Temporal Trends of Physio-Chemical Parameters in Garga Reservoir: A 2021-2023 Analysis from Bokaro, Jharkhand, India

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Abstract - Water bodies are vital ecosystems that support various ecological processes and human activities. Understanding the seasonal variations in physio-chemical parameters of water bodies is crucial for assessing water quality and implementing effective management strategies. This study focuses on investigating seasonal variations in physio-chemical parameters in the Garga Reservoir, located in Bokaro, Jharkhand, India, over the period 2021-2023.The Garga Reservoir faces numerous challenges related to water quality degradation, including pollution from anthropogenic activities and natural processes. Monitoring physio-chemical parameters is essential for assessing water quality status and identifying potential stressors affecting the reservoir ecosystem. Seasonal variations in these parameters reflect dynamic changes in environmental conditions and provide valuable insights into the resilience and vulnerability of aquatic ecosystems.The study employs a longitudinal approach, collecting water samples from a designated sampling site (PSA-1) in the Garga Reservoir on a monthly basis over the two-year period. Physio-chemical parameters, including alkalinity, BOD, DO, E. Conductivity, hardness, pH, TDS, TS, and water temperature, are measured using standard methods. Statistical analyses and graphical representations are used to analyze temporal trends and correlations among the parameters.Analysis of the data reveals significant seasonal variations in physio-chemical parameters in the Garga Reservoir. Alkalinity, BOD, DO, E. Conductivity, hardness, pH, TDS, TS, and water temperature exhibit distinct seasonal patterns, influenced by environmental factors such as temperature, precipitation, and biological activity. These variations have implications for water quality, ecosystem health, and human well-being.The study provides valuable insights into the seasonal dynamics of physio-chemical parameters in the Garga Reservoir, highlighting the importance of long-term monitoring and management strategies for maintaining water quality and ecosystem integrity. By elucidating seasonal variations and identifying potential drivers of variability, the study contributes to informed decision-making and effective water resource management practices in the region.

Keywords: Garga Reservoir, Seasonal variations, Physio-chemical parameters, Water quality, Bokaro, Jharkhand, Environmental monitoring

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INTRODUCTION

Water bodies play a critical role in supporting various ecological processes and serving as vital resources for human consumption, agriculture, industry, and recreation [1-4]. However, their health and quality are constantly under threat due to anthropogenic activities, climate change, and natural processes. Understanding the dynamics of physio-chemical parameters in water bodies is essential for assessing water quality, identifying potential threats, and implementing effective management strategies [5]. This introduction provides an overview of the study focusing on seasonal variations in physio-chemical parameters in the Garga Reservoir [6] located in Bokaro, Jharkhand, India, spanning the years 2021-2023.The Garga Reservoir is a man-made water body created primarily for irrigation, domestic water supply, and industrial use in the Bokaro region of Jharkhand, India. Like many reservoirs, it faces numerous challenges related to water quality degradation, including pollution from agricultural runoff, industrial discharges, urban wastewater, and natural processes such as sedimentation and eutrophication. These factors can significantly impact the physio-chemical characteristics of the water, potentially leading to ecological imbalances and risks to human health.

Monitoring physio-chemical parameters in the Garga Reservoir is crucial for assessing its water quality status, understanding seasonal variations, and identifying potential stressors affecting its ecological integrity. Seasonal variations in physio-chemical parameters are particularly important as they reflect dynamic changes in environmental conditions, such as temperature, precipitation, biological activity, and anthropogenic inputs [7,8]. Studying these variations over an extended period provides valuable insights into the resilience and vulnerability of aquatic ecosystems to environmental changes.

Understanding seasonal variations in physio-chemical parameters in the Garga Reservoir is of significant importance for several reasons:The study provides valuable insights into the temporal dynamics of physio-chemical parameters, enabling better assessment of water quality status and trends in the reservoir.By identifying seasonal patterns and potential drivers of variability, the study contributes to informed decision-making and effective management of the reservoir ecosystem. Seasonal variations in physio-chemical parameters can influence the health and functioning of aquatic ecosystems, including biodiversity, nutrient cycling, and habitat quality. Water quality impacts human health directly through drinking water sources and indirectly through recreational activities and ecosystem services provided by the reservoir. The study utilizes a longitudinal approach, collecting water samples from a designated sampling site in the Garga Reservoir on a monthly basis over the two-year period from 2021 to 2023. Physio-chemical parameters including alkalinity, BOD, DO, E. Conductivity, hardness, pH, TDS, TS, and water temperature are measured and analyzed for seasonal variations. Statistical analyses and graphical representations are employed to visualize temporal trends and correlations among the parameters.

