

# Limnological Study of Panchana Dam, Karauli with Special Reference to Physicochemical Characteristics

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## Abstract

This paper describes limnological study with respect to physicochemical characteristics of water of Panchana dam located in district Karauli in Eastern Rajasthan. Water quality of Panchana dam was studied for period of one year (February 2018 to January 2019) and tested following the standard methods at two sampling sites. The physicochemical values showed temporal or seasonal variation in the dam water. There is total 15 physicochemical parameters showed the different ranges at sites of dam. The value of various physicochemical parameters were: Water pH (7.25-8.29), Chemical Oxygen Demand (5.1-34 mg/l), Dissolved Oxygen (4.1-5.4 mg/l), Biological Oxygen Demand (1.3-3.8 mg/l), Chloride (12-120 mg/l), Sulphate (0.138-186 mg/l), Total Alkalinity (72-220 mg/l), Conductivity (185-490  $\mu$ mhos/cm), Magnesium (16-210 mg/l), Calcium (11-112 mg/l), Nitrate (2.62-8.6 mg/l), Phosphate (0-0.3 mg/l) Total Hardness (60-480 mg/l), Total Dissolved Solids (100-356 mg/l) and total solids (126-391mg/l). Nitrate and phosphate also were present in the dam water. Dam water was found to be alkaline and slightly eutrophic during monsoon season. Thus, this study demonstrated the worth of relationship and analysis of various physicochemical parameters for getting better information about the quality dam water.

**Key words:** Freshwater, Limnology, Panchana dam, Physicochemical status

Limnology is the study of inland waters. It is regarded as a division of ecology or environmental science. It covers the biological, chemical, physical, geological and other attributes of all inland waters (running and standing waters, fresh and saline, natural or man-made). Water is the most essential substance for all life on earth and a precious resource for human civilization. Water is also the most abundant and important resource of earth's surface. Reliable access to clean and affordable water is considered one of the most basic humanitarian goals, and remains a major global challenge for the 21<sup>st</sup> century. In both developing and industrialized countries, human activities play an ever-greater role in exacerbating water scarcity by contaminating natural water sources [1]. In the late 20<sup>th</sup> century and beginning of the 21<sup>st</sup> century, several reports have been published on physiochemical characters of water with reference to a number of water habitats in various places of India. However, it will be enormous here to mention their contributions in detail.

Freshwater ecosystems are more vulnerable to degradation than their terrestrial or marine counterparts. Studies have shown that increase in anthropogenic activities in and around the water bodies harm aquatic ecosystems and

exacerbate environmental issues [2-3]. Regular monitoring of physicochemical properties of a water body is critical for both long and short term studies. Physicochemical analysis is the most significant aspect when assessing the quality of water for its best utilization like drinking, irrigation, fisheries, and industrial purpose and helpful in understanding the complex processes, interaction between the climatic and biological processes in the water [4].

Anthropogenic activities are the main causative agents in the increase of nutrients like phosphates, chlorides and calcium and ultimately lead to eutrophication [5-6]. Due to unplanned management, tremendous development of industry and agriculture and disposal of untreated public sewage water, agriculture runoff and other human and animal wastes into river, lakes, reservoirs and other freshwater bodies are continuously deteriorating their water quality and biotic resources [7-8].

Dams generally built to change the natural flow of water, which leads human topographical interfere in water cycle. Shape, depth and size of dam, its location, its geographical location, with altitude and latitude water retention time, sources of the water, absorption by soil and soil types these all factors

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influence the water quality. All metabolic and physiological activities of life such as feeding, reproduction, movement, and distribution of aquatic organisms are greatly influenced by physicochemical characteristics of the water body. There are only few reports where physicochemical parameters are used for assessment of trophic status and ecological nature of Panchana dam [9-10].

#### Study area

Area wise Rajasthan is the largest state of India which is situated at the northwestern side of the country (Fig 1). There are quite a few freshwater bodies in Rajasthan. Panchana dam is one of the important fresh water-bodies of the district Karauli in Rajasthan, as it is used for irrigation and is also important source of drinking water supply for the city Karauli. The dam is situated near village Kashirampura-Gudla, about 12 km north of city Karauli (Rajasthan). Panchana dam is located across the river Panchana, a tributary of river Gambhir in Yamuna basin named as Panchana in vicinity of the dam site. Because of confluence of the five small rivers namely, Bhansawat, Manchi, Attaki, Bhadrawati and Berkheda, the dam is called as Panchana (Fig 2). All these five rivers are coming from different directions and carrying water which flows through various sediment pockets of different topography, influence by climate hydrology of corridor areas and anthropogenic activities like agriculture and mining operations in the catchment area (Fig 3). It is an earthen dam with the maximum height up to 33.19 m and ogee shaped crest with solid roller bucket type of dam. It is the largest earthen dam of Rajasthan state which is built on the Panchana River near the Gudla village. Panchana dam site falls under eastern gravelly/rocky plateau with outliers of Aravallis with the total catchment area of 621.60 sq. km and the compound area of about 10606 ha. The climate of the Panchana dam is almost semi-arid and comparatively milder with distinct winter, summer and rainy seasons.

