



Directorate of Education in
Musand Abu Bakr Al-Siddiq
School for Basic Education
for Grades 5-9

" The Impact of Climate Change on Vegetation Cover in Khasab Wilayah: A Field Study and a Time Comparison"

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Abstract:

The purpose of this research was to study the impact of climate change on vegetation cover in Khasab Wilayah by answering two main questions:(1) How did climate change affect plants grown in one of Khasab farms? (2) How did it affect the percentage of vegetation cover in the Khalidiya area of Khasab Wilayah?

The study relied on the application of the GLOBE (Land-Water-Soil) protocols in the market railway farm and compared the measurements of March 2018 with the latest measurements in January 2026, in addition to using data and reports from environmental authorities to compare the natural vegetation cover in Khalidiya between 2015 and 2023.

The results on the farm showed a clear decrease in the indicators of planted cover, as the number of trees decreased from 46 to 30 (a decrease \approx 34.78%), and the green grass decreased from 32 to 10 (a decrease \approx 68.75%), with an increase in the "negative" indicators for trees and weeds. The measurements also showed a high pH of irrigation water (8.85), a conductivity of 1320 μ S, and a rise in soil pH to 8.53 (high alkalinity), which explains the weak growth of palms and the decline of some trees.

In Khalidiya, vegetation cover decreased from 0.7% in 2015 to 0.6% in 2023, linked to climatic factors (higher temperature/less erratic rainfall) and human factors (overgrazing, logging, vehicle movement) with the growth of competing plants such as "Elite Eat".

The study recommends managing water resources, regulating grazing, site fencing and enforcing regulations, conducting an environmental study of the "Elite" plant and determining its impact, in addition to measures to mitigate the impact of high temperatures, and continuing periodic monitoring and uploading data on the GLOBE platform to support the environmental decision.

Key Terms:

1 – Climate Change: It is a long-term change (extending for decades or more) in the averages or fluctuations of climate elements such as temperature, precipitation, wind, humidity, and the frequency of extreme events.

2 - Vegetation: It is the total vegetation that covers the surface of an area (natural or cultivated), including its types, distribution, density, height, and structure (trees, shrubs, grasses...), expressed in the field or via remote sensing as an indicator of how well the Earth is covered by vegetation.³ Global warming, also known as global warming, is the continuous increase in the average temperature of the Earth's surface air as a result of the accumulation of greenhouse gases in the atmosphere, such as carbon dioxide, methane and some other gases. These gases trap heat emitted from the Earth's surface, leading to higher global temperatures.

Research Questions

The research sought to answer the following two questions:

1 - How did climate changes affect the number of plants in one of the Khasab Wilayah Farms?

2-How did climate changes affect the percentage of vegetation cover in the Khalidiya area in Khasab Wilayah?

Scientific hypothesis:

We assume that climate changes such as high temperatures, lack of rainfall, and irregular timings have led to a decrease in vegetation cover in Khasab Wilayah, as well as an increase in the salinity of groundwater irrigation water, as well as a rise in soil alkalinity and deterioration of its fertility.

This hypothesis has been observed from the application of the protocol of vegetation, water and soil in several sites in the Wilayah of Khasab from 2017 until 2026 AD

Introduction and Literature Review:

Vegetation is one of the most important components of onshore ecosystems, as it is directly linked to the carbon and water cycle, protecting soils from erosion, supporting biodiversity, and providing environmental and economic services such as grazing, agriculture, and desertification reduction. This component is increasingly important in arid and semi-arid environments—including large parts of the Arabian Peninsula—where water resources are already limited, and plants become more sensitive to any change in temperature or precipitation.

Climate change is scientifically defined as long-term (over decades or more) changes in the averages or fluctuations of climate elements, such as heat, rainfall, frequency of heat waves and droughts, as a result of natural and human factors, with the impact of increased greenhouse gases predominantly in the modern era. International scientific literature and reports confirm that rising temperatures, increasing droughts, and extreme precipitation pose growing risks to terrestrial systems and services, including plant productivity and habitat stability.

