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HYDROCHEMICAL ASSESSMENT OF GROUNDWATER IN RAJAHMUNDRY USING WATER QUALITY INDEX (WQI)

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Abstract : Groundwater quality assessment is crucial for ensuring safe drinking water and sustainable water resource management. This study evaluates the hydro-chemical characteristics of groundwater in Rajahmundry, Andhra Pradesh, using the Water Quality Index (WQI) approach. A total of 15 groundwater samples were collected from different locations and analyzed for key physicochemical parameters. The WQI was computed to classify the groundwater quality into different categories, ranging from excellent to unsuitable for drinking. The results indicate that some samples fall within the permissible limits set by the WHO and BIS, while others exhibit contamination concerns, primarily due to anthropogenic activities such as agricultural runoff, industrial discharge, and improper waste disposal. The findings emphasize the need for continuous monitoring and effective groundwater management strategies. This study provides valuable insights for policymakers and local authorities to implement appropriate measures for maintaining groundwater quality in Rajahmundry.

Index Terms **- Groundwater, Hydro-chemical Assessment, Water Quality Index (WQI), Rajahmundry, Physicochemical Parameters, Water Pollution.**

I. INTRODUCTION

Groundwater is a vital natural resource that serves as the primary source of drinking water for millions of people worldwide. Its quality plays a crucial role in maintaining public health and supporting various economic activities, including agriculture and industry. However, increasing urbanization, industrialization, and agricultural activities have led to the deterioration of groundwater quality, making regular assessment essential for sustainable water resource management.

Rajahmundry, a rapidly growing city in Andhra Pradesh, relies significantly on groundwater for domestic and agricultural needs. Various natural and anthropogenic factors, such as geochemical processes, industrial effluents, agricultural runoff, and improper waste disposal, can influence the physicochemical properties of groundwater in this region. Therefore, a systematic evaluation of groundwater quality is necessary to determine its suitability for drinking and other purposes.

The Water Quality Index (WQI) is an effective tool used to assess overall groundwater quality by integrating multiple physicochemical parameters into a single numerical value. This study aims to analyze groundwater quality in Rajahmundry using WQI by evaluating key parameters such as color, pH, electrical conductivity (EC), turbidity, alkalinity, nitrate, and fluoride. The findings of this study will provide valuable insights for local authorities and policymakers to develop appropriate water management strategies and ensure the availability of safe groundwater for future generations.

II. OBJECTIVES

This research aims to provide a comprehensive assessment of groundwater quality. The specific objectives are:

- To evaluate groundwater quality by analyzing physico-chemical parameters.
- To determine the Water Quality Index (WQI) across different locations.
- To classify groundwater quality in the study area by developing a Water Quality Index (WQI).

III. STUDY AREA

Rajahmundry, also known as Rajamahendravaram, is a prominent city in the East Godavari district of Andhra Pradesh, India, located on the banks of the Godavari River at approximately 16.98°N latitude and 81.78°E longitude**.** Covering an area of about 44.5 square kilometers, the city experiences a tropical climate with an annual average rainfall of around 1100 mm, primarily influenced by the southwest monsoon. Groundwater is a crucial resource for domestic, agricultural, and industrial purposes in Rajahmundry, with its hydrogeology influenced by alluvial and hard rock formations. However, rapid urbanization, agricultural runoff, industrial effluents, and improper waste disposal have raised concerns about groundwater contamination. This study focuses on assessing the physicochemical properties of groundwater in Rajahmundry using the Water Quality Index (WQI) method to determine its suitability for drinking and other uses. The findings will provide essential insights for effective groundwater management and sustainable water resource planning in the region. The study area map is shown in Figure 1.

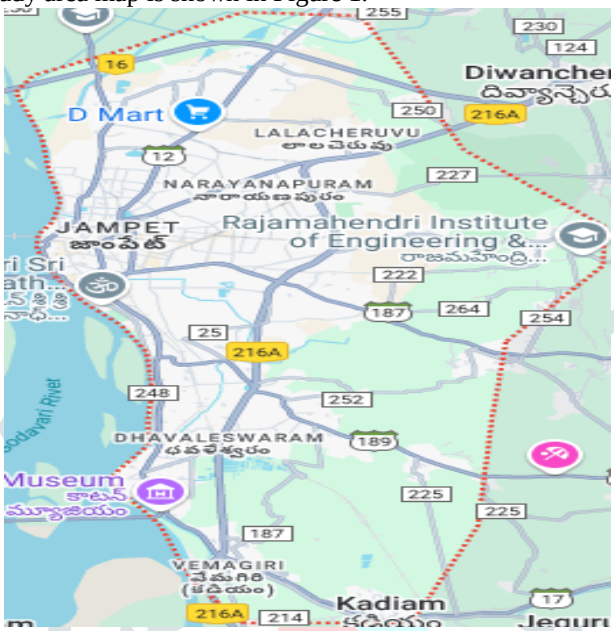


Fig 1:Rajahmundry Map

IV. METHODOLOGY

The methodology for this study involves a systematic approach to assess the groundwater quality in Rajahmundry using the Water Quality Index (WQI). The key steps are as follows:

Study Area Selection and Sampling

A total of 14 groundwater samples were collected from different locations across Rajahmundry to ensure comprehensive coverage of the study area. Samples were taken from bore wells and hand pumps commonly used for drinking and domestic purposes.

