Investigation of the Physical and Chemical Properties of Underground Water in Kabul City

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Abstract

The objective of this research is to assess the quality of underground water in Kabul city in terms of health and compliance with WHO and other relevant standards. To evaluate underground water quality in Kabul city, 25 water samples are collected from various locations. Advanced instruments such as the HQ440d Multi-Meter, Turbidity Meter, Conductivity Meter, and Wag-WE10500, along with reagents like Alkali Solution and Calcium and Magnesium indicator Solution, are used to measure different chemical and physical parameters of the water. Various tests are conducted in the field and laboratory. Chemical parameters including bicarbonate, sodium, magnesium, calcium, iron, fluorine, potassium, chlorine, chloride, arsenic, and nitrate are evaluated. Some parameters, such as fluoride, iron, arsenic, sodium, potassium, and chlorine, are within permissible limits for underground water in Kabul. However, findings confirm previous concerns about deteriorating water quality, including increased water hardness and nitrite levels. Parameters such as chloride, nitrite, total hardness, sulfite, and magnesium exceed permissible limits in most areas, including Kabul. Additionally, physical parameters like turbidity, conductivity, TDS, electrical conductivity, alkalinity, acidity, color, taste, smell, and temperature are assessed. All chemical and physical parameters are compared against WHO, S.EPA, ANSA, E.U, IL standards, and the results are presented in a chart for clarity. Comparisons with established standards are analyzed and discussed.

Keywords: water chemistry parameters, water physical parameters, water quality reduction, effects of low-quality water, public awareness

1. Introduction

Drinking water is a very important substance in human life, although 3/4 of the earth's surface is covered by water, but still, drinking water is received in small quantities in the world. The reason is that water is one of the very good solvents and when water flows on the surface of the earth or underground, it always has some amounts of salts, suspended substances and dissolved gases with it, and this causes the water to flow in different areas. Take on different characteristics. The presence of some salts in water is necessary for human health, and their excessive amounts will endanger human health. Therefore, the existence of healthy drinking water is a guarantee of the health of society and the first step in knowing water is to study the parameters of drinking water (1, 2, 3, and 4) (York: John Wiley & Sons; 1991).

From the beginning of their life on earth, humans lose access to safe drinking water over time due to various factors, and with each passing day, they face a greater shortage of drinking water. Developed countries and societies annually spend huge capital to protect drinking water resources. In developing countries, there is a problem of creating modern and advanced infrastructure, including drinking water systems. Because the creation of such systems requires huge expenses and budgets, which are not available to developing and poor countries like Afghanistan.

Our dear country of Afghanistan and the people who live in it have suffered more than the last three decades due to many wars and in various fields. Reports published in 2011 show that the lives of approximately 85,000 children are threatened by the lack of drinking water (5) (WHO, 2011) .

According to UNICEF's claims, there is also a problem of water quality being affected by climate pollution in Afghanistan (5) (WHO, 2011).

The population density in Kabul city is much higher than other cities and regions of the country and it is said that around 5 million people ring in this city. The source of drinking water for the citizens of Kabul is the use of underground water. Lately, Kabul area, and especially Kabul city has faced the problem of a significant reduction of surface water due to the lack of annual rainfall. Kabul Sea, which has water only for three months of the year and is quite polluted, forms the main source of the underground water supply of Kabul city. According to research by the Dakar Institute, only 20%-27% of Kabul citizens have access to the central water distribution system, the rest of the citizens get their water from semi-deep or shallow wells using water pumps or hand pumps. (6) (Saffi, M. H., 2011).

Currently, the major concerns in the Kabul basin are the significant reduction of natural underground water reserves and even drying due to excessive use, low nutrition, and high evaporation. The reason for the reduction of underground water reserves and the lowering of the underground water level is considered to be due to the low level of nutrition. This is considered a serious risk for reducing the natural reserve in the aquifer. In addition to the lack of quantity of drinking water, its quality is also one of the major and important issues. According to the research of the Dakar Institute, the quality of underground water in the Kabul basin has decreased due to the increase in the number of salts, water hardness, bacteria, boron, and nitrite concentration. An increase in the above parameters can be considered a serious risk to the health of Kabul citizens and agricultural activities. Residents of Kabul frequently get diseases caused by water pollution, and children are more at risk (6) (Saffi, M. H., 2011) .

