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First Arqah High School / Riyadh City

The Effect of Pottery on Brackish Water in the KSA and Its impact of Soil and Vegetation Cover

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Abstract

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Done by: Hala Al-Yousif and Lena Al-Subaie

First Arqah High School- Saudi Arabia/ Riyadh City

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This research aims at identifying the effect of pottery on brackish water in the Kingdom of Saudi Arabia and its impact on soil and vegetation cover, due to the spread of dry desert areas in the Kingdom of Saudi Arabia and the scarcity of fresh groundwater in such areas.

The Kingdom's dependence on wells as the crucial source of groundwater for plant cultivation irrigation makes it a cornerstone for us in conducting this study as an attempt to find the necessary solutions that assistance raise the efficiency of well water in the ability to germinate plants and increase the cultivation area in the region.

Experiments have been made on a sample of water from one of the wells located in the Al-Quwaiyah region in the Kingdom of Saudi Arabia and have been treated by the same sample using pottery at different periods, with studying the extent of its ability to modify the properties of water and soil and as a final result to obtain the extent of its ability to germinate the plant.

This study has demonstrated the ability of pottery to reduce electrical conductivity, as well as the percentage of sodium to water and raise the value of dissolved oxygen in it, the pottery was also able to modify the properties of the soil by distinguishing it with an easy granular structure and containing many roots, other than soil irrigated with well water directly.

The soil irrigated with water treated with pottery was characterized by a very high tree density (95%). It enables us to plant many agricultural crops such as watercress, mint, all kinds of peppers, tomatoes, eggplant, basil, and some flowering plants such as Rose and jelly, in contrast to the soil of well water, only palm trees were able to adapt in that soil and resist its salinity.

This study leads us to many recommendations regarding the generalization of the pottery experiment in afforestation of streets and public gardens using:

Clay bottles for treating saltwater in the area, in addition to the ability of pottery to apply self-irrigation technology through water seepage and on its own from pottery to the soil. We also recommend lining salt wells with pottery and placing pottery tanks in public areas.

To improve the chemical and physical properties of the water, and thus the surrounding soil, and finally the vegetation cover of the site irrigated with that water.

Definition of terms

Water salinity: refers to the percentage of total dissolved salts that includes sodium chloride, calcium sulfate, magnesium sulfate, and various bicarbonate salts) in one liter of water (Farmer, 2019).

Brackish water: It refers to a strong solution of table salt in water, which may reach saturation (Wikipedia, 2020) being described water when the salt concentration exceeds 5. %

Groundwater: refers to a complex natural solution that contains most of the chemical elements in the form of simple or complex electrolytes or the form of conjugates: Complex, liquid, gas, or natural isotopes. (Inventory J Watert, 2010)

Groundwater can also be defined as the water located below the surface of the earth, whether that is found in saturated areas (completely filled with its emptiness). **Water (or unsaturated**) area directly below the surface of the earth (and its constituent geological materials contain water and air in the gaps between grains of soil (Assaf and Al-Masry, 2007)

The chemical properties of water (hydrological): refers to the pH of the water, the salinity of the water, the conductivity of the water, the temperature of the water. (**Water / Hydrology Protocol)**

(Hydrologic) physical properties of water: refers to the transparency of water (Water Hydrology Protocol Research Guide)

Soil chemical properties refer to soil pH, soil salinity, free carbon. (Research Guide for Soil Protocol)

Soil physical properties: refers to soil composition, color, and texture. (Research Guide for Soil Protocol)

(Biological) vegetation cover: is the shade cover, the ground cover, the number of trees and shrubs, their height, and weeds. (Protocol Research Manual) Land cover/biology.

Research Questions

This research aims to identify the effect of pottery on brackish water in the Kingdom of Saudi Arabia and its impact on soil and vegetation cover, by answering the following questions:

1. What are the hydrological properties of brackish water?
2. What are the chemical properties of the soils irrigated with brackish water?
3. What are the physical properties of the soils irrigated with brackish water?
4. What is the nature of the vegetation cover irrigated with brackish water?
5. What classes of plants are adapted to brackish water?
6. What is the effect of pottery on the hydrological properties of brackish water?
7. What are the chemical properties of soil irrigated with pottery water?
8. What are the physical properties of soil irrigated with pottery water?
9. What is the nature of the vegetation cover irrigated with pottery water?
10. What classes of plants are adapted to pottery water?

Introduction and Literature Review

The Arabian Peninsula region has been considered one of the driest regions in the world, with an average annual rainfall of less than 130 mm. The agricultural sector in the Kingdom of Saudi Arabia faces many threats, challenges, and pressures, which negatively affect the future of Cultivation, such as natural processes and human activities, in addition to the decrease and limitations of available water resources.