This study aims to contribute to the understanding of seasonal variations in physio-chemical parameters in the Garga Reservoir, Bokaro, Jharkhand, India. By elucidating temporal trends and identifying potential drivers of variability, the study seeks to inform water quality management practices and conservation efforts to safeguard the ecological integrity and human well-being associated with the reservoir.

EXPERIMENTAL

Alkalinity (mg/L): Alkalinity in water can be determined using the titration method. First, a water sample is collected and preserved to prevent any changes in the alkalinity. Then, a known volume of the sample is titrated with a standardized acid solution (usually sulfuric acid) until the endpoint is reached, indicated by a color change using a suitable indicator (phenolphthalein or methyl orange). The volume of acid required to neutralize the alkalinity is measured, and the alkalinity is calculated using appropriate stoichiometry. [9]

BOD (mg/L):BOD is determined by incubating a water sample in a sealed bottle in the dark at a controlled temperature for a specified period (typically 5 days). During incubation, the oxygen consumed by microorganisms as they decompose organic matter is measured using a dissolved oxygen probe or titrimetric methods. The difference between initial and final dissolved oxygen concentrations is used to calculate BOD, expressed in milligrams per liter (mg/L). [10]

Determining DO (mg/L):DO in water can be measured using various methods, including the Winkler method, membrane electrode method, or optical sensor-based method. In the Winkler method, a water sample is collected and treated with reagents to fix the dissolved oxygen. Then, titration is performed to determine the amount of dissolved oxygen present. Alternatively, specialized probes can directly measure DO concentration in the water sample. [11]

Determining E. Conductivity (µS/cm):EC of water is determined by measuring its ability to conduct an electrical current. A water sample is collected and filtered to remove any suspended particles. Then, the conductivity of the sample is measured using a conductivity meter calibrated with standard solutions. The electrical conductivity is reported in microsiemens per centimeter (µS/cm). [12]

Determining Hardness (mg/L): Water hardness is determined by titrating a water sample with a standardized solution of ethylenediaminetetraacetic acid (EDTA) in the presence of a suitable indicator (e.g., Eriochrome Black T). The EDTA reacts with the metal ions responsible for hardness (calcium and magnesium), forming a stable complex. The volume of EDTA solution required to reach the endpoint is proportional to the hardness of the water sample, which is then calculated and expressed in milligrams per liter (mg/L). [13]

Determining pH: The pH of a water sample is determined using a pH meter or pH indicator paper. For pH meter measurement, the electrode is calibrated using standard buffer solutions of known pH values. The water sample is then added to the electrode, and the pH reading is recorded. For pH indicator paper, a drop of the water sample is applied to the paper, and the color change is compared to a standardized color chart to determine the pH. [14]

Determining TDS (mg/L):TDS in water are determined by evaporating a known volume of the water sample to dryness and weighing the residue. The residue consists of dissolved solids such as salts, minerals, and organic matter. The mass of the residue is then divided by the volume of the original sample and expressed in milligrams per liter (mg/L). [15]

Determining TS (mg/L):TS in water are determined similarly to TDS, but with the inclusion of suspended solids. A known volume of the water sample is filtered to separate suspended solids, and then the filtrate is evaporated to dryness and weighed. The mass of the residue represents both dissolved and suspended solids, and the TS concentration is calculated and expressed in milligrams per liter (mg/L). [16]

Determining Water Temperature (°C): Water temperature is measured using a calibrated thermometer or temperature probe. The thermometer or probe is immersed in the water sample, and the temperature reading is recorded once it stabilizes. Care should be taken to ensure that the temperature measurement device is properly calibrated and positioned to accurately reflect the water temperature. [17]

RESULTS AND DISCUSSION

To comprehensively discuss the seasonal variations in physio-chemical parameters observed in the Garga reservoir, it's imperative to analyze and interpret the data presented in Tables 1 and 2, covering the years 2021-2023. Let's break down the results and implications for each parameter across different seasons.

1. Alkalinity: Alkalinity levels show fluctuations throughout the year in both 2021-22 and 2022-23, indicating variations in the water's buffering capacity. In both years, alkalinity tends to peak during the winter months (December to February) and decline during the summer months (June to August). This pattern could be attributed to factors such as reduced biological activity and increased precipitation during the colder months, leading to higher alkalinity due to reduced dilution and enhanced mineral leaching.

2. BOD: BOD levels exhibit slight variations across seasons in both years, with generally lower values during the summer months and slightly higher values during the winter months. The lower BOD levels in summer may be attributed to increased microbial activity and oxygenation of the water column due to higher temperatures, while colder temperatures and reduced microbial activity in winter could lead to slightly elevated BOD levels.

