UNHCR public drinking water points analysed water quality data evaluation in Afghanistan

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- Financial supporter: United Nations Office for Project Services UNOPS.
- M. Azeem Barat, WETC Manager :Responsible for coordination and implementation of the project
- M. Hassan Saffi, Senior Hydrogeologist: Responsible for analyzed water quality data graphic evaluation and provision of report
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- East, North, Northeast, Northwest and West Regional offices staff: responsible for locating the representative wells, gathering info about the well, and water sample collection.

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ABBREVIATION

WS_ID	Water samples ID
UNHCR	United Nations High Commissioner for Refugees
UNOPS	United Nations Office for Project Services
DACAAR	Danish committee for aid to Afghan refugee
AGOC	Afghanistan Government Operations Centre
GPS	Global Position System
IDPs	Internally Displaced Persons
EC	Electrical Conductivity
ORP	Oxidation Reduction Potential
NTU	Nephelometric Turbidity Units
WETC	Water Expertise and Training Centre

Table 1 Water quality parameters and WHO guidelines

Element	Symbol	Unit	WHO limit-2003
Electrical Conductivity	EC	µS/cm	1500
Total Desolate Salt	TDS	mg/L	1000
Oxidation Potential Redaction	ORP	mV	-
Turbidity		NTU	5
pH			6.5 - 8
Temperature	T	^{o}C	-
Total Alkalinity	as $CaCO_3$	mg/L	-
Alkalinity P	as $CaCO_3$	mg/L	-
Alkalinity M	as $CaCO_3$	mg/L	-
Bicarbonate	HCO_3	mg/L	-
Carbonate	CO_3	mg/L	-
Chloride	Cl	mg/L	250
Sulphate	SO_4	mg/L	250
Sulphite (Sulphatest)	SO_3	mg/L	-
Fluoride	F	mg/L	1.5
Nitrate	NO_3	mg/L	50
Nitrite (Nitricol)	NO_2	mg/L	0.2
Phosphate	PO_4	mg/L	-
Boron	BO_2	mg/L	0.5
Bromide	Br	mg/L	-
Total Hardness	as $CaCO_3$	mg/L	-
Calcium Hardness	as $CaCO_3$	mg/L	-
Sodium	Na	mg/L	200
Potassium	K	mg/L	-
Calcium	Ca	mg/L	-
Chromium	Cr	mg/L	0.05
Magnesium	Mg	mg/L	-
Copper	Cu	mg/L	2
Aluminum	Al	mg/L	-
Total iron	Fe	mg/L	0.3
Arsenic	As	mg/L	0.01
Manganese	Mn	mg/L	0.4
Ammonia	NH_4	mg/L	3.5
Silica	Sio_2	mg/L	-
Hydrogen Sulphurate	H_2S	mg/L	0.100
Total Coli forms		Coli/100 ml	0
Fecal Coli forms (e-Coli)		Coli/100 ml	0

1. GENERAL BACKGROUND OF THE PROJECT

Referring to the contract (CON-023-012 Provision of water quality testing of public wells, Project: 00082278 UNHCR Project) made on 6 September 2012 between the United Nations Office for Project Services (UNOPS) and DACAAR.

UNOPS in Afghanistan is responsible for implementing a number of projects on behalf of the Government of Afghanistan and the aid donor community. The Afghanistan Government Operations Centre (AGOC) has been set up as an organizational mechanism to deliver a range of projects for which UNOPS has been designated as the Implementing Agency. AGOC is currently implementing a project with the purpose of ensuring that public reintegration activities for refugees are correctly implemented, and to determine the effectiveness of these activities. The project is funded by UNHCR.

UNHCR requested UNOPS to conduct water quality analyses of wells located in 22 high-return public locations throughout Afghanistan. The objective of the service is to conduct an analysis of the water quality of public wells that are used by returnees and non-returnees (community members). To this end, the analysis included the following activities:

1. Conduct water quality analysis, according to international standards, of a representative sample of public wells located at the villages/settlements associated with the 22 high-return public locations (See **Annex 1**). Each water quality analysis include the results from the physical, chemical and bacteriological tests and include comments and recommendations for each well.
2. Provide the GPS coordinates of each well; and
3. Summarize the results of the water quality analyses into a final report.

2. EXECUTIVE SUMMARY

UNHCR selected 136 representative wells and DACAAR collected samples and conducted water quality analysis of the representative samples of wells located in the 22-high return public locations throughout Afghanistan (see **Annex 2**).

DACAAR field staff also provided the GPS coordinates of each selected wells along with some other information such as, village name, water point type and caretaker, donor, implementer and year of implementation and whether the well is used by returnees (refugees) non-returnees (community members), Internally Displaced Persons (IDPs) or in combination (see **Annex 3**).

This final report summarizes the results of the water quality analyses from the physical, chemical and bacteriological tests and includes comments and recommendations for each well and in general. The physical, bacteriological and chemical water quality analysis results of 136 selected representative water points at 22 high return public locations is presented in **Annex 4**.

3. OBJECTIVE

The main objectives of this report are as follows:

- Take water samples from UNHCR improved water points
- Physical, bacteriological and chemical analysis of water samples from UNHCR public drinking water points.
- Analyze, manage, graphic evaluate and produce maps and report measured physical, bacteriological and chemical parameters
- Detect elevated elements, which are potentially threat for the health of people (users).
- Identify causes of natural and artificial drinking water point's contamination.

4. METHODOLOGY

The locations of water samples from water points were geo-referenced by GPS (Global Position System) and marked in the map according to the WS_ID (annex 4 and Map figures 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12).

