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# IMPACT OF INDUSTRIAL EFFLUENT ON GROUND WATER OF BALOTRA, RAJASTHAN

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## ABSTRACT

*Industrialization and urbanization are main anthropogenic activities responsible for environmental pollution. This is specifically true about water bodies wherein various toxic solids wastes, effluents and emission discharged, resulting in an excessive amount of toxic and hazardous metals in local groundwater. Due to discharge of untreated industrial effluents in the sewage channels, the groundwater quality deteriorated to great extent therefore availability of healthy, clean, and good quality potable water is a matter of great concern in the urban areas. The extent of groundwater contamination evaluated in the Balotra, Rajasthan. Water samples collected from the hand pumps installed nearby industrial units. These samples analysed for various physicochemical parameters like Total dissolved solids (TDS), alkalinity, pH, hardness, chloride, Nitrate and Total Hardness. Results revealed that in most of cases water samples not fit for drinking purposes when compared with the standard guide lines available for drinking water.*

***Keywords:*** *Environmental Pollution, Groundwater, Physicochemical Parameters, Drinking Purposes.*

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## Introduction

Water, as a fundamental element of life, plays a crucial role in supporting and sustaining all living organisms. However, in the context of today's modern society, the rapid advancement of civilization, urbanization, and population growth, along with industrial activities, has intensified the longstanding issue of water pollution. Consequently, our very existence, the environment that nurtures us, and the medium through which we thrive now contaminated. What is even more concerning is the scarcity of water, coupled with its declining quality, that we currently confront. This situation poses significant challenges to our environment as we grapple with the dual issues of diminishing water quantity and deteriorating water quality.

India, with approximately 18% of the global population, occupies a mere 2.4% of the total geographical area while consuming 4% of the world's water resources. According to a report by the World Bank, India stands as the largest user of groundwater. Groundwater serves as the backbone of India's agricultural sector and provides drinking water security in both rural and urban areas, catering to nearly 80% of the country's drinking water needs and two-thirds of its irrigation requirements (The Hindu, 2023).

Balotra is cloth manufacturing hub in western Rajasthan. In cloth manufacturing related activities like dying, printing, and bleaching took place at one destination. In all these steps various industrial effluent discharge. Major portion of that industrial effluent remain untreated at ultimate reached into groundwater.

When examining sustainable development in relation to human well-being, it is crucial to consider water quality. The quality of water directly affects the welfare of humanity, making it an essential factor that must studied and addressed. In recent years, the expansion of industry, technology, population growth, and water consumption has placed significant strain on both our land and water

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resources. Therefore, preserving and enhancing the quality of groundwater and other water sources has become a top priority in environmental conservation efforts. The degradation of groundwater quality can have long-lasting consequences, and the treatment of contaminated groundwater can be a costly endeavour. Many harmful substances are undetectable by our senses, as they are invisible, tasteless, and odourless, which further complicates their detection and removal. Currently, human activities are the primary source of contamination. According to Kabir et al. (2020), our country faces various sources of contamination, such as chemical pollutants like fluoride, arsenic, and selenium, which pose significant health risks. It estimated that approximately 90 million people are at risk due to excessive fluoride levels. Furthermore, the increasing concentrations of total dissolved solids (TDS) and nitrate in groundwater are major concerns for ensuring sustainable drinking water supplies. The infiltration of pollutants from various sources, including rivers, landfill sites, drains, agricultural effluents, and municipal sewerage systems, is causing the deterioration of potable water. Dumping sites are highly susceptible to contamination production and infiltration, highlighting the need for a comprehensive assessment of their impacts on our ecosystem and the public.

The origins of urban contaminants vary from those found in rural regions and frequently involve higher concentrations of harmful substances that come from sewage, waste disposal sites, industries, and agricultural practices. Specifically, the liquid that seeps out of landfills, known as leachate, is responsible for introducing a wide array of complex chemical compounds, both polar and non-polar, which encompass a multitude of different elements. Furthermore, the levels of organic and inorganic heavy metals, as well as toxic chemicals, have been consistently increasing in numerous areas across the globe. As a result, urban soil that is contaminated poses both direct and indirect risks to human health, affecting it in various manners.

In the year 2023, a total of ten water samples procured from various locations within the Balotra region. These water sources play a vital role in providing drinking water and supporting various domestic activities. To ensure the integrity of the samples, they meticulously collected in high-quality plastic bottles with a capacity of five litters, which thoroughly rinsed with distilled water beforehand.

