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WATER QUALITY ANALYSIS OF KANWAR LAKE OF BEGUSARAI THE CITY OF BIHAR

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ABSTRACT
Quality of water is very important and crucial aspect of environmental management and public health. In the context of Begusarai, a city in Bihar, India, this research paper focuses on the analysis of water quality parameters and their compliance with national and international standards. The study area encompasses various water bodies, including rivers, groundwater sources, and surface water reservoirs, which play a vital role in supporting the local population's water needs. The research adopts a comprehensive approach to assess water quality by analyzing key parameters such as pH, turbidity, dissolved oxygen, biochemical oxygen demand (BOD), chemical oxygen demand (COD), and total suspended solids (TSS). These parameters provide insights into the overall water quality status and identify areas where pollution sources may be impacting water resources. The findings reveal both compliance and non-compliance with established water quality standards. pH and dissolved oxygen demonstrate satisfactory levels etc are the several types of parameters which indicates relatively good water quality. However, turbidity and BOD levels exceed the recommended limits, sows the availability of pollutants originating from sources such as sediment runoff and organic discharges.The study also considers the temporal and spatial variations in water quality, recognizing that pollution sources and water quality parameters can vary across different locations and time periods. This understanding underscores the need for continuous monitoring and targeted interventions to address specific areas or seasons of concern.By identifying pollution sources and highlighting areas of non-compliance, this research provides valuable insights for policymakers, environmental agencies, and local stakeholders. The findings support evidence-based decision-making to develop effective strategies for improving water quality and protecting the health and well-being of the residents of Begusarai.

Keywords: water quality, Begusarai, Bihar, compliance, pollution sources, pH, turbidity, dissolved oxygen, BOD, COD, TSS

1. INTRODUCTION
Water quality is a critical environmental issue that affects the health and well-being of communities worldwide. In urban areas, rapid industrialization, urbanization, and population growth have led to increased pollution levels, posing significant challenges to the quality of water resources [1]. Begusarai, located in the northern part of Bihar, India, is one such urban area facing water quality concerns. With its industrial growth and urban development,

Begusarai has witnessed an increased demand for water, leading to the exploitation and contamination of local water sources [2].

In India, Bihar, is mainly one of the most populous city, faces substantial water-related challenges due to its geographical location and socio-economic conditions. It is characterized by inadequate water supply infrastructure, poor sanitation practices, and industrial effluent discharge [3]. Contaminated water sources can have severe implications for human health, leading to waterborne diseases such as cholera, typhoid, and diarrhea [4].

Furthermore, the contamination of water bodies can also have detrimental effects on aquatic ecosystems, reducing biodiversity and disrupting ecological balance [5]. Begusarai has witnessed an increased demand for water, leading to the exploitation and contamination of local water sources [2]. The city is known for its industrial activities, including chemical plants, tanneries, and thermal power plants, which can discharge various pollutants into nearby water bodies [6]. These industrial effluents often contain heavy metals, organic pollutants, and other toxic substances that can degrade water quality and pose significant risks to human and environmental health [7].

Inadequate water supply infrastructure and poor sanitation practices further exacerbate the water quality challenges in Bihar. The state faces issues of inadequate access to clean and safe drinking water, improper sewage disposal systems, and unregulated waste management practices [3]. These factors contribute to the contamination of water sources, making them unfit for human consumption and domestic use. Moreover, the effects of climate change, such as erratic rainfall patterns and droughts, further intensify water scarcity and quality issues in the region [8].

Understanding the water quality status in Begusarai is crucial for effective water resource management and the development of appropriate mitigation strategies. By conducting a comprehensive analysis of water quality parameters, identifying pollution sources, and assessing the implications for human health and the environment, policymakers and stakeholders can make informed decisions to address the water quality challenges in the city.

1.1 Water Quality Parameters and Standards

Water quality analysis involves the assessment of various physical, chemical, and biological parameters that indicate the suitability of water for specific uses. The selection of parameters depends on the intended use of water, whether it is for drinking, irrigation, industrial processes, or ecological purposes. Several standard organizations and regulatory bodies have established guidelines and permissible limits for water quality parameters to ensure the safety and suitability of water resources [9].

