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ASSESMENT OF GROUND WATER QUALITY OF MUZAFFARPUR OF BIHAR

Ranvir Kumar

Assistant Professor
Department of Chemistry,
Rameshwar Mahavidyalya, Muzaffarpur (Bihar)

Abstract : 60% to 75% of the human body is water. Dehydration occurs when the body loses even 4% of its overall water content; a 15% loss can be lethal. In like manner, an individual could endure a month without food however wouldn't endure 3 days without water. It is obvious that water is essential for life. For many Indians, groundwater is the best source of water for human consumption. It is almost widespread accessible, trustworthy and low capital expense. The drinking water quality index of Muzaffarpur, one of the districts in Bihar, is the primary subject of the current study. In the district, there are around 4.73 lakh urban residents and 43.3 lakh rural residents. For drinking water, these primarily rely groundwater. Analysis was done on fourteen stations of groundwater. The drinking water quality index of Muzaffarpur, one of the districts in Bihar, is the primary focus of the current study. The ground water from fourteen stations was analyzed. Water Quality Index (WQI) put the water into 'good water' category but Alkalinity, Total Dissolved Solids(TDS) and Nitrate concentrations in some stations were found above the drinking water standards.

Index Terms - Ground water, Water quality index, Muzaffarpur, Bihar

I. INTRODUCTION

All of the water that fills the spaces, pores, and fissures in geological formations and comes from atmospheric precipitation either directly through rainfall infiltration or indirectly through rivers, lakes, or canalsis referred to as groundwater. Groundwater resources are dynamic by nature and impacted by a variety of causes, including urbanization, industrialization, and irrigation practices. The use of ground water and its waste are clearly excessive. The exploitation of groundwater and its effects are very disturbing.[1]. Thus, whatever the nature of the physical pollution, beitchemical [2]orbacteriological(bacteria,viruses)[3],theaquifersareaffected. Therefore, it is crucial to monitor and maintain this valuable resource. [4]. Due to the overexploitation of groundwater and its incorrect disposal, especially in cities, Rapid urbanization has an adverse impact on water availability and quality particularly in developing nations such as India. According to WHO organization, about80% of all the diseases in human beings are water borne[5].

Ground water is a valuable resource of water, which accounts for about two thirds of the world's freshwater reserves. The groundwater reservoir of the world at about 5.0 × 1024 L, this volume is more than 2,000 times the volume of waters in all the world's rivers and more than 30 times the volume contained in all the world's fresh water lakes. The ground water reservoir of the world at about 5.0 × 1024 L, this volume is more than 2,000 times the volume of water in all the world's rivers and more than 30 times the volume contained in all the world's fresh water lakes. Groundwater is used for agricultural, industrial and domestic purposes. It accounts for about 50% of livestock and irrigation usage and just under 40% of water supplies, whilst in rural areas, 98% of domestic water use is from ground water. In particular, due to heavy investment in infrastructure and maintenance of surface water development by dam particularly in developing countries, the use of groundwater as a resource for domestic, municipal, agricultural or industrial activities is steadily increasing. Improved technology, such as deeper borehole borings which meet WHO water quality standards, is another factor contributing to the diversion of attention towards this source. Ground water is abstracted through hand-dug wells; hand-pump operated shallow-wells and submersible pump operated deep well or boreholes. Ground water is often high in mineral content such as magnesium and calcium salts, iron and manganese depending on the chemical composition of the stratum through which the rock flows. But there are no clean drinking facilities for humans in many parts of the world.

However, as far as the quantitative aspects are concerned, it is also useful to keep a close eye on water quality levels that have been used by populations. [7].

In urban and rural areas, ground water is the backbone of India's agricultural and drinking water security. In a large measure, ground water is also important for the industrial sector and should be regulated, otherwise there could be serious intersect oral conflict. In India, where more than 80 % of the country's drinking water needs are met by groundwater resources, there is currently a serious ground water crisis due to excessive overdraft and ground water contamination in nearly 60 % of the country's districts, which poses a threat to the security of drinking water for the population. Apart from the overdraft and biological and chemical pollution[8].

With an impact on life style, natural resources and the environment, Bihar is undergoing rapid economic development. However, weaknesses remain in the growth of the economy. Although the state is endowed with water and land, it needs to significantly increase crop yields as well as irrigation efficiency. Assured availability of water for drinking, agriculture and industries are the key factors to determine the future economics scenario. During the last six decades, the remark able feature in irrigation development is the conspicuous growth in the use of groundwater. To enhance the irrigation potential ground water can safely be developed at least to the level of 60-70% as ground water irrigation is under the direct control of the farmers and is am enable to precision agriculture and higher irrigation efficiency[9].

