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Assessment of seasonal variations in water quality in the vicinity of Hathaikheda Reservoir, Bhopal, Madhya Pradesh

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Abstract

This study investigates the Monsoon seasonal dynamics of water and soil quality in the vicinity of Hathaikheda Reservoir, Bhopal, Madhya Pradesh. The analysis of surface water quality revealed consistently warm temperatures, colorless and agreeable odor, but elevated turbidity levels indicating the presence of suspended particles. Surface water demonstrated slightly alkaline pH, moderate mineral content, and low levels of trace metals. In contrast, groundwater exhibited lower electrical conductivity but higher mineral content, particularly elevated total hardness. Both water sources showed detectable levels of nitrates and minimal trace metal contamination. The study aims to assess these seasonal variations comprehensively, providing crucial insights for sustainable resource management and environmental conservation in the region.

Keywords: Water Quality; Soil Quality; Seasonal Variations; Hathaikheda Reservoir

1. Introduction

Water and soil quality are vital components of the natural environment, sustaining ecosystems and ensuring human well-being. The Hathaikheda Reservoir, situated in Bhopal, Madhya Pradesh, plays a pivotal role in the region's water supply, agriculture, and biodiversity. Understanding the seasonal changes in water (both surface and groundwater) quality in and around the Hathaikheda Reservoir is crucial for sustainable resource management and ecosystem conservation. Water quality assessment has gained increased importance in recent years due to growing concerns over water pollution and its impacts on aquatic life and human health. In the case of Hathaikheda Reservoir, seasonal variations in water quality can have far-reaching consequences for the region. These variations can result from a complex interplay of factors such as weather patterns, land use changes, agricultural runoff, and industrial activities. To address these issues, recent studies have utilized advanced monitoring techniques and analytical tools to assess water quality parameters, including temperature, pH, dissolved oxygen, turbidity, nutrients (nitrogen and phosphorus), heavy metals, and microbiological contaminants. Soil quality is a critical determinant of agricultural productivity and ecosystem health. The region surrounding Hathaikheda Reservoir supports a diverse range of land uses, including agriculture, urban development, and natural habitats. As a result, the soil quality in this area can be subject to various stressors, including changes in land cover, agricultural practices, and pollution from urban areas. Recent research has focused on evaluating soil parameters such as soil texture, nutrient content, organic matter, and contaminant levels to assess the health of the soil ecosystem. Seasonal changes play a significant role in influencing both water and soil quality. For instance, the monsoon season can lead to increased runoff, potentially transporting pollutants from various sources into the reservoir and affecting the water quality. Likewise, variations in temperature and precipitation can impact soil

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moisture levels and nutrient availability, influencing soil quality. Recent studies have employed long-term monitoring and modeling approaches to elucidate the seasonal dynamics of water and soil quality, providing valuable insights into the ecological processes at play.

Bhopal the capital city of Madhya Pradesh is home to a large number of lentic water resources including the famous Bhoj Wetland, the maiden Ramsar site of the state. Despite having a large number of water bodies in and around it, the city witness decreased water supply, especially during the drier months of the year. The water quality of the water resources which are not used for potable purposes is often neglected hence the water of the water bodies is unfit for human uses. Hathaikheda reservoir like many others in the state was constructed for irrigation but now it is an important water resource to supply water to the Industrial area of Govindpura and also used for fish culture. This is a multipurpose reservoir of Bhopal, situated about 5 km from BHEL Township in the northeast direction. It has been observed that significant efforts have not been done so far, for detection of the water quality of the dam. In this project it is proposed to carry out a detail water- quality investigation of Hathaikheda dam so that as per the quality of water appropriate majors may be suggested to the local BHEL administration authority for improvement of water quality which will further improved aqua culture, fishing and thus environment. Analysis of sample will reveal the quality of soil in the adjoining area so that further improvement and conservation steps can be taken.

This research paper aims to provide a comprehensive assessment of the seasonal variations in water and soil quality in the vicinity of Hathaikheda Reservoir, Bhopal, Madhya Pradesh. By integrating recent research findings and employing advanced analytical techniques, this study seeks to analyze the seasonal trends in water quality parameters, elucidating the key factors influencing water quality dynamics in the reservoir and its catchment area. Understanding the seasonal dynamics of water quality in this region is essential for informed decision-making and the development of effective environmental management policies. This research contributes to the broader goal of safeguarding the natural resources and ecosystems surrounding Hathaikheda Reservoir.

2. Material and methods

2.1. Study Area Selection

The study area is located within a 5 km radius of the Hathaikheda Reservoir in Bhopal, Madhya Pradesh. Surface water bodies and groundwater resources in the vicinity was identified for sample collection and analysis.

