GLOBE OMAN

A study entitled/

Reasons for the lack of growth of seasonal crops and the death of perennial trees (palms) in the Al-Araja area in Wadi Al-Jizzi

Done by /

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Reasons for the lack of growth of seasonal crops and the death of perennial trees (palms) in the Al-Araja area in Wadi Al-Jizzi

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Summary:

The research aims to study the reasons for the non-growth of seasonal crops and the death of perennial trees (palms) in the Al-Araj'a area in Wadi Al-Jizzi. The research is based on the experimental method. We studied the properties of the soil in the Al-Araj'a area and another sample was taken 3.5 kilometers further from the Al-Sahila area. Samples were taken from 3 different depths (the surface, 0.5 meter depth, and 1 meter depth), and the pH, soil color, conductivity, salinity, and their properties were examined using the soil protocol. Collaboration was also carried out with Sultan Qaboos University to analyze the components and elements of the soil. A sample of water was taken from the Al-Araj area and examined. pH, conductivity, salinity, transparency, and oxygen percentage using the water protocol. The results were as follows:

Seasonal plants (legumes and grains) do not grow in this soil due to the increase in the percentage of carbon and the percentage of manganese leached into the soil, which negatively affects nitrogen fixation in the soil. The death of perennial plants, such as palm trees, mangoes, and citrus trees, due to an increase in iron, calcium, lead, manganese, and magnesium, as their increase causes poisoning of plants and weakens the walls of plant cells, which negatively affects the processes of plant division and hormonal regulation of plant growth, thus weakening the plant and dying. It has been shown that there is a relationship between landfills and waste dams by changing Soil characteristics and plant death through seepage of landfill waste present in the area at a rate of 8% over time.In addition to the high acidity of the water and the abundance of heavy metals in the water and soil in the Al-Araj area, the Globe Environmental Team sought to search for solutions to treat the problem in cooperation with the concerned authorities and the STEM team. The solutions were by extracting these elements from the soil and treating them chemically and technically to separate the materials and benefit from them to return income. Material for the country. And benefit from it in the medical, agricultural, industrial, and soil provision fields.The recommendations were as follows: First, the competent authorities must conduct intensive and extensive studies between time periods in order to ensure that no violations occur as a result of work on the site, and expand the scope of monitoring wells from three wells to a number of no less than five wells. Second, sampling reports must be prepared every month. Monitoring wells and sending them to the Environment Agency for follow-up. Third, allocate a team by the companies operating the site to follow up on the environmental aspects of the facility and receive reports from residents of neighboring areas to receive any reports from residents. The study also recommends conducting broader studies and research on the impact of these landfills on existing plants and animals. In the area.

Basic terms:

1-Waste dams: They are a special landfill, in an area located between two mountains, designed in the old British way, to get rid of waste resulting from copper smelting operations, in an area located between two mountains.
2-Al-Arja area, Al-Arja is one of the small villages, located in the Wadi Al-Jizzi area, about 240 meters above the ground. It includes an important site containing many traces of the production, extraction and smelting of copper since the Majan civilization.
3-Al-Sahila area: It is one of the small villages, located in the Wadi Al-Jizzi area. It is a fertile village and is famous for growing palm trees.

Research questions:

1-What are the reasons for seasonal legumes such as beans and grains not growing in the Al-Araj area?

2-What are the reasons for the weakness and death of perennial trees such as palm trees in the Al-Araj area?

3-How can the problem be addressed or reduced?

The introduction :

The Al-Araj'a area crosses one of the small villages located in the Wadi Al-Jizzi area, and is about 240 meters above the ground. The sites of this region contain many traces indicating the production, extraction, and smelting of copper since the Majan civilization. Work in these mines continued for a long period of time, including the period of the fifth century AD (Arja - Wikipedia (wikipedia.org))

The widespread availability of copper metal in the Al-Araj area is an important cultural element in its cultural history. Many types of copper sulphate were found in this region, which require great technical skill to melt them. In view of the importance of copper metal, the growth of external demand for it, and its effective contribution to diversifying sources of national income, efforts were intensified to explore for it and increase its reserve stock. This began in the Al-Arja area in 1973 AD, i.e. in the early years of the modern renaissance led by His Majesty Sultan Qaboos bin Said through the Oman Mining Company, which carried out the exploration. In the Al-Aseel, Al-Bayda, and Al-Araj mines in the Wadi Al-Jizzi region (Al-Kindi, 2018). As it is known, the people of the Al-Araj area rely mainly on agriculture to meet their needs, such as growing seasonal plants (beans, grains, and vegetables) and perennial plants such as trees (palms, mangoes, and citrus fruits). The people also focus on raising animals, such as sheep and lambs, that graze on the plains and mountains of the region, but after several years have passed, the people notice the beginning of the weakening and death of perennial trees, accompanied by yellowing of the leaves and poor crop productivity, as well as the appearance of symptoms in the animals, such as weak physical structure despite their continuous grazing in the area, and the appearance of convulsions that accompany death. The sudden. (Al-Jahani, 2018).With reference to previous studies, the study of Hedrick, & Mowry (1952) and the study of (Al-Juhani, 2018) indicated that mining waste and the sharp increase in chemical elements in the soil are among the most important problems facing humanity in the modern era, as the concentrations of pollutant materials increase in the soil and seep into the groundwater and layers of the earth. It mixes with the roots of plants and eventually reaches humans.A study (Abzali and Ghafir, 2015) indicated that the leakage of large quantities of copper and other heavy elements into the ground causes great damage to the roots of plants and causes

paleness of the plants that leads to their death. Accordingly, through field observations and the problems that the people suffer from, and by reviewing the studies. The previous prompt prompted the Globe team to study the problem and answer the questions: What is the reason for the death of seasonal plants and the weak production of perennial plants in the Al-Araj area? There is no treatment or ways to reduce the problem. This requires the application of the soil and water protocol and cooperation with the competent authorities, because this research is important for identifying the problem and solving it in a way that benefits the environment and its residents.

Search Plan :

1-Feeling the problem: Through observing the death of farms and conducting interviews with the people of the area, who confirmed the change in environmental conditions in the Al-Araj area over time.

2-Choosing the research problem: which was identified by me with the help of the people of the region and then discussed with the supervisor of the Globe Environmental Program (Mrs. Mona Al-Badi).

3-Determine study tools: GPS, soil catalog, and a device to measure PH, conductivity, and salinity)

4-Official address: To the Environment Agency, the Ministry of Agriculture, and Sultan Qaboos University to present the project idea and cooperate with them to find solutions and analyze samples.

