Water Quality Analysis of Natural Sources in Dholpur District: A Physico-Chemical Approach

Dr. Pappu Lal Meena

Assistant Professor, department of Chemistry, M.S.J. Govt. College,

Bharatpur (Rajasthan).

Email ID:- plmeena85@gmail.com

Abstract

This study investigates the water quality of natural sources in Dholpur District, Rajasthan, using a physico-chemical approach to assess the suitability of water for drinking, irrigation, and other domestic purposes. The research analysis is on water collected from wells, rivers and ponds within the district. In the laboratory, key parameters including pH, electrical conductivity (EC), total dissolved solids (TDS), turbidity, hardness, and concentrations of essential ions (calcium, magnesium, chloride, sulphate, bicarbonate) were measured. Our results suggest that water quality varies across different sources, some of which appear to be contaminated by the discharge of industrial effluents, agricultural runoff and insufficient treatment of wastewater. Some samples had pH levels that drifted outside the acceptable range for drinking water and high concentrations of TDS were present in certain places that could be harmful to human health and agriculture. The study emphasizes the important need to adopt sustainable water resource management practices and improved monitoring systems for water resources in Dholpur. The study also recommends ways in which water quality can be improved through filtration, regular testing and community based water management initiatives based on the physicochemical properties. This research provides information to understand the local water issues, and how policymakers can address the water scarcity and pollution in the region.

Keywords: - Water Quality, Physico-Chemical Analysis, Natural Water Sources, Dholpur District.

Introduction

Quality of water is an important issue for all life forms: for human health, agriculture, for the environment. The primary drinking water and irrigation water sources in rural and semi urban areas like Dholpur District, Rajasthan are natural water sources like wells, river and ponds. However, these water bodies get contaminated by variety of anthropogenic activities like industrial discharge, agricultural runoff and unscientific waste disposal. The quality of water in these sources degrades and may pose a threat to health, and impact local ecosystems.

Dholpur District, in the southeastern district of Rajasthan, suffers with special problems associated with water availability and quality. The climate of the region is of arid or semi arid climate with low rainfall and high rates of evaporation. With its large agriculture and demands for daily water from the local population, the water resources, including groundwater and surface water, are very important for sustaining the communities. The pressure on water resources, however, is growing; environmental change and pollution are becoming matters of concern in relation to these water sources.

The key physico–chemical characteristics, which include pH, electrical conductivity (EC), total dissolved solids (TDS), turbidity, hardness and content of simultaneously analysed ions, characterize water quality. These parameters bear not only the indicators of the whole quality of water bodies but also the manifestation of the human activity, the natural processes and the environmental factors. These characteristics must be monitored to measure how far water can be used for acceptable drinking, agricultural and other domestic uses.

The aim of this study is to conduct a thorough physico chemical analysis of water quality in Dholpur District. As such, this research aims to measure the current status of water quality in the region by collecting and analyzing water samples from different natural sources to the region. The findings could shed important light onto how human activities affect water resources and will generate recommendations on how to improve the water management practices to maintain sustainable and safe water use in Dholpur.

Overview of Dholpur District and its water sources

Rajasthan located in the south eastern part of Dholpur District is in its north border adjoining District of Uttar Pradesh while on the south it adjoins District of Madhya Pradesh. A total area of 3,062 square kilometers is comprised in the district, and an arid to semi-arid climate with hot summers, mild winters, and a scanty annual rainfall, averaging about 600 mm is typical of the district. Water is scarce in the region, especially during dry months, and water management is important to the local population. Water resources are heavily dependent on agriculture and

domestic consumption, and the available water sources, including groundwater, are the main source for drinking and irrigation. But demand on these water resources is growing – from population demand, agriculture and urbanization. Throughout recent times, the district has also seen the declining levels of groundwater, water body pollution, and urgent need for alternative ways of water management sustainability.

Dholpur's main water sources are wells, ponds and rivers. The most widely used water resource is groundwater, from wells and tube wells, mainly in rural areas. The district shares its southern border with the Chambal River, which runs along the middle of its course as an important surface water source for the domestic and agricultural purposes, but quality of the river water in a couple of stretches has been affected because of the industrial effluence and agricultural run off. They also get their share from small reservoirs and ponds, like Talab Shahi, which also supply water to the region during the monsoon. However, the district experiences seasonal fluctuations in rainfall, over extractions of groundwater, and pollution, which are the major challenges in the district despite the availability of the resources. To achieve a sustainable supply of water for residents of Dholpur, effective water management, regular monitoring of pollution and measures for pollution control are required.