The problem with this research stems from the fact that the impact of climate change on vegetation cover is not limited to the direct effect (heat stress and water scarcity), but extends to a series of overlapping effects that ultimately lead to a decline in vegetation cover and poor ecosystem function. On the one hand, rising heat and precipitation disturbance lead to increased evaporation and transpiration and exacerbation of water deficits, which is often the decisive factor in dry environments, reducing plant

growth and productivity and limiting its ability to regenerate. On the other hand, it contributes These changes in soil degradation through mechanisms such as erosion and erosion with severe storms, reduced soil moisture and organic matter, and soil salinization and deterioration of its structure, which reduce soil fertility and its ability to retain water, reducing the soil's ability to support vegetation. In addition, water resources are affected in terms of quantity and quality, as water temperatures rise, some quality indicators change, and the concentration of salts in drought conditions and high evaporation may increase, which exacerbates salt stress and imposters germination and growth in susceptible plants.

The literature also indicates the importance of remote sensing in tracking vegetation changes spatially and temporally, through "green" indicators such as NDVI, which enable the monitoring of long-term trends of improvement or decline, while supporting them with field verification, especially in dry environments where the effect of soil brightness, terrain, and cover dispersion interfere. Therefore, this research relies on an integrative perspective that links climate and vegetation cover through a clear causal pathway: Climate change (higher temperature + drought/rainfall fluctuation + event extremes) → Plant water pressure + soil degradation + change in water properties → Decreased growth and regenerative capacity → Decrease in vegetation cover. The research also takes into account that this relationship may be overlapped by non-climatic factors (e.g., overgrazing, urbanization, and logging), which necessitates a distinction between the climatic signal and the impact of human land use when interpreting the results and making recommendations.

Research Methods:

Research Methods

1- Research Plan

- Schedule the research plan

Action Plan	The month
Formulate a research problem and identify tools	November 2025
Data Collection	December 2025
Coming to conclusions and writing the research	January 2026
Submission of the research	January 2026

Table (1) Research Plan Timeline

- Distribution of work roles to the research team

Taliban Executors	Work
Mohamed Suhaib & Hamad Abdulrahim	Formulating the research problem
Mohamed Suhaib & Hamad Abdulrahim	Data collection, implementation of protocols inside and outside the school, and data entry on the site.
Mohamed Suhaib & Hamad Abdulrahim	Coming to conclusions and writing the research

Table (2) Distribution of Roles to the Research Team

Identify and review some sources that are relevant to the research topic, such as references or the World Wide Web (Internet) as well as GLOBE protocol notes.

- Selecting the different locations for the study in preparation for data collection and the application of protocols

Work	Location
Application of vegetation protocol and counting the number of trees and weeds	Khalidiya area in Khasab province
Applying vegetation, soil, and water protocols and counting the number of trees on the farm	One of the farms of Khasab province

Table (3) Locations for the application of the research plan

- Identify appropriate protocols for data collection

Appropriate protocol	Work
Ground Cover Protocol	Study the number and type of trees and weeds in the Khalidiya region
Water, Soil and Ground Cover Protocol	Study of the properties of plants, water and soil in one of the farms of Khasab province

Table (4) Protocols Applied in the Research

- Tools used in the application of protocols:

**GPS Device - 50 Meter Metric Tape - Shade Density Meter - Slope Angle Meter
Salinity and Water Conductivity Meter - pH Meter**

- Sampling work sites at appropriate times and according to the specifications of the applicable protocols.
- Collect data and organize it in tables as will come later .
- Data entry in the program website (www.GLOBE.gov)
- Data analysis and graphical representation .
- Coordination of a visit to the Department of Environment in Musandam Governorate
- Reaching conclusions and recommendations.

2- Study Location: The plan of this research was carried out in Khasab Wilayat – Musandam Governorate – Sultanate of Oman in two different locations: The first site: Market Railway Farm (one of the farms of Khasab Province).

At these coordinates:

North: 26.112578 East: 56.144544 Elevation: 3m

Second location:

Khalidiya area in Khasab Wilayat Musandam

Governorate at these coordinates:

North: 26.228674 East: 56.215864 Elevation: 163m.

