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Analysis of Physico-chemical Parameters of Surinsar Lake, Jammu (J&K)

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ABSTRACT: Water is the vital substance which is quite essential for plants, animals and humans. Without water, no organism in the world would exist. But, the water quality is depleting these days due to chemicals, pesticides, waste, garbage, etc. posing threat to aquatic life and humans. Therefore, there is need of sustainable use of water resources and water quality is crucial feature to measure purity and quality of water. The present study was undertaken to determine stress on Surinsar lake. For this, water quality was analysed by studying abiotic parameters of lake for one year from May, 2013 to April, 2014. The various parameters *viz*., temperature, pH, dissolved oxygen, free carbon dioxide, carbonates, bicarbonates, biochemical oxygen demand, chloride, calcium, magnesium, sulphate, nitrate and phosphate were estimated. Correlation coefficient expressed significant positive and negative trends indicating pollution load. The results revealed high values of free carbon dioxide, bicarbonates and chloride which also pointed towards neglectance of this Ramsar site. The present study has emphasised the need to raise awareness among the masses for conservation and management of Surinsar lake to maintain the purity of lake.

Keywords: Abiotic, Surinsar, Chloride, Magnesium, Correlation.

INTRODUCTION

Water is the most important asset of nature for human sustenance. It supports biota since ages but man shows no gratitude towards this elixir. The main reasons for present crisis of water bodies are industrialization and urbanization. Water quality can be analysed by abiotic parameters which can aid in strategic management of freshwater bodies (Gupta and Deshpande 2004). The conducible environment is essential for biota as there is continous exchange of energy and material between organisms and environment. This is also furnished by interactions of abiotic and biotic factors (Welch, 1952). So, it is vital to investigate physico-chemical parameters in limnological studies. Today, water is under stress due to many factors which can be analysed through hydrology and habitat. Review of literature reveals that various workers have analysed the water quality of freshwater resources by assessing physico-chemical parameters. National Institute of Hydrology (1995) studied the limnological parameters of Mansar and Surinsar lakes and reported that dissolved oxygen and biochemical oxygen demand were below the prescribed level for class A drinking water standard. Maharana *et al.* (2000) studied the ecotourism in sacred lake of south Sikkim Himalaya and observed that it was under anthropogenic stress due to increasing tourism and pilgrimage. National Institute of Ecology (2002) presented a report which stated that idol immersion in water bodies (Upper lakes of Bhopal, Budda talab of Raipur, Hussain sagar of Hyderabad and Ganga) led the solid wastes accumulation which enhanced its gradual filling. Besides, nutrients contributed to eutrophication and biodegradable material raised the biochemical oxygen demand. Moundiotiya *et al.* (2004) studied the physico-chemical characteristics of Ramgarh lake and observed significant variations in temperature, pH, total dissolved solids, dissolved oxygen, alkalinity, hardness and chloride. Study revealed that pH ranged from 6.8 to 8.5 which might be because of high buffering capacity of water system and total alkalinity ranged from 102.6 to 215mg/l which indicated polluted status. Bhatnagar and Sangwan (2009) investigated the impact of mass bathing on Brahmasarovar, a sacred water body in Kurukshetra, during Amavasya (new moon) and observed decrease in dissolved oxygen and increase in free carbon dioxide and BOD due to organic and biodegradable waste added by the pilgrims. They also reported increased ammonia content in water. During the analysis of physico-chemical parameters of Bibi lake located in Ahmedabad, Umerfaruq and Solanki (2015) observed high values of turbidity, total dissolved solids, pH, hardness, alkalinity and phosphate which indicated the lake was under stress. While studying physico-chemical parameters of Kankaleshwar lake (Beed), Nakhate and Kale, 2018 compared water temperature, pH, dissolved oxygen, BOD, total alkalinity and TDS values with BIS and observed the lake to be non-polluted. But high BOD values pointed towards plenty of organic matter. In monitoring the water quality, physico-chemical parameters are significant. Seasonal limnological investigations can be useful for tracking water quality (Patra *et al.*, 2010). Keeping this in mind, the present work was undertaken to analyse the physico-chemical parameters of Surinsar

lake to know general conditions and pollution load. Assessment of its water quality is the key step for its sustainable use which can be achieved by its regular monitoring.

MATERIAL AND METHODS

Jammu is the southern part of J&K and located in the foothills of lower Shiwaliks. It is situated at an altitude of 275-410m. The Surinsar lake is situated at distance of 42 km from Jammu city. It is oval with deep notch on its north-west and its circumference is 2.49 km. A small island is present within the lake inhabiting rich biota. It is also the religious shrine and associated with snake cult. It is the only source of drinking water for the locals and facing stress from tourism.

