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Analyzing river water quality in Shahdol: A comprehensive assessment of physicochemical parameters and environmental health implications

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Abstract
For the purpose of evaluating water quality, protecting public health, and maintaining aquatic ecosystems, physiochemical examination of river water is essential. Through the analysis of factors including pH, turbidity, dissolved oxygen, and nutrient levels, scientists and decision-makers may detect contaminants, monitor long-term trends, and put into practice efficient management plans. It also aids in assessing the ecological well-being of river systems by tracking the effects of physiochemical variations on biodiversity and aquatic life. Additionally, these investigations help identify the origins of pollution, which makes it possible for authorities to identify certain industrial, agricultural, or urban sources of pollution and put in place focused mitigation measures. This paper compares the physiochemical analysis of the water sample from river Jharwa and the water sample from Borewell water as these two are the important sources of drinking water for the Shahdol City, in MP, India.

Keywords: Jharwa River, Shahdol city, ecological well being, water quality

Introduction

The primary supply of fresh water is the network of rivers. It conveys a respectable amount of stuff, either in dissolved or particulate form, along its route and tributaries. These could have come from man-made and natural sources [1]. According to Prakash [2], the oceans encompass over 71% of the planet and contain 1386 million cubic kilometers of water, of which only 2% is used for human and other activities' needs. Rivers nourished by rainfall provide the majority of the drinkable water [3]. Rivers are life-supporting, delicate freshwater systems. They serve as key conduits across the globe, supplying the majority of the water supplies needed for industrial, agricultural, and local needs [4].

In addition, they support the growth of forest resources, wildlife preservation, and soil fertility [5]. It is well recognized that rivers are important for the movement of products and services. Additionally, they handle the transportation of waste from homes, businesses, and municipalities. River water columns gradually become coated with runoff from farms and other sources that generate pollution, thus introducing contaminants into the river [6].

One of the biggest environmental issues facing the world today is the deterioration of water quality. The spread of different harmful contaminants into water has a significant effect on other ecosystems in addition to the water body itself. Harmful compounds in the water system may cause the aquatic food chain to bio-accumulate, which could have an impact on the aquatic environment's living species. The quality of inland surface water is altered by industrial operations, seasonal variations in river flow, and the use of agrochemicals on the surrounding areas [7]. River water is extensively utilized for a variety of industrial and residential uses, including irrigation, power generation, navigation, and recreation [8].

However, the rivers are becoming more and more contaminated due to the overuse of different agrochemicals in the area surrounding the rivers, unchecked urbanization, poorly planned building along the riverbanks, fast industry, and population expansion. Due to the increased demand for water brought on by growing industrial and residential use, there is a serious problem with water contamination. Every day, the sources of water pollution are almost multiplied. Water-related illnesses are rising in tandem with pollution levels. Therefore, determining the extent of water pollution is vital for the survival of all living things, including people. Any water body needs a certain level of purity in order to function satisfactorily (Table 2). As a result, the idea of managing water quality is becoming increasingly crucial due to the growing demand for water (9). Physiochemical characteristics and biological diversity are prerequisites for the health of aquatic ecosystems [10]. Regular monitoring and assessment of river quality is necessary to stop disease outbreaks and further degradation. Studies on bacteria show that overpopulation of microorganisms can contaminate water, potentially leading to the spread of plant and animal illnesses. The majority of waterborne infections are caused by enteric pathogens [11]. Water pollution is a major environmental issue that has a negative impact on both aquatic biodiversity and human health in rivers. It is commonly believed that providing high-quality drinking water to households is essential to improving welfare [12]. Every year, 525,000 children die as a result of 1.7 billion bouts of diarrhea, according to the World Health Organization [13]. By applying appropriate water treatment and control methods and keeping an eye on their efficacy, water quality monitoring is essential for preventing waterborne illness [10]. In this study we have looked into the physiochemical characteristics of the Jharwa River, which passes through Singhpur, Madhya Pradesh, India and compared it with the physiochemical parameters of Borewell water.

Materials and Methodology

The study area lies between latitude 23.204524° and longitude 81.42591°. Study was connected from January 2024 to May 2024 (Table 1). Jharwa River is the main source of drinking water supply for Singhpur town. The origin of Jharwa River is 3 to 5 km away from Singhpur Village and Jharwa River joins to Son Rivers near Nawalpur.