To determine the physico-chemical characteristics of the groundwater samples, the APHA (2000) standard methods were employed. Portable meters used to measure the pH and electrical conductivity, while volumetric methods utilized to estimate the concentration of magnesium, calcium, hardness, nitrate, and salinity. Subsequently, the obtained results compared with the BIS (1983) standards to assess their compliance.

**Table 1: Various Parameters of Groundwater**

| S. No. | Parameters | Unit | Method Employed |
|---|---|---|---|
| 1. | Total Alkalinity | Mg/L | Titrimetric method (With HCl) |
| 2. | Fluoride | Mg/L | Ion Selective Electrode |
| 3. | Total Hardness (as $CaCO_3$) | Mg/L | Titrimetric method (with EDTA) |
| 4. | Calcium Hardness (as $CaCO_3$) | Mg/L | Titrimetric method |
| 5. | Magnesium Hardness (as $CaCO_3$) | Mg/L | Titrimetric method |
| 6. | Chloride | Mg/L | Titrimetric method (With $AgNO_3$) |
| 7. | Nitrate | Mg/L | Spectrophotometric method |
| 8. | Electrical conductivity | Mhos/cm | Digital Conductivity meter |
| 9. | Total Dissolved Solids (TDS) | Mg/L | Digital Conductivity meter |
| 10. | pH | | Digital pH meter |

**Location of Sampling Stations**

The samples obtained from ten distinct locations, specifically Balotra (A1), Jasoal (A2), Asada (A3), Bithooja (A4), Manjiwala (A5), Kitnod (A6), Parloo (A7), Dudhwa (A8), Gopari (A9), and Mungra (A10).

**Results and Discussion**

The main objective of this study was to evaluate the water quality for household purposes. A comparison conducted between the physico-chemical characteristics of the collected groundwater samples and the standards established by Be. The findings obtained from the analysis of water samples collected from different areas within the Balotra region presented. Furthermore, a comparison made between the physico-chemical properties of the groundwater samples and the drinking water standards outlined in Table 2.

**Table 2: BIS Standards of Permissible and Excessive Limits of Various Parameter**

| S. No. | Parameters | Permissible limit (BIS 2012) | Excessive Limit |
|---|---|---|---|
| 1. | Nitrate | 45 | 100 |
| 2. | Fluoride | 0.9 | 1.5 |
| 3. | Chloride | 250 | 1000 |
| 4. | TDS | 500 | 2000 |
| 5. | TA | 200 | 600 |
| 6. | TH | 300 | 600 |
| 7. | pH | 6.5 | 8.5 |

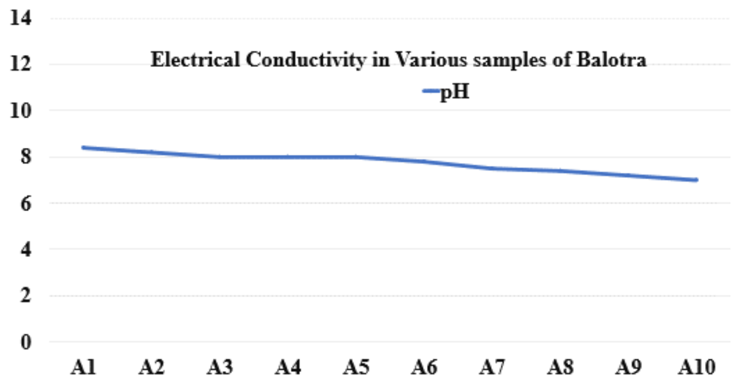
In present study groundwater samples collected from ten different sites and analysis physico-chemical properties. Eight different physico-chemical parameter and results mention in Table 3.