This indicates a decrease in soil fertility and an increase in desertification in the region (Ministry of Environment, Agriculture and Water, 2021).

One of the main reasons behind the water problem in the Kingdom of Saudi Arabia is its geographical location, in which there are many dried desert areas, and there are no lakes or rivers, and they are considered to be low in rain, and they are subject to evaporation quickly due to high temperatures.

The temperature, in summer, may reach 50 degrees Celsius or more (Al-Kamil, 2017). Evaporation, lack of annual rainfall, and depletion of groundwater rates through over-pumping have led to a significant decrease in the levels of Groundwater and the deterioration of its quality (Mahmoud, 2020).

Accordingly, it is resorting to desalination of seawater, and to convert it into safe freshwater for drinking, and thus the Kingdom of Saudi Arabia is at the forefront of the world's global desalination of seawater, as it has established since the year 2000 AD 27. A desalination station, which has a storage capacity of 797 meters, and has also benefited from covering about 70% of the Kingdom's needs from water (Al-Kamil, 2017) knowing that desalination increases the amount of salinity in the seas, which in turn poses a threat to sea living organisms.

With the need to rationalize the consumption of desalinated water, we are witnessing the Kingdom's tendency to rely on wells, which is one of the methods that are depended on to extract groundwater to the surface of the earth without the need to use pumps (Al-Kamil, 2017).

One of the main sources of providing the Kingdom's need of water, as groundwater contributes more than (39%) of the total water in the Kingdom, the total number of government wells that were drilled in 2015 reached (160), increasing to (8,197) wells, with an annual increase of (2%). The number of private wells in 2015 reached (146,369) wells, which are mainly used for agriculture (Statistical Report, 2015).

However, it does not pass for a long time until we find that the water of the wells has been salinized (Mazari' (plants), 2019). In addition to the over-pumping of water, the fresh groundwater led to a decrease in the water level in the ground wells, and an increase in the salinity of the water (Abu Samaka, 2019).

However, increasing irrigation with saline groundwater and brackish water reduces the attraction forces between soil particles, thus reducing voids.

The interlayer causes the difficulty of spreading the roots, which in turn causes the decrease in the rate of water absorption by the roots with the osmotic characteristic.

The growing tips of the roots and burning along the edges or leaves of the plants and some of the terminal branches, and in the advanced stages of the deposition of salts

Reverse osmosis occurs, causing the death of the entire plant (Mazari', (plants), 2019).

The use of saline water led to chemical and physical changes that affected soil fertility as well. Therefore, the properties of the soil are affected by the quality of the water.

Irrigation water is like the structure of the soil and the stability of its grains. As a result, the quality and salinity of the irrigation water, as well as the sodium concentration, must be determined to ensure a positive effect on soil fragmentation.

The identification of the characteristics of the water used to irrigate crops is a necessary and important issue, which cannot be overlooked about its relationship to growth, plants, and crop productivity. As the agricultural crops differ in their sensitivity to the dissolved salts in the irrigation water, as well as the effect of this on the characteristics of Agricultural soil, as it affects the soil fertility due to the accumulation of dissolved salts on the soil surface and in the root zone according to the soil type. (Mahmoud, 2020).

It is obligatory for us, as students and students in the era of the information explosion, and with all the tools and means that our country, the Kingdom of Saudi Arabia, have armed us with to help us protect our environment, to study everything that would preserve natural resources in general and cover Vegetarianism in particular, and the adoption of many agricultural hygienic practices that help with this.

From this standpoint, we had to study the quality of groundwater in the Kingdom of Saudi Arabia and find solutions that help to benefit from it in the growth of vegetation cover in the region.

Adopting new methods and disseminating them as a new vision for agricultural work in a way that serves the protection and sustainability of natural resources and the preservation of the environment with its biological diversity, and activating the role of human resources to achieve the optimal use of these resources.

Research Procedures

First: WORK PLAN

Table (1) Study plan schedule

	Work Plan	Time
1	**Determining Research Plan**	**The Idea is a complement for a previous work 2020**
2	**Writing Resources and Literature**	**December 2020**
3	**Work visits, Collecting the data and analyzing them**	**January 2021**
4	**Writing The Results**	**February 2021**
5	**Collecting the ideas and Finalizing**	**February 2021**
6	**Presenting the work to the Committee**	**March 2021**
7	**Translating the work and Participating at the Virtual International Fair**	**March 2021**

