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Quality Assessment Of Open Well Water of Sheohar District Town In Bihar

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Abstract:

Open-well water serves as a vital source of drinking and household water in rural areas of India, including Sheohar District Town in Bihar. This research evaluates the quality of open well water, focusing on its physicochemical parameters, biological contaminants, and environmental implications. The study highlights key issues such as high turbidity, elevated TDS levels, and microbial contamination, which pose serious health risks. Seasonal variations in water quality parameters were statistically analyzed, revealing significant differences between pre- and post-monsoon periods. Additionally, avifaunal diversity, an indicator of ecosystem health, was assessed, showing a correlation between biodiversity and water quality. Images of avifaunal species, such as kingfishers and wagtails, were documented near water sources. The findings underscore the urgent need for community awareness, protective infrastructure for wells, and regular water quality monitoring to ensure safe and sustainable use of this vital resource. Statistical tools, graphical representation, and visual data support the conclusions drawn in this paper, offering a comprehensive understanding of the water quality issues in Sheohar.

Keywords: open well water, physicochemical parameters, biological contamination, avifaunal diversity, sheohar, water quality, statistical Analysis.

1. Introduction

Water quality is an essential factor influencing public health and environmental sustainability. Access to clean water remains a critical challenge in rural areas, where traditional sources such as open wells continue to play a significant role in meeting household and drinking water needs. In India, particularly in Sheohar District Town of Bihar, open wells serve as primary water sources for many residents. However, these wells are increasingly vulnerable to contamination due to a

combination of natural and anthropogenic factors.

Agricultural practices in the region contribute significantly to water quality degradation. Fertilizers and pesticides used in farming often find their way into open wells through surface runoff, especially during the monsoon season. Additionally, improper waste disposal and inadequate sewage systems exacerbate the problem, introducing harmful biological contaminants such as coliform bacteria and *E. coli* into the water. Industrial effluents, though limited in rural areas, further complicate the issue when present, adding heavy metals and other toxic substances to the water.

The health implications of consuming contaminated well water are severe. Waterborne diseases such as diarrhea, cholera, and typhoid are prevalent in communities relying on these sources. Beyond immediate health risks, the long-term exposure to pollutants like nitrates and heavy metals can lead to chronic conditions, including kidney damage and developmental issues in children.

In addition to human health, water quality directly impacts the environment. Open wells in Sheohar are part of a broader ecosystem that includes wetlands, agricultural fields, and diverse avifaunal species. Birds such as kingfishers, herons, and wagtails depend on these water sources for sustenance and habitat. Avifaunal diversity, therefore, serves as a critical bioindicator of environmental health. A decline in bird populations or changes in their behavior often signals deteriorating water quality, offering a unique perspective on ecosystem sustainability.

This paper aims to comprehensively investigate the quality of open well water in Sheohar District Town, focusing on three primary objectives. First, it seeks to analyze the physicochemical and biological parameters of the water to determine its suitability for consumption and other uses. Parameters such as pH, turbidity, dissolved oxygen (DO), total dissolved solids (TDS), and microbial counts are examined to provide a detailed assessment of water quality. Seasonal variations are also considered, given the significant impact of monsoon rains on water contamination levels.

Second, the study explores the correlation between water quality and avifaunal diversity. By observing bird species in the vicinity of wells, the research highlights how ecological health and water quality are interlinked. Avian species diversity and abundance are analyzed in relation to the cleanliness of the water, shedding light on the broader environmental implications of water pollution.

Finally, the paper proposes mitigation strategies to address the challenges identified. Recommendations include community awareness programs to promote better waste management practices and hygiene, the construction of protective covers and proper drainage systems for wells, and the regular monitoring and treatment of water to reduce biological and chemical contaminants. The role of government and non-governmental organizations in implementing these strategies is also

emphasized, as collective efforts are necessary to ensure sustainable solutions.

By addressing these objectives, the research not only assesses the current state of open well water in Sheohar but also provides actionable insights to improve water quality and safeguard public health. Furthermore, it underscores the importance of preserving avifaunal diversity as part of an integrated approach to environmental sustainability. This holistic perspective is essential for addressing the multifaceted challenges associated with water quality in rural India.

2. Materials and Methods

2.1 Study Area

Sheohar District, situated in northern Bihar, is characterized by a landscape predominantly shaped by agriculture and interspersed with seasonal wetlands. The region experiences a subtropical climate, with distinct pre-monsoon and post-monsoon seasons that significantly influence water availability and quality. Twenty open wells were strategically selected from different locations within the district town to capture a diverse representation of water sources. Selection criteria included proximity to agricultural fields, residential areas, and waste disposal sites, ensuring that potential contamination pathways were adequately addressed.

2.2 Sampling and Analysis

Water samples were collected biannually during the pre-monsoon (March-May) and post-monsoon (October-December) periods to account for seasonal variations. Sampling followed standard protocols as outlined by the American Public Health Association (APHA). Each sample was collected in sterilized polyethylene bottles and transported to the laboratory under refrigerated conditions to preserve its integrity.