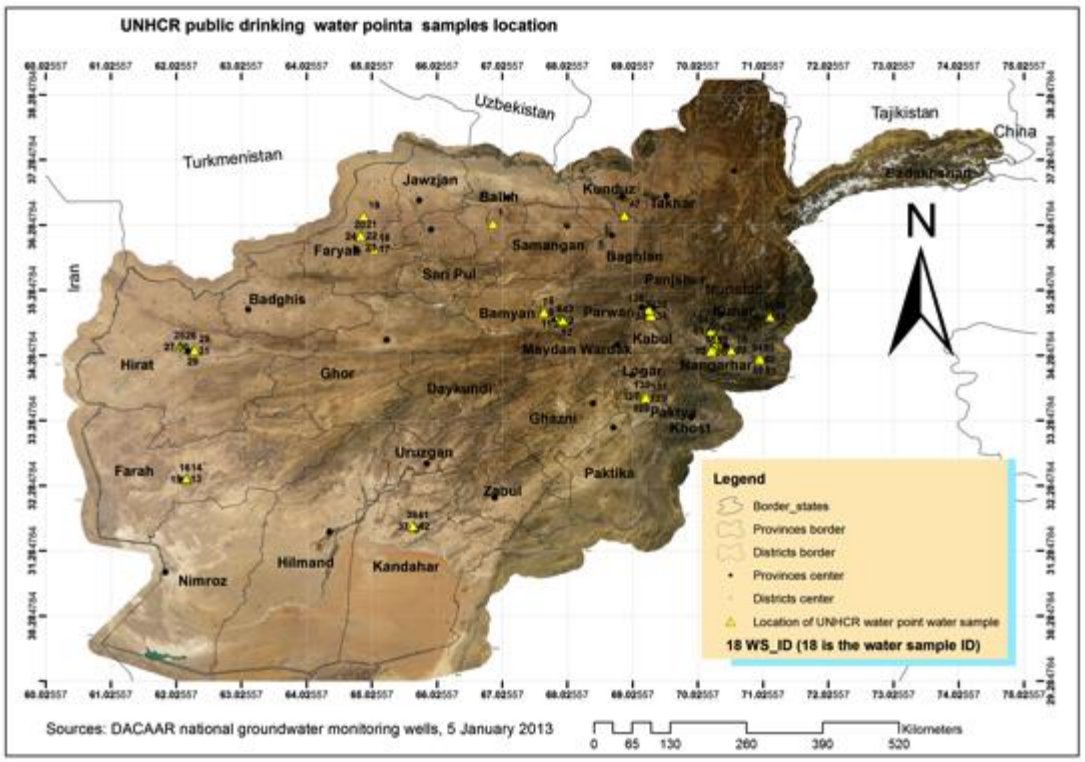

Figure 1 UNHCR locations according to the WS_ID

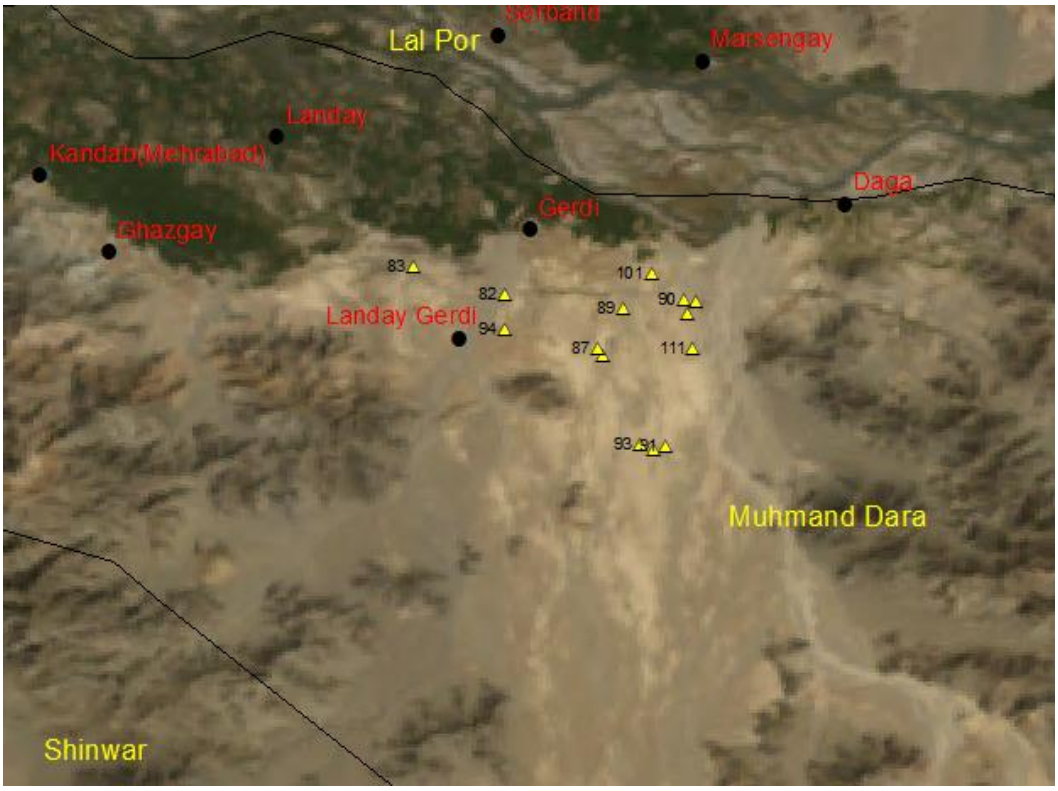

Figure 2 UNHCR water point samples in Muhmand Dara district of Nangarhar

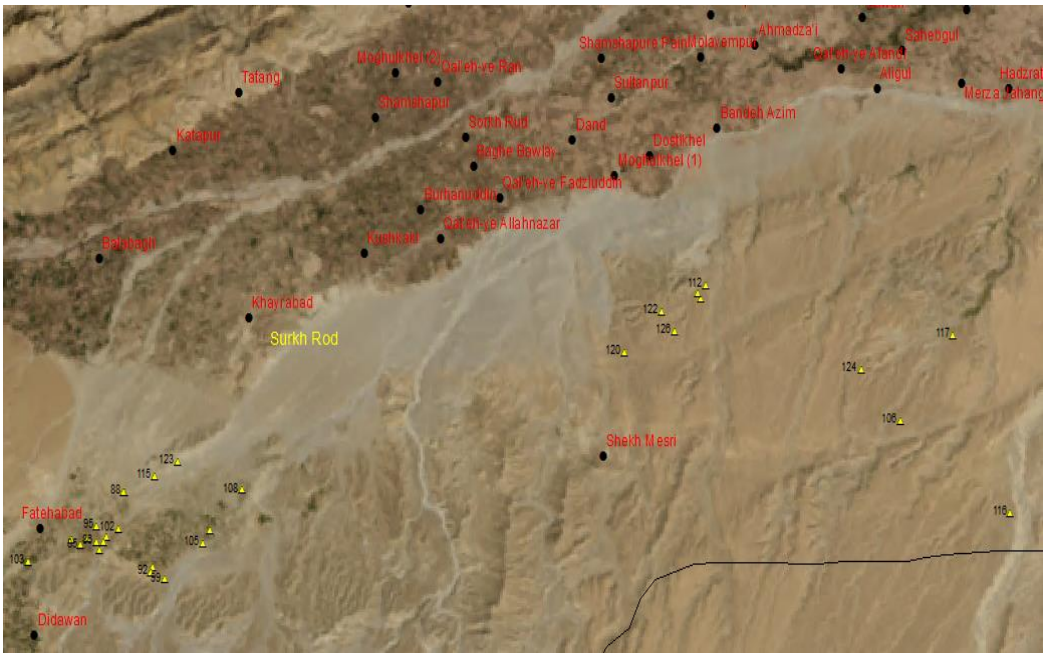

Figure 3 UNHCR public water Point samples in Surkh Rod district of Nangarhar

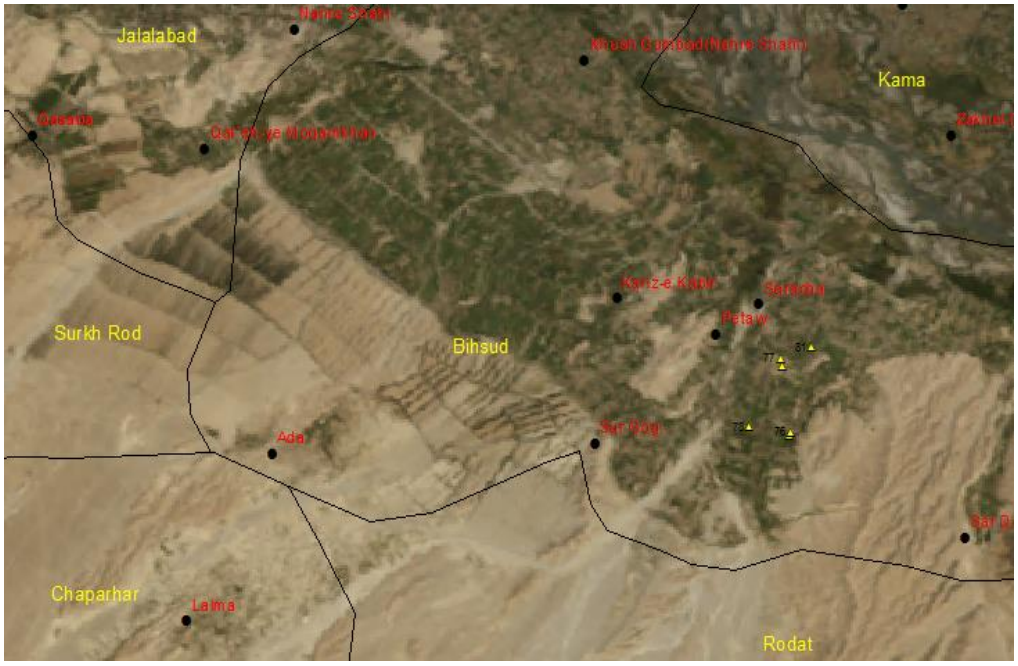

Figure 4 UNHCR public water point samples in Behsud district of Nangarhar

Figure 5 UNHCR public watar point samples in Qarghayi district of Laghman