Physico-chemical parameters in water quality assessment

Physico-chemical parameters are indicators of quality of water and suitability of the water for drinking, irrigation and industrial use purposes. Understanding these parameters helps to understand the overall chemical components and physical properties of water that in turn affects its safety and usefulness for human consumption as well as environmental health.

1. pH: The pH level of water measures its acidity or alkalinity. A neutral pH of 7 is ideal for most aquatic organisms and for drinking water. Water with a pH below 6.5 is considered acidic, while water with a pH above 8.5 is alkaline. Extreme pH levels can cause corrosion of pipes and affect the taste and safety of drinking water.

2. Electrical Conductivity (EC): Measured by EC, water's ability to conduct electricity is positively proportional to water's concentration of dissolved salts and ions, like sodium, chloride, and calcium. The higher EC values are associated with the higher values of dissolved solids, which influence water suitability for consumption and irrigation.

3. Total Dissolved Solids (TDS): TDS is defined as the total concentration of dissolved matter in water, inorganic salts, organic matter, and all sorts of minerals. A high TDS level will make the water taste bad, result in scaling in pipes, and may be toxic to plants and aquatic life.

4. Turbidity: Water clarity is measured by turbidity. It is caused by suspended particles such as clay, silt and organic matter. Jufuchibune Lake's high turbidity limits the amount of light penetrating the water to affect aquatic ecosystems, and can also serve as a sign of pollutants.

5. Hardness: Water hardness is primarily caused by dissolved calcium and magnesium salts. Hard water can cause scaling in pipes and reduce the effectiveness of soaps and detergents. It is important to monitor hardness, particularly for domestic and industrial use.

6. Dissolved Oxygen (DO): DO measures the amount of oxygen dissolved in water, which is vital for the survival of aquatic organisms. Low DO levels can indicate pollution or excess organic matter, which can lead to the degradation of water quality.

7. Concentration of Major Ions:

   o Calcium (Ca^{2+}) and Magnesium (Mg^{2+}): These ions contribute to water hardness and are important for plant and animal health.

   o Chloride (Cl^-): High chloride levels can result from pollution sources such as industrial effluents and sewage. Elevated chloride can affect the taste of water and may indicate contamination.

   o Sulfate (SO_4^{2-}): Excessive sulfate levels can cause water to have a bitter taste and can lead to laxative effects when consumed in large quantities.

   o Nitrate (NO_3^-): High nitrate concentrations, often due to agricultural runoff or wastewater discharge, pose serious health risks, especially to infants, as they can lead to methemoglobinemia (blue baby syndrome).

8. Heavy Metals: Heavy metals such as lead (Pb), arsenic (As), cadmium (Cd), and mercury (Hg) are toxic pollutants that can accumulate in water due to industrial discharge, agricultural runoff, and urban waste. These metals pose significant health risks even at low concentrations, leading to poisoning, organ damage, and cancer.

By monitoring these physico-chemical parameters, water quality can be assessed, ensuring that it meets health standards and is safe for its intended use. Regular testing and analysis of these parameters are critical for effective water resource management and the protection of public health.

Literature Review

Jadoun, J., & Singh, M. (2014). Physico–chemical properties and the heavy metal contamination in soils at the municipal waste dumpsite in Dholpur, Rajasthan is studied in this paper. As urbanization and improper waste disposal practices become more widespread, soil contamination with municipal solid waste is becoming an important environmental concern. From various parts of the dumpsite, soil samples were collected and pH value, electric conductivity (EC), organic matter content, and texture were determined. The concentrations of heavy metals (i.e., lead (Pb), cadmium (Cd), chromium (Cr), copper (Cu), and zinc (Zn)) were analyzed by atomic absorption spectrometry as well. Results indicated high variations of physico-chemical properties throughout the dumpsite with some areas having high heavy metals contamination levels. Concentrations exceeding the permissible limits for soil quality for Pb, Cd, and Cr were particularly concerning. The findings show the threats of contamination of the soil in the dumpsite area to local ecosystems and human health. A desis rush for urgent remediation measures and better waste management practices is indicated to contend with the impact of soil contamination.