Research conducted by the United States Geological Survey (USGS) shows that bacterial contamination has been seen in groundwater and surface water, the level of which exceeds the international standards for drinking water (7) (Mack, T. J., Akbari, 2010).

Campbell (2015) claims that 70.9% of the urban and 39.4% of the rural population in Afghanistan have access to clean drinking water, which means that about 46% of the total population has access to clean drinking water. (25)(Campbell J. A dry and ravaged land, 2015(

Houben et al. (27) (2009b), insufficient sanitation may be related to high child mortality rates. Thus, it is necessary to study the sources of groundwater pollution to prevent other problems that may be caused by groundwater (Houben et al, 2009.(

Uhl (2006) (28). He claims that even most of the urban areas rely on underground water for drinking, while in the country more than 95% of underground water is still used for irrigation (Rana Associates, USA, 2003.(

In addition to the aforementioned problems and threats, the population of Kabul is increasing, which causes more extraction of underground water. This practice is impossible and not allowed due to different factors such as the lack of thickness and watering of water-rich layers. The continuation of the current situation will have negative effects on the quality and quantity of underground water in the Kabul basin and will cause serious problems for social and economic development and environmental security. On the other hand, the continuation of this situation makes it impossible to return the watered floors to a better condition and causes the citizens of Kabul to face a serious problem of drinking water shortage and more water pollution in the future.

According to the evidence and results of research and studies in the field, the issue of assessing the quality of underground water in the Kabul Basin is one of the most important and important issues, and finding the appropriate methods to solve the current problems in the field and predicting and recommending preventive measures require research. It is durable. This study aims to assess the quality of underground water in the Kabul basin and answer questions regarding the compliance of chemical and physical parameters with permissible limits. By finding appropriate methods and recommending preventive measures, this research aims to contribute to resolving the pressing water-related challenges in the region.

2. Material and methods

The method of collecting samples from designated areas involved the following steps and equipment:

Water Level Indicator: Used to measure the depth of the water table at each sampling location.

GPS: Utilized to accurately determine and record the geographic coordinates of each sampling site.

Notebook: Used for noting down relevant information such as the sampling location, date, time, and any specific observations.

Standard Form: A prepared form provided by the General Administration of Water Quality Control and Water Supply Materials, Department of Water Supply, Ministry of Rural Development, which includes details required for sample collection.

Laboratory Bottles: Two bottles were used for each sampling location to collect water samples for subsequent analysis in the laboratory.

Lighter or Burnell: Used to sterilize the sampling site by burning off any organic residue or contaminants on the surface.

Sterilizing Materials: Dettol or similar sterilizing agents were employed to ensure the cleanliness and sterility of the sampling site.

These equipment, materials, and devices were carefully utilized to collect samples and preserve the integrity of the water samples during the sampling process. Proper sterilization techniques were employed to prevent contamination, and detailed records were maintained to ensure accurate data collection. To control groundwater pollution and assess its quality in Kabul city, the following methodology was employed:

Selection of Wells: Twenty-five wells were identified in various locations across Kabul city for the study. Sampling stations were chosen at sufficient distances from each other, except in densely populated areas where a higher number of samples were collected due to a higher potential for contamination.

Sampling Procedure: Water samples were collected from the identified wells using standard methods. Special plastic containers were used to preserve the water samples during transportation to the laboratory.

Temperature Measurement: The temperature of the water at each sampling location was recorded as part of the study.

Testing Categories: The water samples were subjected to two categories of tests: device tests and titrimetric tests.

Titrimetric Tests: Titrimetric tests included the measurement of temporary and permanent hardness, calcium and magnesium levels, alkalinity, and chloride. These tests were conducted following the methods specified in the standard method reference. For example, total hardness, calcium, and magnesium were measured through titration with EDTA, alkalinity was determined using the tetrazolium method with hydrochloric acid or sulfuric acid 0.02, and chlorine was measured through iodometry and silver nitrate titration. Sulfate and bicarbonate levels were obtained through titration with hydrochloric acid.

