

Assessment Of Drinking Water Quality Using Physicochemical Parameters In Durbakheil, Tehsil Halimzai, District Mohmand, Pakistan

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ABSTRACT

Water is one of the most essential natural resources in order to maintain life and environmental balance. The availability of clean and safe drinking water is the most important to human health. This study was conducted to evaluate the physicochemical quality of drinking water in Durbakheil, Tehsil Halimzai, Mohmand District, Khyber Pakhtunkhwa, Pakistan. A total of fifteen groundwater samples were manually obtained at the various locations in line with the standard sampling procedures and later analyzed in the Environmental Science Laboratory. The parameters studied included pH, electrical conductivity (EC), total dissolved solids (TDS), turbidity, total hardness, calcium, magnesium, chloride and total alkalinity. The obtained values were compared with the allowable values of the World Health Organization (WHO) and the National Environmental Quality Standards (NEQS) on drinking water. The pH was recorded between 6.79 and 7.21, which showed the presence of neutral water. The value of electrical conductivity was 611 to 1374 $\mu\text{S}/\text{cm}$, and total dissolved solids were 400 to 800 mg/L. Turbidity measured 3.5 to 4.9 NTU. Total hardness was 180-355 mg/L; calcium 48-148 mg/L and magnesium 172-281 mg/L. The chloride was 32.5 to 145.18 mg/L and the total alkalinity was 235 to 400 mg/L. The measured parameters were found to be within the acceptable limit provided by WHO and NEQS, implying that groundwater in the study area is suitable for drinking purposes. However, continuous observation is recommended to provide the permanent security of the drinking supply of water among the local residents.

Keywords: Drinking Water Quality, Physicochemical Parameters, Groundwater Assessment, Halimzai Tehsil, Mohmand District, Khyber Pakhtunkhwa, Pakistan

INTRODUCTION

The majority of human settlements are closer to freshwater bodies, such as dams, rivers, lakes, and streams. Past communities of urban, rural, and villages developed where water was highly accessible. Modern communities in these areas are dependent on groundwater and groundwater is closely connected with the precipitation patterns. The amount of freshwater resources that is considered in the global groundwater

budget is about 0.61 9 percent (Peavy, 2015), and it is likely that ground water storage will end sooner or later. In addition, groundwater quality is spatially variable, which implies the use of strict monitoring procedures. Water is commonly known as a cradle of life and it sustains all biotic activities but it is a resource that can be depleted in the near future as it is foreseeable (Agarwal, 2002). The Earth contains approximately 1.4 billion cubic kilometers of water but only approximately 1.0 percent of this water is available to the people to drink (Qureshi, 1998).

The hydrological cycle is made up of the transfer of water through the atmosphere. This is a cyclic process whereby surface water in oceans, lakes and terrestrial bodies evaporates and it is then condensed into droplets in clouds and finally this condensed water falls back to the surface. Surface runoff causes water to flow downslope to rivers and lakes, and release back into the sea. Infiltration of soil moisture flows downwards and rejuvenates the saturated zone which adds to groundwater deposits. The groundwater may then occur naturally as springs or be pumped out through wells and this eventually finds its way into rivers or the ocean (Nagabhushaniah, 2001).

The process of evaporation attains water to a near-perfect state, but during condensation, the impurities can be added. As liquid water flows through the rest of the hydrologic cycle, it is exposed to other contaminants, but in particular, exposure of atmospheric particulates and terrestrial substrates occurs. The human activities also further destroy water quality by introducing industrial effluents, domestic sewage, and agricultural chemicals, as well as the other pollutants. This therefore pollutes water that is released into the hydrologic cycle and ultimately, vapor is released into the atmosphere as a comparatively clean water. However, intermediate quality of water is critical because it defines its appropriateness to humanity use (Peavy, 1985).

Water is still essential to support life as it provides the basis of the biological processes and ecological wellbeing in both cities and countryside. Notable amounts are ordered to be used in the country of consumption, food preparation, industry, business, and water irrigation in agriculture (Hussain, 2016).

Drinking water refers to potable water that is clear, aromatic, flavorless and safe to human beings. In Khyber Pakhtunkhwa the relative clean drinking water is available to over 80 per cent of the population. The sources in the province are both surface and ground water. Southern provinces lack enough surface water resources, but the groundwater is either brackish or only available at lower levels. The water potential is higher in central areas, that is, tube wells are used to supply household connections, whereas in the north, springs or surface sources are the main source of water supply. The total amount of the drinkable water can often not meet the required amounts because of archaic distribution systems, inadequate local treatment plants, and pollution of certain water sources (Government of K.P.K. and IUCN, 1996).

According to statistical data, improved water source is available to 71 per cent of the entire population of Khyber Pakhtunkhwa (91 per cent in urban population, 64 per cent in rural population). However, the entire population lacks access to clean potable water, 63 percent allegedly lack access to clean sanitation facilities, making them the source of diseases and contacting infections. The systems of water supply and treatment plants in large towns are of low quality, and some of the available infrastructure is destroyed or damaged (Environmental Profile of Khyber Pakhtunkhwa, June 2017).

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Water pollution involves the degradation of drinking water quality by introducing various parameters, which could be physical, chemical or biological, to oceans, streams, lakes and rivers. This effect refers to poor quality of water on both land and sea that is due to human actions. The existence of foreign elements in water is considered to be dangerous and this speeds up the loss in the general quality of water. Mining and agriculture are among the anthropogenic processes that pollute water to a great extent (Trivedi, 1992).