Although industrialization is unavoidable, industries are the main sources of pollution and degradation problems at different levels due to a number of devastating ecological and demographic disasters that have been happening continuously over the last four decades. [10]. Unplanned and nonscientific development of the ground water resources, mainly driven by individual initiatives, has led to an increased pressure on available natural resources. In the case of a long term decrease in surface water supply, depletion of aquifer zones, increased energy consumption to lift water from progressively deeper levels and quality deterioration caused by saline intrusion into coastal areas within different parts of the country, adverse impacts may be seen. Surprisingly the three major states occupying the alluvial plains i.e. Uttar Pradesh, Bihar and West Bengal, has a share of the in-storage ground water resources to the tune of 7652 bcm which is more than 70% of the total resource. Fragmented land holdings, poor socio-economic status, poor infrastructure facilities, lack of knowledge of modern technologies are some of the reasons for the under-utilization of groundwater resources in these areas, in spite of the growing need for boosting agricultural production [11]. In this context there is an urgent need to explore various befitting options for optimal utilization of these resources.

II. Materials and Methods

2.1 Sample Collection and Analysis

The samples were collected during winter. Water samples from bore well were collected in glass containers. Before collecting samples, water from bore-well was pumped out for about 5-10 minutes or until water temperature is stabilized. In accordance with the standard procedure, samples were collected at each location in different containers to add necessary preservatives. The samples were preserved in icebox and transported to laboratory within 3 hours from the time of collection and analyses.

The samples were analyzed as per Standard methods for the examination of water and waste water,[12]. The results obtained were compared with the drinking water standards as specified by World Health Organization (WHO)[13] and Bureau of Indian Standards(BIS)[14].

2.2 Micro-biological Analyses

For microbiological analyses, 100ml water samples were collected from sixteen study sites of the river stations.

2.3 Statistical Analysis

The data obtained on the physico-chemical and microbiological parameters of the ground water were subjected to correlation analysis. The correlation was carried on statistical software SPSS version18.

III. Results

pH of the water ranged from 6.58 to 7.68 and TDS 175mg/l to 1282.6mg/l. The conductivity of the samples were found between 229µS/cm to 2010µS/cm. Alkalinity ranged between 140 mg/l to 572 mg/l. Chloride ranged from 2.0mg/l to 247.9 mg/l. Total dissolved solids in samples ranged from 174mg/l to 1284mg/l. Total hardness of the samples have a wide range in the samples(157mg/l to 761mg/l) Calcium 44.3 mg/l to 212.5 mg/l. Magnesium from 10.2 mg/l to 68.8 mg/l. Nitrate ranged from 0.06 mg/l to 13.71 mg/l. Sulphate from 2.26 to 78.4mg/l. Fluoride from 0.24 to 0.76 mg/l. Total and faecal coli form ranged from1.1 MPN/100ml to 8MPN/100ml. The samples were subjected to serial dilution in nutrient water containing potassium dihydrogen phosphate and magnesium chloride and inoculated in multiple tubes as per the maximum probable number method. The tubes contained 10ml of lauryltryptose broth for the detection of total coliform and faecal coliform were incubated at 35 ± 0.5°C for three hour in A1broth. For faecal coliform, the tubes were inoculated serially and were incubated for three hours at 35±0.5°C for three hours and transferred to a water bath at 44.5±0.2°C and incubated for an additional 21 ± 2 hour. Production of an acidic reaction or gas production in any A-1 broth culture within 24 hours or less is a positive reaction indicating the presence of faecal coliform[13].

3.1 Water Quality Index

Water quality index (WQI) is valuable and unique rating to depict the overall water quality status in a single term that is helpful for the selection of appropriate treatment technique to meet the concerned issues. This is completed in following three steps. In the first step, each of the nine parameters has been assigned a weight(wi) according to its relative importance in the overall quality of water for drinking purposes. The maximum weight of 5 has been assigned to the parameter nitrate due to its major importance in water quality assessment[15]. Magnesium which is given weight of 2 as magnesium by itself may not be that harmful[12].

Second step, relative weight (Wi) is computed from the following equation:

$$Wi=wi+\sum_{i=1}^{n} wi$$

Where (Wi) is the relative weight, (wi) is the weight of each parameter and 'n' is the number of parameters. The Calculated Water Quality Index of drinking water in Muzaffarpur is also given in the Table 1.

