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Quality Assessment of Drinking Water in Modasa Town, Aravalli District, Gujarat, India

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Abstract— *This study investigates the quality of drinking water in Modasa town, Aravalli district, Gujarat, India, with the objective of evaluating its suitability for human consumption. A comprehensive assessment will be conducted, adhering to the Bureau of Indian Standards (BIS) specifications (IS 10500:2012) for drinking water potability. Water samples collected from diverse locations across Modasa, encompassing public taps, handpumps, and borewells, will undergo rigorous analysis to determine compliance with BIS standards. Moving beyond a simple binary evaluation, the study delves deeper to identify and characterize potential contaminants and their associated health risks. This in-depth analysis will encompass the evaluation of inorganic and organic chemicals, with a particular focus on elements like arsenic, fluoride, and heavy metals known to pose significant health concerns at elevated concentrations. Additionally, the research will investigate organic matter content and residual chlorine levels to understand the effectiveness of disinfection processes and identify potential interferences. By integrating the findings from the physical, chemical, and microbiological assessments, the study will provide a holistic understanding of drinking water quality in Modasa. This comprehensive analysis will pinpoint areas where water quality falls short of BIS standards, facilitating a targeted evaluation of potential health risks associated with contaminant exposure.*

Keywords— ***Drinking water quality, Water quality index, Gujarat, Aravalli district, India***

I. INTRODUCTION

The Indian state of Gujarat faces a unique challenge in ensuring access to safe drinking water for its population. Unlike some regions with mountainous landscapes, a large portion of Gujarat, particularly in the Aravalli district, consists of flat plains. This specific topography forces a significant portion of the rural population, estimated at around 90%, to rely heavily on surface water sources like rivers and streams to meet their daily water needs. With a rising demand for water due to economic growth, agricultural activities, and population increase, the need to maintain the quality of these surface water sources becomes paramount. Unfortunately, the current situation in Aravalli district regarding water quality monitoring paints a concerning picture. There is a conspicuous absence of established and regular water quality monitoring programs. This lack of data makes it challenging to develop effective

water resource management strategies that guarantee the continued suitability of these water sources for various uses, including drinking. Recognizing the urgency of addressing this critical issue, the present study embarks on a comprehensive assessment of the hydrochemical composition of drinking water sources across Aravalli district.

The research methodology employed in this study is multifaceted. It incorporates a comparative analysis of water samples collected during two distinct seasons: the pre-monsoon and post-monsoon periods. Water samples will be collected from two key locations: directly from riverine sources and from adjacent riverbank filtrate (RBF) wells. Analyzing water from both sources allows for a more nuanced understanding of how factors like seasonality and human activities impact water quality. Seasonal variations can significantly influence water quality. The monsoon season, with its heavy rainfall, can lead to increased turbidity and potential contamination from surface runoff. Conversely, the pre-monsoon period, characterized by drier conditions, might see a rise in contaminant concentrations due to reduced dilution. By analyzing samples from both periods, the study aims to capture these seasonal fluctuations and their impact on water quality.

The study design also delves into the potential influence of anthropogenic activities on water quality. The flat topography of the region can contribute to challenges in proper waste disposal. Untreated municipal waste discharged directly or indirectly into river systems can be a significant source of bacterial contamination. The presence of fecal coliform bacteria, a telltale sign of such contamination, can pose serious health risks and contribute to the spread of waterborne diseases like diarrhea, cholera, typhoid, and schistosomiasis. A crucial element of this research project involves the application of a Water Quality Index (WQI). This established tool will be employed to translate the complex water quality data obtained from the analysis of various parameters into a readily understandable format. This simplified and user-friendly output will prove instrumental on two fronts. Firstly, it will allow for a clear assessment of the suitability of these water sources for drinking purposes based on established national standards. Secondly, the WQI results will effectively communicate the findings to both the public and policymakers. By raising awareness about the current state of water quality in Aravalli district, the study aims to empower citizens and encourage policymakers to prioritize the implementation of effective water quality management strategies.

