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Assessment of Surface Water Quality and Physicochemical Analysis of Mamchari Dam in District Karauli (Rajasthan), India

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ABSTRACT: The present study is about the assessment of surface water quality through the physicochemical analysis of Mamchari dam. The dam is located in Mamchari Village of Karauli District of Rajasthan state. The water quality of Mamchari dam was carried out for a period of two years i.e. from February, 2018 to January, 2020 on the basis of monthly samplings. This study has provided the first data set for the assessment of the water quality of the Mamchari dam. The physicochemical parameters such as air temperature, water temperature, light intensity, relative humidity, pH, COD, BOD, DO, nitrate, phosphate, chloride, sulphate, conductivity, total alkalinity, total hardness, TDS and total solids were estimated. Water samples were collected from the selected two sampling sites of dam and estimated onsite and in the laboratory. All the physicochemical factors studied were found within the permissible limit except pH and Mg hardness as recommended by BIS. The dam was found to be more alkaline during the summer season as compared in the winter and monsoon months. The study comprises all types of oppression of the dam and comprises the suggestion and references regarding the management of natural exposures and contesting the proscribed human interloping on entire atmosphere.

Keywords: Freshwater, Mamcahri dam, Physicochemical, Water quality.

INTRODUCTION

Water is the lifeline natural resource to human being, animals, plants and other organisms. Every community's population growth and development requires the availability of quality ground water such as rivers, streams, lakes, dams, wells, boreholes, springs, etc. (Adedeji *et al*., 2019). Water quality generally means the component of water which must be present for optimum growth of aquatic organisms (Verma and Khan 2015). Freshwater obtains a little importance to human beings and other organisms of the environment for the sustenance of life and maintaining the balance of water bodies is becoming very important throughout the world because of the primary concern of man was to be meeting his basic requirements (Sreenivasulu and Damodharam 2016). Different water bodies exhibited their own peculiarities regarding physicochemical characteristics and their aquatic life-forms (Sharma *et al*., 2012; Rajawat and Sharma 2020). Physicochemical parameters are the important component of the aquatic system as they indicate the water quality of various aquatic ecosystems (Verma and Khan 2015; Sreenivasulu and Damodaran 2016; Mahajan and Pokale 2017; Chauhan and Bhardwaj 2019; Rashid and Prakash 2022; Farooquee *et al.*, 2023). While it seems that almost no work is conducted on physic-chemical aspects of Mamchari dam in Karauli district. The objectives after the study were to improve an overall picture of the dam water quality using WQI, assessment of dam water quality and fitness of pond water for different purposes.

Investigation area. Rajasthan is the largest state of the country. There are quite a few freshwater lakes and dams in the state. The Mamchari dam was constructed of a part of irrigation project by the Government of Rajasthan. It is an important water body situated in the local sub-basin of the Gambhir river basin near village Mamchari, Keladevi road, and approachable 15 km far from city of Karauli in district Karauli toward the east of Rajasthan state of India. The name of Mamchari dam was given on the basis of Mamchari village. It is a minor irrigation project and homogenous earthen dam constructed in 1964-65. The location of the reservoir is general low land. Mamchari dam is an old tank and the embankment had been constructed without the help of heavy compacting equipment. Water from Dhandurat dam above the village Mamchari comes in the Mamchari dam, which has approximately 7 km far from the Mamchari dam. The dam is protected on three sides by hills having mining operations in the catchment area. Vehicles like trucks, tractors and camel-carts from the mining area go by the dam. On the hills and bank of dam have a large number of trees species such as *Butea monosperma*, *Anogeissus pendula*, *Moringa*, *Acacia*, *Saccharum*, *Balanites aegyptiaca*, *Mitragyna* etc. Various particulars regarding the geography and climatic data of the study area are given in Table 1.

Table 1: Geographical and climatic data of the Mamchari dam, Karauli (Rajasthan).

(A) Geographical data	
Range	Mamchari dam
District	Karauli
Division	Bharatpur
State	Rajasthan
Location	76˚50' West Longitude; 25˚20' North Latitude
Covering Area	4 sq km
Length	756 m
Top width	3 m
Catchment area	25.5 sq km
Surrounding hills	Vindhyan Range
(B) Climatic data and habitat	
Summer temperature	Maximum 45°C, Minimum 24°C
Winter temperature	Maximum 31°C, Minimum 9°C
Average rainfall	711 mm annually
Monsoon period	July to September
Dominant tree flora	*Anogeissus pendula* and *Butea monosperma*

METHODOLOGY

Sampling sites. Two different water sampling sites have been selected for the present study i.e. (1) area near the main damchannelat waterfall of the dam (named as Site-I), and (2) the area opposite side of the channelat Badi Ka Teela spot of the dam (named as Site-II). Water samples were collected in monthly intervals for two years from February, 2018 to January, 2020.

Collection of water samples: Water samples were collected during morning hours between 8am to 10am once in the last week of each month in the clean plastic bottles of two-liter capacity. The bottles were properly washed with normal water followed by distilled water before sampling. The data were interpreted with respect to three seasons i.e. winter season (November to February), summer season (March to June) and monsoon season (rainy season, July to October).

