were recorded by a number of workers. Singh and Shrivastava (2016) [13] who recorded pH value of Upper Lake ranging 6.72 to 8.32.

3.4 Alkalinity

Seasonal variance of Alkalinity was recorded between 110.75 ± 13.303 and 139.31 ± 19.598 (mg/L). Alkalinity was minimum in summer season and maximum in winter season. Analysis of variance for Alkalinity between seasons ($F = 32.69$) significant ($p < 0.001$ level) and between sampling stations ($F = -1.72$) not significant ($p < 0.05$ level) (Table 1). Alkalinity shows high significant positive relationship ($p < 0.01$ level) with Turbidity ($r = 0.129$), Total hardness ($r = 0.614$), Chloride ($r = 0.218$), DO ($r = 0.256$) whereas Water temperature ($r = -0.398$), pH ($r = -0.294$), BOD ($r = -0.073$) and COD ($r = -0.266$) were show negative relationship ($p < 0.05$ level) (Table 2). Similar observations of total alkalinity range were made by Parashar (2006) [14] who mentioned 88 to 90 mg/l pre monsoon alkalinity and 76 to 80 mg/l post monsoon alkalinity.

3.5 Total hardness

Seasonal variance of Total hardness was recorded between 227.50 ± 32.087 and 245.81 ± 28.111 (mg/L). Total hardness was minimum in summer season and maximum in rainy season. Analysis of variance for Total hardness between seasons ($F = 17.51$) significant ($p < 0.01$ level) and between sampling stations ($F = -0.77$) not significant ($p < 0.05$ level) (Table 1). Total hardness shows high significant positive relationship ($p < 0.01$ level) with Water temperature ($r = 0.012$), Turbidity ($r = 0.417$), Alkalinity ($r = 0.614$), Chloride ($r = 0.433$) whereas pH ($r = -0.316$), DO ($r = -0.031$), BOD ($r = -0.134$) and COD ($r = -0.147$) were show negative relationship ($p < 0.05$ level) (Table 2). These observations are lower than those reported by Salla and Ghosh (2014) [10] who registered variation in the total Hardness of Lower Lake of Bhopal.

3.6 Chloride

Seasonal variance of Chloride was recorded between 89.34 ± 8.201 and 112.84 ± 24.903 (mg/L). Chloride was minimum in summer season and maximum in rainy season. Analysis of variance for Chloride between seasons ($F = 22.53$) significant ($p < 0.01$ level) and between sampling stations ($F = -0.88$) not significant ($p < 0.05$ level) (Table 1). Higher values of chloride in summer, as recorded at all the sampling stations may be due to decreased water quantity. Chloride shows high significant positive relationship ($p < 0.01$ level) with Water temperature ($r = 0.170$), Turbidity ($r = 0.745$), Alkalinity ($r = 0.218$), Total hardness ($r = 0.433$)

whereas pH ($r=-0.316$), DO ($r=-0.312$), BOD ($r=-0.651$) and COD ($r=-0.533$) were show negative relationship ($p<0.05$ level) (Table 2). These findings are higher than those of Shukla and Thakur (2017)^[15] who retrieved the Chloride values from Shahpura Lake in the range of 39.18 to 51.3mg/l in rainy season and 48.98 to 50.18 mg/l in winter season.

3.7 Dissolved Oxygen

Seasonal variance of Dissolved Oxygen was recorded between 5.93 ± 1.283 and 6.28 ± 2.530 (mg/L). Dissolved Oxygen was minimum in rainy season and maximum in winter season. Analysis of variance for Dissolved Oxygen between seasons ($F= 7.52$) significant ($p<0.05$ level) and between sampling stations ($F=-0.84$) not significant ($p<0.05$ level) (Table 1). Dissolved Oxygen shows high significant positive relationship ($p<0.01$ level) with pH ($r=0.165$), Alkalinity ($r = 0.256$), BOD ($r=0.115$) and COD ($r=0.094$) whereas Water temperature ($r=-0.222$), Turbidity ($r=-0.424$), Total hardness ($r=-0.031$) and Chloride ($r=-0.312$) were show negative relationship ($p<0.05$ level) (Table 2). The results were review by the observation from Kumar, *et al.* (2009)^[16] in the Jawahar Sagar Lake.

3.8 Biochemical Oxygen Demand

Seasonal variance of Biochemical Oxygen Demand was recorded between 9.32 ± 0.264 and 12.61 ± 0.952 (mg/L). BOD was minimum in rainy season and maximum in summer season. Analysis of variance for Biochemical Oxygen Demand between seasons ($F= 5.87$) significant

($p<0.05$ level) and between sampling stations ($F=-0.63$) not significant ($p<0.05$ level) (Table 1). Biochemical Oxygen Demand shows high significant positive relationship ($p<0.01$ level) with pH ($r=0.503$), Dissolved Oxygen ($r=0.115$) and COD ($r=0.640$) whereas Water temperature ($r=-0.097$), Turbidity ($r=-0.707$), Alkalinity ($r=-0.073$), Total hardness ($r=-0.134$) and Chloride ($r=-0.651$) were show negative relationship ($p<0.05$ level) (Table 2). The similar result was observed by Agarwal and Rajwar (2010)^[17] in the Tehri dam. Shrivastava and Joshi (2008)^[18] observed BOD values approximates the amount of oxidizable organic matter.

