Sultanate Of Oman
Ministry Of Education

Examine the suitability of groundwater in the Ghuraifa area for human use and agricultural irrigation

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Hafsa Bint Sereen Primary School (5-9)

(2019/2020)

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Summary:

The research aims to study the characteristics of well water in the Ghuraifa area in AL Buraimi and its suitability for human use and agricultural irrigation، we noticed that people were digging wells in their homes, using their water to irrigate crops, cooking and drinking. The research questions are: How valid is the Ghuraifa well water for human use? What is the effect of well water on the germination and growth of vegetable crops grown in people's homes? What is the extent of the impact of Ghuraifa wells water on the soil properties? This research was applied by comparing the growth rates of watercress and coriander plants using groundwater samples from different locations in Ghuraifa, Then study the soil properties. Where the land cover, the soil and water protocol. The results indicated that not all samples match the Omani specifications due to the increased concentration of dissolved salts ،the results of the microbiological examination also showed an increase in the total number of coliform and E. coli bacteria, and therefore they are not suitable for use. In the field of irrigation, we find that the use of organic fertilizers helped the growth of the plant at the beginning better, but because of the high salinity value, this has a negative impact on the vegetative growth of the plant, It also led to an increase in soil salinity, Based on the results of the research, we recommend the necessity of conducting a periodic examination of the well water and treating it with chlorine, in cooperation with the specialists, we also recommend using salt-resistant crops, replacing chemical fertilizers with organic fertilizers, and using drip irrigation with the necessity of adding washing requirements that prevent salt build-up, and an agricultural engineer can be used to do so.

Basic terms:

Groundwater: the water present beneath earth's surface connected below the water surface water layer both internal confined or free.

Microbiological examination of water: It is an analysis of the microorganisms in which samples of water are used for verification and from which the percentage of bacteria can be determined, and according to the percentage of bacteria in these samples the suitability of the water is determined or not.

Osmotic pressure: is the pressure generated by a specific solute concentration difference between two quantities of pure liquid, as the pure fluid moves from low concentration to high concentration.

Research questions:

1. What is the quality and suitability of groundwater wells in Ghuraifa for human use؟

2. What is the effect of groundwater wells in Ghuraifa on the germination and growth of vegetable crops?

3. What is the impact of groundwater wells in Ghuraifa on the soil properties؟

Introduction:

Groundwater is an important source in arid and semi-arid regions, so it is the second source after surface water that covers human needs, which encouraged the development of technologies for exploration, treatment and protection . (Water resources in the Sultanate of Oman, 2018).The chemical properties of groundwater change from one place to another depending on the type of rocks in it and the dissolution of the elements present in these rocks, especially salts, as well as the leaching and leakage of chemical pollutants resulting

from fertilizers, pesticides, industrial and domestic pollutants to the groundwater reservoirs through rain water or surface water sources, which causes pollution to this water and a change Serious in its chemical composition. (Kortatsi, 1651-1662).

The importance of studying the quality of water used for cultivation lies in the irrigation water containing different concentrations of dissolved salts, and that many of the current problems of cultivation are a direct result of the accumulated salts in the soil whose source is added water. Likewise, the importance of studying the quality of irrigation water comes from determining whether it is suitable for use in that it does not cause the formation of saline soil conditions in addition to giving an indication of whether it causes toxicity to agricultural crops when irrigation, so monitoring water in a region is an important process to give Recommendations and precautions required for using this water (Al-Wakeel, 2013). In light of this, we conducted this study with the aim of determining the suitability of groundwater in the Ghuraifa area for human consumption and agricultural irrigation.

Research methods:

First: the research plan:

1. Choose a search problem.
2. Locate the study.
3. Collecting water samples from the study sites.
4. Microbiological examination, in cooperation with the Center for Food Safety and Quality and the Water Quality Department, Al-Buraimi Governorate.
5. Applying the appropriate protocols (land cover, water and soil).

