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Assessment of Water Quality of Neota Dam for Determining its Pollution Status

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ABSTRACT

The current study is to track and evaluate the level of physic-chemical and heavy metal contamination in a water reservoir of Jaipur region and the health hazards due to bioaccumulation. Triplets from specific places inside the Water body were used to collect water samples constantly over a 12-month period, from December 2022 to November 2023 in a quarterly basis. Strict adherence to IS and APHA standards was maintained throughout the sampling and testing process. The observed physico-chemical parameters and heavy metal concentrations were then contrasted with the permissible limits as per the guidelines of the National Plan for Conservation of Aquatic Ecosystem (NPCA), which is overseen by the Ministry of Environment, Forests, and Climate Change of the Indian government. The levels of heavy metal in water and fishes were analysed using Atomic Absorption Spectrophotometer from the collected samples.

INTRODUCTION

The globe, including India, is now experiencing a freshwater crisis in this century. The irony is immense: out of the water that covers 70% of the planet, just 2.5 percent can be used for fresh water. With the discharge of waste water in freshwater sources like lakes and rivers, the freshwater issue is getting worse every day.." Water is a complex element of the environment that possesses unique physical, chemical, and biological properties that are necessary for life. It is home to a wide variety of highly diverse aquatic organisms, and it is currently at a critical stage in their evolution (Gandotra et al., 2017) Heavy metals include iron, manganese, nickel, lead, and zinc (Fe, Mn, Ni, Pb, and Zn) make up 80% of the waste water. In addition, non metallic pollutants such as organic pollutants, hazardous compounds, and solutions have a negative impact on the quality of the water. Other effects, such as an increase in biological oxygen requirement and excessive TDS in drinking water, are caused by the declining water quality. More life is lost annually as a result of this quickly growing problem of contaminated water supplies than via conflict and violence. We were all aware that just 1% of water could be classified as freshwater overall. While many affluent nations may not have many issues with access to clean drinking water, nations like India are facing severe challenges because of their dense populations and scarce water supplies.The water bodies, such as lakes and dams, are made up of a variety of chemical, biological, and physical elements. They can have a freshwater or saltwater source, be deep or shallow, and be either temporary or permanent [Bhateria *et al* 2016]. One of the fields that studies and classifies information about lakes is limnology. One of the most significant places to observe ecological systems, the interactions between various processes on a chemical and biological level, and the relationships between aquatic species and terrestrial and aerial organisms is lakes.(Jain *et al* 2019).The evaporation of groundwater supplies has left some lakes saline, and there is a significant relationship between the land, air, and water ecosystems. Anywhere in the river basin can have lakes. A water reservoir receives input from several streams that are created by groundwater influx and rainfall. Lakes typically have a single source of input and output that sustains the flow of fresh water. Almost half of the world's fresh water is found in the lakes, making them a very important ecosystem for the preservation of freshwater supplies. In addition, it is a valuable resource for a variety of uses, including industry, irrigation, fisheries, and water supply [Bhateria *et al* 2016].Fishes are an important bioindicator and is quite susceptible to heavy metals and other contaminants. This study investigates the possible health risks associated to it.

MATERIALS AND METHODS

Study area

Rajasthan known as the land of kings is a state in north western India famous for its rich heritage, vibrant culture and diverse landscapes. It is India's largest state geographically and features everything from the great thar desert to Aravalli ranges and fertile plains. The state is also famous for its forts, palaces and colorful handicrafts. Rajasthan lies in northern India. It is the largest state of the country, covering an area of 342,239 square kilometres (132,139 sq mi) or 10.4 per cent of the total geographical area of India. The population of Rajasthan is 68,548,437 (as per the 2011 Census). The state ranks seventh in terms of population. Rajasthan has 33 districts. Jaipur is the capital of Rajasthan. The state shares its borders with five Indian states: Punjab to the north; Haryana and Uttar Pradesh to the northeast; Madhya Pradesh to the southeast; and Gujarat to the southwest. The border of Rajasthan touches with the Pakistani provinces of Punjab to the northwest and Sindh to the west, along the Sutlej-Indus river valley.

