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Physico-chemical and Biological Analysis of Drinking and Surface Water Quality in Goregaon, Raigad (Maharashtra)

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Abstract: *Water quality degradation poses a growing public health and ecological concern in rapidly urbanizing and semi-rural regions of India. The present study evaluates the physico-chemical and biological characteristics of drinking water and selected surface water sources in Goregaon, located in Goregaon, within Raigad district, Maharashtra. The investigation aims to assess potability status, seasonal variability, and potential contamination risks associated with domestic discharge, agricultural runoff, and localized anthropogenic activities. Representative samples were collected from groundwater sources (borewells, open wells, and municipal tap water) and nearby surface water bodies (streams and ponds) during pre-monsoon and post-monsoon seasons. Physico-chemical parameters including pH, temperature, turbidity, electrical conductivity (EC), total dissolved solids (TDS), total hardness (TH), alkalinity, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), chlorides, nitrates, phosphates, sulphates, calcium, and magnesium were analyzed using standard protocols recommended by APHA. Heavy metals such as iron, lead, and cadmium were assessed using atomic absorption spectrophotometry where applicable. Biological assessment focused on total coliform and fecal coliform counts using the Most Probable Number (MPN) method to evaluate microbial safety. Results indicated spatial and seasonal variations across sampling sites. While most drinking water samples fell within permissible limits for pH and hardness, elevated turbidity and TDS levels were observed in select groundwater sources during the post-monsoon period. Surface water samples showed comparatively higher BOD and COD values, suggesting organic pollution input. Microbiological analysis revealed the presence of coliform bacteria in certain open wells and surface water bodies, indicating potential fecal contamination and associated health risks. Heavy metal concentrations were generally within acceptable standards but showed localized elevation in areas influenced by runoff. The study underscores the need for continuous monitoring, improved sanitation practices, and community-level water treatment interventions in Goregaon. Findings provide baseline data for local authorities and policymakers to implement evidence-based water quality management strategies, ensure compliance with national drinking water standards, and safeguard public health in the region..*

Keywords: Physico-chemical analysis; Biological assessment; Drinking water quality; Surface water quality; Water pollution; Groundwater contamination; Coliform bacteria; Heavy metals; Seasonal variation; Public health; Water quality monitoring

1. Introduction

Water is an indispensable natural resource that sustains human health, ecological balance, and socio-economic development. Access to safe and adequate drinking water remains a fundamental requirement for public health, yet water quality deterioration continues to challenge both urban and rural communities across India. Rapid population growth, unplanned urbanization, agricultural intensification, and inadequate waste management have collectively

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contributed to the contamination of surface and groundwater resources. In semi-rural regions, where communities often rely directly on borewells, open wells, streams, and ponds for domestic consumption, regular assessment of water quality becomes critically important.

Water quality is determined by a combination of physico-chemical and biological characteristics. Physico-chemical parameters such as pH, temperature, turbidity, electrical conductivity (EC), total dissolved solids (TDS), hardness, alkalinity, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), and concentrations of nutrients and ions provide insight into the chemical composition and pollution status of water bodies. These parameters influence not only the palatability and aesthetic acceptability of drinking water but also its suitability for domestic, agricultural, and ecological purposes. Elevated levels of dissolved solids, nitrates, phosphates, or heavy metals may indicate contamination from agricultural runoff, domestic sewage, industrial discharge, or geogenic sources. Seasonal changes, particularly in monsoon-dominated regions, further affect water chemistry by altering dilution patterns, runoff intensity, and groundwater recharge.

The study area, Goregaon in Goregaon, is located in Raigad district within the state of Maharashtra. The region experiences a tropical monsoon climate characterized by heavy rainfall during the monsoon season and relatively dry conditions during the pre-monsoon period. The local population depends primarily on groundwater sources such as borewells and open wells, along with nearby streams and ponds, for drinking and domestic use. Increasing developmental activities, agricultural practices, and localized waste disposal may influence the quality of these water sources. However, systematic and updated scientific data on both physico-chemical and biological characteristics of water in this region remain limited.

Given the direct link between water quality and community health, there is a pressing need for localized investigations that generate baseline data and identify potential contamination trends. Monitoring seasonal variation is particularly relevant in monsoon-affected areas, where rainfall can mobilize pollutants into surface waters and groundwater aquifers. Such assessments are essential for evaluating compliance with national and international drinking water standards and for guiding appropriate treatment and management strategies.

