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Assessment of Physicochemical Parameters of Groundwater in Various Districts of Tamil Nadu

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Abstract: Groundwater is one of the most important sources of drinking water for human populations. Rapid urbanization, industrialization, and agricultural activities have significantly affected groundwater quality in many regions. This study focuses on the assessment of groundwater quality by evaluating various physicochemical parameters to determine its suitability for domestic and agricultural purposes. Groundwater contamination occurs when harmful substances such as industrial chemicals, fertilizers, pesticides, sewage, and landfill leachate enter underground aquifers. These pollutants alter the natural characteristics of water and reduce its quality. Once groundwater becomes polluted, it is very difficult to restore due to the slow movement of water beneath the Earth's surface. In this study, groundwater samples were collected from six different locations in Tamil Nadu. The collected samples were analyzed for physical and chemical parameters such as colour, odour, temperature, turbidity, total hardness, chloride, fluoride, and residual chlorine. These parameters help determine water quality and suitability for drinking purposes.

The results showed variations in groundwater quality among sampling locations. Some samples showed higher hardness and chloride levels due to mineral dissolution and environmental conditions. However, most parameters were within acceptable limits. Regular monitoring of groundwater quality is necessary to ensure safe water supply and protect water resources for future generations.

I. INTRODUCTION

Water pollution refers to the contamination of water bodies such as rivers, lakes, ponds, oceans, and groundwater by harmful substances that degrade the physical, chemical, and biological quality of water. These pollutants may be solid, liquid, or gaseous and usually enter water sources through human activities such as domestic sewage discharge, industrial effluents, agricultural runoff, and improper waste disposal.

Polluted water becomes unsafe for drinking, cooking, bathing, and other domestic purposes, and it can cause serious health problems. It also changes the color, taste, and odor of water and affects aquatic ecosystems by reducing dissolved oxygen levels, which harms fish and other aquatic organisms.

Excess nutrients from fertilizers may lead to eutrophication, causing rapid algal growth and further depletion of oxygen in water bodies. The major sources of water pollution include domestic sewage, industrial wastewater, agricultural chemicals, solid waste, oil spills, and mining activities.

Untreated sewage contains organic matter and disease-causing microorganisms that spread waterborne diseases such as cholera, typhoid, and dysentery. Industrial effluents often contain toxic chemicals like acids, dyes, solvents, and heavy metals that are harmful to both humans and aquatic life.

Agricultural runoff carries fertilizers and pesticides into nearby water bodies, resulting in chemical pollution and nutrient enrichment. Thermal pollution from industries and power plants, as well as atmospheric deposition such as acid rain, also contribute to water contamination.

Groundwater pollution occurs when harmful substances enter underground water stored in aquifers. These contaminants may come from natural sources like minerals in rocks or from human activities such as agricultural practices, industrial waste disposal, leakage from underground storage tanks, landfill leachate, and untreated sewage. Since groundwater moves slowly, pollutants can remain for long periods and spread over large areas. Contaminated groundwater poses serious risks to human health, causing diseases and long-term health problems. Preventing groundwater pollution through proper waste management, controlled use of fertilizers and pesticides, and regular monitoring of water quality is essential to protect water resources and ensure safe water for future generations.

II. MATERIALS AND METHODS

Section	Details
Sampling Locations	Groundwater samples were collected from six districts of Tamil Nadu: Madurai, Thiruvannamalai, Coimbatore, Kodaikanal, Karur, and Sivagangai.
Sample Collection	Approximately one litre of water was collected from bore wells and groundwater sources using clean polyethylene bottles. The bottles were washed thoroughly before sampling.
Physical Examination	The collected samples were analysed for colour, odour, temperature, and turbidity.
Chemical Analysis	Chemical parameters analysed include total hardness, chloride, fluoride, and residual chlorine using standard laboratory methods.