JAIPUR

Jaipur is a city with a rich tradition and culture, and buildings such as forts, lakes, and old structures define its identity. Because of its strong cultural qualities and heritage, it attracts a large number of tourists during practically every season of the year. Jaipur is situated in latitude 26˚ 55' north and longitude 75˚ 49' east. In terms of latitude, the municipal limit stretches from 26 degrees 46 minutes north to 27 degrees 01 minutes north, and from 75 degrees 37 minutes east to 76 degrees 57 minutes east. The city is encircled by the Aravalli hill ranges, specifically the Jhalana in the east and the Nahargarh hills in the north. There are other prominent hillocks to the city's west and south, although their creation is sporadic and solitary. The present study was carried out in a water body of Jaipur district named **Neota dam.**

Neota Dam

The water body **Neota** (also known as **Neota Dam** which is located in the Sanganer Tehsil of Jaipur district in Rajasthan, India. The total catchment area of the dam is 443,583 ha (1,096,120 acres) and it has a storage capacity at the 16 ft (4.9 m) gauge marker of 236.72×106 cu ft (6.703×106 m3).[2][3]On average, approximately 150 birds, including the uncommon Lesser Whistling-Duck and the widespread Eastern Cattle Egret, have been seen each year on the eastern side of Nevta Dam. This diverse habitat attracts both common and less frequent visitors, contributing to a total of 196 bird species recorded here so far[4]The dam is situated 5 km (3.1 mi) from Muhana and 13 km (8.1 mi) from Mansarovar. The Special Economic Zone (SEZ) called Mahindra World City Jaipur is 3.6 km (2.2 mi) away. This dam is named after the adjacent village of Neota. the latitude and longitude of this dam is 26°48′14.7″N 75°40′56.1″E.

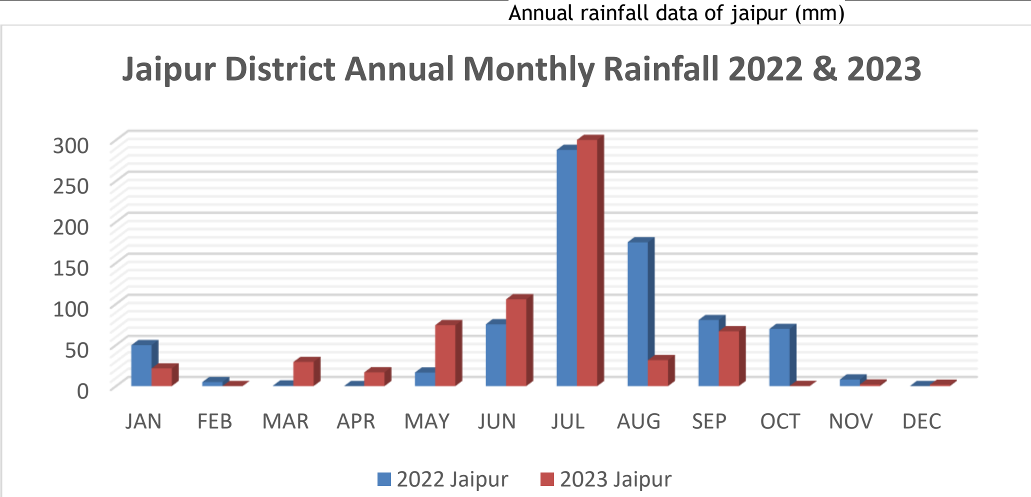
NEOTA DAM

Mateorological data

Rainfall data is an important factor in determining the pollution level of any water body. Average rainfall in Rajasthan is about 313 to 675 mm. The states rainfall varies across its various regions.

S.NO.	DISTRICTS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2022	Jaipur	49.79	4.84	0.68	0	16.42	75.22	287.87	175.09	80.35	69.57	8	0
2023	Jaipur	21.48	0	29.33	16.74	74.13	105.58	315.5	31.54	66.71	0.13	1.88	1.52

Annual rainfall data of jaipur (mm)



Graphical comparison of annual rainfall(2022-2023) (All values in mm)

Annual rainfall overview

Jaipur experiences a semi-arid climate with significant seasonal variations in rainfall. The majority of precipitation occurs during the monsoon months, typically from June to September. Over a period of 30 years Jaipur's average annual rainfall is approximately 635.4 mm with the bulk accuring between June and September during the monsoon season. In 2024, Jaipur district experienced a notable increase in rainfall, recording an average of 748 mm, which is about 68% higher than the previous year Rainfall in Jaipur is highly seasonal, with the majority occurring during the monsoon months. Here's a breakdown of average monthly rainfall: The remaining months experience less rainfall with November and December averaging around 3.9 mm and 4.2 mm respectively.