In conclusion, this study strives to fill the existing data gap regarding water quality in Aravalli district, Gujarat. By conducting a comprehensive hydrochemical assessment and utilizing a Water Quality Index, the research aims to provide a robust evaluation of the current situation. This newfound knowledge will serve as a cornerstone for developing and implementing improved water management practices within the district. Ultimately, this endeavor aspires to safeguard public health and promote sustainable water resource utilization, ensuring access to safe drinking water for the present and future generations of Aravalli district.

II. MATERIALS AND METHODS

2.1. Study Area

Aravalli district, nestled in the northern embrace of Gujarat state, India, unfolds across a sprawling landscape of approximately 5,230 square kilometers. Its geographical coordinates paint a picture of its location, situated between 29° 45' and 30° 15' North latitude and 78° 24' to 79° 23' East longitude. As per the 2011 census, a vibrant community of 6,86,527 individuals calls Aravalli district home. The district is graced by the majestic Mazum River, a vital source of water and a key tributary of the larger Mazum river system. Interestingly, the Mazum river itself is formed by the confluence of two distinct branches – the Eastern and Western Mazum – converging at the picturesque location of Sayara. Climate-wise, Aravalli district experiences an average annual rainfall of 2,180 millimeters. However, the monsoon season paints a distinct picture, concentrating roughly 90 percent of the annual precipitation within its brief but impactful period.

Delving deeper into the geological makeup of Aravalli district, we encounter two distinct types of soil: pedogenetic and transported soils. Pedogenetic soils, formed over millennia through the relentless action of atmospheric elements, physical and chemical weathering processes, and rock slides, tell a story of the land's history. These soils often derive their characteristics from their parent rocks, such as granite gneiss, schistose, and phyllite formations. Interestingly, soils formed from these parent rocks boast a high silica content, a testament to their geological origins. In contrast, soils formed from limestone are blessed with an abundance of calcium carbonate. Transported soils, on the other hand, paint a different picture. Carried and deposited by the meandering streams that flow through the district, these soils embark on a journey, eventually settling in their new locations. Among these transported soils, the brown forest soil stands out for its remarkably high organic matter content. This characteristic makes it particularly valuable for agricultural endeavors. By exploring the geographical tapestry of Aravalli district, we gain a deeper appreciation for its diverse landscape, vibrant communities, and the interplay between climatic factors and geological formations that shape the land. This understanding paves the way for further exploration of the district's ecological

richness, agricultural potential, and the unique cultural heritage that flourishes within its boundaries.

2.2. Methodology

2.2.1 Collection of water sample:

A cornerstone of the water quality assessment in Modasa city, Aravalli district, involved the meticulous selection of two crucial sampling sites. These locations serve as the primary sources of drinking water for the district's substantial population, managed and distributed by the Gujarat Jal Sansthan, the state's designated water supply department.

Following a well-defined strategy, Sayara (Mazum River) (site no.1: GPS(23.485250570846,73.354854574915) Elevation (in meters) ≈154) And Sarvodaynagar (Mazum River)(site no.2: GPS(23.463025399615,73.310733294302) Elevation (in meters) ≈168), were chosen as the sampling sites. Precise geographical positioning was essential, and a state-of-the-art Garmin GPS system (Model: GPSmap 76CSx) manufactured in Taiwan was utilized to acquire the exact coordinates for each location. Sayara boasts an elevation of approximately 154 meters above sea level, while Sarvodaynagar sits slightly higher at 168 meters.

Considering the primary objective of evaluating the water's suitability for human consumption, the sampling strategy strictly adhered to established protocols. A grab sampling technique was employed to ensure the collection of representative samples at specific times and locations. High-density polyethylene bottles, recognized for their durability and chemical resistance, were chosen from the reputable Tarson brand for sample collection. Prior to filling, each bottle underwent a rigorous rinsing process using the source water itself, repeated two to three times. This meticulous approach eliminates any potential contamination from previous contents, ensuring the integrity of the collected samples and minimizing the risk of misleading results.

For trace metal analysis, a specialized protocol was implemented. Acid-leached polyethylene bottles were used to collect these samples. Additionally, ultra-pure nitric acid (5 ml/liter) was introduced as a preservative measure. This acidification step plays a crucial role by minimizing the adsorption of metals onto the container walls and preventing precipitation through a reduction in pH to below 2. This meticulous approach ensures the collected samples retain their integrity and accurately reflect the actual metal concentrations present in the water source.

