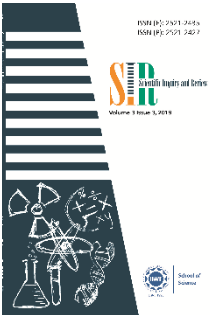

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Article: **Assessment of Groundwater Quality: A Sample Study of Selective Drinking Water Sources in Diplo Area of Sindh**

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Assessment of Groundwater Quality: A Sample Study of Selective Drinking Water Sources in Diplo Area of Sindh

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Abstract

The present study aimed to determine the quality parameters of underground drinking water found in Diplo, a sub-district of Tharparkar. The quality parameters examined in the water samples were pH (acidity), total dissolved solids (TDS), and electrical conductivity (EC). A total of 20 samples were randomly collected from different sources of drinking water, namely dug well and hand pump, from the study area. The results showed that the quality parameters of water samples taken from the hand pump were not within the appropriate range (pH range was 5.7-6.0 and TDS range was 1579-2120 mg/L), while those of well water samples were within range (pH range was 5.09-6.60 and TDS range was 497-1182 mg/L). Therefore, it was concluded that water from the well sources was safe for consumption as per the guidelines set by WHO and EPA and could be used for drinking purposes. The findings revealed that water from the hand pump sources had high TDS and EC (greater than WHO limit), which pose several health risks. It was noted that TDS is directly proportional to electrical conductivity and inversely proportional to the pH level of water. Further, it was recommended that future studies need to be conducted at regular intervals to evaluate the quality of drinking water in rural areas of Sindh province, so that authorities can promptly provide solutions to such issues.

Keywords: drinking water, Electrical Conductivity (EC), pH level, Total Dissolved Solids (TDS), Tharparkar

Introduction

Water is a necessity for the survival of life, which is why the availability of safe drinking water is a universally accepted human right [1]. Due to the rapid growth of population and industrial development, demand for safe drinking water has grown rapidly. Thus, it becomes imperative to regularly measure and manage groundwater quality. Groundwater is globally used for human consumption, industrial, and irrigation purposes. Once it is contaminated, its quality cannot be restored, even if we prevent the pollutants from reaching the groundwater source. Recently, the focus on water quality has increased significantly, which, in turn, has enhanced human well-being and quality of life [2]. Groundwater [3] and canal water [4] is widely used as drinking water in small cities and rural areas of Pakistan. Unfortunately, groundwater sources such as shallow pumps and dug wells get polluted due to seepage from urban sewerage systems and polluted canals. Since drinking water is scarce in desert areas, people are compelled to drink stored water of poor quality brought from such water sources. In some regions, women fetch water from contaminated water sources and bring it to their houses in mud pots/plastic bottles. In one study it was stated that 68% of rural inhabitants are consuming water of poor quality in Pakistan [5]. It has been noted to cause gastrointestinal illnesses among masses. Globally, 100 million diarrheal illnesses cases are registered within a year [6].

In Karachi, 94% of untreated effluent flows into Malir and Liyari river resulting in wide spread pollution along their course and sea shore. Drinking water samples from Karachi displayed an occurrence of *E. coli* [7], which revealed that sewage wastewater was seeping into the drinkable water supply lines. It is important to note that if an aquifer is polluted, cleaning it will become a problematic and time-consuming issue, which may become impossible to resolve as time progresses. According to WHO, around 80% of illnesses in human beings in the under developed countries are caused due to the biological contamination of water [8].

In the past, reports on polluted groundwater heightened public concern about water quality [9]. The deteriorating water quality in developing nations has increased the occurrence of diarrhoea [10, 11, 12, 13, 14], hepatitis E [15, 16], dental caries, oral hygiene [17], and anaemia in children

[18]. It also reduces talent/IQ level brain functioning and development in children [19]. The water quality depends upon various parameters such as TDS, EC, total suspended solids (TSS), hardness, dissolved oxygen (DO), alkalinity, turbidity, minerals (Na, Cu, P, Zn, Mn, Fe, etc.), and biological (coliform) analytes. These are also the essential characteristics of surface and groundwater [11]. Drinking water possesses numerous trace elements that are essential for human health, however, a high and concentrated intake of heavy metals (Zn, Fe, Cu, Mn, Ni, Cd, and Pb) found in water may lead to critical health issues [20, 21]. Thus, the quality of drinking water should be regularly assessed to ensure if it is fit for human consumption. The objective of the present study was to determine some quality parameters of drinking water, such as pH, EC, and TDS, from various groundwater sources located in the Diplo area of Tharparkar district of Sindh province.