Methodology

Collection of Samples

For the purpose of analysing different parameters, water samples were taken on a quarterly basis (in triplicate) from December 2022 to November 2023. Sites were chosen to reflect the water quality at various pond locations, such as the inlet, centre, and outlet, respectively (APHA, 2012), and samples were taken using grab sampling at predetermined times and intervals. Although the sample was tiny in volume, it was representative of the entire body of water. Maintain it without making major alterations. (APHA, 2012).It is commonly recognised that an aquatic body's water quality changes with the seasons as a result of several man-made and natural influences. Every physico-chemical change in the water was monitored and documented for the research (APHA, 2012). Inert polypropylene containers with a capacity of 2.5 litres were used to collect the samples after being washed and rinsed with distilled water. The sample containers' stoppers were securely fastened (APHA, 2012).In between when a sample was taken and when it was examined in the lab, all samples were stored in the dark and preservatives such as mercuric chloride and alcohol were employed to prevent alterations (APHA, 2012). The water samples were kept in the lab for additional examination, which included physico-chemical and Analytical Methods Manual, Water Quality Branch, Environment Canada (1981).The following fish species are found in Neota water reservoirGarra mullya, Puntius sophore, Labeo rohita, Catla catla, Cirrhinus mrigala, Cyprinus carpio, Labeo boggut, and Rasbora daniconius Other noteworthy species are the Bronze Featherback, Wallago, Spotted Barb, Golden Mahaseer, and Ompok bimaculatus (Butter Catfish). Clarias magur is an endangered species of conservation concern.

Analysed parameters

PHYSICAL PARAMETERS

TEMPERATURE

A thermometer was used to determine the temperature. It was then dipped into a 1-liter piece of the water sample for a while (until the reading remained steady), at which point the result was noted and stated in degrees Celsius (APHA, 2012).

CHEMICAL PARAMETERS

PH

One of the most crucial aspects of water chemistry is the measurement of pH. Water's chemical and biological characteristics are directly impacted by pH. Therefore, it is crucial for determining the quality of the water. Using a glass and a reference electrode, the pH of the water sample was measured electrometrically (APHA, 2012).

TOTAL SOLIDS (TS)

The total solids were obtained by drying and evaporating the well-mixed sample in a specified volume at 100 oC until the weight remained constant (APHA, 2012).

TOTAL SUSPENDED SOLIDS(TSS)

The retained proportion of particles on the filter (filter paper size 2.0 μ) is known as suspended solids. Water is not suitable for use in homes or businesses if it contains a lot of suspended solids.

At 100 degrees Celsius, the solids portion that was kept on the filter paper was dried until its weight remained constant.

The total weight of suspended particles was calculated, excluding the weight of the filter paper.

ELECTRICAL CONDUCTIVITY(EC)

This indicates that there is an electric current present in an aqueous solution; it may be measured numerically and is dependent on the concentration of ions, relative concentrations, and aqueous solution mobility, in that order (APHA, 2012).The conductivity meter electrode IS dipped into the sample and the readings of stable value is shown as ms/cm.

DISSOLVED OXYGEN (DO)

All living organisms rely on oxygen in one form or another to sustain their metabolic processes. One important component of precipitation and the breakdown of inorganic materials in water is dissolved oxygen (DO).One fundamental metric for examining water pollution is the measurement of dissolved oxygen in the water (APHA, 2012). This metric was regarded as a gauge of the general health of the water body since oxygen levels can be reduced to a degree that could be detrimental to the living biota.Inkler's technique has been applied.The physical, chemical, and biological processes occurring inside a body of water determine the DO levels of any given type of water. Even yet, at a given temperature, oxygen's solubility fluctuates with air pressure, making it a weakly soluble gas. According to APHA (2012), atmospheric oxygen's solubility in fresh water varies from 14.6 mg/L at 0°C to 7.0 mg/L at 35°C.