The proportion of ground water in the total water cycle is about 0.61 per cent and hence forms a basic element of the surface water body flow and thus a major contribution to the system of the groundwater and the surface water. More than half of the world population relies on ground water that is the major source of drinking water. Although groundwater is a renewable resource, the time taken to renew the groundwater is also a limiting factor because the extraction rate of ground water in aquifers is usually higher than the natural rate of renewal which may take hundreds or even thousands of years. Groundwater mining is thus often controlled by communities to preserve this precious resource, keeping an eye on the domestic levels of the water table and preventing over pumping. The recycled water is in other cases recycled and recharged to supplement groundwater. The issue of climate change also affects the dynamics of groundwater: with the decrease of the surface water supply, the dependence on the groundwater usually rises. In regions where groundwater is the major source of water, the amount of ground water used can increase due to increased demand precipitated by the rate of evaporation increase. India uses an example of 50 per cent of irrigation water being ground water based and in some areas, the water table is dropping at an alarming rate. These high extraction rates and lower recharge rates can result in groundwater resources being depleted quickly (Hoang et al. 2016). Groundwater is an important source of freshwater used for drinking and domestic purposes in many regions of the world (WHO, 2017). On the other hand, the quality of groundwater can be significantly affected by natural geological processes besides anthropogenic activities for instance agricultural runoff, industrial discharge, and improper waste disposal (APHA, 2017).

Nonetheless, the growth of population, farming, and industrialization processes have helped to reduce the quality of groundwater in a number of areas (FAO, 2011).

It is necessary to monitor these parameters in order to define the appropriateness of water to drink and guarantee the safety of human health (UNESCO, 2015).

Groundwater resources are also important in addressing domestic and agricultural water needs, especially in developing nations where the amount of surface water resources is insufficient (PCRWR, 2018). However, the danger of polluting the ground water by the rapid urbanization and the insufficient practices of waste management has risen in numerous regions (UNEP, 2016).

Fresh water resources are crucial in the support of human life, agriculture, and ecology in the world (Gleick, 1993). The growth of population and rise in economic activities, however, have put strain on the available freshwater resources, and there have been growing concerns about the quality and supply of water (Postel, 2000).

In most of the developing nations, ground water is a good source of drinking water because it is affordable and has a fairly constant supply during the year (Todd and Mays, 2005). However, the quality of groundwater may suffer as a result of over

exploitation, agricultural agents, and bad waste disposal habits (Freeze and Cherry, 1979).

The measurement of water quality is usually done by examining various physicochemical parameters which give an idea of the chemical contents of water (Hem, 1985). These parameters are used to establish the suitability of water in human consumption and domestic use based on the international standards (Chapman, 1996). Due to the excessive urbanization and change in land use, the degradation of the groundwater quality has become a major environmental issue in most places (Foster and Chilton, 2003). Sustainable water supply and preservation of human health therefore require constant monitoring and proper management of the ground water resources (Edmunds and Smedley, 2005).

The freshwater resources play a very vital role in ensuring ecological balance as well as enhancing human development at the global level (Shiklomanov, 1993).

Groundwater has been regarded as one of the surest sources of drinking water as it does not face the direct contamination and can serve as a consistent source of drinking water throughout the year (Fetter, 2001). However, the natural geological factors and human activities like agriculture, urbanization and industrial discharge are able to significantly affect the quality of ground water (Domenico and Schwartz, 1998).

Physicochemical analysis is very common to assess the quality of water and establishing the existence of dissolvable compounds that can influence the appropriateness of some water to be used by humans (Sawyer, McCarty, and Parkin, 2003). These variables should be therefore monitored on a regular basis to have safe drinking water as well as proper water resource management (Davis & DeWiest, 1966).

The absence of appropriate water management systems and a weak monitoring mechanism has made contamination of ground water a big threat in many developing nations (Custodio & Llamas, 1976). As a result, groundwater quality needs to be evaluated on a regular basis to safeguard the health of people and to be able to use water resources in a sustainable manner (Alley, Reilly, and Franke, 1999).

This paper aims at investigating the quality of drinking water in Durbakheil, Tehsil Halimzai, District Mohmand, by testing the main physicochemical parameters and comparing the findings with the allowable limits of the National Environmental Quality Standards (NEQS) to determine the appropriateness of this water in relation to its use as a drinking water.

Study area

The main point of the investigation is the village of Durbakheil, which is in the Tehsil Halimzai of the District Mohmand, in the province of Khyber Pakhtunkhwa, Pakistan and consists of several tehsils, including Halimzai. The district lies approximately between latitudes 34°05' to 34°35' North and longitudes 71°05' to 71°45' East.

District Mohmand is surrounded by District Bajaur to the north, District Charsadda and city of Peshawar to the east and District Khyber to the south, with Afghanistan to the west and north-west. A portion of the eastern border of the district is defined by the Kabul River. The area is characterized by mountainous landscape, semi arid climate, and scattered rural villages, in which groundwater, springs and wells are the main sources of drinking water to the locals. The geographical location of the study

area is presented in Figure 1.

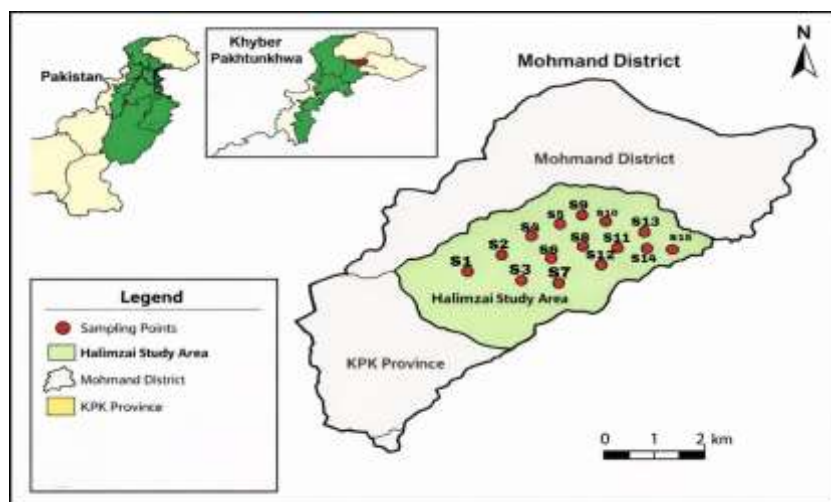


Figure 1 Location map of the study area in Durbakheil, Tehsil Halimzai, District Mohmand

MATERIALS & METHODS

A total of fifteen (15) drinking water samples were collected from the ground water source i.e. bore well in pre rinsed polyethylene bottle.

Samples were analyzed for various physiochemical parameters as well concentration in the laboratory of Department of Environmental science, University of Peshawar.