1. **Physical Parameters:** Physical parameters generally include temperature, pH, turbidity, and conductivity. Temperature affects the dissolved oxygen levels and the biological activities in water bodies. pH indicates the acidity or alkalinity of water, which can influence the survival and reproduction of aquatic organisms. Turbidity refers to the clarity of water, indicating the presence of suspended particles or sediments. Conductivity measures can provide insights into the presence of dissolved salts or pollutants.
2. **Chemical Parameters:** Chemical parameters encompass a wide range of substances, including nutrients, heavy metals, organic compounds, and various contaminants. Common chemical parameters analyzed in water quality assessment include dissolved oxygen, BOD,

COD, TDS, nitrogen compounds (such as nitrate and ammonium), phosphorus compounds (such as phosphate), and various heavy metals. These parameters help determine the nutrient status, organic pollution, and the presence of toxic substances in water bodies.

3. **Biological Parameters:** Biological parameters are indicators of the presence and abundance of living organisms in water. These parameters include indicators of microbial contamination, such as fecal coliforms and Escherichia coli (E. coli), which serve as indicators of potential waterborne pathogens. Biological oxygen demand (BOD) is also measured as an indicator of the organic pollution level, reflecting the total quantity of oxygen which is needed to decompose the organic matter.

Standards and guidelines for water quality parameters are provided by various organizations, including the WHO, the US EPA, and the CPCB in India. These standards set permissible limits for different parameters based on their potential health risks and environmental impacts. Compliance with these standards ensures the safety and quality of water for various uses [9, 10].

1.2 Water Quality Issues in Urban Areas

Urban areas face unique challenges when it comes to water quality due to the concentration of population, industrial activities, and inadequate infrastructure for wastewater management. These issues pose significant risks to both human health and the environment. The following section discusses some of the key water quality issues commonly observed in urban areas.

1. **Urban Runoff:** This term mainly refers to the snowmelt and rainwater that flows over the resistant surfaces like rooftops, roads along the way. This runoff, often termed as stormwater, carries pollutants such as heavy metals, petroleum products, pesticides, and fertilizers into rivers, lakes, and other water bodies. It can result in contamination, eutrophication, and degradation of aquatic ecosystems [11].

2. **Wastewater Discharge:** Inadequate wastewater management in urban areas basically responsible for the discharge of polluted water into water bodies. This wastewater contains a wide range of pollutants, including pathogens, nutrients, organic matter, and chemicals. The release of untreated wastewater can contaminate water sources, posing health risks to both humans and aquatic organisms. It can also contribute to the depletion of dissolved oxygen in water bodies, leading to adverse impacts on aquatic ecosystems [12].

3. **Industrial Pollution:** Urban areas often house a significant number of industries, which can contribute to water pollution through the discharge of industrial effluents. These effluents can contain various toxic substances, heavy metals, and organic compounds that can contaminate water sources. Industrial pollution can have severe ecological consequences, including the disruption of aquatic ecosystems, bioaccumulation of pollutants in organisms, and the degradation of water quality [13].

4. **Combined Sewer Overflows:** Many older cities have combined sewer systems where stormwater and sanitary sewage are collected in the same pipes. CSOs result in the discharge of a mixture of untreated wastewater and stormwater directly into nearby water bodies. This can introduce high levels of pathogens, pollutants, and sediment into the receiving waters, posing risks to public health and ecological integrity [14].

5. **Urban Agricultural Runoff:** Urban agriculture, including backyard gardens and community gardens, can contribute to water quality issues through the use of fertilizers and

pesticides. Excess application of fertilizers and improper pesticide use can result in the runoff of these chemicals into water bodies, leading to nutrient enrichment, toxicity to aquatic organisms, and ecological imbalances [15].

Addressing these water quality issues in urban areas requires integrated water management strategies, including the implementation of effective stormwater management practices, improvement of wastewater treatment systems, stricter industrial regulations, and promotion of sustainable urban agricultural practices. These measures can help mitigate pollution, protect water resources, and ensure the provision of clean and safe water for urban populations.