Second: Work Team Contributions

Table (2) Study team roles

	Task	**Name**
1	Determining Literature Review and referencing.	Hala and Lena
2	Choosing a study site for collecting data (Al-Quwa'a, Riyadh, KSA)	Hala and Lena
3	Determining the suitable protocols for data (Water, soil, vegetation cover).	Hala and Lena
4	Identify the appropriate devices and tools (thermometer, transparency tube, conductivity meter, gauge PH, dissolved oxygen meter, GPS, beakers, Water, paper, pen, smartphone, sample collection boxes, sieve, sensor balance, tape Movement, metric bar, compass, tree density, meter, soil book)	Hala and Lena
5	Collecting soil samples and studying their properties from the study sites	Hala
6	Apply water protocol to samples	Lena
7	Application of the vegetation cover protocol to the study sites	Hala and Lena
8	Monitoring and photographing plant species in the Al Quwai'iyah environment and in the field in which the pottery is used	Hala
9	Apply established protocols to the samples taken from specified sites	Hala and Lena
10	Coordination with King Saud University to examine water samples selected from the research site, and pottery water	Mrs.Nourah
11	Determine the appropriate protocols for data collection	Hala and Lena
12	Collect data and organize them into tables	Hala and Lena
13	Enter the data on the program website http://www.globe.govl	Hala and Lena
14	Analyzing the collected data and writing research papers under the supervision of the teacher	Hala and Lena
15	Discuss the results and write recommendations	Hala, Lena, and Mrs.Noura

Study Site

These figures were implemented in the Al-Quwai'yah governorate of the Riyadh region, the Kingdom of Saudi Arabia, in January (2020). The weather is hot in summer and cold and tends to be moderate in winter, like most regions of the Kingdom, where rainfall is concentrated in the winter season. All protocols specified in this area have been implemented Field, cold protocols on this area located in the following coordinates: (23 ° 41'52.0" N 44 ° 35'26.0 "E), and the following pictures show the nature of the geographical area:

Table (3); the location coordinates data

Village	Al-Quwai'yah
Location coordinates by GPS	23 ° 41'52.0" N 44 ° 35'26.0 "E

Photos (1) shows the geographical areas for the study site

Data Collection and Analysis

- To answer the first and the sixth question, the data have been collected by using a device for measuring water acidity, salinity, conductivity, and the dissolved oxygen in water by applying a sample of water on three types:
    - A sample of the brackish well water in Al-Quwai'yah Governorate.
    - Three samples of water placed inside the pottery at different periods.

In addition to the frequency of the specified parameters, the total number of the numbers will return to be analyzed in terms of the number and the multiplicity of the frequency of the number and duration.

Photos (2) Water Protocol Application

- To answer the second and seventh research questions, the data were collected by applying the soil (acidity protocol and the presence of carbonates), by taking two soil samples from two different locations along a flow path Brackish well water from the surface layer (5-20 cm) of soil, and two other samples from the layered Surface (5-20 cm) of soil irrigated with water treated by pottery.
- As for the third and eighth research question, the soil protocol was applied (soil structure, color Soil, soil consistency and consistency, soil texture, presence of roots, and presence of rocks) on samples from Selected locations.

Photo (3) Soil Protocol Application

- To answer the fourth and ninth question of the research, the application of the protocol of vegetation is applied to the part of the soil, which is irrigated with a sample of water from the well of Al-Quwai'yah well directly, with an area estimated at (32 * 32) m 2, and the same protocol has been applied to the other part of soil cities that are irrigated with the same water, But by the number of being treated by pottery on an area estimated at (3 * 3) m 2, and by measuring the density of trees and vegetation cover for both soils.

- The fifth and tenth research question was answered by using observation to collect information about species of plants that can live and adapt in the water flowing from the well and plant species that can live and adapt.

In pottery treated water, and photographing these elements in every direction, interviews were also conducted with farm owners to learn about the types of crops irrigated with well water, and several crops were tested and irrigated with pottery water to see the extent of the water's ability to germinate these crops.

Data Analysis

Question 1: What are the hydrological properties of brackish water?

Table (4): Hydrological characteristics of water collected from the study site using GLOBE program tools

Date January 3, 2021, at 10:00 am

Sample	Transparency	Temperature ˚C	Electrical Conductivity µs	Salinity ppm	Acidity pH	Dissolved oxygen
Well Water (Al-Quwai'yah)	More than 60	25	1265	6340	10,6	4
Pottery water (treated a week)	More than 60	25	1	4260	8,89	8
Pottery water (treated two weeks)	More than 60	25	1	3300	8,4	8
Pottery water (treated four weeks)	More than 60	25	1	2110	8,4	8

From the above table, we note the decrease in the electrical conductivity of water from (1265 µS) Microsiemens to (1 µS) Microsiemens immediately after putting it in the pottery under the same conditions (temperature 25 ° C, coefficient of transparency more than 60), as we notice the decrease in salinity, which increased from (6340) for well water to (4260) after treating it with pottery for a week up to (2110) after four weeks. Also, a decrease in the acidity of the well water was observed from (10.6) to (8.89) in the first week, and then it remained constant at (8.4). Finally, the value of dissolved oxygen in water increased from (4) in well water to (8) in water treated with pottery from the first week, and its value remains constant even after four weeks.

