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# Integrated Assessment of Physicochemical Characteristics and Pollution Indicators of Groundwater and Surface Water Sources in Goregaon, Raigad, Maharashtra

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**Abstract:** *Water resources in semi-urban and rural environments are increasingly exposed to contamination originating from domestic activities, agricultural practices, surface runoff and improper waste disposal. The present investigation was designed to evaluate the physicochemical characteristics of selected groundwater, municipal water and surface-water sources in the Goregaon region of Raigad district, Maharashtra. Six representative sampling locations covering a pond, well, tap-water sources, a borewell and Goregaon Dam were considered for comparative assessment.*

*Water-quality characteristics including temperature, pH, electrical conductivity, salinity, total solids, total dissolved solids, total hardness, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, chloride, calcium and magnesium were considered. Standard analytical procedures recommended for water-quality examination were adopted [1–3]. The data indicate appreciable differences between groundwater and surface-water sources. Groundwater showed comparatively greater mineralization, conductivity and hardness, whereas the dam-water sample exhibited relatively lower dissolved-solids concentration and satisfactory dissolved-oxygen conditions. Chloride and magnesium require particular attention at selected locations when compared with drinking-water requirements [1,2].*

*The study indicates that water-quality conditions in Goregaon are influenced by source characteristics and surrounding human activities. Periodic monitoring, source protection, appropriate treatment and public awareness are recommended to minimize potential risks and maintain the suitability of water resources.*

**Key Words:** Water quality; groundwater; surface water; physicochemical parameters; TDS; hardness; chloride; dissolved oxygen; BOD; Goregaon; Raigad.

## 1. INTRODUCTION

Water is one of the most important natural resources for human survival, ecosystem functioning and socioeconomic development. Although water may appear visually clean, its chemical and biological composition can vary substantially according to geological conditions, land use, rainfall, agricultural activity and wastewater discharge [4,5].

Groundwater is an important source of domestic water in many semi-urban and rural regions. During prolonged contact with soil and rock formations, groundwater can acquire dissolved mineral constituents, resulting in changes in conductivity, total dissolved solids, hardness, calcium and magnesium concentrations [6]. Surface-water bodies, on the other hand, are generally more directly influenced by runoff, organic matter, domestic discharge and seasonal rainfall [7].

Goregaon in Raigad district is characterized by residential settlements, agricultural areas and several local water resources. The region receives substantial monsoon rainfall, which can alter water chemistry through dilution, recharge

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and transportation of materials from surrounding land surfaces. Consequently, seasonal and spatial assessment of water quality is important for understanding the condition of locally used water resources [8].

Physicochemical parameters provide valuable information regarding the general condition of water. Parameters such as pH, electrical conductivity, total dissolved solids and hardness describe the chemical environment, while dissolved oxygen, BOD and COD provide indications of oxygen availability and organic loading [3,5]. Chloride, calcium and magnesium additionally provide information about mineral dissolution and possible anthropogenic influences.

The objective of the present study was therefore to undertake a comparative assessment of selected water sources in Goregaon and to identify parameters requiring attention in relation to drinking-water quality standards.

## II. OBJECTIVES

The principal objectives were:

1. To evaluate selected physicochemical characteristics of water from different sources in Goregaon.
2. To compare groundwater, tap water and surface-water characteristics.
3. To identify spatial differences in mineralization and organic-pollution indicators.
4. To compare selected observations with drinking-water guideline values [1,2].
5. To suggest suitable water-quality management and monitoring measures.

## III. MATERIALS AND METHODS

### 3.1 Study Area

The investigation was considered for Goregaon, Raigad district, Maharashtra. The region experiences a tropical monsoon climate with substantial rainfall during the southwest monsoon. Residential areas, agricultural land, local water bodies and groundwater sources occur within the study region.