2. Methodology

2.1. Study Location

The location was selected based on the enormity of waterborne diseases in the area and number of local complaints about drinking water quality and characteristics such as taste, turbidity, hardness, and odor. This study collected the water samples from several villages situated in Diplo, a sub district of district Tharparkar, located in the southeast of Sindh, Pakistan. Its coordinates are 24°28'^{0}N 69°35'^{0}E and its altitude is 26 meters (85 feet). Taluka Diplo is one of the oldest towns of Sindh and is 40 kilometres away from Mithi city.

2.2. Sample Collection

As per standard, water samples were collected in sterile plastic bottles from water sources such as hand pumps and dug wells. The samples were labelled accordingly. A total of 20 samples (50% from the well and 50% from the hand pump/motor pump) of potable drinking water were randomly collected for this study. All the samples carried identification of their water source.

2.3. pH Measurement

pH of the water was determined using a pH Water Tester with LCD Screen Handheld pH Hydroponics Pen model [22].

2.4. TDS Measurement

The LCD Screen Digital TDS Water Quality Tester was used to evaluate the TDS level of water samples. It should be noted that the electrical conductivity of water is directly related to the concentration of dissolved ionized solids in the water [22].

2.5. Electrical Conductivity (EC)

The ions present in water were examined based on electrical conductivity. This was accomplished by using a digital electrical conductivity meter [22].

2.6. Statistical Analysis

Using a statistical analysis software called R (version 4.1.0), the descriptive analysis and econometrics of the current data were calculated.

3. Results and Discussion

The pH value of the sample water revealed that the water was either soft or hard since pure water carries a pH of 7. As per WHO recommendation, the normal range of pH for groundwater is 6-8.5. Extremely alkaline or acidic water consumption could prove hazardous for human health. Moreover, water with a higher pH tastes like baking soda, has a slippery feel, and leaves deposits on fixtures. On the other hand, a lower pH value results in a metallic or bitter taste that causes dental corrosion [23]. The pH noted for the hand pump water samples was 5.7-6.0 (Figure 1), while the well water sample had a pH range of 5.09-6.60 (Figure 2). The figures depicted that the pH values showed a variable range in samples. The findings revealed that the pH level of all samples was not within acceptable limits as per WHO guidelines. Most of the results were less than the EPA standards and showed acidic nature of the water samples (Table 1).

Table 1. Physical and Sensory Properties of Drinking Water

Samples	Characteristics	Results
Well water	Color	SC
Well Water	Odor	RO
Well water	Taste	SS
Handpump water	Color	C
Handpump water	Odor	RO
Handpump water	Taste	S

C= Clear, SC= slightly clear, RO= Roots odor, NO= No odor, S=Salty, SS= Some Salty