5-Implementing a meeting: with officials from the Environment Agency, and discussing with them the best proposed solutions and how to reduce the problem.

6-Locating study locations using a GPS device

7-Implementing the Soil, Water, and Vegetation Protocol and entering the data into the GLOBE website. https: //www.globe.gov/

8-Collecting data, analyzing it and converting it to graphs.

9-Extracting results, interpreting them, comparing them to the results of other research, and writing recommendations.

A meeting was held with the GLOBE Environmental Activity Officer, and the research plan and necessary measurements were developed, and the GLOBE program protocols were determined that would be applied to study the problem. Soil samples were also collected from the Al-Araj'a area and from the Al-Sahila area at different sizes of the Earth's surface. Water samples were also collected from the Al-Araj'a area and from the Al-Sahila area. Al-Sahila.

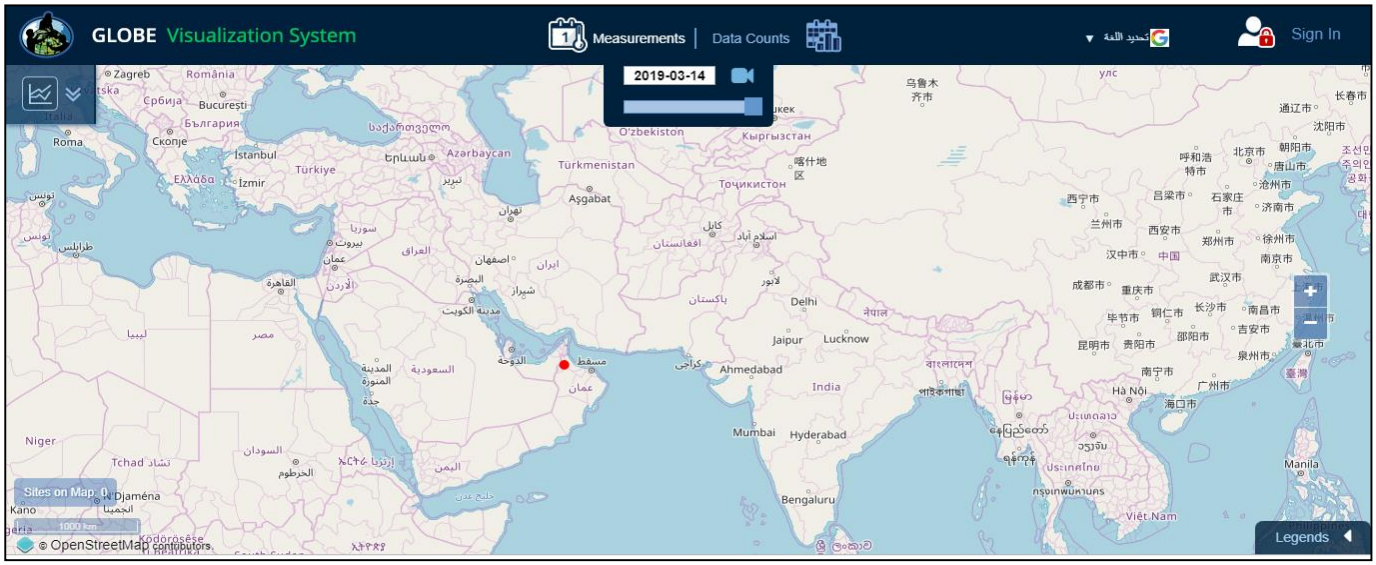
Time plan for preparing the research

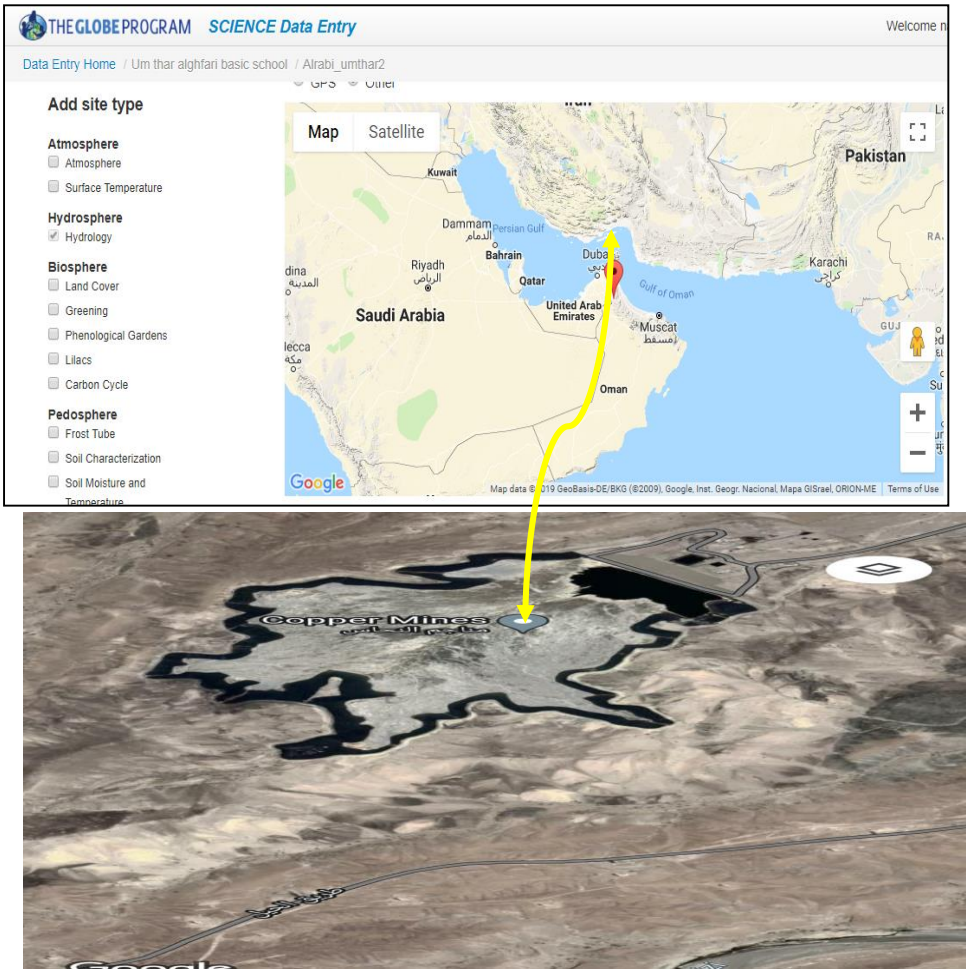
Notes	Implementation officer	the plan	the month
Addressing the authorities concerned with the school's correspondence system	Student/Moza Al Shamsiyya Student/ Aisha Al-Rashidi In cooperation with the team and program supervisor GLOBE	Defining the problem Corresponding to the • Environment Authority of North Al Batinah Governorate Corresponding to the • governorate's Department of Agriculture Correspondence to • Mawarid Mining Company	September