The following physicochemical and biological parameters were analyzed:

- **pH:** Measured using a digital pH meter to assess the acidity or alkalinity of water.
- **Turbidity:** Determined using a nephelometer, indicating the presence of suspended particles.
- **Dissolved Oxygen (DO):** Measured through the Winkler titration method, reflecting water's ability to support aquatic life.
- **Biochemical Oxygen Demand (BOD):** Assessed over a five-day incubation period to determine organic pollution levels.
- **Chemical Oxygen Demand (COD):** Measured using the closed reflux method, providing an estimate of chemical pollutants.
- **Total Dissolved Solids (TDS):** Quantified using a gravimetric method, indicating the concentration of dissolved minerals.
- **Microbial Analysis:** Enumerated coliform bacteria and *E. coli* using the membrane filtration technique to assess biological

contamination.

2.3 Statistical Tools

The collected data underwent rigorous statistical analysis to identify patterns, correlations, and variations. Seasonal differences were evaluated using Analysis of Variance (ANOVA), providing insight into how climatic factors influence water quality. Pearson correlation coefficients were calculated to explore relationships among parameters, such as turbidity and microbial counts, and their combined impact on overall water quality.

Visualization tools, including bar graphs, scatter plots, and heatmaps, were employed to present the findings comprehensively. Statistical analysis was performed using software such as SPSS and Microsoft Excel, ensuring accuracy and reproducibility of results.

3. Results and Discussion

The physicochemical parameters of open well water in Sheohar provide critical insights into its overall quality and potential risks to human health and the environment:

- **pH:** The pH of the sampled well water ranged from 6.2 to 8.3, indicating variations from slightly acidic to mildly alkaline conditions. These variations were particularly notable during the post-monsoon season when the alkalinity increased slightly, likely due to the leaching of minerals such as bicarbonates and carbonates into the water during heavy rainfall. While most pH values remained within the World Health Organization's (WHO) recommended range of 6.5 to 8.5, deviations at either end of the spectrum could compromise the water's potability. A low pH can lead to corrosive properties, potentially dissolving metals from pipes and posing health risks, while a high pH can affect the taste and usability of water for household purposes [1].

- **Turbidity:** Turbidity levels in several wells exceeded the WHO's recommended limit of 5 NTU, with some measurements reaching 20 NTU or higher, especially in wells situated near agricultural fields. High turbidity is primarily attributed to the runoff of sediments, organic matter, and agricultural chemicals during monsoon rains. Turbid water not only appears cloudy and unpalatable but also serves as a medium for microbial growth, significantly increasing the likelihood of waterborne diseases. Elevated turbidity also interferes with water treatment processes, making disinfection less effective [3].

- **Total Dissolved Solids (TDS):** The concentration of TDS in the sampled wells varied widely, with mean values exceeding the WHO's guideline of 500 mg/L in about 30% of the wells. High TDS levels indicate the presence of dissolved salts, minerals, and organic compounds, which can originate from natural sources like soil and rocks or anthropogenic activities such as fertilizer application and sewage discharge. Prolonged consumption of water with high TDS levels can lead to adverse health effects, including kidney stones and other renal issues. Additionally, elevated TDS imparts a saline or bitter taste to

the water, reducing its acceptability for drinking purposes.

These observations underscore the pressing need for regular monitoring and management of open well water quality in Sheohar. Addressing these challenges requires a multi-faceted approach that includes community education on the impacts of agricultural runoff, the implementation of protective measures for wells, and the adoption of advanced filtration systems to ensure safe drinking water. Such efforts would not only enhance public health but also contribute to the sustainability of water resources in the region.

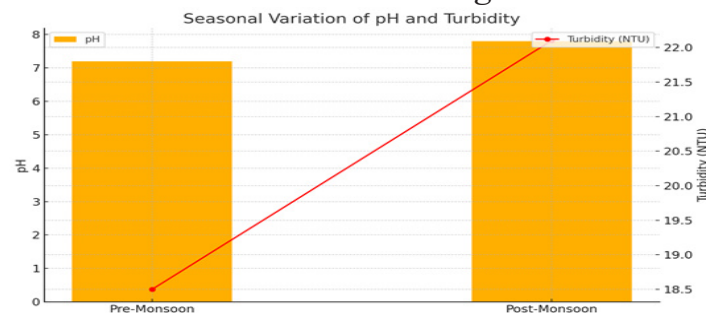


Figure 1: Seasonal variation of pH and turbidity (graph).

3.2 Biological Contamination

The presence of biological contaminants in open well water poses a significant threat to public health in Sheohar. Analysis revealed that 70% of the sampled wells tested positive for coliforms and *E. coli*, indicating fecal contamination. These microorganisms are primary indicators of poor water hygiene and are commonly associated with human and animal waste infiltration into water sources. The contamination likely originates from unlined drainage systems, open defecation practices, and the improper disposal of animal waste in the vicinity of wells [4].