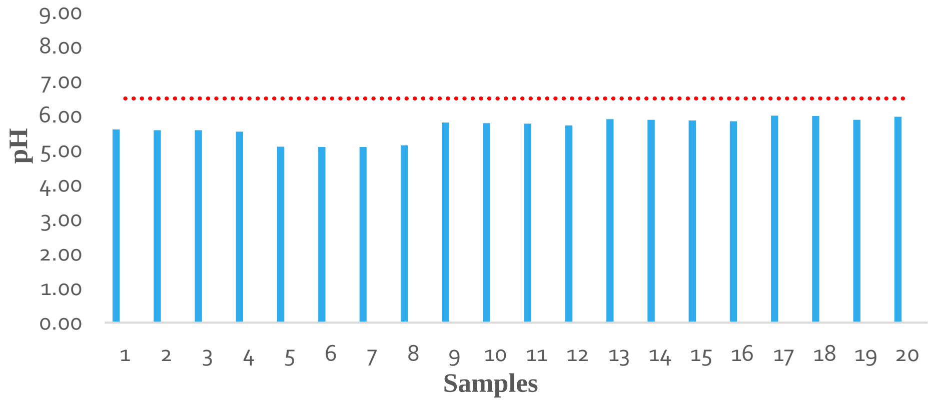

Figure 1. pH value of hand pump water samples

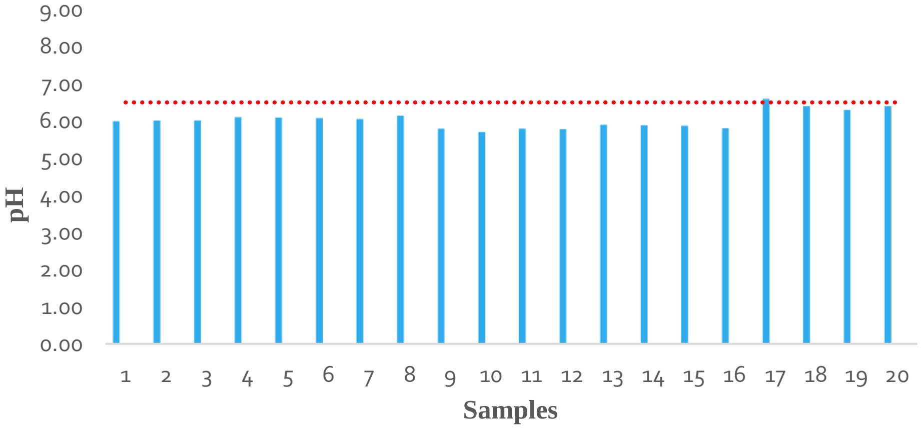

Figure 2. pH value of well water samples

3.1. Total Dissolved Solids (TDS) of Well Water and Hand Pump Water Samples

Water contains a cluster of all organic and inorganic substances that are usually measured as total dissolved solids (TDS). Water with <500mg/L TDS is permissible to drink, but saliva adds TDS in water with lower TDS levels to raise its level before it reaches the gut [24]. Figure 3 showed that the TDS level of samples taken from the well water was within the range of 497-1182 mg/L. The samples from the other four well sources had high TDS levels that exceeded the permissible limit set by WHO. Drinking water from such sources can lead to serious health consequences. Whereas, the water samples from the other four sources of well water showed favourable results and could be used for drinking purposes.

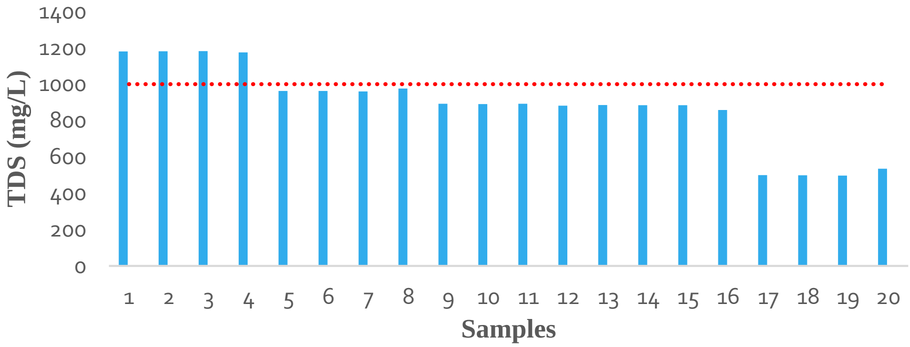

Figure 3. TDS value of samples taken from well water following WHO standards, EPA, and other regulatory standards

As shown in Figure 4, the TDS values of water samples taken from the handpump were within the range of 1579-2120mg/L. This water could not be used for drinking purposes since it was susceptible to water borne diseases. Such high levels of TDS values can have a harmful impact on public health. The inhabitants of the studied area were facing gastro-intestinal problems, kidney stone formation cases, headache, and other related illnesses due to varying physiological and biochemical traits of the water found in the water pump.