BIOLOGICAL OXYGEN DEMAND (BOD)

Airtight bottles were used to collect all water samples. These samples were incubated for five days at a temperature of 20 °C. A sample's dissolved oxygen content was assessed both before and after incubation, and the oximeter was used to record the DO value (APHA, 2012).

CHEMICAL OXYGEN DEMAND (COD)

The organic matter contained in the water was oxidized fully by potassium dichromate with the presence of conc. H_2SO_4. The COD was then determined by titrating a potassium dichromate solution with $FeSO_4$. The volume that was used of Dichromate demonstrated how organic matter needs oxygen to oxidise (APHA, 2012).

TOTAL HARDNESS (TH)

Cations, such as Ca, Mg, Fe, Mn, etc., are the main source of hardness. The overall hardness of the water is determined by the concentration of Ca and Mg ions. Temporary hardness is caused by the carbonate and bicarbonate compounds of these two, namely Ca and Mg. Permanent hardness is provided by compounds of sulphates and chlorides. Water hardness renders it unfit for industrial use in addition to being unfit for bathing and washing. Water hardness prevents detergent from creating a lather, makes it unfit for bathing and washing, causes scales to build in boilers or tanks, and renders it unfit for industrial use. A conical flask was filled with 50 ml of the sample, followed by the addition of 1 ml of NH_4^+ buffer and two to three drops of the indicator Eriochrome black-T. The faint blue hue appeared at the end point when the aforesaid combination was titrated against standard 0.01M EDTA (APHA, 2012). Range of hardness of water is described that soft water (0-60 mg/L), medium hardness (60 – 120 mg/L), Hard water (120 - 180 mg/L) and Very Hard water (> 180mg/l).

NITRATES

Symptomatic pollution is caused by a high nitrate content in water. The sample's nitrate content was estimated as per (APHA 2012) guidelies.

CALCIUM HARDNESS(Ca+)

EDTA is used to test calcium. When the calcium solution was mixed with mercuric oxide (as an indicator), the calcium reacted with the EDTA at pH 12–13, changing the solution's hue from pink to purple.

MAGNESIUM HARDNESS (Mg++)

Magnessium hardness is estimated as follows

Water that had a high concentration of it exceeding 500 mg/L tasted bad and was no longer fit for human consumption (APHA, 2012).

POTASSIUM (K)

A flame photometer set to 766.5 nm was used to measure the amount of potassium. "Emission Spectroscopy" is the basis for the flame photometry principle. The flame photometer was filled with the filtered sample. The concentration was displayed using the standard curve was developed (APHA, 2012).

SODIUM(Na+)

The concentration was plotted on a graph after the flame photometer's filter was adjusted for the 589 nm wave length, which is designated for Na. (APHA, 2012).

HEAVY METALS

Heavy metals are discovered as ores at great depths in the earth and have large atomic numbers. Because of their toxic nature, these metals are separated from ores and can enter water bodies straight from any source. In addition to these qualities, they play a significant role in a number of industrial uses, such as paper, cars, and pins. They thereby infiltrate the environment and have an impact on the food webs (APHA, 2012). The Atomic Absorption Spectrophotometry was used to analyse the heavy metals in the samples that were collected (APHA, 2012).

Following metals were analysed

Lead (Pb) Lead was determined at a wavelength of 283.3 nm by AAS.

Copper (Cu) The determination of Copper was carried out at a wavelength at 324.7 nm.

Zinc (Zn) The estimation of Zinc was accomplished at a wavelength of 213.9 nm by AAS (APHA, 2012). Different wavelength for different element mentioned as per APHA (2012).

Maganese (Mn) The Mn atom is estimated at a wavelength of 279.5 nm as mentioned in APHA 2012

FISH SAMPLING

Fish samples were collected and were washed with distilled water and kept in an ice box and then brought to the laboratory. Samples were measured (length, breadth and weigh) after getting it to room temperature and dissected with stainless steel knife and kept in a freezer at -4̊c. All the laboratory equipment were washed thoroughly and then soaked in a 2% nitric acid sol. and rinsed with double distilled water prior to experimentation to avoid contamination. Five grams of the homogenized spineless muscle tissue of each fish was taken into a beaker and then 7ml of supra pure HNO3 (65% v/v) and 3ml of H2O2 (30% v/v) 3 ml (1:3 ratio) were added to it (Durali et al., 2010; APHA 2005) and covered it using watch glass and kept it overnight The mixture was placed on thermostatically controlled hot plate maintained at 70̊c for 45 minutes. The clear solution was cooled down and filtered through waltz men filter paper and make up to 25 ml using double distilled water(APHA 2014).The concentration of heavy metals was measured using Inductively Coupled Plasma Mass Spectrometry (ICP-MS - Agilent 7700 series USA) results are expressed in µg/g per wet weight. All the digested samples and blank were run parallelly using standard solution acid mixture.