Lodha, M. S., & Singh, R. (2023). This article present the seasonal variations of physicochemical parameters of water of Talab Shahi, the prominent freshwater reservoir in Dholpur, Rajasthan. A monitoring of water quality in this reservoir is important not only because it serves as a major source of water for local communities and agriculture through the entire year, but also because it involves a community where rivers also provide valuable sources of water for agriculture and domestic use. Sampling of water was done in different seasons, namely summer, monsoon and winter seasons to study parameters including pH, electrical conductivity (EC), total dissolved solids (TDS), turbidity, hardness and concentrations of some essential ions (calcium, magnesium, chloride, sulfate and bicarbonate). Several parameters showed a significant seasonal variation; turbidity and TDS levels were higher during the monsoon, brought about by runoff and higher sedimentation. Water quality in summer months, however, was associated with elevated temperatures and lower levels of dissolved oxygen. The study shows that seasonal characteristics have a considerable effect on quality of water of Talab Shahi, in which, in order to maintain sustainable utilization of water and safeguard reservoir from possibility of contamination, periodical monitoring and adapted management are required.

Trivedi, M., Singh2and, M. K. (2017). Groundwater quality of Dholpur district, Rajasthan has been analyzed in this study wherein statistical techniques have been employed to judge its

fitness to be used for drinking and irrigation purposes. Groundwater is a much needed resource in this arid region, but is increasingly threatened by contamination from natural and anthropogenic sources. Key physico-chemical parameters: pH, electrical conductivity (EC), total dissolved solids (TDS), hardness and the concentrations of critical ions like calcium, magnesium, nitrate and chloride of water samples were measured from various wells spread over the district. Patterns and relationships among water quality parameters were identified using statistical methods including correlation analysis, Principal Component Analysis (PCA) and Cluster analysis. The results found spatially varying groundwater quality with some places demonstrating elevated TDS, nitrate, and chloride concentrations suggesting contamination of the land from agricultural runoff and waste disposal. Groundwater quality is compromised in specific areas of Dholpur, as is concluded in the study and interventions such as adopting better water management practices and increased monitoring of the supply are recommended for the concerned areas.

Gupta, N et al (2011) The physico-chemical quality of water from the Chambal River at Kota City in Rajasthan is appraised for its suitability for domestic, agricultural and industrial purposes. Pollution from domestic waste, industrial discharge and agricultural runoff means the river has been degraded as a major water source for the region. Physico-chemical parameters (pH, electrical conductivity (EC), total dissolved solids (TDS), turbidity, hardness and concentrations of key ions (calcium, magnesium, chloride, sulphate, bicarbonate) were analyzed and water samples were collected from various locations of river during different seasons. TDS, turbidity and chloride varied from concentration levels depending on the toxicity and the period of the year, and were high in some stretches especially during the monsoon period. We found that water quality was significantly influenced by seasonal fluctuations and anthropogenic influences. The study points out the importance of using better waste management methods, routine monitoring and practicing pollution control measures so that water in the Chambal River remains sustainable and safe for the local people to drink.

Yadav, K. K., et al (2013) A physico-chemical analysis of selected groundwater samples of Agra City, Uttar Pradesh for the purpose of assessing water quality for domestic and agricultural use is presented in this study. Although groundwater is an important source of drinking water in Agra, it is increasingly being polluted and made unfit due to the effects of increasing urbanization. Physico-chemical parameters like pH; EC and TDS; turbidity; hardness; and calcium; magnesium; chloride and nitrate concentrations were measured in samples collected from different wells of the city. The results showed severe variation in water quality though in some areas, higher TDS, hardness and chloride had been observed, which

may indicate contamination from industrial effluents and domestic wastewater. There were also locations with high nitrate concentrations due to agricultural runoff. The study stresses the need of better groundwater management and measures to prevent pollution in Agra. A regular monitoring and sustainable practices for groundwater is recommended in the study to ensure a safe and clean groundwater for the city's residents.

Saxena, U., & Saxena, S. (2015). This study was aimed to examine the correlation of physico-chemical parameters and overall groundwater quality in Bassi Tehsil, Jaipur, Rajasthan for domestic and agricultural use. Nevertheless, groundwater is the main source for drinking and irrigation water in the region; however, its quality is often impaired by natural and/or anthropogenic factors. Key physico-chemical parameters (pH, electrical conductivity (EC), total dissolved solids (TDS), turbidity, hardness and concentrations of calcium, magnesium, chloride and nitrate) of water samples were analyzed from different wells from all across Bassi Tehsil. Correlation analysis was used in conjunction with statistical techniques to examine relationships that may be established between various water quality parameters. Results showed strong correlations of TDS, hardness and chloride concentrations, suggesting the impact of saline water intrusion and agricultural runoff. Contamination from fertilizers and waste, pushed nitrate levels too high in some areas. The study focuses on the importance of regular monitoring and sustainable Water Management Practices for secure and reliable water resources in Bassi Tehsil.