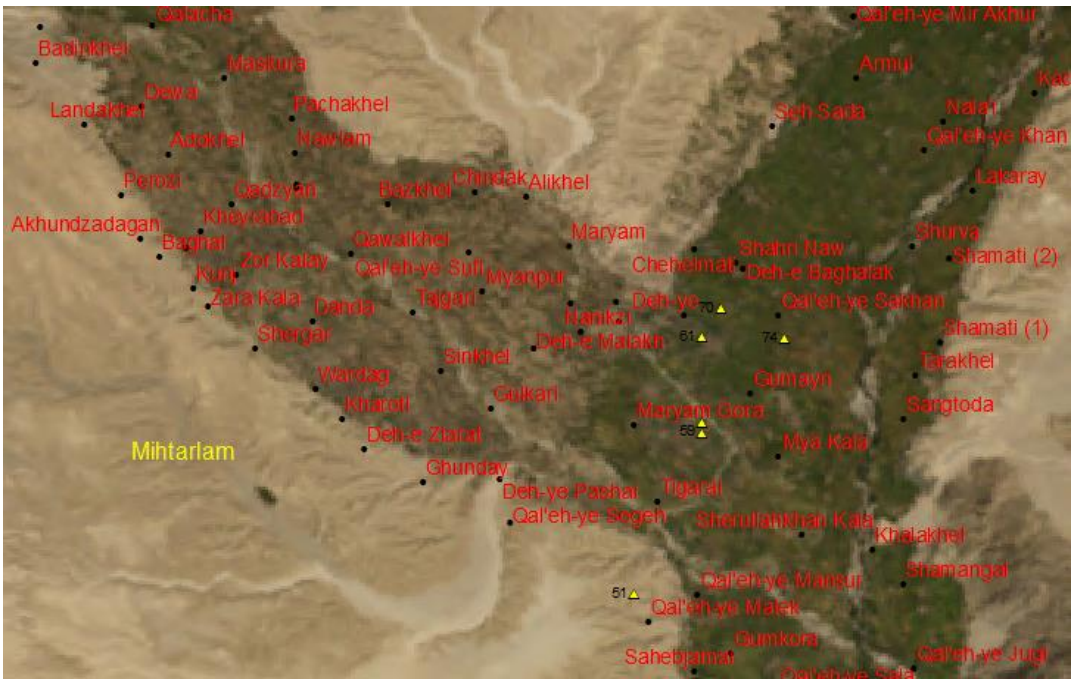

Figure 6 UNHCR public water point samples in Mihtarlam center of Laghman

Figure 7 UNHCR public water point samples in Arghandab district of Kandahar

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Figure 8 UNHCR public water point samples in Injil district of Hirat

Figure 9 UNHCR public water point samples in center of Farah

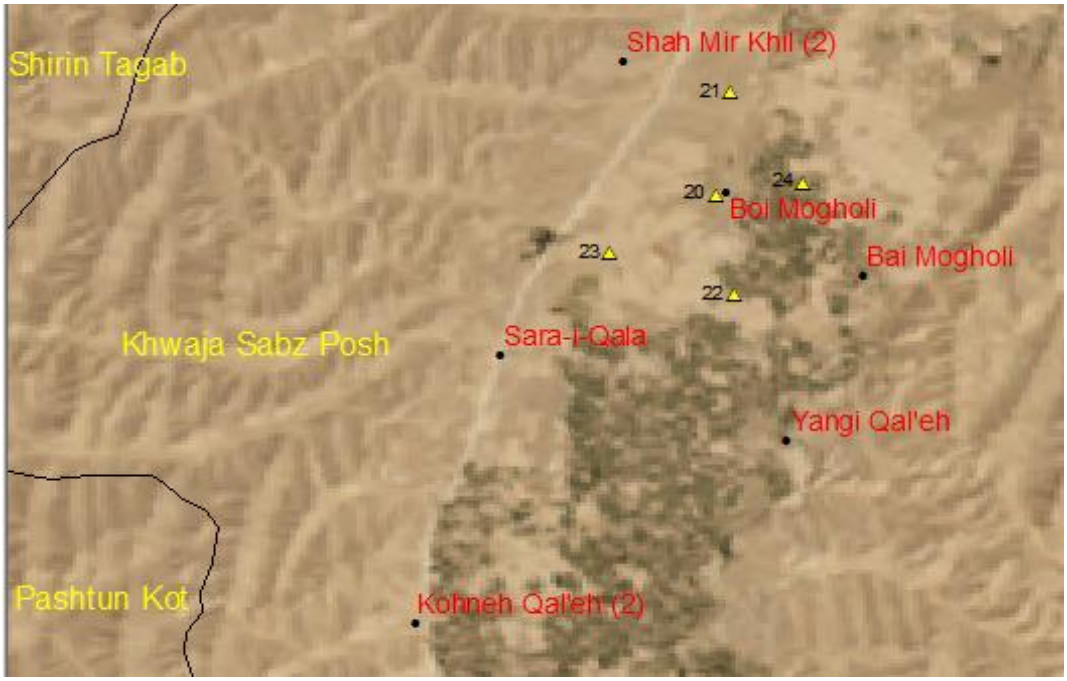

Figure 10 UNHCR public water point samples in Khwaja Sabz Posh district of Faryab