In the third step, a quality rating scale (qi) for each parameter is assigned by dividing its concentration in each water sample by its respective standard according to the guidelines laid down in the BIS and the result is multiplied by100:

$$qi=\left(CiSi\right)*100$$

Where qi is the quality rating, Ci is the concentration of each chemical parameter in each water sample in mg/l, and Si is the BIS (Bureau of Indian standards) water standard for each chemical parameter in mg/l according to the guidelines of the BIS and WHO.

For computing the WQI, the SIi is first determined for each chemical parameter, which is then used to determine the WQI as per the following equation

$$SIi=Wi*qi$$

$$WQI=\sum SIi$$

SIi is the sub index of Ith parameter, qi is the rating based on concentration of ith parameter and n is the number of parameters. The computed WQI values are classified into five types "excellent water", "good water", "poor water" "very poor water" and "water unsuitable for drinking" as shown in the Table 2.

Table-1. The Water Quality Index of Muzaffarpur, Bihar

	Concentration of parameters(mg/l) (Ci)	Weightage (wi)	Relative weight(Wi)	Standard Concentration (mg/l) (Si)	Quality Rating(qi)	SubIndex (SIi)
TDS	544.50	4	0.13	500	108.9	14.5
Chloride	63.18	3	0.10	250	25.3	2.5
Total hardness	345.86	3	0.10	300	115.3	11.5
Calcium	92.52	2	0.07	75	123.4	8.2
Magnesium	28.04	2	0.07	30	93.5	6.2
Nitrate	7.71	5	0.26	45	17.1	4.5
Sulphate	19.99	4	0.13	200	10.0	1.3
Fluoride	0.53	4	0.13	1	52.6	7.0
Alkalinity	354.29	3	0.10	200	177.1	17.7
					WQI=73.5	

Table-2. Water quality classification based on WQI value[16]

WQI Value	Water Quality
<50	Excellent
50–100	Goodwater
100–200	Poor water
200–300	Very poor water
>300	Water unsuitable for drinking

