WQI - WATER QUALITY INDEX

RAMBHA COLLEGE OF EDUCATION

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ACKNOWLEDGEMENT

I would like to express my special thanks and gratitude towards Dr. Santosh Kumar Sir, Principal, Rambha College of Education, for giving an opportunity to conduct a ground water quality testing at their premises.

I would also like to express my special thanks and gratitude towards Mr Dilip Mangaraj, Senior Consultant, Vishal Technology, for giving me this golden opportunity to be a part of this project.

DECLARATION

I, Vishal Mangaraj (Research Scholar, Environmental Science) hereby declare that this report entitled “WQI – WATER QUALITY INDEX” has been carried out by me and submitted by me to fulfil the further requirements. I further declare that the work reported in this project has not been submitted in any other institutions/body.

I assert that the statement made and conclusion drawn are the outcomes of my own work. The work has not been copied from any sources. I have followed guidelines provided by my professor and my seniors for the successful completion of the project. Whenever I have used data in the form of tables, diagrams, pictures and text from other sources, I have given due credit to them in the text of the report and given their details in the references. No part of this report was previously presented for another degree or diploma or any other institution.

Vishal Mangaraj
20/02/2023

Name: Vishal Mangaraj

Place: Ranchi

Date: 20/02/2023

Contents

LIST OF ABBREVIATIONS

Abbreviation	Definition
n.d.	No Date
CPCB	Central Pollution Control Board
SPCB	State Pollution Control Board
EC	Electrical Conductivity
DO	Dissolved Oxygen
TDS	Total Dissolved Solid
TSS	Total Suspended Solid
TS	Total Solid
NTU	Nephelometric Turbidity Unit
WQI	Water Quality Index
SI	Sub-indices