		Providing project tools (providing water and soil protocol tools) • • •	
Providing project tools	Student/Moza Al Shamsiyya Student/ Aisha Al-Rashidi Collaboration with the GLOBE team The Environment Agency and Sultan University	Apply the (soil) protocol in the specified locations Apply the (water) protocol in the specified locations Analysis of water and soil samples at Sultan Qaboos University and some private analysis laboratories	October
Data Entry Meetings with the team	Student/ Aisha Al-Rashidi Collaboration with the GLOBE team The Environment Agency and Sultan University	Entering data into the GLOBE website Cooperating with the competent authorities, developing recommendations, and starting to write the research	November
Summary, introduction and research problem (common application) Student/ Aisha Al-Rashidi, results, analysis, conclusion, and research coordination	Student/ Aisha Al-Rashidi Program supervisor GLOBE	Write your research and prepare to participate in the competition	December

Study site

(Sultanate of Oman, North Al Batinah Governorate), Al Araj'a area (Latitude 24.18.770), (Longitude 56.23.748), (Elevation 273 m)., The (Water, Soil, and Vegetation Cover) protocol was applied.





Data collection and analysis:

To answer the first and second questions:

First: Water samples were collected with the help of Mawarid Mining Company, the Environment Agency team, and the Ministry of Agriculture. Then the water protocol (PH, salinity, conductivity, transparency, oxygen percentage) was studied in the laboratory, and cooperation was also carried out with the competent authorities such as the Lunostar Laboratory (analysis Water samples from different places in the Al-Araj area.

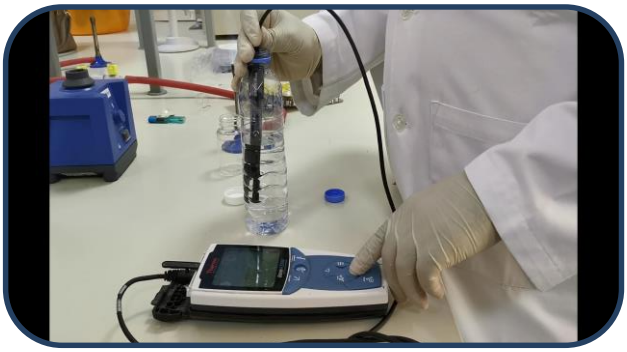
Second: Soil protocol: Soil samples were taken from two locations at a different depth for each sample and their characteristics and components were studied with the help of Sultan Qaboos University in analyzing their components.

The spread of iron and manganese rocks, which are considered waste of copper smelting, was also observed in the third millennium BC, and this indicates the abundance of minerals in the region.

To answer the third question:

First: Vegetation protocol (study of plant types in different places)

The Water Analysis Laboratories Department of the General Directorate of Regional Municipalities and Water Resources was also visited.



Results

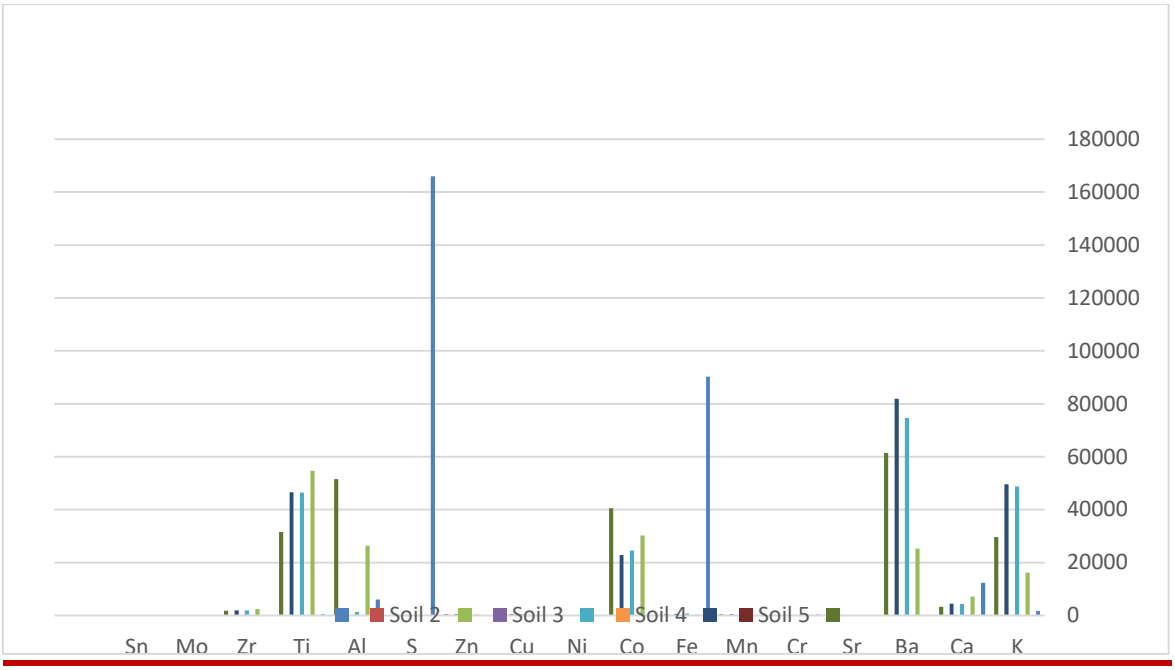
Table 1

Results of soil analysis and study of its chemical components from Sultan Qaboos University from Al Arajah area.