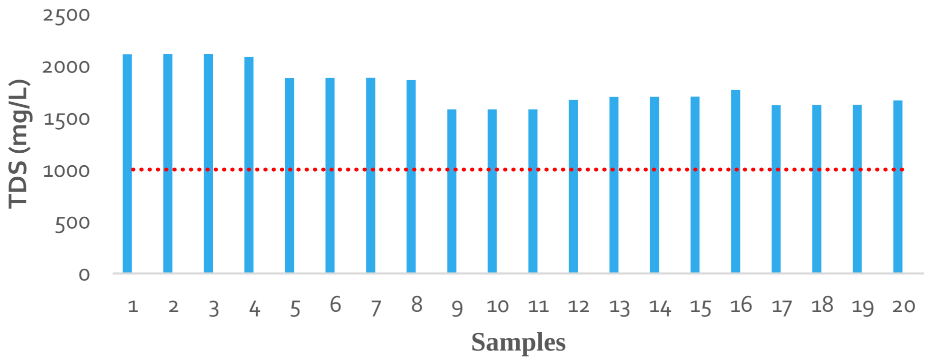

Figure 4. TDS value of handpump water samples

The main ingredients of water are typically calcium, sodium, magnesium, potassium cations, hydrogen carbonate, carbonate, sulfate, chloride, and nitrate anions [25]. TDS associates positively with conductivity and disturbs the pH level. In other words, it is directly proportional to conductivity and inversely proportional to the pH level. It may also affect the taste of water. The acceptable ranges of TDS in drinking water have been reported in Table 2 [26].

Table 2. Total Dissolved Solids (TDS) Level of Drinking Water

TDS Level	
Excellent	<300mg/L
Good	300-600mg/L
Fair	600-900 mg/L
Poor	900-1200mg/L
Unacceptable	>1200mg/L

3.2. Electrical Conductivity (EC) of Underground Drinking Water

The electrical conductivity of the samples was checked using digital electrical conductivity meter. It was concluded that the electrical conductivity of all handpump water samples was high as per WHO standards. The results of this test are given in Figure 5. Hence, the handpump was considered an unfit source of drinking water since it may cause severe illnesses.

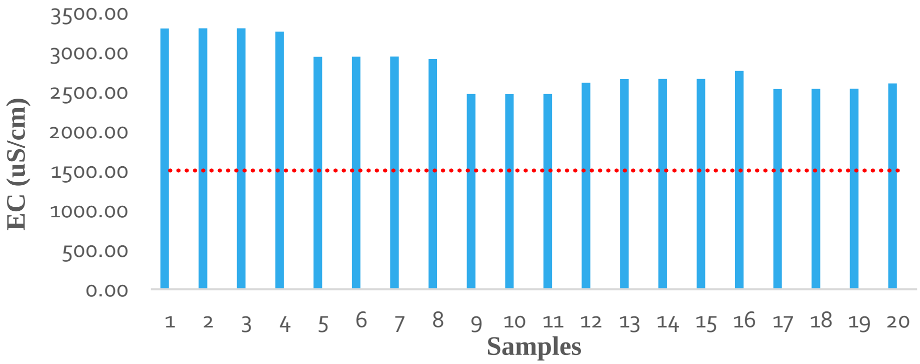

Figure 5. EC of hand pump water

On the other hand, the water samples from the well showed EC levels within the permissible limit except for the first four samples which had a greater electrical conductivity as compared to others. This is expressed in Figure 6. Therefore, it is recommended that the people from the study area should drink water from wells rather than handpumps so they do not fall ill. Brahman et al. investigated the fluoride and arsenic species in the groundwater of the sub districts (Diplo and Chachro) of Tharparkar. They reported dangerous levels of these minerals in the groundwater samples. Their level surpassed the WHO provisional recommendation value and standard limits prescribed by US Environmental Protection Agency (EPA), whose maximum contaminant level is 1.5 mg/L and 0.01 mg/L, respectively [27]. Another study conducted in Taluka Chachro, a District of Tharparkar, reported that the TDS and EC level exceeded the permissible range set by WHO [28]. The TDS and EC findings are similar to our hand pump water sample results. Rout and Sharma compared the results for water samples taken from tube wells located in Haryana, India and compared it with the standards prescribed by the World Health Organization and Bureau of Indian Standard (BIS). The physio-chemical parameters were observed to be in the permitted limit, but the groundwater was in an alkaline condition. Its total hardness ranged between 116.6-129.4 mg/l, which indicated moderate hardness in the deep aquifer. Therefore, it was suggested to the soften tube well water before consumption [22].