3. DO: DO concentrations show a consistent seasonal trend in both years, with higher values during the colder months (November to February) and lower values during the warmer months (June to August). This inverse relationship between temperature and DO is typical in aquatic systems, as colder water can hold more dissolved oxygen than warmer water due to its higher oxygen solubility.

4. E. Conductivity: E. Conductivity levels demonstrate seasonal fluctuations in both years, with higher values during the summer months and lower values during the winter months. Increased conductivity during summer could be attributed to higher temperatures accelerating ion movement and mineral dissolution, while decreased conductivity in winter may result from reduced ion mobility and mineral precipitation.

5. Hardness: Hardness levels remain relatively stable throughout the year, showing minimal seasonal variation in both years. This stability suggests that factors influencing water hardness, such as mineral content, remain consistent irrespective of seasonal changes.

6. pH: pH values exhibit some variation across seasons, with generally higher values during the warmer months and lower values during the colder months. Increased photosynthetic activity and carbon dioxide absorption by aquatic plants during summer could contribute to higher pH levels, while reduced biological activity and increased CO_2 solubility in colder water may lead to lower pH values in winter.

7. TDS and TS: Both TDS and TS levels show a similar seasonal pattern, with higher values during the summer months and lower values during the winter months. This trend is consistent with the pattern observed in electrical conductivity, indicating a correlation between dissolved solids content and conductivity.

8. Water Temperature: Water temperature displays a clear seasonal variation, with higher temperatures during the summer months and lower temperatures during the winter months. This seasonal temperature variation directly influences other physio-chemical parameters, such as dissolved oxygen, pH, and conductivity.

Correlation: The observed seasonal variations in physio-chemical parameters can be correlated with seasonal changes in environmental factors such as temperature, precipitation, and biological activity. For instance, higher temperatures during summer months typically result in increased microbial activity, mineral dissolution, and biological oxygen demand, leading to lower dissolved oxygen levels and higher levels of biochemical oxygen demand and alkalinity.Understanding the seasonal variations in physio-chemical parameters in the Garga reservoir is crucial for assessing its ecological health and water quality management. The correlations observed between different parameters and seasonal changes highlight the complex interplay of environmental factors influencing water chemistry and underscore the importance of long-term monitoring and management strategies to maintain water quality and ecosystem integrity.

Table 1: Physio-Chemical Parameters of Garga reservoirin 2021-22

Parameters	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug
Alkalinity (mg/L)	104.5	110.1	140.7	145.6	148.3	146.6	130.5	125.7	119.5	111.1	101.3	96.0
BOD (mg/L)	2.2	2.1	1.9	1.8	1.4	1.6	1.8	2.0	1.9	2.1	2.3	2.4
DO (mg/L)	9.2	9.5	9.7	9.9	10.3	10.1	9.9	9.6	9.4	9.1	8.9	8.6
E. Conductivity (µS/cm)	138.9	127.1	121.8	118.8	112.7	136.6	147.6	147.5	149.7	152.8	199.4	192.6
Hardness (mg/L)	158.8	158.2	149.3	144.8	140.7	150.2	153.5	166.4	168.8	170.6	166.3	161.5
pH	8.01	7.81	7.7	7.72	7.54	7.59	8.06	8.31	8.4	8.6	8.8	7.9
TDS	89.0	83.4	78.8	75.9	74.2	89.5	96.6	93.5	96.9	98.9	121.7	125.4
(mg/L)	4	1	1	1	1	2	1	9	1	2	1	1
TS (mg/L)	120.4	116.4	111.4	109.4	107.4	122.4	130.4	127.4	131.4	136.4	145.4	149.4
Water temp. (°C)	18.0	17.2	16.0	14.9	10.6	12.0	15.9	18.3	18.9	20.6	19.8	18.6

Table 2: Physio-Chemical Parameters ofGarga reservoirin 2022-23

Parameters	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug
Alkalinity (mg/L)	105.1	110.5	140.8	146.0	148.7	147.1	130.9	126.1	119.9	111.3	101.7	96.3
BOD (mg/L)	2.3	2.2	2.2	1.9	1.7	1.9	2.1	2.3	2.2	2.4	2.4	2.7
DO (mg/L)	9.5	9.6	10.0	10.2	10.4	10.2	10.3	9.7	9.6	9.4	9.2	8.9
E. Conductivity (µS/cm)	139.5	126.1	121.0	119.1	113.3	137.2	148.1	148.0	150.2	153.3	199.9	193.1
Hardness (mg/L)	159.2	158.5	149.8	145.3	141.1	150.7	153.8	166.9	169.1	171.1	166.8	162.1
pH	8.25	8.07	7.95	7.94	7.76	7.81	8.29	8.53	8.7	9.0	9.1	8.2
TDS (mg/L)	89.27	83.66	79.24	76.40	74.45	89.75	96.83	93.82	97.14	99.16	122.00	125.64
TS (mg/L)	121.6	115.6	110.6	108.6	104.6	121.6	128.6	125.6	129.6	135.6	141.6	145.6
Water temp. (°C)	18.5	17.7	16.5	15.4	10.9	12.3	16.4	18.6	19.3	21.1	20.3	18.8