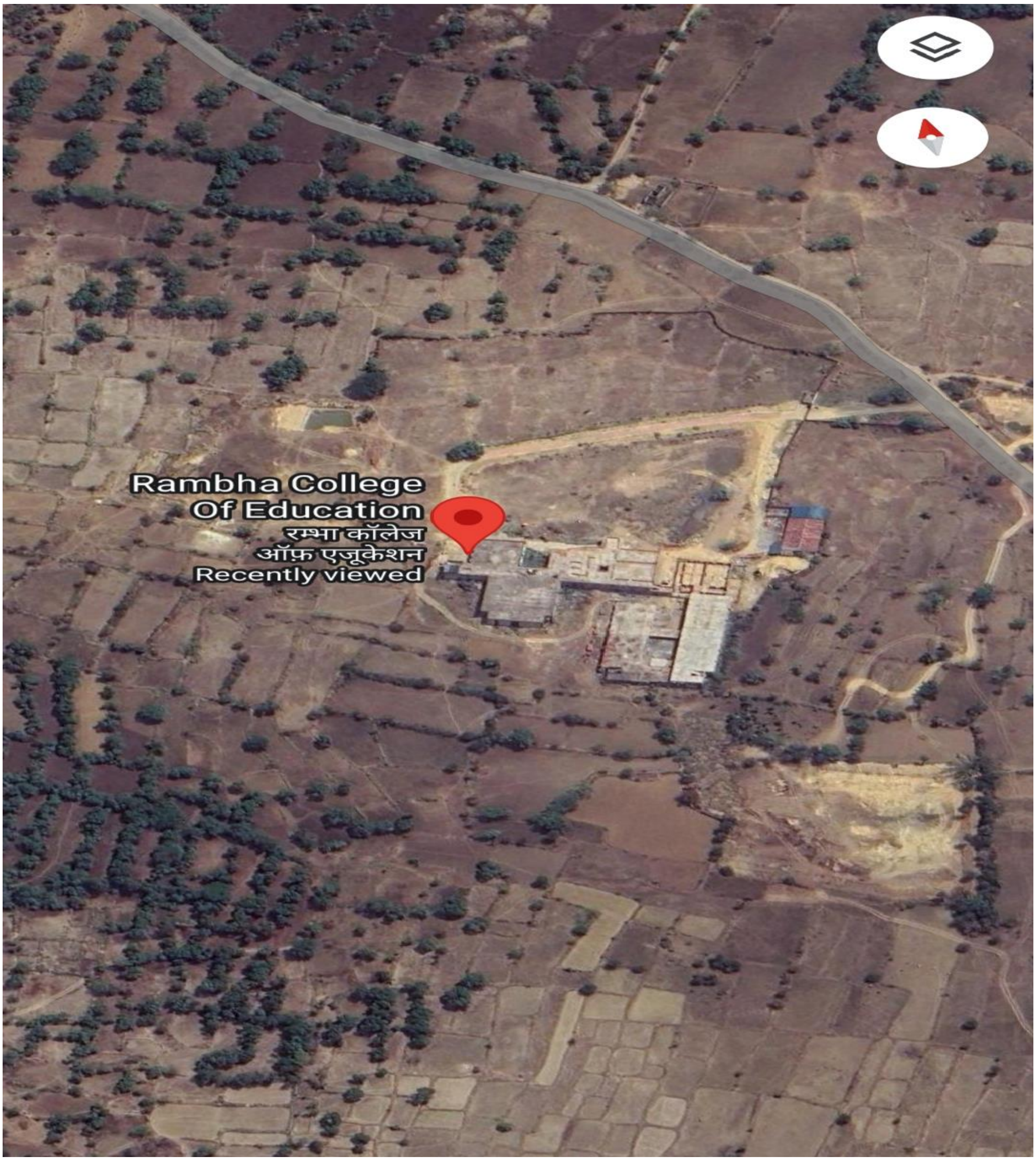
INTRODUCTION

The chemical formula of water is H_2O, which is an inorganic compound. This chemical substance is transparent, tasteless, odourless, and virtually colourless. It is the primary component of Earth's hydrosphere and the fluids found in all known living creatures, where it functions as a solvent. Even though it doesn't include organic micronutrients or dietary energy, it is essential for all known forms of existence. Each of its molecule has one oxygen and two hydrogen atoms, joined by covalent bonds, as indicated by its chemical formula, H_2O. ("Water," n.d.).

The water found in the pore spaces of rock, soil, and rock formation fissures beneath the surface of the earth is known as groundwater. Groundwater makes up around 30% of the freshwater that is readily available worldwide. An aquifer is an unconsolidated deposits or unit of rock that can provide a useful amount of water. The water table is the depth at which the pores spaces in soil or the cracks and gaps in rock are totally saturated with water. Groundwater receives its replenishment from the surface; it can naturally seep and burst out of the ground, creating oases and wetlands. Groundwater is also frequently extracted through the construction and maintenance of extraction wells for use in industry, agriculture, and cities. The study of the distribution and movement of ground water is hydrogeology, also called groundwater hydrology. Due to high rise in population and fast-growing development the quality of ground water is depleting day by day. Ground water pollution occurs through various processes, often involving human activities. Industrial Discharges, Agricultural Runoff, Landfills and waste Disposal, Sewage and Septic Systems, Urban Runoff, Mining Activities, Leaking Underground Storage Tanks, Saltwater Intrusion, Chemical Spills and Accidents. Factories and Industrial plants may release pollutants directly into the ground, which can seep into the groundwater. Pesticides, herbicides, and fertilizers used in farming can leach into the groundwater, especially after rainfalls. Improper management of landfills and waste disposal sites can leak harmful chemicals into the ground, contaminating the groundwater. Faulty or poorly maintained septic systems can leak bacteria, viruses, and chemicals into the groundwater. Runoff from roads, parking lots, and other urban areas can carry pollutants like oil, heavy metals, and chemicals into the ground. Mining can expose and release natural contaminants like heavy metals into the groundwater. Tanks used for storing petroleum products, chemicals, and other hazardous materials can leak over time, contaminating the groundwater. Over extraction of groundwater in coastal areas can cause saltwater to seep into freshwater aquifers, leading to contamination. Accidental spills of chemicals can infiltrate the ground and contaminate groundwater. To check the amount of pollution in groundwater, we have to estimate different water quality parameters of the groundwater. In our case it is the groundwater from 'Rambha College of Education Gitilata, Jharkhand.

