RESEARCH PAPER

Water Quality Dynamics And Environmental Health: A Study Of Banaskantha District

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Abstract

Water quality plays a critical role in determining environmental sustainability and human health, particularly in arid and semi-arid regions. The present study evaluates the spatial and temporal dynamics of water quality in banaskantha district, gujarat, during the period march - 2025. Groundwater samples were analyzed for physicochemical and microbiological parameters including ph, total dissolved solids (tds), electrical conductivity (ec), hardness, chloride, fluoride and coliform bacteria. The results indicate significant spatial variability, with several locations exceeding permissible limits prescribed by who and bis standards. High salinity, mineralization, and microbial contamination were identified as key concerns. The study highlights the urgent need for sustainable water management strategies and public health interventions in the region.

Keywords: Water Quality Index, Groundwater, Environmental Health, Banaskantha, Salinity, Microbial Contamination.

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1. Introduction

Water is an essential natural resource for human survival, agriculture, and industrial development. In arid regions like Banaskantha district of Gujarat, groundwater is the primary source of water due to limited surface water availability. However, increasing anthropogenic activities, climate variability, and over-extraction have led to deterioration in water quality.

Banaskantha, located in northern Gujarat, is characterized by semi-arid to desert climatic conditions, making it highly vulnerable to groundwater depletion and contamination. Recent studies indicate that groundwater in this region is increasingly affected by salinity, hardness, and microbial pollution, posing serious environmental and health risks . This research examines groundwater quality in Banaskantha district, Gujarat, highlighting high Total Dissolved Solids (TDS), salinity, and hardness, particularly in northern/western regions due to overdraft and agricultural intensification. The study indicates significant water stress, directly impacting dairy production, agricultural productivity, and human health, necessitating immediate sustainable water management. Dairy farming is a crucial livelihood activity for rural households in Chhattisgarh, significantly contributing to nutrition, employment, and income generation (Gupta et. al, 2025). India is the world's largest milk producer, with dairy farming playing a vital role in the livelihoods of millions of rural families (Gupta et. al, 2025a). Dairy enterprise has been regarded as an important instrument of economic and social change and supplement to the income and employment to rural women (Gupta et. al, 2020). The rural women play a significant role in agriculture and other agro-based activities (Gupta et. al, 2020a). The prosperity and growth of a nation depends on the status and development of its women, as they not only constitute nearly half of its population, but also positively influence the growth of remaining half of the population (Gupta et. al, 2020b). Agri-entrepreneurship and rural livelihoods are closely intertwined with sustainable

economic activities that create employment, income, and ultimately ensure food and livelihood security for rural dwellers (Gupta et. al, 2025b). Farmer field schools (FFS) constitute a globally disseminated group-learning extension approach grounded in a participatory, experiential-learning methodology (Gupta et. al, 2025c). Agriculture plays an indispensable role in the socio-economic development of rural areas, especially in developing countries (Gupta et. al, 2024). Agricultural extension services play a pivotal role in India's economy, providing essential knowledge and technical assistance to farmers across the country (Gupta et. al, 2024a). Women play a critical role in agricultural extension. Agricultural extension is a vehicle through which technology transfer occurs and could bridge the gaps between research, development, and the users of technology (Gupta et. al, 2025d). Extension services in agriculture, often referred to simply as extension, play a crucial role in improving agricultural productivity and promoting rural development (Gupta et. al, 2025e). Dairy farming in Chhattisgarh has evolved as a significant sector contributing not only to rural livelihoods but also to the state's agricultural economy (Gupta et. al, 2025f). Agri-tourism, a blend of agriculture and tourism, has emerged as a potent solution for rural economic development and diversification of income streams for farmers (Gupta et. al, 2025g). The Kisan Rail is a part of the Indian government's vision to enhance the infrastructure and supply chain for agriculture (Gupta et. al, 2025h). Agriculture is undergoing a significant transformation driven by the integration of data and technology (Gupta et. al, 2024b). India's agricultural sector, comprising around 16% of the country's GDP, sustains nearly 58% of the rural population and contributes significantly to the global food supply (Gupta et. al, 2024c). Climate-resilient horticulture focuses on practices that enable crops to withstand climate-induced stresses such as temperature fluctuations, drought, flooding, and changing pest and disease patterns (Gupta et. al, 2024d).
Banaskantha, located in North Gujarat, faces severe groundwater stress due to arid conditions and intensive agriculture/dairy farming. Groundwater is the primary source of drinking and irrigation.
Rapid population growth, over-extraction, and industrial/agricultural activities have led to declining water tables, increased salinity, and contamination in the region.