This dam was constructed in 1977 under the Panchana Irrigation Project, Irrigation Division, Karauli (PIP, 2005). It includes seven tunnel gates with the Russian dam technology. The door of every gate is opened and pulled by the powerful and solid iron wires by the motor engines. The dam has a canal system known as Panchana main (feeder) canal, 11.57 km long which bifurcates into two branches (Shri Mahaveer Ji, 14.8 km; and Piloda, 18.8 km) at its tail end. Various features regarding geography and climate of the Panchana dam are given in (Table 1).

**Table 1** Geographical and climatic features of Panchana dam

Geographical features	
Range	Panchana dam
District	Karauli
Division	Bharatpur
State	Rajasthan
Location	77°00'00" E Longitude; 16°33'30" N Latitude
Highest point	262 m
Length	1040 m with top width 10.98 m, height 33.19 m
Gross catchment area	621.60 sq. km.
Surrounding Hills	Hilly area of Vindhyan and Aravali
Climatic features	
Summer temperature	Maximum 45°C, Minimum 24°C
Winter temperature	Maximum 31°C, Minimum 9°C
Average annual rainfall	724 mm annually
Monsoon period	July to September

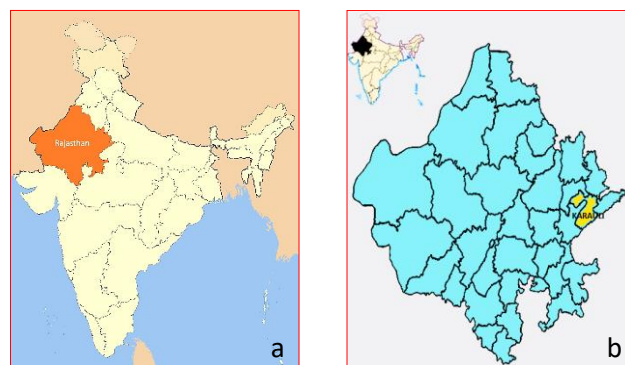
For the present investigation, we have selected two different sites of the dam (Fig 4-5), these are:

1. Dam site area where dam made up in Tiketpura and Pahari villages (Site-I)
2. Main Ghat of Panchana reservoir near Karauli-Hindaun city state highway (Site-II)

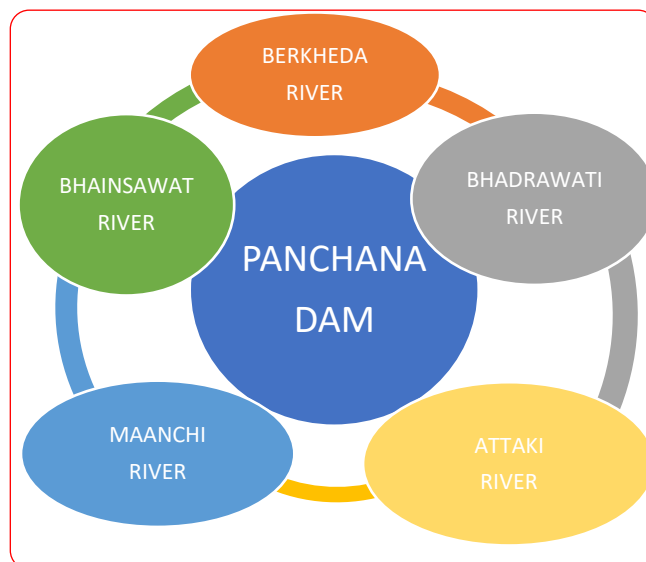
There is a temple of Anjani Mata (mother of the God Hanuman Ji) located on top of the hill near Panchana reservoir. This hilly region which is beautifully surrounded to Karauli city on one side and another side is Panchana reservoir in bottom of hill. Every year, there is a fair during the month of November when many people come to visit the Anjani Mata temple to receive blessing for health and happiness that time bathing, washing activities done by peoples at the dam site (Site-II). These activities of the pilgrims make the water dirty.