Sample Collection and Preservation

Standard procedures were followed for sample collection using pre-cleaned polyethylene bottles to prevent contamination. The collected samples were stored at 4°C and transported to the laboratory for further analysis.The sample locations are shown in Table 1.

Table 1 Groundwater Sample Locations

SAMPLE CODE	LOCATION
S1	Balaji Petta
S2	Tyagaraja Nagar
S3	Ambika Nagar
S4	Navabharat Nagar
S5	Innespeta
S6	Morampudi
S7	Tumalam
S8	Kambala Cheruvu
S9	Danavaipet
S10	Gandhipuram
S11	Venkateswara Nagar
S12	Padmavathi Nagar
S13	Seethampet
S14	Lalitha Nagar

Physicochemical Analysis

The groundwater samples were analyzed for various physicochemical parameters to assess water quality. Color was observed visually to detect any noticeable discoloration, which may indicate the presence of impurities. Turbidity was measured using a nephelometric turbidity meter to determine the clarity of water and the presence of suspended particles. pH was analyzed using a digital pH meter to assess the acidity or alkalinity of the water. Electrical conductivity (EC) was measured with a conductivity meter

to estimate the concentration of dissolved ions. Total dissolved solids (TDS) were determined through gravimetric analysis to quantify the overall dissolved mineral content in water. Total alkalinity as $CaCO_3$ was analyzed using titrimetric methods to evaluate the water's buffering capacity. Fluoride (F^-) concentration was measured using a spectrophotometer to determine its suitability for consumption. Nitrate (NO_3^-) levels were also analyzed using spectrophotometric methods to assess potential contamination from agricultural runoff and other sources. These parameters are essential in determining groundwater quality and its suitability for drinking and other purposes.

Water Quality Index (WQI) Calculation

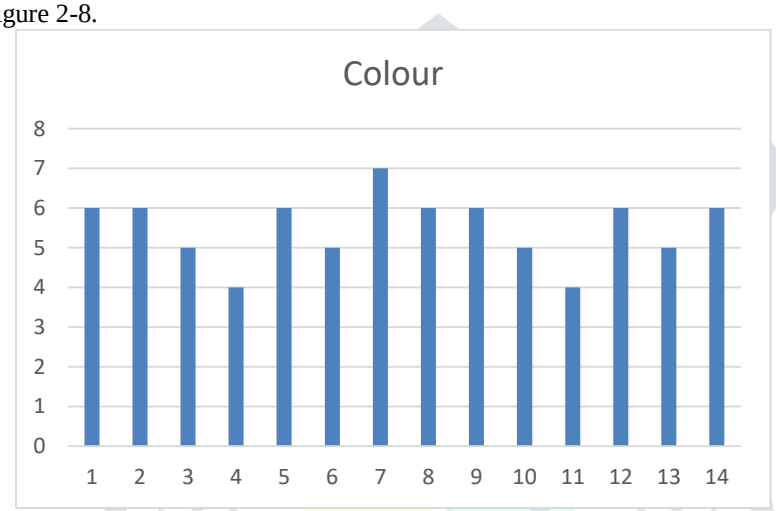
The WQI was calculated using standard procedures by assigning weightage to each parameter based on its significance for water quality. The overall WQI was computed using the weighted arithmetic index method, categorizing groundwater quality into different classes (e.g., excellent, good, poor, very poor, and unsuitable for drinking).

