British Journal of Environmental Studies
ISSN: 2755-0982
DOI: 10.32996/bjes
Journal Homepage: www.al-kindipublisher.com/index.php/bjes

BJES
AL-KINDI CENTER FOR RESEARCH AND DEVELOPMENT

| RESEARCH ARTICLE

Analysis of Groundwater Quality in Ghazni City, Ghazni, Afghanistan

Mohammad Naeem Sarwary[1] ✉, Mohammad Hussain Behzad[2], Mohammad Latif Rahimi[3] and Abdulbaqi Ahmani [4]

[123]*Faculty Members of the Geology Department, Ghazni Technical University, Ghazni, Afghanistan*
[4]*Kabul Polytechnic University, Kabul, Afghanistan*

Corresponding Author: Mohammad Naeem Sarwary, **E-mail**: sarwarynaeem5@gmail.com

| ABSTRACT

Historical groundwater level and water quality data in Ghazni province poorly were reviewed and compared with the data collected in the past than recently. The results suggest that the groundwater quality and water level have been improved progressively with urban development, land use, climate change, social development and frequent drought events. The main impact of these events include; 1- most of the springs and flumes have dried up; 2- decreased annual atmospheric precipitation; 3- increased serious deterioration of water quality; 4- increased water logging and irregulation salinization; 5-declining of water level in excess of recharge trend; 7- increased evaporation and discharge; 6- marshes dried up in several areas of the Basin, leaving salt crust at the surface. The above impacts have resulted in the replacement of surface water with groundwater resources to support socio-economic development. This, however, is basically not possible because of the low thickness and productivity of the aquifers. We have done very little to advertency water quality deterioration and serious lowering of the groundwater level due to fragmented institutional arrangements and poor formulation of effective water policies, strategies and regulations for integrated groundwater resources management, development, protection and sustainability. Groundwater natural reserves have been depleted, and water quality has deteriorated due to over-exploitation. Overall Afghanistan, Arsenic (total as) contamination are an issue of current drinking water supply systems where users have been using groundwater sources. Arsenic contamination is a major environmental health management concern, especially in Ghazni province in the WASH sector. Increasing human activities and haphazard urbanization have modified the cycle of heavy metal, non-metal and metalloids. The arsenic contaminated groundwater used for drinking can cause an adverse effect on the human health of the study area. The water quality study with 96 samples from drinking water points (DWPs) was carried out in the center of Ghazni province results show that the arsenic concentration values in the study area varied between 0.00-0.99 mg/L and 38% of DWPs samples exceeded the value of the WHO guideline of 0.01 mg/L of As Owever, 62% of analyzed water samples exceeded the National drinking water quality standard (NDWQS) of 0.05 mg/L of As.

| KEYWORDS

Natural groundwater resources depletion; study Arsenic concentration variation, water table variation fluctuation, determined the water Ions and nitrate concentration in the Ghazni city.

| ARTICLE INFORMATION

ACCEPTED: 02 February 2023 **PUBLISHED:** 25 February 2023 **DOI:** 10.32996/bjes.2023.3.1.1

1. Introduction

A large percentage of people living in Ghzni city (around 200000 people) depend on groundwater as their primary source of domestic/drinking water. Ghazni basin, especially Ghazni city, has encountered a scarcity of surface water due to the unequal and timely distribution of precipitation. The Ghazni River flows only for three months and is extremely contaminated; therefore, groundwater resources have played the lead role in the development of social - economic growth. Approximately 20% of the inhabitants of Ghazni city have access (intermittently) to the central water supply system. The rest depend on shallow wells equipped with hand pumps which are mainly from groundwater. Currently, in Ghazni Basin, there is a depletion of natural groundwater storage and an increase in the concern of overdraft in groundwater due to over-abstraction, low recharge and high evaporation and discharge. The depletion of water storage has occurred due to the lowering of groundwater level in excess of the low recharge trend. This is a real threat to the depletion of the aquifer's natural storage and perhaps a cause of land subsidence.

The groundwater quality has progressively deteriorated with the following parameters of salinity, water hardness, coliform bacteria, arsenic, fluorite, nitrate and boron concentrations, which potentially can become a real threat to the health of Ghazni's inhabitants and agricultural activities. Ghazni's inhabitants have frequently been affected by contaminated water-born related diseases, and children are the most vulnerable group.

As Ghazni's population, similar to the other cities, continues to grow up, there is increasing pressure to further exploit groundwater for various purposes, which are basically not possible because of the low thicknesses and low productivity of the aquifers. This trend will cause further negative consequences on the groundwater quality and quantity that will challenge our social development and environmental safety. This vulnerability of the aquifer may not be reversible, and the city will face a severe shortage of drinking water and most probably increased water contamination in future.

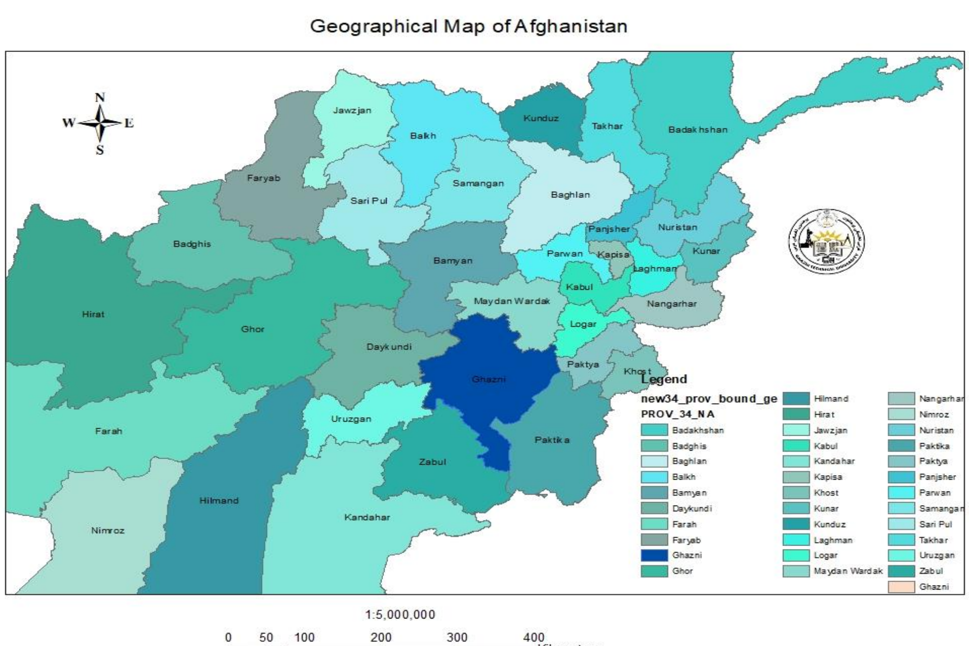
The results of all investigations, in comparison to the other basins, show the quality and quantity of groundwater in this Basin also will not be recoverable; on the other hand, if this trend continues, the current arrangements and management tools may not meet the emerging needs. It is urgently required to be prevented all the processes and activities which cause the degradation of water quality and depletion of natural water storage