Sample Collection: About 2 liters of water sample was collected in the sterilized bottle from the Jharwa River at 8:00 am in the morning, 28 February 2024. After this, within one hour water samples were brought to Madhya Pradesh pollution control board Shahdol for treatment or analysis approximately 14 kilometers away, samples were collected from a point where water was in flow condition.

Physical parameters: The temperatures of all tap water samples were measured by using Digital PH Meter (Systronics, 361). Turbidity and electrical conductivity were measured using Digital Nephelo-Turbidity Meter (Systronics, 135) and Digital Conductivity Meter (Systronics, 304), respectivley. Suspended solids and Total solids were calculated with the help of weighing balance (Sartorius, CPA224S Balance).

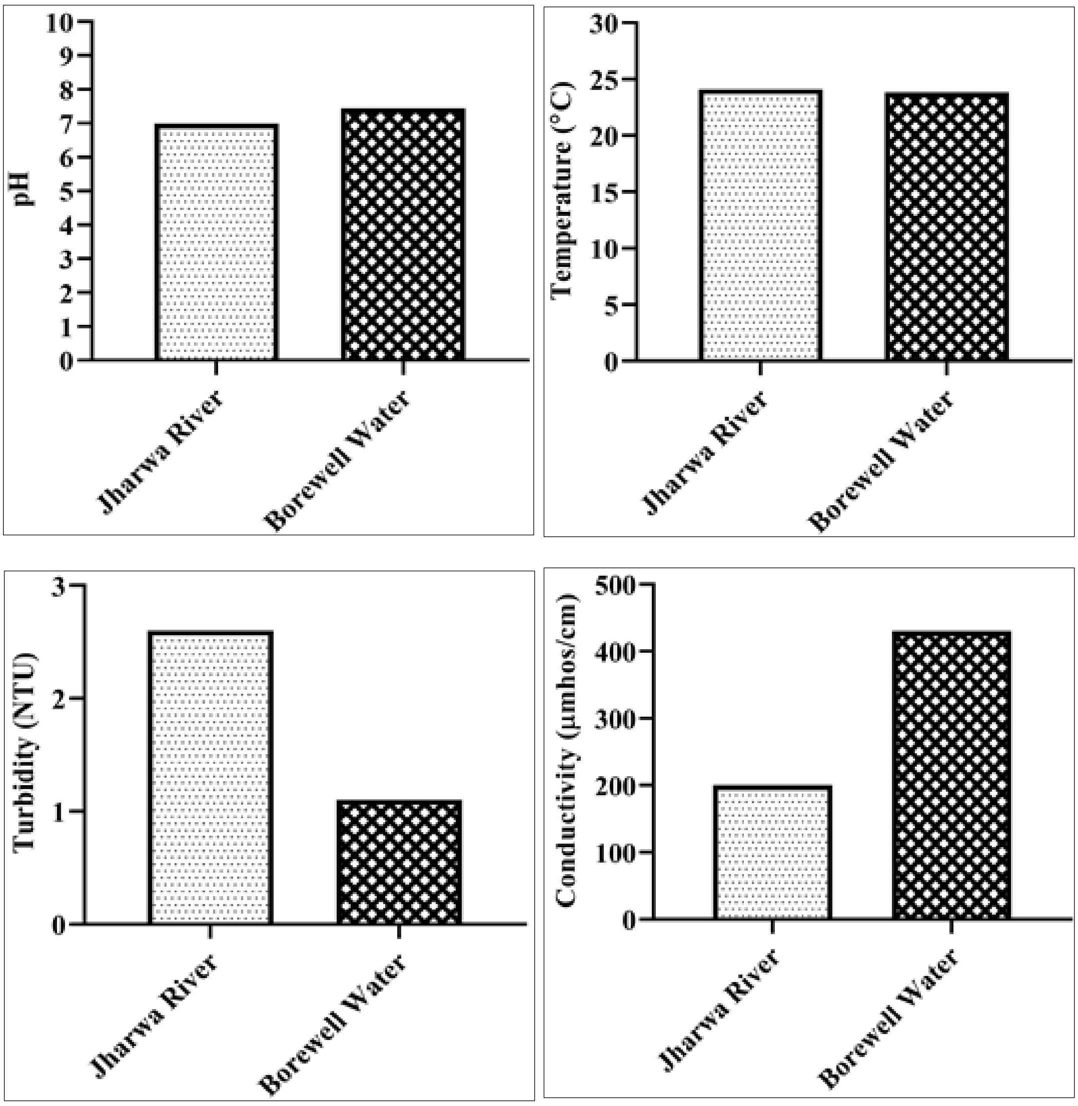
Chemical Parameters: The pH of the water sample was carried out by using caliberated pH meter (Digital PH Meter 361, Model No.: 361). Total hardness, calcium hardness and magnesium hardness of tap water samples were carried out by using titration method with EDTA solution. The chloride and alkalinity were determined volumetrically and by titrating the water sample with standard H_2SO_4 using indicator respectively. Biochemical oxygen demand (BOD) and Chemical oxygen demand (COD) were estimated by using alkali azide method and dichromate refluction method of all tap water samples respectively.