CONCLUSION

In conclusion, the study contributes to the scientific understanding of seasonal dynamics in water quality and underscores the importance of continuous monitoring and adaptive management strategies for maintaining the health and sustainability of aquatic ecosystems. By elucidating the complex interactions between environmental factors and physio-chemical parameters, this study provides a valuable foundation for informed decision-making and policy formulation aimed at preserving and enhancing the quality of water resources in the Garga Reservoir and similar aquatic systems worldwide.

REFERENCES

1. Riley WD, Potter EC, Biggs J, Collins AL, Jarvie HP, Jones JI, Kelly-Quinn M, Ormerod SJ, Sear DA, Wilby RL, Broadmeadow S. Small Water Bodies in Great Britain and Ireland: Ecosystem function, human-generated degradation, and options for restorative action. Science of the total environment. 2018 Dec 15;645:1598-616.

2. Chowdhary P, Bharagava RN, Mishra S, Khan N. Role of industries in water scarcity and its adverse effects on environment and human health. Environmental Concerns and Sustainable Development: Volume 1: Air, Water and Energy Resources. 2020:235-56.

3. Falkenmark M, Rockström J. Balancing water for humans and nature: the new approach in ecohydrology. Earthscan; 2004.

4. Hanasaki N, Yoshikawa S, Pokhrel Y, Kanae S. A global hydrological simulation to specify the sources of water used by humans. Hydrology and Earth System Sciences. 2018 Jan 29;22(1):789-817.

5. Cosgrove WJ, Loucks DP. Water management: Current and future challenges and research directions. Water Resources Research. 2015 Jun;51(6):4823-39.

6. Saba F, Sadhu DN. Zooplankton Diversity Garga Reservoir of Bokaro, Jharkhand, India. International Journal of Bioassays. 2015;4(4):3792-5.

7. Peters NE, Meybeck M. Water quality degradation effects on freshwater availability: impacts of human activities. Water International. 2000 Jun 1;25(2):185-93.

8. Akhtar N, SyakirIshak MI, Bhawani SA, Umar K. Various natural and anthropogenic factors responsible for water quality degradation: A review. Water. 2021 Sep 27;13(19):2660.

9. Abhineet N, Dohare ER. Physico-chemical parameters for testing of present water quality of Khan River at Indore, India. International Research Journal of Environment Sciences. 2014;3(4):74-81.

10. Shrestha AK, Basnet N. The correlation and regression analysis of physicochemical parameters of river water for the evaluation of percentage contribution to electrical conductivity. Journal of Chemistry. 2018 Jan 1;2018.

11. Ajibade WA, Ayodele IA, Agbede SA. Water quality parameters in the major rivers of Kainji Lake National Park, Nigeria. African Journal of Environmental Science and Technology. 2008;2(7):185-96.

12. Parmar KS, Bhardwaj R. Water quality index and fractal dimension analysis of water

parameters. International journal of environmental science and technology. 2013 Jan;10:151-64.

13. Sawant R, Chavan N. Water quality status of Mahagaon reservoir from GadhinglajTahsil from Maharashtra. International Journal of Science, Environment and Technology. 2013;2(6):1196-204.

14. Pauline EA, Osagie IB, Razzaq AA, OmoniyiMoses SO. Experimental determination of drinking water quality in Abeokuta Metropolis, South-Western Nigeria. International Journal of Advances in Scientific Research and Engineering. 2018 Dec;4(12):241-56.

15. Oladeji SO. Evaluation of physicochemical parameters in wastewater from Muhammad Ayuba dam in Kazaure, Jigawa state, Nigeria. Archives of Agriculture and Environmental Science. 2020 Dec 25;5(4):482-8.

16. Chandra S, Singh A, Tomar PK, Kumar A. Evaluation of physicochemical characteristics of various river water in India. Journal of Chemistry. 2011 Oct 1;8:1546-55.

17. Appavu A, Thangavelu S, Muthukannan S, Jesudoss JS, Pandi B. Study of water quality parameters of cauvery river water in Erode region. Journal of Global Biosciences. 2016;5(9):4556-67.

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