During the Keladevi fair (March-April, every year) peoples take bath, washing vehicles and wash their clothes at a large scale on the Panchana Ghat at Site-II. Sometimes human beings and cattle drop down (sinks) in deep water. There are cattle fair on Shivratri festival at every year in Karauli city from long time ago. People released many things in water at the time of Navratra and Shraddh Paksh. Food grain, cereals, Poojan-hawan-samagri, poly-bags, dead body ashes also thrown in the dam water. Besides this, plastic materials (like bottles, sacs, clothes and broken idols etc.) also released in water of dam.

It is also noticeable that the sewage water of Karauli city is pouring in Bhadrawati River, a tributary of Panchana dam. This river flows in Panchana and making the dam water highly dirty. Some farmers also made encroachment in the catchment area of Bhadrawati River. They are using river-land for growing of vegetables.



**Fig 1** Map showing India (a) Rajasthan and (b) Karauli district



**Fig 2** Rivers attributed to Panchana dam

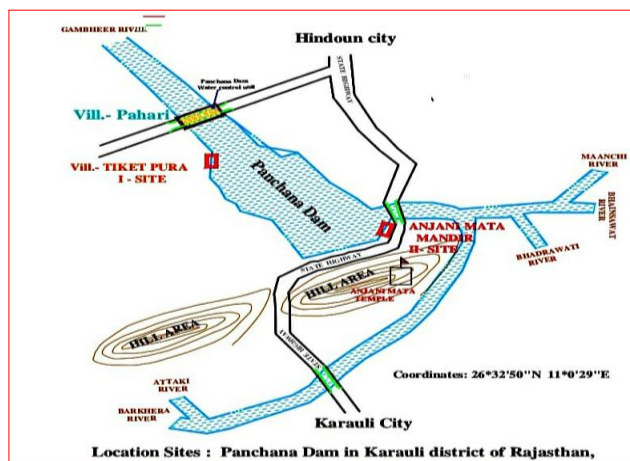


Fig 3 Map showing the whole catchment area of Panchana dam

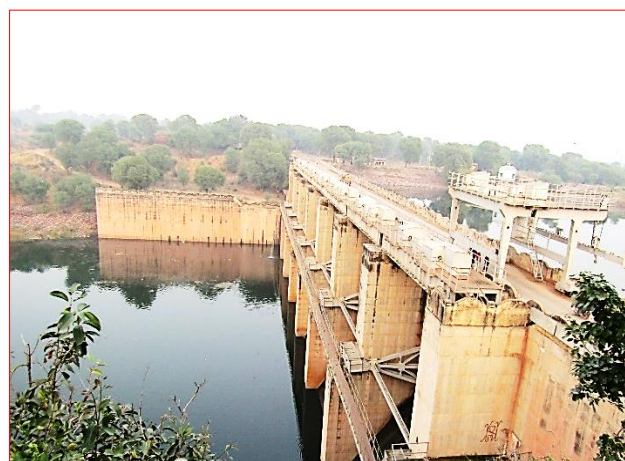


Fig 4 Actual view of the Panchana dam



Fig 5 Actual view of Site-I (a) and Site-II (b) chosen for the study of Panchana dam

## MATERIALS AND METHODS

This study was performed in Panchana dam for the period of one year i.e., from February, 2018 to January, 2019). Every year, periodical survey (monthly) and the collection of water samples were done from the selected two different sites of the dam in order to ensure sufficient data for study and to arrive at conclusions. Water samples were collected in each last week of the month in the morning hours at 8 am to 10 am from two selected sites of the water body. Before collection of the samples, the physical data like water color, odor, water and air temperature, TDS, relative humidity and light intensity were recorded at both the sites by respective handy devices. These data were taken by portable pH meter, Relative Humidity meter, digital TDS meter (HANNA, instruments, HI9811, Italy), and Light intensity by Lux meter (Photometer, HTC LX-101A). Samples were collected in plastic canes of 2-liter capacity, each sample with three replicates and marked with the site number and date of collection and immediately brought to the laboratory for analysis. The collected water samples were analyzed for fifteen physicochemical parameters pertaining to pH, Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Chloride, Sulphate, Total Hardness, Magnesium, Calcium, Phosphate, Total Dissolved Solids (TDS), Conductivity, Total Alkalinity, Dissolved Oxygen (DO), Nitrate and Total Solids. The data were interpreted with

respect to three seasons i.e., winter season from November to February; summer season from March to June and rainy season (monsoon) from July to October.

The methods of instrumentation and procedures for analysis of water samples were carried out. The estimation of various parameters was determined as per the standard methods of APHA [11]. In order to test the significance of data, the statistical analysis will be performed using Excel Analysis ToolPak (MS Office). The mean and standard deviation (SD) of the data was calculated of both sites. Graphical presentation of selected data was based on the empirical distribution function, associated with the empirical measurement of the sample.