XRF RESULTS in mg/kg									
Soil 1		Soil 2		Soil 3		Soil 4		Soil 5	
K	١٦٤٠	Mg	١٦٢٠٠	Mg	٤٨٨٠٠	Mg	٤٩٦٠٠	Mg	٢٩٦٠٠
Ca	١٢٣٠٠	K	٧١٧٠	K	٤٤٠٠	K	٤٤٣٠	K	٣٢١٠
Ba	ND	Ca	٢٥٣٠٠	Ca	٧٤٦٠٠	Ca	٨١٩٠٠	Ca	٦١٤٠٠
Sr	١٣,٩	Ba	٥١,٩	Ba	٥٨,٢	Ba	٥٦,٤	Ba	٦٢,٧
Cr	٣٧٩	Sr	٧٣,٩	Sr	١٤١	Sr	١٤٠	Sr	٨٣,٥
Mn	ND	Cr	١٥٥	Cr	٤٨٠	Cr	٥٣١	Cr	٤٧٨
Fe	٩٠٢٠٠	Mn	٤٠٤	Mn	٧٥٥	Mn	٦٣٥	Mn	٤١٥
Co	ND	Fe	٣٠٢٠٠	Fe	٢٤٦٠٠	Fe	٢٢٩٠٠	Fe	٤٠٥٠٠
Ni	١٥١	Co	ND	Co	ND	Co	ND	Co	ND
Cu	١٨٤	Ni	٢٢٦	Ni	٤١٧	Ni	٤٢٤	Ni	٣٤٠
Zn	٧٤,٩	Cu	٣٠٨	Cu	٢٧٣	Cu	٤٩٦	Cu	٤٧١
S	١٦٦٠٠٠	Zn	٩١,٩	Zn	٦٣,٧	Zn	٩٥,٨	Zn	١١٥
Al	٦٠٥٠	S	٢٦٤٠٠	S	١٣٠٠	S	٢١٧٠	S	٥١٥٠٠
Ti	٤٦٦	Al	٥٤٧٠٠	Al	٤٦٥٠٠	Al	٤٦٦٠٠	Al	٣١٦٠٠
Zr	٣,٩٥	Ti	٢٤٦٠	Ti	١٩٤٠	Ti	١٩١٠	Ti	١٧٧٠
Mo	٣,٧٢	Zr	٥٦,٢	Zr	٢٣,٦	Zr	٢٧,١	Zr	١٨,٧
Sn	٩,١٥	Mo	٣	Mo	ND	Mo	ND	Mo	ND
		Sn	١١,٣	Sn	٧,٠٤	Sn	٧,١١	Sn	٦,٢٦

Figure 1

A graph showing the results of soil analysis in the Al-Sahila area and the Al-Arja area.



Results:

Table 2

Application of the soil protocol: Samples were taken from the soil of Al-Sahila and the Al-Araj area, and their properties were studied in terms of (soil color, pH, soil quality, conductivity) and other properties, as shown in the following table:

temperature	Soil colour	conductivity	Salinity	PH	Rocks	Fabric	Consistency	structure	sample
38.4	5Y 7/6	0	6 ppm	1.47	a lot	sandy	Fragile soil	Granular	Soil from Al-Araj area
36.2	7.5YR 6/8	0	3 ppm	6.72	middle	sandy muddy	Fragile soil	Granular	The soil is from the Suhaila region

Table 3

The water protocol was applied. A sample was taken from the Al-Araj area and its characteristics were studied, as shown in the following table:

Water sample from the Al-Araj area	
parameter	**Result**
ph	**2.19**
tss	**32**
NH4-N	**0.09**
COD	**41.6**
cond	**38800**
Caco3	**20710**
CL	**8365**
Na	**5025**
Cu	**4800**
Fe	**56600**
K	**288**

Figure 2

Results of water sample analysis from the Al-Araj area.

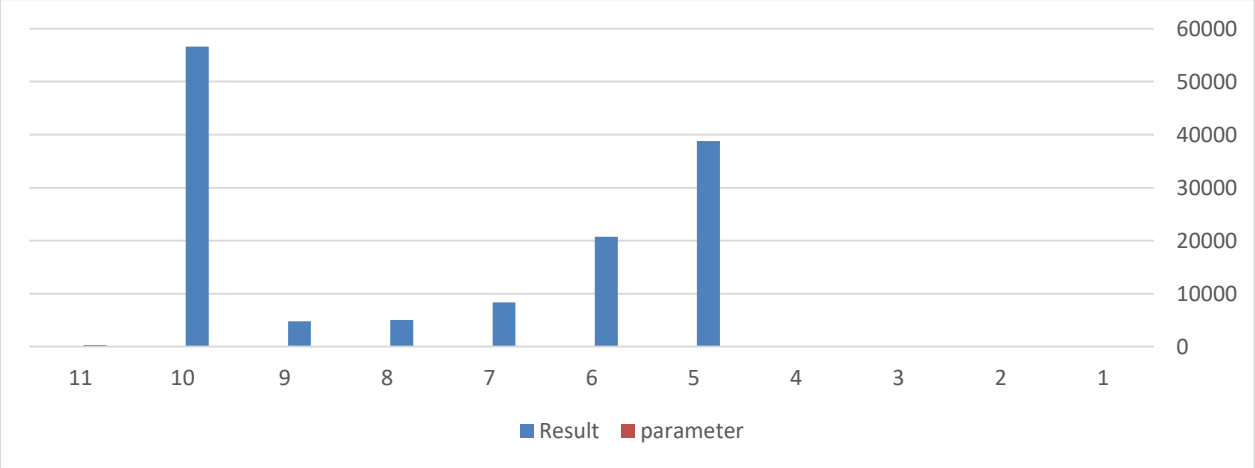


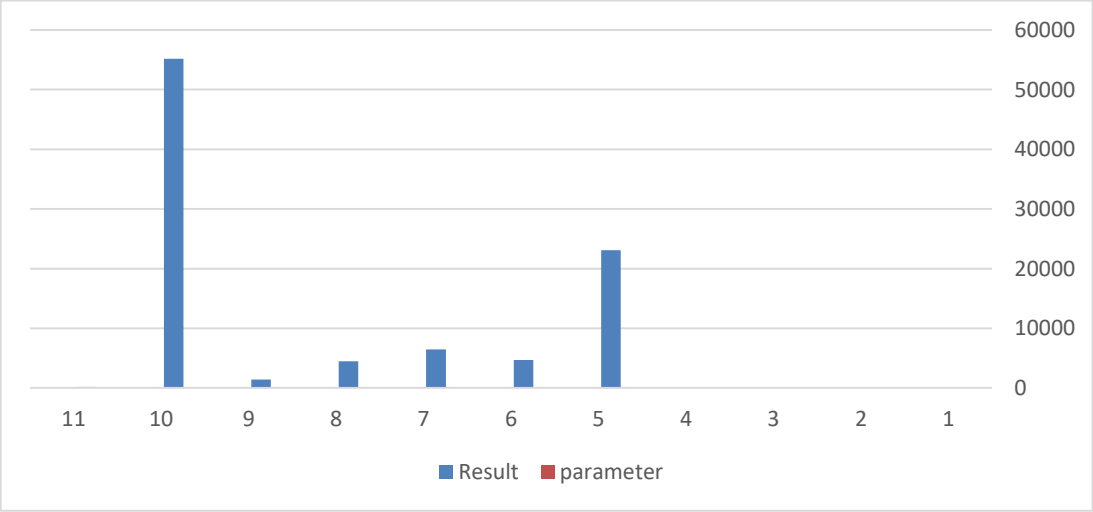
Table 4

The water protocol was applied. A sample of water from the Suhaila area was taken and its characteristics were studied, as shown in the following table