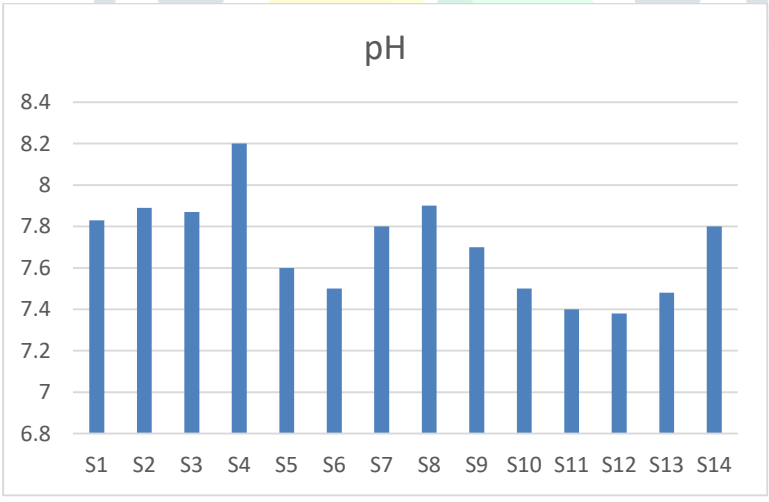
Data Interpretation and Conclusion

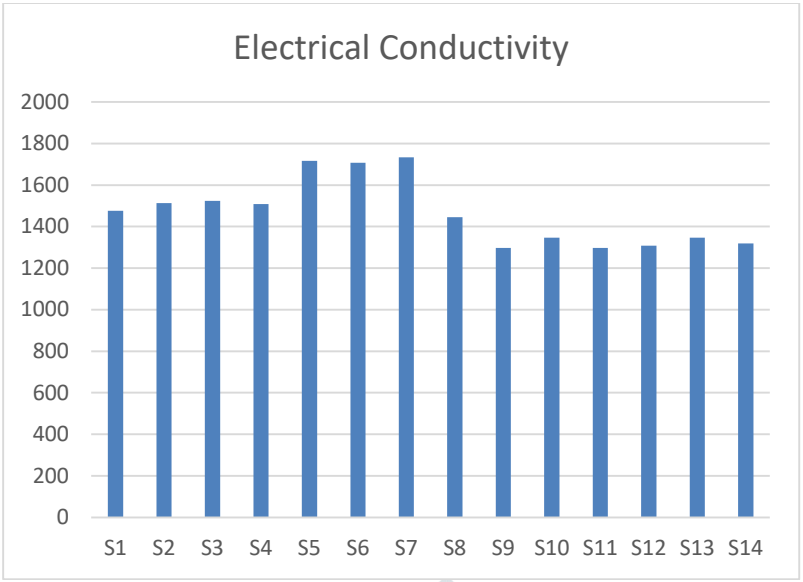
The results were compared with the permissible limits set by the World Health Organization (WHO) and Bureau of Indian Standards (BIS) to assess the suitability of groundwater for drinking purposes. Based on the findings, recommendations were made for groundwater management and conservation strategies in Rajahmundry.

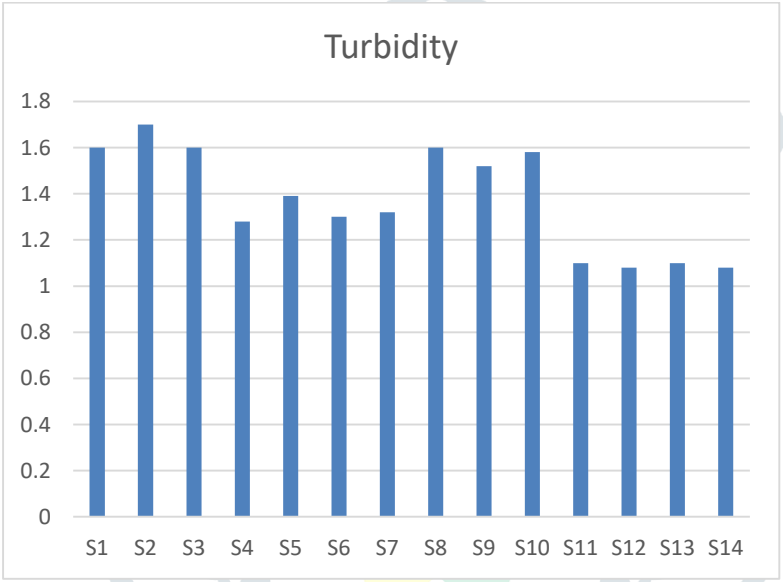
V. RESULTS AND DISCUSSIONS

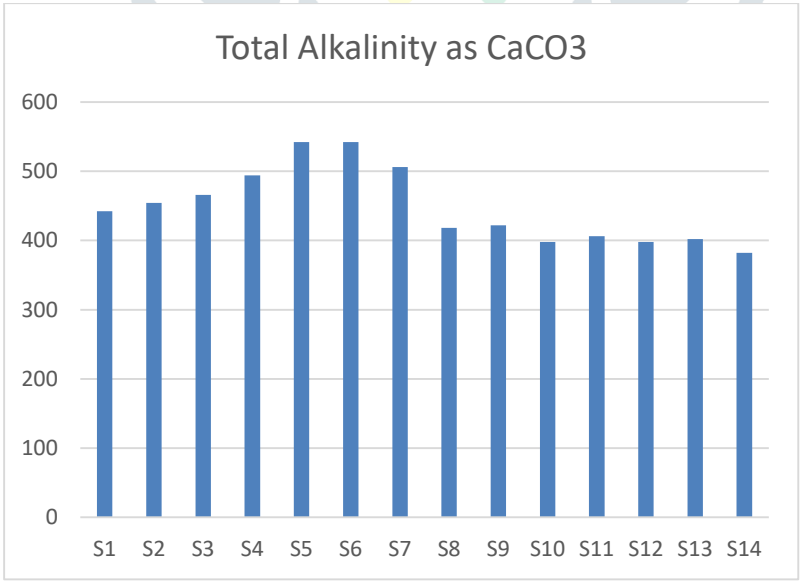
The results are shown in Figure 2-8.