Mechanism of application	The protocol	research question
Study the properties of water (temperature, conductivity, salinity, acidity) for different locations in Ghuraifa area (first stage A, B, second and third)	Water protocol	**The first question**
Cultivation of leafy vegetables (coriander and arugula) in the same type of soil (fertilized with organic fertilizer and non-fertilized soil), watering it in the same amount of water with dividing it into sections according to the type of water sample from each stage of Ghuraifa area (first A, B and second and third), and note the growth And record the data	Ground Cover Protocol	**second question**
Study the soil properties (conductivity, salinity, temperature) before and after using well water samples	Soil protocol	**The third question**

Table (1) Mechanism of applying protocols for data collection

6. Record the vegetables' growth data (coriander and watercress) every two days, and water it with equal quantities of water.

7. Entering data into the program's website (www.globe.gov).

8. Compare results and write recommendations.

Schedule of research plan:

work plan	the month
Formulation of research problem in tools	**November / 2019 M.**
Data collection and analysis	**December**
Reaching conclusions and writing the research	**January / 2020**
Submit the search	**February**

Distribution of roles work on the research team:

students	the work
Raghad - Jinan	**Formulation of the research problem**
Jinan - Hams	**Collecting and analyzing data through the application of soil and water protocols**
Raghad - Hams	**Collection and analysis of data through the application of the land cover protocol**
Raghad - Jinan	**Reaching conclusions, drafting the abstract, and writing the paper**

Second: Study Location:

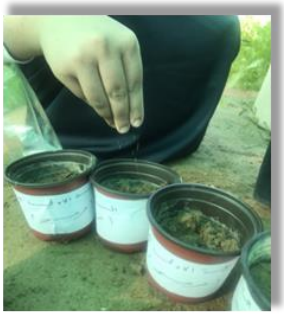
(Sultanate of Oman, Al Buraimi Governorate, Ghuraifa District, December and January. The weather is cold. The soil, water and land cover protocol was implemented).

Well sites on which the study was applied

Third: Data collection and analysis:

The data related to the first question was collected by applying the water protocol to samples of water wells dug in the homes of the residents of the study area, and sent to the Food Safety and Quality Center for microbiological examination in order to know the extent of the water quality and its suitability for human consumption, and it was also sent to the Water Quality Department to conduct the examination Chemist and inventory results.

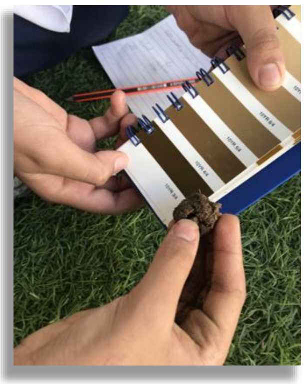
To answer the second question, samples of leafy vegetables (coriander and arugula) were selected and cultivated in fertilized soil with organic fertilizer and non-fertilized soil, and watered in the same amount of water with divided into sections according to the type of water sample from each stage of the Ghuraifa area (first A, B, second and third), and from Then measure the amount of stem growth for each plant, compare and note the color change of leaves in the plant





As for the answer to the third question, data related to soil properties (temperature, conductivity, salinity, acidity) were collected before applying groundwater samples and after application then comparing the results and analyzing them.




Results:

First: the water protocol

1. Data of characteristics of well water in Ghuraifa (first, second and third stage):

The third stage	The second stage	First stage B	First stage A	Region / Properties
20.6	25.4	20.2	21.4	**temperature**
8.3	8.7	8.8	9.1	**PH**
6.3	5.28	1265	1648	**conductivity**
4.4	3.7	889	1152	**Salinity**
3	5	6	5	**Dissolved oxygen**

Table (2) Data of characteristics of well water in Ghuraifa (first, second and third stage)

