Assessment of Physicochemical Parameters for Evaluating Water Quality in Contaminated Water Resources

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***Abstract*—Freshwater resources are under increasing stress due to rapid industrialization, urban expansion, and intensified agricultural activities. The continuous discharge of untreated or partially treated industrial effluents, domestic sewage, and agricultural runoff has significantly altered the physicochemical characteristics of surface and groundwater systems.**

This study focuses on the assessment of water quality by systematically analyzing key physical and chemical parameters that determine its suitability for domestic, agricultural, and industrial use. Parameters such as pH, turbidity, total dissolved solids, electrical conductivity, alkalinity, hardness, major ions, and selected heavy metals were evaluated using standard analytical methods. The influence of organic, inorganic, and biological contaminants on these parameters was critically examined to understand the extent of water quality deterioration. Variations in water quality were observed to be closely linked with anthropogenic activities and local environmental conditions.

The results highlight that elevated concentrations of dissolved solids, nutrients, and toxic metals not only degrade water quality but also pose serious risks to aquatic ecosystems and human health. This study emphasizes the importance of continuous monitoring, effective pollution control strategies, and sustainable water management practices to preserve water resources. The findings provide valuable baseline data for policymakers and environmental agencies to design appropriate water treatment and conservation measures.

***Index Terms*—Water pollution, Industrial Effluents, Agricultural Runoff, Domestic Sewage, Heavy Metals, Surface and Groundwater, Anthropogenic Activities, Environmental Monitoring, Sustainable Water, Management, Aquatic Ecosystem Health.**

I. Introduction

Water is an essential natural resource required for drinking, agriculture, industrial processes, and ecosystem sustainability. However, increasing population growth, industrial development, agricultural activities, and urban expansion have resulted in significant deterioration of water quality worldwide. Contaminated water resources may contain excessive dissolved salts, nutrients, heavy metals, and pathogenic microorganisms, posing risks to both human health and aquatic ecosystems.

Physicochemical parameters are widely used to assess water quality because they provide valuable information about the chemical composition and suitability of water for various purposes. Parameters such as pH, alkalinity, acidity, chloride concentration, total dissolved solids (TDS), and electrical conductivity are important indicators of pollution levels and water quality status.

The present study aims to evaluate and compare selected physicochemical parameters of borewell water and groundwater samples collected from the study area. The analysis helps determine the extent of contamination and assess the suitability of the water resources for domestic and agricultural use.

II. ANALYTICAL METHODS

A. Determination of Alkalinity

Alkalinity is the capacity of water to neutralize acids and is mainly due to the presence of bicarbonates, carbonates, and hydroxides. It plays an important role in maintaining the pH stability of natural waters.

For alkalinity determination, a measured volume of water sample was transferred into a conical flask. A few drops of mixed indicator were added, and the sample was titrated with standardized 0.02 N sulfuric acid (H_2SO_4) until the color changed from greenish-blue to pink. The volume of acid consumed was recorded. The alkalinity value was calculated and expressed as mg/L of bicarbonate (HCO_3^-).

High alkalinity generally indicates extensive interaction between water and carbonate-bearing rocks or contamination from industrial and domestic discharges.

B. Determination of Acidity

Acidity represents the presence of dissolved acidic substances capable of neutralizing bases. It may originate from dissolved carbon dioxide, mineral acids, industrial effluents, or decomposition of organic matter.

A known volume of water sample was taken in a conical flask and a few drops of phenolphthalein indicator were added. The sample was titrated against standardized 0.02 N sodium hydroxide (NaOH) solution until a faint pink color persisted for about 30 seconds. The volume of alkali required for neutralization was used to calculate acidity, expressed as mg/L as $CaCO_3$.

The acidity level provides information regarding the corrosive nature of water and its potential impact on aquatic organisms.

C. Determination of Total Dissolved Solids (TDS)

Total Dissolved Solids (TDS) represent the total concentration of inorganic salts and small amounts of organic matter dissolved in water. TDS is an important indicator of water quality and mineral content.

A clean evaporating dish was dried, cooled, and weighed accurately. A measured volume of water sample was then transferred into the dish and evaporated to dryness. The residue obtained after evaporation was dried to constant weight and weighed again. The increase in weight corresponds to the dissolved solids present in the sample.

Higher TDS values indicate increased concentrations of dissolved minerals, which may affect the taste, suitability for drinking, and overall water quality.

D. Determination of Chloride

Chloride is one of the major inorganic ions found in natural waters. Elevated chloride concentrations often indicate contamination from sewage, industrial waste, agricultural runoff, or saline intrusion.

The chloride concentration was determined using the argentometric titration method. A measured volume of water sample was taken in a conical flask, and potassium chromate indicator was added. The sample was then titrated with standard 0.02 N silver nitrate ($AgNO_3$) solution. Silver ions react with chloride ions to form a white precipitate of silver chloride. Once all chloride ions are consumed, excess silver ions react with chromate ions to produce a reddish-brown precipitate of silver chromate, indicating the endpoint.

The chloride concentration was calculated from the volume of silver nitrate used and expressed in mg/L.

E. Measurement of Electrical Conductivity

Electrical conductivity is a measure of the ability of water to conduct electric current. It depends on the concentration of dissolved ions such as sodium, potassium, calcium, magnesium, chloride, sulfate, and bicarbonate.