Bacteriological analysis necessitated a distinct approach. Here, sterilized Tarson bottles, covered with aluminum foil to maintain sterility, were employed for sample collection. These specific measures are essential to prevent contamination by external bacterial sources during transportation and storage.

Recognizing the importance of on-site analysis for specific parameters, pH and turbidity were measured directly at the sampling locations using calibrated instruments. However, for a broader range of parameters requiring more sophisticated equipment and controlled laboratory conditions, the collected water samples were transported at a chilled temperature of 4°C. This temperature-controlled environment was maintained within a designated sampling box. This approach helps to minimize any potential changes in the water chemistry during transport, ensuring the accuracy of the subsequent laboratory analyses.

Upon arrival at the laboratory, stringent sample preservation and physico-chemical analysis protocols were followed, adhering to the established standards outlined by the American Public Health Association (APHA). Colorimetric analysis, a well-established technique used to determine the concentration of colored dissolved substances in water, was performed using a high-performance UV-VIS spectrophotometer (Model: Pharo300) manufactured by Merck, Germany.

For the analysis of metal ion concentrations, a flame atomic absorption spectrometer (FAAS) was utilized. This specialized instrument, a Varian AA240 model sourced from a reputable Australian manufacturer, employs a technique that atomizes the sample and measures the characteristic light absorbed by the metal ions at specific wavelengths. This method provides highly accurate and reliable data on the presence and concentration of various metal ions in the water samples.

Finally, it is noteworthy that all the chemicals and reagents used throughout the analysis process were of analytical grade, procured from a trusted supplier, Merck India. Additionally, analytical grade water obtained from a Millipore water purification system (Model: Elix and Synergy) manufactured by Millipore in the USA was employed for the preparation of all standards and solutions used in the analysis. This meticulous attention to detail ensures the accuracy and reliability of the obtained results, providing a robust foundation for understanding the water quality in Modasa city.

2.2.2 Test Procedure:

1. Turbidity:

- Method: Nephelometric Method
- Apparatus:
    - Nephelometer conforming to ISO 7027:1999 "Water quality -

Determination of turbidity by nephelometry"

- Sampling bottles made of borosilicate glass or polyethylene

- Procedure:

a. Calibrate the nephelometer using the manufacturer's instructions and standardized formazin solution.
b. Collect a representative water sample in a clean, dry glass or polyethylene bottle.
c. Ensure the sample is free from air bubbles and any suspended particles settled at the bottom.
d. Pour the sample into the sample cell of the nephelometer.
e. Measure the turbidity of the sample directly using the calibrated nephelometer.
f. Report the turbidity value in Nephelometric Turbidity Units (NTU).

2. pH:

- **Method:** Electrometric Method
- **Apparatus:**
  - pH meter conforming to IS 12630 (Part 1 & 2):2010 "Electrometric pH measurements - Part 1: Specification for pH meters and combined pH electrodes; Part 2: Laboratory reference, routine and field reference methods"
  - Standard buffer solutions with pH values close to the expected pH of the sample water
- **Procedure:**
  a. Calibrate the pH meter using the manufacturer's instructions and standardized buffer solutions with pH values bracketing the expected pH of the sample water.
  b. Collect a representative water sample in a clean, dry glass or polyethylene bottle.
  c. Rinse the electrode with a portion of the sample water and discard the rinse water.
  d. Immerse the electrode in the sample and ensure good contact between the electrode and the sample.
  e. Allow the reading to stabilize on the pH meter display.
  f. Record the pH value displayed on the meter.
  g. Rinse the electrode with deionized water and store it as per the manufacturer's instructions.

3. Total Hardness:

- **Acceptable Limit:** BIS doesn't specify a single numerical limit for total hardness. However, it recommends that hardness, expressed as CaCO3 (calcium carbonate), be reduced whenever it exceeds 200 mg/L to make the water more palatable for drinking.
- **Standard Test Method:** The BIS standard references IS 3025 (Part 21) (Methods of sampling and test (physical and chemical) for water and wastewater, Part 21: Hardness) for determining total hardness. This method involves a titrimetric procedure using a standard solution of a chelating agent, typically EDTA (Ethylenediaminetetraacetic acid).