2. Locality and characteristics of the Study Area

The study area is located in the south direction of Kabul, and geographically, it is situated between latitude 33.39776 - 33.84776 and longitude 68.26683 - 68.61683 (Figure2. 1). It covers a total area of about 928.027738 km^2 with a population of about 200000. It has semi-arid climate with major fluctuations during the day and night fluctuations. Winter is characterized by low temperatures of less than -20 °C, while summer is dominated by high temperatures of more than 35 °C. , over rainfall and snowfall are the main sources of groundwater and surface water, and the area receives an average of 200 mm/y rainfall. There are several numbers of seasonal rivers and abandoned channels which have water flow only in the rainy seasons.

Groundwater flow direction is from the north mountains front hydrogeological boundaries (upstream) to the south flood plain (downstream) along the Ghazni seasonal river.

Fig. 2.1: Location of the Study Area



3. Geological setting of Afghanistan

The geology and tectonics of Afghanistan are significantly complicated. The country is located within the range of the great tectonic upheaval that has produced the world's highest mountain ranges, such as the Hindu Kush, Pamir, Karakoram, and Himalaya (Broshears et al., 2005). Afghanistan's geology includes Proterozoic metamorphic rocks, Paleozoic metamorphic and sedimentary rocks, basic igneous rocks, acidic igneous rocks, volcanic rocks, Paleocene sedimentary rocks, Cretaceous-Paleocene sedimentary rocks, Triassic sedimentary rocks, Cretaceous sedimentary rocks, Neogene sedimentary rocks, Jurassic sedimentary rocks, Permian-Triassic sedimentary rocks, and Quaternary sediments. Tünnermeier and Houben (2005) determined that the Kabul Basin formed by plate movements occurring during the Late Paleocene with metamorphic rocks surrounding the basin. Based on the tectonic origin, the Helmand basin is a structurally closed and large basin that started to form during the middle Tertiary because of the collision of numerous former Gondwanaland fragments (Whitney, 2006). Karstic and jointed aquifers are observed in different parts of the region where geological and tectonic factors have affected groundwater aquifers in the country.

The study area occurs in the region, including the Hazarajat Mountains, Ghazni-Kandahar Uplands, South Afghanistan Plain and South Afghanistan Mountains, which bound the region on the south (Chagai Range). This is the largest region lying almost entirely within the limits of Afghanistan. The region occupies about 300,000 sq. km., though initially, its size was much greater. Significant parts of the region were cut along its border with the neighboring regions by the most recent strike-slip faults. These first-order structures can be recognized in the region: Farah Rod and Dari Rod troughs and Helmand-Argandab Uplift. The Seistan Basin was formed there in recent times.

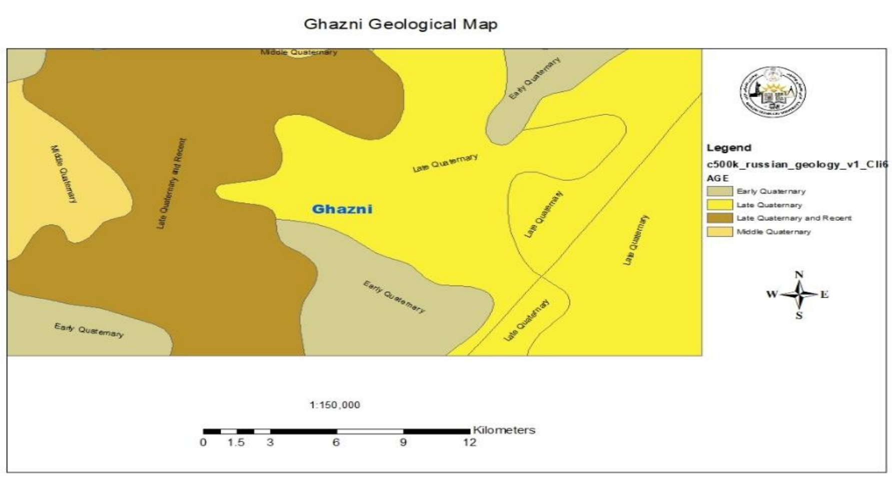
From the Geological Setting aspects, two cycles can be distinguished in the geological history of the region, the geosynclinals and epigeosynclinal. The first cycle covers the period from the earliest Precambrian through the Cretaceous and the second from Paleogene to Quaternary.

3.1 Surface Geology of Study Area

The main Exposure parts of Surface Geology in the study area are classified as follows:

- Recent Q_4: Gravel, sand, silt and clay
- Late- Recent Q_{34}: Gravel, sand, silt clay, clay and conglomerate
- Late Q_3: Gravel mixed with sand, silt and clay, conglomerate and clay
- Middle Q_2: Conglomerate, sand with sand and silt and clay
- lower Q_1: Andesite tuff, Granite and granodiorite
- Eocene: Dunit, peridotite and serpentines
- Late Permian $p_{3:}$ granodiorite, Limestone, dolomite, marl,
- Middle Permian p_2 : ultramafic intrusions
- Carboniferous-Earl Permian CP_1: Siltstone, sandstone, shale, mafic volcanic
- Middle Proterozoic Ym: shiest, gneiss, quartz, marble and amphibolite's.

Figure 3.1 surface Geology of the study area.