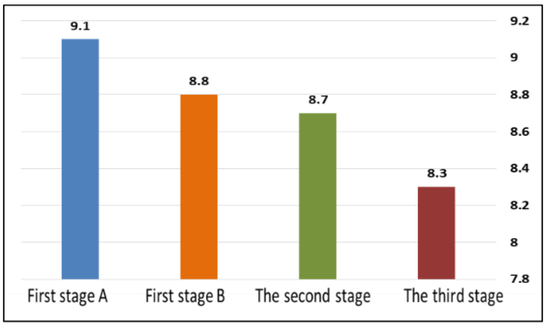


Diagram (2) Comparing the pH of the Al Ghuraifa well water

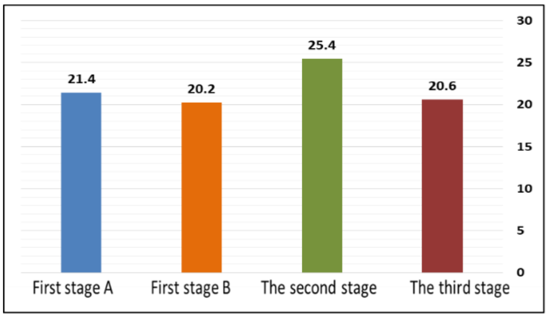


Diagram (1) Comparing the temperature of Al Ghuraifa well water

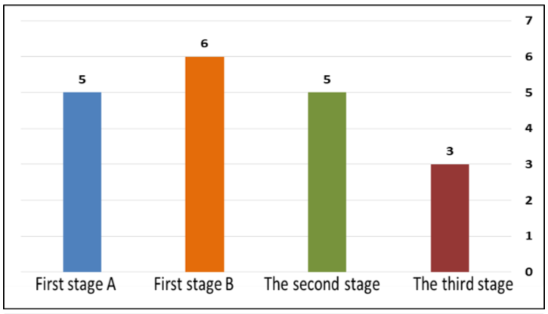


Diagram (4) Comparing the ratio of dissolved oxygen to Al Ghuraifa well water

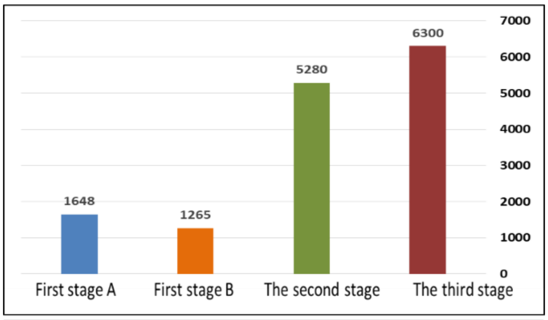


Diagram (3) Comparing the degree of conductivity of Al Ghuraifa well water

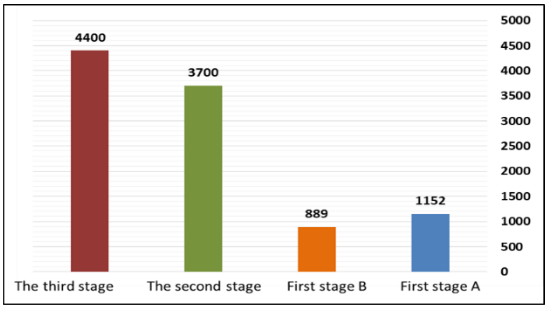


Diagram (5) comparison of salinity percentage of Al Ghuraifa well water

2. Comparing the results of the microbiological examination of well water samples in Ghuraifa (first, second and third stage):

Total Dissolved Solids	Visual Examination	E.Coil	Coliform	Region
958	Normal	0	144.5	First stage A
4650	AbNormal	0	> 200	First stage B
5090	AbNormal	0	0	The second stage
6450	AbNormal	2	> 200.5	The third stage

Table (3) Results of the microbiological examination of well water samples in Ghuraifa (first, second and third stage)

3. Comparing the results of the chemical examination of well water samples in Ghuraifa (first, second and third stage):

Parameters	Samples			
	The first sample is A	The first sample is B	Sample of the second Ghuraifa	Sample of the third Ghuraifa
Temperature	20.7	20.7	20.7	20.7
PH	8.01		7.88	
EC	1568	7140	**5009**	**1339**
TDS	1030.9	46241	**3255.8**	**870.35**
Chloride	352.3		**1404.2**	**179**
phenolphthalein. Alkalinity	0	0	0	0
Total alkalinity	13.6	288	160.8	135.6
calcium hardness	173.8	699.2	240.8	420
Total Hardness	632.4		673.2	
NO_3	1.85	0.485	1.68	0.292
PO_4	0.8	0.06	0.8	0.07
SO_4	116.45	118.45	138.47	93.84
Florid	1.37	0.935	4.09	0.447
Sodium	263	**1400**	**1500**	**201**
Sulfate		1		10.1