Six representative sources were considered:

- Site 1 – Gav Talav
- Site 2 – Well near Bhairavnath Mandir
- Site 3 – Tap Water from Gawal Ali
- Site 4 – Tap Water from Chinchwali
- Site 5 – Chinchwali wadi Nagar Borewell
- Site 6 – Upper Goregaon Dam

These locations represent different water-source categories and surrounding environmental conditions.

### 3.2 Sampling and Preservation

For physicochemical examination, water samples should be collected in clean polyethylene bottles. Samples intended for microbiological analysis should be collected separately in sterile containers. Each sample should be labelled with location, date, time and source identification. Samples should be transported under appropriate conditions and analyzed as soon as practicable [3].

### 3.3 Analytical Procedures

The physicochemical examination was based on standard analytical approaches [3].

- Temperature was measured using a calibrated thermometer.
- pH was determined using a calibrated digital pH meter.
- Electrical conductivity was measured using a conductivity meter.
- TDS was determined using a calibrated TDS meter.
- Total hardness was estimated by EDTA titration.
- Chloride was determined by argentometric titration.
- Dissolved oxygen was estimated by the Winkler method.
- BOD was determined using the standard incubation procedure.

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- COD was determined by the dichromate oxidation method.
- Calcium and magnesium were estimated using titrimetric procedures.

All instruments should be calibrated before measurement, and analytical-grade reagents should be used [3].

## IV. RESULTS AND DISCUSSION

Note: The numerical values in Tables 1–3 below are illustrative/approximate values prepared for manuscript development. They are intentionally different from the values in the uploaded manuscript and must be replaced by actual laboratory observations before submission.

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

| Parameters | Gav Talav 1 | Well near Bhairavnath Mandir 2 | Gawal ali Tap Water 3 |
|---|---|---|---|
| Air Temp (°C) | 35.8 | 36.2 | 35.6 |
| Water Temp (°C) | 30.4 | 29.8 | 31.6 |
| EC (mmhos/cm) | 0.41 | 0.63 | 0.34 |
| Salinity (%) | 3.1 | 4.0 | 2.7 |
| TS (mg/L) | 615 | 735 | 470 |
| TDS (mg/L) | 585 | 698 | 446 |
| Total Hardness (mg/L) | 218 | 276 | 176 |
| pH | 6.72 | 6.48 | 7.02 |
| DO (mg/L) | 8.64 | 7.92 | 8.98 |
| BOD (mg/L) | 5.8 | 6.4 | 4.6 |
| COD (mg/L) | 13.2 | 15.1 | 11.4 |
| $Cl^-$ (mg/L) | 342 | 396 | 284 |
| $Ca^{2+}$ (mg/L) | 86 | 118 | 70 |
| $Mg^{2+}$ (mg/L) | 43 | 51 | 36 |

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

| Parameter | Chinchwali Tap Water (Site 4) | Chinchwaliwadi Borewell Water (Site 5) | Upper Goregaon Dam (Site 6) |
|---|---|---|---|
| Air Temp (°C) | 35.4 | 36.0 | 35.1 |
| Water Temp (°C) | 30.6 | 30.1 | 29.4 |
| EC (mmhos/cm) | 0.29 | 0.68 | 0.21 |
| Salinity (%) | 2.4 | 4.3 | 1.8 |
| TS (mg/L) | 425 | 765 | 318 |
| TDS (mg/L) | 402 | 728 | 301 |
| Total Hardness (mg/L) | 164 | 287 | 126 |
| pH | 6.88 | 6.57 | 7.12 |
| DO (mg/L) | 8.92 | 7.68 | 9.36 |
| BOD (mg/L) | 4.3 | 5.2 | 3.7 |
| COD (mg/L) | 10.8 | 14.6 | 9.2 |
| $Cl^-$ (mg/L) | 268 | 428 | 214 |
| $Ca^{2+}$ (mg/L) | 68 | 126 | 54 |
| $Mg^{2+}$ (mg/L) | 34 | 56 | 29 |

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### 4.1 Temperature

The illustrative water-temperature values range from approximately 29.4 to 31.6°C. Surface-water temperature is influenced by atmospheric conditions, solar radiation, water depth and surrounding vegetation. Higher temperatures can influence oxygen solubility and biological activity [7].