## RESULTS AND DISCUSSION

### Water pH

The pH value is a negative logarithm of concentration of hydrogen ion in a dilute solution. Extreme low and extreme high pH are harmful for aquatic ecosystem. We have recorded highest pH in February 8.29 and lowest in November 7.51 at Site-I whereas at Site-II highest in December 8.20 lowest 7.25 in November. The pH of water was always on the alkaline side; it was relatively high in summer and low in winter season. The high pH during summer season may be due to high biological activity [12] including photosynthesis [13] alkaline water can support higher productivity [14]. Most of the natural waters are



generally alkaline due to the presence of sufficient quantity of carbonates [15]. Dilution of lake water by rain water influx,

primary productivity, salinity, temperature fluctuations, CO<sub>2</sub> for photosynthesis and decomposition of organic matter [16].

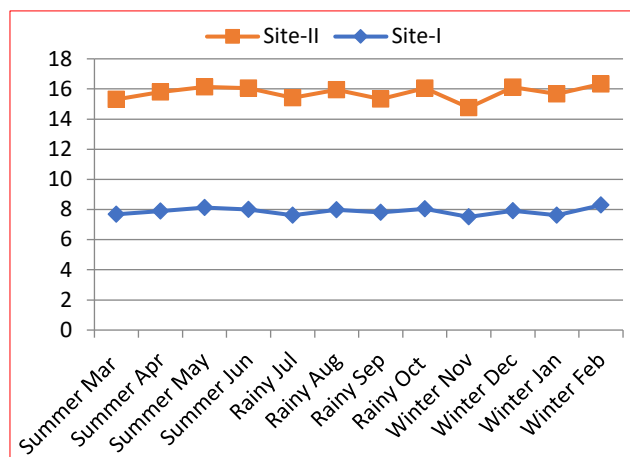


Fig 4 Monthly variation in pH value of water of Panchana dam

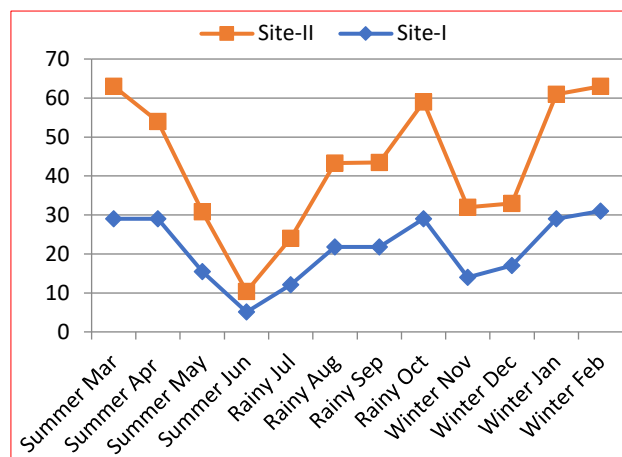


Fig 5 Monthly variation of COD in water of Panchana dam

#### Chemical oxygen demand (COD)

Chemical oxygen demand (COD) increases as the concentration of organic material increases. Water with COD typically contains high level of decaying plant matter, human waste and industrial effluent. BOD is the amount of oxygen required by the microorganisms to break down to the organic materials whereas chemical oxygen demand is the amount of oxygen required to break down the organic material via oxidation. COD is always higher than BOD because chemical oxidation is easier than biological oxidation. COD is reliable parameter for judging the extent of pollution in water [17]. The ranges COD was 5.1 to 34 mg/l. In Panchana dam, high COD

values recorded during the dry season has been ascribed to the death and decay of plants and the consequent increase in organic matter. The COD of water increases with increasing concentration of organic matter [18].

#### Biological oxygen demands (BOD)

BOD indicates that how much oxygen utilized by microbes during aerobic respiration to decompose or stabilizing the organic material. When the BOD increased then level of DO decrease. BOD in Panchana dam was in the range between 1.3 mg/l to 5.44 mg/l with low values in winter season and high values during monsoon season [19].