**Table 3: Groundwater Quality in Relation to Physico-Chemical Parameters at Balotra**

| S. No. | Location | pH | EC | TDS | Alkalinity | TH | $F^-$ | $Cl^-$ | $NO_3^-$ |
|---|---|---|---|---|---|---|---|---|---|
| 1. | A1 | 8.4 | 14520 | 8000 | 740 | 3070 | 3.2 | 4600 | 80 |
| 2. | A2 | 8.2 | 8433 | 6700 | 510 | 2250 | 2.8 | 4150 | 53 |
| 3. | A3 | 8 | 7859 | 5700 | 490 | 1710 | 2.4 | 3350 | 67 |
| 4. | A4 | 8 | 7641 | 5100 | 460 | 1140 | 1.9 | 2700 | 63 |
| 5. | A5 | 8 | 7218 | 4900 | 420 | 1090 | 1.6 | 2480 | 58 |
| 6. | A6 | 7.8 | 5178 | 4300 | 350 | 930 | 1.4 | 1450 | 53 |
| 7. | A7 | 7.5 | 3740 | 3300 | 300 | 710 | 1.4 | 1140 | 47 |
| 8. | A8 | 7.4 | 1780 | 2450 | 240 | 570 | 0.8 | 650 | 27 |
| 9. | A9 | 7.2 | 1440 | 1650 | 180 | 450 | 0.5 | 240 | 17 |
| 10. | A10 | 7 | 1240 | 770 | 110 | 310 | 0.5 | 210 | 10 |

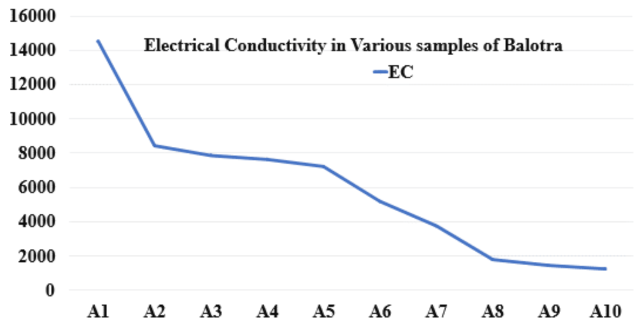
**pH (Power of H ions)**

The pH levels of the ground in Balotra range from 7.0 to 8.4, suggesting that the water samples have a slightly alkaline nature. Additionally, these samples demonstrate elevated salinity levels. Nevertheless, it is important to highlight that the ground water samples remain within the acceptable limits.



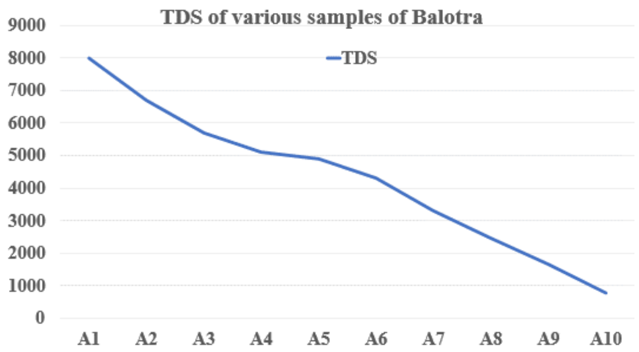

**Electrical Conductivity (EC)**

It widely acknowledged that the measurement of electrical conductance is a reliable indicator for detecting the presence of dissolved solids. The high concentration of sodium in water not only poses a risk to irrigation, but also renders the soil unsuitable for cultivation. In the present study, the electrical conductivity of the water samples varied from 1240 to 14520 mhos/cm. The U.S. Salinity Laboratory has established a classification system for groundwater based on its electrical conductivity, where readings up to 250 mhos/cm considered excellent, 250-750 mhos/cm are classified as good, 750-2250 mhos/cm are categorized as fair, and values exceeding 2250 µ mhos/cm are labelled as poor. According to this classification, none of the water samples fall within the fair category, while all of them fall under the poor category.



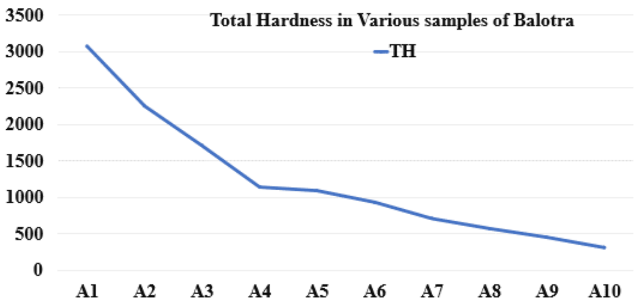

**Total Dissolved Solids (TDS)**

The measurement of Total Dissolved Solids (TDS) used to assess the salinity and overall quality of water. In the specific area under investigation, the TDS values of the water samples ranged from 770 to 8000 mg/L. The World Health Organization (WHO, 1971) has established guidelines for TDS levels in drinking water. According to these guidelines, a TDS level of up to 500 mg/L is highly desirable for drinking purposes, while a maximum permissible limit of 1000 mg/L has been set. Based on the concentration of TDS, groundwater can categorize as follows: TDS levels up to 500 mg/L are suitable for drinking, TDS levels up to 1000 mg/L are permissible for drinking, and TDS levels up to 3000 mg/L are useful for irrigation purposes. However, none of the water samples analysed in this study meet the criteria for considered suitable for drinking.