Analysis of water samples: During the determination, physicochemical characteristics like Color, Odor, Atmospheric Temperature, Water Temperature, Water pH, Relative Humidity, Total Dissolved Solids (TDS) and Light intensity were determined at the time of sample collection non the sampling spot. Temperature, pH, TDS and Relative Humidity were recorded with a centigrade thermometer, digital pH meter, digital TDS meter and digital Hygrometer (HTC-1), respectively. Light intensity was recorded by the digital light meter (HTC LX-103). For rest of the analysis, collected water samples were immediately carried out to the laboratory and physicochemical parameters were analyzed. Chloride was estimated by the-titrimetric method recommended by Wilcox and Hatcher. Total Hardness, TDS, Calcium hardness, Magnesium hardness, Sulphate, Phosphate, Nitrate, Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD)were estimated by the method recommended by APHA (2005). Dissolved oxygen (DO) was estimated by DO meter in the field and subsequently cross-checked in the lab by Winkler's method (Winkler, 1988).

Fig. 1. Location map of district Karauli (a) and the Google map (b) of Mamchari dam.

Fig. 2. Images showing actual view of Mamchari dam: Larger overview of the dam (a), Sampling Site-I (b) and Sampling Site-II (c).

RESULTS AND DISCUSSION

The physicochemical parameters of Mamchari dam were studied and analyzed for two years for the assessment of the surface water quality of the dam. The surface water samples were collected from the two sites (Site-I and Site-II) of Mamchari dam. The dam is a main source of water for inhabitants of the villages Mamchari, Karsai, Bamanpura, Kota, Maholi and Tarauli for irrigation, washing, bathing and drinking. At Site-I, local inhabitants use the dam water for bathing and washing of clothes and vehicles using detergents, shampoo, soap etc. The funeral ash is also dropped into the dam water at Site-I. Land runoff also derives within the dam especially towards the Site II during the rainy season. Besides this, the dam also has appreciable fish productivity potential of freshwater fishes for commercial purpose. The dam also attracts migratory birds.

The analysis of physicochemical parameters is most important feature to decide the quality of water. In the present study, water quality of the Mamchari dam was tested using various physicochemical parameters for the period of two years i.e. from February 2018 to January 2020 as mentioned below:

Color and Odor: Water of Manchuria dam was clean, colorless and odorless.

The results of different physicochemical parameters of two study sites have been represented in the graphs (Figs. 3-21) where the monthly time periods were taken on the X-axis and the values of physicochemical parameters were taken on the Y-axis.

Temperature: Temperature is an important biological significance factor, which play an important role in the metabolic activities of the organism. During this study, atmospheric temperature of Site-I ranges from 15.63ºC to 42ºC and Site-II 15.17ºC to 39.97ºC while water temperatures were at Site-I 17.57ºC to 31.67ºC and Site-II 17.23ºC to 33.67ºC (Figs. 3, 4). Water temperature is influenced by atmospheric temperature. Highest temperature was recorded during summer season and the lowest during winter season. The atmospheric temperature was always found higher than the water temperature. Similar results were reported by other studies like Pareek and Singh (2012); Pimple and Pranjali (2015); Vashistha *et al.* (2016); Mhajan and Pokle (2017); Tichkule and Bakare (2017); Sharma and Kumar (2022).

Light Intensity. Light intensity at the surface of the water body varies seasonally and with cloud cover and decreases with depth down in the water. In this study, Light Intensity was recorded in the range from 103.33 Lux to 751.67 Lux at Site-I and Site-II from 103.33 Lux to 753.00 Lux, Light Intensity was found to be maximum in January and minimum in March and July (Fig. 5).

Relative humidity (RH): Humidity on relative data for two years fluctuates February (2018) to January (2020) Site-I and Site-II. Seasonally in summer lowest and maximum in monsoon was observed. Similar results were also reported by Hulyal and Kaliwal (2011) in Almatti reservoir of Bijapur district in Karnataka State (Fig. 6).

Water pH: pH is an important ecological factor. It is the measure of the concentration of H^+ ions. Water pH affects the biotic life's biology and life cycle (Nirbhay *et al.*, 2015). The pH value of water samples for the study period from February 2018 to January 2020 varied from 6.96 to 10.4 at Site-I and 6.87 to 9.86 at Site II. It is noted that the pH value of drinking water ranges between 7.22 to 8.55 and is found permissible limit as prescribed by WHO (2017). The water pH of Mamchari dam fluctuates and remained alkaline throughout the period of study (Fig. 7). This study is also close with the reports of Hulyal and Kaliwal (2011); Harney (2013) and the same results were also recorded by Agrawal *et al.* (2018); Vashisth *et al.* (2020); Rashid and Prakash (2022).

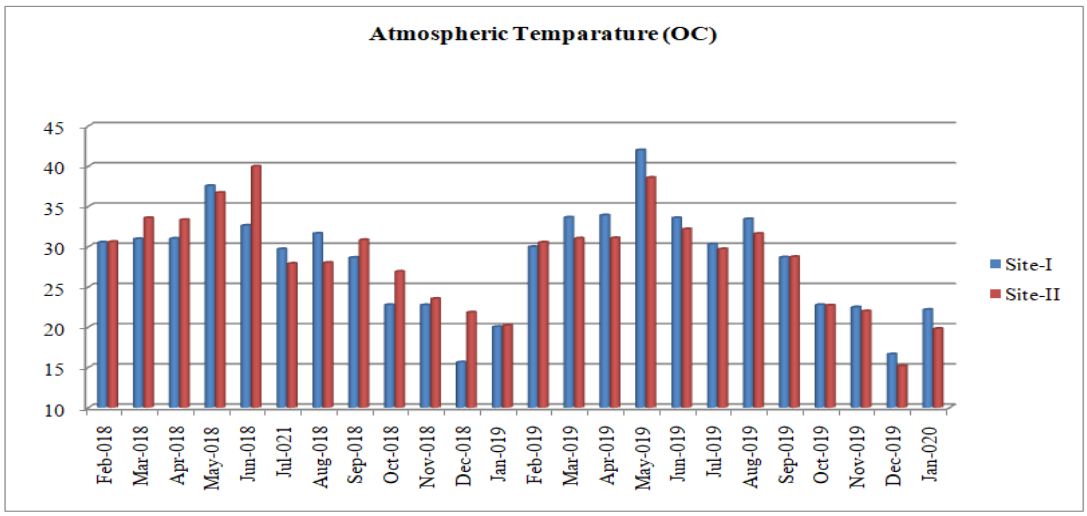

Fig. 3. The monthly average of Air (Atmospheric) Temperature of Mamchari dam.