Table (4) Results of the chemical examination of well water samples in Ghuraifa

Second: the ground cover protocol

Comparing the growth rates of the (coriander and watercress) plant according to the type of water used for irrigation:

The Third Ghuraifa		Second Ghraifa		Ghuraifa B		Ghuraifa A		Date
Soil without fertilizer	Soil with organic fertilizer	Soil without fertilizer	Soil with organic fertilizer	Soil without fertilizer	Soil with organic fertilizer	Soil without fertilizer	Soil with organic fertilizer	
Cultivation of seeds	Cultivation of seeds	Cultivation of seeds	Cultivation of seeds	Cultivation of seeds	Cultivation of seeds	Cultivation of seeds	Cultivation of seeds	12/31
-	-	-	-	-	-	-	Beginning of plant growth	1/2
-	-	-	-	-	-	-	1cm	1/5
-	Beginning of plant growth	-	Beginning of plant growth	-	Beginning of plant growth	-	1.2cm	1/7
-	1.5 cm	-	1.5 cm	-	1.5 cm	-	2cm	1/9
-	4.5 cm	-	5.5 cm	Beginning of plant growth	3.5 cm	-	5cm	1/14
-	5 cm	-	6 cm	1 cm	4 cm	-	5.5cm	1/16
Beginning of plant growth	5.5 cm	-	7 cm	2 cm	4.5 cm	1 cm	6cm	1/19
1 cm	5.6 cm	Beginning of plant growth	7.3 cm	2.5 cm	5 cm	2.5 cm	6.5cm	1/21
2 cm	5.8 cm	1.8 cm	8 cm	3.5 cm	6 cm	4.5 cm	7cm	1/23
3.2 cm	6 cm	3 cm	8.5 cm	5 cm	7.5 cm	6 cm	8.5cm	1/26
2.2cm	4.5cm	1.2cm	7cm	4cm	6cm	7cm	7.5cm	growth rate

Table (5) Follow-up stages of the growth of (coriander) plants

The Third Ghuraifa		Second Ghraifa		Ghuraifa B		Ghuraifa A		Date
Soil without fertilizer	Soil with organic fertilizer	Soil without fertilizer	Soil with organic fertilizer	Soil without fertilizer	Soil with organic fertilizer	Soil without fertilizer	Soil with organic fertilizer	
Cultivation of seeds	Cultivation of seeds	Cultivation of seeds	Cultivation of seeds	Cultivation of seeds	Cultivation of seeds	Cultivation of seeds	Cultivation of seeds	2019/12/31
-	Beginning of plant growth	-	Beginning of plant growth	-	Beginning of plant growth	-	Beginning of plant growth	2020/1/2
-	3.5cm	-	2.5cm	-	4.1cm	-	3.5cm	1/5
-	5.2cm	-	3.8cm	-	5.3cm	-	4.6cm	1/7
-	5.5cm	-	4.5cm	-	5.5cm	-	5.4cm	1/9
1.5cm	7.5cm	Beginning of plant growth	6.5cm	Beginning of plant growth	6cm	1cm	5.7cm	1/14
2cm	8.3cm	0.8cm	7cm	1cm	6.3cm	1.9cm	6.2cm	1/16
4cm	8.5cm	2cm	7.3cm	2cm	6.5cm	3cm	6.5cm	1/19
4.5cm	9cm	4cm	7.5cm	3.8	7cm	5.8cm	7cm	1/21
5,5cm	9.5cm	4.5cm	7.7cm	4cm	7.4cm	6.5cm	8cm	1/23
7cm	10cm	4.8cm	8cm	5.7cm	8.8cm	7cm	9.5cm	1/26
5.5cm	6.5cm	4cm	5.5cm	4.7cm	4.7cm	6cm	6cm	growth rate

Table (6) Monitoring the stages of plant growth (watercress)