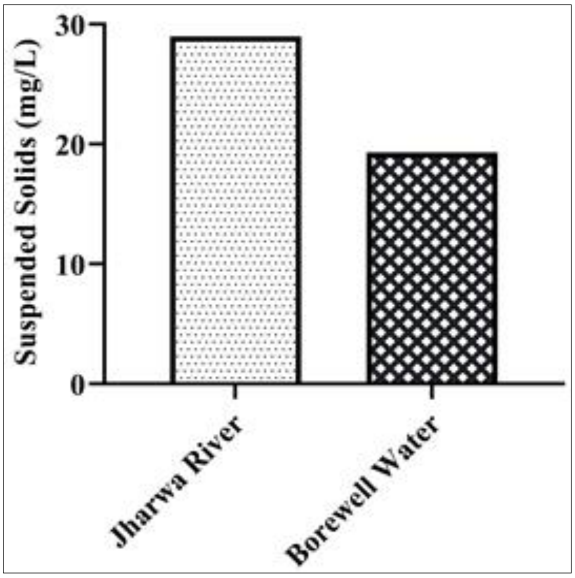
Statistical analysis: The average value of each physical and chemical parameters were plotted and analyzed using Graph Pad Prism (6.0 version).

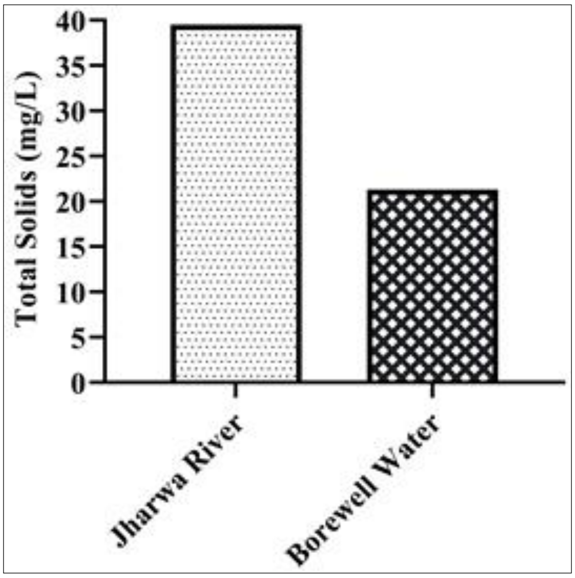
Table 1: Location of Water Samples

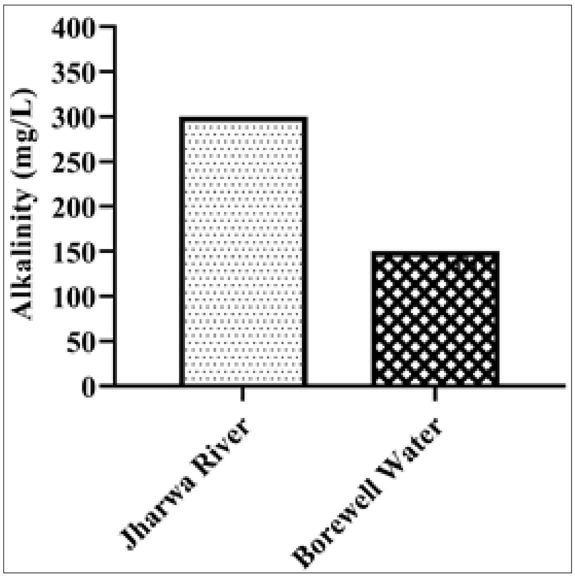
Sampling Site	Demarcation	Landmark of Sampling Zone	Geo-coordinate of sampling site	
Site 1	S1	Jharwa River, Singhpur	23.204524°	81.42591°
Site 2	S2	Borewell Water, Singhpur	23.209313°	81.418882°