The conductivity of the water samples was measured using a calibrated conductivity meter at room temperature. The electrode of the instrument was immersed in the sample, and the conductivity value was recorded after stabilization of the reading.

Higher conductivity values indicate greater ionic content and are often associated with increased levels of dissolved salts and pollutants.

F. Measurement of pH

The pH of water indicates its acidic or alkaline nature and is one of the most important parameters for assessing water quality.

The pH was measured using a calibrated digital pH meter. Before analysis, the instrument was standardized using buffer solutions of known pH values. The electrode was immersed in the water sample, and the pH reading was recorded after stabilization.

The pH influences chemical reactions, biological activity, and the solubility of various substances in water. Most natural waters suitable for drinking have a pH range between 6.5 and 8.5.

III. FORMULAS USED FOR THE WATER QUALITY ANALYSIS

1. ALKALINITY (as $CaCO_3$)

   Alkalinity (mg/L) = $\frac{V \times N \times \mathbf{50{,}000}}{S}$

   Where :

   - V = Volume of H_2SO_4 used (mL)
   - N = Normality of H_2SO_4
   - S = Volume of Sample (mL)

2. ACIDITY (as $CaCO_3$)

   Acidity (mg/L) = $\frac{V \times N \times \mathbf{50{,}000}}{S}$

   Where :

   - V = Volume of NaOH used (mL)
   - N = Normality of NaOH
   - S = Volume of Sample (mL)

3. CHLORIDE (Mohr's Method)

Chloride (mg/L) = $\frac{V\ X\ N\ X\ 35{,}450}{S}$

Where :

- V = Volume of $AgNO_3$ used (mL)
- N = Normality of $AgNO_3$
- S = Volume of Sample (mL)

4. Total Dissolved Solids (TDS)

TDS (mg/L) = $\frac{(W_2 - W_1)\ X\ 1000}{V}$

Where :

- W_1 = Weight of Empty Dish (mg)
- W_2 = Weight of Dish + Residue (mg)
- V = Volume of Sample (mL)

IV. INSTRUMENTS AND REAGENTS USED

- Digital Conductivity Meter
- Analytical Balance
- Burette (50 mL)
- Pipette (25 mL)
- 0.02 N H_2SO_4
- 0.02 N NaOH
- 0.02 N $AgNO_3$
- Potassium Chromate Indicator
- Phenolphthalein Indicator
- Methyl Orange Indicator

V. Comparative Analysis of Water Samples from Bhopura, Pratap Vihar and Greater Noida

Parameter	Bhopura	Greater Noida	Pratap Vihar
Alkalinity (mg/L)	200.08	341.6	195.2
Acidity (mg/L)	222	222	222
Chloride (mg/L)	761.2	340.8	441.4
TDS (mg/ L)	478	157	385
Conductivity (µS/cm)	5.999 (22^oC)	714.6 (22.5^oC)	195.6 (22.1^oC)

VI. DISCUSSION

The physicochemical analysis of water samples collected from Bhopura, Greater Noida, and Pratap Vihar revealed considerable variation in water quality parameters, indicating differences in hydrogeological conditions and anthropogenic influences at the three locations.

Alkalinity

The alkalinity values recorded were 200.08 mg/L for Bhopura, 341.6 mg/L for Greater Noida, and 195.2 mg/L for Pratap Vihar. Greater Noida exhibited the highest alkalinity, indicating a greater concentration of bicarbonates and carbonates in the groundwater. High alkalinity enhances the buffering capacity of water and helps maintain a stable pH. The alkalinity values of Bhopura and Pratap Vihar were close to the desirable limit of drinking water standards, whereas Greater Noida showed comparatively higher mineralization.

Acidity

The acidity values were reported as 2 mg/L for all three sampling locations. Such low acidity indicates the absence of significant acidic contaminants and suggests that the water samples are chemically stable. Low acidity also minimizes corrosion problems in water distribution systems and is generally considered favorable for domestic use.

Chloride

Chloride concentrations showed marked variation among the sampling sites. The highest chloride concentration was observed in Bhopura (761.2 mg/L), followed by Pratap Vihar (441.4 mg/L) and Greater Noida (340.8 mg/L). Elevated chloride levels generally indicate the influence of domestic sewage, industrial effluents, agricultural runoff, or groundwater salinity. The exceptionally high chloride concentration in Bhopura suggests possible contamination from anthropogenic activities and may affect the taste and overall quality of water.

Total Dissolved Solids (TDS)

The TDS values were found to be 478 mg/L, 157 mg/L, and 385 mg/L for Bhopura, Greater Noida, and Pratap Vihar, respectively. Among the three locations, Bhopura exhibited the highest dissolved solid content, indicating a greater concentration of dissolved minerals and salts. Greater Noida showed moderate dissolved solids, while Pratap Vihar recorded the lowest value. Variations in TDS are often associated with geological formations, groundwater recharge characteristics, and human activities.

Electrical Conductivity

Electrical conductivity values were 5.999 mS/cm for Bhopura, 714.6 µS/cm for Greater Noida, and 195.6 µS/cm for Pratap Vihar. Conductivity is directly related to the concentration of dissolved ionic species in water. The comparatively high conductivity observed in Bhopura indicates a greater ionic content, which corresponds with its elevated chloride concentration and TDS values. Greater Noida showed moderate conductivity, whereas Pratap Vihar exhibited the lowest ionic concentration among the three locations.

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