Methods for Analysis of Physical Parameters

pH

It is defined as "power of hydrogen ion concentration in water". pH indicates the strength of an acidic or basic solution. The pH scale ranging from 0 to 14. The middle of the range i.e. pH 7 represent a neutral solution. Pure water is neutral because it holds the similar number of hydrogen ions as hydroxide ions. Solutions with pH values less than 7 are acidic and those with values greater than 7 are alkaline or basic.

Procedure

pH was determined through meter. We took water of all fifteen samples in 100 ml beakers. pH meters have two electrodes, one of which is for water. We immersed the electrode in each sample then observed and noted the pH value. It gives maximum and minimum values. By adding and dividing on two, we determined the average pH value. We washed the electrode through distilled water when determining the next sample. pH meter was calibrated with pH 4,7 and 11 buffer solutions.

Electrical Conductivity

Conductivity is a amount of the capability of an aqueous solution to move an electric current. This ability depends upon the presence of ions in aqueous solutions. Conductivity is stated in positions of micro-Siemens per centimeter ($\mu\text{S}/\text{cm}$) (Greenberg, 1992).

Procedure

The conductivity of the samples was determined using the conductivity meter. The conductivity meter was first calibrated with distilled water and KCl (0.001M) prepared by dissolving 745.6 mg of anhydrous KCl in one-liter distilled water. For the analysis of each sample for the conductivity test the bulb of the conductivity meter was washed each time with distilled water.

Total Dissolves Solids (TDS)

The apparatus used for the determination of Total Dissolved Solids (TDS) included a vacuum desiccator, magnetic stirrer, china dish, drying oven, analytical balance, and glass funnel. These apparatuses were used through the laboratory analysis to certify correct measurement of dissolved solids present in the water samples.

Procedure (Gravimetric method)

Total dissolve solids were measured using gravimetric method. First of all, China dishes were taken according to samples number, they were washed with HCL and distill water to remove impurities and were kept in oven for some time to measure its initial dry weights. After initial weight, filtration of the samples was done using P-40 filter paper in a conical flask using funnel. 50 ml of each sample was passed through filter paper; the filtered water was then kept in China dishes and was oven dried for 24 hours at 120°C.

The Total Dissolved Solids (TDS) concentration was calculated using the following formula:

$$TDS = \frac{(A - B) \times 1000 \times 1000}{Volume\ of\ sample}$$

where **A** represents the weight of the china dish with dried residues, and **B** represents the weight of the empty and clean china dish. The modification between these weights specifies the amount of dissolved solids current in the water tester after vaporization and drying.

Turbidity

Turbidity is measured photo metrically by determining the percentage of light of a given intensity that is either absorbed or scattered. The original gauging apparatus, called a Jackson turbidity meter, based on bright interest engaged a long tube and identical candle. The candle is placed beneath the glass tube so that light can only be seen from above the apparatus; water sample is then poured slowly into the tube until the lighted candle is no longer visible. The glass tube is calibrated with the reading for turbidity produced by silica dioxide. One Jackson turbidity unit is equivalent to the turbidity made by 1 mg of silica dioxide in single liter of distilled water.

In recent year this awkward method has been replaced by a turbidity meter in which standardized electric bulbs produce a light that is then directed through sample. The turbidity meter mostly work on the principle of scattering of light. Turbidity meter reading is expressed as NTU (Howard S Peavy, 1985).

Methods for Analysis of Chemical Parameters

Total Hardness

Water hardness is definite as the awareness of multivalent metallic cations, mainly calcium (Ca^{2+}) and magnesium (Mg^{2+}), present-day in water. These ions react with anions to form insoluble precipitates and reduce the ability of water to form soap lather. Total hardness be there normally cataloged by way of the total amount of calcium and magnesium absorptions, indicated as milligrams per liter (mg/L) of calcium carbonate (CaCO_3). The toughness of water may possibly extensively contingent on the geological source and the control processes applied.

Total hardness of the water samples was determined using the EDTA titrimetric method. The apparatus used during the analysis included a graduated cylinder, pipette, conical flasks, stirrer, burette, and iron stand. For reagent preparation, a 0.01 M EDTA (ethylenediaminetetraacetic acid) solution was prepared by dissolving 3.724 g of disodium EDTA in 1000 ml of distilled water. An ammonia buffer solution was able by dissolving 16.9 g of ammonium chloride (NH_4Cl) in 143 ml of extreme ammonium hydroxide (NH_4OH) and diluting the blend to 250 ml with distilled water. Eriochrome Black T (EBT) was used as an indicator during the titration.

For standardization, a distinguishing calcium carbonate result keep on consummate by dissolving 1 g of anhydrous CaCO_3 in irrigated downcast hydrochloric acid (1+1 HCl). Later thorough suspension, the result existed diluted with distilled water, emitted concisely to eradicate carbon dioxide (CO_2), cool, and used to an intermediary orange color using methyl red indicator and ammonium hydroxide or hydrochloric acid. The solution was formerly diluted to 1000 ml with distilled water, where 1 ml of the solution was equivalent to 1 mg of CaCO_3 .

During the analysis, 20 ml of water sample was taken in a conical flask and 1 ml of buffer solution was added to maintain the pH around 10. Then Eriochrome Black T indicator was added, which produced a wine-red color due to the formation of a complex with calcium and magnesium ions. The sample was titrated with standard EDTA solution until the color changed from wine-red to blue, indicating the endpoint of the titration. The total hardness of the water sample was calculated using the following formula:

$$\text{Hardness (mg/L as CaCO}_3\text{)} = \frac{A \times B \times 1000}{\text{Volume of sample}}$$

Wherever A signifies the volume (ml) of EDTA used in the titration and B exemplifies the milligrams of CaCO_3 the same to 1 ml of EDTA solution.

Calcium Hardness

The apparatus used during the analysis included a graduated cylinder, pipette, titration flasks, stirrer, burette, and iron stand. These apparatuses be situated hand-me-down to complete the titration and make sure perfect measurement of water samples and reagents. The reagents used for the determination of calcium hardness included murexide indicator, EDTA (Ethylene diamine tetra acetic acid) titration solution, and buffer solution with a pH of 12.5.