3- Data collection and analysis:

Measurements were taken for vegetation, soil and water in one

of the farms of Khasab province on January 20, 2026 to compare these data with the data measured for the same farm on March 20, 2018 to find out how the farm's plants were negatively or positively affected by climate changes.

Photos (1, 2, 3 and 4) Application of vegetation, soil and water protocols for the site of the market railway farm in Khasab province





As for the Khalidiya area in Khasab Wilayah (the second site), the Department of Environment in Khasab Wilayah was contacted to obtain the necessary data to compare the percentage of vegetation cover in the mentioned area between 2015 and 2023 to find out how climate changes have affected the percentage of vegetation cover in the region.

Important note: The Khalidiya area is a natural vegetation area and is considered a local park and is predominantly samar and Ghaf trees and some grasses.

Results:

First: To answer the first question and how climate changes have affected the plants grown in one of the farms of Khasab Wilayah, and to make a comparison between the farm measurements in 2028 and the modern measurements in

THE GLOBE PROGRAM | إدخال البيانات | Mostafa Ahmad

علم الإحصاء الحيوي تحرير

Measured on date: 2026-01-20

خبر إلى المقياس أو المثل الصغرى

Biometry

Canopy cover		الغطاء الأرضي	
Canopy Type	Canopy Observations	Ground Type	Ground Observations
نار الصبرة	30	الأحمر (G)	10
خيزر (T)	30	الخط (GD)	0
الضفد	0	الخيزر (B)	0
خيزر (SB)	0	النباتات ذات الأوراق العريضة	0
مجموع ** المثلثات	60	خيزر العري	0
		مجموع ** المثلثات	60
		خيزر (SB)	0
		الخيزرات الصغرى (DS)	0
غطاء شجري	غطاء شجيرة مستقيمة		
مجموع ** المثلثات	30	مجموع ** المثلثات	20
	30		20

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Measured on date: 2026-01-20

خبر إلى المقياس أو المثل الصغرى

Biometry

Canopy cover		الغطاء الأرضي	
Canopy Type	Canopy Observations	Ground Type	Ground Observations
نار الصبرة	40	الأحمر (G)	32
خيزر (T)	40	الخط (GD)	0
الضفد	0	الخيزر (B)	0
خيزر (SB)	0	النباتات ذات الأوراق العريضة	0
مجموع ** المثلثات	52	خيزر العري	0
		مجموع ** المثلثات	40
		خيزر (SB)	0
		الخيزرات الصغرى (DS)	0
غطاء شجري	غطاء شجيرة مستقيمة		
مجموع ** المثلثات	52	مجموع ** المثلثات	40
	52		40

January 2026, where water, soil and vegetation cover protocols were applied to the farm components.

Figures (5) and (6) are examples of data uploads
 www.GLOBBE.gov where new sites were added and data collected from the
 research sites
 of the Market Rail Farm in 2018 and 2026 were entered

Sum of the negatives of the trees	Total Negative for Weeds	Green Grass	Number of Trees	Date of Measurement
52	40	32	46	20Mar 2018
60	60	10	30	20 January 2026

Table (5) Comparison of Ground Cover Protocol Measurements in 2018 and 2026

Acidity (pH)	Salinization (ppm)	Conductivity MicroSiemens	Temperature (Favorable)	Transparency (cm)	Date of Measurement
8.85	8.46	1320	22	67	20 /1/2026

Table (6) Results of Water Protocol Measurements on the Farm Irrigation Water Source

Harmony	Acidity	Temperature (Warm)	Date of Measurement
Sandy mud	8.53	22.5	20 /2/2026

Table (7) Results of measurements of some elements of soil protocol (for farm soil)