Table-Characteristics of the examined fish species

S.No.	Scientific name	Common name	Feeding habit	length
1	Lobeo Rohita	Rohu	Surface feeder,filamentous algae and sand	0.5m
2	CatlaCatla	Catla	Surface feeder,zooplanktons	3.5 m
3	Luciobarbus Esocinus	Mangar	Zooplanktons and small fishes,insects	2.3 m

RESULTS AND DISCUSSION

Table - Heavy metal concentrations in Dam water

Heavy metal	**Water sample 1**	**Water sample2**	**Water sample 3**	**Unit**
Zinc(Zn)	0.83-3.5 mg/L	0.73-3.4 mg/L	0.83-2.5 mg/L	**Mg/l**
Cadmium(Cd)	0.02-1.14 mg/L	0.02-1.24 mg/L	0.02-1.04 mg/L	**Mg/l**
Lead(Pb)	0.05-0.59 mg/L	0.06-0.49 mg/L	0.06-0.79 mg/L	**Mg/l**
Manganese(Mn)	1.2-2.04 mg/L	1.2-2.44 mg/L	1.2-2.54 mg/L	**Mg/l**

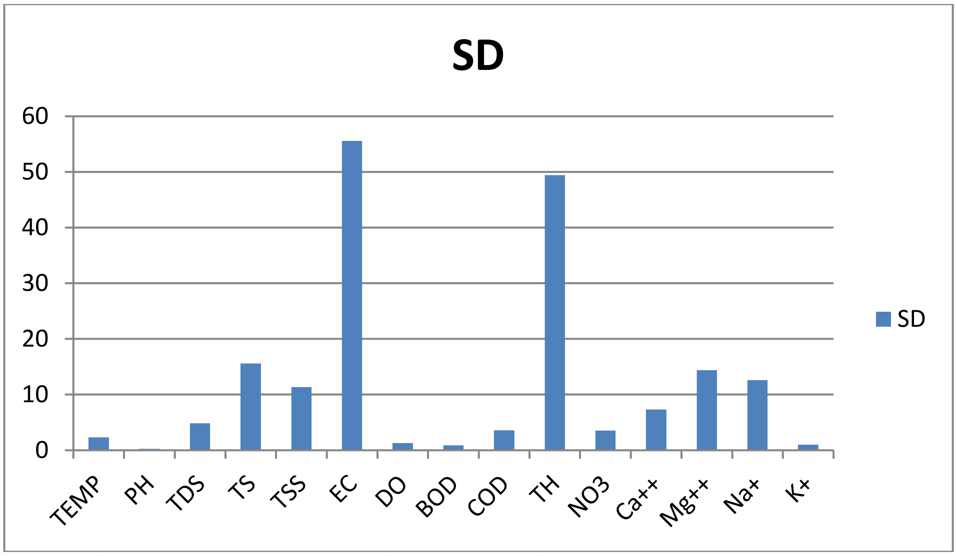
Table - Heavy Metal Concentrations of fish samples

Heavy metal	Lobeo Rohita	Catla Catla	Luciobarbus Esocinus	**Unit**
Lead (Pb)	3.08 µg/g	0.0352±0.0069	1.00 µg/g	**Mg/l**
Copper (Cu)	1.88 µg/g	2.97µg/g	2.93µg/g	**Mg/l**
Zinc(Zn)	59.89 µg/g	42.87 µg/g	42.87 µg/g	**Mg/l**
Manganese(Mn)	1.02 µg/g	0.86 µg/g	1.14 µg/g	**Mg/l**