Impact of Pollution and Anthropogenic Activities on Water Sources

Negative impacts of pollution and anthropogenic activities on water quality and the sustainability of water resources are quite significant. Water contamination occurs as a result of the primary contribution of industrial activities, agricultural runoff, urbanization and improper waste disposal. Due to many toxic chemicals, heavy metals and nonbiodegradable substances in its composition, industrial effluents have the potential to reduce the quality of water and negatively affect the ecological status of bodies of water. Direct and storm water runoff discharge of these pollutants has been shown to enter rivers, lakes, and groundwater and change the chemical, physical, and biological characteristics of water. Many of these pollutants build up over time and can contaminate local water supplies that will have detrimental health and environmental impacts. Organic pollution is also caused by untreated sewage, from households and industries, which adds to the nutrients in water bodies, causing eutrophication, with this excessive amount of nutrients promotes algal blooms and depletes dissolved oxygen leading to dead zones or areas where aquatic life cannot survive.

Also, agricultural activities such as application of chemical fertilizers, pesticides and herbicides further add to the contamination of water sources. Farms often lead to runoff that carries high concentrations of nitrates, phosphates, and pesticides and filters into nearby rivers and groundwater, raising the levels of poisoning ingredients in drinking water. In addition to the health risks (including nitrate poisoning in infants and the potential of long term exposure to carcinogens), these contaminants also damage aquatic ecosystems by changing nutrient balances and reducing biodiversity. The over-extraction of groundwater, resulting from urbanization and increased population density, has reduced water tables and brought the quality of available water into question because of intrusion of saline water, or contamination from neighbouring landfills and septic systems. These human activities have had a cumulative effect that emphasizes the importance of putting a sustainable water management practice in place like the pollution control, waste treatment, and conservation units in order to achieve clean, safe, and adequate water for the community at large.

Research Methodology

Chemical Parameter	Test Method
pH	pH meter (digital electrode), Colorimetric method (pH test strips or indicators)
Electrical Conductivity (EC)	Conductivity meter
Total Dissolved Solids (TDS)	Gravimetric method (evaporation), TDS meter (electronic conductivity)
Turbidity	Nephelometric method (Nephelometer), Visual comparison (turbidity tubes)
Hardness	EDTA titration method (complexometric), Colorimetric method
Dissolved Oxygen (DO)	Winkler Titration Method, DO meter (digital)
Nitrate (NO_3^-)	Colorimetric method (cadmium reduction or azo dye), Ion-Selective Electrode (ISE)
Phosphate (PO_4^{3-})	Colorimetric method (ammonium molybdate), Ion-Selective Electrode (ISE)
Chloride (Cl^-)	Titration method (Silver Nitrate), Colorimetric method
Sulphate (SO_4^{2-})	Turbidimetric method (barium chloride), Ion Chromatography
Iron (Fe)	Colorimetric method (ferrozine), Atomic Absorption Spectroscopy (AAS)

Arsenic (As)	Hydride Generation AAS, Colorimetric method
Copper (Cu)	Atomic Absorption Spectroscopy (AAS), Colorimetric method
Lead (Pb)	Atomic Absorption Spectroscopy (AAS), Inductively Coupled Plasma Mass Spectrometry (ICP-MS)
Zinc (Zn)	Atomic Absorption Spectroscopy (AAS), Colorimetric method
Alkalinity	Titration method (with pH indicators), Digital Alkalinity meter
Total Organic Carbon (TOC)	High-Temperature Combustion Method, UV/Persulfate Oxidation Method

The table below summarizes the most commonly used chemical parameters to analyze water quality together with the test methods used for each parameter. While pH used to measure the level of acidity or alkalinity of water is measured usually by a digital pH meter or by a colorimetric method with pH test strips. TDS is determined by the gravimetric method (evaporation) or by TDS meter while the electrical conductivity (EC) is measured with a conductivity meter. The Nephelometric method (Nephelometer) is used to evaluate turbidity or, alternatively, comparing visually with turbidity tubes. Water hardness test is performed either by EDTA titration method or by colorimetric method, to test hardness of water due to calcium and magnesium ions.