3.2 Hydrogeology of Afghanistan, Ghazni city

The natural system of groundwater in Afghanistan involves five hydrogeological units of the upper Cretaceous-Paleocene fracture-karstic aquifers, crystalline rocks, quaternary aquifers, Triassic–lower Cretaceous pressure thermal water, and Neogene aquifer aquitard (Saffi and Kohistani, 2013). The principal aquifer systems include the following: (a) Quaternary deposits in the major river valleys, particularly in the Kabul river basin, the river systems in the Helmand river basin in the east (Ghazni, Tarnak, Arghistan, and Arghandab), the Harirud river and certain river systems within Northern flowing rivers and Amu Darya basin; (b) semi-consolidated Neogene age deposits in the Kabul river and other river basins; (c) carbonate rock aquifer systems on the northern flank of the Hindu Kush mountain range and along portions of the Helmand river in Oruzgan Province; and (d) carbonate rock systems at other locations (Uhl, 2003).

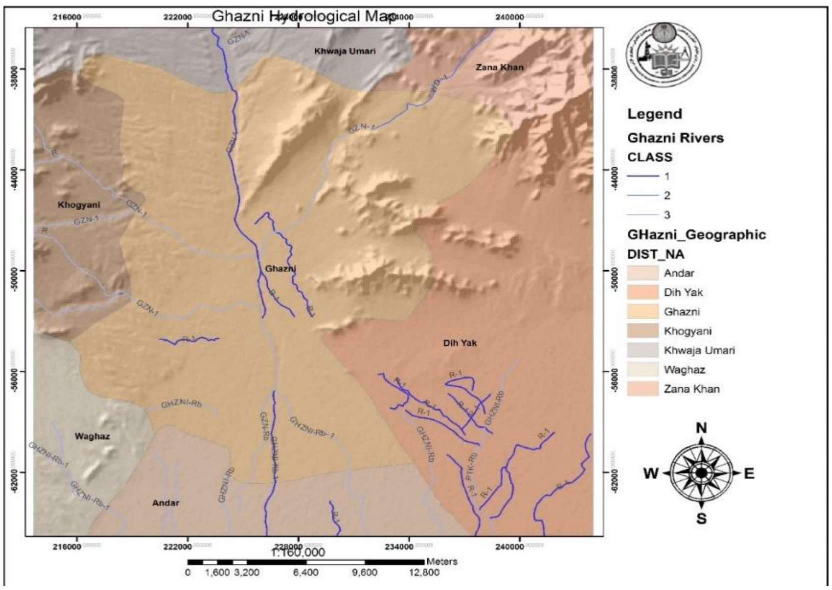


Figure 3.2 hydrological Map of the study Area (Ghazni, Afghanistan)

Campbell (2015) asserts that 70.9% of the urban and 39.4% of the rural population in Afghanistan have access to safe drinking water, which means that about 46% of the total population has access to safe drinking water. If we even consider this report as the highest one in terms of access to safe drinking water, there is still a great concern about the quality of water causing different kinds of diseases risking human health as far as very little is known about its quality because of the limited studies. The central Ghazni City shallow groundwater is a good example that is approximately unsafe for human health. According to the computation of Houben et al. (2009b), insufficient water hygiene can be connected to the high infant mortality rate to some degree. Thus, studies are required to be conducted to investigate groundwater contamination sources in order to prevent further problems that may arise due to groundwater contamination. Groundwater is also used for irrigation purposes, especially in areas where there is no access to surface water.

Water pumps and turbines are commonly used to withdraw the groundwater for both drinking and irrigation in rural areas; some karez wells (qanats) and springs are also sources of drinking and irrigation water in some areas, as it is already mentioned that more than 15% of the irrigated land receives groundwater. Uhl (2006) claims that even most of the urban areas rely on groundwater for drinking, though more than 95% of the groundwater usage in the country is still accounted for by irrigation. Due to the drought that occurred between 1999 and 2003, most of the karez wells and springs dried up. A comprehensive study was carried out by Taher et al. (2014) to observe the static and dynamic groundwater levels in 96 wells in the Center of Ghazni city in Oct 2020 Ghazni Technical university students.

The hydrogeology of the study Areas The recent-late Quaternary deposits (silt clay, silt, sandy clay, sand, gravel and conglomerate) are contained the main aquifers. Rainfall and snowfall are the main sources of groundwater recharge. The depth of the water table ranged between 10 - 45 m. Groundwater flow directions are from the north mountains front hydro geological boundaries (upstream) to the south flood plain (downstream) along the Ghazni seasonal river.

3.3 Sampling and field measurement

In total, 96 water samples of DWPs (hand pump tube wells and dug wells) were collected and tested on site for measurement of arsenic concentration values and physical parameters like temperature, pH and electrical conductivity (EC) using a digital Arsenator and pH/conductivity meter. 50 out of them were sampled for chemical analyses for more concentration before the collection of samples; each hand-pump was flushed for about 10 minutes then the samples were collected in sterilized 500 mL polyethylene bottles according to the water sample collection procedure; all samples were immediately shifted to the laboratory and stored to the refrigerator at 4 °C in the dark until the analysis took place.

The water samples were chemically analyzed for 34 parameters. The analytical data quality was ensured through a collection of duplicate samples for chemical analysis and comparisons. The ionic charge balance of each sample was <5%.

4. Results and Discussion

4.1 Mechanism of Arsenic Contamination of Water & Sources

- ✓ Rocks and minerals followed by subsequent leaching and runoff. It can also be introduced into soil and groundwater from anthropogenic sources.
- ✓ Arsenic is released in the soil as a result of weathering of the arsenopyrite or other primary sulfide minerals.