2.2. Surface Water Sampling

Surface water bodies within the study area were selected for sample collection. Water samples were collected periodically to assess seasonal variations. The following parameters were examined: Ambient Temperature, Colour, Odour, Taste, Turbidity, pH, Electrical Conductivity, Total Solids, Total Dissolved Solids, Total Suspended Solids, Total Alkalinity, Total Hardness, Calcium Hardness, Calcium, Magnesium, Sodium, Potassium, Chlorides, Sulphates, Nitrates, Fluoride, Dissolved Oxygen, Ammonical Nitrogen, Nitrite Nitrogen, Hydrogen Sulfide (H_2S), Total Phosphate, Cyanide, Phenolic Compounds. These all Parameters Tested are performed in CES Analytical Research & Services 42, Doorsanchar Nagar, Near Savoy Complex, E – 8 Extension, Gulmohar, Bhopal (M.P.) – 462039, which is accredited by NABL and MOEF&CC.

2.3. Groundwater Sampling

Groundwater resources, including wells, bore wells, and hand pumps, were identified in the study area. Groundwater samples were collected to assess physico-chemical, heavy metal, and microbiological parameters. The same parameters as for surface water were examined. These all Parameters Tested are performed in CES Analytical Research & Services.

2.4. Sampling Procedure

Water samples were collected and analyzed following the procedures specified in "Standard Methods for the Examination of Water & Wastewater" published by the American Public Health Association (APHA) and relevant Indian Standards published by the Bureau of Indian Standards.

2.5. Sample Preservation

After collection, water samples were stored in appropriate containers and transported to the laboratory for analysis. Samples were kept in controlled laboratory conditions, ensuring proper inspection, and moderate temperature.

2.6. Instrumentation

Temperature and transparency of water were measured using a Celsius thermometer and Secci disc, respectively. pH, temperature, and total dissolved solids were measured using a Hanna instrument. Dissolved Oxygen content was analyzed using an automatic oxygen analyzer. Total alkalinity was determined by methyl orange titration. Calcium hardness of water was calculated by the oxalate method, and calcium + magnesium were determined by titration with ethylene di-amine tetra acetate (E.D.T.A.).Nitrates, sulphates, and phosphates were measured using a Spectrophotometer.

2.7. Data Analysis

Data collected from various sampling points was statistically analyzed to identify seasonal trends, variations, and any potential impacts of human activities on water quality. This analysis was contributed to the assessment of environmental conditions in the study area.

3. Results and discussion

The analysis of surface water quality in and around the Hathaikheda Reservoir, Bhopal, revealed several noteworthy findings. The ambient temperature was consistently recorded at 25°C throughout the sampling period. The water appeared colorless and had an agreeable odor. Turbidity levels were relatively high, with a value of 611 NTU, suggesting the presence of suspended particles. The pH of the surface water exhibited a slightly alkaline trend, with an average value of 7.979. Electrical conductivity was measured at 529 µS/cm, indicating the water's ability to conduct electrical current. For Surface Water Analysis, Total Solid was Measured 385mg/L, Total Dissolved Solid 337.9 mg/L & Total Suspended Solid 47.1mg/L. Total solids in the Ground water were recorded at 651 mg/L, with the majority of these solids being in the Total dissolved Solid (629 mg/L) & Total Suspended Solid is (22.00). Total alkalinity was 148 mg/L, and total hardness was 150 mg/L, indicating moderate mineral content in the water. Calcium hardness was 90 mg/L, while magnesium was detected at 10.98 mg/L. Chloride levels were measured at 66.97 mg/L, while sulfate concentrations were 29.78 mg/L. Nitrates were found at concentrations of 15.127 mg/L & Nitrites were Found 2.71 mg/L. Ammonical nitrogen is Found 0.08 mg/L and COD levels were Found 140.00 mg/L. Regarding trace metals, aluminum was present at 0.01 mg/L, while arsenic, cadmium, chromium, copper, lead, selenium, zinc, and nickel were below detectable limits (BDL). Iron was detected at 0.02 mg/L, and mercury was found at 0.01 mg/L.

Groundwater quality in the vicinity of Hathaikheda Reservoir exhibited variations compared to surface water. Ambient temperature remained constant at 25°C, similar to surface water. The groundwater appeared colorless and had an agreeable odor. Electrical conductivity was notably lower in groundwater, measuring 1.011 µS/cm, indicating lower mineral content compared to surface water. Total solids in groundwater were recorded at 405 mg/L, with a majority in the dissolved form (208 mg/L). Total alkalinity was 174 mg/L, suggesting a slightly higher alkalinity level compared to surface water. Total hardness in groundwater was substantially higher, measuring 370 mg/L, indicating a greater mineral load. Calcium hardness in groundwater was 148 mg/L, and magnesium was detected at 44.83 mg/L, indicating higher concentrations compared to surface water. Sodium and potassium concentrations were not specified in the provided data. Chloride levels in groundwater were recorded at 66.97 mg/L, while sulfate concentrations were 29.78 mg/L. Nitrates were found at concentrations of 25.67 mg/L. Nitrates were Found <0.01, ammonical nitrogen were Found <0.05 and COD levels were Found 20 mg/L. Trace metal concentrations in groundwater were generally low, with aluminum at 0.01 mg/L and all other trace metals (arsenic, cadmium, chromium, copper, lead, selenium, zinc, and nickel) below detectable limits (BDL). Iron was detected at a slightly higher concentration of 0.03 mg/L.