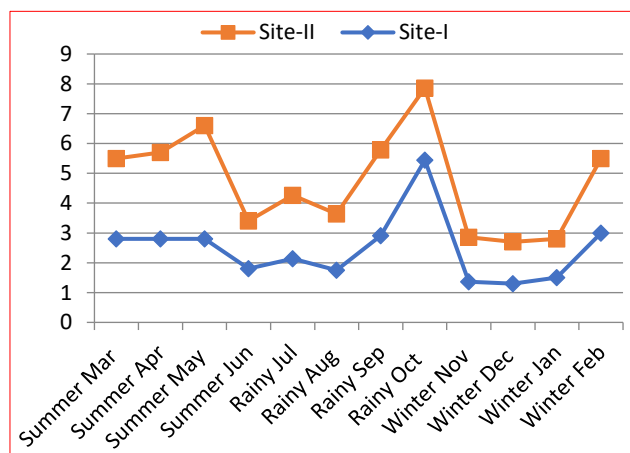


Fig 6 Monthly variation of COD in water of Panchana dam

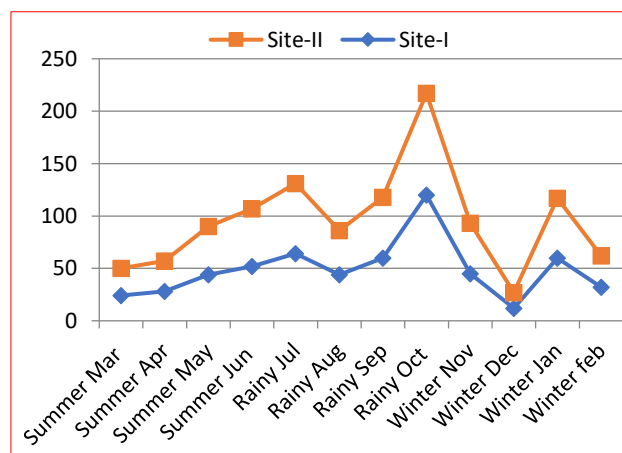


Fig 7 Monthly variation of Chloride in water of Panchana dam

#### Chloride

Ranges chloride were recorded from 15 mg/l to 120 mg/l during the investigation of Panchana dam water. Highest value appeared in monsoon season whereas lowest in winter. This content came from NaCl or CaCl<sub>2</sub> in aquatic environment. High concentration of chloride content can be harmful for freshwater ecosystem because it may create a negative role in osmo-regulation process.

#### Sulphate

Sulphate, the anion of sulphuric acid, is everywhere in the natural environment and is released by many aquatic, terrestrial and geological processes, such as the dissolution and erosion of evaporates and the eruption of volcanoes. The variation in sulphate level was between 0.138 mg/l to 186 mg/l.

Sulphates are found in appreciable quantities in all natural waters. They are particularly high in arid and semiarid waters where salt content is more [20].

#### Hardness

During the summer months, the values of total hardness increase due to high evaporation. It's important parameter for freshwater which determines the water quality is suitable for domestic useable or not useable. It tells about dissolved minerals like calcium and magnesium.

The range of hardness was fluctuating during the winter months which show the ranges from 60 mg/l to 480 mg/l. It was observed lowest in June month. It may be cause of anthropogenic activities in crop fields surrounding the Panchana dam.

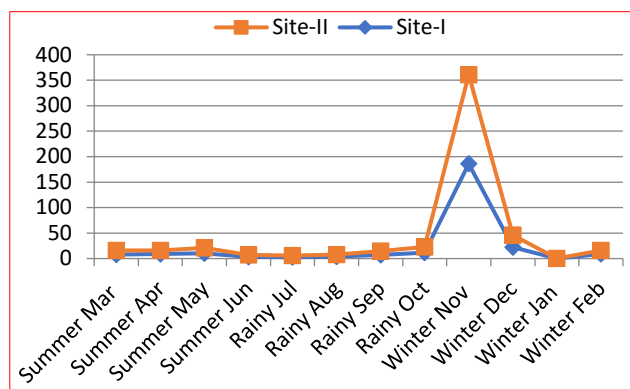


Fig 8 Monthly variation of Sulphate in water of Panchana dam

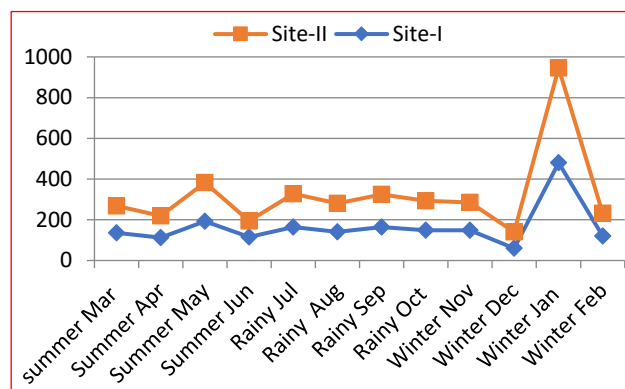


Fig 9 Monthly variation of Hardness in water of Panchana dam

### Magnesium

Magnesium a very essential element of plant growth, plants lose their natural color due to the deficiency of magnesium. It's absorbed in the form of magnesium ions

(Mg<sup>2+</sup>). Magnesium is often associated with calcium in all kinds of waters, but its concentration remains generally lower than the calcium [21]. The ranges of magnesium were highest in winter months and lowest during the monsoon months.