Important factors controlling this phenomenon are:

- ❖ Moisture (hydrolysis)
- ❖ pH
- ❖ Temperature
- ❖ Solubility
- ❖ Redox characteristics of the species
- ❖ Reactivity of the species with CO2/H2O

It has been reported that weathering of arsenopyrite in the presence of oxygen and water involves oxidation of S to $SO4^{2-}$ and As(III) to As(V):

$$4FeAsS + 13O2 + 6H2O \leftrightarrow 4SO4^{2-} + 4AsO4^{3-} + 4Fe^{3+} + 12H^{+}$$

- ✓ Although there are both natural and anthropogenic inputs of arsenic to the environment, elevated arsenic concentrations in groundwater are often due to naturally occurring arsenic deposits.
- ✓ The average abundance of arsenic in the earth's crust is between 2 and 5 mg/kg, with enrichment in igneous and sedimentary rocks, such as shale and coal deposits.
- ✓ Arsenic-containing pyrite (FeS) is probably the most common mineral source of arsenic, although it is often found associated with more weathered phases.
- ✓ Arsenic can also be released directly into the aquatic environment through geothermal water, such as hot springs.
- ✓ Anthropogenic sources of arsenic include pesticide application, coal fly ash, smelting slag, feed additives, semiconductor chips, and arsenic-treated wood, which can cause local water contamination.

4.2 Distribution pattern of Arsenic concentration

Recent research by Saffi and Eqrar (2016) studied 764 drinking water points, including hand pump tube wells and dug wells, to identify arsenic contamination in the groundwater of Ghazni and Maidan Wardak provinces. They found that 61% of the water samples exceeded the WHO guideline of 10 µg/L of As, and 38% of the analyzed water samples exceeded the National Drinking Water Quality Standard of Afghanistan (NDWQS) of 50 µg/L of As. Also, out of 42 countries affected by arsenic, Afghanistan is ranked 22nd with groundwater naturally deteriorated by arsenic; the province of Ghazni had the highest concentration of arsenic in groundwater, exceeding the WHO limit (Mukherjee et al., 2006). Moreover, Amini et al.

Arsenic concentration in the DWPs of the study area is mostly a Geologic (geogenic) occurrence, and its special distribution levels are irregular throughout the study areas. In the center of Ghazni province, the total arsenic (As^3 and As^5) concentrations ranged between 0.00 - 0.97 mg/L, and 35% (34 out of 96) of groundwater samples exceeded the value of NDWQS of 0.05 mg/L of As; however, 65% of analyzed water samples exceeded the WHO guideline of 0.01 mg/L of As.

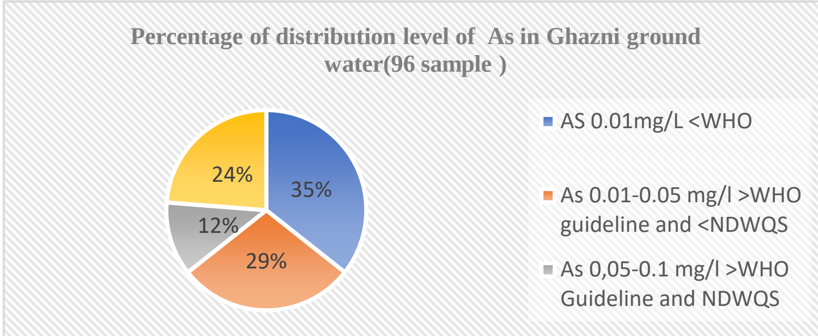


Figure 4.1 distribution level of As in Study Area

As we have in the chart, the variation of As content is in different areas. The blue area indicates a lower percentage of As is (0.01 mg/L < WHO guideline)35% out of 96 water samples, the orange area indicates the As (0.01-0.05 mg/L >WHO guideline and <NDWQS is 29% out of 96 water sample, the gray one is showing the As is (0.05-0.1 mg/L>WHO guideline and NDWQS) 12 % out of 96 water sample, the yellow area is indicating the As is (0.1-0.57 mg/L very > WHO guideline and NDWQS) is 24% out of 96 water sample.

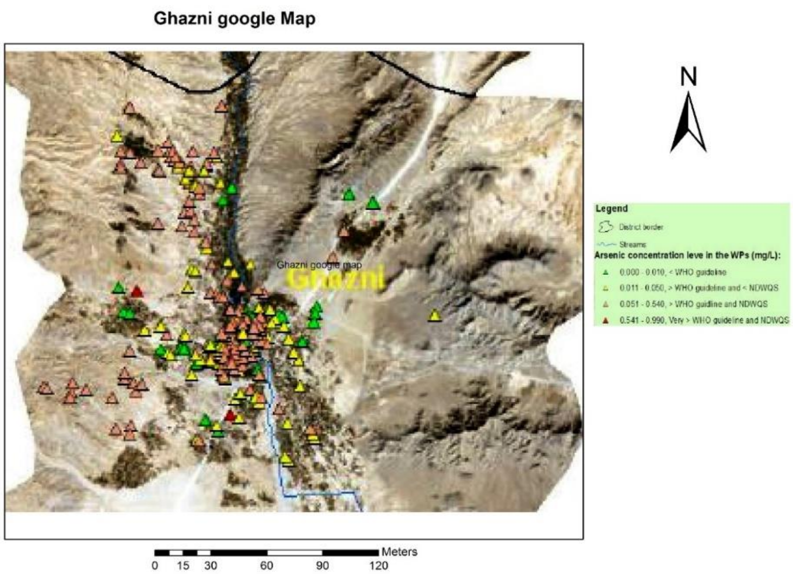


Figure 4.2 sampled Location and Arsenic spatial level Distribution

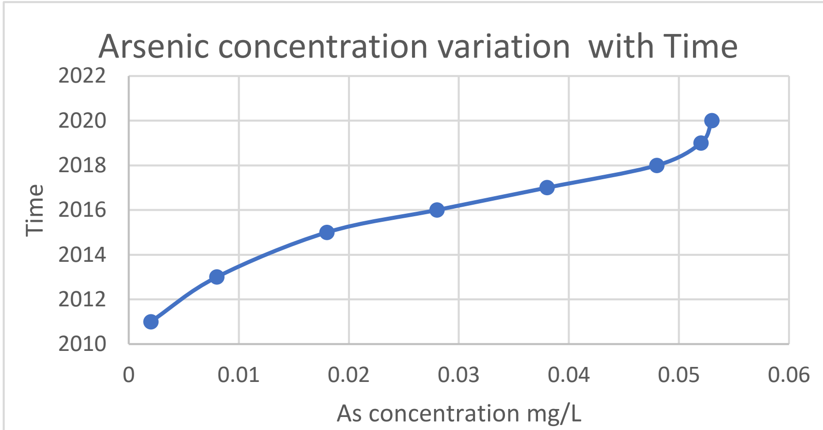
4.3 Arsenic Health risk

High arsenic content in drinking water causes adverse effects on the health of the users and consequently leads to skin, bladder, liver and lung cancers; toxicity of various arsenic species increases in the order of As^{V}<MMA^{V}<DMA^{V}<As^{III}<MMA^{III}<DMA^{III}.