Fig1. Collected water samples

A. *Total Hardness*

1) *Principle: The total hardness of groundwater is mainly due to the presence of calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions. This test is based on complexometric titration using EDTA (Ethylenediaminetetraacetic acid).*
2) *Procedure: Take 25 ml of water sample in the test bottle. Add 10 drops of Total Hardness reagent -2 and mix. Add few specs of Total Hardness reagent -1 and mix until a distinct pink colour develops .For Hard water, add Total hardness reagent -3, shake well after 3 drop until the colour changes. From pink to blue count the number of drop.*
3) *Calculation:* Total Hardness = no. of drops*5 (p.p.m. in terms of $CaCO_3$)

B. *Fluoride content*

1) Principle: Fluoride decolourises the Zirconium alizarin complex and the decolourisation is proportional to fluoride concentration. As the fluoride concentration increases, the reddish colour changes to yellow.
2) Procedure: Take 5 ml of water sample in the test tube. Shake well the fluoride reagent and then add 5 drops of the water sample. Mix the content. The colour that forms is compared with the Fluoride colour chart and record the fluoride value.

C. *Chloride content*

1) Principle: In this test, chloride ions present in the water sample react with Chloride Reagent-1 to produce a yellow colour, indicating the presence of chloride. On gradual addition of Chloride Reagent-2, the reagent reacts first with the chloride ions. Once all the chloride ions are consumed, a further drop of Chloride Reagent-2 causes a colour change from yellow to red, which indicates the end point of the reaction. The number of drops of Chloride Reagent-2 required for the colour change is directly proportional to the concentration of chloride ions present in the water sample and is used to calculate the chloride content of the sample (mg/L).
2) Procedure: Take 25 ml of water sample in the test bottle. Add 5 drops of Chloride reagent -1 and mix well until a distinct yellow colour develops.Add Chloride reagent -2, shake well after each drop until the colour changes from yellow to red. Count the no. of drops of chloride reagent – 2 requires for colour change. Calculation : Chloride mg/l= No. of drops*10.

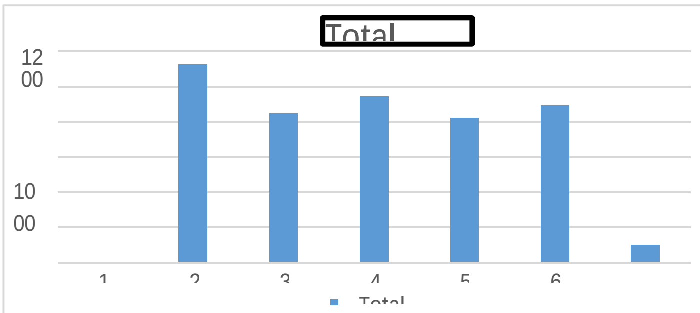
D. Residual chlorine content

1) Principle: Residual chlorine present in the water sample reacts with Residual Chlorine Reagent-1 to form a yellow-coloured compound. The intensity of the colour produced is directly proportional to the concentration of residual chlorine in the sample. The developed colour is visually compared with a standard residual chlorine colour chart, and the corresponding chlorine concentration is recorded (usually in mg/L or ppm).
2) Procedue: Take 5 ml of water sample in the test tube. Add 5 drops of Residual chlorine reagent -1 and mix well. The colour that forms is compared with the Residual chlorine colour chart and record the Residual chlorine value.

III. RESULTS AND DISCUSSION

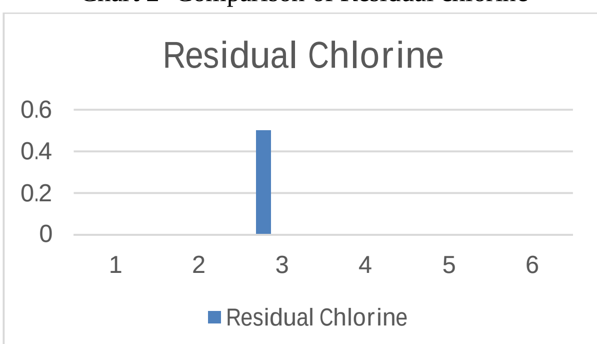
Physical examination showed that all water samples were colourless and odourless, indicating no visible contamination.
Temperature varied slightly between locations due to climatic differences.
Chemical analysis showed variations in total hardness, chloride, and fluoride, residual chlorine levels. Some samples had higher hardness due to dissolved calcium and magnesium salts. Residual chlorine was detected only in one sample indicating disinfection. Chloride variations may be due to geological conditions or agricultural activities. Overall, groundwater quality varies depending on environmental and geological factors.