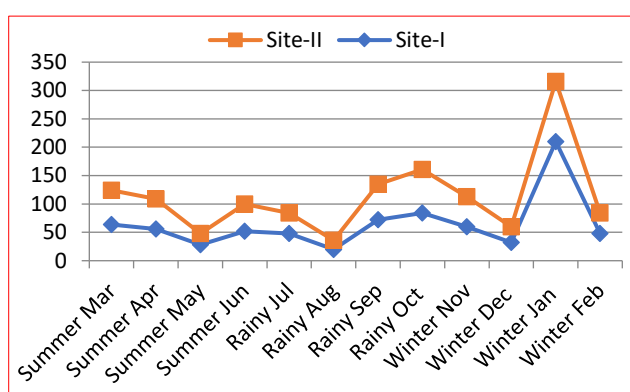


Fig 10 Monthly variation of magnesium in water of Panchana dam

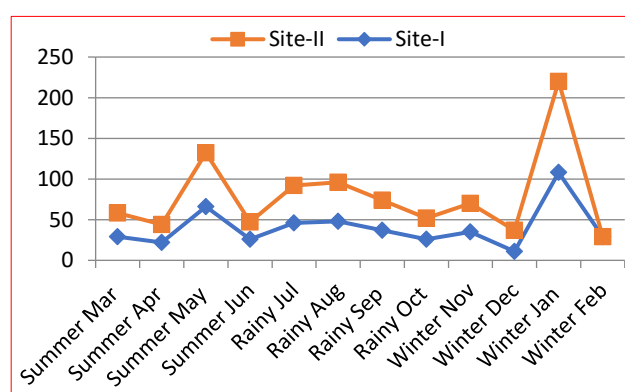


Fig 11 Monthly variation of calcium in water of Panchana dam

### Calcium

In aquatic environment, calcium serves as one of the micronutrients for most of the organisms. It is an important part of bones and scales of fishes. Both calcium and magnesium make total hardness of any water ecosystem. In the present study, the values of calcium level were maximum fluctuating during the peak of winter and summer seasons.

could be attributed to winter rainfall, surface runoff receiving cattle dung, detergents and more use of agricultural fertilizers from surrounding catchment area of the dam. The ranges of phosphate were zero to 0.3 mg/l in Panchana dam.

### Phosphate

Phosphate is part of the animal bones and teeth. Phosphorus containing chemical compounds is known as phosphate. Phosphate level in aquatic ecosystem regulates the growth of algae. The high concentration of phosphate is always indicative of eutrophy [22]. In the present study, the concentration of phosphate is highest during the winter season

### Total dissolved solids (TDS)

Total dissolved solids (TDS) show the presence of sodium, potassium, chloride, toxic elements (like Arsenic, Nitrates, and Cadmium) and dead matters which have both long and short term negative impact in water. High Total dissolved solids (TDS) affects water quality. Range of TDS was highest in October i.e., 356 mg/l and lowest in June 110 mg/l, it means during the monsoon (rainy) season the range of TDS increased and in summer season Total dissolved solids (TDS) values became slow down.

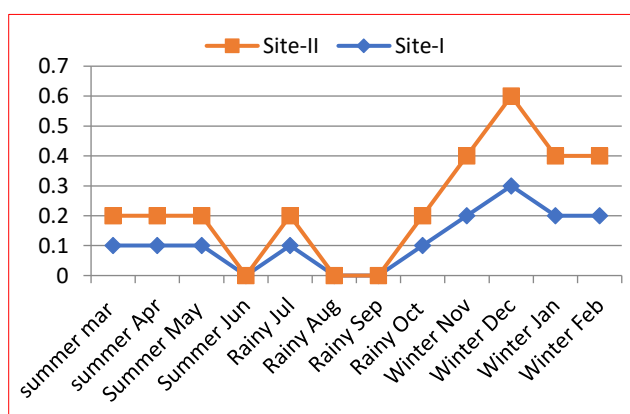


Fig 12 Monthly variation of phosphate in water of Panchana dam

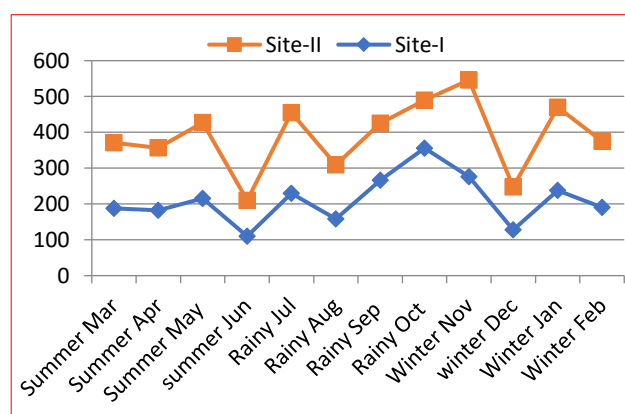


Fig 13 Monthly variation of TDS in water of Panchana dam

### Conductivity

The electrical conductance represents total ionic load in water due to dissolved substances. It shows the electrical flow capability of water. Less ion shows low conductivity and more ion indicates the higher conductivity. A sudden change in the conductivity indicates the pollution in water because of the level of chloride, phosphate and nitrate increases or decreases.