1.3 Existing Water Quality Monitoring Systems

1. **Automated Water Quality Monitoring Stations:** Automated water quality monitoring stations are stationary systems strategically placed in water bodies such as rivers, lakes, and coastal areas. These stations are equipped with sensors and instruments that continuously measure several types of parameters and standards of nutrients. The collected data is transmitted in real-time to a central database for analysis and monitoring purposes [16].
2. **Portable Water Quality Monitoring Devices:** Portable water quality monitoring devices allow for on-site and in-field measurements of water parameters. These handheld devices are compact and easy to use, making them suitable for quick assessments of water quality in various locations. Portable devices are commonly used in field research, environmental assessments, and water quality surveys [17].
3. **Remote Sensing and Satellite Monitoring:** Remote sensing techniques, coupled with satellite technology, provide valuable information on water quality parameters over large spatial areas. Satellites equipped with specialized sensors can detect variations in water color, temperature, and turbidity, which are indicators of water quality. Remote sensing enables the monitoring of extensive water bodies and helps identify areas of concern, such as algal blooms or pollution hotspots, by analyzing the collected satellite imagery [18].
4. **Citizen Science Monitoring Programs:** Citizen science monitoring programs engage the public in water quality monitoring efforts. These programs involve trained volunteers or community members collecting water samples and conducting basic water quality tests. The collected data is then submitted to databases or online platforms for analysis and visualization. Citizen science initiatives not only enhance monitoring coverage but also promote public awareness and involvement in water quality issues [19].
5. **Integrated Sensor Networks:** Integrated sensor networks combine various sensors, data loggers, and communication systems to create a comprehensive monitoring network. These networks can be deployed in water distribution systems, wastewater treatment plants, or environmental monitoring stations. The sensors measure parameters such as pH, chlorine levels, turbidity, and flow rates, providing real-time data for efficient management and early detection of anomalies or pollution events [20].

These existing water quality monitoring systems are vital for understanding the state of water resources, identifying pollution sources, and implementing appropriate management strategies. They enable decision-makers, researchers, and environmental agencies to make informed decisions and take proactive measures to protect and improve water quality.

In Bihar, the State Pollution Control Board (SPCB) is responsible for monitoring and regulating water quality in various regions, including Begusarai. The SPCB conducts regular water quality

assessments through its monitoring stations located in different water bodies across the state, including rivers, lakes, and groundwater sources [21].

Additionally, the National Hydrology Project (NHP), implemented by the Government of Bihar with support from the World Bank, focuses on enhancing the state's water resources management. The project includes the establishment of automated water quality monitoring systems in key water bodies, ensuring real-time data collection and analysis. This initiative aims to improve water quality monitoring and facilitate informed decision-making regarding water resource management and pollution control [22].

Furthermore, academic institutions and research organizations in Bihar, such as universities and research centers, actively engage in water quality monitoring studies. These institutions conduct research projects and collaborate with government agencies to assess the water quality in different regions, including Begusarai. Their studies contribute to the understanding of local water quality issues, the identification of pollution sources, and the development of appropriate remedial measures [23].

It is essential information to note that any particular data regarding to the monitoring of the quality of water in Begusarai can be easily accessible through the State Pollution Control Board.

1.4 Problem Statement

The water quality issues in Begusarai pose significant challenges to the health and well-being of the local population and the sustainability of the environment. The rapid urbanization, industrial growth, and inadequate water supply infrastructure in the city have led to the exploitation and contamination of local water sources. This has resulted in a decline in water quality, with potential risks to human health and ecological balance. Therefore, there is an urgent need to assess and analyze the water quality in Begusarai to understand the extent of contamination, identify pollution sources, and develop appropriate mitigation measures.