Here's a simplified explanation of the BIS method for total hardness:

1. **Sample Preparation:** A measured volume of the water sample is taken in a conical flask.
2. **Indicator Addition:** A small amount of an indicator solution, like Erichrome Black T, is added to the sample. This indicator changes color depending on the presence of free metal ions (hardness) in the water.
3. **Titration:** A standard EDTA solution of known concentration is gradually added to the sample using a burette while continuously stirring. EDTA reacts with the calcium and magnesium ions (primary contributors to hardness) in the water, forming a stable complex and removing them from solution.
4. **Endpoint Determination:** As the EDTA solution is added, the indicator color changes, signifying the point where all the metal ions have been complexed by EDTA. This endpoint signifies the total hardness of the water sample.
5. **Calculation:** The volume of EDTA solution used and its concentration are used to calculate the total hardness, typically expressed in milligrams per liter (mg/L) of calcium carbonate (CaCO3).

4. Alkalinity:

- **Acceptable Limit:** BIS doesn't specify a single limit for alkalinity. However, excessively high or low alkalinity can affect water quality. The standard recommends considering alkalinity along with other parameters for overall water quality assessment.
- **Standard Test Method:** The BIS standard references IS 3025 (Part 51) (Methods of sampling

and test (physical and chemical) for water and wastewater, Part 51: Carbonate and Bicarbonate) for determining alkalinity. This method involves a two-part titration process to differentiate between carbonate ($CO3^{2-}$) and bicarbonate ($HCO3^{-}$) alkalinity.

Here's a simplified explanation of the BIS method for alkalinity:

1. **Sample Preparation:** A measured volume of the water sample is taken in a conical flask.
2. **Phenolphthalein Titration:** A few drops of phenolphthalein indicator solution are added. This indicator changes color in the presence of free hydroxide ions (OH^{-}) associated with carbonate alkalinity. The solution is then titrated with a standard solution of sulfuric acid (H2SO4) until the pink color disappears. The volume of acid used corresponds to the carbonate alkalinity.
3. **Methyl Orange Titration:** After the first titration, a few drops of methyl orange indicator solution are added. This indicator changes color in the presence of both carbonate and bicarbonate alkalinity. The solution is again titrated with the standard sulfuric acid solution until a specific endpoint color is reached. The additional volume of acid used corresponds to the bicarbonate alkalinity.
4. **Calculation:** The volumes of sulfuric acid used in each titration and their concentration are used to calculate carbonate alkalinity and bicarbonate alkalinity, typically expressed in mg/L of CaCO3. Total alkalinity is then obtained by summing the carbonate and bicarbonate alkalinity values.

5. Calcium, Magnesium, sodium, Potassium and Iron: It is measured using **Flame Atomic Absorption Spectrometry (FAAS) (Referred to in general BIS standards)**

This instrumental technique offers a highly accurate and reliable method for measuring individual metal concentrations, including calcium and magnesium. Here's a simplified overview:

- **Sample Preparation:** The water sample might require pretreatment steps like acidification or dilution depending on the specific FAAS instrument and analysis requirements.
- **Atomization:** The prepared sample is introduced into the FAAS instrument, where it's subjected to high temperatures, causing it to atomize (convert into individual atoms).
- **Light Absorption:** The atomized sample is then exposed to specific wavelengths of light characteristic of the elements of interest (calcium and magnesium in this case). Each element absorbs light at specific wavelengths.
- **Signal Measurement:** The FAAS instrument measures the amount of light absorbed at the characteristic wavelengths for calcium and magnesium.
- **Concentration Determination:** The instrument uses a calibration curve (prepared using standard solutions with known concentrations of calcium and magnesium) to convert the measured light absorption into the actual concentration of these elements in the water sample.

6. Chlorine:

- Acceptable Limit: The BIS standard specifies a residual chlorine range of 0.2 to 1.0 mg/L for disinfected drinking water.
- Standard Test Methods: Primary method referenced by the BIS standard for measuring chlorine residual:
    - DPD Colorimetric Method (IS 3025 Part 26 - Methods of sampling and test (physical and chemical) for water and wastewater, Part 26: Chlorine, residual)

This widely used method involves adding a DPD (N,N-Diethyl-p-phenylenediamine) indicator solution to the water sample. The DPD reacts with the free chlorine present in the water, producing a colored complex. The intensity of the color is directly proportional to the chlorine concentration and can be measured using a spectrophotometer or visually compared to a color chart for qualitative estimation.