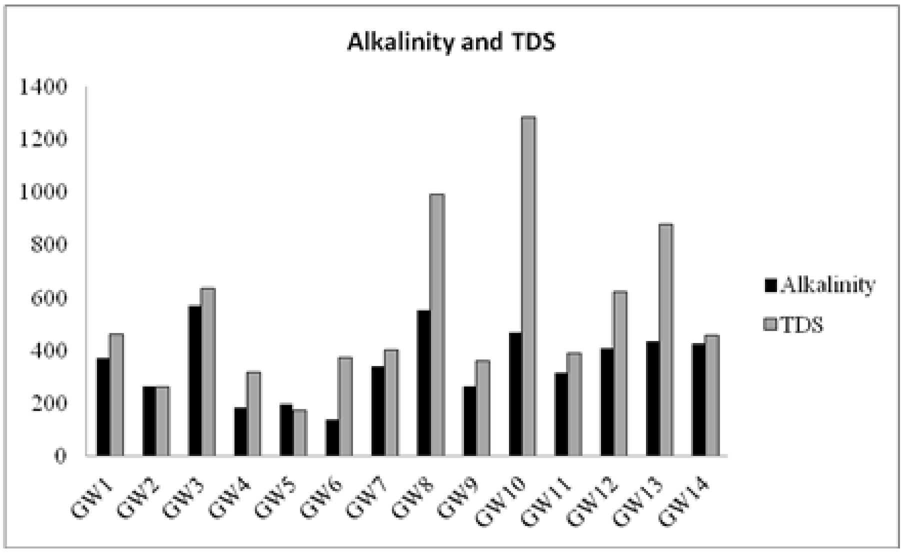

Figure1.Concentration and relationship between Alkalinity and TDS

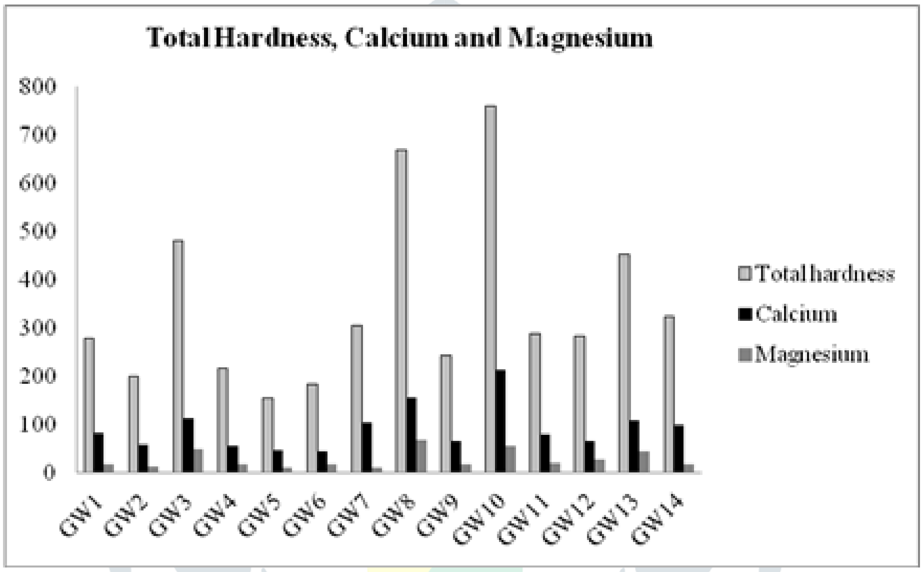

Figure 2. Concentration and relationship between Total Hardness, Calcium and Magnesium

IV. Discussion

pH usually has direct effects on biotic environment. For satisfactory water disinfection and clarification at all stages the control of pH is very necessary. Effective disinfection with chlorine, the pH should preferably be less than 8. pH of all the stations in Muzaffarpur were found within the range of Indian standards (6.5-8.5). The Total dissolved solids(TDS) of five stations were higher than the standard. Craun et al. [17] reported that increase TDS concentrations in drinking water cause of cancer, coronary heart disease, arteriosclerotic heart disease and cardiovascular disease. The concentration and relationship Alkalinity and TDS is shown in Figure1.

The Total Hardness is an important parameter of water quality whether it is to be used for domestic, industrial or agricultural purposes. Total hardness of the seven stations of was above the Indian standards for drinking water. Total hardness has a high significant correlation ($p<0.01$) between Total Dissolved solids(TDS). The calcium concentration in three stations was found above the standards. In case of magnesium, eight stations have high amount of magnesium concentration. The concentration and relationship between Total Hardness, Calcium and Magnesium is shown in Figure 2. The nitrate concentration in all the water samples were well within the limit of standards except in one station where the concentration is 61mg/l. Nitrate losses from non-point agricultural sources, mainly originated by fertilizers application, have been recognized as one of the most serious threats for pollution of groundwater [18].

An improvement of knowledge is however essential to make the water services more powerful and to reinforce the policy for the access to safe water in the country[7]. Nitrates and nitrites may themselves be carcinogens or may be converted in the body to a class of compounds known as the nitrosamines, compounds that are known to be carcinogens[19]. Nitrate-nitrogen levels below 90mg/L and nitrite levels below 0.5 mg/L seem to have no effect on warm-water fish, but salmon and other cold-water fish are more sensitive [20].

Chloride concentration of one station was found above the standards. Chloride has a high significant correlation ($p<0.01$) between TDS and Total hardness. A report showed that people drinking chlorinated water over long periods have a 21% increase in the risk of contracting bladder cancer and a 38% increase in the risk of rectal cancer[19]. Due to urbanization and heavy industrialization the ground water of our country becomes unpleasant for drinking[21]. The factors which control the fluoride concentration includes the climate of the area and the presence of accessory minerals in the rock mineral assemblage through which the ground water is circulating[22]. In the present study the concentration of fluoride is within the permissible limits of WHO.

Most water borne pathogens are introduced into drinking-water supplies in human or animal faeces, do not grow in water and initiate infection in the gastrointestinal tract following ingestion [13].

In all the stations, the total and faecal coliform exceeds the standards for drinking water[12,13] which put the ground water unfit for drinking but lack of other drinking water sources people are forced to drink the water. This is a matter of serious concern in the state of Bihar in which the largest reservoir of ground water in the country exists.

Water Quality Index (WQI) is one of the most effective tools to provide feedback on the quality of water to the policy makers and environmentalists. It provides a single number expressing overall water quality status of a certain time and location [23]. The WQI of Muzaffarpur city is 73.5 which categorizes the ground water in the "good water" category as per the water quality classification based on WQI value. But the presence of faecal and total coliforms in water makes them unfit for drinking. The single parameter which has high significance in determining the quality of drinking water has to be thoroughly studied and to be checked.

V. CONCLUSION

Ground water is one of the major sources of potable water in Muzaffarpur City. Furthermore, the contamination of groundwater is enhanced by depletion of this limited resource alongside unpredictable waste disposal in surface water. Appropriate management strategies to balance development without compromising the environment or public health must therefore be identified. Groundwater pollution will increase regional water scarcity; leading to a humanitarian crisis. Intensive, daily coordination between the parties is necessary for the successful implementation of projects. The responsibility for this coordination lies with all parties.

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