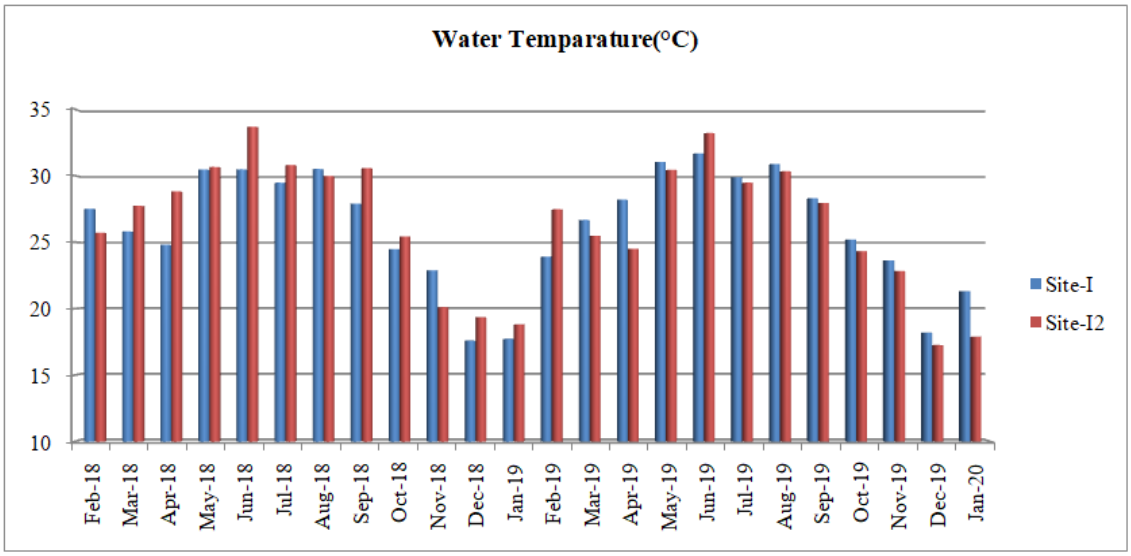

Fig. 4. The monthly average of Water Temperature of Mamchari dam.

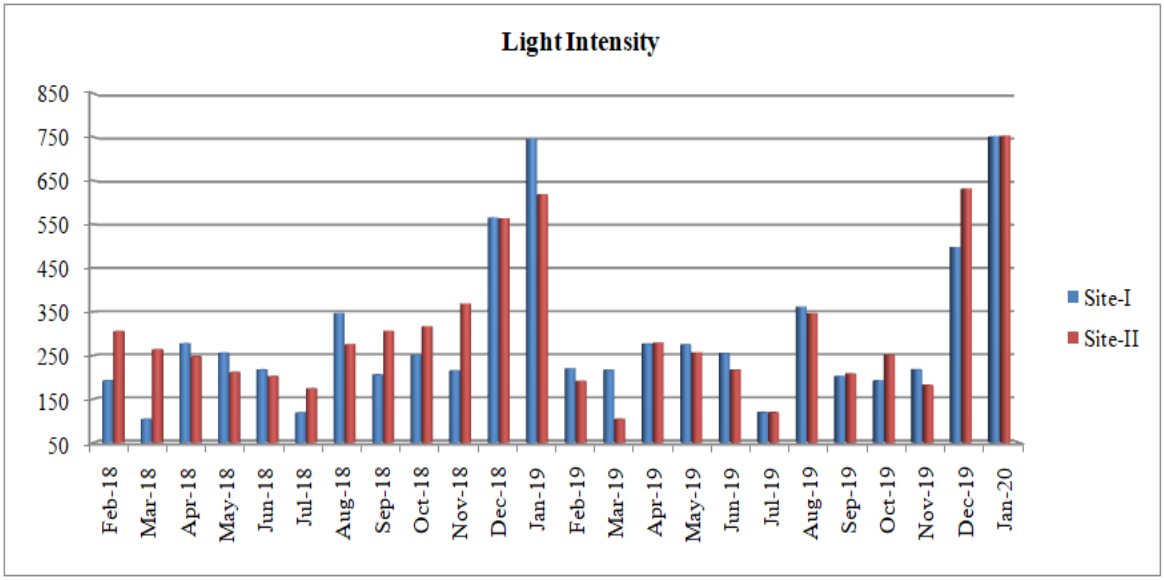

Fig. 5. The monthly average of Light Intensity of Mamchari dam.