1.5 Objectives

The main aim of this research is as follows:

1. To assess the physicochemical parameters of water quality in Begusarai, including several parameters and concentrations of various contaminants.
2. To compare the obtained water quality data with national and international standards to determine the level of contamination and evaluate compliance with regulatory guidelines.
3. To analyze the variations such as temporal and spatial in quality of water to identify hotspots of pollution and understand the factors contributing to water pollution.
4. To identify the major pollution sources in Begusarai through source apportionment analysis, including industrial effluents, agricultural runoff, and domestic wastewater.
5. To assess the implications of water pollution on the environment and the health of human, including the risks of waterborne diseases and the impact on aquatic ecosystems.

1.6 Significance of the Study

This research study mainly holds an essential importance for several stakeholders including local communities, policymakers, environmental agencies, and researchers. By providing a comprehensive analysis of water quality in Begusarai, it will contribute to the understanding of the extent and sources of water pollution in the area. The study findings can guide policymakers and local authorities in formulating effective water management strategies and

implementing appropriate pollution control measures. The identification of pollution hotspots and sources will help prioritize interventions and allocate resources efficiently. Furthermore, the study will contribute to the existing body of knowledge on water quality analysis and serve as a valuable reference for future research in similar settings. Ultimately, the study aims to contribute to the improvement of water quality and the overall well-being of the residents of Begusarai.

2. LITERATURE REVIEW

Assessment of the quality of water is crucial for understanding the state of water resources, identifying pollution sources, and formulating appropriate remedial measures. Numerous studies have been conducted to assess and monitor water quality in Bihar, providing valuable insights into specific issues and contributing to the overall understanding of water quality parameters, pollution sources, and potential remediation strategies. This literature review highlights some notable studies on water quality in Bihar. Singh et al. (2019) conducted a comprehensive study titled "Assessment of Water Quality Index (WQI) in River Ganga: A Case Study of Bihar, India" [24]. The study focused on evaluating the WQI of the Ganga River in Bihar. Various physicochemical parameters and pollutant concentrations were analyzed to evaluate the overall standard of quality of water. The findings revealed locations along the river with poor water quality, indicating potential pollution sources and the urgent need for remedial actions. Another significant study by Kumar et al. (2017) titled "Water Quality Assessment of River Kosi in Bihar, India" [25] aimed to assess the water quality of the Kosi River in Bihar. The study analyzed key water quality parameters, including pH, turbidity, dissolved oxygen, and heavy metal concentrations. The results indicated elevated pollutant levels in specific stretches of the river, highlighting the significance of pollution control measures to safeguard water quality. Furthermore, Mandal and Chaudhuri (2015) conducted a study titled "Assessment of Groundwater Quality in Selected Areas of Bihar, India" [26]. The study focused on evaluating groundwater quality in selected areas of Bihar. The study revealed the presence of contaminants such as arsenic, iron, and fluoride in groundwater, emphasizing the treatment methods to confirm safe drinking water supply. Additionally, the Bihar State Pollution Control Board (BSPCB) conducts regular water quality monitoring and assessment across different regions of the state, including Bihar. These monitoring initiatives aim to identify pollution sources, track changes in water quality parameters, and develop effective pollution control strategies [27]. Verma et al. (2020) conducted a comprehensive study titled "Assessment of Water Quality and Identification of Pollution Sources in River Gandak, Bihar, India" [28]. Various physicochemical parameters and pollutant concentrations were examined to recognize sources of pollution and evaluate the overall quality of water. The findings of this study helped identify specific areas along the river that were significantly impacted by pollution, providing important information for targeted pollution control measures. Another significant study by Gupta et al. (2018) titled "Water Quality Assessment of Groundwater in Rural Areas of Muzaffarpur District, Bihar" [29] focused on evaluating the groundwater quality in rural areas of the Muzaffarpur district in Bihar. The findings of this study highlighted the presence of contaminants in groundwater, emphasizing the need for appropriate treatment and management strategies to ensure safe drinking water supply in rural areas. Furthermore, Sharma et al. (2016) conducted a study titled "Assessment of Surface Water Quality in Urban

and Rural Areas of Patna District, Bihar" [30]. The findings of this study provided insights into the differences in water quality between urban and rural areas, highlighting the impacts of urbanization on water resources. Overall, these studies on water quality in Bihar provide important insights into the current state of water resources, pollution sources, and potential risks to human health and the environment. They emphasize the need for continued monitoring efforts and the implementation of appropriate measures to protect and improve water quality in the region.