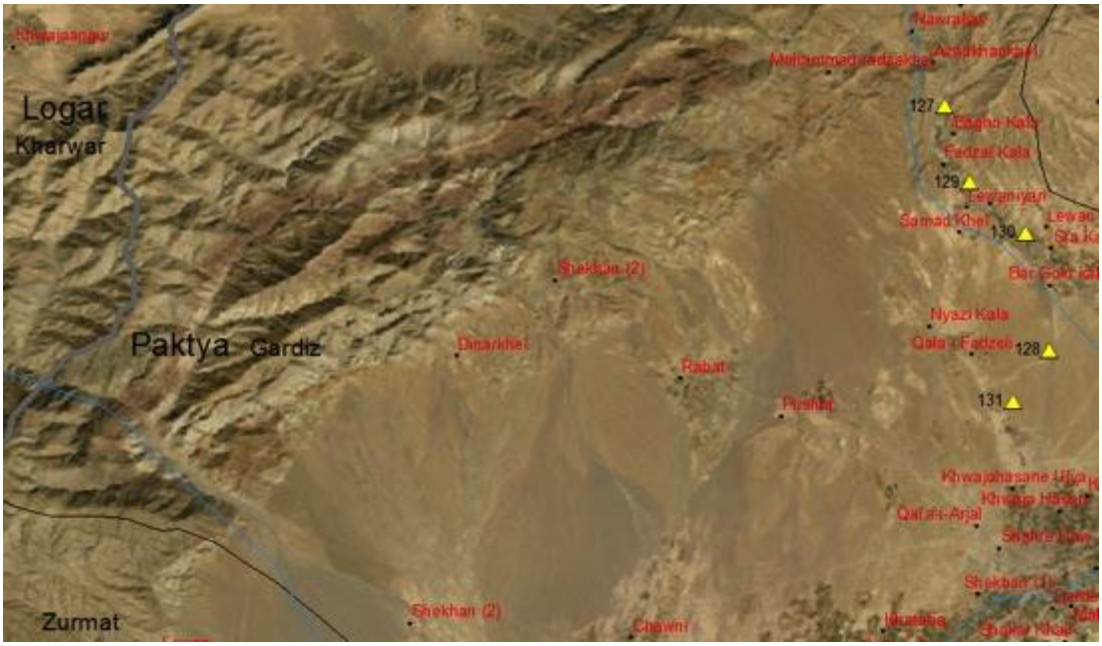

Figure 11 UNHCR public water point samples in Gardiz center of Paktya

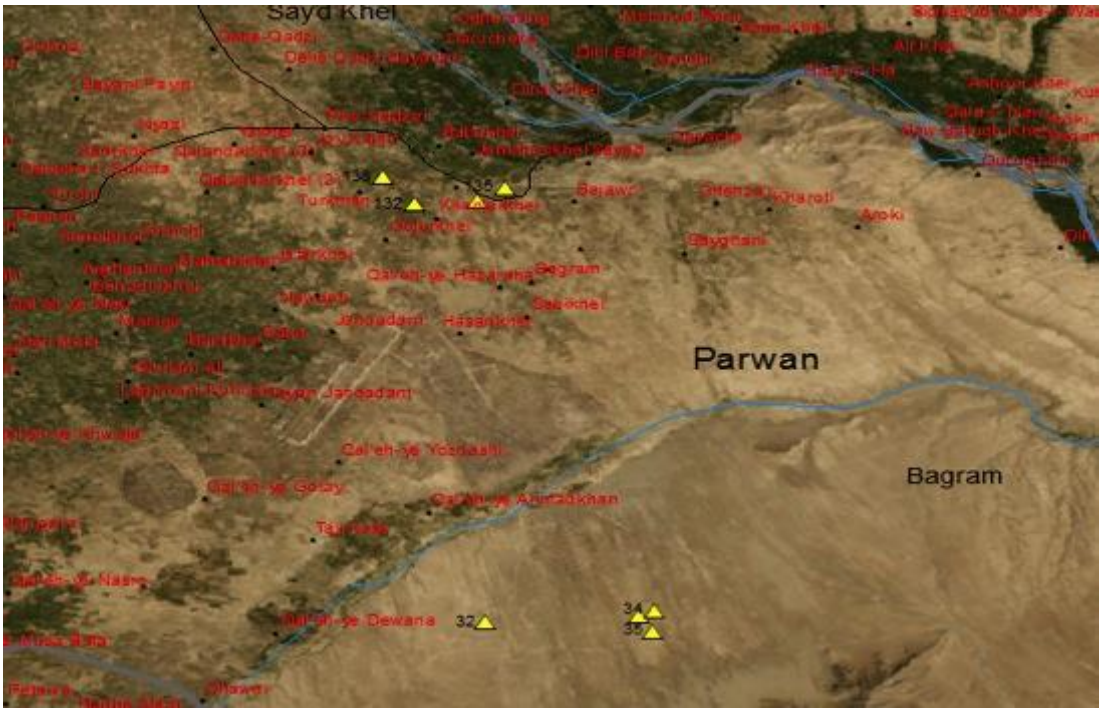

Figure 12 UNHCR public water point samples in Bagram district of Parwan

The physical (EC, temperature, ORP and pH) and bacteriological parameters of water samples were measured on site using pH/conductivity meter and turbidity meter POTATEST (figure 13).


Figure 13 Measurements on site

The chemical parameters of water samples from UNHCR drinking water points were determined using a Photometer 800 (from WagTech) and Arsenator (figure 14).

Figure 14 Chemical analysis measurement devices

5. INTERPRETATION OF ANALYZED WATER QUALITY DATA

The tested water quality (physical, bacteriological and chemical) parameters from UNHCR drinking water points were managed, graphically evaluated and mapped after processing and checking. The water quality data evaluation and interpretation results are as follows.

5.1 Elevated water quality parameters

The following analyzed water samples parameter have exceeded the WHO limit:

1. The WS_ID 2, 3, 11, 17, 18, 19, 21, 22, 23, 24, 25, 26, 27, 47, 72, 73 and 83 (figure 1) show that the electrical conductivity (salinity) is higher than the WHO limit of 1500 µS/cm (annex 4).
2. Approximately half of water samples from drinking water points have feacal coliform bacteria (annex 4). The distribution of high level fecal coli form bacteria contamination in drinking water points is an indicator of potential presence of microbial pathogens including bacteria, viruses, protozoa and helminthes which may cause diarrhea, dysentery, hepatitis, typhoid fever and potentially threat the health of people
3. The WS_ID 2, 3, 4, 13, 17, 18, 19, 26, 29, 30, 33, 35, 40,41, 43, 45, 47, 50, 53, 61, 63, 66, 69, 77, 78, 80, 81, 85, 86, 88, 89, 92, 110, 115, 120, 121, 124, 127, 128 and 130 have turbid water which are higher than the WHO limit of 5 NTU (annex 2). Poor construction of wells causes high turbid of drinking water point.
4. The WS_ID 2, 14, 15, 21, 22, 23, 24 25, 47, 52, 72, 76, 78 and 83 show that the sulfate concentration level is higher than the WHO limit of 250 mg/l (annex 4). Sulfate content water excess of 250 mg/l may give water a bitter taste and have laxative effect on humans. Sulfate concentration above 250 mg/l can cause diarrhea and can lead to dehydration and is special concern for infants. Sulfur oxidizing bacteria pose no known human health.
5. The WS_ID 2, 13, 14, 15, 17, 18, 19, 25, 26, 27 and 47 indicate that the fluoride concentration level is higher than WHO limit 1.5 mg/l (annex 4). The low concentrations of fluoride in drinking water are hygienically desirable and the high concentration of fluoride in drinking water causes dental, skeletal, crippling skeletal fluorosis and *affect Brain and Arthritis*.

6. The WS_ID 2, 3, 11, 17, 29, 33, 34 and 61 indicate that the boron concentration level is higher than the WHO limit of 0.5 mg/l (annex 4). High boron content in drinking water affects the testes and sperm of males, and causes birth defects in the offspring of pregnant females.
7. The WS_ID 2, 3,11, 15, 17, 18, 19, 21, 22, 23, 24, 25, 26, 27, 29, 30, 31,33, 34, 36, 39, 40, 47, 55, 65, 73, 75, 76, 80, 81, 83, 116, 118, 120, 122, 124, 125, 126, 131 and 135 show that the sodium concentration level is higher than WHO limit 200 mg/l (annex 4). A high content of sodium in drinking water injurious to health (increases blood pressure). High concentrations can cause considerable damage to the body's fluid balance.
8. The WS_ID 35, 48, 62, 64 and 67 indicate arsenic contamination which the WS_ID 62 and 67 are exceeded the WHO limit of 0.01 mg/l (annex 4). High Arsenic content drinking water causes cancers-bladder, lungs, skin, kidneys, nasal passages, liver and prostate diseases and effects nervous system as well as heart and blood vessels.
9. The WS_ID 43, 47, 53 and 63 indicate that the chromium concentration is higher than the WHO limit of 0.05 mg/l (annex 4).

5.2 Hardness of water

The 60% of analyzed water samples indicate that the water is very soft and 40% of analyzed water samples indicate that the water is classified as hard and very hard (figure 15).

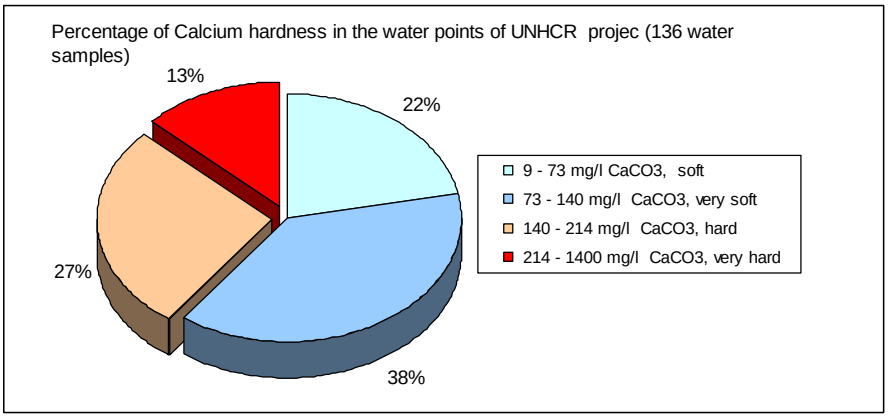

Figure 15 Classification of Calcium Hardness

5.3 Major ions chemistry of water

Plot of water samples from water points illustrate correlation of EC against major ions and pH (Figures 16, 17, 18 and 19). The major ions plot shows that the groundwater has been evolved to yield from mixing between Ca-HCO_3 recharge water (fresh or natural water type) and pre-existing groundwater of the Mg-SO_4 and Mg-Cl types (polluted groundwater).