Question 6: What is the effect of pottery on the hydrological properties of brackish water?

Table (5): Results of analysis of well water components from Al Quwai'yah Governorate and the sample of water in pottery.

Total dissolves	Well water	Pottery water
The total of dissolved substances	697	475
Alkaline carbonate	28.1	15.3
Alkaline bicarbonate	43.9	195.2
Ammonia	0.89	.36
Chlorine	334	134
Nitrates	25.3	9.1
Sodium	291	77.4
Potassium	14.2	8.2
Calcium	26.4	9.1
Magnesium	18.2	5.9
Sulfate	56.6	41.1
Boron	<0.1	<0.1

It is obvious from the above table that the total dissolved substances decreased after treating the water with pottery to reach (475), as well it is present in alkaline carbonates to reach (15.3), and low in ammonia, chlorine, nitrates, potassium, calcium, magnesium and sulfate to reach the following numbers respectively (0.36, 134, 9.1, 8.2, 9.1, 5.9, 41.1). On the other hand, the alkaline bicarbonate found in it increased to (195.2), and sodium reached (77.4), while boron remained the same Less than 0.1.

The second question: What are the chemical properties of the soil irrigated with brackish water?

The seventh question: What are the chemical properties of the soil irrigated with pottery water?

The table below shows the results of applying a soil acidity protocol and some chemical properties of flowing soils. It has the well water in Al Quwai'yah governorate, soil acidity, and some chemical properties of the same soil that is irrigated with water Pottery.

Table (6): The Chemical properties for Soil irrigated by Well water

	At spring source	10 meters away
Carbonates	many	many
Soil Acidity	8.8	8.6

Table (7): The Chemical properties for Soil irrigated by Pottery water

	At spring source	10 meters away
Carbonates	Little	Little
Soil Acidity	8.3	8.1

The third question: What are the physical properties of the soil irrigated with brackish water?

The eighth question: What are the physical characteristics of the soil irrigated with pottery water?

Table (8) The Physical Properties for a soil irrigated by a well water

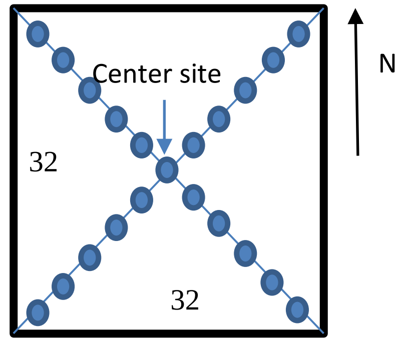
Soil Sample	At spring source	10 meters away
Rocks	few	non
Roots	few	few
Soil structure	Granular	Blocky
Soil color	7.5 YR 4/4	7.5 YR 3/4
Soil consistency	Friable	Firm
Soil texture	Clay loam	clay

Table (9) The Physical Properties for a soil irrigated by a Pottery water

Soil Sample	At spring source	10 meters away
Rocks	few	few
Roots	many	many
Soil structure	Granular	Blocky
Soil colour	7.5 YR 4/3	7.5 YR 2.5/3
Soil consistency	Friable	Friable
Soil texture	Clay loam	clay

It can be noted from Tables (8) and (9) that there is an increase in the number of roots in pottery water soil than in well water soil.

The fourth question: What is the nature of the vegetation cover irrigated with brackish water?



Based on the MUC terminology guide, the vegetation cover specifications were defined as follows:

(1) From level 1: woodland

(11) Level II: mainly Evergreen trees

(112) From the third level: Needle-Leaved

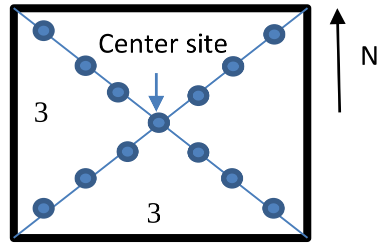
1123 (from the 4th level: Cylindrical Crowns

Accordingly, the MUC number for vegetation is 1123, and then the land cover protocol was applied on an area of (32 * 32) m 2 after irrigation of crops with well water in Al-Quwai'iyah Governorate, from which we reached the following results:

Table (10) The Nature of vegetation cover of a soil irrigated by Well water

No.	Canopy Cover	plant scientific name	E- evergreen D- Falling leaves Sky	Land cover G - green B - brown - nothing	Land cover classification
North					
1	+	Phoenix dactylifera	E	-	
2	+			+	GD
3	+			+	GD
4	+			-	
5	+			-	
East					
6	+	Phoenix dactylifera	E	-	
7	+			-	
8	+			-	

9	+			+	GD
10	+			-	
South					
11	+	Phoenix dactylifera	E	-	
12	+			-	
13	+			-	
14	+			-	
15	+			-	
West					
16	+	Phoenix dactylifera	E	-	
17	+			-	
18	+			-	
19	+			+	GD
20	+			-	
Total	+20			-16	



Question 9: What is the nature of the vegetation cover irrigated with pottery water?