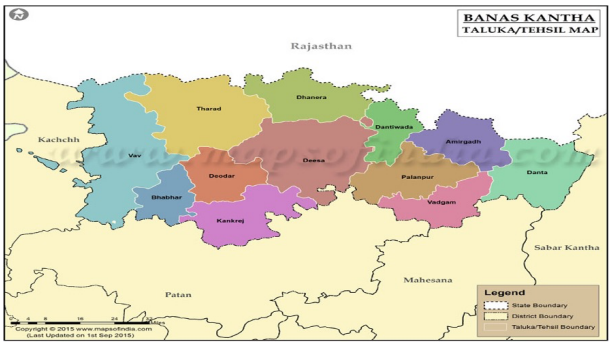
2. Study Area Description

Banaskantha district lies in the northwestern part of Gujarat and includes talukas such as Tharad, Vav, Vadgam, Deodar and Bhabhar. The region experiences low rainfall, high evaporation rates, and dependence on groundwater resources.

Key characteristics:

- Climate: Semi-arid to arid
- Average rainfall: ~500–600 mm/year
- Major water source: Groundwater (borewells and tube wells)

Soil type: Sandy and alluvial



3. Materials and Methods

3.1 Sampling Design

Study Area: Selected talukas of Banaskantha district.
Sampling: Groundwater samples (borewells, handpumps, open wells) collected during seasonal variations.
Parameters: Analysis of pH, Total Dissolved Solids (TDS), Hardness, Fluoride, Chloride and microbial quality (MPN) based on BIS standards.
Data Analysis:
Comparison with WHO/BIS standards to assess suitability for consumption and irrigation.

- Duration: March - 2025
- Sampling Locations: Multiple talukas including Tharad, Vav, Vadgam, Deodar and Bhabhar

3.2 Parameters Analyzed

Physicochemical Parameters:

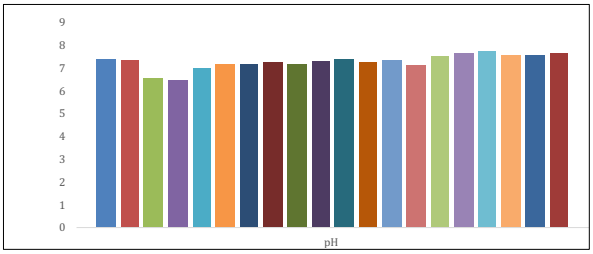
- pH
- TDS
- Electrical Conductivity (EC)
- Total Hardness
- Chloride
- Fluoride

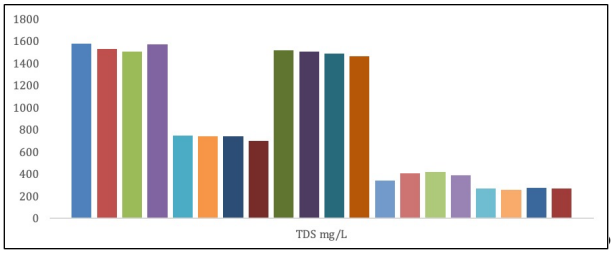
Microbiological Parameters:

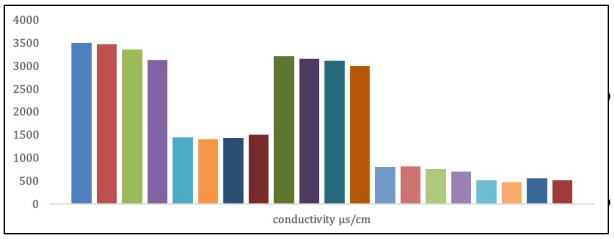
- Total coliform

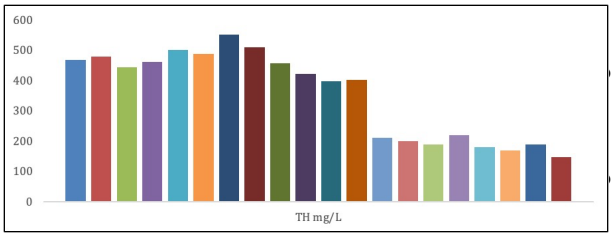
3.3 Analytical Methods

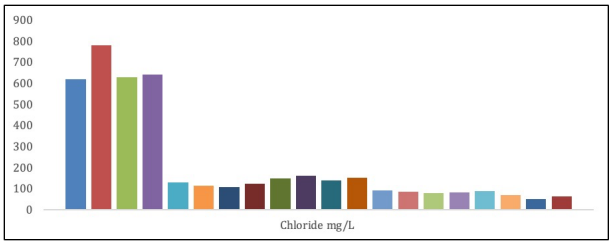
- Standard methods (APHA, WHO guidelines)
- Water Quality Index (WQI) calculation
- Statistical analysis (mean, correlation, PCA)