In the up gradient of river basins, the groundwater type is Ca-HCO_3 and the natural hydro chemical processes like weathering and dissolution of rocks (mostly carbonate rock) with interaction of water impacts ions chemistry of groundwater. In the middle parts of river basins the groundwater types is mostly Ca-Mg-CO_3 and Ca-HCO_3 with considerable increase in sodium and sulphate concentrations and the natural hydro chemical processes like dissolution/precipitation and anthropogenic sources impact ions chemistry of groundwater. In the down gradient of hydraulic boundaries of river basins the groundwater is mixed with increased concentrations of sodium, sulphate and chloride and the water types are Mg-SO_4, Na-Mg-CO_3, Na-Mg-SO_4-Cl, Na-SO_4 and Na-Mg-Ca-HCO_3-CO_3-SO_4. The natural hydro chemical processes like dissolution/

precipitation; evaporative condition and anthropogenic sources impact ions chemistry of groundwater.

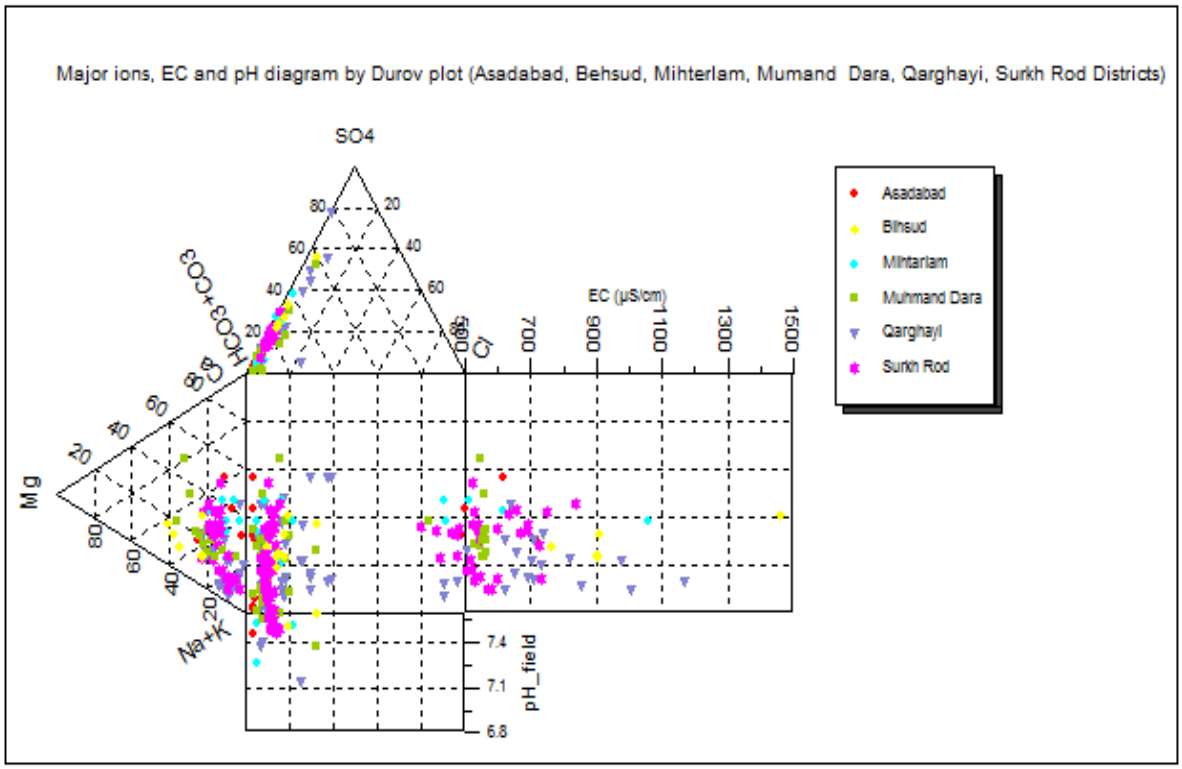

Figure 16 Major ions chemistry of water points in Kunar, Nangarhar, and Laghman

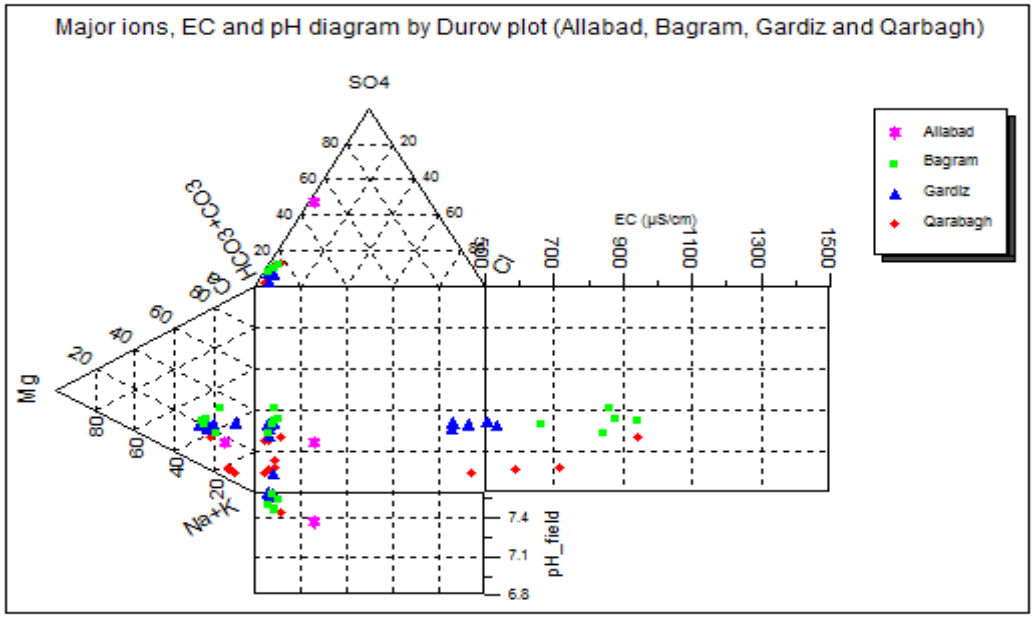

Figure 17 Major ions chemistry of water points in Kunduz, Kabul, Parwan and Paktya