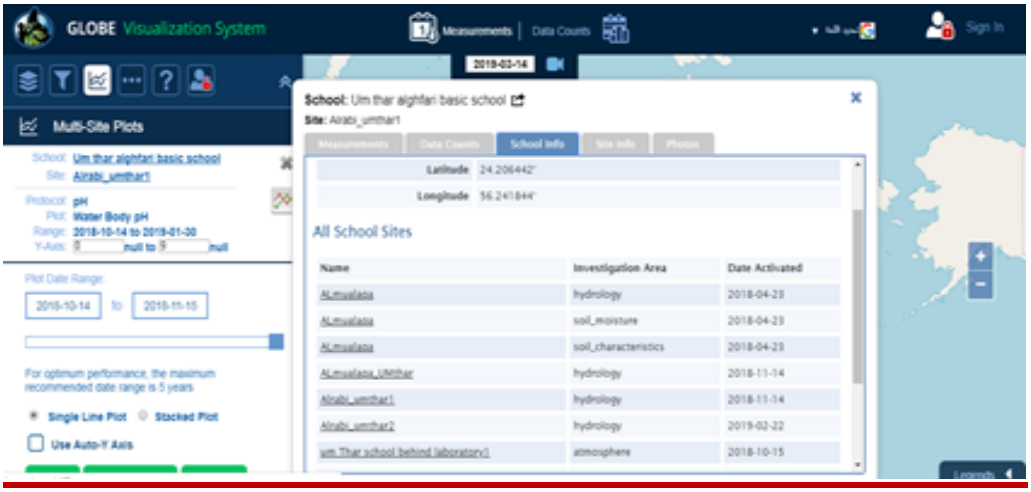
A sample of water from the Suhaila area	
parameter	**Result**
ph	**6.16**
tss	**24**
NH4-N	**0.09**
COD	**41.6**
cond	**23100**
Caco3	**1703**
CL	**1431**
Na	**1448**
Cu	**1390**
Fe	**12200**
K	**77**

Figure 3

A chart showing the results of water sample analysis from the Al-Sahila area



Data were entered and sent to the program website (www.GLOBE.gov) via the DATA ENTRY application, where a new website was added and the water protocol data collected in the research was entered.



Discussing the results:

After obtaining the results, they were presented to officials from the Environment Team, the Agriculture Department, the school's science teachers, the STEM team, and engineer Mohammed Al Shamsi to interpret the results.

To answer the first question: "What are the reasons for seasonal legumes, such as beans and grains, not growing in the soil of the Al-Araj area?" The data of Table No. (1) and Table No. (2) were noted, and it became clear that: the death of seasonal plants (beans and grains) and the reason is the inability of these plants to fix nitrogen in the soil, despite the ability of these plants to fix nitrogen in the soil due to the symbiotic relationship. Among the nitrogen-fixing bacteria that live in the root nodules of legumes. After studying the results of Table (1), it was shown that the manganese element in samples (2-3-4-5) increased in proportions (404-755-635-415), respectively, which are proportions higher than the natural level of the element in the soil (40-60) mg/ kg. Which directly affected nitrogen fixation, and thus the inability of seasonal plants to grow in this soil.

To answer the second question: “What are the reasons for the weakness and death of perennial trees such as palm trees in the Al-Araj area?” The data in Table No. (1) and Table No. (2) were observed, and it was found that: the death of perennial plants (such as palm trees , mangoes and citrus fruits) due to the iron element, its percentage is 56,600 mg/L, which is considered a very high percentage, compared to the permissible limit (5 mg/L), and thus negatively affects the formation of chlorophyll in the plant, and this explains the reason for the yellowing and death of perennial plants, and the element lead was also found in a percentage Less than 0.0.1 mg/L, and therefore it is considered less than the permissible limit of 5 mg/L, which may negatively affect the growth of plant cells. This is what the study (Al-Jahani, 2018) indicates. Manganese appeared at a rate of 356 mg/L in the sample, and the maximum permissible level is 0.2 mg/L, as it is considered a toxic element for a number of crops (palms, mangoes, and citrus fruits) at low concentrations in acidic soil. Calcium appeared at levels (12300-25300-74600). -81900-61400) mg/kg in samples (1-2-3-4-5), which is a very high percentage.Compared to the normal level of its presence in the soil (1400 mg/kg). Magnesium (16200-48800-49600-29600) is mg/kg in samples 2-3-4-5, which is a very high percentage above the normal limit, which is 100 mg/kg. These high levels lead to coagulation and wrinkling of the plant’s leaves, thus affecting the process of photosynthesis. The plant does not find the sufficient amount of food it needs, so it weakens and then dies. Iron appeared in very high levels in each of the samples (1-2-3-4-5) in the following ratios (90200-30200-24600-22900-40500) milligrams/kg. It is higher than the natural limit for the element in the soil (50-100) mg/kg. These high percentages lead to yellowing of the leaves and prevent the absorption of potassium, thus the plant leaves also curl and the plant stops growing.As for zinc, it is considered one of the elements that affect the level of maturity of seeds and stems.

Its natural percentage in the soil is from 1 to 200 mg/kg, and the result of the analysis in samples (1-2-3-4-5) appeared to be (74.9-91.9- 63.7-95.8-115) mg/kg, respectively. (Huang, Shi, &Wang, 2021) and the presence of sulfur in the samples (1-2-3-4-5) is (166000-26400-1300-2170-51500) mg/kg, respectively, compared to the natural level (10-20 milligrams/kg), which leads to a high increase in protein levels in grain crops. Hedrick, &Mowry (1952). As for the nickel element, it appears at very high levels, exceeding the maximum limit for the element in the soil (1-20 mg/kg), as results appeared in the samples (1-2-3-4-5) in proportions

mg/kg. It is considered a heavy metal that negatively (340-424-417-226-15)

affects the processes of plant division and hormonal regulation of plant growth, thus the plant weakens and dies. This is what the study (Al-Jahani, 2018) indicates. An increase in the element copper and it appears above the maximum normal level (2-50 mg/kg) in ratios of (184-308-273-496-471) mg/kg in samples (1-2-3-4-5), which causes these high percentages. There is poisoning of some plants, and its effect may extend for many years. Also, some crops, such as alfalfa, are affected by copper, which may indirectly affect the animals that feed on it. Symptoms of copper poisoning in animals include liver damage, high blood pressure, and cramps in the abdominal area.This explains the people's suffering from the death of sheep and sheep, and the weakness of their physical structure, despite letting them graze on the plains of the region. As for the Sahel region, the soil is sandy and fragile, the Mosulity is 6.72, and the salinity is low, and these percentages are good for the growth of plants. The source of water in the region is a running falaj between the agricultural areas, so there is a lot of cultivation.