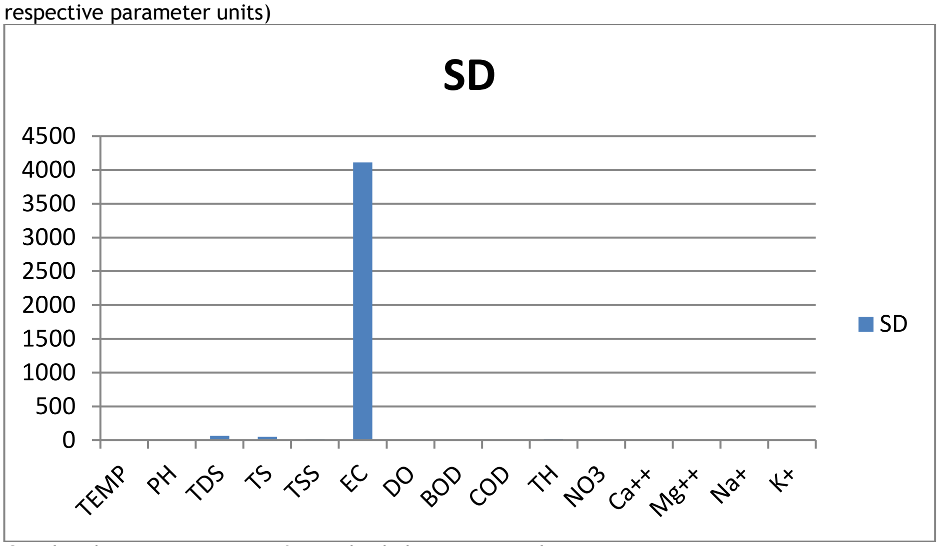
Table- Water quality parameters of Neota Dam (2022-2023)

Parameter/month	DEC-FEB	SD	MAX-MIN	MARCH-MAY	SD	MAX-MIN	JUN-AUG	SD	MAX-MIN	SEP-NOV	SD	MAX-MIN
TEMP	16.06±1.71	2.34	16.72-12.18	27.06±2.29	3.97	30.22-22.60	30.86±1.24	2.16	32.54-28.42	21.56±1.74	3	24.22-18.28
PH	8.24±0.15	0.26	8.44-7.94	8.60±0.03	0.05	8.64-8.54	7.74±0.40	0.7	7.16-8.52	7.87±0.36	0.63	8.35-7.16
TDS	492±2.82	4.88	495.40-486.40	546.86±35.74	61.9	618.20-507.20	620.06±8.30	14.38	635.60607.20	540±57.97	100.41	655.40-472.60
TS	561.4±9.00	15.6	577.20-546.00	636.86±29.14	50.47	694.80-602.40	734.66±21.71	37.61	765.60692.80	645.73±73.56	127.41	792.40-562.409
TSS	69.41±6.54	11.34	81.83-59.60	90±6.75	11.7	98.20-76.60	114.6±14.50	25.13	130.00-85.60	105.73±15.63	27.07	137.00-89.80
EC	829.73±32.08	55.56	892.00-785.20	865.4±23.72	4110	906.60-824.40	909.06±4.69	8.13	918.20902.60	903.8±37.50	64.96	974.00-845.80
DO	6.48±0.74	1.28	7.96-5.66	5.09±0.12	0.22	5.26-4.84	4.27±0.21	0.36	4.54-3.85	5.19±0.34	0.6	5.82-4.62
BOD	4.15±0.52	0.9	4.82-3.12	5.00±0.06	0.1	5.13-4.93	6.22±0.21	0.37	6.64-5.91	4.80±0.92	1.6	6.33-3.13
COD	54±2.08	3.6	58.00-51.00	62±3.60	6.24	67.00-55.00	81±4.04	7	88.00-74.00	65.33±2.60	4.5	70.00-61.00
TH	226.6±28.53	49.41	283.60-195.80	326.4±9.21	15.95	344.40-314.00	373.60±11.82	20.5	394.40-353.40	368±28.01	48.51	397.40-312.00
NO3	11.93±2.03	3.52	16.00-9.90	11.80-0.35	0.61	12.20-11.10	12.63±0.68	1.19	14.00-11.80	12.86±0.59	1.02	14.00-12.00
Ca++	63.28±4.24	7.34	71.75-58.55	65.50±4.31	7.48	70.64-56.92	66.34±3.52	6.1	70.53-59.33	65.07±1.38	2.39	66.75-62.33
Mg++	38.38±8.29	14.37	54.82-28.18	37.37±3.01	5.22	40.54-31.35	43.57±2.19	3.8	47.84-40.54	49.32±1.52	2.64	51.83-46.56
Na+	61.94±7.29	12.62	75.33-50.25	62.07±3.94	6.84	69.68-56.43	44.98±2.59	4.48	49.76-40.46	63.27±7.41	12.83	71.22-48.46
K+	29±0.57	1	30.00-28.00	37±3.60	6.24	44.00-32.00	49±1.15	2	51.00-47.00	41.66±2.02	3.51	45.00-38.00