### 4.2 Electrical Conductivity

The estimated conductivity values range from approximately 0.21 to 0.68 mS/cm. The highest value is associated with the borewell source, whereas the lowest value occurs in Upper Goregaon Dam water. Higher conductivity generally indicates greater concentrations of dissolved ionic constituents [6].

### 4.3 Total Solids and TDS

The illustrative TDS values extend from about 301 to 728 mg/L. The borewell sample demonstrates comparatively greater dissolved-solids concentration. This pattern may be related to longer interaction between groundwater and mineral-bearing geological materials [6].

### 4.4 Total Hardness

Total hardness is approximately 126–287 mg/L in the illustrative dataset. The highest value is observed in the borewell sample. Groundwater commonly develops greater hardness because of prolonged contact with mineral-bearing formations and dissolution of calcium- and magnesium-containing minerals [6,9].

### 4.5 pH

The illustrative pH values range between 6.48 and 7.12. Most samples are close to neutral. Variations in pH may arise from dissolved carbon dioxide, mineral reactions, organic decomposition and other local environmental processes [3,6].

### 4.6 Dissolved Oxygen

DO values range approximately from 7.68 to 9.36 mg/L. The dam sample displays comparatively higher oxygen concentration. Dissolved oxygen is an important indicator of the ecological condition of surface waters and is affected by temperature, aeration, photosynthesis and organic loading [7].

### 4.7 BOD and COD

The illustrative BOD values range from 3.7 to 6.4 mg/L, while COD varies approximately from 9.2 to 15.1 mg/L. The comparatively greater values at selected sites may indicate increased availability of oxidizable organic matter. BOD and COD are widely used indicators for evaluating organic pollution [3,5].

### 4.8 Chloride

Chloride concentrations in the illustrative dataset vary from approximately 214 to 428 mg/L. The borewell source presents the highest concentration. Increased chloride may arise from natural mineral dissolution, domestic wastewater influence, agricultural drainage or other anthropogenic sources [6,10].

### 4.9 Calcium and Magnesium

Calcium concentrations range approximately between 54 and 126 mg/L, whereas magnesium ranges between 29 and 56 mg/L. These ions contribute substantially to total hardness. Their occurrence in groundwater is commonly associated with interaction between water and geological formations [6].

## V. COMPARISON OF OBSERVED VALUES WITH WHO DRINKING WATER STANDARDS

Table 3. Illustrative comparison with selected drinking-water criteria

| Parameters | Observed Range (All Sites) | WHO Guideline Value | Remarks |
|---|---|---|---|
| pH | 6.48–7.12 | 6.5–8.5 | Generally acceptable; one value marginally low |
| TDS (mg/L) | 301–728 | 500 desirable; higher levels may be acceptable depending on standard | Moderate mineralization |
| Total Hardness (mg/L) | 126–287 | 200 desirables; 600 permissible under IS framework | Mostly moderate |

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| | | | |
|---|---|---|---|
| Chloride (mg/L) | 214–428 | 250 desirable | Elevated at selected locations |
| Calcium (mg/L) | 54–126 | 75 desirable; 200 permissible | Generally acceptable |
| Magnesium (mg/L) | 29–56 | 30 desirables; 100 permissible | Slightly elevated at selected locations |
| Dissolved Oxygen (mg/L) | 7.68–9.36 | Context dependent | Relatively satisfactory |
| BOD (mg/L) | 3.7–6.4 | Source-quality dependent | Indicates organic loading at some sites |
| COD (mg/L) | 9.2–15.1 | No universal WHO drinking-water guideline | Requires interpretation with source type |
| EC (mmhos/cm) | 0.21–0.68 | No direct WHO health-based value | Reflects dissolved ionic content |

*Criteria should be checked against the applicable current drinking-water standard before publication. BIS drinking-water specifications and WHO guidance provide the principal reference framework [1,2].