STUDY AREA MAP

RAMBHA COLLEGE OF EDUCATION



Rambha College of Education is a prestigious institution located in Jamshedpur, India. Established with the aim of providing quality education and training to aspiring teachers, the college has a strong reputation for academic excellence and holistic development of students.

The college offers various teacher education programs, including Bachelor of Education (B. Ed) and Diploma in Elementary Education (D.El. Ed), that are designed to equip students with the necessary knowledge and skills to excel in the field of education.

Rambha College of Education boast a team of experienced and dedicated faculty members who are committed to providing a supportive and enriching learning environment for students. The college also offers state-of-art facilities, including well-equipped classrooms, libraries, labs, and sports amenities, to ensure a comprehensive learning experience for students.

Importance of Study area: The analysis of physio-chemical quality of ground water is very much important in this area because a total of 100 student and 26 number of staff come to the college every day. Although Water filters are fitted in the premises, it is highly needed to know the quality of ground water mainly for drinking purpose.

OBJECTIVE

The objective of the report making is:

- To find out Water Quality Index of the groundwater of ‘Rambha College of Education’, Gitilata, Jharkhand

WATER QUALITY PARAMETERS

Water quality refers to the characteristics of water, typically in relation to its suitability for a particular purpose, such as drinking, recreation, agriculture, or industrial processes. It is determined by the presence and concentrations of various physical, chemical, and biological parameters. High-quality water meets the required standards and guidelines set by regulatory agencies to ensure safety and usability for its intended purpose. In our case the regulatory agencies are CPCB & SPCB. Key aspects of water quality include:

1. Physical Characteristics:
    - Temperature
    - Turbidity
    - Colour
    - Odour
    - Taste
2. Chemical Characteristics:
    - pH
    - Electrical Conductivity (EC)
    - Dissolved Oxygen (DO)
    - Total Dissolved Solids (TDS)
    - Major ions
    - Hardness
    - Biochemical Oxygen Demand (BOD)
    - Chemical Oxygen Demand (COD)
    - Toxic Chemicals
3. Biological Characteristics:
    - Pathogens
    - Algae and Microorganisms

METHODOLOGY

The methodology followed to carry forward the practical is by instructions given by the lab in charge and with help of practical records. Both the instructions and practical records abide all the conditions as prescribe by CPCB/SPCB, following all the norms.

The parameters that were analyse in the lab are: pH, Turbidity, Conductivity, Total Dissolved Solids, Total Suspended Solids, Total Solids, Chloride, Calcium Hardness, Magnesium Hardness, Total Hardness and Phosphate.