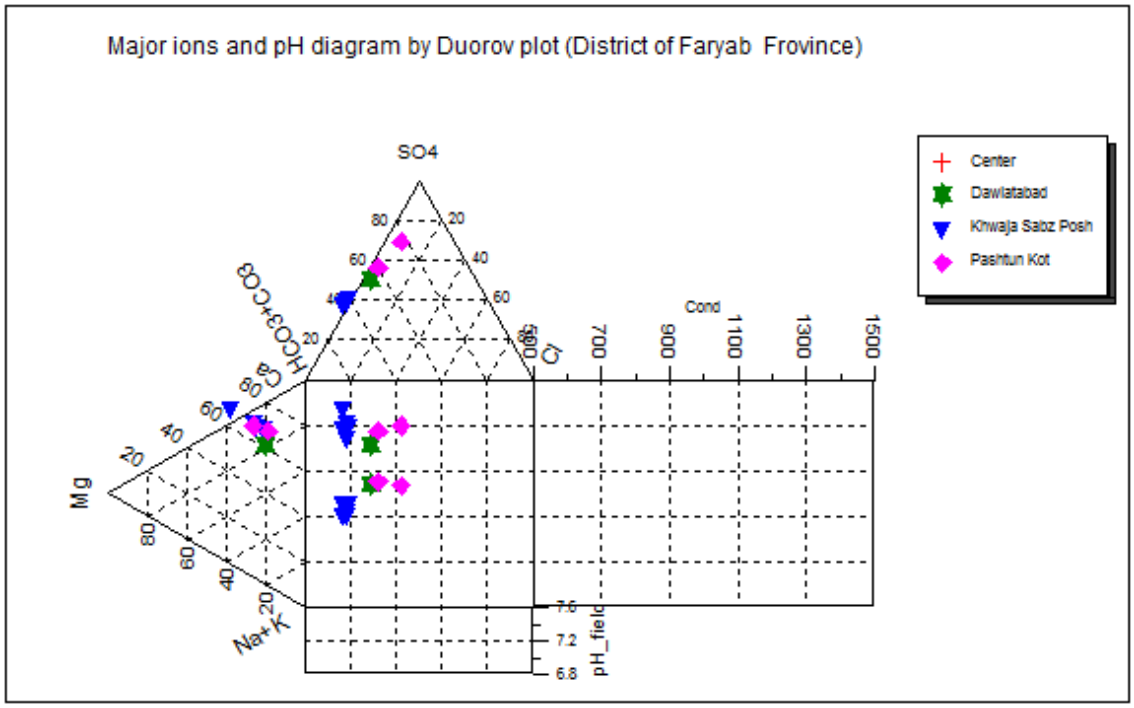

Figure 18 Major ions chemistry of water points from Faryab

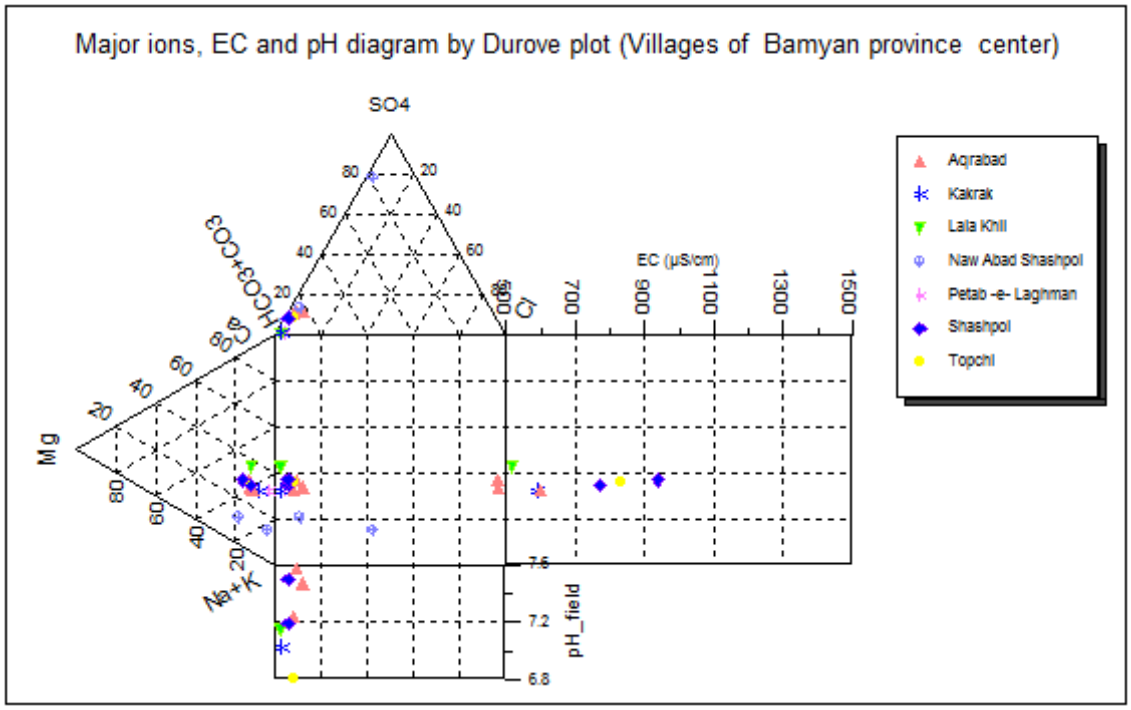

Figure 19 Major ions chemistry of water point from Bamyan

6. CONCLUSION

1. 14% of tested water samples from water points show that the electrical conductivity (EC) of water is higher than the WHO limit of 1500 **µS/cm** (figure 20).

2. 33% of tested water samples from water points are turbid and very turbid (figure 21).
3. 48% of tested water samples from water points show that the fecal coliform is higher than WHO limit of 0 Coli/100 ml (figure 22).
4. 9% of tested water samples from water points show that the fluoride concentration level is higher than WHO limit 1.5 mg/l (figure 23).
5. 7% of tested water samples from water points show that the boron concentration level is higher than WHO limit of 0.5 mg/l (figure 24).
6. 18% of tested water samples from water points show that the sulphates concentration level is higher than WHO limit 250 mg/l (figure 25).
7. 29% of tested water samples from water points show that the sodium concentration level is higher than WHO limit 1.5 mg/l (figure 26).
8. 40% of tested water samples from water points show that the calcium hardness of water is classified as hard and very hard (figure 15).
9. The WS_ID 35, 48, 62, 64 and 67 indicate arsenic contamination which the WS_ID 62 and 67 are exceeded the WHO limit of 0.01 mg/l (Annex 4).
10. The WS_ID 43, 47, 53 and 63 indicate that the chromium concentration is higher than the WHO limit of 0.05 mg/l (Annex 1).
11. The nitrate concentration in tested water samples range from 0.25 mg/l to 37.76 mg/l. These values are lower than the WHO limit of 50 mg/l, but indicate water contamination by human waste due to poor sanitation and hygienic practices (Annex 4).

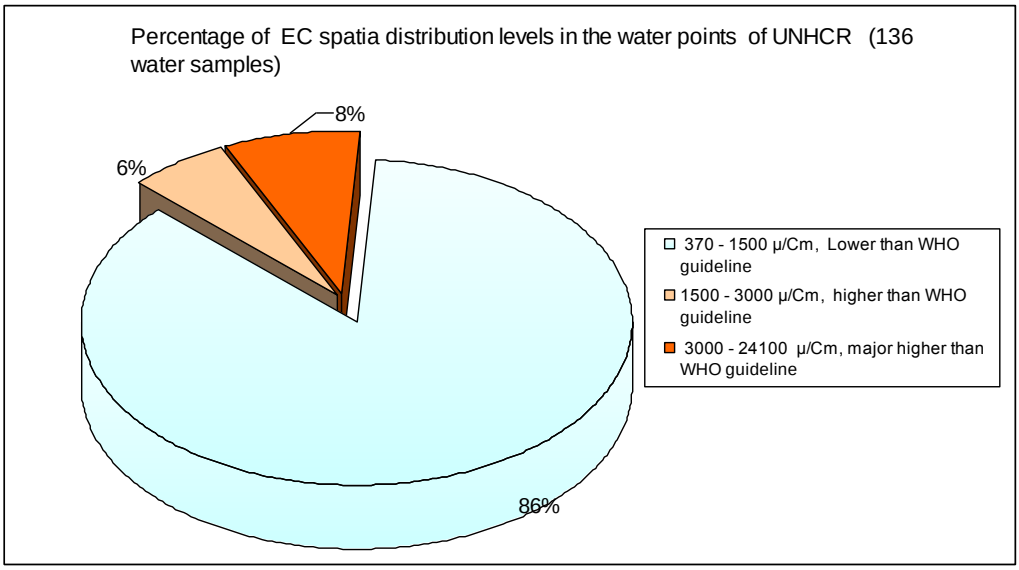

Figure 20 Percentage of EC spatial distribution level in the water point of UNHCR