Sampling and analysis. Samples were collected from study area in glass bottles for the period of one year from May, 2013 to April, 2014. Various physicochemical parameters *viz.*, water temperature, pH, DO, FCO_2, CO_3^{2-}, HCO_3^-, BOD, Cl^-, Ca^{2+}, Mg^{2+}, SO_4^{2-}, NO_3^- and PO_4^{3-} were estimated. Out of them, water temperature, pH, DO, FCO_2 and CO_3^{2-} were observed at the study station whereas the other parameters were determined in the laboratory (APHA, 1985).

RESULTS AND DISCUSSION

The physico-chemical parameters of water bodies are important aspects to analyse water quality. The present study estimates the seasonal variations of abiotic parameters in Surinsar lake (Table 1).

Water Temperature. It is the measure of heat intensity stored per volume of water. It is vital for biota as oxygen is dependent on temperature of water body. In the present study, mean maximum value, 27.75ºC was recorded in summer which may be due to longer photoperiod (Sawhney, 2008) and greater insolation (Jawale and Patil 2009). The mean minimum value of temperature, 15.87ºC was recorded in winter might be due to shorter daylength and decreased illumination (Chourasia and Adoni 1985; Sawhney, 2008). Similar findings were reported by Hassan *et al.* (2015).

pH. pH is the negative logarithm of hydrogen ion concentration (Wetzel, 2001). It can affect the productivity of aquatic ecosystem (Kumar and Gupta 2002). The mean maximum value 7.6 was recorded in winter which may be due to lowered decomposition rate in winter (Singh, 2004). Whereas mean minimum value 6.8 was observed in summer. The reason might be high value of free carbon dioxide (Langer *et al.*, 2007) in summer.

Dissolved Oxygen (DO): It is an indicator of trophic status of water body (Saksena and Kaushik 1994) and DO less than 5mg/l is an indication of pollution (Khandaker, 1986). Its value in aquatic ecosystem depends on temperature, photosynthesis, respiration, etc. In the present study, DO ranges from 4.2-8.0 mg/l with mean maximum value 7.5 mg/l in winter which may be due to its increased solubility at low temperature (Bhandarkar and Bhandarkar, 2013) and low biological activity (Qadri *et al.*, 1981). On the other hand, mean minimum value 4.5 mg/l was observed in summer as high temperature lowers the oxygen solubility (Dutta and Patra 2013) and enhances biological activity (Hassan *et al.*, 2008).

Free Carbon dioxide (FCO_2). FCO_2 is indispensable for photosynthesis in aquatic bodies and its main sources are respiration and decomposition of organic substances (Dwivedi and Pande 2002). The acceptable limit of free carbon dioxide for surface water is 10mg/l. The mean maximum value of 16mg/l was recorded in summer might be due to high decomposition rate (Hutchinson, 1957; Ahangar *et al.*, 2012) and raised respiratory activities of biota (Saksena *et al.*, 2008) at high temperature. Whereas, mean minimum value 5.0 mg/l was recorded in winter which may be due to low decomposition rate (Kumar *et al.*, 1987).

Calcium. It plays an essential role in pH buffering and carbonate-bicarbonate system in water bodies (Goldman and Horne 1983). As per BIS, the upper permissible limit for calcium is 75.0 mg/l. The present study showed maximum mean value 32.5 mg/l in winter which may be ascertained to low temperature (Abdel Satar, 2005) and winter rains carrying calcium rich surface run off (Kumar, 1990). The calcium revealed minimum mean value 17.5mg/l in summer. The reasons might be its utilization by phytoplankton (Sawhney, 2008) and high temperature lowering its solubility (Abdel Satar, 2005).

Magnesium. It is used by the plants for chlorophyll-porphyrin metal complex. It also acts as limiting factor for phytoplankton growth in aquatic bodies. The lake waters showed magnesium ranging from 9.95mg/l to 54.4mg/l with mean maxima 38.3 mg/l in winter and mean minima 19.5mg/l in summer. Maxima in winter may be due to low temperature which further increases its solubility (Chowdhary, 2011) whereas minima in summer might be due to its uptake for chlorophyll molecules and enzymatic transformation by phytoplankton (Malik and Pandit 2006).

Chloride. It is an essential parameter to regulate salinity of water and exert osmotic stress on biota. Chlorides in water are generally due to salts of calcium, sodium and potassium. High level of chlorides in water bodies is an indicator of pollution load of animal origin. During the present study, mean maximum value 65.0 mg/l was recorded in summer, the reason could be ascertained to increased evaporation at high temperature (Shiddamallayya and Pratima 2008). On the other hand, mean minimum value 22.7mg/l was observed in winter which might be attributed to dilution by winter rains (Shinde *et al.*, 2011).