It causes renal problems (kidney cancer, bladder cancer), cardiovascular problems (hypertension & heart attack), neurological problems (impaired intellectual function & neuropathy), respiratory (pulmonary tuberculosis & lung cancer) and reproductive problems, dermal effects (skin lesions, hyperpigmentation, skin cancer etc.)

4.4 Time series arsenic concentration value variation

There are many hand pumping wells already installed as GMWs in the study area by DACAR, and the GMWs were monitored from the quantitative and quantitative points of view. The location of GMWs is shown in the (figure3.2). The analyzed data result indicated that the arsenic concentration values varied with time and water table fluctuation.



The time series arsenic concentration values in GMW (center of Ghazni province) reneged between 0,01 - 0,061 mg/L, and the concentration values varied with time and groundwater table fluctuation. The time series water table fluctuation and arsenic variation are shown in figure 4.3.

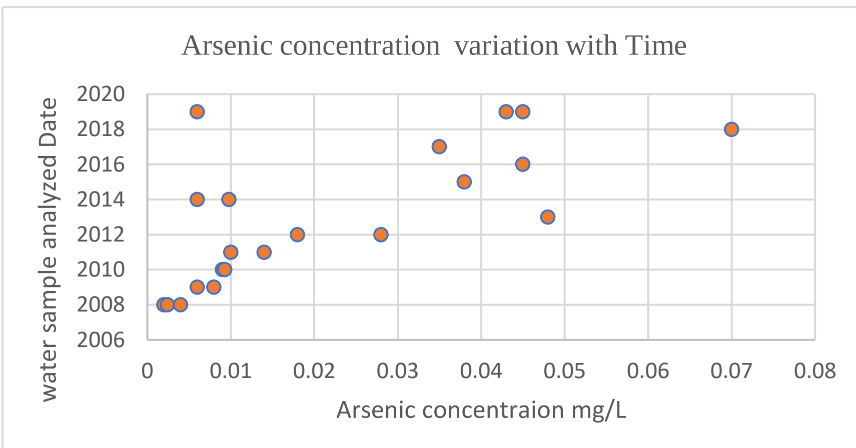


Figure 4.3 Arsenic concentration base on the water sample analyzed

Figure 4.3 arsenic concentration variation with time

The time series of arsenic concentration values of GMW (Ghazni center) reneged from (0, 04 mg/L to 0, 07 mg/L), and the concentration values varied with time and seasonal fluctuation of the water table. The GMW time series water table fluctuation and arsenic variation are shown in figure 3.5. Time variability of the arsenic concentration in the GMWs shows dissolution and desorption hydro-chemical processes reaction that the arsenic releases from the solid phase into the liquid phase (groundwater). The water sample analyzed indicated a great difference according to the time series of Electrical conductivity and water table variation in Ghazni city that measured from years 2008 to 2019, as shown (figure 3.4. &4.1).

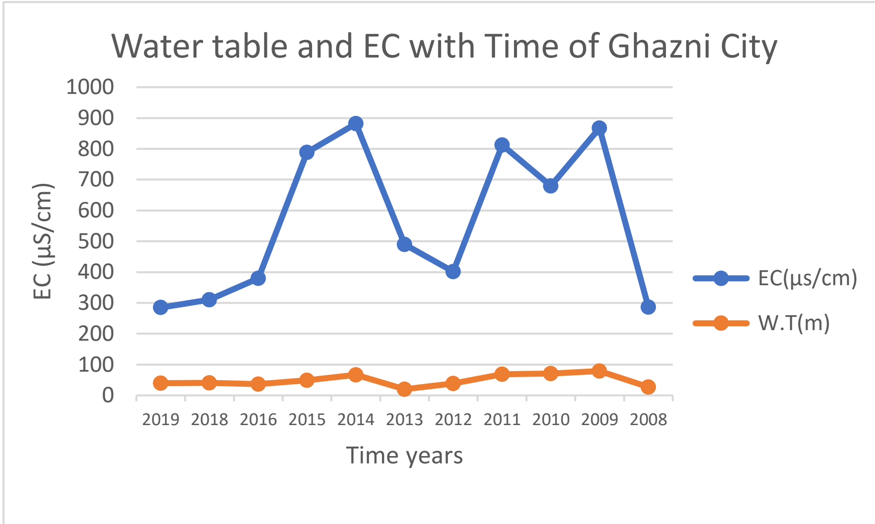


Figure 4.4 Electrical conductivity variation and water table fluctuation with time.

4.5 Arsenic concentration values in the Surface water

Water samples were taken from upstream (Khwaja Umary district) and downstream (Ghazni center) for chemical analysis. The results show the Arsenic concentration value increased from upstream (0.016 mg/L) to downstream (0.021 mg/L); however, the major ions are not considerably changed. The location of sampled water and Arsenic concentration values with respect to other major chemical ion parameters is shown in Figure 3.5.