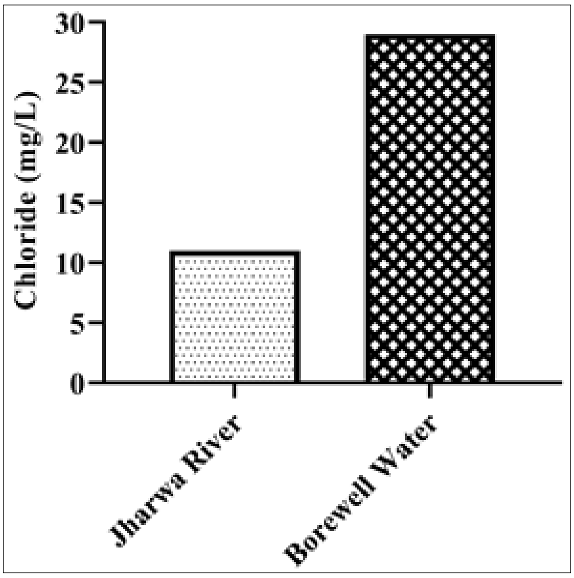
Result

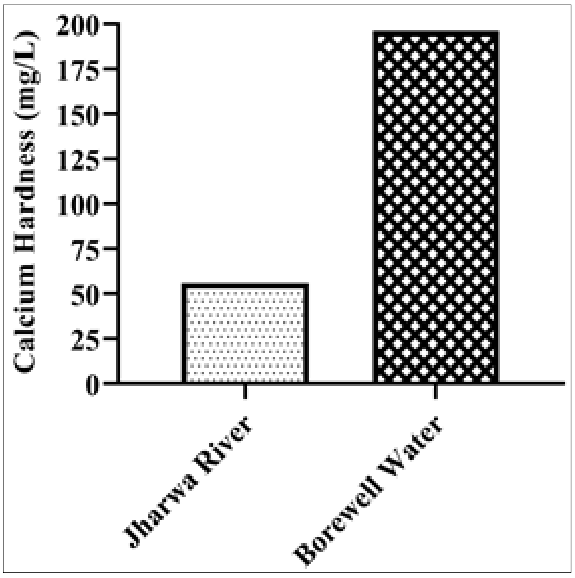


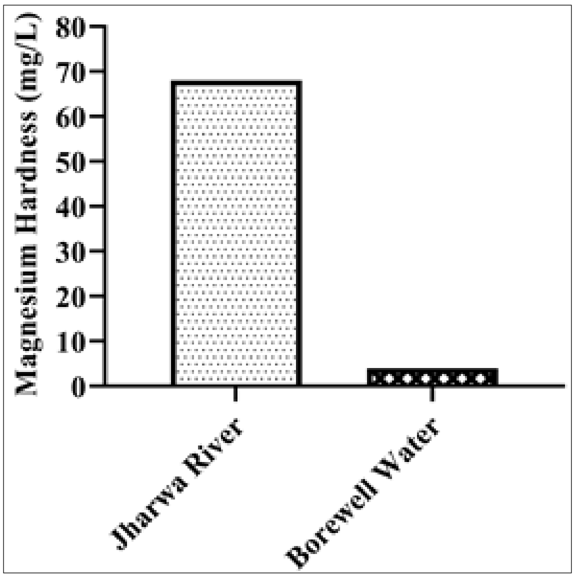

Suspended Solids (mg/L)
30
20
10
0
Jharwa River
Borewell Water

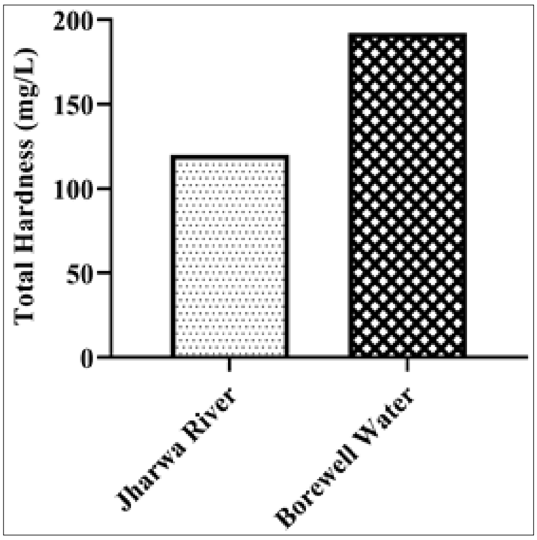

Total Solids (mg/L)
40
35
30
25
20
15
10
5
0
Jharwa River
Borewell Water

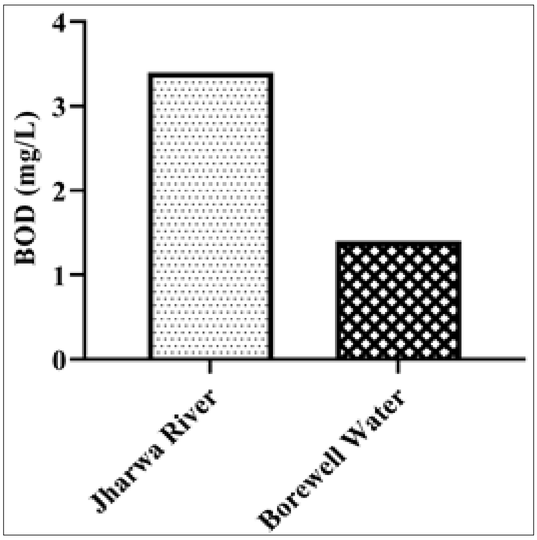

Alkalinity (mg/L)
400
350
300
250
200
150
100
50
0
Jharwa River
Borewell Water

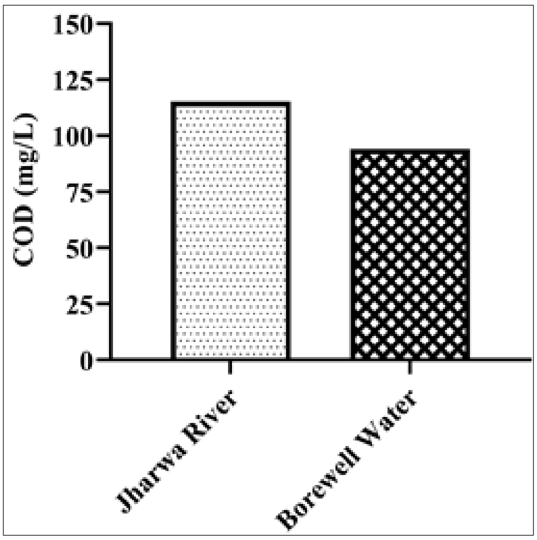

Chloride (mg/L)
30
25
20
15
10
5
0
Jharwa River
Borewell Water


Calcium Hardness (mg/L)
200
175
150
125
100
75
50
25
0
Jharwa River
Borewell Water


Magnesium Hardness (mg/L)
80
70
60
50
40
30
20
10
0
Jharwa River
Borewell Water







Result

The evaluation of physical and chemical parameters of the Jharwa River and Borewell water were analysed which revealed the following results

Suspended Solids and Total Solids

Suspended Solids: The higher concentration of suspended solids was recorded (around 30 mg/L) at Jharwa River (S1) while Borewell Water (S2) exhibited lower concentration of suspended solids.

Total Solids: The total solid concentration was also found to be higher at Jharwa River water (S1) as compared to borewell water (S2)

Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)

BOD: The BOD was observed to be lower at S2, suggesting minimal organic pollution at the source. In contrast, S1 had considerably higher values of BOD, indicating significant organic matter pollution likely from agricultural runoff and domestic waste. COD: Similarly, COD levels were lower at S1, while S1 showed the higher values, pointing to considerable chemical pollutant presence.

pH Levels, Temperature and Chloride

pH: The pH of borewell water (S2) was found to be higher, indicating more alkaline conditions at these sites while S1 had the most neutral pH.

Temperature: The temperature of both the water sources was found to be moderate i.e., around 25^{o} Centigrade.