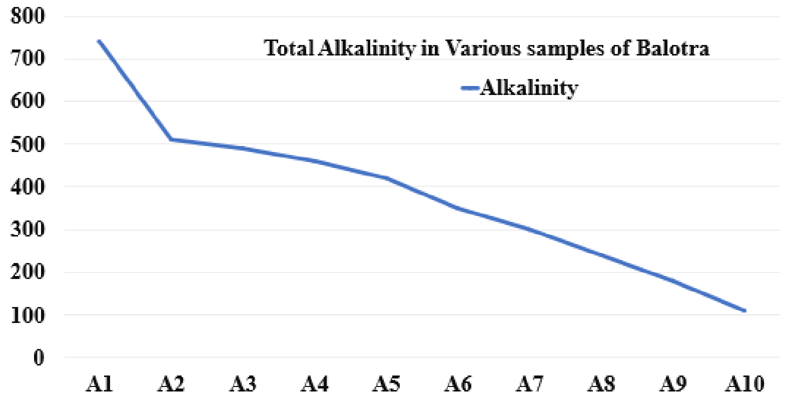

**Total Hardness (TH)**

Water hardness is a result of the existence of soluble bicarbonates, chlorides, and sulphates of calcium and magnesium (Raju, et al., 2014). In the present study, the water samples displayed a hardness range of 310-3070 mg/L. The analysis of the water samples from the study area revealed that almost all of them surpassed the permissible limit according to the hardness classification set by the Bureau of Indian Standards (BIS).



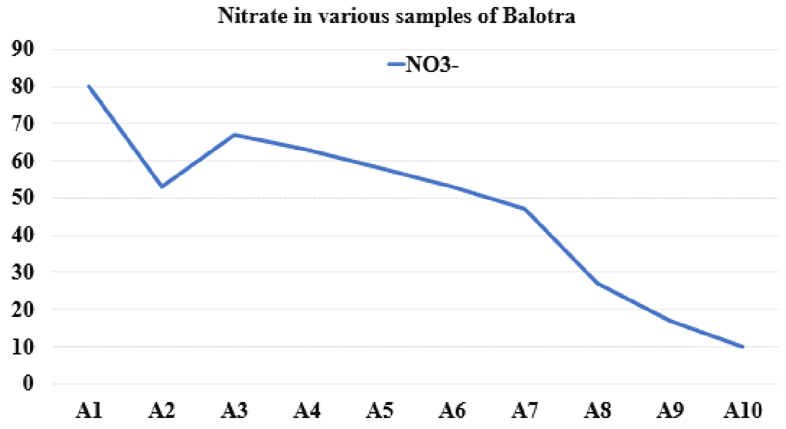
**Total Alkalinity**

The water's alkalinity increased by the presence of phosphates, limestone, and borates, as stated by Boyd et al. (2020). The investigation conducted revealed that the water samples had a hardness range of 310-3070 mg/L. The classification of hardness (BIS) for the water samples in the study area indicated that majority of them exceeded the allowable limit.