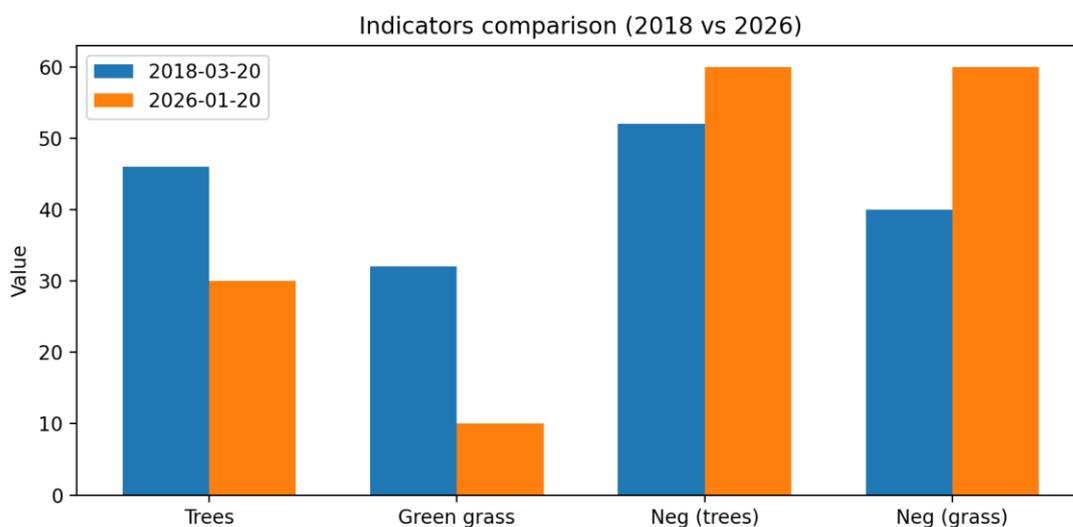
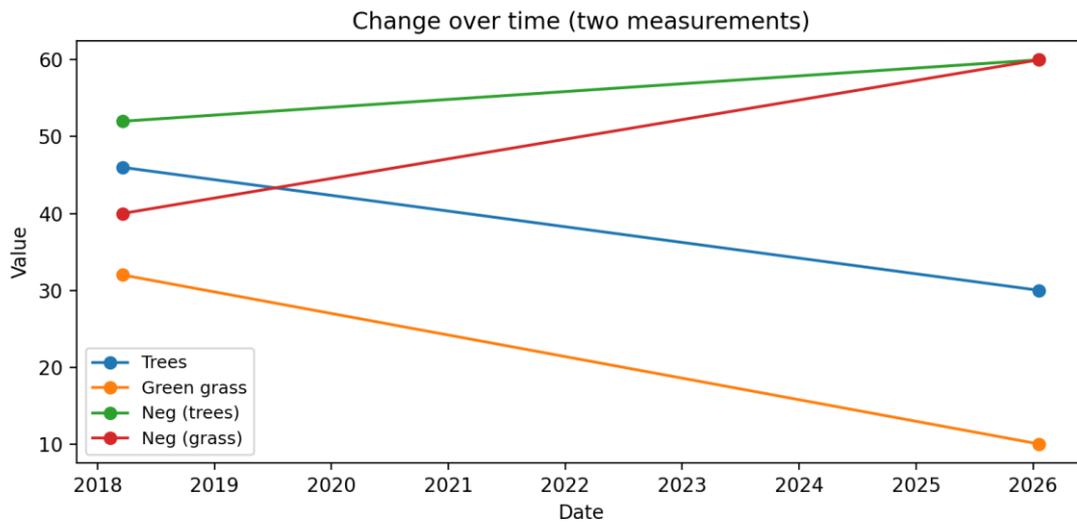


Chart (1) to compare farm land cover measurements between 2018 and 2026)



Graph (2) shows how the measurements of the number of trees and grasses per farm have changed between 2018 and 2026

Second: To answer the second question related to the impact of climate change on the percentage of climate cover in the Khalidiya area in the Wilayah of Khasab, we addressed the officials of the Environment Department in Musandam Governorate as well as the Environment Center in Dibba in the governorate and reviewed the reports on the percentage of vegetation cover in the region between (2015 and 2023).