Based on the MUC terminology guide, the vegetation cover specifications were defined as follows:

(4) Level 1: Herbaceous Area

(42) Level Two: Medium Tall Vegetation Graminoid Shrubs

(422) Level 3: With Trees Covering <10%

(4222) Tier 4: Trees: Broad-Leaved Semi-Evergreen

So the MUC number for vegetation will be 4222, and by applying the land cover protocol on an area (3 * 3) m 2, after irrigation of the soil with pottery water, we obtained the following results:

Table (11): The nature of vegetation cover for soil water treated with pottery

No.	Ground Cover	The plant scientific name	E- evergreen D- Falling leaves Sky	Land cover G - green B - brown - nothing	Land cover classification
			North		
1	+	Capsicum Baccatum	F	+G	SB
2	+	Ocimum	F	+G	SB
3	-			-	
			East		
4	+	Solanum melongena	F	+G	SB
5	+	Eruca Sativa	F	+G	DS
6	+	Jasminum sambac	F	+G	SB
			South		
7	+	Capsicum Baccatum	F	+G	SB
8	+	Eruca Sativa	F	+G	DS
9	-			-	

West					
10	+	Mentha	F	+G	SB
11	+	Solanum	F	+G	SB
12	+	Salvia	E	+G	DS
Total	+10			+10	

Fifth question: What classes of plants be adapted to brackish water?

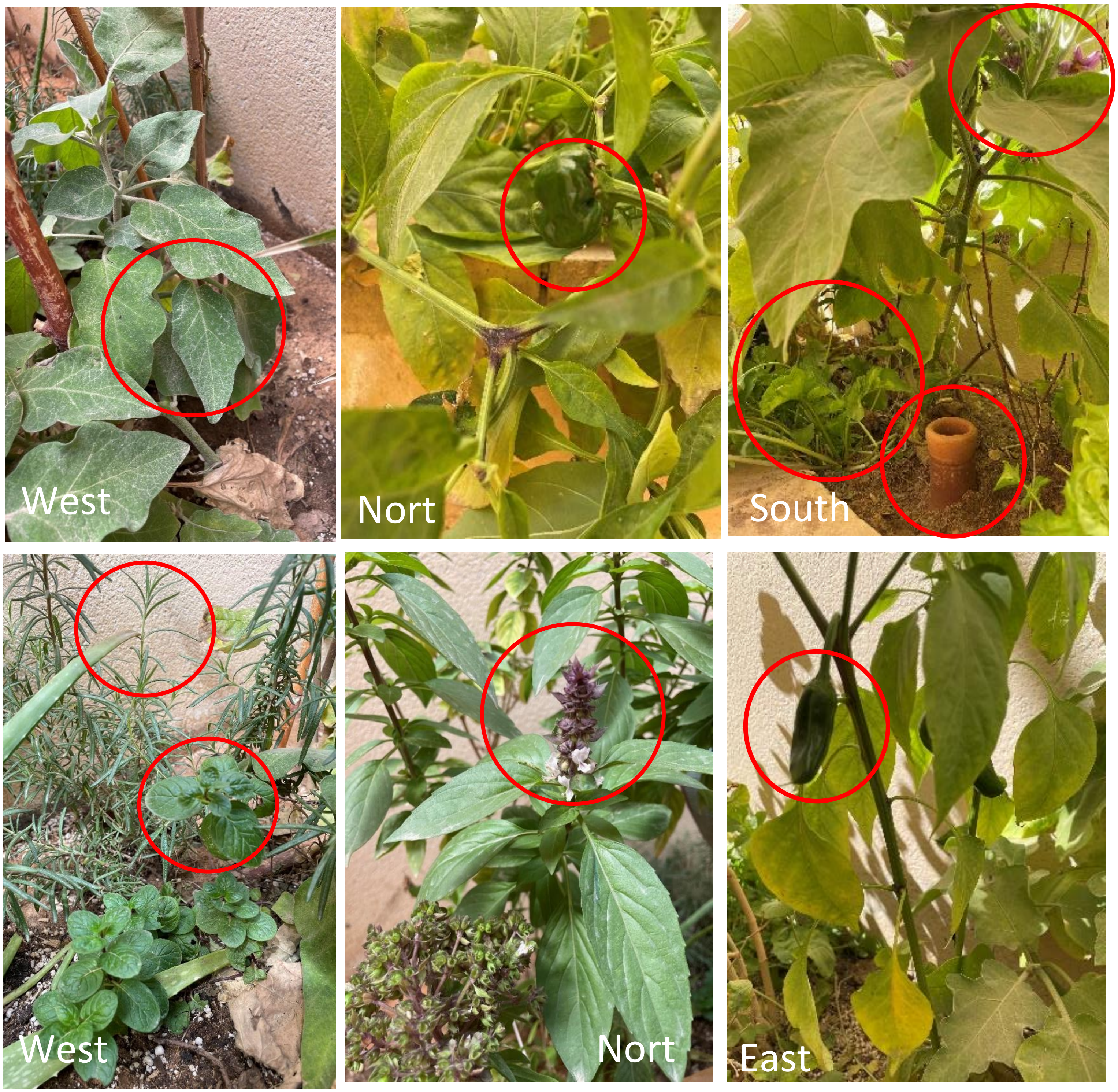
The tenth question: What classes of plants are adapted to pottery water?