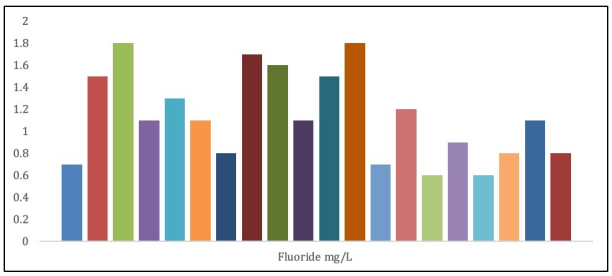


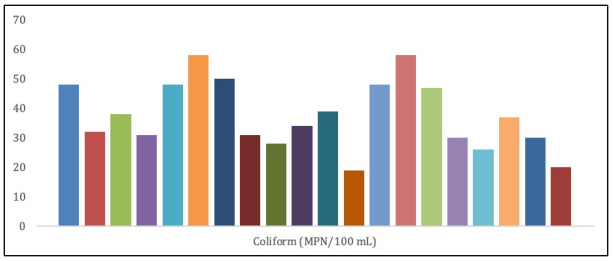












4. Results and Discussion

4.1 Physicochemical Characteristics

The study revealed considerable variation in groundwater quality across different locations.

- TDS values ranged from 250 to 1580 mg/L.
- EC reached up to 3500 µS/cm in some areas.
- Hardness levels exceeded 479 mg/L in sample.

High TDS and EC indicate salinity problems, making water unsuitable for drinking in many regions.

Furthermore, more than **80% of groundwater samples were found unsuitable for drinking** due to high salinity and mineralization .

High Salinity: Many areas, particularly Bhabhar and surrounding talukas, exhibit high TDS and electrical conductivity (EC), exceeding permissible limits.

Hardness & Fluoride: Elevated levels of calcium/magnesium hardness and fluoride are found in parts of the district.

Microbial Contamination: Some, but not all, sites show the presence of fecal coliforms, indicating sewage contamination.

Seasonal Dynamics: Water quality deteriorates significantly during pre-monsoon periods due to low water tables and concentration of salts.

Water Stress: The district lies in a heavily water-stressed zone where milk production alone requires massive water usage, impacting groundwater levels.

4.2 Microbial Contamination

Microbial analysis showed:

- Coliform counts ranged between 20 –58 MPN/100 mL.
- Most samples exceeded permissible drinking water limits.

This indicates contamination due to:

- Poor sanitation
- Leakage from septic systems
- Agricultural runoff

Such contamination poses serious risks of waterborne diseases.

4.3 Spatial Variability

Water quality varied significantly across talukas:

- **Vav, Bhabhar & Tharad:** High salinity and hardness
- **Vadgam:** Moderate contamination
- **Deodar :** Severe groundwater deterioration

This variability is influenced by:

- Geological formations
- Evaporation and ion exchange processes
- Anthropogenic activities

4.4 Environmental Health Implications

Poor water quality in Banaskantha has direct impacts on human health:

Contaminant	Health Impact
High TDS	Gastrointestinal issues
Hardness	Kidney stones
Chloride	Hypertension risk
Coliform bacteria	Waterborne diseases

Long-term consumption of contaminated water can lead to chronic illnesses and reduced quality of life.

4.5 Water Quality Index (WQI)

Based on WQI classification:

- 20% samples: Good quality
- 35% samples: Poor quality
- 45% samples: Unsuitable for drinking

This indicates an alarming decline in groundwater quality.

5. Causes of Water Quality Degradation

Major contributing factors include:

- Over-extraction of groundwater
- Agricultural fertilizers and pesticides
- Natural salinity due to arid climate
- Lack of wastewater management
- Climate change and reduced recharge

6. Management Strategies and Recommendations

6.1 Sustainable Water Management

- Rainwater harvesting
- Artificial recharge structures
- Check dams and percolation tanks

6.2 Water Treatment Measures

- Installation of RO and filtration systems
- Community-level water purification units

6.3 Policy and Awareness

- Regular monitoring programs
- Public awareness campaigns
- Implementation of water quality standards

Recent initiatives such as large-scale recharge wells and water conservation efforts in Banaskantha highlight the importance of community participation in improving water sustainability .

7. Conclusion

The study concludes that groundwater quality in Banaskantha district is significantly deteriorating due to both natural and anthropogenic factors. High salinity, hardness, and microbial contamination make a large portion of water unsuitable for drinking. Immediate interventions, including sustainable water management, treatment technologies, and policy implementation, are essential to safeguard environmental health and ensure water security in the region.

8. Acknowledgement

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