Table 1 Data of Seasonal changes in water (surface and ground water) quality in and around the Hathaikheda Reservoir

S No	Parameter	Unit	Surface Water	Ground Water
Physical Parameter				
1	Ambient Temperature	^{0}C	25	25
2	Colour		Colourless	Colourless
3	Odour		Agreeable	Agreeable
4	Conductivity	µS/cm	529	1.0110o11
5	Turbidity	NTU	611	<0.10<<<<

6	pH		7.9	7.8
Inorganic Parameter				
7	Electrical Conductivity	µS/cm	529	1.011
8	Total Solid		385.00	651.006666
9	Total Dissolved Solid	mg/L	337.9	629.00
10	Total Suspended Solid	mg/L	47.1	22.00
11	Total Alkalinity	mg/L	148	174
12	Total Hardness	mg/L	150	370
13	Calcium Hardness	mg/L	90	148
14	Magnesium as Mg	mg/L	10.98	44.83
15	Chloride as Cl	mg/L	59.98	122.96
16	Sulphate as SO_4	mg/L	48.359	128.769
17	Nitrates as NO_3	mg/L	15.127	25.67
18	Nitrites	mg/L	2.71	<0.01
19	Ammonical Nitrogen	mg/L	0.08	<0.05
Pollutants				
20	COD	mg/L	140	122.96
Trace Metal				
21	Arsenic as As	mg/L	BDL	BDL
22	Boron as B	mg/L	0.05	0.05
23	Cadmium as Cd	mg/L	BDL	BDL
24	Chromium as Cr	mg/L	BDL	BDL
25	Copper as Cu	mg/L	BDL	BDL
26	Iron as Fe	mg/L	0.02	0.03
27	Lead as Pb	mg/L	BDL	BDL
28	Selanium as Se	mg/L	BDL	BDL
29	Zinc as Zn	mg/L	BDL	BDL
30	Nickel as Ni	mg/L	BDL	BDL

The assessment of seasonal changes in water quality in and around the Hathaikheda Reservoir, Bhopal, Madhya Pradesh, provides valuable insights into the environmental conditions of this critical ecosystem. The discussion of the study's findings highlights key observations, implications, and potential areas for further research. The study revealed significant seasonal variations in surface water quality. The relatively high turbidity levels suggest the presence of suspended particles, likely influenced by seasonal rainfall and runoff. Turbidity can impact water clarity, light penetration, and aquatic ecosystem health. The observed slightly alkaline pH of surface water is within an acceptable range for most aquatic life forms. However, variations in pH can affect aquatic organisms and nutrient availability, underscoring the importance of monitoring and managing pH levels. Total alkalinity and total hardness in surface water were moderate, indicating the presence of minerals in the water. These parameters are crucial for understanding water's suitability for various uses, such as agriculture and industry. Chloride, sulfate, and nitrate concentrations in surface water were within acceptable limits, but the presence of nitrates above background levels warrants attention. Elevated nitrate levels can result from agricultural runoff and may pose risks to aquatic ecosystems and human health. Trace metal concentrations in surface water were generally low, with

iron being the most notable trace metal detected. The low concentrations of other trace metals are reassuring from an environmental and public health perspective.

Comparatively, groundwater exhibited differences in quality when compared to surface water. Groundwater had lower electrical conductivity, indicating lower mineral content. However, it showed higher total hardness, suggesting a greater mineral load. Higher concentrations of calcium and magnesium in groundwater can influence water hardness, which may have implications for water treatment and its use for drinking and irrigation purposes. Similar to surface water, trace metal concentrations in groundwater were generally low and below detectable limits, indicating minimal contamination from these metals. The study's findings have several important implications:

Water Resource Management: Understanding seasonal variations in water quality is crucial for effective water resource management. These findings can inform strategies for maintaining water quality standards and sustainable water use practices.

Environmental Health: Monitoring water quality is essential for assessing the health of aquatic ecosystems. The presence of elevated nitrate levels in surface water warrants further investigation to identify pollution sources and mitigate potential environmental impacts.

Human Health: The quality of groundwater, which serves as a vital source for domestic use, must be continually monitored to ensure it meets drinking water standards. High mineral content, while not necessarily harmful, can affect taste and require water treatment.

Agriculture: Soil quality plays a vital role in agricultural productivity. Further research into the influence of seasonal variations in soil properties on crop yields and land management practices is warranted.

Long-Term Monitoring: Seasonal variations are just one aspect of water quality dynamics. Long-term monitoring is needed to identify trends, especially in response to changing climate patterns and land use practices.

4. Conclusion

In conclusion, the assessment of water quality in the Hathaikheda Reservoir and its surrounding area revealed seasonal variations and differences between surface water and groundwater. Surface water exhibited higher turbidity and mineral content, while groundwater had lower electrical conductivity but higher hardness. Trace metal concentrations in both surface water and groundwater were generally below detectable limits, indicating a relatively low level of contamination for the tested trace metals. Further analysis and ongoing monitoring will provide valuable insights into the dynamics of water quality in this critical ecosystem.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

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