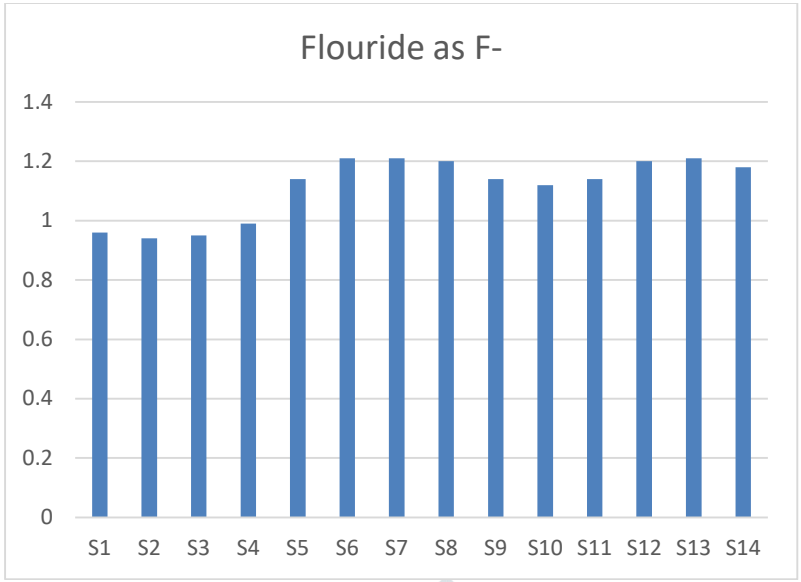





Electrical Conductivity
2000
1800
1600
1400
1200
1000
800
600
400
200
0
S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14


Turbidity
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14


Total Alkalinity as CaCO3
600
500
400
300
200
100
0
S1 S2 S3 S4 S5 S6 S7 S8 S9 S10 S11 S12 S13 S14



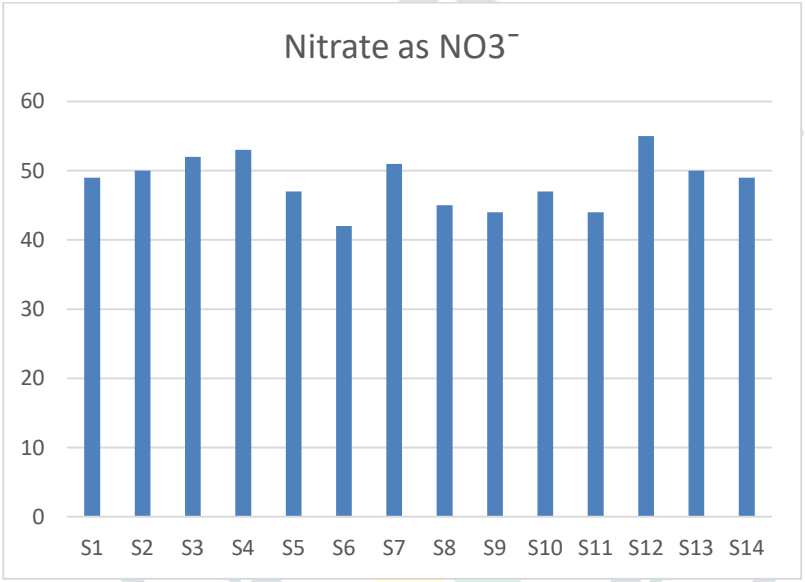


Figure 2-8 Physico Chemical Parameters for Study Area

VI. CONCLUSIONS

The groundwater quality assessment in Rajahmundry using the Water Quality Index (WQI) indicates that most locations fall within the Good to Poor Water Quality range, highlighting variations in contamination levels. While pH and turbidity remain within permissible limits, electrical conductivity and total dissolved solids are elevated in some areas, indicating mineral dissolution and possible anthropogenic influences. Total hardness exceeds recommended limits in several locations, contributing to very hard water conditions. Fluoride levels are within acceptable limits, but nitrate concentrations exceed safe levels in certain locations, posing potential health risks. The WQI classification shows that while some locations have good water quality, others fall into the poor category, necessitating treatment before consumption. The primary sources of contamination include agricultural runoff, industrial discharge, and improper waste disposal. To ensure safe groundwater use, regular monitoring, appropriate treatment, pollution control measures, and public awareness initiatives are essential for effective water resource management.

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