Palm trees and other crops in the region. The data of Table No. (3) and Table No. (4) were noted, and it was found that: The presence of copper in the sample in an amount of 4800 mg/L, while the permissible limit is 0.2 mg/L. Which may affect crops, as it is a toxic element to many plants, at a concentration of 0.1-1 mg/L in nutrient solutions, and its effect decreases in alkaline soil. As for the iron element, its percentage is 56,600 mg/L, which is considered a very high percentage compared to the permissible limit (5 mg/L), and therefore, it negatively affects the formation of chlorophyll in the plant. The lead element was also found at a percentage of less than 0.0.1 mg/L, and therefore it is considered less. The permissible limit is 5 mg/L, which may negatively affect the growth of plant cells.Manganese appeared at a rate of 356 mg/L in the sample, and the maximum permissible level is 0.2 mg/L, as it is considered a toxic element for a number of crops at low concentrations in acidic soil. As for the zinc element, the maximum level is 2.0 mg/L, which indicates the presence of a very high percentage in the water. The zinc element affects the work of the necessary enzymes in the plant, and also affects the oxidation of sugars in the plant, and also leads to the burning of the tips of the leaves, and thus the death of the plant. . Based on the soil results in Table No. (1) and Table No. (2), it was found that there was a leakage rate of 8%.

To answer the third question: "How can the problem be addressed or reduced?" The results of the research, and what was reached, were discussed with some of the concerned authorities, such as the Environment Agency, the Ministry of Agriculture, Mawarid Company, and Dr.

Shaher Al-Olayan from (Sultan Qaboos University) to find solutions that serve the environment and the people of the region. The solutions were to treat them chemically and technically to separate the materials and benefit from them to generate income Material for the country. Extracting these elements and benefiting from them in the medical, agricultural, and industrial fields. An agreement was reached with the Environment Agency and Mawarid Company in

Expanding the scope of monitoring wells from three wells to no less than five wells

Preparing sampling reports every month for monitoring wells and sending them to the Environment Agency for follow-up. Allocating a team to follow up on environmental aspects and receiving reports from residents of neighboring areas, to receive any reports from residents, and providing exotic soil, which is adding new soil with the aim of improving soil contaminated with heavy elements, supporting farmers financially and directing them to the correct methods for how to use this soil. In addition to supplying farmers with potable water from desalination plants. The result of the research is identical to the research of (Abzali, Ghafar, 2015).

Conclusion :

In this research, we have tried to identify what are the reasons for the failure of seasonal legumes such as beans and grains to grow in the Al-Araj area, the reasons for the weakness and death of perennial trees such as palms, and how can the problem be treated or reduced? We applied the Globe protocols (soil protocol) and (water protocol) as well as field visits. We found the following: the death of seasonal plants (beans and grains) and the reason is the inability of these plants to fix nitrogen in the soil, despite the ability of these plants to fix

nitrogen in the soil. Soil loss due to the symbiotic relationship between nitrogen-fixing bacteria that live in the root nodules of legumes. In addition to the sharp increase in heavy metals in the soil and water. Through this research, a set of recommendations were developed with the help of the environmental team, the most important of which are:

1-Providing agricultural soil for farmers, providing everything that every farmer in the region needs, and working to eliminate the problem of lack of irrigation water by supplying farmers with safe water from nearby desalination plants.

2-Extracting these elements and processing them chemically and technically to separate the materials, and benefit from them, to return financial income to the state, and benefit from them in the medical, agricultural, and industrial fields.

3-Allocate a team by the companies operating the site to follow up on the environmental aspects of the facility and receive reports from residents of neighboring areas to receive any reports from residents.

We recommend spreading the idea of the research to the Omani community to benefit from it, and communicating the problem to the relevant authorities, so that they can play an effective role in reducing the impact of neighboring areas. The strengths of the research, from my point of view, are the contribution to solving an environmental problem, conserving water, and helping the people of the region to grow agricultural crops better. The research also contributed to developing the cognitive aspect, skills, and research and experimentation strategies to find environmental solutions. We believe that this research is very useful and can contribute to treating a Gulf problem, in general, if officials pay attention and take up the proposals.

Thanks and appreciation

We are pleased to extend our sincere thanks and appreciation to Mr. Ahmed Al Balushi, the National Coordinator of the GLOBE Environmental Program in the Sultanate of Oman, for all the information he provided and to the members of the program's central team, and the program team for maintaining their follow-up and continuous encouragement to prepare and produce the research, in the appropriate manner. STEEM Team

We also extend our thanks to Ms. Nawal Al Shamsi, Director of the Step School, for her cooperation and her role in providing advice and guidance for everything related to the research. And to Ms. Rahma Al-Badi, laboratory specialist at Umm Dhar Al-Ghafari School, for her cooperation with us. And to Mr. Adel Al-Ghaithi, from the Environment Agency, for his cooperation with us in collecting and analyzing data, and to engineer Muhammad Al-Shamsi for his support in contributing to finding solutions to the problem.