Picture (1) effect of the study area water on the vegetative growth of the plant

Picture (2) effect of chloride concentration in irrigation water on leaves (watercress)

Third: the soil protocol

Comparing soil properties before using well water for irrigation and after use:

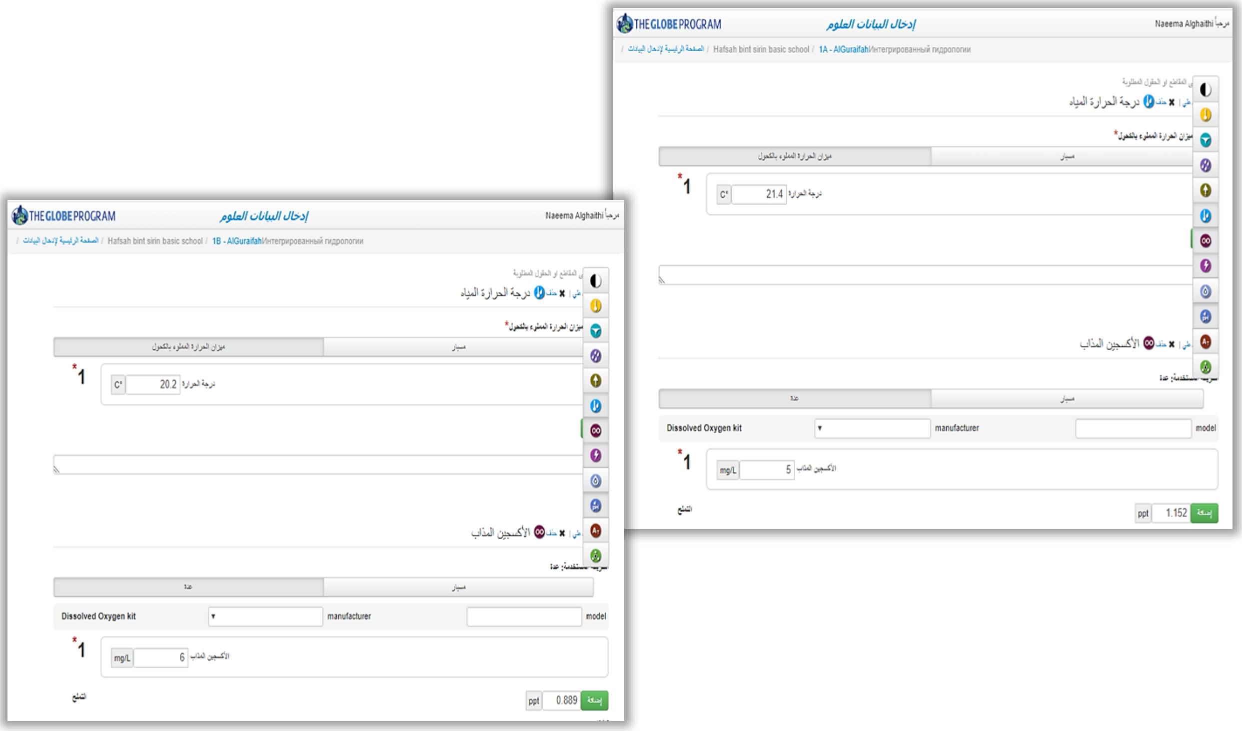
After using water samples for irrigation				Before using water samples for irrigation	Properties
The third stage	The second stage	First stage B	First stage A		
				Sand, gravel, roots	Soil properties
20	20.2	20.5	20.7	22	temperature
630	763	320	678	6.53	Salinity
714	1116	387	753	7.25	conductivity