Instrumental Tests: Instrumental tests were performed to measure Total Dissolved Solids (TDS) and Electrical Conductivity (EC) using an EC meter (model CD 20, Aquatic mark, made in Germany) with an accuracy of 0.01. Turbidity was measured using a turbidity meter (model P 2100, Hach mark, made in America) with an accuracy of 0.01. pH levels were measured using a pH meter (model 654, Meterohm mark, made in Switzerland.(

Anions and Cations: Anions such as fluorine, iron, sodium, nitrite, and nitrate were measured using a spectrophotometer (model 7000) with a precision of 0.1 units, manufactured in England.

The above testing procedures were conducted to evaluate the chemical and physical parameters of the groundwater samples in Kabul City. These parameters provide valuable insights into the water quality and assist in monitoring and managing groundwater pollution.

3. Discussion

The most important chemical parameters include the following:

3.1 Fluorides (F)

Fluorides are naturally present in water. Increasing the amount of fluoride in drinking water is beneficial for the health of teeth. Children should benefit from such waters.

The excess amount of fluoride in water causes diseases such as fluorosis (line on the teeth) or painful bone diseases in children and adults, and the measure of fluoride in drinking water is to prevent caries and also to prevent the streaking of teeth (Appelo , C, A, J . Postma).

The amount of daily intake of fluoride depends on the geographical area. If the diet includes fish and tea, contact through food is especially high. Exposure to fluoride through drinking water also depends on the temperature of the region, and the higher the temperature, the more fluoride in water should be at least 1.5 mg/litter (Nabizade Nodhi, Others 1375).

The results of the fluoride level of the wells range from a maximum of 1.8 mg/litter in well number 8 to a minimum of 0 mg/litter in well number 7. According to the above-mentioned standards, without the sample of well number 8, all the water samples from (Table No. 3) do not cause any problems in terms of different uses.

Nitrite: The amount of oxidized nitrogen is equal to the total nitrogen of nitrite and nitrite including water. The presence of nitrite and a high amount of ammonia in surface water indicates water pollution with waste materials. In iron-containing waters, nitrites in groundwater are referred to as nitrites. Nitrite is the last product of ammonia oxidation and ammonia in the organization of organic materials, this oxidation process is carried out in soil and water by nitrification bacteria and this process is only possible in the presence of oxygen. The use of nitrogen-containing chemical fertilizers has caused an increase in nitrites in surface and underground waters. Water with a high amount of nitrite is harmful to infants. According to the practice of the European Union, the amount of nitrite in drinking water has been accepted as equal (Mark J. Hammer, 1986). (Program and budget organization 1375).

Therefore, in terms of nitrite (table no. 3), the water of wells no (1, 5, 6, 8, 14, 20, 21, 22, 23, 25) Creates an opinion.

There are health problems caused by this parameter, and it is recommended that necessary monitoring be done so that necessary control measures can be applied in case of a growing trend of nitrite in underground water sources.

Chlorine: high concentrations of chlorine cause taste in drinking water. The taste threshold limit for anion chloride depends on the type of Kat ion combined with it. The threshold for sodium, calcium, and potassium chloride is in the range of 200 to 300 milligrams per litter. No health-based guideline amounts have been suggested for it (Mark J. Hammer, 1986). (Program and budget organization 1375).

The results of the chlorine level in the wells range from a maximum of 251 mg/litter in well number 22 to a minimum of 0.1 mg/litter in well number 17(table no. 3).

Therefore, the results show that the chloride of the well water (table no. 3) is less than the permissible limit (average value is 106.312 milligrams per litter) and does not cause any problems in terms of different uses.

But the chlorine present in the water of well No. 22 is more than the maximum allowed amount. It likely is one of the reasons for creating an unpleasant taste in drinking water.

Sulfate: The presence of sulfate in drinking water can create a noticeable taste. The unfavorable taste of water varies with the nature of the corresponding Kat ion. Usually, this taste is considered that in amounts below 250 mg/litter, the unpleasantness of the taste is minimized ((Program and budget organization 1375). (Canter L& Others, 1987).