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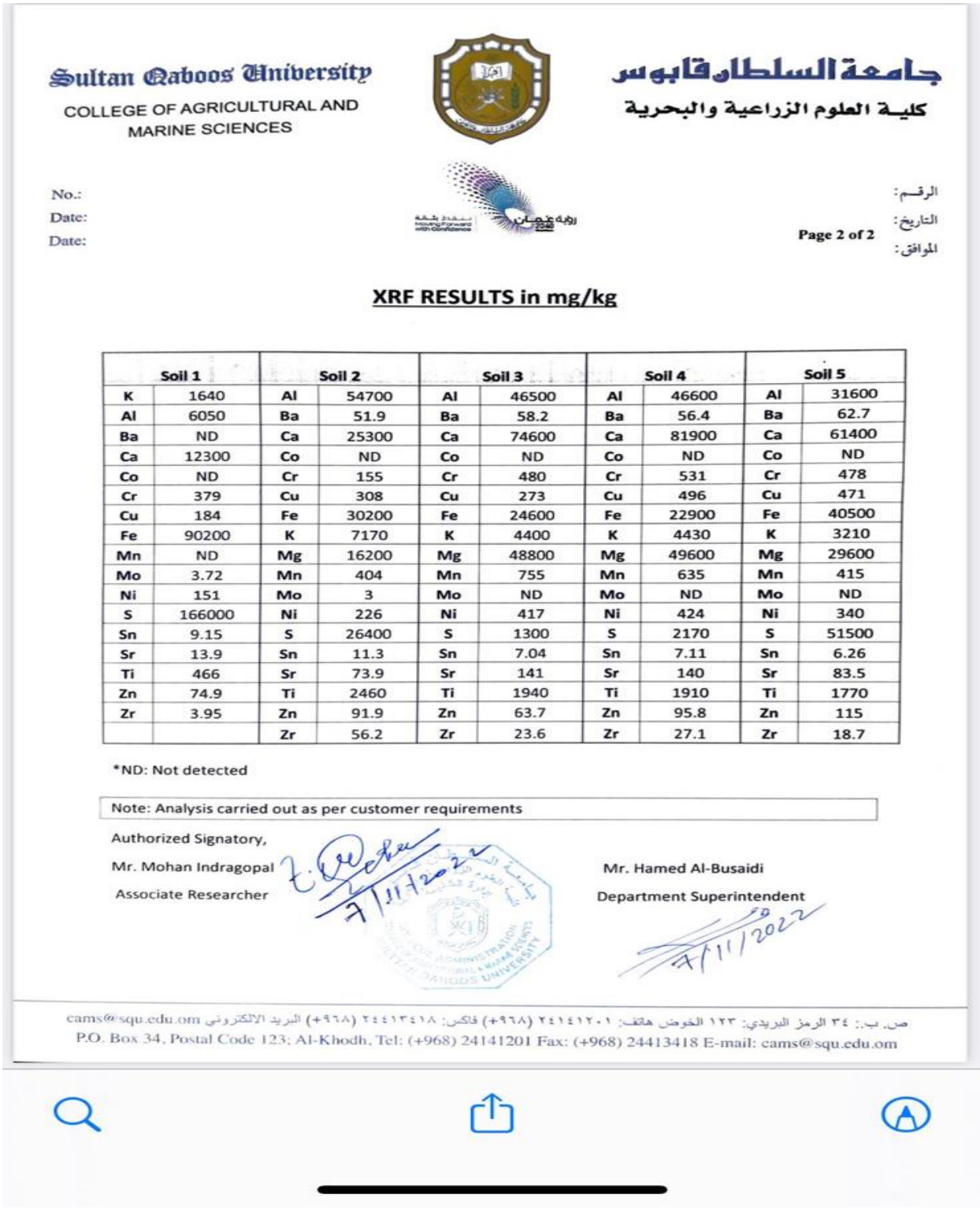
Appendix (1)

Pictures from Al-Araj'a and Al-Sahila areas

Appendix (2)

Soil analysis results from Sultan Qaboos University



Sultan Qaboos University
COLLEGE OF AGRICULTURAL AND MARINE SCIENCES

جامعة السلطان قابوس
كلية العلوم الزراعية والبحرية

No.: الرقم:
Date: التاريخ:
Date: الموافق:

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XRF RESULTS in mg/kg

Soil 1		Soil 2		Soil 3		Soil 4		Soil 5	
K	1640	Al	54700	Al	46500	Al	46600	Al	31600
Al	6050	Ba	51.9	Ba	58.2	Ba	56.4	Ba	62.7
Ba	ND	Ca	25300	Ca	74600	Ca	81900	Ca	61400
Ca	12300	Co	ND	Co	ND	Co	ND	Co	ND
Co	ND	Cr	155	Cr	480	Cr	531	Cr	478
Cr	379	Cu	308	Cu	273	Cu	496	Cu	471
Cu	184	Fe	30200	Fe	24600	Fe	22900	Fe	40500
Fe	90200	K	7170	K	4400	K	4430	K	3210
Mn	ND	Mg	16200	Mg	48800	Mg	49600	Mg	29600
Mo	3.72	Mn	404	Mn	755	Mn	635	Mn	415
Ni	151	Mo	3	Mo	ND	Mo	ND	Mo	ND
S	166000	Ni	226	Ni	417	Ni	424	Ni	340
Sn	9.15	S	26400	S	1300	S	2170	S	51500
Sr	13.9	Sn	11.3	Sn	7.04	Sn	7.11	Sn	6.26
Ti	466	Sr	73.9	Sr	141	Sr	140	Sr	83.5
Zn	74.9	Ti	2460	Ti	1940	Ti	1910	Ti	1770
Zr	3.95	Zn	91.9	Zn	63.7	Zn	95.8	Zn	115
		Zr	56.2	Zr	23.6	Zr	27.1	Zr	18.7