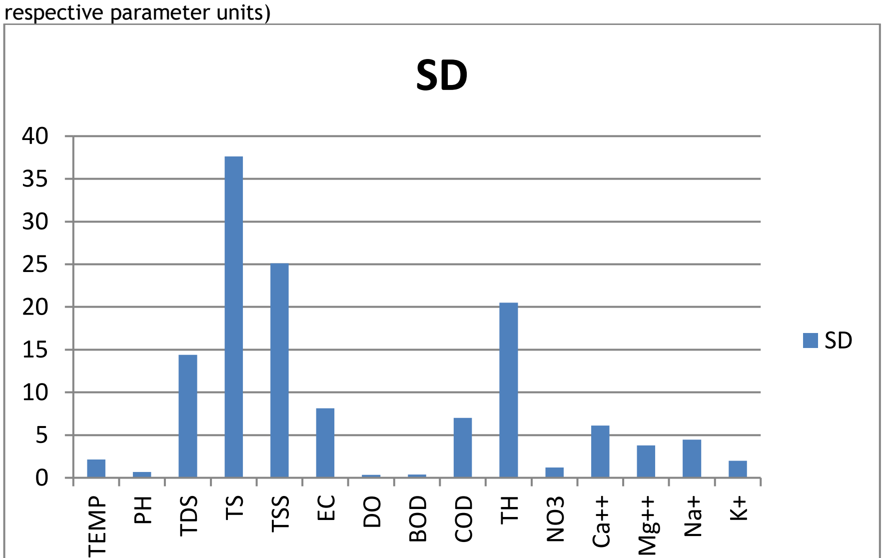
Month name: Dec.-December, Feb-February, Sep.-September, Nov.-November; Values are Mean ± SE ; Units: - Concentration in mg/l, except pH; Temperature (ºC); EC (µS/ cm); Total Dissolve Solid (TDS),Total Solid (TS), Total Suspended Solid (TSS),Dissolve Oxygen (DO), Electrical Conductivity (EC), Bio-chemical Oxygen Demand (BOD), Chemical Oxygen Demand(COD), Total Hardness (TH), Nitrate (NO3), Calcium (Ca),Magnesium (Mg),Sodium (Na), Potassium (K)



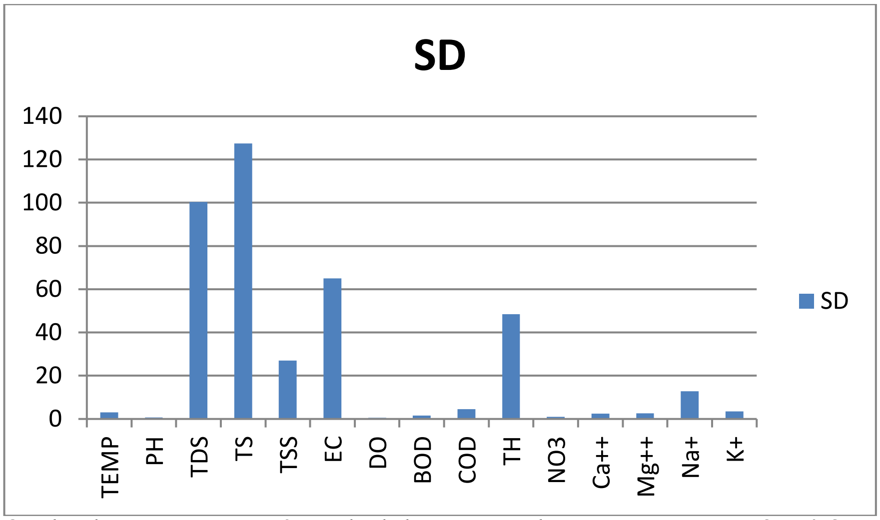
Graphical representation of standard daviation in the water quality of first quarter(DEC-FEB 2022-2023) (All values in respective parameter units)