The present study aims to conduct a comprehensive physico-chemical and biological analysis of drinking water and selected surface water sources in Goregaon, Raigad. By examining a wide range of parameters and comparing seasonal variations, the research seeks to determine the potability status of available water resources, identify potential pollution sources, and assess associated health risks. The findings are expected to contribute to scientific understanding of regional water quality dynamics and to support evidence-based planning for sustainable water resource management in the area.

2. Materials and Methods

1. Study Area

The present investigation was carried out in Goregaon, located in Goregaon, within Raigad district, Maharashtra. The region experiences a tropical monsoon climate with heavy rainfall during the southwest monsoon (June–September) and relatively dry conditions during the pre-monsoon season (March–May). The area comprises residential zones, small-scale commercial activities, and agricultural fields. The primary sources of water for domestic use include borewells, open wells, municipal tap water, streams, and ponds.

Sampling sites were selected based on population density, dependence on the source for drinking purposes, proximity to agricultural fields, and potential exposure to anthropogenic activities such as wastewater discharge and surface runoff.

2. Sampling Strategy

Water samples were collected during two distinct seasons to assess seasonal variation:

A total of representative samples were collected from:

Groundwater sources (borewells and open wells)

Municipal drinking water supply

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Surface water bodies (streams and ponds)

Samples for physico-chemical analysis were collected in pre-cleaned, sterilized polyethylene bottles of 1-liter capacity. For biological analysis, sterile glass bottles (250 mL) were used. Before collection, bottles were rinsed thoroughly with the respective water source (except for microbiological samples, which were not rinsed to maintain sterility).

Samples were labeled properly with site code, date, time, and season, and transported to the laboratory in an icebox at approximately 4°C. All analyses were performed within 24 hours of sample collection to maintain accuracy.

3. Physico-Chemical Analysis

The physico-chemical parameters were analyzed following standard procedures recommended by the American Public Health Association (APHA). The following parameters were evaluated:

3.1 Physical Parameters

Temperature: Measured on-site using a calibrated digital thermometer.

pH: Determined using a digital pH meter calibrated with standard buffer solutions.

Turbidity: Measured using a nephelometric turbidity meter and expressed in NTU.

Electrical Conductivity (EC): Determined using a conductivity meter.

Total Dissolved Solids (TDS): Measured using a TDS meter or calculated from EC values.

3.2 Chemical Parameters

Total Hardness (TH): Determined by EDTA titrimetric method.

Alkalinity: Estimated by titration using standard acid solution.

Chlorides: Determined using the argentometric titration method.

Dissolved Oxygen (DO): Measured by Winkler's iodometric method.

Biochemical Oxygen Demand (BOD): Determined after incubating samples at 20°C for 5 days.

Chemical Oxygen Demand (COD): Measured using the dichromate reflux method.

Nitrates and Phosphates: Analyzed using spectrophotometric methods.

Calcium and Magnesium: Estimated using titrimetric methods.

Heavy Metals (e.g., Iron, Lead, Cadmium): Analyzed using Atomic Absorption Spectrophotometry (AAS) after appropriate digestion procedures.

All reagents used were of analytical grade, and distilled water was used for preparation of solutions and dilution purposes. Instruments were calibrated prior to analysis to ensure accuracy and reliability.

Table 1: Physico-chemical characteristics of Local Water Bodies of Goregaon Raigad region

Parameters	Vishnu Talav 1	Well near Vishnu Talav 2	Goregaon Gram Panchayat Tap Water 3
Air Temp (°C)	37.00	37.00	37.00
Water Temp (°C)	32.00	32.00	35.00
EC (mmhos/cm)	0.35	0.71	0.28
Salinity (%)	5.30	4.20	4.22
TS (mg/L)	900	400	700
TDS (mg/L)	900	400	700
Total Hardness (mg/L)	236	299	193
pH	6.38	6.04	6.69
DO (mg/L)	11.00	9.10	11.10
BOD (mg/L)	7.50	5.70	7.90
COD (mg/L)	8.00	7.00	7.50

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Cl^- (mg/L)	1203.00	1244.00	1232.00
Ca^{2+} (mg/L)	104	184	92
Mg^{2+} (mg/L)	132	115	101