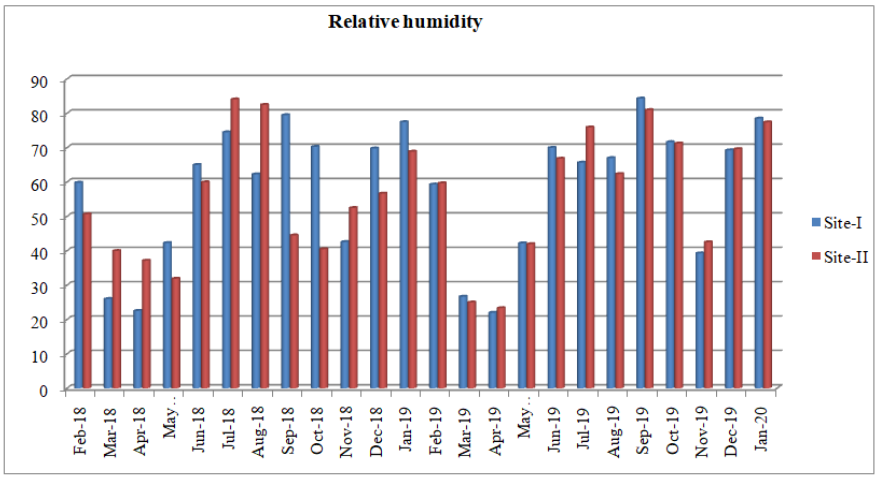

Fig. 6. The monthly average of Relative Humidity of Mamchari dam.

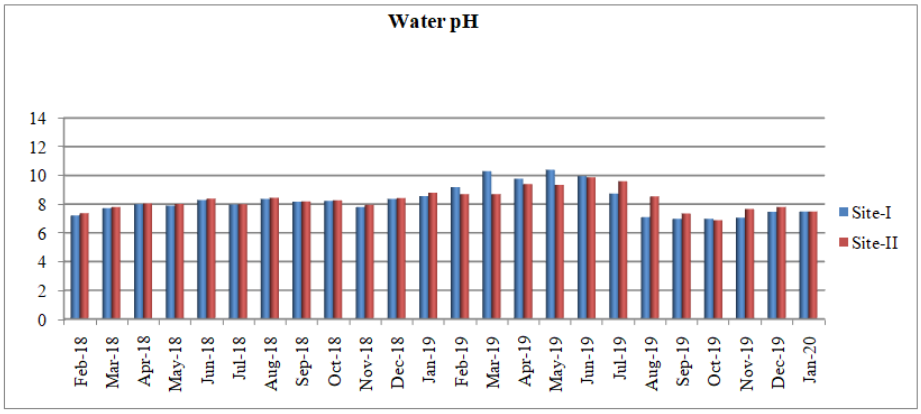

Fig. 7. The monthly average of Water pH of Mamchari dam.

Chemical Oxygen Demand (COD): The COD is a measure of the oxygen equivalent of the organic matter content of water that is susceptible to oxidation by strong chemical oxidants. In the present investigation, COD values fluctuated between 11.43 mg/l to 32.63 mg/l at Site-I and 0.89 mg/l to 40.47mg/l at Site II (Fig. 8). The COD was found to be higher during summer and monsoon while lower during the winter season. Similar observations were also made by Tichkule and Bakare (2017; Rajawat and Sharma (2020); Rashid and Prakash (2022).

Biological Oxygen Demand (BOD): BOD is the amount of dissolved oxygen demand by aerobic biological organisms to break down organic material present in a given water sample at certain temperature over a specific time period. In the present investigation, BOD was recorded the in range 0.77mg/l to 5.46 mg/l at Site-I while 0.01 mg/l to 6.25mg/l at Site-II (Fig. 9). In seasonally, the values of BOD were higher during monsoon and low during winter season. Peak values of BOD were found in the months of June and July may be due to the increased growth rate of algae in the dam water (Rajawat and Sharma 2020; Rashid and Prakash 2022).

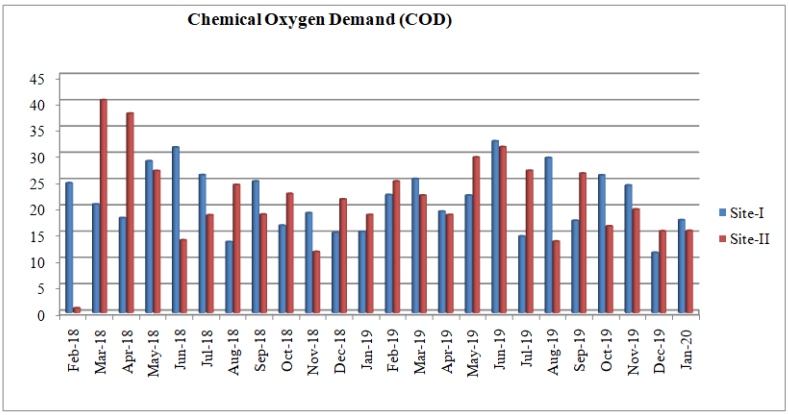

Fig. 8. The monthly average of COD of Mamchari dam.

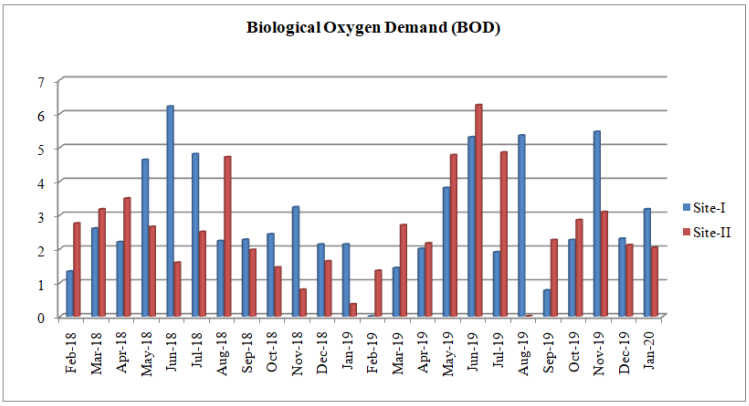

Fig. 9. The monthly average of BOD of Mamchari dam.