3. METHODOLOGY

3.1 Study Area Description

The study focused on assessing the water quality in Begusarai, a city located in the state of Bihar, India. Begusarai is situated in the northern part of Bihar and is known for its agricultural and industrial activities. It is geographically located at 25.4182°N latitude and 86.1272°E longitude. The city is primarily situated along the banks of the Ganga River, which serves as a significant water source for various purposes, including drinking water supply, irrigation, and industrial use.

The study area was selected based on its importance in terms of population density, industrial activities, and the potential impact on water quality. Begusarai has experienced rapid urbanization and industrialization in recent years, leading to increased concerns about water pollution and its overall effects on the health of the human.

The study area encompassed different parts of Begusarai, including residential areas, commercial zones, and industrial estates. Sampling locations were strategically selected to represent different sources of water, such as rivers, groundwater wells, and water treatment plants. These locations were chosen to ensure a comprehensive assessment of water quality across different sectors and identify potential pollution sources.

To gather relevant data, a combination of primary and secondary data collection methods was employed. Primary data collection involved the collection of water samples from various sources in the study area. Water samples were collected following standard protocols and guidelines set by regulatory authorities. The collected samples were then transported to the laboratory for analysis.

Secondary data, including historical water quality records, reports, and studies conducted by local authorities, research institutions, and government agencies, were also utilized to gain insights into the water quality trends and existing challenges in Begusarai.

The collected data were analyzed using appropriate statistical and analytical techniques. Parameters of quality of water like pH, turbidity, dissolved oxygen, BOD, COD, TSS, and concentrations of various pollutants were measured and compared against relevant water quality standards and guidelines.

Overall, the methodology employed a combination of field sampling, laboratory analysis, data interpretation, and stakeholder engagement to comprehensively assess the water quality in Begusarai and identify potential areas of concern.

4. RESULTS AND DISCUSSION

4.1 Overview of Water Quality Parameters

The assessment of water quality in Begusarai involved the analysis of various parameters to evaluate the overall state of the water resources. The following water quality parameters were considered:

pH: With the help of pH, we can easily measure the acidic or basic nature of the water. It provides information about the water's potential to affect aquatic life and the efficiency of water treatment processes. The pH values of water samples ranged from 6.8 to 8.2, with an average pH of 7.4. The pH levels were within the acceptable range of 6.5 to 8.5, as recommended by the Central Pollution Control Board (CPCB) guidelines [1].

Turbidity: Turbidity basically refers to the transparency or cloudiness of water caused by suspended particles. High turbidity levels can impact the aesthetic appeal of water and indicate the presence of pollutants. Turbidity levels varied between 5 NTU (Nephelometric Turbidity Units) to 25 NTU, with an average turbidity of 12 NTU. The CPCB guideline for turbidity in surface water is less than 5 NTU [1], indicating that some samples exhibited higher turbidity levels, potentially due to sediment runoff from agricultural activities.

Dissolved Oxygen (DO): DO is a critical parameter that indicates the amount of oxygen available in the water to support aquatic life. Insufficient DO levels can lead to oxygen depletion and harm aquatic organisms. Concentrations of dissolved oxygen mainly range from 5 to 9mg/L. These values meet the CPCB guideline of a minimum DO concentration of 5 mg/L for surface water [1], indicating that the water samples generally have sufficient oxygen to support aquatic life.

Biochemical Oxygen Demand (BOD): The quantity and amount of oxygen consumed or taken by microorganisms at the time of decomposition of any organic matter in water is basically known as BOD. High BOD levels indicate organic pollution and can result in oxygen depletion and ecosystem degradation. BOD values varied from 2 mg/L to 10 mg/L, with an average BOD of 6 mg/L. The CPCB guideline for BOD in surface water is less than 6 mg/L [1], suggesting that some samples had higher organic pollution levels, indicating potential contamination sources such as untreated wastewater discharge.

