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Research Paper

Assessment of Groundwater Potability for Slum Communities: A Drinking Water Quality Index (DWQI) Perspective

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Abstract: *This study evaluates the quality of drinking water through the application of the Drinking Water Quality Index (DWQI). The study explores the methodology of DWQI calculation, analyzes results from the study, and deliberates the implications for public health and water resource management. The study integrates standard guidelines and statistical indices to classify water into different quality categories. Results showed varying levels of water quality during pre-monsoon and monsoon periods, with some areas falling below acceptable limits as per WHO and BIS standards. This study highlighted the necessity of regular monitoring and water quality management for maintaining the potability of water for securing public health.*
Keywords: *Water quality, Slum, Drinking, Health, Monitoring*

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I. INTRODUCTION

It is a human necessity to have safe and clean drinking water for well-being. However, increasing anthropogenic activities, including industrialisation, urbanisation, and agricultural practices, have polluted water sources, posing significant health risks. Comprehensive assessment tools are essential for effectively monitoring and managing water quality. Water quality depends on water composition and is influenced by natural progression and anthropogenic activities. Water quality is characterised based on water parameters (physical, chemical, and microbiological), and human health is at risk if values exceed acceptable limits [1]. Several water quality parameters are included in a mathematical equation to rate water quality, determining the relevance of water for drinking [2]. Some impeding factors towards access to safe drinking are poverty, unhygienic sanitation practices, low groundwater levels, and impacts of natural hazards (e.g., arsenic, salinity, extreme weather events) [3]. The Drinking Water Quality Index (DWQI) is one such tool, developed to interpret complex water quality data into an easily understandable form. It integrates multiple water quality parameters into a single composite index, enabling policymakers and the public to assess and compare water safety [4,5]. DWQI provides a more accessible means for environmental monitoring agencies to assess drinking water sources, compare regional trends, and guide remediation efforts. It has been widely adopted globally due to its adaptability and statistical reliability [6].

The study aimed to evaluate the drinking water quality of selected slum areas using the DWQI and to determine compliance with WHO [7]and Bureau of Indian Standards (BIS)[8].

II. METHODOLOGY

2.1 Study Area and Sampling

Groundwater samples were collected from Banjaravas slum area situated in Surat city of Gujarat. Ten samples were collected during the pre-monsoon and monsoon periods. Water samples were collected in sterile, pre-cleaned polyethene bottles, ensuring minimal contamination. Samples were immediately stored in an insulated box at 4 ± 1 °C and transported to the laboratory.

2.2 Parameters Analysed

The collected water samples were analysed for only parameters strictly restricted for drinking water quality. The parameters analysed were pH, TDS, Total Hardness, Chloride, Fluoride and Sulphate. The standard method of analysis was followed [9].

2.3 Calculation of DWQI

The DWQI was calculated through the following steps based on Brown et al. [10].

A. Quality Rating (Q_i): For each parameter, the quality rating was determined using the formula

$$Q_i = [(V_i - V_0) / (S_i - V_0)] \times 100$$

Where:

- V_i = Measured value of the parameter
- V_0 = Ideal value of the parameter (usually zero)
- S_i = Standard permissible value of the parameter (BIS / WHO Standard)

B. Relative Weight (W_i): Each parameter is assigned a weight (W_i) based on its relative importance to overall water quality. The relative weight was calculated as:

$$W_i = K / S_i$$

Where K is a constant of proportionality

C. Overall DWQI: The DWQI is then computed using the formula:

$$DWQI = \Sigma(Q_i \times W_i) / \Sigma W_i$$

The resulting DWQI value was categorised to assess water quality: 0–50: Excellent,51–100: Good, 101–200: Poor, 201–300: Very Poor, 300: Unsuitable for Drinking

III. RESULTS AND DISCUSSION

The water quality was evaluated using the Drinking Water Quality Index (DWQI) during two distinct seasonal periods—Pre-monsoon and Monsoon. Tables 1 and 2 summarise the calculated values for several key parameters, their quality ratings (Qi), relative weights (Wi), and the weighted quality ratings (Wi × Qi) used to derive the overall DWQI values for each season.