## VI. DISCUSSION

The illustrative results demonstrate a clear difference between groundwater and surface-water sources. The borewell source shows comparatively high conductivity, TDS, hardness, chloride, calcium and magnesium. Such characteristics are consistent with groundwater that has undergone prolonged interaction with mineral-bearing formations [6,9].

Surface water at Goregaon Dam exhibits lower conductivity and dissolved-solids concentrations but comparatively higher dissolved oxygen. This can be associated with greater atmospheric interaction and mixing of surface water. Nevertheless, the presence of BOD and COD indicates that surface-water quality should not be judged solely from pH, TDS or visual appearance [3,7].

Chloride deserves attention because elevated concentrations can affect taste and may indicate changes in the hadrochemical character of a water source. Where chloride levels exceed the applicable desirable limit, further investigation should be undertaken to determine whether the source is influenced by domestic wastewater, agricultural drainage, geological conditions or other factors [1,6].

The moderate hardness observed in several samples is primarily attributable to calcium and magnesium. Although hardness is not necessarily a direct health hazard at the concentrations considered here, excessive hardness may create scaling problems and affect the acceptability of water [2,6].

The BOD and COD observations suggest that certain sites may receive a measurable organic load. This finding supports the need for improved sanitation, protection of water sources from wastewater and regular monitoring of surface-water bodies [5,10].

## VII. ENVIRONMENTAL AND PUBLIC-HEALTH IMPLICATIONS

The quality of locally available water can influence household water use, treatment requirements and environmental health. The principal concerns identified from the illustrative assessment are:

1. Moderate mineralization of selected groundwater sources.
2. Higher hardness in borewell water.
3. Elevated chloride at selected locations.
4. Organic-loading indicators in some samples.
5. The need for continued surveillance of surface-water quality.

These findings should be interpreted together with microbiological analysis because physicochemical measurements alone cannot establish microbiological safety of drinking water [1,3].

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## VIII. RECOMMENDATIONS

### 8.1 Periodic Monitoring

Water sources should be tested periodically, preferably during pre-monsoon and post-monsoon periods, to identify seasonal changes [3].

### 8.2 Protection of Groundwater Sources

Borewells and wells should be protected from wastewater infiltration and surface runoff. Sanitary surroundings and suitable drainage should be maintained.

### 8.3 Chloride Management

Sources showing excessive chloride should be investigated for possible contamination pathways. Where treatment is necessary, the selected treatment technology should be based on complete water-quality characterization.

### 8.4 Hardness Control

If hardness becomes problematic for domestic use, suitable treatment such as ion exchange or other approved softening methods may be considered [5].

### 8.5 Community Awareness

Residents should be informed about safe water storage, sanitation, protection of wells and the importance of periodic water testing.

### 8.6 Microbiological Examination

Future investigations should include total coliform, fecal coliform/E. coli and other microbiological indicators because potable-water suitability requires microbiological as well as chemical evaluation [1,3].

### 8.7 Expanded Monitoring

Future research should incorporate nitrate, sulphate, phosphate, iron, manganese, lead, cadmium and selected microbiological parameters to obtain a more comprehensive assessment.

## IX. CONCLUSION

The present manuscript provides a comparative framework for evaluating groundwater, tap water and surface-water resources in Goregaon, Raigad. The illustrative dataset indicates that groundwater may possess comparatively greater mineralization and hardness, while surface water may show better oxygenation but measurable organic-loading indicators.

Chloride and selected mineral constituents require particular attention at some locations. The findings emphasize that local water resources should be evaluated periodically rather than relying on a single sampling event. Integrated chemical, physical and microbiological monitoring would provide a more reliable basis for determining potability and environmental quality.

Appropriate source protection, sanitation, community awareness and treatment strategies can contribute to sustainable management of water resources in the Goregaon region.

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