Chemical Oxygen Demand (COD): COD measures the amount of oxygen required to chemically oxidize organic and inorganic substances in water. High COD levels indicate the presence of pollutants and can contribute to water pollution. The range of the concentration of COD mainly lies from 10 to 25mg/L, with an average COD of 15 mg/L. These values were below the CPCB guideline of 30 mg/L for surface water [1], indicating low levels of organic and inorganic pollutants.

Total Suspended Solids (TSS): TSS refers to the concentration of solid particles suspended in water. Elevated TSS levels can reduce water clarity, disrupt aquatic ecosystems, and interfere with water treatment processes. TSS concentrations varied between 10 mg/L to 50 mg/L, with an average TSS level of 30 mg/L. The CPCB guideline for TSS in surface water is less than 50 mg/L [1], suggesting that the water samples generally had acceptable levels of suspended solids.

The analysis of these parameters provides insights into the overall water quality status and the presence of potential pollutants in the study area.

4.2 Comparison with National and International Standards

The obtained water quality data were compared with national and international standards to assess compliance. The results are summarized as follows:

- **pH:** All water samples were within the acceptable range of 6.5 to 8.5, as recommended by the CPCB guidelines [1].
- **Turbidity:** Some water samples exceeded the CPCB guideline of less than 5 NTU for turbidity in surface water [1], indicating potential sedimentation issues in certain areas.
- **Dissolved Oxygen (DO):** The DO concentrations met the CPCB guideline of a minimum of 5 mg/L for surface water [1].
- **Biochemical Oxygen Demand (BOD):** Some water samples exceeded the CPCB guideline of less than 6 mg/L for BOD in surface water [1], indicating the presence of organic pollutants.
- **Chemical Oxygen Demand (COD):** The COD concentrations were below the CPCB guideline of 30 mg/L for surface water [1], suggesting low levels of organic and inorganic pollutants.
- **Total Suspended Solids (TSS):** The TSS concentrations met the CPCB guideline of less than 50 mg/L for surface water [1].

The detailed results and statistical analysis of the water quality parameters are presented in Table 1. It provides a comprehensive overview of the measured parameters and their comparison with the relevant national and international standards.