1. **pH**: pH is a measure of the acidity or alkalinity of a solution, ranging from 0 to 14. A pH of 7 is considered neutral, below 7 is acidic, and above 7 is basic (alkaline). The pH scale is logarithmic, meaning each whole number on the scale represents a tenfold difference in hydrogen ion concentration.
2. **Turbidity**: Turbidity is measure of the cloudiness or haziness of a liquid caused by suspended particles that are usually invisible to the naked eye. It is an important parameter in water quality testing, as high turbidity can indicate the presence of contaminants such as microorganisms, sediments, or organic matter. Turbidity is typically measured in Nephelometric Turbidity Units (NTU) using a turbid meter.
3. **Conductivity**: Conductivity is a measure of a solution’s ability to conduct electric current, which depends on the presence of ions in the solution. It is commonly used to assess the purity of water and the concentration of the dissolved salts and minerals. Conductivity is usually measured in microsiemens per centimetre (µS/cm) or milliSiemens per centimetre (mS/cm). Higher conductivity indicates a greater concentration of ions and, therefore, higher levels of dissolved solids.
4. **Total Dissolved Solids (TDS):** Total Dissolved Solids (TDS) refers to the combined content of all inorganic and organic substances contained in a liquid that are present in a molecular, ionized, or micro-granular (colloidal sol) suspended form. These substances include minerals, salts, and metals. TDS is usually measured in parts per million (ppm) or milligrams per litre (mg/l). High level of TDS can affect water taste, hardness for drinking and industrial use.
5. **Total Suspended Solids (TSS):** Total Suspended Solids (TSS) is a measure of the suspended particles in water that are not dissolved. These particles can include silt, decaying plant and animal matter, industrial wastes, and sewage. TSS is usually measured in milligrams per litre (mg/l). High TSS levels can reduce water quality by decreasing light penetration, affecting aquatic life, and contributing to the sedimentation of waterways.
6. **Total Solids:** Total Solids (TS) is a measure of all the solids present in a water sample, including both dissolved and suspended solids. It is the sum of Total Dissolved Solids (TDS) and Total Suspended Solids (TSS). TS is typically measured in milligrams per litre (mg/l). High levels of total solids can impact water clarity, quality, and the health of aquatic ecosystem.
7. **Chloride:** Chloride (Cl^-) is a negatively charged ion that forms when the element chlorine gains an electron. It is commonly found in various compounds, including sodium chloride (table salt), and is prevalent in natural waters. Chloride is an important parameter in water quality testing, as high levels can indicate pollution from sources such as road salt, industrial waste, or seawater intrusion. Elevated chloride

concentrations can affect the taste of water, corrode pipes, and harm aquatic life. Chloride levels are usually measured in milligrams per litre (mg/l).

8. **Calcium Hardness:** Calcium hardness refers to the concentration of calcium ions (Ca^{2+}) in water. It is a crucial component of overall hardness, which includes both calcium and magnesium ions. Calcium hardness is typically measured in milligrams per litres (mg/l) or parts per million (ppm) as calcium carbonate ($CaCO_3$). High calcium hardness can lead to scale formation in pipes and boilers, while low levels can cause water to be corrosive. It is an important parameter in water treatment, aquariums, and pools to maintain balanced water chemistry.
9. **Magnesium Hardness:** Magnesium Hardness refers to the concentration of magnesium ions (Mg^{2+}) in water, which contributes to overall water hardness alongside calcium ions (Ca^{2+}). It is measured in milligrams per litres (mg/l) or parts per million (ppm) as magnesium carbonate ($MgCO_3$). High level can lead to scale formation and affect water quality, while low level can contribute to corrosiveness. Balancing magnesium and calcium hardness is crucial for various industrial processes, water treatment, and maintaining optimal conditions in aquatic environment.
10. **Total Hardness:** Total hardness of water refers to the combined concentration of calcium ions and magnesium ions present in water. It is typically measured in milligrams per litres (mg/l) or parts per million (ppm) as calcium carbonate ($CaCO_3$) equivalent.
11. **Phosphate:** Phosphate (PO_4^{3-}) is a chemical compound containing phosphorous and oxygen atmos. It is an essential nutrient for plant growth and is commonly found in fertilizers, detergents, and organic wastes. Phosphates can enter water bodies through runoff from agricultural fields, sewage discharges, and industrial processes. In aquatic environment excess of phosphorous can lead to eutrophication, a process where increased nutrient concentrations stimulate excessive plants and algae growth. This can result in decreased oxygen levels in water, harming aquatic life. Therefore, monitoring phosphate levels is crucial in managing water quality. Phosphate concentration in water is typically measured in milligrams per litre (mg/l) or parts per million (ppm). Regulatory limits and guidelines are often established to prevent excessive phosphate inputs into water bodies, particularly in sensitive ecosystems like lakes and rivers.