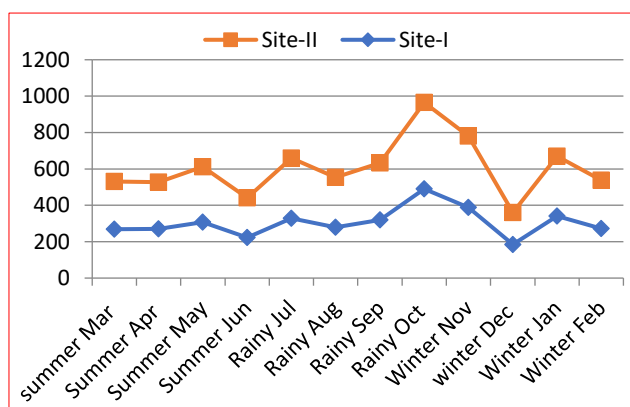


Fig 14 Monthly variation of conductivity in water of Panchana dam

### Total alkalinity

Total alkalinity is the measure of water's ability to neutralize acids. It is the reverse form of acidity in any liquid. Alkalinity is the measure of hydroxide and carbonate ion content of water sample. Water sample is titrated with standard HCl using indicator. During the year, high value of total alkalinity was found in winter months especially in September (209-220 mg/l) month while low value (72-80 mg/l) in December month.

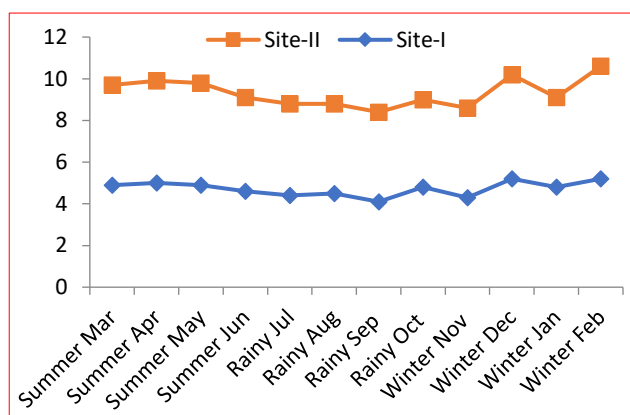


Fig 16 Monthly variation of DO in water of Panchana dam

### Dissolved oxygen (DO)

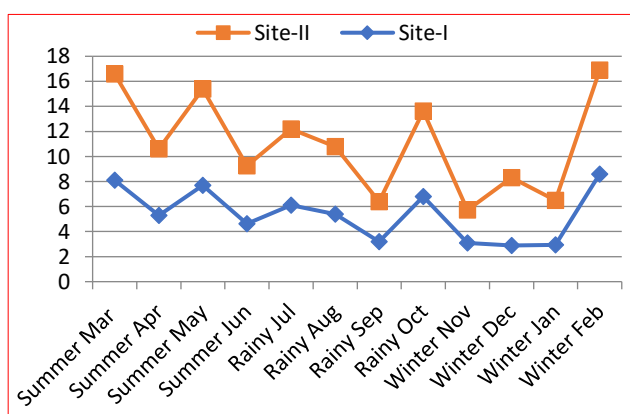


Fig 17 Monthly variation of nitrate in water of Panchana dam

Reason of sudden decreasing or increasing of elements is agricultural run-off or sewage or garbage poured in water. Conductivity is fast and frequent indicator of change in water. In the present study, the electrical conductance of Panchana dam was found to be range from 490 mg/l to 185 mg/l at Site-I and 475 mg/l and 175mg/l at Site-II.