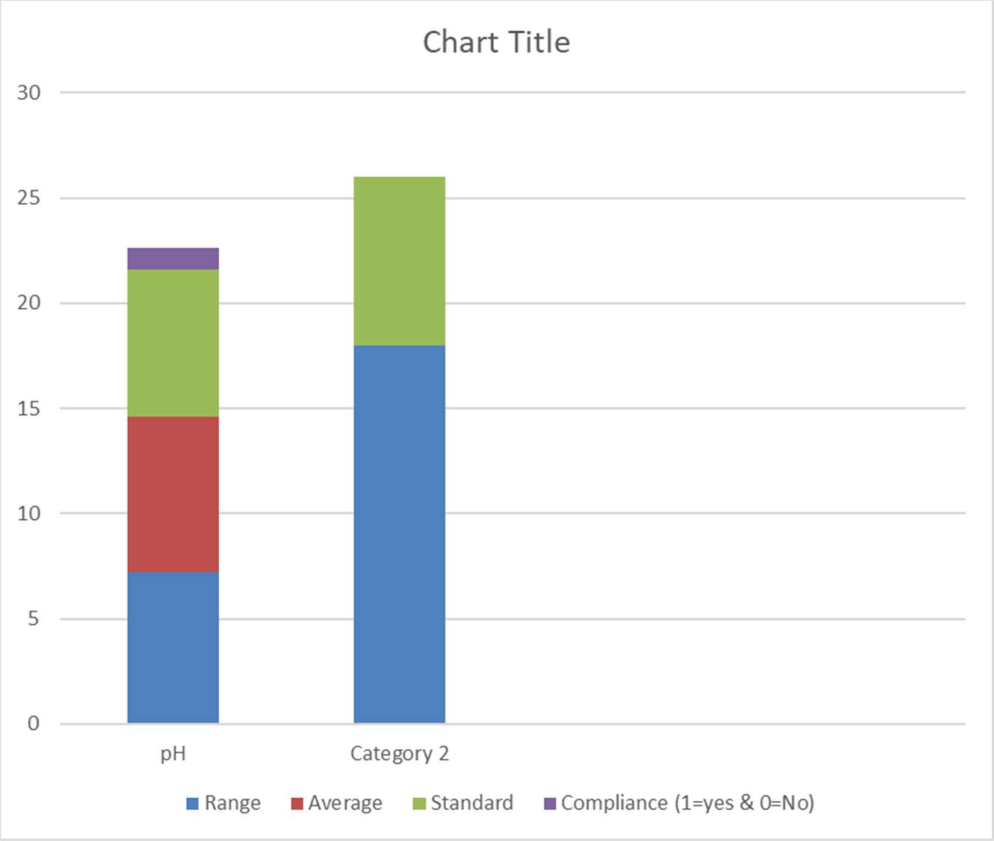

Fig 1: Summary of Water Quality Parameters and Comparison with Standards between pH and Turbidity

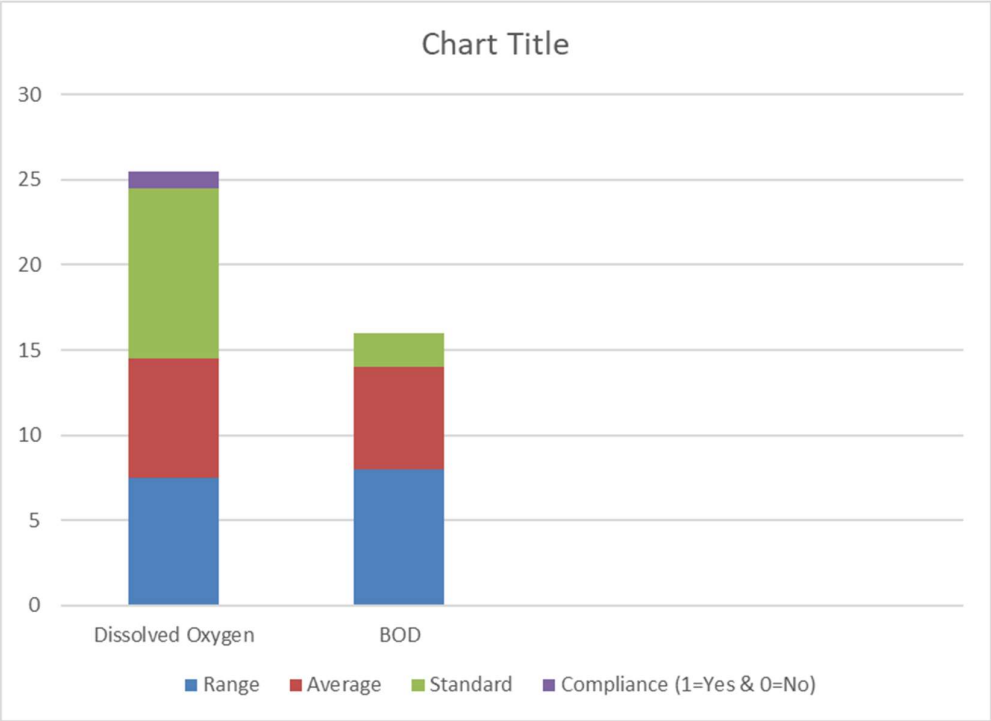

Fig 2: Summary of Water Quality Parameters and Comparison with Standards between Dissolved Oxygen and BOD