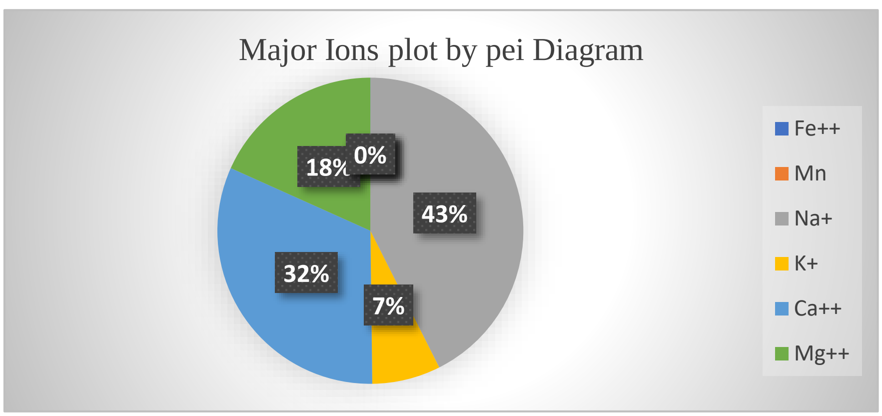


Figure 4.5 Major Ions percentage

5. Hydrochemistry of Groundwater

The major ions, pH and EC parameters of groundwater were plotted by the Durov diagram (figure 4.1) using AquaChem 2014.2. Table 4.1 illustrates hydro-chemical facies with respect to pH and electrical conductivity of DWPs (groundwater) within the hydrogeological boundaries of study areas. The dominant inions in the water samples are HCO3− > Cl^- > $SO4^{-2,}$ and the dominant cat-ions in the water samples are Na+ > Ca^{+2}> Mg^{+2}. The main water types are Na-Ca-CO3, Na-Mg-CO3, Ca-Mg-Na-CO3, Na-HCO3-Cl, Mg-Na-HCO3-SO4, Mg-Na-HCO3-SO4- Cl, and Mg-Ca-HCO3-SO4-Cl. These different chemical compositions may be due to weathering and dissolution of calcite, dolomite, silicate, sulfide and other minerals. However, some water samples show the mixing of water types with high chloride (Cl^-); this occurrence may be due to silicate weathering ion exchange and calcite dissolution. High HCO3 is ubiquitous in groundwater in Afghanistan, which plays an important role in hydrochemical evolution and trace metal mobilization.

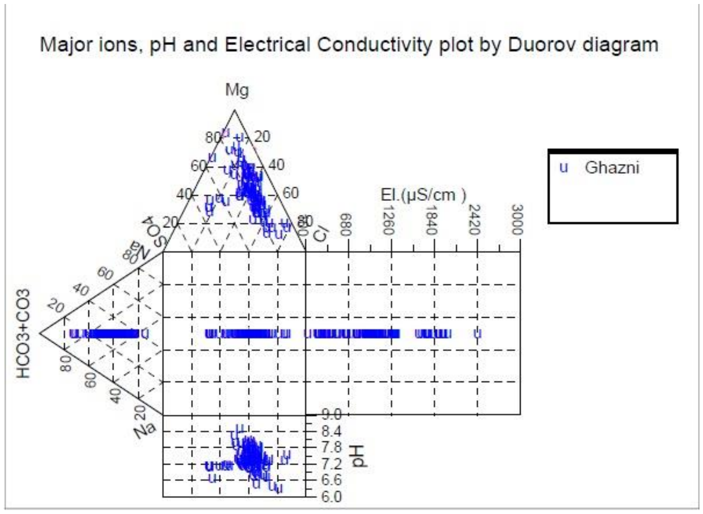


Figure 5.1 major ions, PH and Electrical conductivity

Table 5.1 Water Quality Statistic Analysis Results

No	Element	Unite	statistic				Acceptable limited	
1			Co Unit	Max	Min	Mean	WHO	NDWQS
2	PH		106	6.33	8.52	7.43	6.5-8.5	6.5-8.6
3	El.Conductivity	µS/cm	106	2440	145	1020	1500	3000
4	ORP	mv	106	291	0	136		
5	Temp	C°	106	20.8	6.5	24.8		
6	As	mg/L	106	0.99	0	0.037	0.01	0.05
7	Fe++	mg/L	106	0.3	0	0.06	0.3	0.3
8	Mn	mg/L	106	0.08	0	0.004		0.4
9	Cl^-	mg/L	106	500	2.5	138.2	250	250
10	$PO3^{---}$	mg/L	106	1.8	0.02	0.51		
11	$HCo3^-$	mg/L	106	1170	115	451		
12	$No3^-$	mg/L	106	127.2	4.2	41.91	50	50
13	Na^+	mg/L	106	570	24	172	200	200
14	K^+	mg/L	106	90	12	17		
15	Ca^{++}	mg/L	106	200	14	75		70
16	Mg^{++}	mg/L	106	190	11	43		30
17	Cu	mg/L	106	0.8	0.1	0	2	2
18	So^{4--}	mg/L	106	248	3	70	250	250
19	F^-	mg/L	106	2.4	0.02	0.71	1.5	1.5
20	$NH4^+$	mg/L	106	0.9	0.1	0	1.-3.5	
21	Mn^{++}	mg/L	106	0.8	0	0	0.05	

The water sample is a plot on the central of the tri-linear diagram; the anion carried in groundwater is mainly of $HCO3^-$ Cl^- as cation K^+ Na^+ primarily the highest total arsenic concentration contained in this zone in the north mountainous terrain, which contained Oligocene and Eocene igneous rocks (granite, diorite, per diorite and serpentine), because of the steep topography, fairly cycle condition, proceeding the weathering and leaching action, mineral substance dissolve into groundwater. Arsenic and other compounds are carried by groundwater into the flow direction along the Ghazni River. The wide variability in the electrical conductivities of sampled water defines the measurement of the dissolved saline of water. The EC ranged from145µS/cm to 2440 µS/cm. The pH values of samples ranged from 6.33 to 8.52, and most of the sampled water points are shown alkaline characteristics.

5.1 Hydro chemical statistical analysis

The 50 sampled chemical tested data were analyzed statistically, and the characteristic features of groundwater indicated the presence of total As (0.001- 0.999 mg/L), total Fe (0.01-0.3 m/L), Na+ (24-570 mg/L), K^+ (1.2-90 mg/L), Ca^{2+} (14-200 mg/L), Mg^{2+} (11-190), Cl^- (2-500 mg/L), $SO4^{2-}$ (3-248 mg/L), $NO3^-$ (4.2-127 mg/L), F (0.02-2.40 mg/L), Cu (0.1-0.8 mg/L), NH4 (0.1-0.9 mg/L), Mn (0.0-0.8 mg/L), Cr (0.0-0.09 mg/L), ORP(177-291mV/L)and HCO3(115-1170 mg/L). The pH of groundwater was found to be neutral to slightly alkaline (6.1-8.52) with high EC (145-2440 µS/cm)). The Hydro Chemical Statistic Analysis result is shown in Table 5.1 and figure 5.1.