Dissolved Oxygen (DO): The amount of DO varies from 3.20mg/l to 5.45mg/l at Site-I while 3.16mg/l to 5.53mg/l at Site-II (Fig. 10). The minimum DO record during monsoon and maximum in winter (Fig. 11). The results of this study are also similar with the study of Hulyal and Kaliwal (2011); Roka *et al.* (2022).

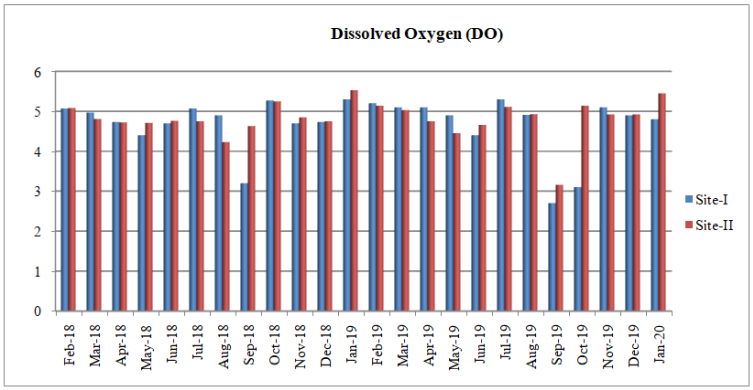

Fig. 10. The monthly average of DO of Mamchari dam.

Hardness Total: Total Hardness can be equivalent to the total calcium and magnesium hardness; the most common cations in hard water are Mg^{+2} and Ca^{+2}. In the present study, the values of the hardness of dam water varied from 50.33 mg/l to 491 mg/lat Site-I while at Site-II 49 mg/l to 430 mg/l (Fig. l1). Seasonally, maximum value of hardness is recorded in summer and the minimum in winter. Similar values of hardness were also recorded by Hulyal and Kaliwal (2011).

Higher values of Total hardness during summer season of dam water can be attributed to decrease in water volume and increase the rate of evaporation and concentration of soap and detergent precipitate by the calcium and magnesium ions. The desirable maximum limit of hardness is 300 mg/l (BIS, 2012). Thus the water of Mamchari dam is Hard.

Mg Hardness: For chlorophyll growth magnesium is needed. It acts like a limiting factor for the considerable growth of phytoplankton (Sreenivasulu and Damodharan 2016). Magnesium hardness is the concentration of magnesium ions expressed as equal of $CaCO_3$ in water. Magnesium recorded at Site-I range from 13.33 mg/l to 120.67 mg/l, and at Site-II ranges from 12.33 mg/l to 261.67 mg/l (Fig. 12). The maximum amount was recorded during summer season where as minimum amount was recorded during spring season. Same record also observed by Harney *et al.* (2013; Mahajan and Pokle (2017); Anuradha and Rao (2021).

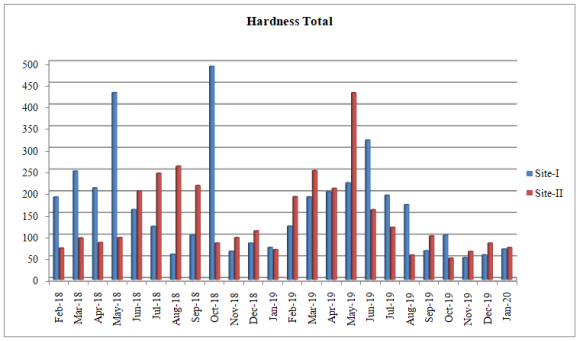

Fig. 11. The monthly average of Hardness Total of Mamchari dam.

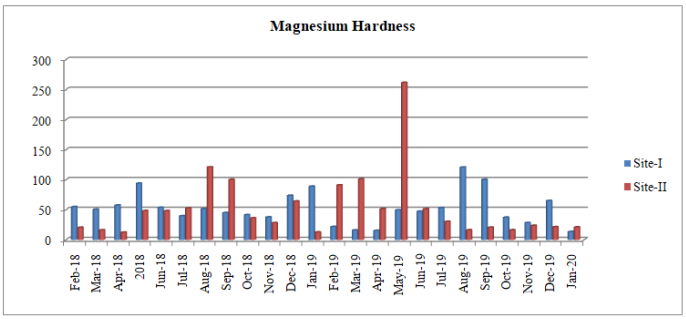

Fig. 12. The monthly average of Magnesium Hardness of Mamchari dam

Ca Hardness: Calcium is identified in high abundance in all usual element in which water such as its key source is enduring the rocks into leachate (Sreenivasulu and Damodaran 2016; Vashistha *et al.*, 2016). Calcium hardness ranged from12.80 mg/l to 77.33 mg/l at Site-I while at Site-II recorded range from 12.97 mg/l to 77.17 mg/l (Fig. 13). Seasonal value of Calcium hardness reported as a minimum in winter and maximum in summer. Mahajan and Pokle (2017) also observed similar trends. Maximum value of Calcium hardness was observed in summer due to low water level.

Phosphate: Phosphate mostly esteemed as a key nutrient in deciding the fertility of a water body. It impacts on fish production and extreme concentrations of Phosphorus are sometimes responsible for the production of blue-green algae. In the present study, the phosphate content in the dam water fluctuates between 0.05 to 0.1 mg/l (Fig. 14). Hulyal and Kaliwal (2011) also reported the same.