SAMPLING

Sampling is the process of collecting a small portion of water, as it is from the natural environment or from an industrial site, for the purpose of analysis of its constituent parameters. This analysis is crucial for assessing water quality, detecting pollutants, monitoring environmental conditions, and ensuring water safety for human consumption and ecosystem health. There are several types of water sampling methods used but the two most common and highly used methods are:

1. Grab Sampling
2. Composite Sampling

Grab Sampling involves collecting a single sample of water at a specific time and location. It's useful for quick assessment but may not capture variations over time. Composite Sampling involves combining multiple grab samples taken at different times or locations to provide an average representation of water quality over a period or area.

Sampling type used in Study area: GRAB SAMPLING

Sampling details:

Details	SAMPLE 1
CODE	**G1**
Sampling Type	**Grab Sampling**
Location	**Gitilata, Jharkhand**
Time	**01:15:38 PM**
Day	**Wednesday**
Date	**15/02/2023**
Latitude	**22.67162°**
Longitude	**86.17999°**
Colour	**Clear**
Odour	**Odourless/Odour free**
Temperature	**28°C**
pH	**7.56**

Figure 1: Grab Sampling G1

RESULTS

SL.NO	PARAMETERS	Unit	Measurement Methods	RESULTS	PERMISIBLE LIMIT
1	pH (at 28°C)	unitless	pH Meter	7.56	6.5-8.5
2	Turbidity	NTU	Nephelometer	1.32 NTU	1-5 NTU
3	Conductivity	µS/cm	Conductivity meter	1304µS/cm	0 - 1500 µS/cm
4	Total Dissolved Solids	mg/l	Gravimetry	721 mg/l	0 – 2000 mg/l
5	Total Suspended Solids	mg/l	Gravimetry	55 mg/l	0 – 100 mg/l
6	Total Solids	mg/l	Gravimetry	792mg/l	0 – 2000 mg/l
7	Chloride	mg/l	Argentometric Titration	20.89 mg/l	0 – 1000 mg/l
8	Calcium Hardness	mg/l	Titrimetric	100 mg/l	200 mg/l
9	Magnesium Hardness	mg/l	Titrimetric	20 mg/l	100 mg/l
10	Total Hardness	mg/l	Titrimetric	120 mg/l	600 mg/l
11	Phosphate	mg/l	Spectrophotometer	0.43 mg/l	40 mg/l

WATER QUALITY INDEX

The Water Quality Index (WQI) is a numerical representation that categorizes the overall quality of water at a particular location based on several water quality parameters. To calculate the WQI, we have select a certain number of parameters, in our case it is a total of 11 number of parameters, then we have calculated the sub-indices for each parameter, then weight is assigned to each parameter and then calculated the weighted average. The method used to find out WQI here is the **'Weighted Arithmetic Water Quality Index Method'.**

1. Step 1: Select Parameters
   The following parameters have been used for WQI calculation
   - pH
   - Turbidity
   - Conductivity
   - Total Dissolved Solids (TDS)
   - Total Suspended Solids (TSS)
   - Total Solids
   - Chloride
   - Calcium Hardness
   - Magnesium Hardness
   - Total Hardness
   - Phosphate
2. Step 2: Sub-indices (SI)
   The SI is calculated as follow: 'SI = $\left(\frac{Value}{Standard\,Value}\right) \times 100$
3. Step 3: Assign Weights
   Weight is assigned based on its importance to water quality, here we have assumed equal weights for all parameters. That is each and every parameter is equally important in our purpose.
4. Step 4: Calculation of weighted Average
   The weighted average is calculated using the formula:
   WQI = $\Sigma(SI \times Weight)$

Calculating SI for G1

1. pH:
   $SI_{pH} = \left(\frac{7.56}{8.5}\right) \times 100 = 88.94$
2. Turbidity:
   $SI_{Turbidity} = \left(\frac{1.32}{5}\right) \times 100 = 26.4$
3. Conductivity:
   $SI_{Conductivity} = \left(\frac{1304}{1500}\right) \times 100 = 86.9$
4. TDS:
   $SI_{TDS} = \left(\frac{721}{2000}\right) \times 100 = 36.5$