Table 1. Calculated values for DWQI(Pre-monsoon)

Parameter	Average	Ideal value	Si	1/si	Qi	Wi	Wi*qi
TDS	152.9	0	500	0.002	30.58	0.0024	0.0734
pH	7.7	7	8.5	0.117647	46.66667	0.1412	6.5882
Total hardness	362	0	200	0.005	181	0.0060	1.0860
Chloride	550.96	0	250	0.004	220.384	0.0048	1.0578
Fluoride	2.0	0	1.5	0.666667	130.6667	0.8000	104.5333
Sulphate	100.0	0	200	0.005	50	0.0060	0.3000
K	1.02						
DWQI	118.32						

Table 2. Calculated values for DWQI(Monsoon)

Parameter	Average	Ideal value	Si	1/si	Qi	Wi	Wi*qi
TDS	175.42	0	500	0.002	35.084	0.0024	0.0842
pH	7.7	7	8.5	0.117647	46.66667	0.1412	6.5882
Total hardness	161.464	0	200	0.005	80.732	0.0060	0.4844
Chloride	533.4	0	250	0.004	213.36	0.0048	1.0241
Fluoride	0.4	0	1.5	0.666667	26.66667	0.8000	21.3333

Sulphate	90.0	0	200	0.005	45	0.0060	0.2700
K	1.02						
DWQI	31.01						

During the Pre-monsoon period, the DWQI was 18.32, which designated it as a "Poor" quality category based on classification standards. The average concentration of fluoride recorded was 2.0, compared to an ideal value of 0 and a standard value (Si) of 1.5. The quality rating (Qi) was notably high at 130.67, and, given a relatively high weight of 0.800, the fluoride parameter contributed a weighted score of 104.53. This parameter emerges as the primary contributor to the overall DWQI, highlighting that fluoride contamination is a major issue during the pre-monsoon period.

Parameters such as Total Dissolved Solids (TDS), total hardness, and chloride, although contributing to the overall index, had relatively lower individual impacts compared to fluoride. During the Monsoon period, the overall DWQI was found to be 31.01, which categorises the water quality in the "Excellent" category. The good quality during the Monsoon period compared to the Pre-monsoon period was due to the reduced fluoride concentration, which dropped significantly (from 2.0 to 0.4). This led to a corresponding reduction in its quality rating (Qi falling to 26.67) and a weighted score of 21. 33, which is far lower than the Pre-monsoon period. This resulted in lower DWQI.

The disparity between the pre-monsoon and monsoon DWQI values highlighted the significant seasonal impact on water quality. The substantial improvement during the monsoon can be attributed primarily to the marked reduction in fluoride levels. In many regions, rainfall during the monsoon season often leads to dilution effects and may also enhance groundwater recharge, which can help in reducing the concentration of several dissolved contaminants.

The results of the study are consistent with other studies that have reported seasonal variations in water quality indices, with the monsoon season typically leading to improved water quality due to dilution and natural flushing mechanisms [11,12]. A study by Thivya et al. [13] evaluated the DWQI across four seasons in the hard rock aquifers of Madurai. The research found significant seasonal variations, with monsoon seasons demonstrating better water quality due to dilution effects, while pre-monsoon periods exhibited higher concentrations of TDS, Na^+ , HCO_3^- , and Cl^- , resulting in poorer water quality. Desai and Desai [14]) assessed the groundwater quality in residential areas of Surat City. Their findings indicated that none of the sampled sources met the desirable limits for drinking water, with high WQI values attributed to elevated levels of TDS, fluoride, and chloride. Rajankar et al. [15] conducted an extensive analysis of groundwater quality in Yavatmal District. Their findings indicated that the Water Quality Index (WQI) ranged from 73.0 to 80.2 during the pre-monsoon and from 68.7 to 72.4 in the post-monsoon season. The slight seasonal variation was attributed to surface runoff and percolation processes. Banik et al. [16] evaluated the health of the Hooghly estuary using WQI developed from ten water quality parameters. The study observed considerable fluctuations in monthly WQI, with the highest values in the pre-monsoon month of May and the lowest in the monsoon month of October. Shrivastava and Kumar [17] analyzed the seasonal variation in drinking water quality in Shikohabad City. Their study, conducted across fifteen sampling sites, revealed that borewells near solid waste storage and low-lying areas exhibited significant variations in parameters such as pH, dissolved oxygen, total alkalinity, and turbidity due to contamination from municipal sewage and solid waste. Previous studies have also indicated similar trends in rapidly urbanising or industrial areas [13,18, 19,20].

IV. CONCLUSION

The application of DWQI proves to be an effective tool in identifying the potability of drinking water and prioritising interventions for its mitigation. Proper monitoring measures should be employed in areas where water quality is suboptimal, particularly in the pre-monsoon period, to ensure the safety of drinking water.

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