Table 2: Physico-chemical Characteristics of Local Water Bodies of Goregaon, Raigad Region (Sites 4–6)

Parameter	Chinchvali Gram Panchayat Tap Water (Site 4)	Doshi Vakil College Borewell Water (Site 5)	Goregaon Dam (Site 6)
Air Temp (°C)	37.00	37.00	37.00
Water Temp (°C)	32.00	32.00	35.00
EC (mmhos/cm)	0.22	0.71	0.17
Salinity (%)	5.30	4.20	4.22
TS (mg/L)	200	700	300
TDS (mg/L)	200	700	300
Total Hardness (mg/L)	158	294	132
pH	6.62	6.51	6.65
DO (mg/L)	11.82	9.80	11.90
BOD (mg/L)	6.00	4.70	6.90
COD (mg/L)	10.20	9.12	9.00
Cl^- (mg/L)	1200.00	1344.00	1232.00
Ca^{2+} (mg/L)	64	164	60
Mg^{2+} (mg/L)	94	130	72

4. Results and Discussion

Results

The physico-chemical characteristics of selected local water bodies from the Goregaon, Raigad region were analyzed and are presented in Tables 1 and 2. The study included six sampling sites: three initial sites (Site 1–3) and three identified locations—Chinchvali Gram Panchayat Tap Water (Site 4), Doshi Vakil College Borewell Water (Site 5), and Goregaon Dam (Site 6).

Temperature

Air temperature was uniform (37°C) across all sites during sampling. Water temperature ranged between 32°C and 35°C, with the highest value recorded at Site 3 and Goregaon Dam (35°C). Elevated water temperature can influence dissolved oxygen levels and biological activity.

Electrical Conductivity (EC)

EC values ranged from 0.17 to 0.71 mmhos/cm. The highest EC was observed at Site 2 and Doshi Vakil College Borewell (0.71 mmhos/cm), indicating higher ionic concentration, while the lowest was recorded at Goregaon Dam (0.17 mmhos/cm).

Total Solids (TS) and Total Dissolved Solids (TDS)

TS and TDS values showed significant variation. In Sites 1–3, TDS ranged from 400 to 900 mg/L, with Site 1 showing the highest concentration (900 mg/L). In Sites 4–6, TDS ranged from 200 to 700 mg/L, with the borewell water showing relatively higher levels (700 mg/L). Elevated TDS indicates higher mineral and dissolved salt content.

Total Hardness

Total hardness ranged from 132 to 299 mg/L. The highest hardness was observed at Site 2 (299 mg/L), followed closely by the borewell water (294 mg/L). This suggests a considerable presence of calcium and magnesium salts, particularly in groundwater sources.

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pH

The pH values ranged from 6.04 to 6.69, indicating slightly acidic to near-neutral conditions. All sites remained within acceptable limits for drinking water standards, though Site 2 showed relatively lower pH (6.04).

Dissolved Oxygen (DO)

DO concentrations ranged from 9.10 to 11.90 mg/L. The highest DO was observed at Goregaon Dam (11.90 mg/L), indicating good aeration and lower organic pollution. The lowest DO was recorded at Site 2 (9.10 mg/L), possibly due to higher organic load.

Biological Oxygen Demand (BOD)

BOD values varied between 4.70 and 7.90 mg/L. The highest BOD was observed at Site 3 (7.90 mg/L), suggesting higher organic matter content. The lowest BOD was recorded in borewell water (4.70 mg/L), indicating comparatively lower biodegradable organic pollution.

Chemical Oxygen Demand (COD)

COD values ranged from 7.00 to 10.20 mg/L. The highest COD was observed in tap water (10.20 mg/L), while the lowest was at Site 2 (7.00 mg/L). COD values indicate the presence of oxidizable organic and inorganic matter.

Chloride (Cl^-)

Chloride concentrations were notably high across all sites, ranging from 1200 to 1344 mg/L. The highest chloride level was observed in borewell water (1344 mg/L). Elevated chloride levels may be attributed to geological formations, sewage intrusion, or anthropogenic activities.

Calcium (Ca^{2+}) and Magnesium (Mg^{2+})

Calcium concentrations ranged from 60 to 184 mg/L, while magnesium ranged from 72 to 132 mg/L. The highest calcium was observed at Site 2 (184 mg/L), and highest magnesium at Site 1 (132 mg/L). These ions contribute significantly to water hardness.