For the analysis, 0.01 M EDTA solution was prepared and placed in the burette. A measured volume of 20 ml of each water sample was taken in a titration flask. To this

sample, 1 ml of buffer solution (pH 12.5) was added followed by 1–2 drops of murexide indicator. The solution was then titrated with 0.01 M EDTA solution until the color change indicated the endpoint of the reaction.

The calcium hardness was calculated using the following formula:

$$\text{Calcium Hardness} = \frac{(A - B) \times 0.01M \times 100 \times 1000}{\text{Volume of sample}}$$

Wherever **A** represents the volume of EDTA castoff for the period of titration and **B** signifies the blank value. The result be there stated as milligrams per liter (mg/L) as calcium carbonate (CaCO₃).

Magnesium Hardness

The magnesium hardness of the water samples was determined by subtracting calcium hardness from the total hardness. The calculation was performed using the following relationship:

Magnesium Hardness = Total Hardness - Calcium Hardness

The gotten value shows the concentration of magnesium hardness in the water taster and is indicated in milligrams per liter (mg/L) as calcium carbonate (CaCO₃).

Chlorides (Cl⁻)

Chloride is a dualistic compound of chlorine twisted what time chlorine chemically syndicates with a metal. It arises naturally in water when hydrochloric acid act in response by way of metals existing in the environment. Chloride concentration in water samples was determined using the argentometric titration method with standard silver nitrate solution and potassium chromate as an indicator (Neelima, 2005).

The apparatus hand-me-down for the analysis contained within a graduated cylinder, pipette, titration flasks, stirrer, burette, and iron stand, which simplified exact capacity and titration of the water samples.

For chemical preparation, potassium chromate indicator (K₂CrO₄) stood able by dissolving 50 g of potassium chromate in distilled water. Silver nitrate solution was then added until a definite red precipitate formed. The mixture was allowed to equilibrate for 12 hours, filtered, and diluted to 1000 ml with distilled water. A ordinary silver nitrate solution (0.014 N) be there equipped by dissolving 2.395 g of AgNO₃ in refined water and diluting it to 1000 ml.

During the procedure, the AgNO₃ solution was placed in the burette, and 20 ml of the water sample was taken in a titration flask. Approximately 1 ml of potassium chromate indicator was added to the sample. The resolution be located then titrated with AgNO₃ while waiting for the color altered beginning pale yellow to brick red, symbolic of the endpoint of the titration. The initial and final burette readings were recorded, and the procedure was repeated for all water samples.

The chloride concentration was calculated using the following formula:

$$\text{Cl}^- = \frac{\text{Volume of sample} \times \text{Volume of AgNO}_3 \times \text{Normality of AgNO}_3 \times \text{Atomic weight of Cl} \times 1000}{\text{Volume of sample}}$$

The conclusion be contemporaneous indicated as milligrams per liter (mg/L) of chloride in the water sample.

Alkalinity

Alkalinity is distinct such as the dimensions of water to counterweight acids. It signifies the calculation of elements in water that surge the pH above 4.5. Alkalinity in water vestiges predominantly in amount overdue to the existence of hydroxide (OH^-), carbonate (CO_3^{2-}), and bicarbonate (HCO_3^-) ions. Adequate alkalinity in drinking water is needed for the reason that it benefits steady the water and reduces the corrosive properties of acidity. Yet, judicious alkalinity may perhaps cause opposing taste and scaling destructions in water source systems.

The apparatus used during the analysis included a graduated cylinder, pipette, titration flasks, stirrer, burette, and iron stand, which were used for accurate measurement and titration of the water samples.

For reagent preparation, a standard sulfuric acid solution was prepared by taking 27 ml of concentrated sulfuric acid and diluting it to 1 liter with distilled water in a volumetric flask to prepare a stock solution. Since this ordinary solution, 20 ml be there taken and diluted to 1 liter with distilled water to obtain a 0.02 N working solution. The preparation was based on the equivalent weight of sulfuric acid (H_2SO_4), which is 49 g, and its density of 1.84 g/ml. Considering the average purity of sulfuric acid (96.5%), approximately 27 ml of concentrated acid was required for preparing the stock solution.

Phenolphthalein indicator (2–3 drops) and methyl orange indicator (one drop) were used during the titration process. The standardization of the solution was carried out using the relationship:

$$N_1V_1 = N_2V_2$$

Wherever (N_1) and (V_1) characterize the ordinariness and volume of the run of the mill solution, and (N_2) and (V_2) represent the ordinariness and capacity of the diluted solution.

For the analysis, a burette was filled with 0.02 N sulfuric acid solution. A measured volume of 20 ml of the water sample was taken in a titration flask and a few drops of phenolphthalein indicator were added. If no pink color appeared, it indicated the absence of carbonate alkalinity. Then 1–2 drops of methyl orange indicator were added to the same sample, which produced a yellow color indicating methyl alkalinity. The taster be situated titrated with sulfuric acid in anticipation of the color changed from yellow to orange, indicative of the endpoint and the being there of total alkalinity. The initial and final readings were recorded, and the procedure was repeated for all samples.

The alkalinity of the water samples was calculated using the following formula:

Alkalinity (as CaCO_3)

$$= \frac{\text{Volume of sample ml of } \text{H}_2\text{SO}_4 \text{ used} \times \text{Normality of acid} \times \text{Equivalent weight of } \text{CaCO}_3 \times 1000}{\text{Volume of sample}}$$

The results were expressed in milligrams per liter (mg/L) as calcium carbonate (CaCO_3).

RESULTS AND DISCUSSIONS

In order to determine the physio-chemical parameters of drinking water of [Durbakheil Tehsil](#) Halimzai District Mohmand, a total of fifteen (15) samples were collected from different sites and then these samples were analyzed. The results obtained from the experimental work were compared with the permissible limit given by PAK-NEQS.