Nitrate as Nitrogen: Nitrates are essential for plants but huge amounts of nitrates in water cause health hazards. The amount of Nitrate content at Site-I recorded ranged from 1.56mg/l (in November, 2018) to 11.26 mg/l and at Site-II 1.68 mg/l to 11.48 mg/l with peak value recorded in monsoon and lowest in winter season (Fig. 15). Range of 0.1 to 24.23 ppm nitrate observed by Pareek *et al.* (2015) from Ellenabad town and its nearby villeges. Mahajan and Pokle (2017) also observed same in Mohali Lake near Bhadrawati District Chandrapur (MS). Rawat *et al.* (2020) reported 9.68 mg/l to 16.40 mg/l nitrate from Beeshazri Lake, Tropical lowland, Nepal. The low value of Nitrate in winter months was also observed by Tamot and Sharma (2006). The high amount of nitrate was recorded during rainy season may be due to runoff.

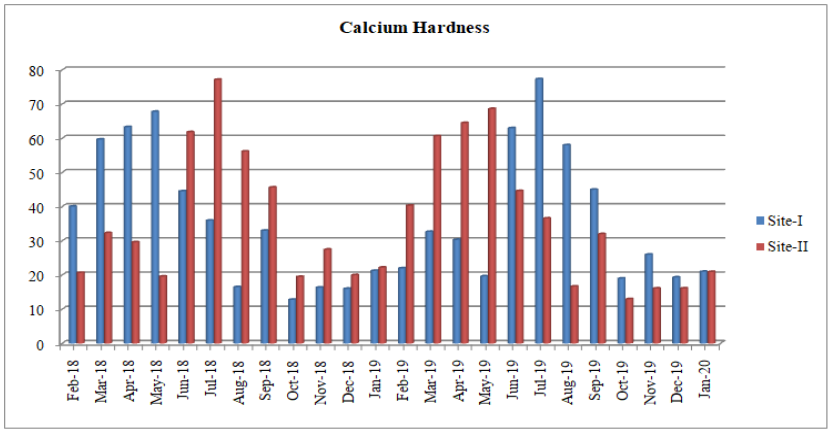

Fig. 13. The monthly average of Calcium Hardness of Mamchari dam.

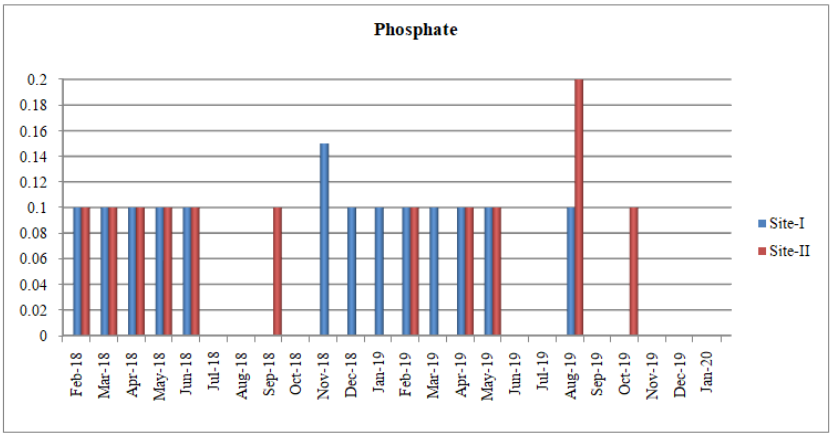

Fig. 14. The monthly average of phosphate of Mamchari dam.

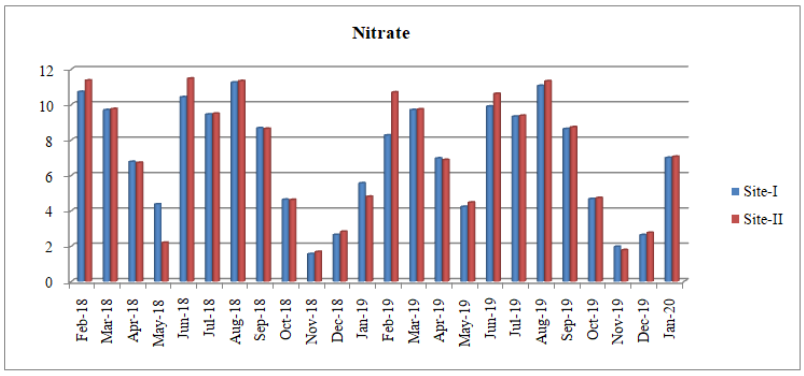

Fig. 15. The monthly average of Nitrate as Nitrogen of Mamchari dam.

Chloride: The amount of Chloride ranged from 12.57 mg/l to 82.67 mg/l at Site-I and 13.12 mg/l to 84.33mg/l at Site-II (Fig. 16). Seasonally, minimum Chloride was recorded during winter and maximum during monsoon season as reported earlier (Hulyal and Kaliwal 2011). Sharma and Tiwari (2018) also recorded similar trends in Nachiketa Tal in Garwal Himalaya.