3.9 Chemical Oxygen Demand

Seasonal variance of Chemical Oxygen Demand was recorded between 15.92 ± 0.249 and 20.00 ± 0.119 (mg/L). COD was minimum in rainy season and maximum in summer season. Analysis of variance for Chemical Oxygen Demand between seasons ($F= 6.82$) significant ($p<0.05$ level) and between sampling stations ($F=-0.59$) not significant ($p<0.05$ level) (Table 1). Chemical Oxygen Demand shows high significant positive relationship ($p<0.01$ level) with Water temperature ($r=0.210$), pH ($r=0.461$), Dissolved Oxygen ($r=0.094$) and BOD ($r=0.640$) whereas Turbidity ($r=-0.647$), Alkalinity ($r=-0.266$), Total hardness ($r=-0.147$) and Chloride ($r=-0.533$) were show negative relationship ($p<0.05$ level). (Table 2) These result were conformity with the study of Dubey *et al.*, (2013)^[19] found the similar COD in Sahapura lake, Bhopal.

Table 1: Average with standard deviation values of Physico-chemical parameters at Govindgarh Lake (2018-20)

S. No.	Parameters	July 2018-June 2020			Analysis of variance of calculated f value	
		Rainy season	Winter season	Summer season	Between seasons	Between stations
1.	Water Temperature	33.72±0.134	22.83±1.897	33.65±0.595	0.55	0.13
2.	Turbidity	234.41±54.324	81.16±62.038	56.19±34.663	6.51*	-0.11
3.	pH	8.05±0.188	8.20±0.515	8.66±0.760	10.07*	-0.72
4.	Alkalinity	124.75±14.369	139.31±19.598	110.75±13.303	32.69***	-1.69
5.	Total Hardness	245.81±28.111	244.16±25.668	227.50±32.087	17.51**	-0.77
6.	Chloride	112.84±24.903	97.78±6.756	89.34±8.201	22.53**	-0.88
7.	Dissolved Oxygen	5.93±1.283	6.28±2.530	6.01±1.489	7.52*	-0.84
8.	Biochemical Oxygen Demand	9.32±0.264	11.20±0.727	12.61±0.952	5.87*	-0.63
9.	Chemical Oxygen Demand	15.92±0.249	17.44±0.143	20.00±0.119	6.82*	-0.59

Table 2: Average Correlation Matrix of Physico-chemical parameters of Govindgarh Lake from July 2018 to June 2020.

	Water Temperature	Turbidity	pH	Alkalinity	Total Hardness	Chloride	DO	BOD	COD
Water Temp.	1.000								
Turbidity	0.363	1.000							
pH	-0.199	-0.668	1.000						
Alkalinity	-0.398	0.129	-0.294	1.000					
Total Hardness	0.012	0.417	-0.316	0.614	1.000				
Chloride	0.170	0.745	-0.454	0.218	0.433	1.000			
DO	-0.222	-0.424	0.165	0.256	-0.031	-0.312	1.000		
BOD	-0.097	-0.707	0.503	-0.073	-0.134	-0.651	0.115	1.000	
COD	0.210	-0.647	0.461	-0.266	-0.147	-0.533	0.094	0.640	1.000

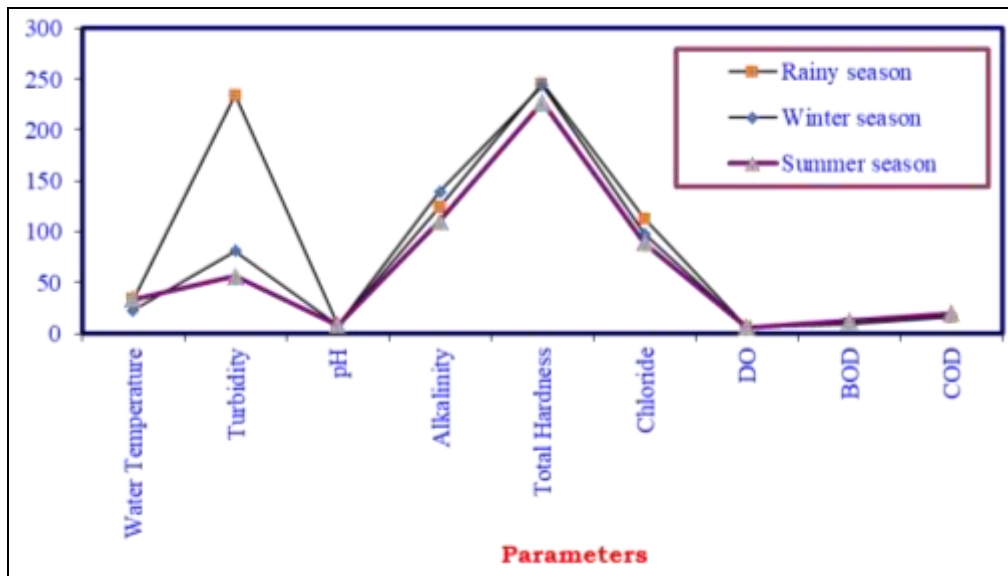


Fig 1: Seasonal variations of physicochemical parameters at Govindgarh Lake (July 2018-June 2020)

4. Conclusion

Fluctuations in various physico-chemical parameters were observed during rainy, winter and summer seasons. The study shows that the water of Govindgarh lake exhibits high concentration of Water temperature, Turbidity, pH, Alkalinity, Total Hardness, Chloride, Dissolved Oxygen (DO), Bio-chemical Oxygen Demand and Chemical Oxygen Demand due to addition of detergents and soap by washing clothes surround the lake which directly released into the lake and also evaporation of water which make the water more concentrated during summer season. Other physico-chemical parameters were within desirable limits suggest by WHO (1998) [8]. The correlation coefficient indicates positive and negative correlation of physico-chemical parameters with each other. This study may be helpful in sustainable management of the Govindgarh Lake.

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