Sulfate in drinking water causes hardness (non-carbonate hardness) and changes the taste of water. Areas, where residents have to use sulfite water, get used to its high concentration. If sulfite is referred to, it will be produced with the smell of rotten eggs, this gas is also produced in deep wells, and its smell is quickly removed due to the effect of aeration.

Sulfate in the water samples of the wells (Table No. 3) of the studied area varies from 0.08 to 360 mg/litter in terms of sulfate ion. A large amount of sulfate in water creates limitations in various uses. Wells's numbers (24, 22, 20, and 18) have to sulfate much more than the water standard (250 mg/litter).

Sodium: The taste threshold for sodium is 200 mg/liter, and since no definite conclusion can be made about the health effects of sodium, no health-based guideline amount has been obtained for it (Program and budget organization 1375). Sodium is an abundant element in water, and due to its high solubility, it is more present in natural waters, and its amount increases in salty waters.

During the softening of hard water utilizing lime-sodium, the amount of sodium in the water is increased with the changes. According to the guidelines of the European Union, the appropriate concentration of sodium in water is 20 mg/L, and the maximum concentration of sodium in water is 200 mg/L. The level of sodium in water should be kept low so as not to cause diseases.

The results showed (Table No. 2) that the amount of sodium in the water source of the wells is within the permissible limit, and in the well water samples of the study area, it varies from 12 to 115 mg/litter in terms of sodium ions.

Total hardness: The hardness of water is related to the specific salts that are present in them, these salts consist of different Kat ions, such as: which is available in solution form with – anions : Water with a hardness of more than 200 milligrams per litter can cause mass deposition in the distribution system and high consumption of soap, and on the other hand, water with a hardness of fewer than 100 milligrams per litter will be very corrosive for pipes (Mark J.Hammer, 1986).

Table 1 shows the characteristics of water hardness (Stumm, W, 1990).

Table 1. Divisions and hardness of water

difficulty level	CaCO3(mg/l)
soft	0-50
semi-soft	50- 100
little soft	100 – 150
semi-hard	150 – 200
hard	More than 200
very difficult	More than 300D

Water with a hardness of more than 300 mg is considered very hard water and considering that the hardness in the water samples of the wells (Table No. 2) of the studied area varies from 80 to 830 mg/liter. The wells number (10, 11, 12, 13, 18, 20, 22) have a hardness much higher than this value, therefore according to table number 1 of the divisions and degree of water hardness, you are placed in the category of very hard water.

3.2 Turbidity rate

Water quality can be interpreted as a lack of water clarity, but water quality should not be mistaken. Water can be dark in color, but not cloudy. It is caused by the presence of extremely low insoluble substances in water, whose amount varies from a very small amount to a large amount that causes the water to become completely cloudy. There are no problems for separating large suspended materials that can precipitate, because placing water in the right place will cause the same materials to precipitate, but small particles can be separated from water by filtering, if the particles are very small, they can be removed by the process of adding aluminum sulfite, etc. Measuring the concentration can be useful in determining the amount of colloidal particles that are not precipitated and cannot be filtered (Krapitov, 1981).

The minimum acceptable standard for drinking water is 5 units and the maximum is 25 units.

The amount of industrial water should be as low as possible, this issue is particularly important for boiler water; because it loads sediments in boilers and can produce foam and be carried by steam. In the food industry, the amount of water needed should be low, because its increase affects the products and spoils them. The amount of water in the cooling systems and central heating systems is a great barrier to heat, which as a result causes overheating and blockage of the taps and also causes erosion of the systems.

The measuring instrument is called a turbidity meter.

The test showed that the turbidity of the water samples taken from the wells in the city of Kabul due to the study by the standard of the maximum desired in some water samples from table number 3 (wells number 4, 15, 16, 17, 19, 24) is higher than the minimum standard.

3.3 Electrical Conductivity.

It is a criterion for measuring the electric current of a solution. This electric current capability of solutions depends on the existence of ions in aqueous solutions. The measurement of electrical conductivity shows the substances dissolved in water and its measurement unit is micro Siemens per centimeter [μS/cm].