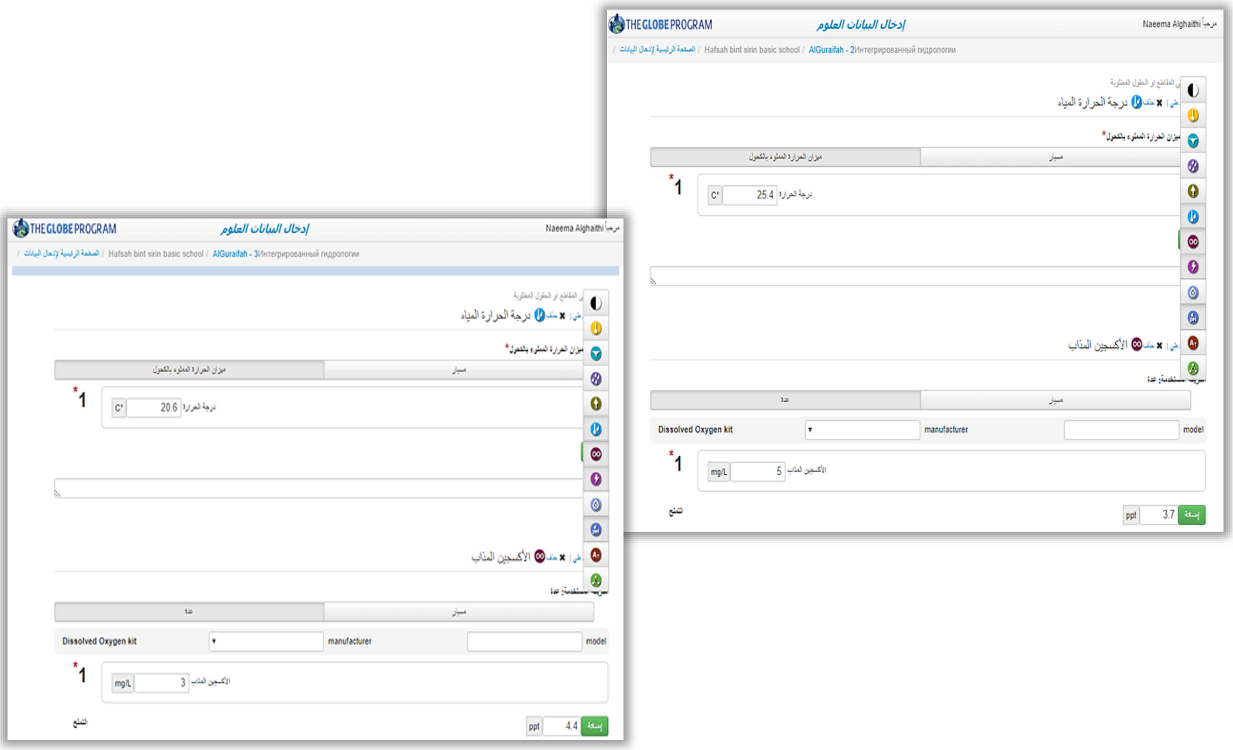
Table (7) Characteristics of uncharged soils before and after the use of well water in Ghuraifa (first, second and third stage) for irrigation of crops

After using water samples for irrigation				Before using water samples for irrigation	Properties
The third stage	The second stage	First stage B	First stage A		
				Sand, gravel, roots	Soil properties
20.2	20.4	21.3	20.7	20.4	temperature
924	978	216	202	3.57	Salinity
508	1089	251	425	6.3	conductivity

Table (8) characteristics of fertilized soil before and after the use of well water in Ghuraifa (first, second and third stage) for irrigation of crops

The data has been entered in the program website (www.Globe.com) where the study sites were added and enter data collected in research:





Discussion of the results:

We note through the measurements and readings that were taken during the application of the water protocol as an answer to the first question, that the ratio of dissolved oxygen was appropriate in the wells of the first and second stages, which ranged between (5-6 m / L), while this percentage decreased in the wells of the third stage to reach To (3 m / L) as in Table (2), as the results of measuring the pH showed that it exceeded the permissible range according to the Omani water quality standards (Appendix 1) where it ranged between (8.3 - 9.1), which indicates the alkalinity of the water of these wells.

The results of the microbiological examination showed that the samples did not conform to the Omani standards due to the increase in the total number of coliform bacteria in the first and second stage wells, and the presence of E. coli in the water of the third stage wells.