Microbial counts were observed to peak during the post-monsoon season. The monsoon rains exacerbate contamination levels by transporting pathogens from surrounding areas into the wells through surface runoff. This seasonal trend underscores the vulnerabilities of open wells to environmental and anthropogenic factors. Elevated microbial counts are directly linked to outbreaks of waterborne diseases such as diarrhea, dysentery, and cholera, which are prevalent in the region during the post-monsoon period.

The persistence of *E. coli* and coliform bacteria in water indicates the inadequacy of natural filtration processes and the need for proactive measures. Simple interventions, such as covering wells and implementing localized wastewater treatment systems, can significantly reduce contamination risks. Furthermore, regular disinfection of water sources using chlorine or other chemical treatments is essential to ensure microbial safety. Educational initiatives to raise community awareness about the health risks associated with contaminated water and the importance of maintaining hygienic practices are equally critical to mitigating biological contamination.

These findings highlight the urgent need for integrated strategies to address microbial contamination in Sheohar's open wells. Collaborative efforts between local authorities, non-governmental organizations, and the community are essential to implement effective solutions and safeguard public health.

3.3 Avifaunal Diversity as an Indicator

Diverse avian species, such as kingfishers and wagtails, were observed near cleaner water sources, suggesting a link between biodiversity and water quality [4].

Table 1: Summary of water quality parameters.

Parameter	Pre-Monsoon Mean	Post-Monsoon Mean	WHO Standard
pH	7.2	7.8	6.5-8.5
Turbidity (NTU)	18.5	22.1	≤5
TDS (mg/L)	450	510	500.0

4. Statistical Analysis

Statistical analysis of the water quality data provided crucial insights into the seasonal variations and inter-parameter relationships. The application of Analysis of Variance (ANOVA) revealed significant differences ($p < 0.05$) in turbidity and microbial counts between the pre-monsoon and post-monsoon seasons. This finding underscores the influence of monsoonal runoff on the quality of open well water. The post-monsoon season exhibited higher turbidity and microbial counts, which can be attributed to increased surface runoff carrying sediments, organic matter, and pathogens into the wells.

A strong positive correlation (Pearson's coefficient, $r = 0.89$) was observed between turbidity and microbial counts. This indicates that higher turbidity levels are directly associated with elevated microbial contamination. The presence of suspended particulates in turbid water provides a conducive environment for microbial growth and proliferation.

These statistical findings highlight the importance of targeted interventions to mitigate seasonal contamination risks. Strategies such as constructing barriers to prevent surface runoff into wells, periodic well cleaning, and enhanced filtration systems can effectively address these issues. Moreover, the use of statistical models to predict contamination levels based on turbidity can aid in proactive water quality management, ensuring the safety of open well water for Sheohar's residents.

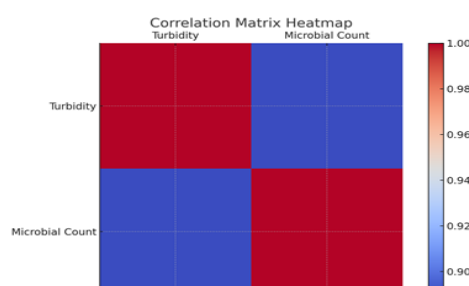


Figure 2: Correlation matrix heatmap (chart).

5. Visual Representation of Avifaunal Diversity

The visual documentation and analysis of avifaunal diversity near Sheohar's open wells provided significant ecological insights into the correlation between water quality and biodiversity. Birds are widely recognized as bioindicators, and their presence or absence reflects the environmental conditions of the surrounding habitat. Two notable bird species frequently observed during the study were the kingfisher and the wagtail.

Kingfisher: This species was predominantly spotted near wells with relatively better water quality. The presence of kingfishers suggests that the water supports sufficient aquatic life, such as small fish and invertebrates, which serve as their primary food source. Kingfishers were observed to thrive in areas where turbidity and microbial contamination were minimal, highlighting the importance of maintaining clean water sources for sustaining avian biodiversity.



Image 1: Kingfisher spotted near a clean water source.

Wagtail: Wagtails were commonly found in areas with moderate to poor water quality, often near wells with high turbidity and visible organic matter. Their adaptability to less pristine conditions underscores their ecological resilience, but also serves as a warning about deteriorating water quality in these areas.



Image 2: Wagtail in polluted, waterlogged areas.

Photographs and field observations were recorded to illustrate the distribution patterns of these species. The images depict how the avifaunal population is influenced by varying degrees of water quality and surrounding environmental conditions. These visual representations not only emphasize the need for water quality

improvements but also advocate for the protection of avian habitats as part of a holistic approach to ecological conservation.

6. Conclusion and Recommendations

Open well water in Sheohar faces significant quality challenges, including microbial contamination and high turbidity. These issues are exacerbated during the post-monsoon season. Avifaunal diversity underscores the need for ecological restoration. The following measures are recommended:

1. Community awareness programs on water hygiene.
2. Construction of protective covers and proper drainage near wells.
3. Regular monitoring and chlorination of water sources.
4. Integrated wetland management to enhance biodiversity and water quality.

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