Biochemical Oxygen Demand (BOD). It is determination of organic matter in the water. As per BIS, drinking water should have zero BOD but 3-6mg/l is permissible. In the present study, mean maximum value 3.37 mg/l was observed in summer. It may be due to decomposition of dead organic matter with raised temperature (Garg *et al.*, 2009). Whereas, the mean minimum value 2.15 mg/l was recorded in winter which might be attributed to low temperature, thereby, decreasing microbial activity and algal blooms

(Shiddamallayya and Pratima 2008). Similar observations were reported by Liu *et al.* (2010).

Carbonates. It is considered to be form of inorganic carbon when free carbon dioxide is not present in water bodies (Stumm and Morgan 1995). It is bound form of carbon dioxide and is unavailable for photosynthesis. The present study showed direct relation of pH and carbonate, and indirect relation of carbonate and FCO_2 (Hutchinson, 1957). Carbonates were absent in the lake throughout the study except in December (14.4mg/l).

Bicarbonates. The bicarbonate ions serve the purpose of photosynthesis by providing carbon dioxide to the producers. These ions also participate in regulating pH of aquatic bodies. The present study recorded bicarbonates ranging from 53.7mg/l to185.4mg/l in the lake waters. Mean maximum value 154.12mg/l was recorded in winter which may be ascribed to reduced photosynthetic rate and low FCO_2 in winter (Sharma, 2013). Whereas, mean minimum value 76.28mg/l was observed in summer. It might be due to its uptake for photosynthesis by phytoplankton (Chandrakiran, 2011).

Sulphates. Its ions are essential for protein metabolism. The main sources of sulphates are run-off, fertilizers, leaching of rocks as gypsum, etc. Its limitation in the water system may interfere the development of plankton. The values of sulphate in lake fall in the range 0.0017-0.0021mg/l with mean maxima 0.0019mg/l in monsoon. Higher concentration of sulphates in monsoon was also reported by Abubakar (2012). The reason for increased value of sulphates in lake during monsoon may be the run-off (Chernogaeva, 1994) and mineral inflow by leaching. Mean minima 0.0017mg/l was recorded in winter might be due to low temperature which resulted in low decomposition rate and reduction of sulphate to sulphide (Kaur, 2006).

Phosphates. It is employed in the metabolism of biota and acts as limiting factor among plant nutrients (Dugan, 1972). As per BIS, the upper permissible limit of phosphates is 0.2mg/l. Excess phosphates in water resources could lead to algal blooms and thus, indicates the pollution load. Mean maxima 0.13mg/l was observed in summer that may be due to increased evaporation rate (Garg *et al*., 2009) and decomposition rate at high temperature. On the other hand, mean minima was recorded in monsoon with its absence which might be due to dilution by rains (Ishaq and Khan 2014).

Nitrates. It is the stable and most oxidized form of nitrogen. Its sources are dead and decaying matter, effluents, fertilizers and atmospheric washouts. Nitrates are important for assessment of water quality (Johnes and Burt, 1993). Mean maxima 0.5726 mg/l was observed in summer which may be ascribed to increased evaporation (Garg *et al*., 2009) and increased decomposition rate at high temperature (Paulose and Maheshwari 2007). On the other hand, mean minima 0.5723mg/l was recorded in monsoon that might be due to dilution by rains (Ishaq and Khan 2014).

Correlation. Pearson correlation among physico-chemical parameters showed significant positive and negative values (Table 2). Water temperature showed significant positive correlation with FCO_2, Cl^- and BOD but shared negative correlation with pH, DO, Ca^{2+}, Mg^{2+} and HCO_3^-. pH shared significant positive relation with DO, Ca^{2+}, Mg^{2+} and HCO_3^-, whereas showed negative with FCO_2, Cl^- and BOD. DO showed its significantly positive correlation with Ca^{2+}, Mg^{2+} and HCO_3^- and negative with FCO_2, Cl^- and BOD. Whereas FCO_2 revealed significant positive relation with Cl^- and negative with Mg^{2+}. On the other hand, Ca^{2+} showed significant and positive relation with Mg^{2+} and HCO_3^- but expressed negative relation with Cl^- and BOD. Mg^{2+} shared significantly positive relation with HCO_3^- and negative with Cl^- and BOD. Cl^- in the present study showed significant positive relation with BOD and negative with HCO_3^-. BOD shared significantly negative correlation with CO_3^{2-} and HCO_3^-.