The interview conducted with some residents of Al-Quwaiyah, who relied on well water for irrigation, revealed that palm trees are capable. To grow and adapt to this water source, the rest of the plants cannot adapt to the amount of salinity in the water. As for the observations we got after treating the water with pottery, it was only found that there were a large number of crops that managed to live such as watercress, green pepper, eggplant, mint, etc.

This has been evidenced by the results that we reached through the application of the water protocol, which is shown in the pictures below.

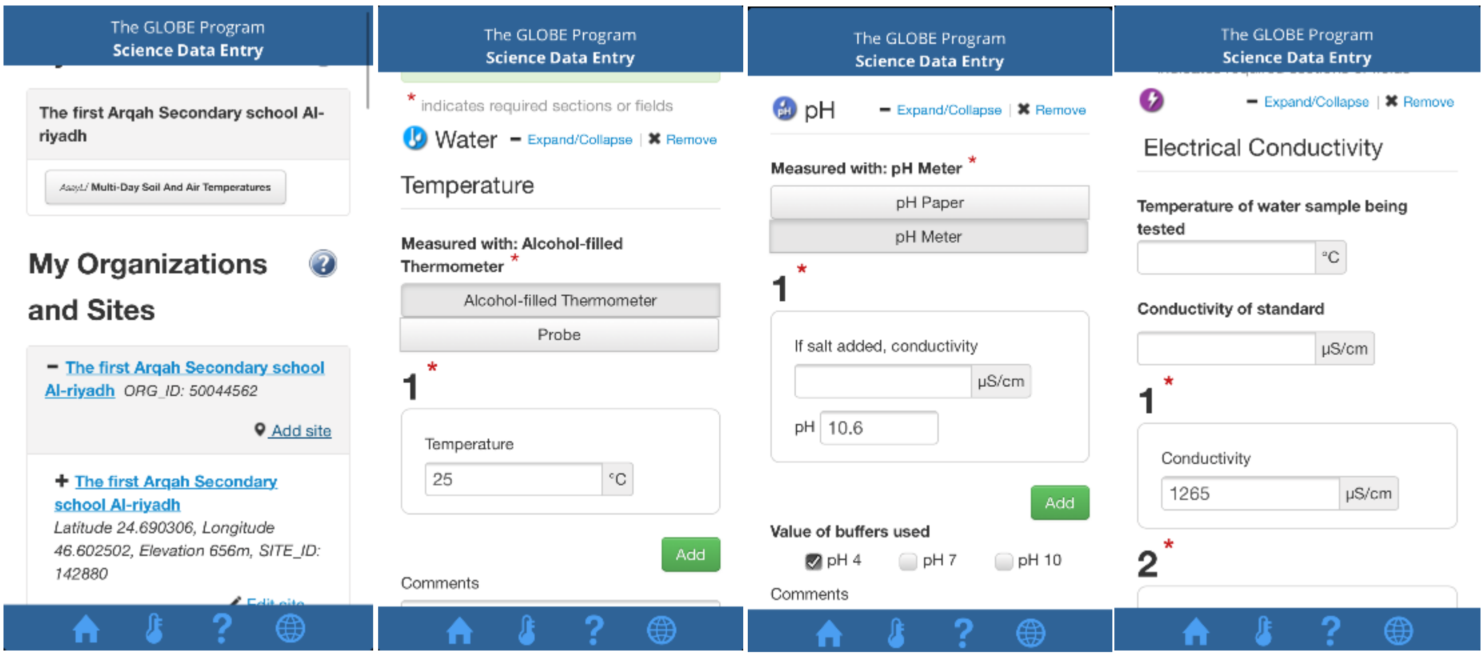
Photos (4): Some types of palm trees found in the well water area

Photos (5): Samples of some plants and crops in pottery water soil



The data collected was entered and sent to the program's website (www.GLOBE.gov) via the application (DATA ENTRY), where a new work site was added and the collected data was entered.