We obtained the following results:

Vegetation cover decreased from 0.7% in 2015 to 0.6% in 2023

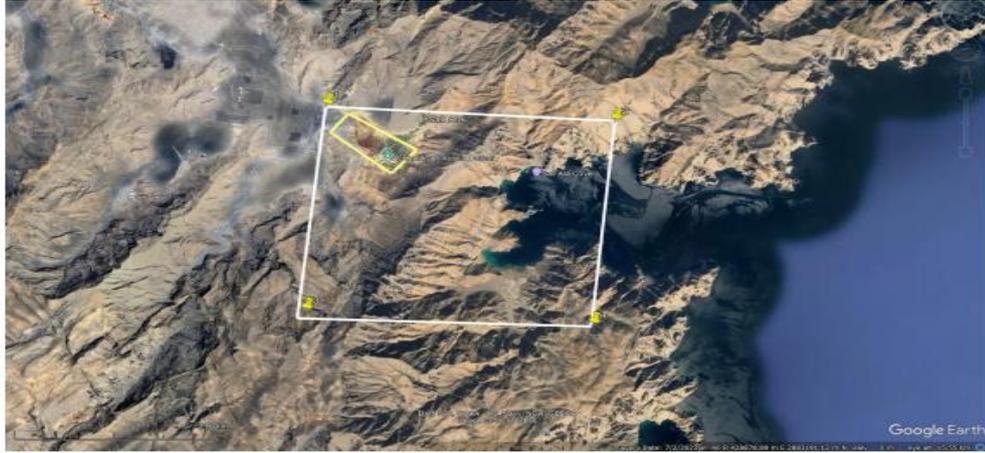
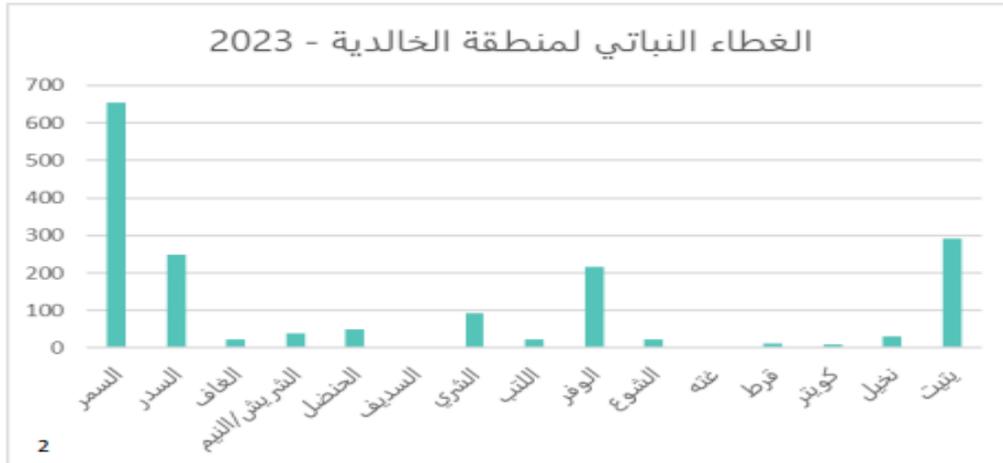
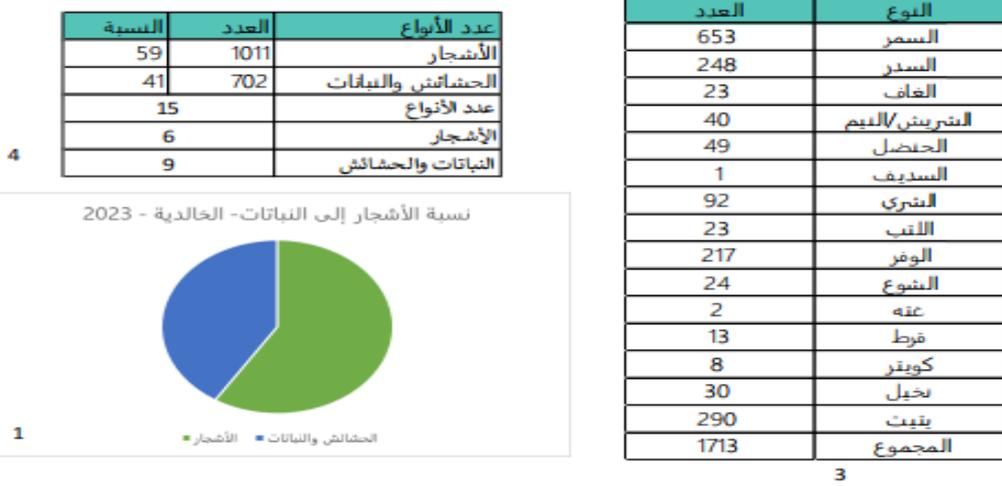