*ND: Not detected

Note: Analysis carried out as per customer requirements

Authorized Signatory,
Mr. Mohan Indragopal
Associate Researcher
7/11/2022

Mr. Hamed Al-Busaidi
Department Superintendent
7/11/2022

ص.ب: ٣٤ الرمز البريدي: ١٢٣ الخوض هاتف: ٢٤١٤١٢٠١ (+٩٦٨) فاكس: ٢٤٤١٣٤١٨ (+٩٦٨) البريد الالكتروني cams@squ.edu.om
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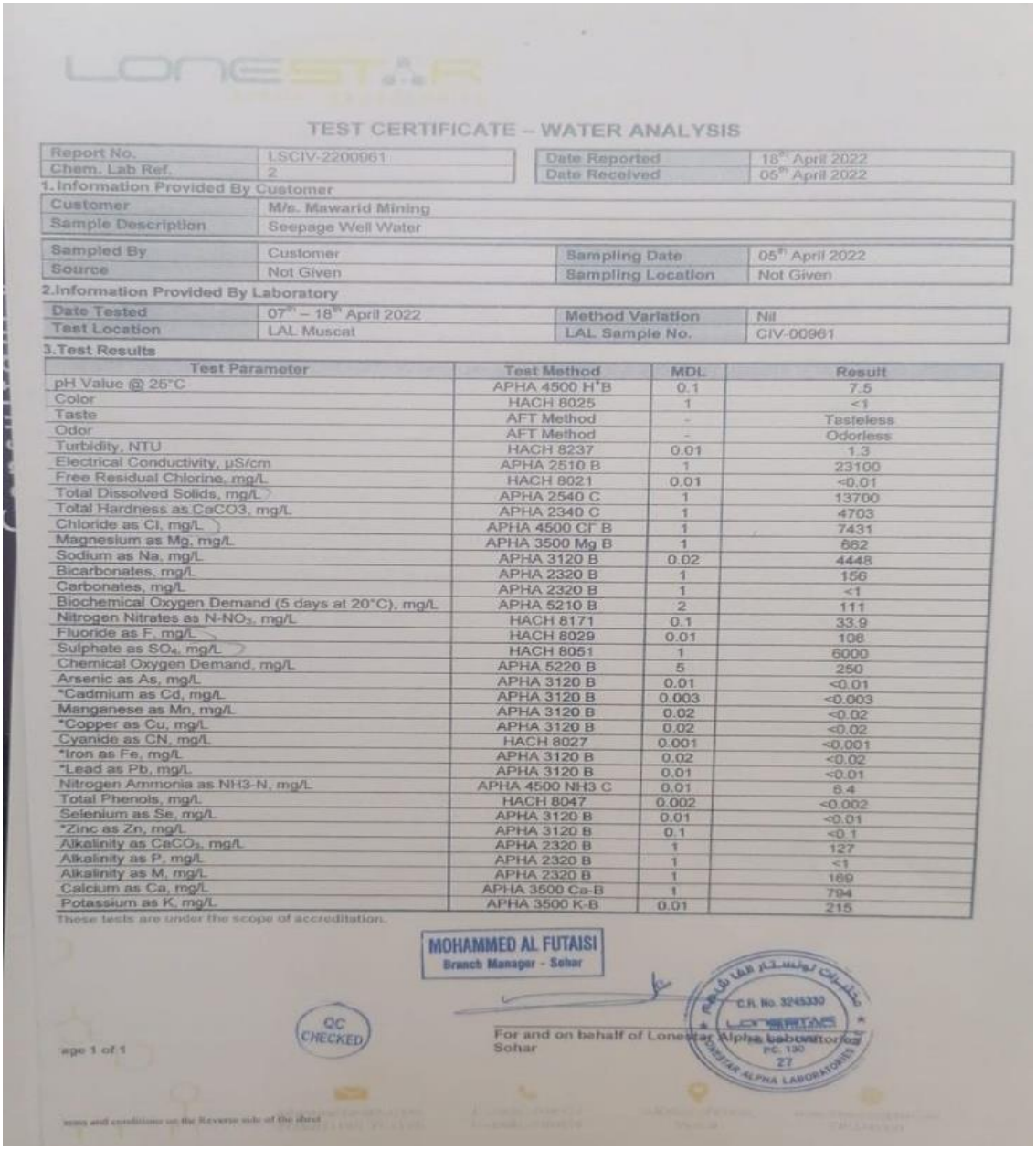
Appendix (3)

Results of the Lunostar laboratory's analysis of the water sample



LONESTAR

TEST CERTIFICATE – WATER ANALYSIS

Report No.	LSCIV-2200961	Date Reported	18th April 2022
Chem. Lab Ref.	2	Date Received	05th April 2022

1. Information Provided By Customer

Customer	M/s. Mawarid Mining		
Sample Description	Seepage Well Water		
Sampled By	Customer	Sampling Date	05th April 2022
Source	Not Given	Sampling Location	Not Given

2. Information Provided By Laboratory

Date Tested	07th – 18th April 2022	Method Variation	Nil
Test Location	LAL Muscat	LAL Sample No.	CIV-00961

3. Test Results

Test Parameter	Test Method	MDL	Result
pH Value @ 25°C	APHA 4500 H+B	0.1	7.5
Color	HACH 8025	1	<1
Taste	AFT Method	-	Tasteless
Odor	AFT Method	-	Odorless
Turbidity, NTU	HACH 8237	0.01	1.3
Electrical Conductivity, µS/cm	APHA 2510 B	1	23100
Free Residual Chlorine, mg/L	HACH 8021	0.01	<0.01
Total Dissolved Solids, mg/L	APHA 2540 C	1	13700
Total Hardness as CaCO3, mg/L	APHA 2340 C	1	4703
Chloride as Cl, mg/L	APHA 4500 Cl- B	1	7431
Magnesium as Mg, mg/L	APHA 3500 Mg B	1	862
Sodium as Na, mg/L	APHA 3120 B	0.02	4448
Bicarbonates, mg/L	APHA 2320 B	1	156
Carbonates, mg/L	APHA 2320 B	1	<1
Biochemical Oxygen Demand (5 days at 20°C), mg/L	APHA 5210 B	2	111
Nitrogen Nitrates as N-NO_3, mg/L	HACH 8171	0.1	33.9
Fluoride as F, mg/L	HACH 8029	0.01	108
Sulphate as SO_4, mg/L	HACH 8051	1	6000
Chemical Oxygen Demand, mg/L	APHA 5220 B	5	250
Arsenic as As, mg/L	APHA 3120 B	0.01	<0.01
*Cadmium as Cd, mg/L	APHA 3120 B	0.003	<0.003
Manganese as Mn, mg/L	APHA 3120 B	0.02	<0.02
*Copper as Cu, mg/L	APHA 3120 B	0.02	<0.02
Cyanide as CN, mg/L	HACH 8027	0.001	<0.001
*Iron as Fe, mg/L	APHA 3120 B	0.02	<0.02
*Lead as Pb, mg/L	APHA 3120 B	0.01	<0.01
Nitrogen Ammonia as NH3-N, mg/L	APHA 4500 NH3 C	0.01	6.4
Total Phenols, mg/L	HACH 8047	0.002	<0.002
Selenium as Se, mg/L	APHA 3120 B	0.01	<0.01
*Zinc as Zn, mg/L	APHA 3120 B	0.1	<0.1
Alkalinity as $CaCO_3$, mg/L	APHA 2320 B	1	127
Alkalinity as P, mg/L	APHA 2320 B	1	<1
Alkalinity as M, mg/L	APHA 2320 B	1	169
Calcium as Ca, mg/L	APHA 3500 Ca-B	1	794
Potassium as K, mg/L	APHA 3500 K-B	0.01	215

These tests are under the scope of accreditation.

MOHAMMED AL FUTAISI
Branch Manager - Sohar

QC CHECKED

C.R. No. 3245330

For and on behalf of Lonestar Alpha Laboratories
Sohar

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