Photos (6) of data entry on the GLOBE website



Discussing Results

When studying the data recorded in the previous tables, starting from Table (4) to Table (11), the results confirmed the impact.

The positive effect of pottery and its ability to modify water properties, in a way that is reflected in the soil and thus the possibility of plant germination, and crop diversity,

So we have arrived at the following implications:

1 - When comparing the properties of well water and water treated with pottery in the same site and by applying the water protocol to the two samples - Table (4)-

They found a clear difference in the conductivity, salinity, acidity, or dissolved oxygen in favor of the water treated with pottery. Where the well water was recorded a higher value of electrical conductivity (1265 μs), while a lower amount of oxygen (4) was detected. On the other hand, the values indicated that low levels of conductivity (1), salinity, the acidity of water treated with pottery, and the high percentage of dissolved oxygen in it (8).

Moreover, it is known that the quality of irrigation water is one of the most important factors that affect the production of agricultural crops, especially in dry ground conditions in which water resources are declining due to rainfall fluctuations in recent years, the following table shows how Irrigation water is classified is based on total dissolved salts (criteria for assessing the suitability of water for irrigation).

Table (12) Irrigation Water Salinity Index

Salinity index	Electrical conductivity micrometers / cm at 25 ˚C	The seriousness of salinity
A	<750	little
B	750 – 1500	medium
C	1500 – 3000	high
D	3000>	very high

It is difficult for crops to absorb nutrients and moisture, which results in stunted growth (ATAGO, n.d.).

It indicates the significance of pottery and its ability to reduce the conductivity of water, to raise the ability of plants to absorb nutrients and moisture, and thus increase plant growth.

2- One of the most important measures of water quality after water salinity is the relative concentration of sodium, as it is mentioned that irrigation water that contains a high percentage of sodium has a shallow surface crust that is poorly dried and its colloidal substance is widely dispersed. This leads to a decrease in water permeability, which reduces the drainage rate required to get rid of the salts contained in irrigation water that accumulates through evaporation (Assaf and Al-Masry, 2007). And as is indicated by table (5) for the results of analyzing two samples of well and pottery water, the rate of the sodium in well water was (291), compared to (77.4) in pottery water.

3 - The value of potassium has decreased from (14.2) well water to (8.2) in pottery water, which is one of the basic ions required by plants, because of its great impact on the productivity and growth of agricultural crops, but it is still within the required rate. The boron rate is less than 0.1, and according to the criteria for irrigation water quality, it does not pose any risk.

4- It has been concluded that the acidity of the well water's soil has changed - Table (6) - between (8.8 - 8.6), which indicates that the soil is not acidic and it contains a large amount of carbonate at different distances are along the brackish well water flow line. The acidity of the pottery water soil was also was ranged from (8.3 - 8.1) - Table (7) - which indicates that the soil is not acidic as well, but the number of carbonates in the pottery water soil samples was less. The presence of carbonate in soils irrigated with well water indicates a climate or a type of material rich in calcium, such as Limestone (a general introduction to soil research).

There is no doubt that the soil obtained calcium from the water flowing over it as shown in Table No. (5). Image (4) also indicates the presence of a white limestone layer on the surface of the well water soil, which indicates, however, that the soil may suffer from drought, and therefore it is necessary to take care of it and provide it with the necessary amount of water regularly.

5- The soil through which the well water flows is distinguished - Table (8) - with a granular structure that is easy to break at sites near the well and it is full and firm in areas further away from it, and also has few roots, with a clay texture. It is known that it is difficult for plant roots to grow in a cohesive, sturdy soil compared to soil with a loose texture (a general introduction to soil research). The data also indicates that the inspected soil sample has a high sodium clay tissue, so a decent system is required to drain the water from this soil so that the salts do not accumulate and cause a layer that prevents the water from reaching the roots. In return, the physical characteristics of pottery water soil – is explained in Table (9) - It has an easy granular structure, many roots, and a texture Clay. Thus, the availability of roots is an indicator of soil porosity (general introduction to soil research). However, general observations can be summarized through the following table:

Table (13) Summary for land Cover Data

<table>
<tr><th>Protocol</th><th colspan="2">Canopy Cover</th><th>Tree cover classification</th><th colspan="2">Land cover</th><th>Land cover type</th></tr>
<tr><td rowspan="2">Total</td><td>0</td><td>+20</td><td rowspan="2">Phoenix dactylifera</td><td>+4</td><td>-16</td><td rowspan="2">GD</td></tr>
<tr><td colspan="2">20</td><td colspan="2">20</td></tr>
</table>