The results of the electrical conductivity of well water range from the maximum [μS/cm] of 24450 in well number 18 to the minimum [μS/cm] of 227 in well number 7.

The results of the analysis in the electrical conductivity parameter section show that without the water of sample number 7 of the well, all the water samples of the wells (table number 3) are higher according to the WHO standard ([μS/cm] 250).

Total dissolved solids TDS: TDS is a very effective parameter in creating the taste of drinking water, water that has TDS less than 500 mg/litter is considered very good water from the point of view of drinking standard. TDS between 500 and 1000 is desirable and widely 1000 to 15000 is allowed for drinking, but water with TDS of more than 1500 is not acceptable for drinking (Mark Jammer, 1986). (Program and budget organization 1375).

EC indicates the ability to pass electric current in the water, which has the same properties as TDS (Ashton, J., Wampler, P., Kneeshaw, T, 2020).

Using Table No. 3, the results of the water range of TDS changes in the wells are from a maximum of 1100 mg/litter in well No. 18 to a minimum of 131 mg/litter in well No. 7. According to the aforementioned standards, the water of all the wells is acceptable for drinking and use in industries, and only well number 18, which has TDS more than 1000 mg/litter, is not suitable for drinking, which is classified as salty water. (WHO, Geneva. 1993) and causes consumer complaints.

3.4 Bicarbonate

Carbon dioxide and bicarbonate in water are the basic components of carbonates and as a result of the hydrolysis of bicarbonate, the water environment becomes alkaline (Ashton, J., Wampler, p., Kneeshaw, T., 2020).

It can be seen from Table number 3 of the water laboratory results that the bicarbonate parameter in the water samples of the studied wells varies from 60 to 410 mg/liter. Bicarbonate in all the well water samples taken for the study is more than the standard (10 mg/litter), which is the best value of the results, the amount of bicarbonate in the well water is from the maximum of 410 mg/liter per well number of 25 to the minimum. It is 0.1 mg/L in well number 17.

3.5 Calcium and magnesium

Because calcium and magnesium are the main factors of water hardness. A large amount of elements in water causes an increase in the hardness of water and as a result, limits the different uses of water and as a result limits the different uses of water. The maximum amount of calcium and magnesium was observed in the water of wells No. 18 and 20 (Table No. 2) and these wells have higher hardness than the studied wells in the region. In terms of hardness, the waters of the region are considered very hard waters and create restrictions for various uses.

4. Conclusion

From the point of view of the chemical and physical parameters of the underground water of Kabul city, it is problematic from the health point of view, and in general, the underground water in the lower part of Kabul city is considered to be very hard water.

In terms of most of the chemical parameters, including EC, TDS, SO4, NO3, and HCO3, the water of wells No. 1, 2, 3, and 14 are polluted beyond normal and permissible limits.

The main source of underground water supply in the Kabul area is the infiltration of atmospheric water (snow and rain) through the rocks of the aeration zone to the surface of the underground water, and the infiltration of seawater that flows as a result of rain or after the melting of snow in the mountains.

The lack of annual rainfall in this area has caused the level of underground water to decrease, which, as a result, increases the radius of influence and contamination of underground water due to the absorption of surface polluted water.

The results obtained from this research confirm the previous claims and results regarding the deterioration of the quality of underground water in the Kabul region, such as the increase in water hardness, the increase in the amount of nitrite, etc. as a whole. But it provides more accurate results and results for the absolute majority of water quality parameters.

Based on the obtained results, we can say that the important physical parameters of groundwater quality such as TDS, electrical conductivity, and pH are not good in all parts of the Kabul area, and most of the opinion is the minimum limit of the determined standard.

Some of the chemical parameters of underground water quality in the Kabul area such as fluoride, total amount of iron, arsenic, sodium, potassium, and chlorine are within the permissible limit in all samples.

The amount of chloride in all basins (four water layers) except the sub-basin of Kabul Merkazi is within the permissible limit. Also, the amount of nitrite is within the permissible limit only in the Pulcharkhi sub-area, and for all three other areas it is more than the permissible limit according to the minimum criteria. Of course, the highest amount of nitrite has been received in the Dar al-Aman area.