Physical Parameters

The samples were analyzed for physical parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), total suspended solid (TSS), and turbidity. The results of these parameters are given below.

pH

pH opinion headed for the acidity or alkalinity of water. The pH values of the analyzed samples ranged from **6.79 to 7.21**. According to the standards of the **National Environmental Quality Standards (NEQS)** and the **World Health Organization (WHO)**, the permissible limit for drinking water is **6.5-8.5**. All samples fall within the acceptable range, indicating that the water is suitable for drinking (as shown in Figure 2).

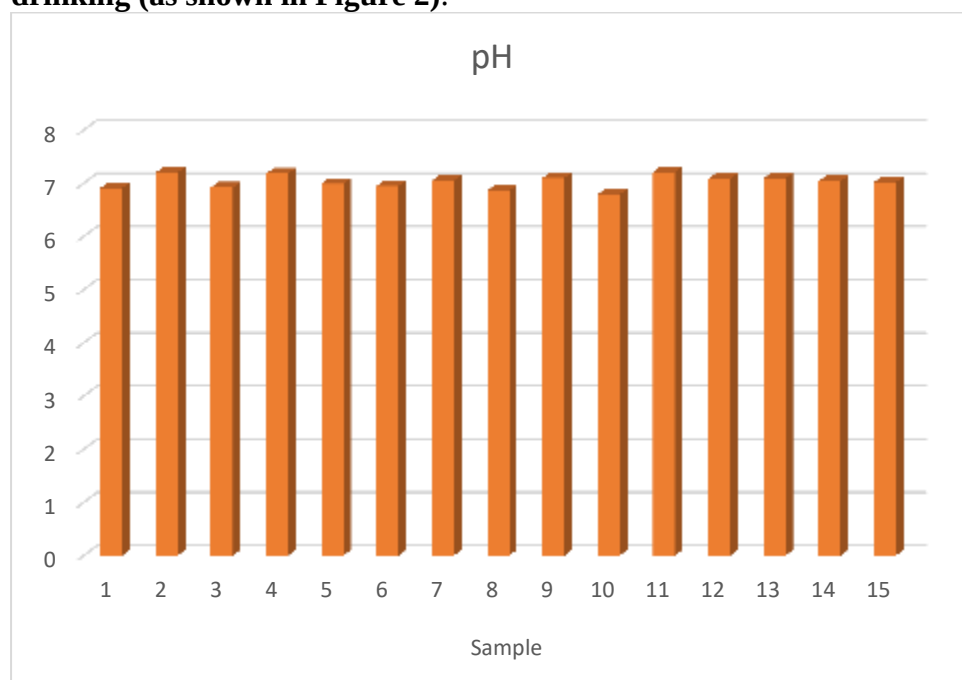


Figure 2 pH values of the drinking water samples

Electrical Conductivity

Electrical conductivity insist on the competency of water to bearing electricity due to dissolved ions. In this study, EC values ranged from 611 to 1374 $\mu\text{S}/\text{cm}$. According to the National Environmental Quality Standards (NEQS) and World Health Organization (WHO), the permissible limit is 1500 $\mu\text{S}/\text{cm}$. All samples be present contained by the acceptable limit, indicative of standard ionic concentration in the groundwater (as shown in Figure 3).

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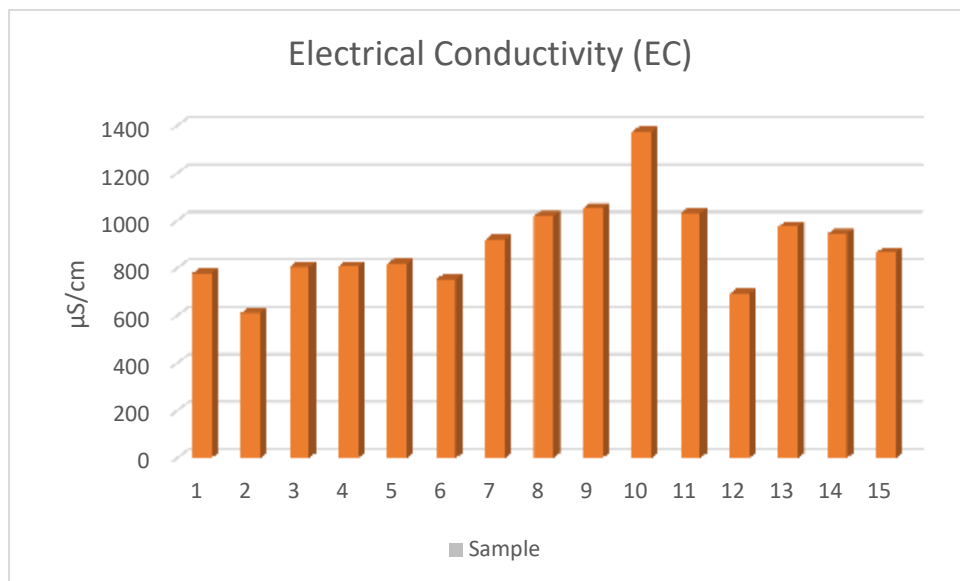


Figure 3 E.C values of drinking water samples

Total Dissolved Solids (TDS)

Total dissolved solids symbolize the sum of dissolved inorganic salts and small amounts of organic matter existing in water. In the present study, TDS values ranged from **400 to 800 mg/L**. According to the **National Environmental Quality Standards (NEQS)** and **World Health Organization (WHO)**, the permissible limit for drinking water is **1000 mg/L**. Altogether analyzed samples be present surrounded by the acceptable limit, demonstrating that the groundwater is appropriate for drinking purposes (as shown in Figure 4).