Graphical representation of standard daviation in the water quality of first quarter(MAR-MAY2022-2023) (All values in respective parameter units)



Graphical representation of standard daviation in the water quality of first quarter(JUNE-AUG2022-2023) (All values in respective parameter units)



Graphical representation of standard daviation in the water quality of first quarter(SEP-NOV2022-2023) (All values in respective parameter units)

DISCUSION

This study showed that the water quality parameters were slightly high in some months *i.e*. Temperature peaks in summers showing seasonal stratification and indicates potential algal blooms in winter months due to industrial effluents. The PH is more alkaline in summers and drops during monsoon due to runoff and dilution effect.TDS peaks in the monsoon likely due to surface runoff which suggests increasing salt and mineral loads in warmer months. TSS is highest in monsoon and slightly lowers in post monsoon. DO is high in winter and low in monsoon.BOD highest in monsoon and lowest in winters and COD follows the same pattern. TH highest in monsoon and post monsoon shows seasonal leaching. Calcium and magnesium both rise with seasonal rainfall influence. Calcium and magnesium both rise with seasonal rainfall influence. Nitrates are fairly stable across seasons and peaks slightly post monsoon which may be due to consistent anthropogenic effluents addition into the water body like sewage and fertilizers. With the above data we understand that water quality deteriorates during monsoon with elevated BOD,COD,TSS and Hardness. Winters being the best water quality conditions and post monsoon recovery shows mixed conditions influenced by sediment deposition and slower flushing.Lead (Pb): Lobeo Rohita and Luciobarbus Esocinus exhibit lead concentrations significantly exceeding permissible limits of (0.3µg/g).The continuous exposure of lead may result into neurological impairments, developmental delays in children and kidney dysfunction. Water samples showed elevated levels of some heavy metals including cadmium(Cd),Lead (Pb) and Manganese(Mn).Zinc(Zn) had a value nearly equal to the WHO permissible limits 3.0 mg/l but in sample 1 the upper range slightly exceeds WHO limits.Cadmium (Cd) levels in all the samples were above the permissible limits(0.003 mg/l).Lead (Pb) concentrations were higher then the permissible limits of (0.01 mg/l). Manganese (Mn) in all the samples were higher then the WHO and IS guidelines. Copper (Cu): All the species have copper values below the FAO/WHO permissible limit of 3.0 µg/g indicating minimal risk from copper exposure. Zinc (Zn): Lobeo Rohita's zinc concentration is higher than the FAO/WHO limit of 40 µg/g .Although zinc is necessary for various bdy functions excessive intake can lead to gastrointestinal distress and may interfere with the absorption of other vital nutrients. Manganese(Mn): All three species have exceeding manganese concentration as the recommended limit is 0.1mg/prolonged ingestion of high manganese level is associated with increased bioaccumulation in aquatic organisms(i.e Fishes)

CONCLUSION

From the above study we conclude that there is a seasonal deterioration in water quality due to runoff and organic pollution and winters being the best as far as water quality is concerned. The majority of the dam's different physico-chemical and biological characteristics, which represent the overall ecological integrity of water bodies, were within the study's acceptable range or limit. However, a few of them—TCS, EC, DO, BOD, TH, and NO3—as well as Mn, Pb, and Cd were marginally elevated and Zn being slightly above the threshold, which might raise concerns about the system's health and the water's appropriateness for the population's needs.These findings highlight the impact of anthropogenic activities such as industrial discharge ,improper waste disposal and leachate infiltration on water quality.Chronic exposure to these heavy metals through drinking water and fishes may lead to neurological disorders ,kidney damage ,increased risk of cancer and developmental issues in children.Immediate intervention is needed including implementation of efficient water treatment technologies, Regular monitoringof groundwater and surface water sources, enforcement of pollution control regulations and awareness campaigns to nearby villages .Failure to address these issues may lead to long term ecological degradation public health issues particularly for communities dependent on this dam for drinking and agriculture.

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