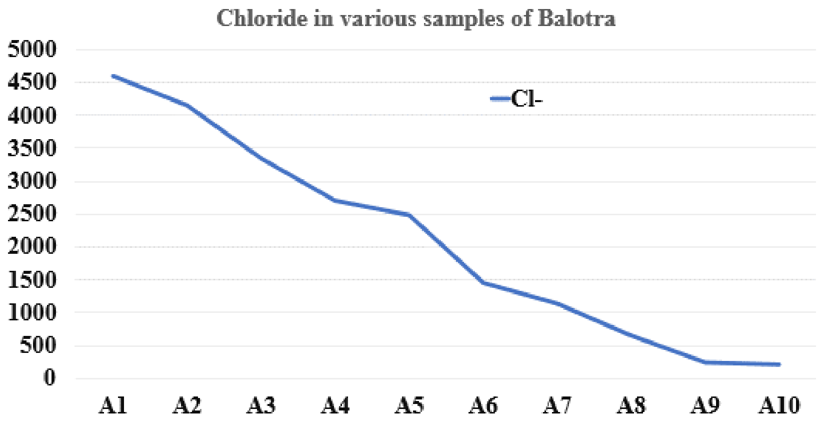

**Nitrate**

The Bureau of Indian Standards (BIS) has established that the maximum allowable level of nitrate in drinking water is 45 mg/L. During the collection of water samples, the concentration of nitrate varied between 10-80 mg/L. It is crucial to monitor nitrate levels in drinking water due to the potential harm it can cause to human health when it exceeds 50 mg/L. Methemoglobinemia, commonly known as "blue baby disease," is a condition that primarily affects bottle-fed infants and can caused by the consumption of water with high nitrogen content (Fewtrell, 2004). Additionally, repeated ingestion of high doses of nitrates can have adverse effects. Although nitrate itself is not toxic, it can converted to nitrite and ammonia, both of which are toxic, when consumed through food or water (Cressey and Cridge, 2021). In this study, 70% of the 10 collected samples exceeded the permissible limit of nitrate, while the remaining 30% fell within the acceptable range.



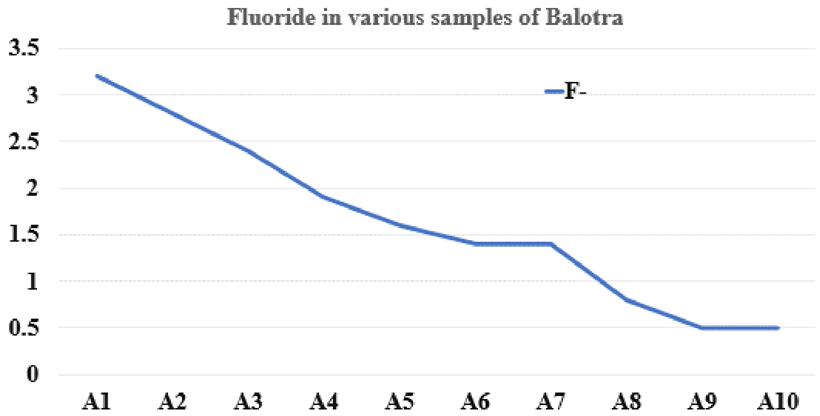

**Chloride ($Cl^-$)**

Water with an excessive amount of chloride can have a distinct salty flavour, and those who not used to high chloride levels may encounter mild consequences. In the specific region under investigation, the chloride concentration ranged from 210 to 4600 mg/L. The Bureau of Indian Standards (BIS) has established the acceptable range of chloride in drinking water to be between 250 and 1000 mg/L. Among the tested water samples, 30% had chloride levels within the acceptable range, while the remaining 70% surpassed the permissible limit.




**Fluoride ($F^-$)**

In their study, Patil, et al. (2018) discovered that the long-term use of groundwater for drinking has resulted in the emergence of a common condition called fluorosis. This condition includes both mild cases of dental fluorosis and severe cases of skeletal fluorosis. The concentration of fluoride in the samples analysed varied from 0.5 to 8.3 mg/L. Among all the samples, 7 of them had fluoride levels within the acceptable range, while the remaining 3 samples had elevated fluoride levels that made them unsuitable for consumption.




**Conclusion**

Balotra is currently facing several challenges related to groundwater, including water scarcity, significant pollution at the local level, and the depletion and excessive use of resources. The main source of pollution in the area investigated is unregulated landfills that are poorly managed and contaminated by industrial waste, as well as drainage systems. If immediate action not taken, these problems will only worsen. The purpose of the current study is to provide valuable insights for the development of a comprehensive water management plan that can guide future development.

To address these challenges, it is crucial to regularly monitor the quality of water. The results of water analysis should made accessible to the public for documentation purposes and to promote public welfare. Strict regulations should enforced on industries that discharge untreated effluents directly into water bodies. It is also important to consistently monitor small-scale industries, as they significantly contribute to surface water pollution, which in turn contaminates groundwater. Educating individuals, especially the labor class employed in industries, about various environmental issues will also play a role in maintaining a clean environment. It is essential to recognize that the most effective approach to environmental management is by taking responsibility for our own actions.

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