The samples were analyzed and the chemical elements' concentrations were calculated. It is clear from the results of Table (4) that the values of electrical conductivity exceeded the permissible limits according to the Omani standards as they ranged between (1339 - 7140) and thus are not suitable for drinking as it is not possible to use the water of the first borehole well B And the second Ghuraifa according to the classification of (Dradkeh, 1988) in Appendix (2), and this indicates an increase in the concentration of dissolved salts in the water of these wells, as they ranged between (958 - 6450) as in Table (3) and this increase may be due to the amount of water withdrawn as well To the geological composition and sources of wells.

Concentrations of chloride in the samples ranged between (179 - 1404.2 mg / L), where the lowest value was in the sample of the third packet water (179mg / L), while the largest value in the sample of the second packet water (1404.2mg / L), and gives the water an unpleasant taste Acceptable if the concentration of chloride exceeds (250 mg / L) (WHO, 2011), and according to the standard criteria for drinking water the permissible limit is less than (250 mg / L) as stated in Appendix (1). Based on the above, all water samples are not suitable for drinking.

As an answer to the second question, after measuring the chemical properties of water, it was compared to several criteria and standards used to evaluate water for irrigation purposes, including:

- The classification of irrigation water based on the concentration of TDS (train, 1979) appendix (3). The results shown in Table (4) show that the concentration of total dissolved salts in the wells of the study area ranged between (870.35-46241mg / L), as the third ALGhuraifa water The first A fell into the second and third category, which was characterized by its negative impact on crops, especially those with high sensitivity that need high experience.
- The American Salinity Laboratory Classification: This classification divides irrigation water into four sections based on the value of electrical conductivity in units (micros / cm) (USDA salinity lab, 1954) and as in Table (4) it is noted from the results that the wells of the first and third ALGhuraifa have classified their water It was very salty while other well water was very high salinity.

When applying water samples to the plant, the results showed through table (6) and (7) that the process of germination of the seeds planted in the fertilized soil was faster than the soil plants without fertilizer, because the salinity of the water causes the delay of a large number of seeds in the germination due to insufficient absorption The water needed for drinking and bloating of seeds (Al-Zubaidi, 1989), and we conclude from this that organic fertilizers have a role in reducing the damages of irrigation water salinity to plant growth, improving soil permeability and increasing salt washing (Muhammad, 2013).

However, it was noticed that the indicators of vegetative growth decreased in terms of the number of leaves and their area as in the picture (1) after the passage of three weeks after the irrigation process, due to the high osmotic pressure of leaf cells caused by the lack of water entering the vegetative system and then the production effort of the leaf cells, and this leads to Low elongation, which is reflected in the paper area. It was found that chlorophyll has decreased in leaves due to the toxic effect of salts on the activity of the enzymes responsible for forming pigments and chloroplasts. Salinity caused a reduction in

the size of vegetative growth of the plant, which led to the small size of the leaves and the small number of green chloroplasts (As-Sahaf, 1989).

The presence of high concentrations of chloride ion in the water samples causes a toxic effect for some crops, and poisoning with chlorides is shown by burning the edges of the leaves or the fall of the leaves early (Al-Zubaidi, 1989). As the percentage of chloride reached (1404mg / L) in Table (4), thus the water of the wells under study is classified as highly harmful crops based on the concentration of soluble salts and chloride.

As an answer to the third question, it is noted through table (7) and (8) that the salinity of irrigation water led to an increase in the value of electrical conductivity and an increase in the salinity of the soil as the highest salinity value in the soil watered by the water of the second and third wells which may lead to the passage of time leads to the risk of salinization Soil degradation.

We also note that the organically fertilized soil that was watered with water from the first wells A and B is less salty compared to the soil without fertilizer, but this effect of fertilizer was not evident in the soil that was watered with water from the second and third wells, due to the high amount of soluble salts therein as in Table (3) This indicates that the use of organic fertilizers is not considered a sufficient solution over time, but good soil management must be used using appropriate washing requirements or by mixing or alternating irrigation, and that unprogrammed use will lead to salt accumulation.