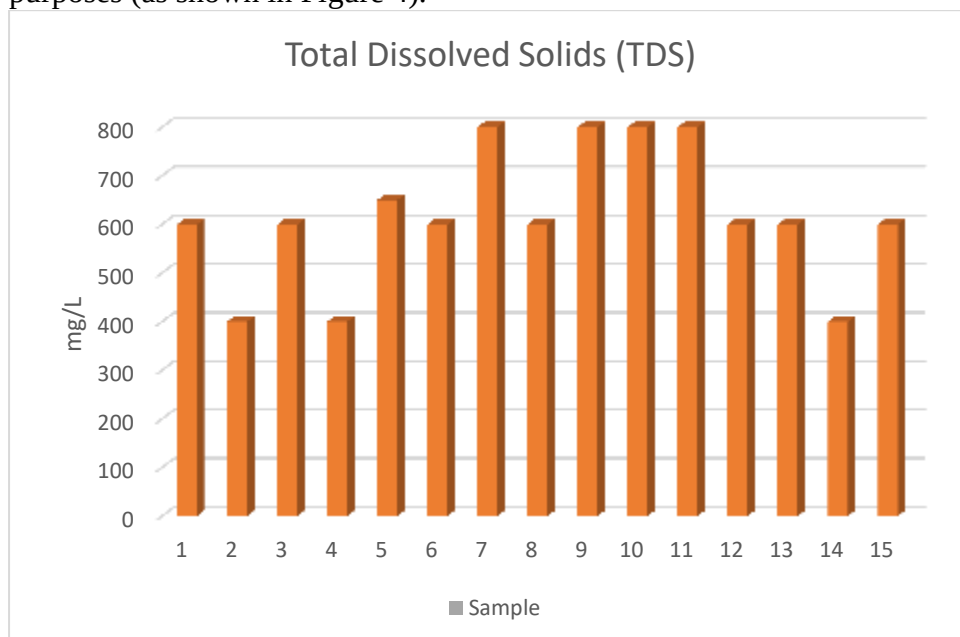


Figure 4 TDS values of the drinking water samples

Turbidity

Turbidity actions the precision of water and point toward the existence of suspended particles such as clay, silt, organic matter, and microbes. In this research, turbidity values reached from **3.5 to 4.9 NTU**. Allowing in the direction of the **National Environmental Quality Standards (NEQS)** and **World Health Organization (WHO)**, the permitted limit for drinking water is **5 NTU**. Altogether analyzed samples be present surrounded by the acceptable limit, demonstrating that the groundwater is appropriate for drinking clarity (as shown in Figure 5).

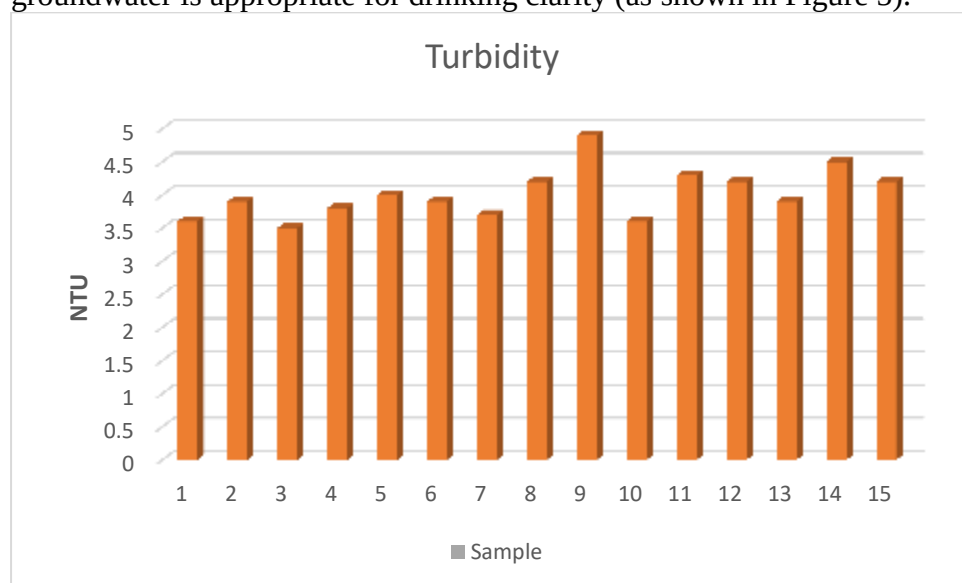


Figure 5 Turbidity values of the drinking water samples

Chemical Parameters

The samples were analyzed for chemical parameters such as total hardness, Calcium hardness, Magnesium hardness, alkalinity and Chloride. The results of these parameters are given below.

Total Hardness

It is essentially affected by dissolved calcium and magnesium in water. Now the present research, total hardness values reached from **180 to 355 mg/L**. According to the standards of the **National Environmental Quality Standards (NEQS)** and the **World Health Organization (WHO)**, the permissible limit is **500 mg/L**. All analyzed samples were within the acceptable limit, indicating that the groundwater is moderately hard but suitable for drinking purposes (as shown in Figure 6).

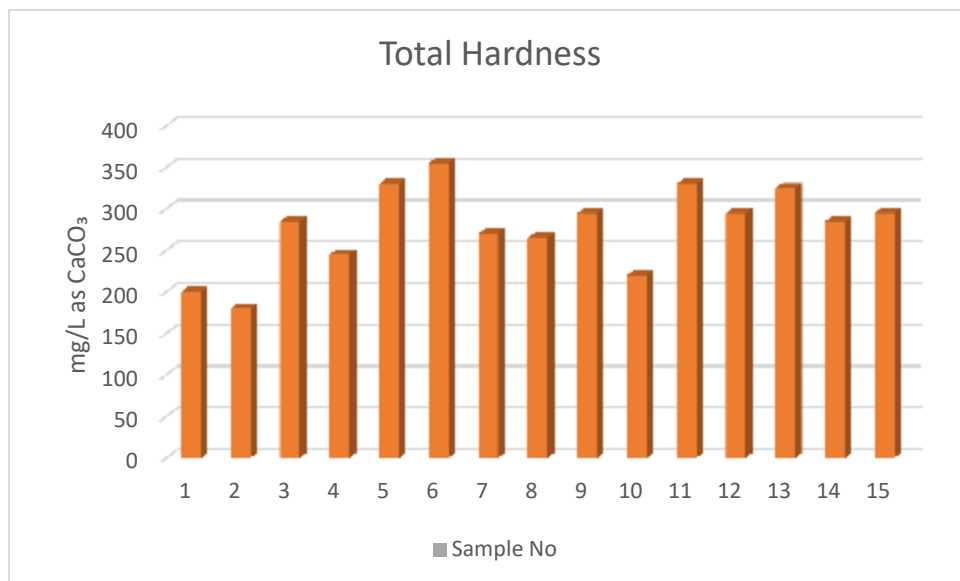


Figure 6 Total Hardness values of drinking water samples

Calcium

It is an important parameter contributing to water hardness. In this research, calcium concentrations reached from **48 to 148 mg/L**. Agreeing in the direction of the **National Environmental Quality Standards (NEQS)** and the **World Health Organization (WHO)**, the permissible limit for calcium in drinking water is **200 mg/L**. All evaluated samples be situated contained by the standard limit, symbolic of safe calcium levels in the groundwater (as shown in Figure 7).