The amount of sulfite is within the permissible limit only in the Darlaman sub-area, and it is more than the permissible limit in the remaining three areas. In terms of the amount of sulfite in the underground water of the central Kabul sub-basin, it is in the worst situation with this quantity being more than 75% including 17 samples and the maximum quantity of 360 mg/l.

The general hardness of underground water in all areas for a certain percentage of samples is higher than the permissible limit. But the percentage of violations is very different from the maximum and minimum standards. The highest value of hardness was obtained in the waters of central Kabul samples (830 mg/l CaCO3). Overall, it can be said that the overall hardness of Polcharakhi and Central Kabul waters is higher than the other two areas.

The amount of magnesium in the underground water of all sub-basins is more than the permissible limit. The maximum amount of magnesium has been found in the water of Logar and central Kabul sub-basins (75 mg/l).

Based on the obtained results, we can say that some of the important chemical parameters of underground water quality, such as the amount of chloride, nitrite, total hardness, sulfite, and magnesium in the Kabul area are not within the permissible limits for the majority of areas including this area .

Table 2- Concentration of chemical Kat ions and physical parameters in underground water of Kabul city

Location	well number	The concentration and balance of ions in water $(mgr / liter)$						
		1	2	3	4	5	6	7
		Na [mg/l]	Mg [mg/l]	Ca [mg/l]	K [mg/l]	T/H [mg/l]	Ca/H [mg/l]	As [mg/l]
Khushal Khan Mina	1	23	25	110	0.4	380	250	0
Deh Araban village	2	12	26.7	56	0.1	250	140	0
Afshar-water supply project	3	-	-	-	-	-	-	-

company - Afshar project	4	-	-	-	-	-	-	-
Dasht Barchi (Onchi)	5	30	12	96	6.6	290	240	0
Wazir Castle	6	23	29	144	0.5	480	360	0
straps	7	10	7.2	24	0.2	80	60	0
Paghman- Abdul Ali village	8	68	26	60	3.7	230	150	0
Gulai Mehtab Qualia	9	57	13	26	0.5	300	240	0
National Museum of Afghanistan	10	55	29	33	0.4	520	270	0
Deh Dana Neswan High School	11	67	62	35	0.8	571	170	0
Guzarga (the gaiby castle)	12	60	63	32	0.6	560	180	0
Forty Pillars (Ansarullah)	13	63	59	33	0.6	570	260	0
Chial Stone - Factory	14	65	27	28	0.4	440	210	0
Alauddin project	15	51	-	-	-	-	-	-
areas of Deh Mezang	16	66	-	-	-	-	-	-

Seyyed Jamaluddin University	**17**	-	-	-	-	-	-	-
Tuberculosis Hospital	**18**	*58*	*49*	*250*	**4.9**	**830**	**200**	**0**
Ibn Sina's Hospital	**19**	-		-	-	-	-	-
Muhammad Khan's Pole	**20**	*38*	*75*	*195*	**2.7**	**800**	**400**	**0**
Fethullah Castle	**21**	*165*	*46*	*45*	**3.4**	**285**	**112**	**0**
Polcharkhi Bank of Afghanistan	**22**	*56*	*41*	*200*	**0.7**	**670**	**200**	**0**
Lab Darya (bathing well)	**23**	*35*	*23*	*150*	**0.9**	**470**	**340**	**0**
Bagrami- Darya Logar	**24**	-	-	-	-	-	-	-
Bagrami-Shivaky	**25**	*115*	*45*	*44*	**4.8**	**480**	**110**	**0**
average		*55*	*36.55*	*86.72*	**1.79**	**455.88**	**216.22**	**0**
standards	The optimal maximum of the standard	*200*	*30*	*200*	**10**	**150**	-	**0.01**
	Maximum allowed	*200*	*300*	*200*	**10**	**500**	-	**0.05**

Table 3- Concentration of chemical anions and physical parameters in underground water of Kabul city