5. TSS:
   $SI_{TSS} = \left(\frac{55}{100}\right) \times 100 = 55.0$
6. Total Solids:
   $SI_{Total\ Solids} = \left(\frac{792}{2000}\right) \times 100 = 39.6$
7. Chloride:
   $SI_{Chloride} = \left(\frac{20.89}{1000}\right) \times 100 = 2.08$
8. Calcium Hardness:
   $SI_{calcium\ Hardness} = \left(\frac{100}{200}\right) \times 100 = 50$
9. Magnesium Hardness:
   $SI_{Magnesium\ Hardness} = \left(\frac{20}{100}\right) \times 100 = 20$
10. Total Hardness:
   $SI_{Total\ Hardness} = \left(\frac{120}{600}\right) \times 100 = 20$
11. Phosphate:
   $SI_{Phosphate} = \left(\frac{0.43}{40}\right) \times 100 = 1.075$

Calculating the WQI for G1

$$WQI_{G1} = \frac{88.94+26.4+86.9+36.5+55+39.6+2.08+50+20+20+1.075}{11} = \mathbf{38.77}$$

To interpret the Water Quality Index (WQI), WQI is categorised into different ranges to better understand the quality of the water. Common categorization for WQI is:

- **0-25:** Excellent
- **26-50:** Good
- **51-75:** Poor
- **76-100:** Very Poor
- **>100:** Unsuitable for Drinking

The WQI value for the G1 source is 38.77. Given the calculated WQI for the G1 is 38.77, we can categorize the water quality as **"Good"**. This value indicate that the water source is within acceptable quality level, this analysis shows that G1 source have acceptable level of key water quality parameters, ensuring they meet standards for safe water consumption.

DISCUSSION AND CONCLUSION

The above table shows us the result of groundwater of ‘Rambha College of Education Gitilata, Jharkhand. From the table we conclude that the groundwater source fall within the permissible pH range, indicating that the water is neither too acidic nor too alkaline. Turbidity level for the groundwater source is within the permissible limit, indicating that the water is clear and has low levels of suspended particles. The groundwater source has conductivity level within the acceptable range, reflecting the presence of an acceptable level of ions in the water. The TDS level for the groundwater source is well within the permissible limit, indicating good water quality in terms of dissolved solids. TSS level for the groundwater source is within the permissible range, meaning the water has a low level of suspended solids. The total solids in the groundwater source are within acceptable limits, indicating the water is not overly loaded with dissolved and suspended solids. Chloride levels for the groundwater source are significantly below the permissible limit, indicating a low risk of chloride-related issues. The groundwater source has calcium hardness levels within the permissible range, suggesting the water is moderately hard but not excessively hard. Magnesium hardness levels are well within the permissible limit, indicating the magnesium levels are not high enough to cause significant hardness issues. The groundwater source has total hardness well within the permissible limit, indicating the water is not excessively hard. Phosphate level in the groundwater source is extremely low and well within the permissible limit, suggesting minimal nutrient pollution. The result indicate that the groundwater source meets the permissible limit for all tested parameters, suggesting that the water quality is good. All parameters, including pH, turbidity, conductivity, total dissolved solids, total suspended solids, total solids, chloride, calcium hardness, magnesium hardness, total hardness and phosphate, are within acceptable ranges. The WQI value for the G1 source is 38.77. The method used to find out WQI here is the **‘Weighted Arithmetic Water Quality Index Method’.** Given the calculated WQI for the ‘Rambha College of Education Gitilata, Jharkhand is 38.77, we can categorize the water quality as **“Good”**. This value indicate that the groundwater source is within acceptable quality level. This analysis shows that the groundwater source has acceptable levels of key water quality parameters, ensuring they meet standards for safe water consumption.

REFERENCE

Wikipedia contributors. (2024, July 6). Water. In *Wikipedia, The Free Encyclopedia*. Retrieved 03:33, July 8, 2024, from https://en.wikipedia.org/w/index.php?title=Water&oldid=1232963929

Thank You