7. Fluoride:

- Acceptable Limit: The BIS standard recommends an optimal fluoride concentration of 1.0 mg/L for drinking water. However, permissible limits may vary depending on climatic conditions and potential health risks associated with excessive fluoride intake.
- Standard Test Methods: Primary method referenced by the BIS standard for measuring fluoride concentration:
    - Ion Selective Electrode (ISE) Method (Referred to in general BIS standards)

This technique utilizes an ion-selective electrode specifically sensitive to fluoride ions. When the electrode is

immersed in the water sample, the fluoride ions interact with the electrode membrane, generating a potential difference. The measured potential is directly proportional to the fluoride concentration in the water.

8. Nitrate (NO3-):

- Acceptable Limit: The BIS standard specifies a maximum permissible limit of 45 mg/L for nitrate in drinking water.
- Standard Test Methods: Primary method potentially applicable for nitrate measurement is **Ion Chromatography (IC):** This technique separates dissolved ions based on their interaction with a specialized column. Nitrate ions are separated from other ions in the water sample and then detected by a conductivity detector. The detector signal is then compared to a calibration curve prepared with standard solutions with known nitrate concentrations to determine the unknown nitrate concentration in the water sample.

9. **Sulfate ($SO4^{2}$-):**

- **Acceptable Limit:** The BIS standard specifies a maximum permissible limit of 200 mg/L for sulfate in drinking water.
- **Standard Test Methods:** Primary method potentially applicable for sulfate measurement:
    - **Gravimetric Method (IS 3025 Part 47 - Methods of sampling and test (physical and chemical) for water and wastewater, Part 47: Sulfate)**

This traditional method involves the precipitation of sulfate ions as barium sulfate (BaSO4) through the addition of a barium chloride (BaCl2) solution. The formed barium sulfate precipitate is then filtered, dried, and weighed. The weight of the precipitate is then used to calculate the original sulfate concentration in the water sample.

10. The Bureau of Indian Standards (BIS) doesn't outline a single specific procedure for bacteriological analysis of total coliform and fecal coliform in drinking water within its specification, IS 10500:2012. However, the standard references a well-established method:

10. Methods of sampling and microbiological examination of water

This standard provides detailed procedures for the detection and enumeration of total coliforms and fecal coliforms in water samples. Here's a simplified breakdown of the key steps involved:

1. Sample Collection:

- Sterilized bottles, typically made of high-density polyethylene, are used for sample collection.
- Specific disinfection procedures are outlined for ensuring bottle sterility.
- Grab sampling is the preferred method, where a representative sample is collected from the chosen location at a specific time.
- Samples must be collected aseptically (minimizing contamination) and transported to the laboratory within a specific timeframe (typically within 24 hours with proper chilling at 4°C) for analysis.

2. Media Preparation:

- Specific culture media formulations are outlined in the standard for both total coliform and fecal coliform analysis. These media provide the necessary nutrients for bacterial growth.
- Examples of commonly used media include:
    - MacConkey Agar for total coliform: This medium allows for the differentiation of lactose-fermenting coliforms (usually pink colonies) from other lactose-fermenting bacteria (usually yellow colonies).
    - Lauryl Tryptose Broth (LTB) for total coliform: This liquid medium allows for the detection of coliforms based on gas production during fermentation.
    - Fecal Coliform confirmation media like EC Broth or M-FC Broth: These broths are used to confirm the presence of fecal coliforms from presumptive coliform colonies obtained on MacConkey Agar.

3. Membrane Filtration Technique:

- This is the preferred method for analyzing drinking water samples as per IS 1622.
- A measured volume of the water sample is filtered through a sterile membrane filter with a specific pore size (typically 0.45 micrometers).
- The membrane filter traps bacteria from the sample on its surface.
- The filter is then placed onto a specific culture medium depending on the analysis (total coliform or fecal coliform).

4. Incubation:

- The inoculated membranes are incubated at a specific temperature (typically 37°C) for a defined

period (typically 24-48 hours) to allow bacterial growth.