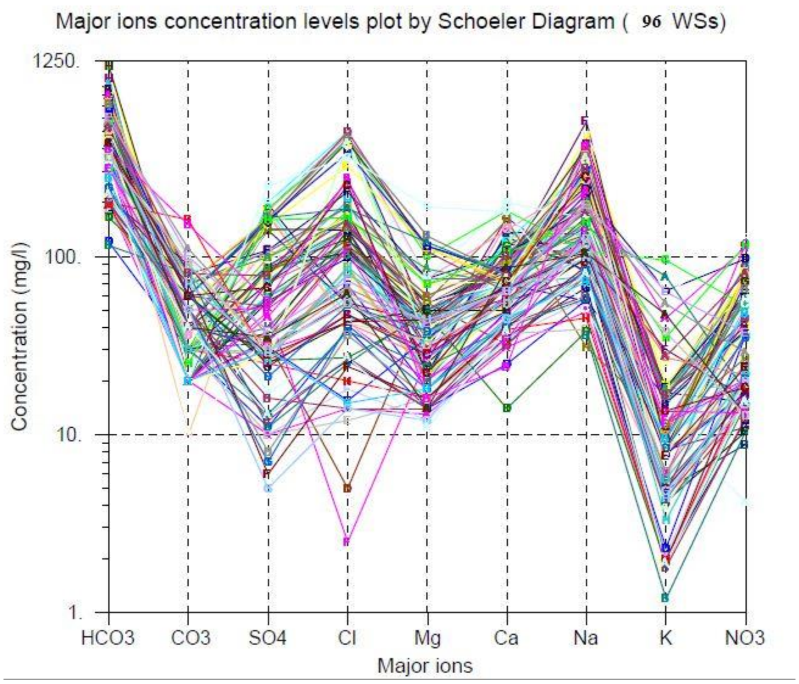


Figure 5.2 Major Ions Concentration Level in Ghazni

5.2 Nitrate concentration in the Study Area

Nitrate concentration distribution level in the study area is determined by 38% of analyzed water samples from drinking water points exceeding the NDWQS of 50 mg/l of NO_3, specified 50-127 mg/l (Figure 5.3). The high concentration of nitrate in the drinking water points is a major concern and potentially affects the health of the inhabitants.

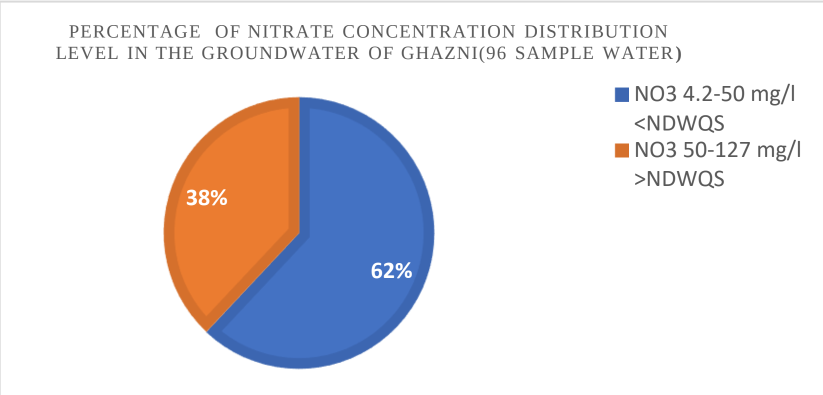


Figure 5.3 Nitrate concentration in Ghazni

5.3 Correlation Analysis

To understand the correlation mechanism of As concentration in the groundwater, the correlation coefficient (r) of arsenic with pH (r = -0.18), Ca^{++} (r = -0.214), Mg^{++} (r = -0.176), Na^+ (r = 0.025), EC (r = 0.049), $SO4^{--}$ (r = -0162), K^+ (r= 0.152), Cl^- (r = -0.032), $HCO3^-$ (r = - 0.118), Mn^{++} (r = 0.140), total Fe (r = -0.301), $NO3^-$ (r = 0.139), $NH4^+$ (r = - 0.290), SiO2 (r = 0.156) and F^- (r = 0.058) were plotted by scatter plots using AquaChem 2014.1 software.

The correlation analysis of arsenic with other water quality indicated complex hydro chemical processes which contribute to the mobilization of arsenic in the groundwater of the study area. The correlation between $SO4^{-2}$ and pH is negative, which would be the result of sulfide oxidation. The influencing hydro-chemical may be a dissolution of total iron and Mn^{++} oxide and sulfide dissolution.

6. Conclusions

- As the contamination of Groundwater is outspreading over the world, so, in this case, the evolution of groundwater quality in Ghazni city is feeling cogency.
- The key finding for the completion of this paper was the amenability of the uncertainty situation of Groundwater in Ghazni City, and it's done by the cooperation of many organs and colleagues. It clearly has a significant impact on the method of usage and controlling of groundwater in contaminated areas.
- From the geohistorical settings point of view, there are two different distinguished cycles of geological history region (geosynclinals and epigeosynclinal), including Cambrian to quaternary geological periods.
- The study was done in a very bad security situation with effort and hard work. So I do suggest if there would be a chance of studying the study area in deeper detail would be more efficient and more reasonable because our analysis in this paper showed that the degree of contamination in the groundwater of the study areas is comparatively high, and the risk of health problems is increasing timely in the other hand the study of these types would be a very big help in humanity, and it would become a sample for the groundwater problems in Afghanistan and even all over the world because the water contamination crises are increasing day by day in the world.
- Groundwater is also used for irrigation purposes, especially in areas where there is no access to surface water; especially in the recent time that most Qanats (karez wells) and springs are dried up, water pumps and turbines are commonly used to withdraw the groundwater for both drinking and irrigation in study areas; from 2003 up to present.
- The arsenic contamination in the DWPs of the study area is mostly a geologic occurrence and its irregular distribution. 62% (60 out of 96) of drinking water points samples exceeded the values of the NDWQS of 0.05 mg/L of As, and 38% (35 out of 96) of analysed water samples exceeded the WHO guideline of 0.01 mg/L of As.
- The arsenic concentration values varied with time and seasonal fluctuation of the water table.
- The nitrate contamination in the drinking water points is due to Anthropogenic (human activities), and 38.4% (40 out of 96) analysed water samples from drinking water points exceed the NDWQS of 50 mg/l of NO3. The high concentration of arsenic nitrate in the drinking water points is a major concern and potentially affects the health of inhabitancies of study areas.
- The result of the investigation indicates that As concentration value increases from the northern part toward the southern part of the study area.
- The correlation coefficient of total Arsenic with other chemical parameters indicated a complex hydro chemical process which contributes to the mobilization of arsenic concentration in the groundwater of the study area. The influencing hydro chemical may be the dissolution of Iron and Manganese oxide and sulphide dissolution.
- Within the hydro geological boundaries of study areas. The dominant inions in the water samples are $HCO3^{-} > Cl^{-} > SO4^{-2,}$ and the dominant cat-ions in the water samples are $Na^{+} > Ca^{+2} > Mg^{+2}$.
- Nitrate determined to study area 38% over the NDWQS guideline (38% of analysed sample contain 50-127ml/l >NDWQS).