Location	well	The concentration and balance of ions in water. $(mgr / liter)$					Physical parameters of water			
		1	2	3	4	5	1	2	3	4
		Cl [mg/l]	Hco_3 [mg/l]	So_4 [mg/l]	No_3 [mg/l]	F [mg/l]	Turbidity [NTU]	E.C [µS/cm]	TDS [mg/l]	pH
Khushal Khan Mina	1	96	110	98	15	0.1	0	842	480	8
Deh Araban village	2	110	65	45	0	0.3	0	442	293	8.1
Afshar-water supply project	3	-	-	37	2.7	0.18	0.29	490	619	7.5
company - Afshar project	4	-	-	0.08	5.3	0	0.32	480	619	7.5
Dasht Barchi (Onchi)	5	107	80	74	20	0.1	0	710	475	7.6
Wazir Castle	6	125	130	118	10	0.2	0	990	484	7.2

straps	**7**	*26.7*	*60*	*23*	**0**	**0.1**	**0**	**227**	**131**	**8.2**
Paghman-Abdul Ali village	**8**	*21*	*325*	*34*	**26.04**	**1.8**	**1.1**	**900**	**619**	**7.6**
Gulai Mehtab Qualia	**9**	**111**	*82*	*85*	**10**	**0.1**	**0**	**720**	**477**	**7.3**
National Museum of Afghanistan	**10**	**170**	*164*	*156*	**0**	**0.3**	**0**	**1068**	**651**	**7**
Deh Dana Neswan High School	**11**	**190**	*165*	*172*	**0**	**0.2**	**0**	**1239**	**672**	**7.7**
Guzarga (the gaiby castle)	**12**	**181**	*150*	*186*	**0**	**0.20**	**0**	**1104**	**659**	**7.65**
Forty Pillars (Ansarullah)	**13**	**185**	*160*	*170*	**0**	**0.5**	**0**	**1224**	**670**	**7.4**
Chial Stone - Factory	**14**	**135**	*100*	*94*	**30**	**0.4**	**0**	**927**	**470**	**7.48**
Alauddin project	**15**	**-**	**-**	**40**	**5.7**	**0.08**	**0.51**	**637**	**619**	**7.7**

areas of Deh Mezang	**16**	**-**	**-**	**98**	**3.5**	**0.11**	**0.49**	**1093**	**430**	**8.1**
Seyyed Jamaluddin University	**17**	**0.1**	**0.01**	**42**	**3.1**	**0.20**	**0.41**	**878**	**619**	**8.1**
Tuberculosis Hospital	**18**	*262*	*310*	*360*	**0**	**0.2**	**0**	**2450**	**1100**	**7.6**
Ibn Sina's Hospital	**19**	**-**	**-**	**46**	**1.9**	**0.5**	**0.37**	**710**	**619**	**7.4**
Muhammad Khan's Pole	**20**	*240*	*120*	*271*	**10**	**0.2**	**0**	**1856**	**930**	**7.2**
Fethullah Castle	**21**	*200*	*350*	*37*	**18.65**	**0.89**	**1.5**	**909**	**625**	**7.68**
Polcharkhi Bank of Afghanistan	**22**	*251*	*170*	*280*	**25**	**0.3**	**0**	**1300**	**883**	**7.75**
Lab Darya (bathing well)	**23**	*149*	*130*	*155*	**25**	**0.3**	**0**	**1000**	**595**	**7.69**
Bagrami-Darya Logar	**24**	-	-	*260*	**1.7**	**0.35**	**0.37**	**1211**	**619**	**7**
Bagrami-Shivaky	**25**	*98*	*410*	*118*	**20.44**	**0.91**	**1.1**	**900**	**619**	**7.6**

average		*106.312*	*123.24*	*119.96*	**7.36**	**0.34**	**0.25**	**972.28**	**599.08**	**7.602**
standards	The optimal maximum of the standard	IL 45	IL 1.7	IL 45	U.S.EPA 10	WHO 1.5	U.S.EPA 0.3-5	WHO <250	U.S.EPA <500	WHO 6.5-8.5
	Maximum allowed	ANSA 250	U.S.EPA 10	ANSA 250	WHO 11	U.S.EPA 2	IL 0-25		WHO <1000	ANSA 6.5-8.5

Data Availability

Requests for access to these data should be made to the corresponding author via e-mail address: Asadullahshakir228@gmail.com

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper .

5. References:

[1] Wachinski, A. M. (2016). Environmental ion exchange: Principles and design. CRC Press.

[2] Audi, Qasim. (1373). Drinking water quality. First Edition. Researcher Publications.

[3] Kawamura S,(1991). Integrated design of water treatment facilities. 1st Ed. New York: John Wiley & Sons.

[4] Shariat Panahi, Mohammad,(1377). Principles of water and wastewater quality and treatment. Fifth Edition. Tehran University Publications.

[5] WHO, (2011) Guidelines for drinking water quality. 4th ed. Geneva: World Health Organization.

[6] Saffi, M. H., (2011) Groundwater natural resources and quality concern in Kabul Basin, Afghanistan. Kabul: DACAAR.

[7] Mack, T. J., Akbari, M. A., Ashoor, M. H., Chornack, M. P., Coplen, T. C., Emerson, D. G., Hubbard, B. E., Litke, D. W., Michel, R. L., Plummer, L. N., Rezai, M. T., Senay, G. B., Verdin, J. P., and Verstraeten, I. M., (2010). Conceptual Model of water resources in the Kabul Basin, Afghanistan. Virginia: U.S. Geological Survey.

[8] Campbell J. A dry and ravaged land, (2015). investigating water resources in Afghanistan. Earth mag; 60(1–2):48–55 .

[9] - Houben G, Tünnermeier T, Eqrar N, Himmelsbach T, (2009). Hydrogeology of the Kabul Basin (Afghanistan), part II: groundwater geochemistry. Hydrogeology Journal, b; 17(4):935–948.

[10] Uhl VW, (, 2003). Afghanistan: an overview of groundwater resources and challenges. Rana Associates, Inc. Washington Crossing, PA, USA.

[11] Sadid, Abdurrahman. (1350) Physical geography of the province, Kabul, Geography magazine, numbers 3 and 4, Kabul: Kabul University .

[12] Japan International Cooperation Agency (JICA) (2011) is a report on the potential of underground water resources in the Kabul area in the Geoengineering and Hydrogeology Research Department of the Ministry of Energy and Water of the Islamic Republic of Afghanistan.

[13] Krapitov. (1981) Rapur Geological (Geological Building of Kabul City Area), Kabul: Soviet Ministry of Mines and Industries and Techno-Export .

[14] The report on the exploration of drinking underground water in the Jail Seton area, for water supply to Kabul city by: Shevchenko, VV Dimitri, VN, I. Amin Akbari, Mehrabi and Mohammad Akbar - from the archive of Geological Survey of Afghanistan (in Russian) .

[15] The current state of drought in Afghanistan - International Water Institute, 2002, accessed 2005 at the Internet address:
URL http:// www.iwmi.cgiar.org/Droughtassessment/fileepdf/Drought2000in Afghanistan.pdf

[16] Apple, C, A, J . Postma, D . Geochemistry, Ground Water and Pollution.

[17] APHA, AWWA, WPCF (19855) Standard Methods for the Examination of Water.

[18] Nabizade Nodhi, Ramin. Faizi Razi, Dadmehr, (1375). Drinking water quality guidelines. The World Health Organization. First Edition. Tehran. Nass publications.

[19] Program and budget organization, (1375). a look at Lanjan city.

[20] Mark J. Hammer, (1986) Water and Waste Water Technology Second Edition 190 236 -239, 183- pp 35-88 New York.

[21] Canter L.W., Knox R.C. and Fair Child D.M. (1987) Ground Water Quality and Protection, Lewis Pub. Chelsa, MI.

[22] Stumm, W., (1990): Aquatic Chemical Kinetics, the reaction rate of processes in natural waters. Wiley Interscience New York.

[23] Shariat Panahi, Mohammad, (1377). Principles of water and wastewater quality and treatment. Fifth Edition. Tehran University Publications.

[24] Ashton, J., Wampler, P., Kneeshaw, T. (2020). Grand River Water Quality Sampling: A Comparison of 1990 to 2020 Water Quality Data, Grand Valley State University.

[25] Campbell J. A, (2015). Dry and ravaged land: investigating water resources in Afghanistan. Earth mag 60(1–2):48–55.

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