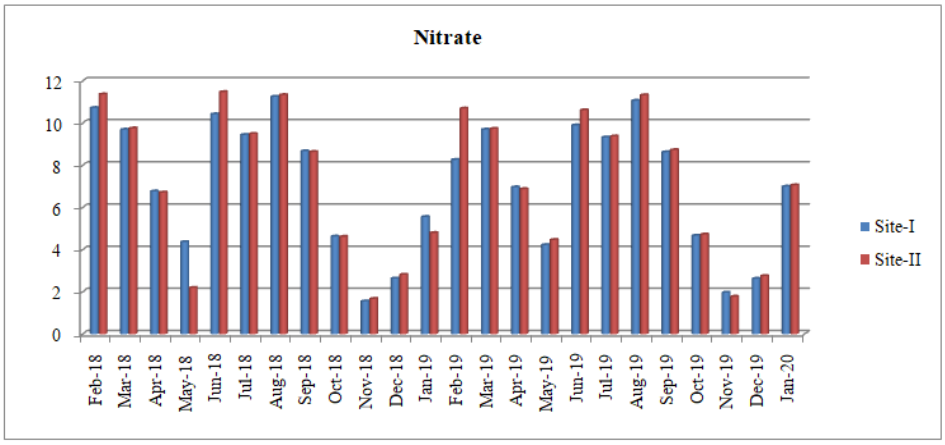

Fig. 16. The monthly average of Chloride of Mamchari dam.

Sulphate: During the present investigation, the values of Sulphate were minimum 0.08mg/l to peak value 32.47 mg/lat Site-I while 0.29 mg/l to 28.50 mg/l, respectively, at Site-II (Fig. 17). The peak values of Sulphate contents were observed during the monsoon months which may be due to incoming runoff with water of monsoon rain (Vashistha *et al.*, 2016).

Total dissolved Solids (TDS): TDS is the quality of all dissolved substances including inorganic and organic substances in liquid medium. TDS is an important parameter that shows impact on water quality. The High amount of TDS value usually has a disagreeable water taste. The amount of TDS recorded in Site-I range from 66 mg/l to 180 mg/l and at Site-II range from 106 mg/l to 216.50 mg/l (Fig. 18). The high amount of TDS was observed during monsoon due to runoff with water of monsoon rain and minimum during summer (Kumari *et al*. 2018).

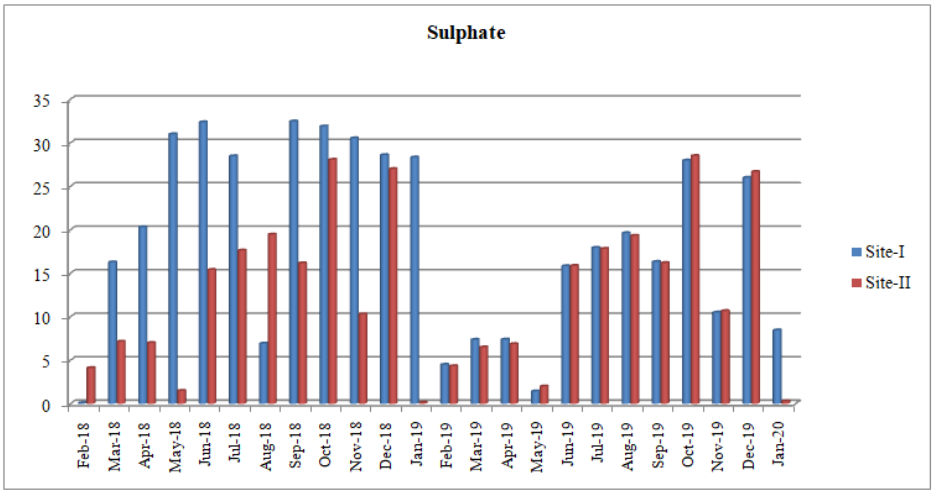

Fig. 17. The monthly average of Sulphate of Mamchari dam.

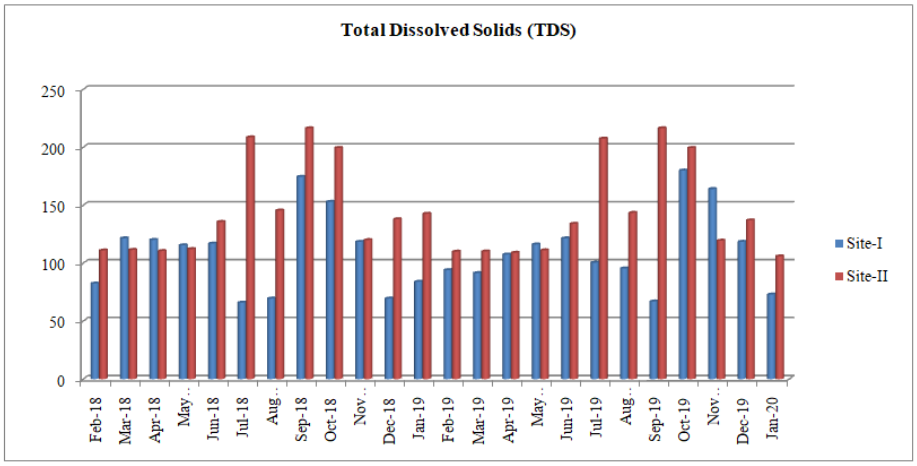

Fig. 18. The monthly average of TDS of Mamchari dam.

Total Alkalinity: The amount of Total Alkalinity recorded in Site-I ranged from 12.60 mg/l to 267.67 mg/l and at Site-II ranged from 65 mg/l to 269 mg/l (Fig. 19). Average values of seasonally were found maximum in monsoon and minimum during summer due to runoff effluent with water. The same study was done (Harney *et al.*, 2013; Sharma and Kumar 2022).

Conductivity: The amount of Conductivity recorded was a minimum 102.50 µmho/cm^2 and maximum of 482.00µ mho/cm^2 at Site-I while 103.50 µmho/cm^{2}to 482.33 µmho/cm^{2}at Site-II (Fig. 20). Seasonally, Conductivity was recorded minimum in summer and maximum during monsoon season. Kumari *et al.* (2018) recorded maximum Conductivity during monsoon and minimum during the summer season in a pond in Bihar state. In monsoon, Sharma and Tiwari (2018) from Nachiketa Tal, Garhwal Himalaya also observed maximum conductivity.