Figure (7) The Khalidiya area under study is defined by the vegetation cover in the yellow rectangle



جدول (3) و (4) حصر أنواع النباتات والغطاء النباتي في منطقة الخالدية - 2023م، بياني رقم (1) و (2) إحصائيات المسح 2023م. (2)

Photo (8) Distribution of vegetation cover in the Khalidiya region in 2023

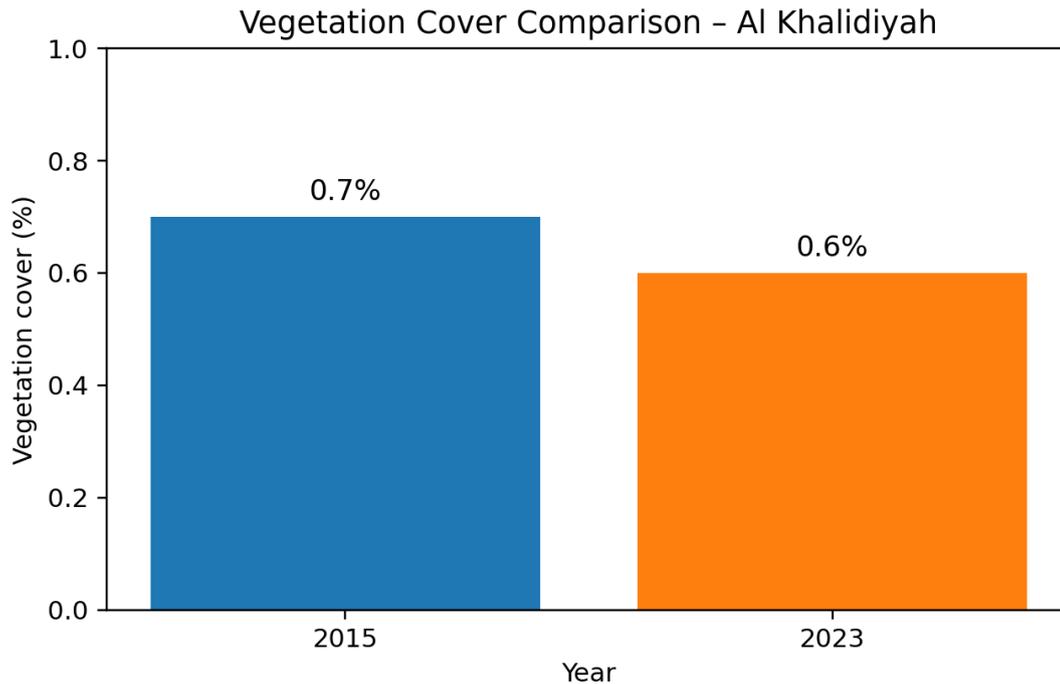


Chart (3) Comparison of vegetation cover percentage between (2018 and 2023)

Discussion of the results:

To answer the first question: How did climate change affect the vegetation cover in one of the farms of Khasab Wilayah?

The results collected from the first site (Market Railway Farm) with the application of water, soil and vegetation protocols between 2018 and 2026 showed a significant decrease in the number of farm trees (palm trees) for comparison between 2018 and 2026

**Number of Trees: Decreased from 46 to 30
Difference = -16 Trees (decrease \approx 34.78%)**

**Green Grass: Down from 32 to 10
Difference = -22 (down \approx 68.75%)**

**Total negative for trees: Increased from 52 to 60
Difference = +8 (\approx rise 15.38%)**

**Negative Sum of Weeds: Increased from 40 to 60
Difference = +20 (High = 50%)**

These results are consistent with the scientific hypothesis that climate change has led to a decrease in the percentage of vegetation cover in cultivated lands in recent years.