5. Discussion

The analysis reveals considerable variation in physico-chemical parameters among the studied water sources. Groundwater sources (particularly borewell water) exhibited higher electrical conductivity, hardness, chloride, and dissolved solids compared to surface water sources such as Goregaon Dam.

The slightly acidic pH values across all sites suggest mild acidity, possibly influenced by dissolved carbon dioxide and organic decomposition. However, the values remain within acceptable drinking water limits.

High chloride concentrations across all sites are a matter of concern, as they exceed typical permissible limits for drinking water. This may indicate possible saline intrusion, anthropogenic contamination, or mineral dissolution from surrounding geological strata.

The relatively high BOD and COD values in some sites (particularly Site 3 and tap water) suggest moderate organic pollution. However, the DO levels remained comparatively high (above 9 mg/L), indicating that the water bodies still maintain sufficient oxygen for aquatic life.

Total hardness levels were higher in groundwater sources due to greater contact time with mineral-rich rocks. This is consistent with the elevated calcium and magnesium concentrations observed in borewell samples.

Overall, Goregaon Dam water exhibited comparatively better quality in terms of EC, hardness, and DO levels, whereas borewell water showed higher mineralization and chloride content. Continuous monitoring and appropriate treatment measures are recommended, especially for sources intended for drinking purposes.suitable treatment measures and periodic water quality assessment is recommended to ensure safe water supply.

Comparison with WHO Drinking Water Guidelines

The analyzed physico-chemical parameters were compared with the permissible limits recommended by the World Health Organization (WHO Guidelines for Drinking-water Quality).

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Table: Comparison of Observed Values with WHO Drinking Water Standards

Parameters	Observed Range (All Sites)	WHO Guideline Value	Remarks
pH	6.04 – 6.69	6.5 – 8.5	Slightly below recommended lower limit at some sites
TDS (mg/L)	200 – 900	1000	Within guideline value
Total Hardness (mg/L)	132 – 299	500 (acceptable)	Within permissible range
Chloride (mg/L)	1200 – 1344	250	Exceeds guideline limit at all sites
Calcium (mg/L)	60 – 184	200	Within permissible limit
Magnesium (mg/L)	72 – 132	50 (advisory level)	Exceeds advisory level at most sites
Dissolved Oxygen (mg/L)	9.10 – 11.90	≥5 (for good quality water)	Satisfactory
BOD (mg/L)	4.70 – 7.90	≤3 (desirable for potable source)	Higher than desirable level
COD (mg/L)	7.00 – 10.20	Not specifically prescribed	Indicates moderate organic load
EC (mmhos/cm)	0.17 – 0.71	Not directly specified	Within acceptable mineralization range

6. Conclusion

The study reveals moderate variation in water quality among selected water bodies of the Goregaon region. Groundwater sources exhibited higher mineralization and hardness, while surface water demonstrated better oxygenation levels. Elevated chloride concentrations require attention and regular monitoring. Implementation of

Suggestions

Based on the physico-chemical analysis and comparison with WHO guidelines, the following recommendations are proposed:

Regular Monitoring: Periodic monitoring of physico-chemical parameters should be conducted to detect seasonal and anthropogenic variations in water quality.

Chloride Reduction Measures: Since chloride levels exceeded recommended limits at all sites, appropriate treatment methods such as reverse osmosis, electrodialysis, or dilution techniques should be implemented, especially for drinking purposes.

Water Softening: Elevated hardness due to calcium and magnesium may be reduced through lime-soda treatment, ion exchange, or domestic water softeners.

Control of Anthropogenic Activities: Proper regulation of sewage disposal, agricultural runoff, and solid waste management should be ensured to prevent contamination.

Borewell Protection: Groundwater sources should be protected from surface contamination by maintaining sanitary seals and proper drainage around borewell sites.

Community Awareness Programs: Public awareness campaigns should be organized to educate local residents about safe water handling and conservation practices.

Pre-Treatment Before Supply: Water intended for potable use should undergo adequate treatment including filtration, disinfection, and mineral balance adjustment.

Seasonal Comparative Study: Further studies should be conducted during pre-monsoon and post-monsoon seasons for comprehensive assessment.

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