Abstract:

We thank God for completing this research, which we reached through the application of the water protocol and sample testing in cooperation with the Center for Food Safety and Quality and the Department of Water Quality to the fact that well water in the study area is not suitable for drinking due to the high percentage of PH and dissolved salts in addition to containing coliform bacteria and (E.Coli) which causes health damages, as the high level of chloride causes intestinal problems, infections, dehydration, diarrhea, and worsening the health condition of people suffering from kidney, heart and blood pressure diseases (Al-Minhrawi, 1997: 162), and accordingly, efforts should be intensified to educate families not to Digging wells in their homes due to the damage The health consequences of using well water without an examination and the necessity to notify the specialists of treating it with chlorofiltering.

The results of the study also showed that adding organic fertilizers is an effective strategy in reducing the salinity of irrigation water and increasing plant tolerance, but many problems may arise for the soil and crops by increasing the concentration of dissolved salts in irrigation water. Therefore, environmental awareness should be spread among the population and clarify the risk of groundwater salinity on soil and plants, so use This type of water in irrigation needs expertise in the type of soil, climate, and type of plant that can withstand high salinity. An agricultural engineer can be used to avoid salt damage to soil and plants.The strengths of the research were obtaining important and influential results after examining the water in the Food Quality and Safety Center, which contributed to educating citizens about the damages resulting from the use of contaminated water from bacteria from wells where the people responded and refrained from using this water for drinking and cooking purposes, and the study area samples were used only Irrigation of palm trees due to their high ability to withstand the salinity of this water, and we believe that the research can be applied again and expand the study area to examine the water of other wells and study their impact on soil and agricultural crops.

Thanks and appreciation:

We are pleased to extend our sincere thanks and appreciation to Ms. Nadheera Al Harthy counterpart national environmental GLOBE Program Coordinator with the Sultanate of Oman on all the information provided, and to the distinguished Ahmed AL Balushi and and Maryam Al Rawahiya members of the central team of the program and the Honorable Rabia Al Alyaniya, the Supervisor of the Program Team, to maintain its continuous follow-up and provide us with the recommendations necessary to prepare the research.

We also thank the two Globe Program supervisors Laila Al-Badia and Naeema Al-Ghaithiya, for their follow-up to prepare the research and the school's director, Ms. Salma Al-Yahyaee, for following up and motivating us to conduct the research, and we thank Ms / Latifa Al-Mamaria and Muzna Al-Badia for their cooperation in providing some of the water samples for study.

Special thanks also to the agricultural engineer, Ahmed Al-Eisaei, who helped us choose the type of plant to apply the study to and provided us with the correct and appropriate scientific steps to conduct this study.

We also thank the General Directorate of Regional Municipalities and Water Resources in the governorate, the Food Quality and Safety Center, and the head of the Water Quality Department A. Layla Al-Isayya for their cooperation in examining the water samples and providing us with the results.

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Appendices

Appendix (1) to the international and Omani specifications to determine the validity of drinking water

Omani standard specifications	WHO specifications (mg, l)	The laboratory
1000	1000	TDS
8 - 6.5	8.5 - 6.5	PH
> 200	-	Total hardness (TH)
	-	K^+
> 200	200	Na^+
50	50	Mg^{2+}
> 200	200	Ca^{2+}
> 250	250	Cl^-
> 0.05	250	SO_4^{-2}
-	-	HCO_3^-
50	50	$N0_3$

Appendix (2) classification of water by value of electrical conductivity (Daradkeh, 1988: 400)

the description	Category
very good	Less than 250
Good one	250-750
Water that can be used	750-2000
Suspicious water	3000-2000
do not use	More than 3000

Appendix (3) classification of irrigation water based on (TDS), (Train, 1979).

Specifications	The amount of dissolved salts (TDS) (mg/L)
The salts have no harmful effect in the water	500
The presence of salts affects crops with great sensitivity	1000-500
The presence of salts negatively affects crops, especially those with allergies, which need expertise	2000-1000
The presence of salts does not affect plants with high tolerance	5000-2000

Appendix (4) classification of irrigation water based on (EC), (D.D.A Salinity lab, 1954).

Category	Electrical conductivity value (EC) (m / cm)
Less salty water	250-100
Medium salt water	750-250
High salinity water	2250-750
Very high salinity	5000-2250