5. Colony Counting and Interpretation:

- After incubation, the number of colonies formed on the membrane filter is counted using a colony counter.
- The colony count is then used to calculate the Most Probable Number (MPN) of total coliform or fecal coliform bacteria per 100 ml of water sample using statistical tables provided in the standard.
- The presence or absence of total coliforms and fecal coliforms is determined based on specific criteria outlined in the standard, along with colony morphology (appearance) on the culture media.

III. RESULTS AND DISCUSSION

The detailed discussion of analysed physico-chemical characteristics of collected water samples from Aravalli district is presented under. These results are also compared with Bureau of Indian Standard IS 10500 recommended for drinking purpose.

3.1. Turbidity and pH

The turbidity values fluctuated from 1.0 to 24 NTU and7.8 to 9.8 NTU, respectively during pre- and post monsoon seasons. Site no.1 (i.e. Sayara) has higher turbidity value as 24 NTU than the permissible limit of 5NTU during pre-monsoon season. The higher turbidityvalues in water sources of Aravalli district has also been verified by the monitoring study of Govt. of India. The pH values ranged from 7.10 to 8.26 and from 7.38 to7.87 during pre- and post-monsoon seasons, respectively.The pH values in all drinking water sources were found within the recommended limit of BIS as 6.5 to 8.5.

3.2. Total Hardness and Alkalinity

The range of total hardness were found in between 41to 152 mg/l and 21 to 69 mg/l, respectively during pre and post-monsoon seasons for all the samples falling within the desirable limit of 200 mg/l of BIS. Alkalinity values in the analyzed water samples were obtained from27 to 114 mg/l and 18 to 52 mg/l, respectively during pre and post-monsoon seasons. The results show that allconcentrations were found to be within the desirable limitof 200 mg/l.

3.3. Total Dissolved Solids (TDS)

TDS values fluctuated from 68 to 236 mg/l and 49 to116 mg/l, respectively in pre- and post-monsoon seasons.TDS content in all the samples were well within the desirable range of 500 mg/l of BIS.

3.4. Calcium and Magnesium

The calcium contents in water samples ranged within 9.45 to 36 mg/l during pre-monsoon season and 4.45 to 15mg/l during post-monsoon season. The magnesium content varied from 4.28 to 15 mg/l and 1.80 to 7.39 mg/l, respectively for pre- and post-monsoon seasons. The results indicate that no site exceeded the concentration ofcalcium and magnesium from their desirable limits as per BIS 10500 of 75 and 30 mg/l, respectively.

3.5. Sodium and Potassium

The values of sodium were quite lower in analysed water samples, which fluctuated from 2.86 to 3.87 mg/land 2.62 to 6.73 mg/l, respectively in pre- and post monsoon seasons. The sodium values in all samples werewell within the prescribed limit of WHO as 20 mg/l. The potassium ion concentration oscillated within 0.88 to 1.72mg/l during pre-monsoon season and 0.39 to 2.43 mg/lduring post-monsoon season. BIS and WHO have notprescribed any limit for potassium ions in drinking water but it is useful for total ionic balance as well as important nutrient for human body. The seasonal variations for potassium ion were negligible during study.

3.6. Chloride and Fluoride

The chloride concentrations were found from 12 to 18mg/l and 8 to 12 mg/l in analysed samples during pre- andpost-monsoon seasons. Fluoride concentration ranged from 0.34 to 0.43 and 0.05 to 0.23 mg/l, respectively during pre- and post-monsoon seasons. No sample exceeded the desirable limit of 250 mg/l for chloride and1.0 mg/l for fluoride.

3.7. Nitrate and Sulphate

The values of nitrate were confined between 0.4 to 3.4and 0.6 to 1.4 mg/l, respectively during pre- and post-monsoon seasons. Nitrate concentration in water samples of all sites were well within the prescribed limit of 45 mg/l.The sulphate concentration fluctuated in a limited range of ND (not detected) to 18 mg/l in pre-monsoon season and ND to 12 mg/l in post-monsoon season. The collected concentrations of sulphate were much lower than thedesirable limit of sulphate as 200 mg/l.