Acknowledgements: I would like to express my special thanks of gratitude to my colleagues who worked hard in collecting water samples and packing the bottles of water samples; on the other hand, I also gratefully thank the DACAAR organization, especially the water quality analysis Laboratory branch, for their cooperation and information sharing. I also appreciate the cooperation and efforts of Mohammad Hussain Behzad, a faculty member of the geology and Mine Department, for his assistance and interpretation in the analysis of water quality data for recording and management. I also gratefully show my gratitude to my other colleagues, especially to the Head of the Marine Water subdivision of Ghazni. Finally, I would like to gratefully thank Mirza Hussain Amirkhani, JRS Project Director, for his golden comments and editing of this report.

Funding: This research received no external funding.
Conflicts of Interest: The authors declare no conflict of interest.
Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers.

List of Abbreviations

DACAAR: Danish Committee for Aid to Afghan Refugee
ECHO: European Commission Directorate General – Humanitarian aid and Civil Protection
WASH: Water Sanitation and Hygiene
WHO: World Health Organization

DWPs: Drinking Water Points
NDWQS: National Drinking Water Quality Standard
GWMs: Groundwater Monitoring Wells
GWM_ID: Groundwater Monitoring Wells Identity Number
EC: Electrical Conductivity
mg/L: Milligram per letter
°C: Degree Celsius
AquaChem Integrated water quality data management, analysis, plotting and modeling.
DWPs: Drinking Water Points
µS/cm: Micro-mhos per centimeter
As_3: Arsenite
MMA: Monomethylarsonic Acid
DMA: Dimethyl arsenic Acid
As_5: Arsenate
r: Correlation coefficient
WSs: Water Samples
JRS: Jesuit Refugee Service

References

[1] ANSA, (2O13). Afghanistan Drinking Water Quality Standard [3].

[2] Agromet, (2009) Afghanistan Geo-meteorological data. http://afghanistan.cr.usgs.gov/agro.asp [6]

[3] AquaChem (2014) .2 software, http://www.waterloohydrogeologic.com [10]

[4] Abdullah, Sh and Chmyriov, V M (editors in chief). (2008) Geology and Mineral Resources of Afghanistan. Volumes 2[15].

[5] Abdullah, Sh and Chmyriov, V M (editors in chief). (2008) Geology and Mineral Resources of Afghanistan. Volumes 2[15].

[6] Bureau of Indian Standards. Drinking water – specification (Second revision). IS 10500, 2009[4]

[7] Campbell, J. (2015). A dry and ravaged land: investigating water resources in Afghanistan. Earth mag, 60(1–2), 48–55[16].

[8] Dronov V.I,. Chmyrov V.M, S. A, (1975). Geology of south and central Afghanistan [7]

[9] Houben, G., Tünnermeier, T., Eqrar, N., & Himmelsbach, T. (2009b). Hydrogeology of the Kabul Basin (Afghanistan), part II: groundwater geochemistry. Hydrogeology Journal, 17(4), 935–948[19].

[10] Uhl V. W. (2003). Afghanistan: an overview of groundwater resources and challenges. Rana Associates, Inc. Washington Crossing, PA, USA[17].

[11] Study area population, (2009) The population of Afghanistan. Fa.m.wikipedia.org [5]

[12] T.Yoshida, H. Yamauchi, and G.Fan Sun, (2004) Chronic health effect in people exposed to arsenic via drinking water 198, .3, PP. 243-252.[12]

[13] USEPA (2001). Technical Fact Sheet: Final Rule for Arsenic in Drinking Water EPA-815-F-00- 016, Washington, DC: U.S. Environmental Protection Agency. Available http://www.epa.gov/safewater/ars/afs_rule_techfactsheet.html [2]

[14] U.S. Army, (2009). Southeast Afghanistan Water Resources Assessment [9]

[15] Velch. A.H. M.S.Lico (1988) Arsenic in groundwater of the western US, .26, 3.333-347 [11].

[16] Vincent W.UHI, and Qasm M T (2003). An overview of groundwater resources and challenges in Afghanistan [8]

[17] Vincent W. Uhl Uhl, (2003) An overview of groundwater resources and challenges in Afghanistan, Baron, Rana Associates, Inc. Washington Crossing, PA, USA Assisted by: Eng. M Qasem Tahiri Basic Afghanistan Services Kabul, Afghanistan [14].

[18] Saffi, M. H. and Eqrar, M. N. (2016). Arsenic contamination of groundwater in Ghazni and Maidan Wardak provinces, Afghanistan. Arsenic Research and Global Sustainability: Proceedings of the Sixth International Congress on Arsenic in the Environment (As2016), June 19–23, 2016, Stockholm, Sweden. CRC Press, 41–42[18].

[19] WHO (2004) Guidelines for drinking water quality, vol. 1; Recommendations, Third Edition [1]

[20] Water Contamination in Afghanistan © (2016) By LaWanda McErvin[13].

[21] Whitney, J. W. (2006). Geology, water, and wind in the lower Helmand Basin, southern Afghanistan. U.S. Geological Survey Scientific Investigation Report 2006–5182, 40 p., http://pubs.usgs.gov/sir/2006/5182/ [20].