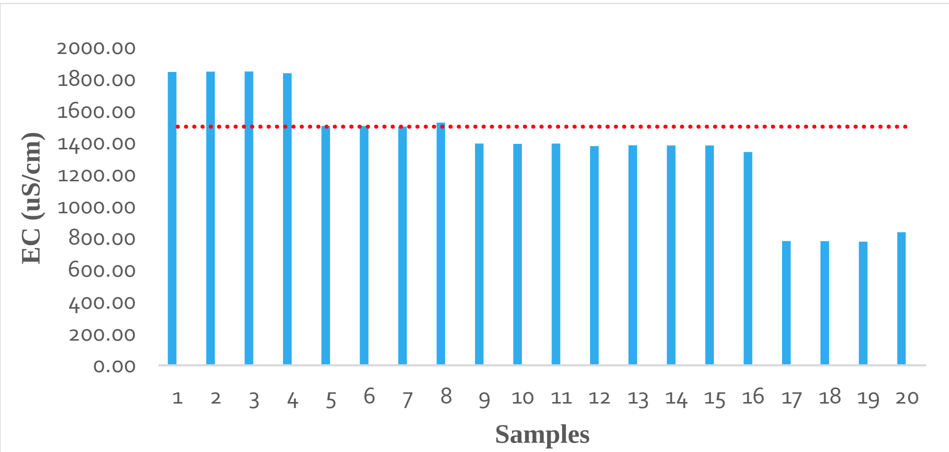

Figure 6. EC of well water

This study highlights the poor quality of drinking water in the Diplo area of Sindh by examining its pH (acidity), total dissolved solids (TDS), and electrical conductivity (EC). Many existing studies reported that the poor quality of drinking water may cause several illnesses. For example, Memon, et al. evaluated the water quality parameters of water samples taken from southern regions of Sindh (Thatta, Badin, Tharparkar). They concluded that due to the poor quality of water, having high TDS, low pH, and solutes in a large amount, several communicable diseases such as diarrhea, gastroenteritis, vomiting, kidney, and skin issues were found in the above-mentioned regions [29]. Anwar and Rani [30] stated that the exposure to arsenic found in groundwater could cause serious skin ailments, lung, skin, kidney, and bladder cancers, tumors, hypertension, peripheral vascular disease, and diabetes. It was identified that the subjects in the study area were not aware of the drinking quality of water. Rasool et al. [31] revealed that drinking the water contaminated with heavy metals pose an emerging health risk to the populaces in the study area. For this reason, it was recommended that this issue needs to be efficiently and vigilantly dealt with on immediate basis. It was also recommended that future management policies regularly assess the heavy metal levels in areas with poor water quality.

4. Conclusion

After examining the findings of the present study, it is concluded that water quality is a major concern in the desert areas of Tharparkar district due to climatic variations, unavailability of the ground sources of fresh water, and rare installations of reverse osmosis plants. There is scarcity of drinkable water in far flung areas. To resolve this issue, different organizations have installed handpumps as a water source for the vulnerable population. However, the water from such handpumps was identified to have high levels of TDS and EC which is considered unfit for human health. Conversely, the water from wells was identified to be suitable for drinking purposes as per the guidelines set by WHO and EPA.

It is suggested that as Federal and Provisional water analysis laboratories run by EPA should conduct research studies to identify groundwater problems and find solutions to offer a safe source of water and get rid of waterborne illnesses in the area. Reverse osmosis plants should be used to control and maintain the quality parameters of water to ensure the supply of potable and safe drinking water to the population living in the studied area.

Conflict of Interest

The authors declare no conflict of interest.

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