Total Solids: Total Solid is a measurement that includes the combination of total dissolved solids and total suspended solids in a liquid. In the present investigation the value of total solids was recorded between 78 mg/l to 349 mg/l at Site-I. In comparison the Site-II Total Solids were recorded between 77.67 mg/l and 349.67 mg/l (Fig. 21). Seasonally, maximum Total Solids were observed during monsoon and minimum during summer due to run off clay rocks particles and dump with rainwater. Khan *et al.* (2012); Mahajan and Pokle (2017) also recorded the similar findings.

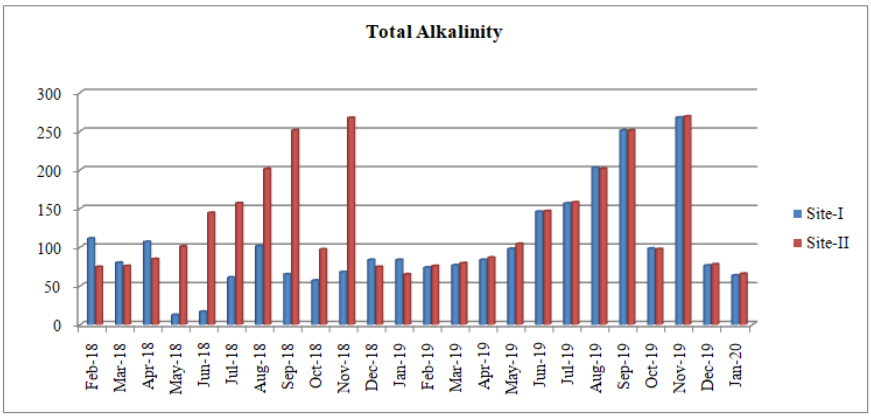

Fig. 19. The monthly average of Total Alkalinity of Mamchari dam.

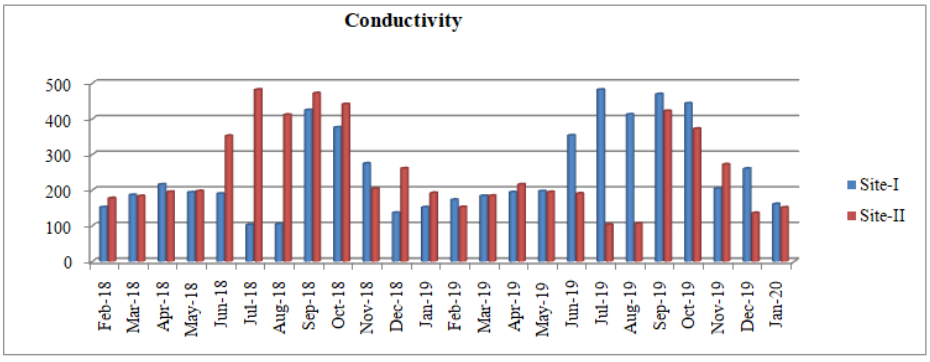

Fig. 20. The monthly average of Conductivity of Mamchari dam.

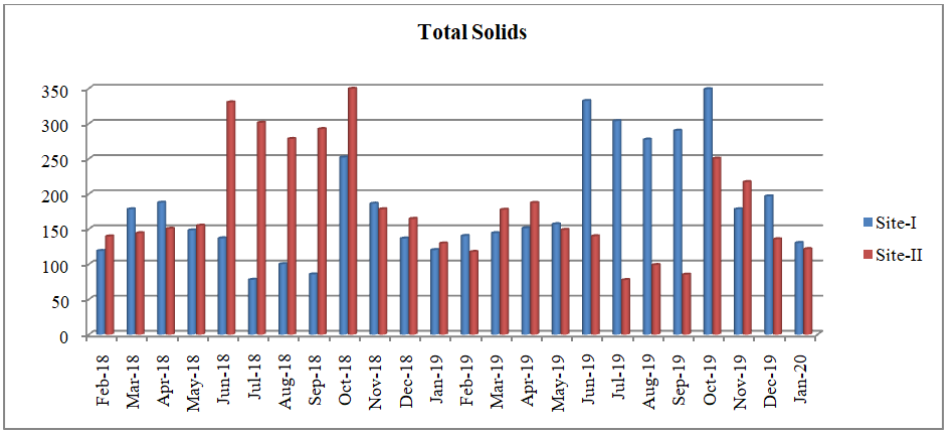

Fig. 21. The monthly average of Total Solid of Mamchari dam

CONCLUSIONS

Our objectives focus on the study of physicochemical characteristics of freshwater of Mamchari dam to monitor the water quality. Previous work has yet to be done on this dam. Thus, this is the first attempt of such study on the Mamchari dam for the assessment of surface water quality. From the following study it can be observed that the pH of water is more than the permissible limit thus water is alkaline. While most of the other parameters like TDS, Total hardness, Ca hardness, Mg hardness, Chloride, Sulphate and Nitrite have values which are lesser than the permissible limits. The water of the dam studied is all soft due to low values of hardness. So, it is concluded that the Mamchari dam's water indicates suitability for fish culture.

Authors Contribution Statement. The first author Rameshi Meena, Ph.D. research scholar was responsible for sampling, testing, observations and data analysis of the research work and wrote the paper with input from Dr. Vijendra K. Sharma, Ph.D. supervisor. Overall direction and planning of the work was done by Dr. Sharma. Finally, both authors have discussed the results and contributed to the manuscript.

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Conflict of Interest. None.

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