3.8. Iron

In the drinking water samples, the iron content was from 0.104 to 0.364 mg/l and 0.073 to 1.777 mg/l, respectively during pre- and post-monsoon seasons. The maximum concentrations of iron as 0.364 mg/l and 1.777mg/l were recorded at Sarvodaynagar (Mazum River)sampling site no.1 during both pre- and post-monsoon seasons. These concentrations of iron were higher than the permissible limit of 0.3 mg/l, which is further confirmed by another study.

3.9. Bacteriological (Total Coliform and FecalColiform) Analysis

In the bacteriological assessment of water sources ofstudy area, total coliform were recorded from absent to160 colonies/100ml during pre-monsoon season. While in post-monsoon season, these organisms were recorded as 9 colonies/100ml at Sarvodaynagar (Mazum River) sampling location. Fecal coliform counts were found as 75colonies/100ml only at Sarvodaynagar sampling site during premonsoon season, while in post-monsoon season, all siteswere free from any fecal contamination. In the study,higher total and fecal coliform contaminations were noted only at Sarvodaynagar sampling site (Site no.1).

IV. SUITABILITY OF WATER FOR DRINKINGPURPOSE USING WATER QUALITY INDEX

Weight Arithmetic Water Quality Index Method wasemployed in determining the water Quality Index forassessing the suitability of water sources for drinkingpurpose. Such WQI has been extensively used for surfaceand groundwater quality assessment, mainly in differentregions of India and also outside. The index classifies the water quality based on the purity of sampleby using the most commonly measured water qualityparameters. This index was computed by using thefollowing steps:

In the first step, water quality parameters includingTDS, HCO3, Cl, SO4, NO3, F, Ca, Mg, Na and K wereselected to summarize the water quality, which indicatethe considerable impact in the regions.In the second step, quality rating or subindex (qi) iscomputed for each of the parameter by using the givenexpression:

$$q = V - Videal/ Vstandard - Videalx\ 100$$

Where, Vactual is the estimated value of ith parameter in the analysed water sample; Videalis the ideal value of thisparameter in pure water. The ideal value is zero for allparameters except pH =7.0 and Vstandard is the recommended standard value of ithparameter given.

In the third step, the unit weight (Wi) for each waterquality parameter was determined by using the followingformula:

$$Wi = K / Si$$

Where, Si is standard value of ith parameter recommended by BIS; K is the proportionality constant which iscalculated by using the following equation:

$$K = 1/ \Sigma 1/ Si$$

In the final step, the overall WQI is calculated by usingfollowing formula:

$$WQI = \Sigma qiWi/ \Sigma Wi$$

The water quality ratings on the basis of index value for this WQI are summarized .

The results of WQI method during pre- and post monsoon seasons are summarized. The valuesof WQI ranged from 30.52 to 37.98 during pre-monsoonseason and from 5.31 to 22.51 in post-monsoon season.

All water samples in pre-monsoon season indicate the‘Good’ water quality with ‘B’ grade, whereas in post monsoon season, all samples were of ‘Excellent’ waterquality with ‘A’ grade water. The lowering of results inpost-monsoon season shows the dilution effect of rainwater in monsoon season. Overall results conclude thatwater samples of all sites of Aravalli district were foundsuitable for drinking purpose during both pre-monsoon seasons.

V. CONCLUSION

Major drinking water sources in Aravalli district aresurface water sources. The quality of surface water variesfrom one season to another season due to the heavyrainfall of the region. The water quality of major surfacewater sources of study area has been assessed for drinkinguses by analyzing various physico-chemical and bacteriological parameters during pre- and post-monsoonseasons. The ranges of turbidity and iron are significantlyvarying in surface water and exceed the desirable as wellas permissible limits of BIS specification. Coliformcontamination in surface water is also high. Piper

diagrams indicate the dominancy of calcium, magnesiumand bicarbonate ions in all the selected samples i.e. Ca-Mg-HCO3 water type. Water Quality Index (WQI) revealsthe ‘Good’ and ‘Excellent’ water quality during pre- and post-monsoon seasons, respectively. The results of thestudy confirm the suitability of all selected water sourcesfor drinking purposes. But, regular monitoring is requiredto determine the pollution load with follow up treatmentof water toimprove the water quality, which is being usedfor drinking purpose.

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