As we can see from the results (Table 7) the high alkalinity of the soil, which reached (8.53), which is a very high percentage, according to reference No. (2) in the reference list, this value of soil alkalinity

leads to the risk of failure of the growth of palm trees, and this was observed on the farm trees, where the farm lost approximately 40% of its palm trees.

To answer the second question: How did climate changes affect the percentage of vegetation cover in the Khalidiya area in Khasab Wilayah?

Second: To answer the second question related to the impact of climate change on the percentage of climate cover in the Khalidiya area in the Wilayah of Khasab, we addressed the officials of the Environment Department in Musandam Governorate as well as the Environment Center in Dibba in the governorate and reviewed the reports on the percentage of vegetation cover in the region between (2015 and 2023).

We obtained the following results:

The percentage of vegetation cover decreased from 0.7% in 2015 to 0.6% in 2023
Chart No. (3)

and we reached the reasons for this decline as follows:

First: Climatic changes such as high temperature, lack of rainfall, and irregular rainfall periods, which lead to severe soil stress and the growth of elite grasses and its scientific name (*Vicoa divaricate*), which are herbs that compete for water and food and have no pastoral benefit.

Second: Human activities: such as overgrazing, loose animals, logging, and the movement of cars within the vegetation.

The bottom line:

This research dealt with the impact of climate change and its associated environmental pressures on vegetation cover in Khasab Wilayah, by integrating field monitoring according to the protocols of the GLOBE program with the temporal comparison of vegetation cover indicators. The study aimed to understand the trend of change in vegetation cover at two levels: (1) the cover planted in an agricultural site (the market railway farm), and (2) the natural vegetation cover in the Khalidiyah region, using comparative data between 2015 and 2023 to determine whether there is a decline in the The percentage of cover and what are the most related environmental factors (high temperature, fluctuation of rainfall, deterioration of soil and water properties, in addition to some human factors).

The farm recorded a significant decline in the indicators of planted cover between the 2018 and 2026 measurements, which included a decrease in the number of trees, a decline in green grass, and a rise in the indicators of theSALB.

Field measurements showed an increase in soil alkalinity and irrigation water, which may explain the poor nutrient absorption of palms and the deterioration of plant vitality, especially when combined with drought and heat conditions.

In the Khalidiya region, the vegetation cover decreased from 0.7% (2015) to 0.6% (2023), indicating a slight decline, with the possibility of overlapping climatic and human factors (overgrazing/logging/vehicle movement) in explaining the general trend.

Recommendations:

Strengthen the periodic monitoring of local climate indicators (temperature, rainfall, humidity) and link them temporally to vegetation indicators and field measurements to ensure a more accurate causal explanation.

Manage irrigation water by regularly monitoring pH and EC electrical conductivity, and improve irrigation efficiency (drip irrigation, temperature scheduling) to reduce water and salt stress on palms.

Improving soil properties in agricultural sites by increasing organic matter (compost/decomposing compost) and improving drainage, with periodic soil/water analysis to determine alkalinity, sodicity and salinity.

Support the palm nutrition program with microelements (such as iron, zinc and manganese) according to the results of the analyses, because the high alkalinity reduces the availability of these elements and is reflected in the growth and production.

Protecting the natural cover sites in Khalidiya by regulating grazing, reducing wood logging, preventing the entry of vehicles into sensitive areas, while setting up signs, specific routes, and applying environmental regulations.

Carry out an environmental study on the spread of competing plants/herbs (e.g. Elite) to determine their role as an indicator of changing soil/water conditions or as a crowding factor for native species, and identify appropriate management mechanisms..

Repeat measurements seasonally (winter/summer) to reduce the impact of seasonal fluctuations and improve the reliability of results, while engaging students in monitoring and building environmental awareness.

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