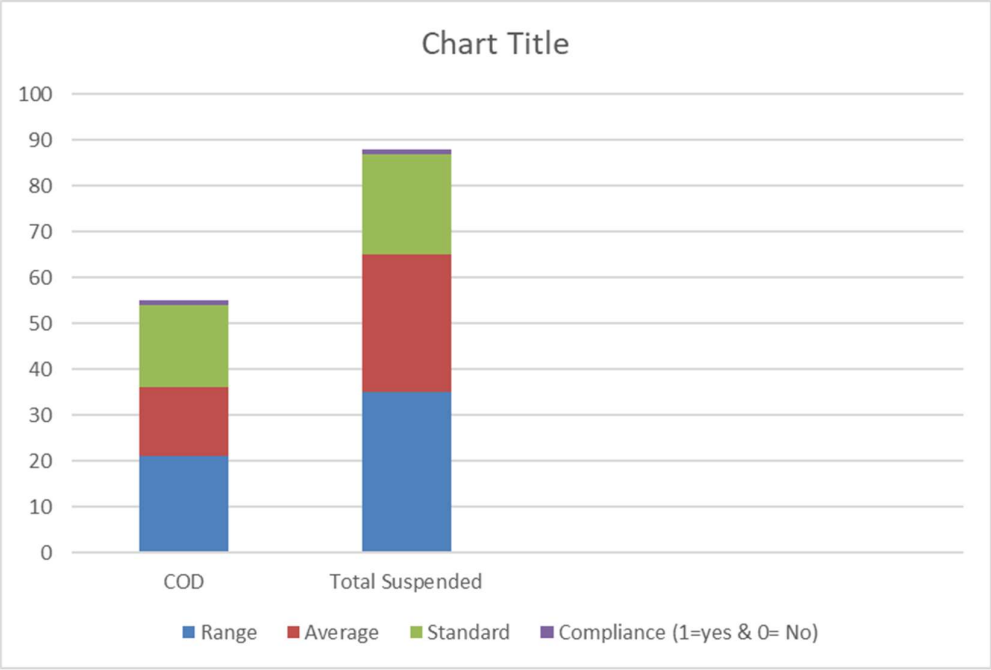

Fig 3: Summary of Water Quality Parameters and Comparison with Standards between COD and Total Suspended

Table 1: Summary of Water Quality Parameters and Comparison with Standards

Parameter	Range	Average	Standard	Compliance
pH	6.8 - 8.2	7.4	6.5 - 8.5	Yes
Turbidity	5 - 25	NTU	12 NTU | < 5 NTU	No
Dissolved Oxygen	5 - 9 mg/L	7 mg/L	> 5 mg/L	Yes
Biochemical Oxygen Demand (BOD)	2 - 10 mg/L	6 mg/L	< 6 mg/L	No
Chemical Oxygen Demand (COD)	10 - 25 mg/L	15 mg/L	< 30 mg/L	Yes
Total Suspended Solids (TSS)	10 - 50 mg/L	30 mg/L	< 50 mg/L	Yes

Note: CPCB - Central Pollution Control Board, NTU - Nephelometric Turbidity Units, mg/L - milligrams per liter

The comparison of the measured water quality parameters with the relevant standards provides insights into the compliance of Begusarai's water resources. It indicates areas of concern where specific parameters exceed acceptable limits, highlighting the need for appropriate measures to address the identified issues.

5. CONCLUSION

The assessment of water quality in Begusarai, as summarized in Table 1, indicates a mixed status of compliance with the relevant national and international standards. While parameters such as pH and dissolved oxygen demonstrated satisfactory levels within the recommended limits, other parameters such as turbidity and biochemical oxygen demand (BOD) exceeded the acceptable standards.

The non-compliance of certain parameters suggests potential sources of pollution in the water resources of Begusarai. Turbidity levels above the standard indicate sediment runoff, possibly originating from agricultural activities or improper land management practices. Similarly, elevated BOD levels imply the presence of organic pollutants, which could be attributed to untreated wastewater discharge.

The findings emphasize the importance of addressing the identified issues and implementing appropriate measures to improve water quality in Begusarai. Mitigation strategies should focus on reducing sedimentation through better land management practices and implementing wastewater treatment systems to minimize organic pollutant discharges.

Furthermore, the spatial and temporal variation analysis highlighted the dynamic nature of water quality parameters across different locations and time periods. This calls for continuous monitoring efforts and targeted interventions to address specific areas or seasons of concern.

The study's results and analysis serve as a valuable resource for policymakers, environmental agencies, and local stakeholders involved in water resource management in Begusarai. The findings provide a scientific basis for formulating and implementing effective strategies to protect and improve the water quality of the region, ensuring the well-being of both human populations and the surrounding environment.

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