Chloride: Chloride levels showed significant high value at (S2), possibly due to higher pollution levels from anthropogenic sources.

Calcium Hardness, Magnesium Hardness and Total Hardness

Calcium Hardness: S2 exhibited the greater calcium hardness, indicating significant mineral content in the water, possibly from geological formations or inflows. Magnesium Hardness: S1 showed the higher level of magnesium hardness while S2 showed the negligible amount. Total Hardness: Total hardness was higher at S2, while lower values were observed at S1.

Turbidity, Alkalinity and Conductivity

Turbidity: Turbidity was greater at S1, reflecting the high suspended solids and sediment load. Alkalinity: Alkalinity was lower at S2 and higher at S1, suggesting different levels of bicarbonate and carbonate ions due to varying geological and environmental factors.

Electrical Conductivity: Conductivity, which indicates the water's ability to conduct electrical current due to dissolved ions, was greater at S2 and lower values at S1.

Table 2: Drinking Water Standards as per WHO and Indian System

S.N.	Parameters	Unit	Indian Standards	WHO Standards
1.	Temperature	°C	10 - 22	-----
2.	Turbidity	NTU	1 - 5	Less than 5
3.	Electrical Conductivity	μmhos/cm	200 - 800	1000
4.	Suspended Solids	mg/L	Less than 50	1 - 50
5.	Total Solids	mg/L	Less than 50	Less than 50
6.	pH	-	6.5 - 8.5	6.5 - 8.5
7.	Chloride	mg/L	250	250
8.	Alkalinity	mg/L	200	-----
9.	Calcium Hardness	mg/L	75	200
10.	Magnesium Hardness	mg/L	30	30 -100
11.	Total Hardness	mg/L	300	200 - 500
12.	BOD	mg/L	4.0	Less than 5
13.	COD	mg/L	200	Less than 200

Discussion and Conclusion

In the present study, the comparative analysis of physical and chemical parameters of the water of Jharna River and Borewell water was conducted that revealed significant spatial variations in water quality, influenced by both natural and anthropogenic factors. These variations have important implications for the river's ecosystem health, potential uses, and management strategies. Maximum suspended solids and total solids were observed at Jharwa River (S1). The study's findings consistently indicated total solids levels below the recommended threshold of 500 mg/L. This suggests compliance with the recommended value across all samples analyzed. The BOD and COD value ranges from around 1 to 4 mg/L and around 80-120 mg/L respectively. Lower BOD and COD levels at S2 indicate minimal organic pollution at the borewell water source. In contrast, the highest BOD and COD levels at S1 suggest significant organic and chemical pollutants, possibly from agricultural runoff, effluents, and other anthropogenic activities near the dam and downstream areas. Elevated BOD levels pose a significant threat to aquatic life, leading to stress, asphyxiation, and mortality among organisms due to oxygen depletion (14). The permissible limits for Chemical Oxygen Demand (COD) are set at 10 mg/l for both drinking purposes and sustaining aquatic life. However, the observed higher values could be attributed to heightened chemical pollutants (15). The higher pH values at S2 suggest alkaline conditions, which could be due to the geology of the area or discharges affecting these sites. Alkaline water can influence the solubility of minerals and the toxicity of certain pollutants, impacting aquatic ecosystems. Temperature variations across the sites are within the typical range for river systems in this region during the winter months. Temperature influences the solubility of gases (like oxygen) and the metabolic rates of aquatic organisms, thereby affecting overall water quality and ecosystem health. S2's minimum alkalinity reflects its source purity, while S1's higher alkalinity could be due to the presence of bicarbonates and carbonates from natural and anthropogenic sources. Higher magnesium hardness at S1 and higher calcium and total hardness at S2 indicate mineral-rich waters, likely from geological formations or runoff containing these minerals. Increased levels of total alkalinity, total hardness, and turbidity suggest human activities have impacted the water, likely leading to higher concentrations of organic matter (16). The greater turbidity levels were recorded at the S1. Increased turbidity levels could be attributed to the discharge of urban waste originating from the cities (17). The maximum conductivity at S1 highlight significant suspended particulate matter and dissolved ion content, respectively (18). This is indicative of substantial sediment load and potential pollutants entering the water system at this site, affecting its clarity and electrical conductivity (18,19).

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None

Conflicts of Interest

The authors declare no conflict of interest.

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