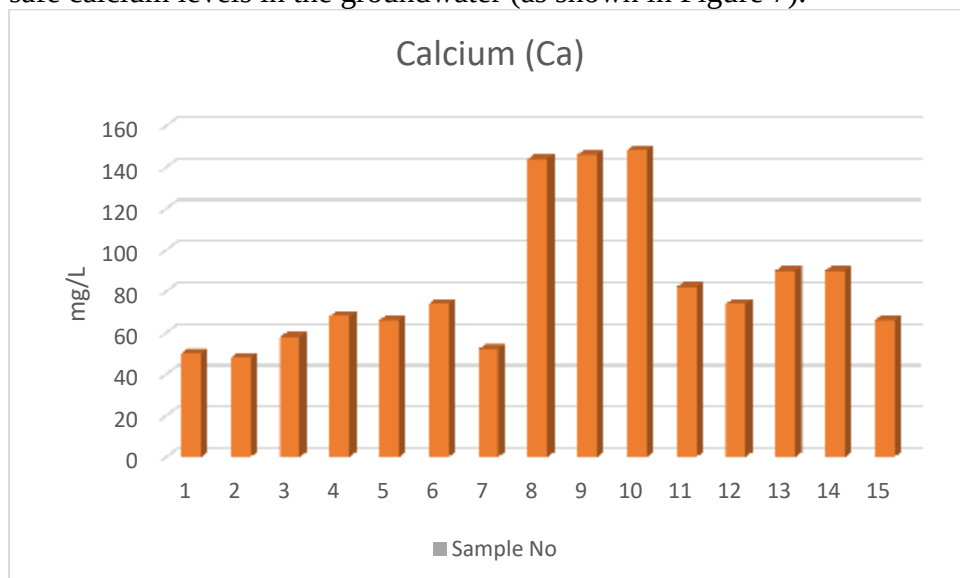


Figure 7 Calcium values of drinking water samples

Magnesium

It is one and only of the key ions subsidizing to water hardness. In this study, magnesium concentrations reached from **172 to 281 mg/L**. Permitting on the way to

the **National Environmental Quality Standards (NEQS)** and the **World Health Organization (WHO)**, the permitted limit for magnesium in drinking water is **300 mg/L**. Altogether analyzed samples be there in the interior the acceptable limit, signifying safe magnesium levels in the groundwater (as shown in Figure 8).

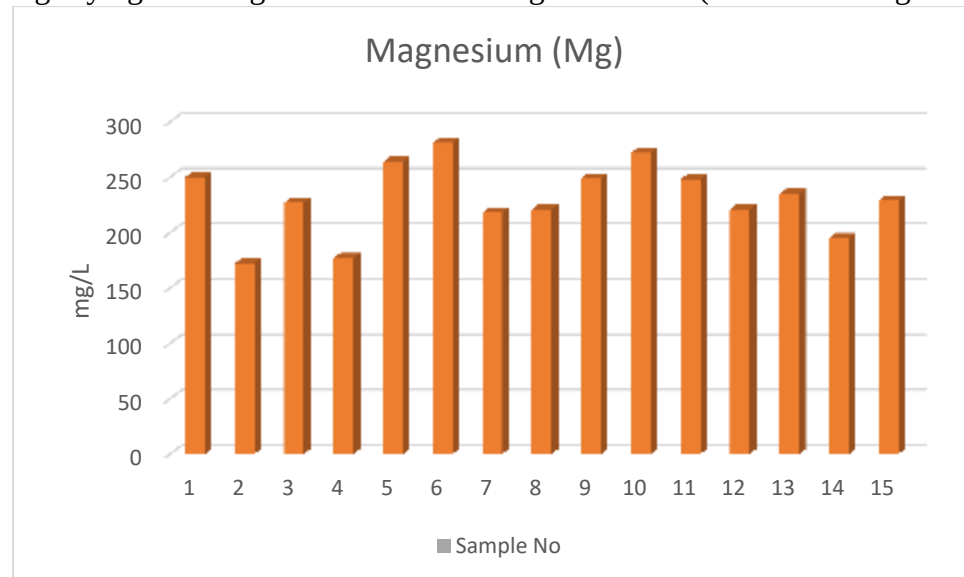


Figure 8 Magnesium values of drinking water samples

Chloride

It is a corporate ion present in water and high concentrations might affect taste and wellbeing. In this research, chloride concentrations reached from 32.5 to 145.18 mg/L. Permitting on the way to the National Environmental Quality Standards (NEQS) and the World Health Organization (WHO), the permissible limit for drinking water is 250 mg/L. Altogether analyzed samples were within the standard limit, indicative of that chloride levels in the groundwater are safe for drinking (as shown in Figure 9).