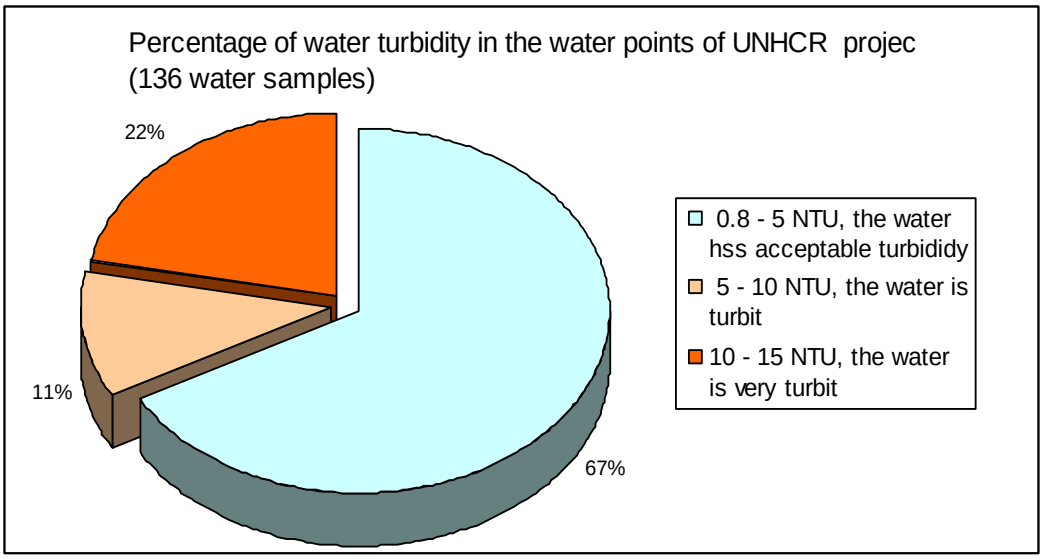

Figure 21 Percentage of turbidity levels in the drinking water point of UNHCR

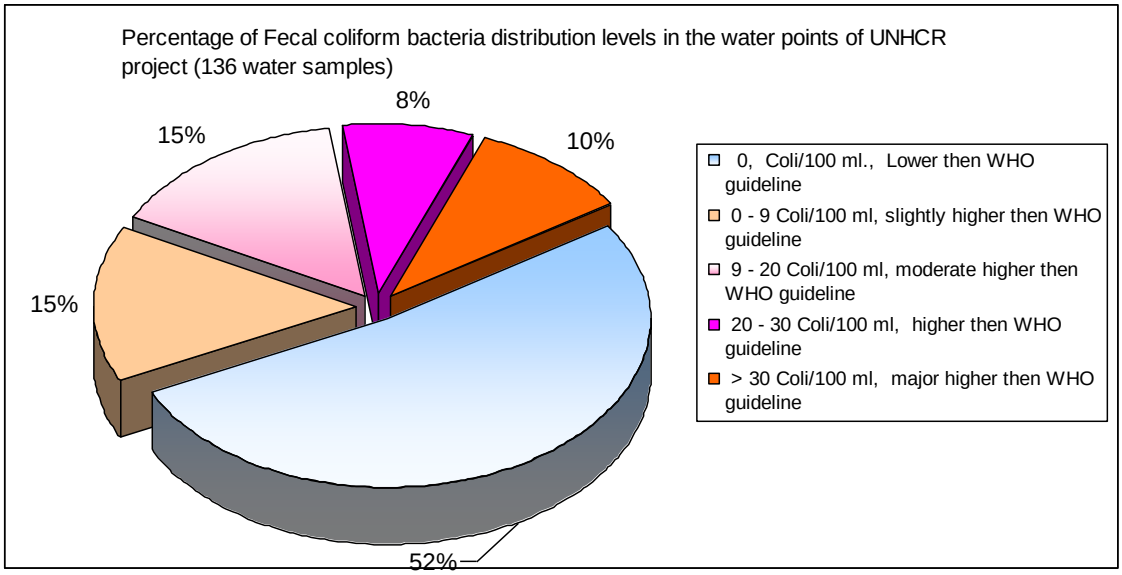

Figure 22 Percentage of feacal coliform in the drinking water point of UNHCR

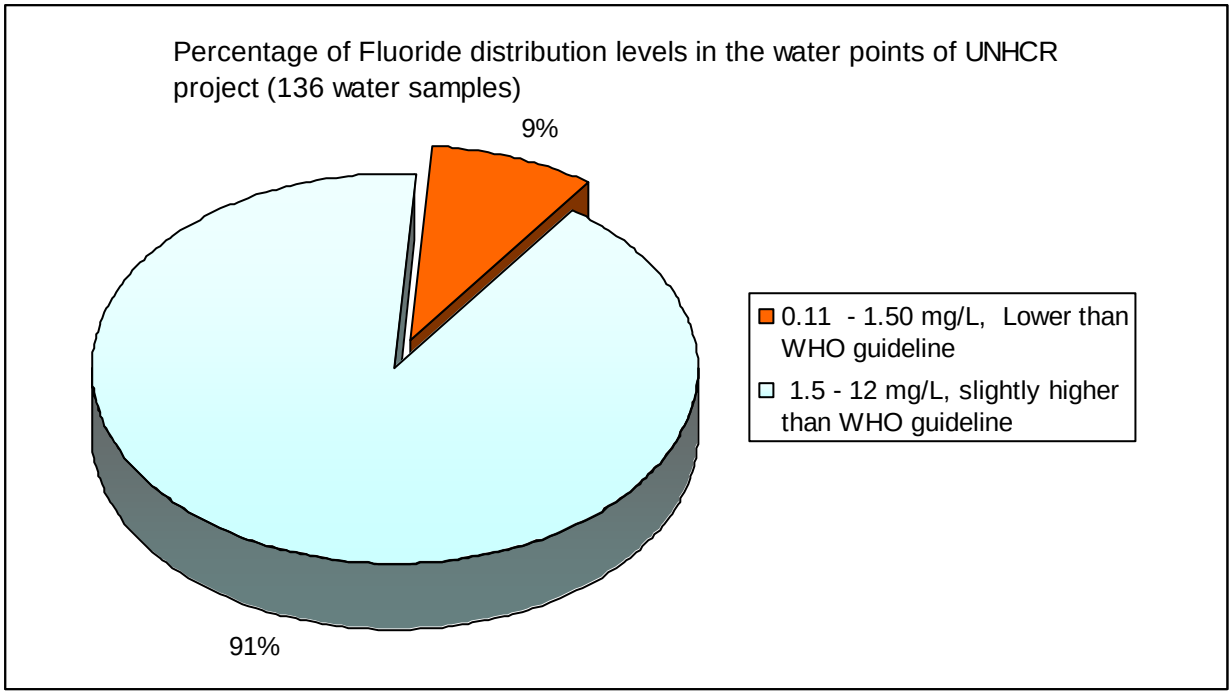

Figure 23 Percentage of Fluoride concentration levels in the drinking water point of UNHCR

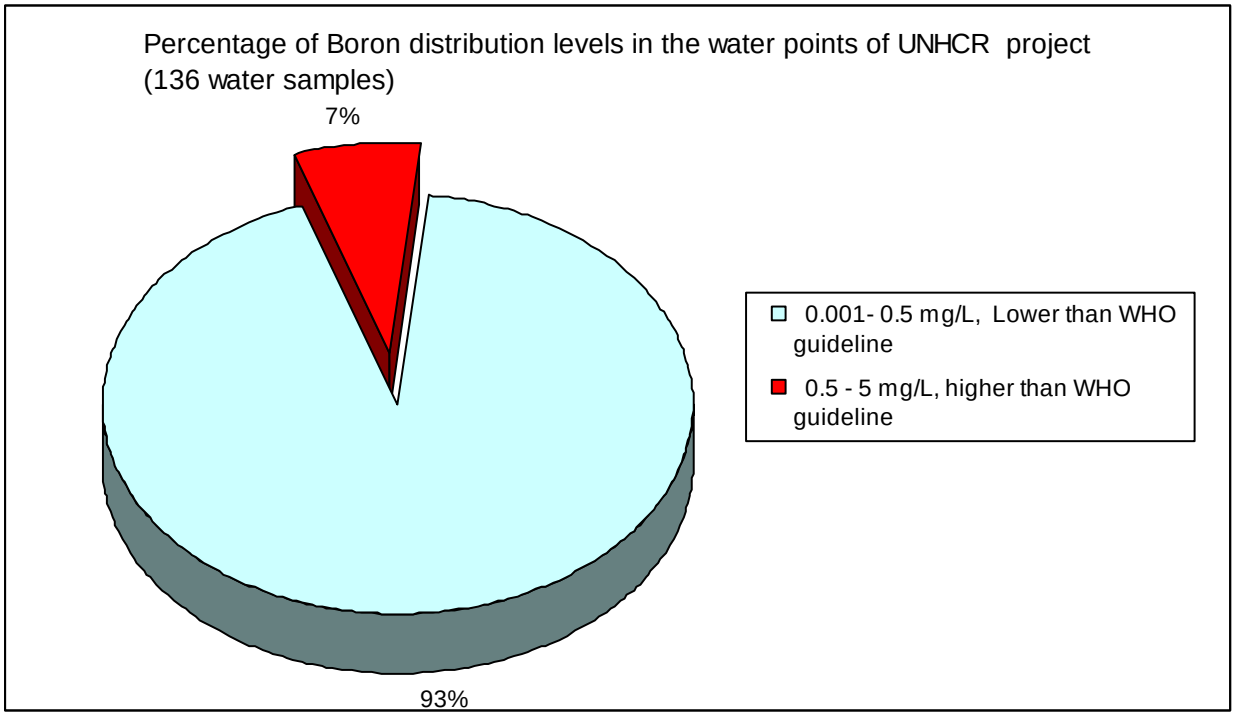

Figure 24 Percentage of boron concentration level i the drinking water point of UNHCR