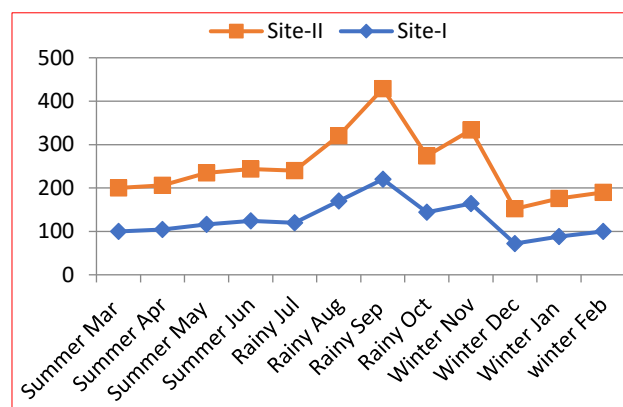


Fig 15 Monthly variation of total alkalinity in water of Panchana dam

DO of the Panchana dam water was found highest 5.4 mg/l in winter months and lowest 4.2 mg/l in monsoon months. The maximum value of DO was recorded in winter months while minimum in monsoon months. The DO is a very important parameter as it serves as an indicator of the physical, chemical and biological activities of water body. Two main sources of dissolved oxygen are diffusion of oxygen from the air and the photosynthetic activity [23]. DO plays very important role in growth, survival and physiology of aquatic organisms. When DO level decreases then temperature, salt levels and pressures increase. Bacteria and fungi decompose the organic matter where both required more DO for decomposition of the decaying matter.

### Nitrate

Nitrate is a leading component of farm fertilizer and required for crop production. Higher values of nitrate concentration recorded during the winter season (8.6 mg/l) due to anthropogenic activities. When rain is varying, nitrate amount wash from farmland into the nearby waterways. Another possible way of nitrate input might be through oxidation of ammonia in the form of nitrogen to nitrite and consequently to nitrate [20]. The recorded low values during winter may be due to slow decomposition of organic matter at low temperature combined by uptake of nitrate by phytoplankton [24]. Lowest value in winter months and highest value were found in February and March months.

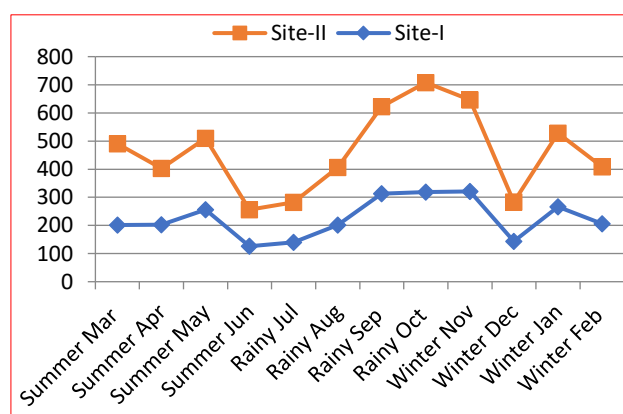


Fig 18 Monthly variation of total solids in water of Panchana dam

### Total solids

Total solids are dissolved solids plus suspended and settle able solids in water. In stream water, dissolved solids consist of Ca, Cl, NO<sub>3</sub>, phosphorus, iron, sulfur and other ions particles that will pass through a filter with pores of around 2 microns (0.002 cm). In the present study, the range of Total solids was between 391 mg/l to 126 mg/l at dam sites. During monsoon season, Total solids increased and June and December months shows the lowest values which are peak months of winter season respectively summer seasons.

## CONCLUSION

This study has provided information on and about the status of water quality of Panchana dam located in district Karauli in Rajasthan. The study revealed that the most of the physicochemical parameters were found within the observed ranges in unpolluted water bodies. The present investigation shows that water body relatively found moderate levels of nutrients so that these can be placed under the category of moderately eutrophic water. On the basis of physicochemical characteristics of dam, the status of water was found slightly alkaline. They continue to be degraded through habitat loss due to human activities and conservation methods are urgently required to maintain the integrity and biodiversity of such ecosystems. The sustainability of Panchana rivers ecosystem will depend upon managing the nearby agricultural setups as well as other disturbing factors. Moreover, high pressure of the human activities during the fair of Anjani Mata temple and Keladevi in and around the dam as mentioned in the study area

should be regulated. Governments must take a serious eye over the issue as it is just the beginning of the deterioration of the ecosystem. Besides, the topographic characteristics of Panchana corridor area provide an inclination towards the river and the dam. Therefore, the high rate of sedimentation takes place in rainy season. The corridor features of individual rivers are quite different which consequently differentiate rivers of the Panchana dam with respect to physicochemical parameters. The agricultural fields surround the dam and therefore the chemicals and fertilizers are influencing the dam water, which is used by farmers of this area. These all-anthropogenic factors are polluting the Panchana dam water.

### Authors contribution statement

The first author Sonum Bamania, Ph. D. Research Scholar is responsible for sampling, testing, observation and data analysis of the work done 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.

### Conflict of interest

Conflict of interest declared none by the authors.

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