Chart 1- Comparison of Total Hardness in the sample taken



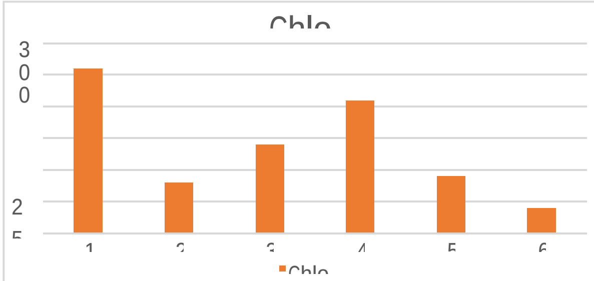
The chart 1 compares total hardness levels of six water samples (mg/L as $CaCO_3$). Samples 1–5 show very high hardness ranging from about 850 to 1100 mg/L, while Sample 6 has a much lower value around 200 mg/L. The high hardness in the first five samples may result from dissolved calcium and magnesium from mineral-rich rocks or groundwater sources, indicating the need for treatment before use.

Chart 2- Comparison of Residual chlorine



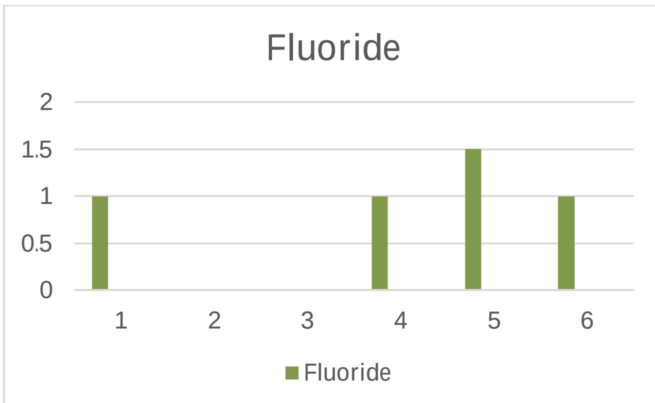
The chart 2 compares residual chlorine levels in six water samples (mg/L). Sample 3 shows the highest value of about 0.5 mg/L, which is within the recommended range for proper disinfection, while Samples 1, 2, 4, 5, and 6 have nearly zero residual chlorine. This indicates that only Sample 3 is adequately chlorinated, whereas the other samples may require additional treatment to ensure safe drinking water.

Chart 3- Comparison of Chloride content



The chart 3 compares chloride concentrations in six water samples (mg/L). Sample 1 shows the highest level at about 250 mg/L, while Sample 6 has the lowest at around 50–60 mg/L, with other samples showing moderate fluctuations. High chloride levels may result from salt-rich soils, sewage seepage, agricultural runoff, industrial discharge, or evaporation, indicating the need for regular water quality monitoring.

Chart 4- Comparison of fluoride content



The chart compares chloride concentrations in six water samples (mg/L), showing noticeable variation among them. Sample 1 has the highest level at about 250 mg/L, while Sample 6 has the lowest at around 50–60 mg/L, with other samples showing moderate fluctuations. High chloride levels may result from salt-rich soils, sewage seepage, agricultural runoff, industrial discharge, or evaporation, indicating the importance of regular monitoring.

IV. CONCLUSION

The groundwater analysis study reveals that the quality of groundwater varies depending on geological formation, human activities, and environmental conditions. The quality of ground water samples collected from 6 different locations around Tamilnadu was analysed and studied. The physicochemical parameters such as pH , total hardness, chloride, residual chlorine, fluoride were analyzed . The results indicates that most of the parameters are within the acceptable range for domestic purposes, while a few samples show slight variations due to agricultural runoff, industrial discharge, or natural mineral dissolution. Increased hardness levels in some areas suggest the presence of dissolved salts and minerals. Overall, the groundwater in the study area is found to be suitable for irrigation purposes, with minor treatment recommended in areas where certain parameters exceed permissible limits. Continuous monitoring and proper groundwater management practices are essential to prevent further contamination and to ensure safe and sustainable use of groundwater resources.