Table 1: Seasonal variations of physico-chemical parameters of Surinsar lake during the study.

Parameters	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Water temp. (°C)	28	31	26	29	27	22	18	14.5	15	16	24	28
pH	6.8	6.4	7.2	7.9	7.1	7.2	7.4	8.1	7.2	7.8	7.1	6.9
DO (mg/l)	5.2	4.4	4.8	5.2	7.2	6.8	8.4	7.6	7.2	6.8	4.2	4.4
FCO_2 (mg/l)	10	12	10	6	10	6	2	-	10	8	18	24
Ca^{2+} (mg/l)	11.77	17.66	18.6	20.5	21.77	26.3	21.86	30.69	42.05	35.4	19.6	21.02
Mg^{2} (mg/l)	19.98	23.62	33.6	19.49	24.41	20.08	37.81	29.02	54.37	32.32	24.49	9.95
Cl^- (mg/l)	75	58	26	30	21	28	30	22	18	21	56	71
BOD (mg/l)	3.8	3.4	3.6	2.8	2.4	2.4	3.2	1.2	1.4	2.8	2.4	3.9
CO_3^{2-} (mg/l)	-	-	-	-	-	-	-	14.4	-	-	-	-
HCO_3^- (mg/l)	53.68	56.24	124.8	87.8	124.6	100.04	112.24	158.64	185.4	160.2	85.4	109.8
SO_4^{2-} (mg/l)	.0018	.00175	.00215	.00176	.00184	.00189	.001756	.00174	.00176	.0017	.00171	.00177
PO_4^{3-}(mg/l)	.0160	-	-	-	-	-	.01112	-	-	-	.0261	.0104
NO_3^- (mg/l)	.57261	.57255	.57241	.572407	.57247	.572482	.57250	.57245	.5726	.5725	.572668	.5727

Table 2: Correlation among various physico-chemical parameters in Lake Surinsar during the study.

Parameter	Water temp.	pH	DO	FCO_2	Ca^{2+}	Mg^{2+}	Cl^-	BOD	CO_3^{2-}	HCO_3^-	SO_4^{2-}	PO_4^{3-}	NO_3^-
Water temp.	1												
pH	-0.643**	1											
DO	-0.704**	0.667**	1										
FCO_2	0.437*	-0.618**	-0.768**	1									
Ca^{2+}	-0.792**	0.628**	0.604**	-0.348	1								
Mg^2	-0.715**	0.476*	0.690**	-0.482*	0.676**	1							
Cl^-	0.635**	-0.700**	-0.736**	0.625**	-0.659**	-0.683**	1						
BOD	0.625**	-0.504*	-0.423*	0.247	-0.585**	-0.521**	0.563**	1					
CO_3^{2-}	-0.355	0.378	0.241	-0.363	0.156	0.017	-0.188	-0.46*	1				
HCO_3^-	-0.808**	0.638**	0.625**	-0.294	0.796**	0.746**	-0.716**	-0.68**	0.242	1			
SO_4^{2-}	0.260	-0.133	-0.246	0.054	-0.182	-0.110	-0.193	0.232	-0.111	-0.143	1		
PO_4^{3-}	-0.100	-0.002	-0.058	0.088	-0.088	-0.087	0.363	-0.117	0.339	0.014	-0.368	1	
NO_3^-	-0.163	0.122	0.024	0.176	0.290	0.118	-0.287	-0.235	0.036	0.345	-0.105	-0.132	1

* Correlation is significant at 0.05 level (2 tailed); ** Correlation is significant at 0.01 level (2 tailed)

CONCLUSIONS

The present work was performed with detailed investigation of physico-chemical parameters of Surinsar lake. The lake is found to be under stress as parameters viz. dissolved oxygen, free carbon dioxide and biochemical oxygen demand were beyond the prescribed limits. The surface run-off, waste discharge, cattle bathing, washing, neglectance by the inhabitants, tourism stress, etc. may be the factors for the present status of lake waters. There should be an awareness drive to protect it. It is our duty to protect the lake from further deterioration which holds international stature. Water quality of lake can further be improved by fencing the lake which prohibits the anthropogenic pressure along the lake. Individual efforts would not work but all stakeholders including NGOs, govt. and community members have to come forward for this herculean task to accomplish.

FUTURE SCOPE

The present study performed detailed analysis of physico-chemical parameters of Surinsar lake which showed the lake to be under stress. It would stir interest among the scholars and masses to regularly monitor the water quality of this lake, which would further help in proper planning and management for its sustainable use.

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Conflict of Interest. None.

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