<table>
<tr><th>Protocol</th><th colspan="2">Ground Cover</th><th>The plant scientific name</th><th colspan="2">Land cover</th><th>Land cover type</th></tr>
<tr><td rowspan="9">Total</td><td rowspan="8">-2</td><td>+2</td><td>Capsicum</td><td rowspan="3">+7</td><td rowspan="8">-2</td><td rowspan="3">SB</td></tr>
<tr><td>+1</td><td>Ocimum</td></tr>
<tr><td>+1</td><td>Solanum melongena</td></tr>
<tr><td>+2</td><td>Eruca Sativa</td><td rowspan="5">+3</td><td rowspan="6">DS</td></tr>
<tr><td>+1</td><td>Jasminum sambac</td></tr>
<tr><td>+1</td><td>Mentha</td></tr>
<tr><td>+1</td><td>salvia</td></tr>
<tr><td>+1</td><td>Solanum</td></tr>
<tr><td colspan="2">12</td><td></td><td colspan="2">12</td></tr>
</table>

6- The application of the tree density protocol in the area irrigated with well water proved the existence of a large number of palm trees dependent on the Well water, with a density of 80%. The research team did not expect a high percentage of densities of trees dependent on the well as it was believed that this water could not be used for irrigation. This result indicates the ability of the palm to resist the high amount of salts, and this explains their abundance in the Arabian Peninsula region and the Kingdom of Saudi Arabia in particular. On the other hand, there were no other agricultural crops on the site, despite the farmers' effort to grow them in the area. The density of trees in the pottery water soil reached a very high rate, reaching (95%), as many crops have experimented with agricultural farmers, which were able to live and grow.

Conclusion and recommendations

The figures and data obtained indicate the presence of implication and indicators of the ability of pottery to positively cause chemical changes on the water properties, which are reflected in the increase in soil fertility and the possibility of cultivating many crops in the same areas of Saline groundwater.

The most prominent and most famous of which are watercress and mint, in addition to vegetable crops such as all kinds of peppers and tomatoes and eggplant, as well as basil and some flowering plants such as rose and jasmine.

Pottery has proven its ability to reduce the amount of salinity in the water from the first day the water is put into the pottery as longer the water remains in pottery. The makes us able to use salt water to irrigate plants and produce agricultural crops that it is impossible to grow with high amounts of salinity, using simple technology as in a pottery experiment.

The application of this study can be generalized to large surfaces of desertified land, and through the passage of saline groundwater into storage tanks coated with clay, it can be converted into the green ground at the lowest costs, and with a high capacity to rationalize the consumption of desalinated water.

At the end of this study, we recommend generalizing the experience of pottery in the afforestation of streets and public gardens by placing a series of pottery bottles to treat saltwater in the area. Thus, we will be able to improve the quality of the soil and plant cover in addition to the possibility of applying the self-irrigation technique that the pottery does through seepage Water and autonomously from pottery to soil. To expand the generalization of this experiment, we recommend lining the salty wells with pottery, and placing pottery tanks in public areas to improve the chemical and physical properties of the water, and thus the surrounding soil, and finally the vegetation cover of the irrigated site with that water.

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We also thank Ms. Abeer Al-Qassem, a professor of science.

Finally, we sincerely thank dr. Ebrahem Saleh, King Saud University in Riyadh for providing an opportunity to use its laboratories to analyze water samples.

Badges

1- Collaborator:
e have prepared this research in a participatory manner in all its procedures and stages, and we have also cooperated with Ms. Najlaa Abdel-Aziz Al-Thumairi, master of information technology, Ms. Abeer Al-Qassem, a professor of science at our school, in addition to cooperating with Ms. Nada Al-Habib, supervisor and researcher in the globe program activities in the office to which our school belongs. On a larger scale, cooperation has been made with dr. Ebrahem Saleh, king saud university, riyadh to benefit from the laboratories they have.

2-

2-Data Scientist
To answer the research questions, we relied entirely on the data that we collected during the conduct of the experiments, analyzing them, comparing them, and then extracting results from them and finally coming out with results that can be generalized, as well as developing future recommendations.

3-Impact
The research in a summary studies a real problem that the local community suffers from, and tries to answer the questions to reach specific results that are expected to lead to actual solutions, and this is what we recommended at the end of this research and we aspire to be able to generalize the proposed solutions and results on the scale of the community and from Then the international for all countries that live the same geography conditions

4-STEM (STEM Professional)
In this research, cooperation was made with a professor of computer science at the school, A. Naglaa Al-Thumairi to supervise the research, as well as a science professor. Abeer Al-Qassem in providing consultations and answering various questions.

5- STEM Storyteller
We shared our experience with many of our school-level colleagues, as well as recording a video and posting it on social media as well as the school's computer on Twitter to reach the largest possible segment of society.

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