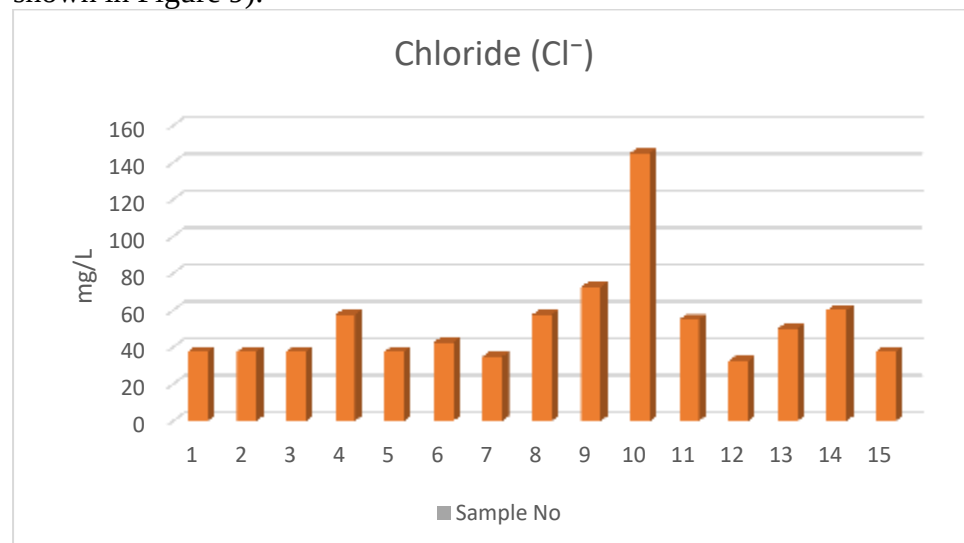


Figure 9 Chloride values of drinking water samples

Total Alkalinity

Its represents the capability of water to nullify acids and reservation balanced pH levels. In this research, total alkalinity values reached from 235 to 400 mg/L. Permitting in the direction of the National Environmental Quality Standards (NEQS) and the World Health Organization (WHO), the standard limit for drinking water is 500 mg/L. All examined samples were within the standard limit, specifying that the groundwater has adequate alkalinity and is appropriate for drinking purposes (as shown in Figure 10).

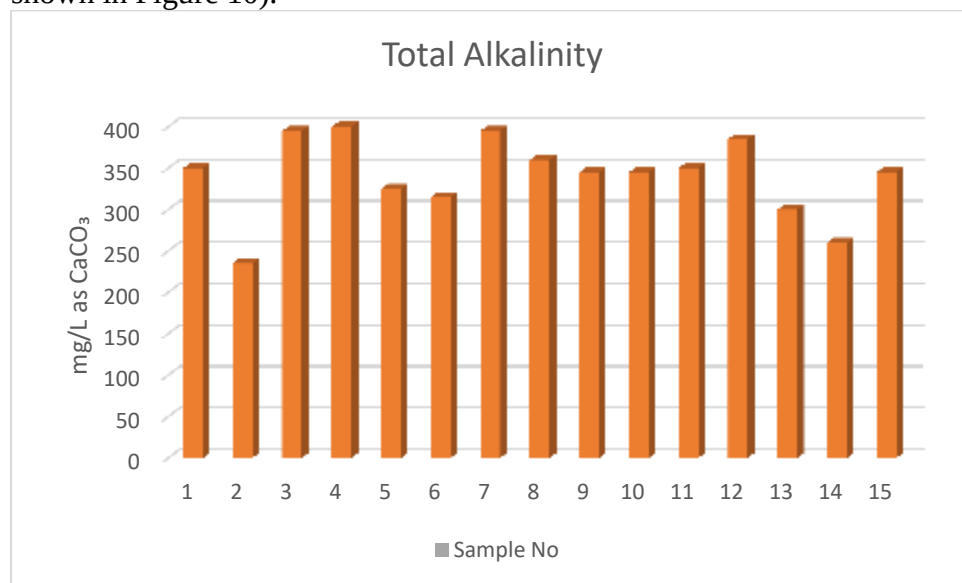


Figure 10 Total Alkalinity values of drinking water samples

Table 1 Sampling area And Source of drinking water

Sample No	STUDY AREA	SOURCES
S1	Marbel chowk Adehara kali	bore well
S2	Chaman Abad Koruna	bore well
S3	Chaman Abad Dap Koruna	bore well
S4	Mian morcha afridi kali	bore well
S5	Mian morcha pla kali	bore well
S6	Mian morcha Hussain kali	bore well
S7	Nawi kali abu khel	bore well
S8	Lora mena ghari korona	bore well
S9	Lora mena ghari kali	bore well
S10	Lora mena bazar kali	bore well
S11	Haji niamat kali	bore well
S12	Haji niamat korona	bore well

S13	Zaga kali	bore well
S14	Zaga kali qari korona	bore well
S15	Haji jummat mir marbal kali chowk	Bore well

Table 2 The result of All the Physiochemical parameters Compared with NEQS and WHO

Sample No	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	NEQS	WHO
pH	6.91	7.2	6.92	7.18	6.99	6.95	7.05	6.86	7.10	6.79	7.21	7.08	7.09	7.04	7.02	6.5-8.5	6.5-8.5
E.C	777	611	805	808	819	753	919	1020	1053	1374	1032	692	975	944	865	1500	1500
TDS	600	400	600	400	650	600	800	600	800	800	800	600	600	400	600	1000	1000
Turbidity	3.6	3.9	3.5	3.8	4	3.9	3.7	4.2	4.9	3.6	4.3	4.2	3.9	4.5	4.2	5	5
T.H	200	180	285	245	330	355	270	265	295	220	330	295	325	285	295	500	500
Ca	50	48	58	68	66	74	52	144	146	148	82	74	90	90	66	200	200
Mg	250	172	227	177	264	281	218	221	249	272	248	221	235	195	229	300	300
Cl	37.5	37.6	37.5	57.5	37.5	42.5	35.0	57.5	72.5	145.18	55.07	32.5	50.06	60.06	37.5	250	250
T.Alk	350	235	395	400	325	315	395	360	345	345	350	385	300	260	345	500	500

CONCLUSIONS

The current research determined the physicochemical quality of drinking water in Durbakheil, Tehsil Halimzai, District Mohmand. The samples of fifteen groundwater were analyzed in terms of parameters such as pH, electrical conductivity, total dissolved solids, turbidity, total hardness, calcium, magnesium, chloride and total alkalinity. The outcomes indicated that all the parameters examined were within the permissible limits by the World Health Organization (WHO) and National Environmental Quality Standards (NEQS). These results mean that the groundwater in the research location can be used to drink. Nonetheless, the water quality should be regularly monitored to make sure that the drinking water will be safe in the long term to the local residents.

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