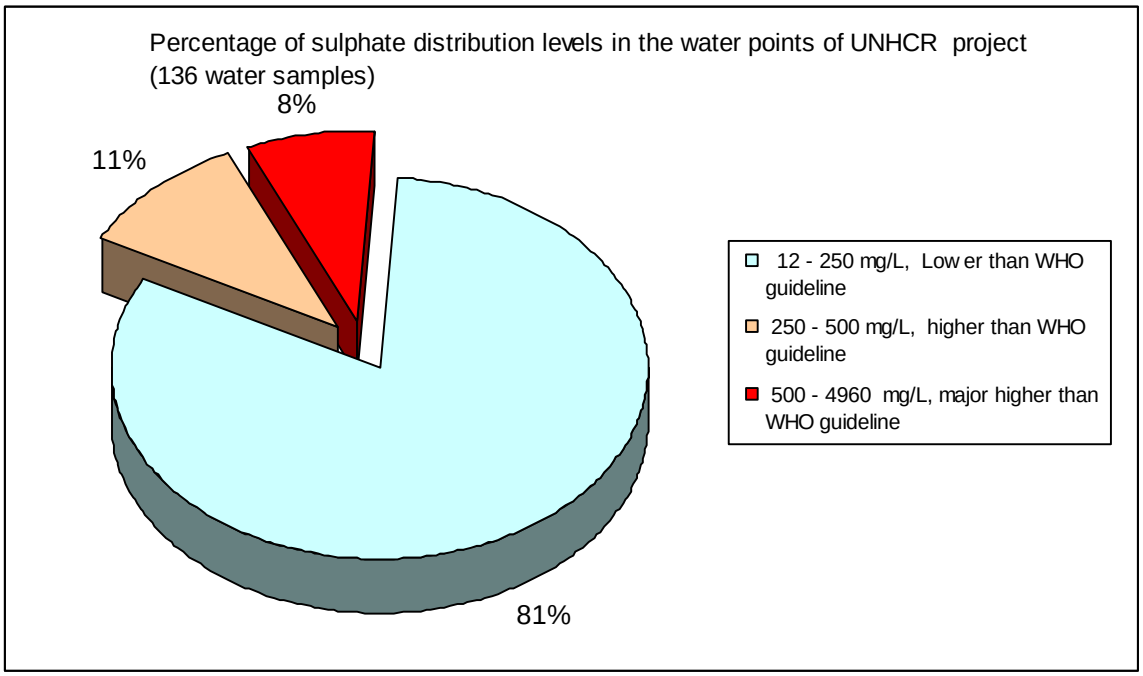

Figure 25 Percentage of Sulphate concentration levels in the drinking water point of UNHCR

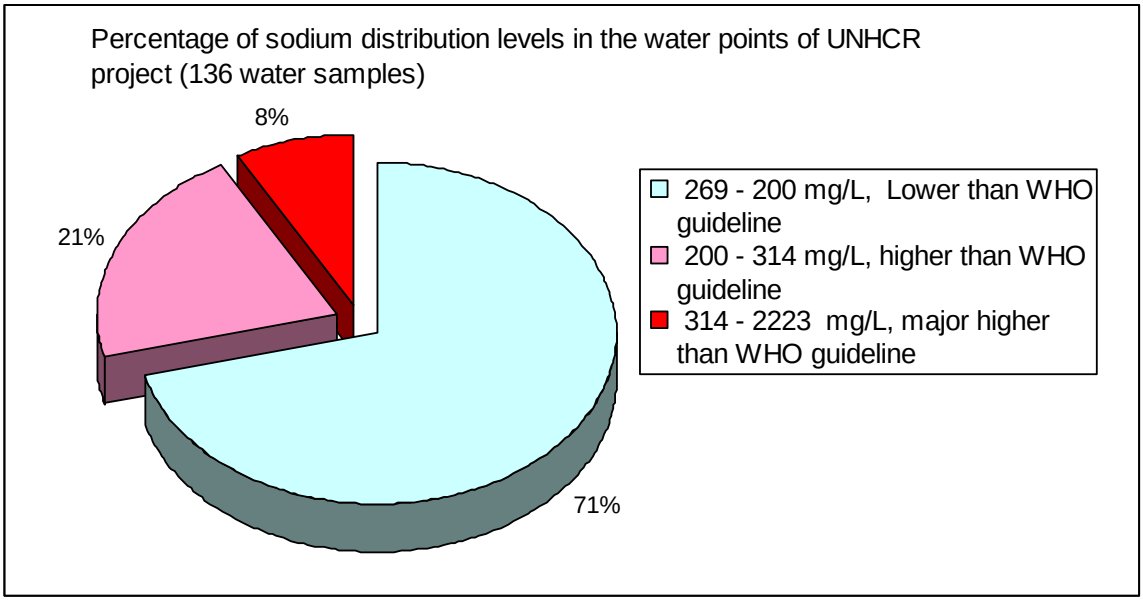

Figure 26 Percentages of sodium concentration levels in the drinking water point of UNHCR

7. RECOMMENDATIONS

1) 48% of tested water samples from water points indicate that the fecal coliform is higher than WHO limit of 0 Coli/100 ml. The distributions of high-level fecal coli form bacteria contamination in drinking water points is an indicator of potential presence of microbial pathogens and potentially threat to the health of people. *Poor construction of water points and poor housing sanitation and hygiene practices are the main causes of high bacteria contamination in the drinking water points. Therefore it is suggested;*

- *Perform chlorination of water point or boiling the water before using for drinking.*

- *Improve construction of water points. Poor construction of wells caused to promote, facilitate bacteria contamination to the water points.*
- *Promote housing sanitation and hygiene practices*

2) 33% of tested water samples from water points are turbid and very turbid and it is higher than the WHO limit of 5 NTU. *The improper gravel packing (around the filter) and improper selection of the ratio of gravel and screen slots size are the main causes of high turbidity of water. Therefore it is suggested;*

- *Take core samples from layers during drilling*
- *Select proper filter pack fraction (gravel pack) according to lithology of water bearing formation (aquifer)*
- *Proper selection of screen slot size according to filter pack fraction*

3) 14% of tested water samples from water points show that the EC (salinity) of water is higher than the WHO limit of µS/cm, however 8% of these water samples indicate that of water is higher than the WHO limit of 3000 µS/cm*. The high salinity of water potentially threats to the health of people, therefore, it is suggested to search alternative water source for provision of safe drinking water.*

4) The nitrate concentration in tested water samples range from 0.25 mg/l to 37.76 mg/l. and it is lower than the WHO limit of 50, but it indicates contamination of water points by anthropogenic (human waste). The pit latrines, leakage septic tanks and waste water drainage responsible for nitrate contamination of groundwater. *Therefore, it is suggested to take care during selection of water point and prevent construction of pit latrines and septic tanks near water points.*

5) Laghman province The WS_ID 35, 48, 62, 64 and 67 indicate arsenic contamination and it is potential affect health of people. It is suggested to search for arsenic contamination in the groundwater of Laghman province and find alternative sources of water.

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