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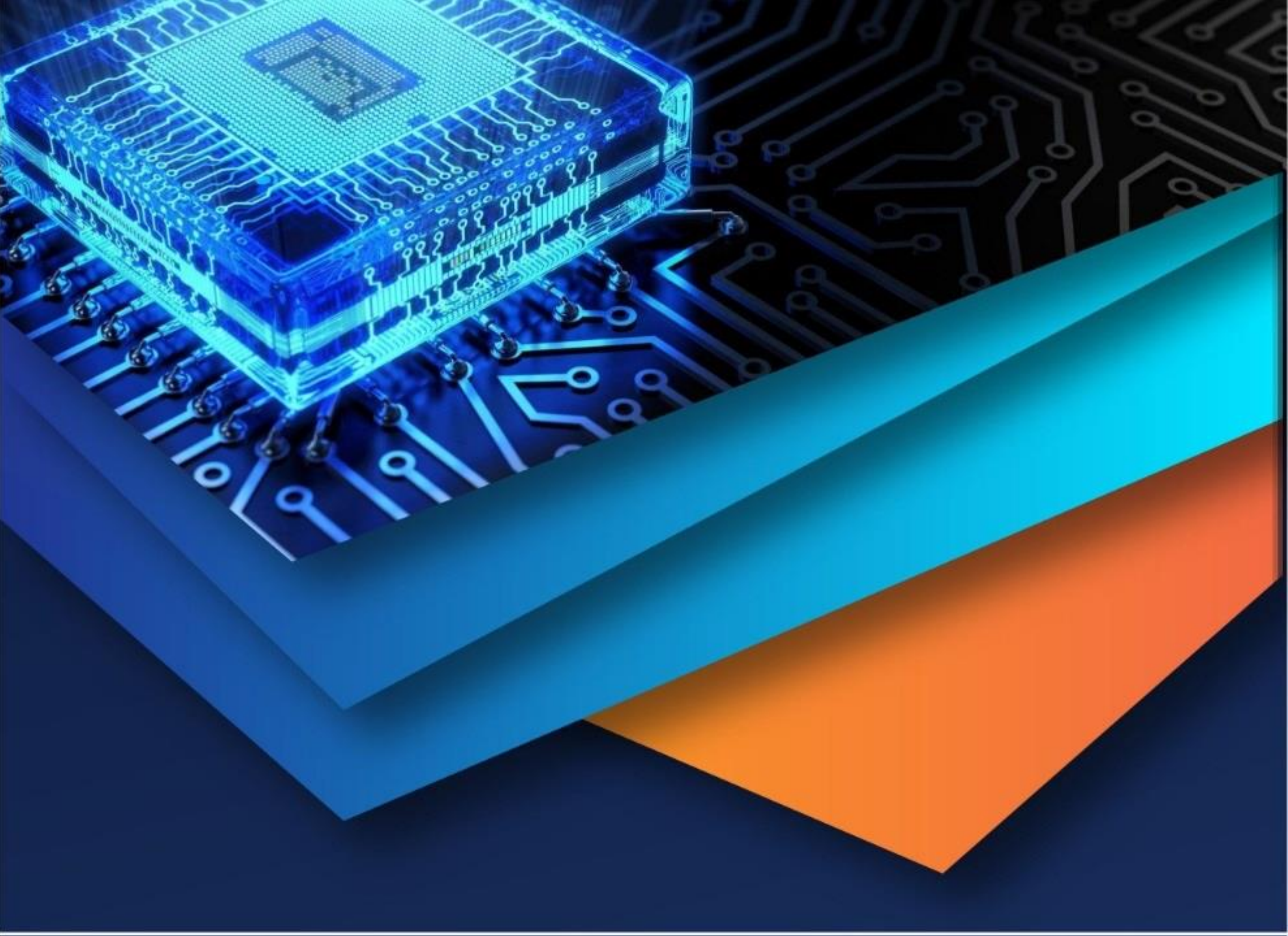

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