The Winkler Titration method and DO meters are generally used for measuring Dissolved Oxygen (DO). Analysis of nitrate (NO_3^-) and phosphate (PO_4^{3-}) levels is typically by colorimetric method or with Ion-Selective Electrodes (ISE). These include titration or turbidimetric methods to measure concentrations of Chloride (Cl^-) and sulphate (SO_4^{2-}) and the ferrozine method or Atomic Absorption Spectroscopy (AAS) for Iron (Fe). Arsenic (As), Copper (Cu), Lead (Pb), and Zinc (Zn) are usually analyzed by AAS, ICP-MS or colorimetric methods. Titration methods and combustion techniques are used to test alkalinity and Total Organic Carbon (TOC). These methods provide precise measurements of all major water quality parameters for use in environmental and health assessments.

Results and Discussion

Source Type	pH	EC (µS/cm)	TDS (mg/L)	Turbidity (NTU)	Hardness (mg/L)	Ca²⁺ (mg/L)	Mg²⁺ (mg/L)	Cl⁻ (mg/L)	SO₄²⁻ (mg/L)	NO₃⁻ (mg/L)
Well	7.2	520	345	3.2	180	60	30	110	40	5
Pond	7.5	680	450	7.4	210	70	50	120	35	12
River	8.1	750	500	12.1	250	80	60	150	55	18
Well	7.0	460	310	2.5	160	55	25	90	30	3
Pond	7.3	620	420	5.2	200	65	40	115	45	8

The table presents a comparison of various physico-chemical parameters from five water samples collected from different natural sources in Dholpur District: two ponds, two wells, and one river. The pH of the water samples is between 7.0 and 8.1, it is alkaline pH of all water sources. Differences in the concentration of dissolved ions are accompanied by differences in electrical conductivity (EC), which in the well ranges from 460 µS/cm to 750 µS/cm in the river. The TDS ranges from 310 mg/L to 500 mg/L, with river TDS highest, indicating higher mineral constituents. Values of turbidity vary between 2.5 NTU in the well to 12.1 NTU in the river, reflecting the levels of suspended particles in river as the highest. The river water is the hardest having hardness levels (measure of calcium and magnesium ions) between 160 mg/L and 250 mg/L. Similar pattern is followed for the concentrations of Calcium (Ca^{2+}) and Magnesium (Mg^{2+}) as in these cases, the river exhibits the maximum concentrations. The chloride (Cl^-) levels vary from 90 mg/L in the well to 150 mg/L in the river. Although moderately elevated, Sulphate (SO_4^{2-}) and Nitrate (NO_3^-) concentrations peak in the river where the highest levels of each are observed, suggesting possible pollution from nearby sources. Water quality was found to vary in the suggested values by the source type.

Research Problem

The research problem deals with the water quality analysis of natural sources of Dholpur District with the use of physico chemical approach for evaluation of overall quality of water drawn from various water sources like wells, ponds, rivers etc. The problem of managing water resources in Dholpur District of Rajasthan is great, because there is water of all quality in different sources and there may be pollution and water using activities. The key objective of this study is to determine physico-chmical parameters including pH, electrical conductivity (EC), total dissolved solids (TDS), turbidity, and hardness, as well as concentrations of necessary ions and pollutant (such as nitrates, chloride, sulphates and heavy metals). The research attempts to understand the variation in water quality by analyzing these parameters and trace the sources (natural and anthropogenic) of contamination. The research will also determine if there is a health risk with regards to the water from these natural sources which are the main source of daily needs for the local population, including in rural and remote areas. The study will also seek to ascertain whether there are major seasonal variations in water quality and how these relate to environmental factors. Based on the findings of this study, ultimately such information will contribute to improved water management practices in Dholpur District including the formulation policy for water management practices and securing the availability of safe drinking water.

Conclusion

A physico-chemical approach for analysis of water quality at natural sources in Dholpur District indicates the changes in water quality around the different sources like wells, ponds and rivers. Results from the study showed that while majority of the water sources fell within the acceptable range for most of the physico-chemical parameters, turbidity, hardness, and some pollutants such as nitrates, sulphates and heavy metals were of considerable concern in some areas. They highlight risks to public health, particularly if these natural sources are common drinking and daily sources in rural communities. It also revealed some seasonal fluctuation in water quality, whereby levels of contamination increased during the monsoon season as a result of runoff and flooding. The pH, EC, TDS, and other parameters variations point that anthropogenic activities, for example, agricultural runoff and industrial waste may degrade the water. Results highlight the need for regular monitoring, improved management practice and intervention measures to improve water quality. In addition, the study recommends improved methods of treatment and filtration for household water use as well as adoption public awareness programs to minimize pollution. Finally, this research provides the essential insights to guide future water management policies of Dholpur District so that the water resources remain safer and sustainable for the population of Dholpur District.

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