

“Investigate The Percentage of Forests out of The Total Land Area in Dhofar Governorate”

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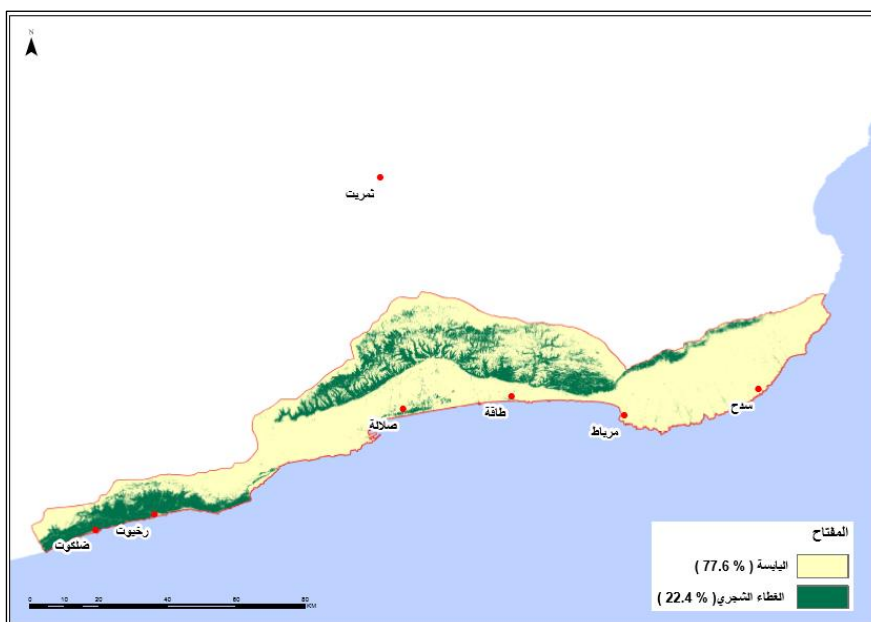
1. Abstract:

This study is a survey study aimed to investigate the percentage of forests out of the total land area in Dhofar Governorate. It took approximately 10 months during which 33 sites were surveyed as representative samples of the diverse geographical nature in Dhofar. The sites were inspected and studied, then the area of all trees present within the field survey sites was calculated and compared mathematically to the land area. The study concluded that the percentage of forests in Dhofar is approximately 4.73%, which represents approximately 464,722 hectares of the total area of Dhofar, this study can be considered as a scientific contribution to understanding and monitoring the change in forest cover in Dhofar and also to evaluate the desertification in Dhofar.

Keywords: Forest, Vegetation cover, Desertification, Plant species, Overgrazing, Dhofar, Oman.

2. Introduction:

The Dhofar mountains forms a botanical treasure in the arabian peninsula, as having a rich and distinctive diversity of plant species. Dhofar also has a cloud forest habitat, where there are trees that intercept moisture of the fog formed as a result of the annual summer monsoon which is locally called the Khareef season (Horisk, 2023). The annual monsoon created a wealthy ecosystem, with high diversity of plant species, blooming flora and desirable climate (Ramadan, 2021). Unfortunately, desertification has appeared in Dhofar, represented by a decrease in forests, vegetation cover and agricultural crops. As a result, the mountains lost a large number of local plants the thing that led to a decline in the forest areas and increase in soil erosion. In addition to obvious decrease in biomass and wood mass. The great risk of desertification in Dhofar is caused by multiple factors, but the most dangerous factor is the large increase in livestock numbers and the resulting overgrazing (Ghazanfar, 1998). especially the large-bodies livestock, such as cattle and camels as they can significantly affect the composition, Phyto-morphology and structure of semi-arid plant species (Ball, 2020). Urban expansion in Dhofar Mountains region is also one of the critical factors responsible for the desertification and the decline of vegetation cover (Ghazanfar, 1998). In addition, the presence of some invasive plant species that affect the health and presence of forests in Dhofar, such as Parthenium hysterophorus which considered as extremely harmful invasive weed (Shammas, 2021). And the invasion of Prosopis juliflora which is another invasive plant species that significantly threatens the local plants population (Al-Wardy, 2021). Moreover, agricultural pests are a serious threat to the vegetation and forest cover in Dhofar. Batocera rufomaculata (citation) is the most dangerous pest to plants in Dhofar at the time (Ambrus, 2012). Furthermore, It worths mentioning that the climate changes which the region as well as, the entire world are experiencing represented in high temperatures and low rainfall rates have an active role in vegetation and forest degradation (Ramadan, 2021). The endangered plants in the Sultanate of Oman represent 4.6% of the total plant species present, and unfortunately 80% of them are found in the Dhofar Governorate (Ghazanfar, 1998). The serious issue of forests deterioration in Dhofar requires a rapid and effective intervention, especially that the main causes can be controlled by humans.



3.Methodology

The specialists in the information technology department in environment authority published a map resulted from the analysis of satellite images in 2021, the map in figure 1 shows a general statistic for percentage of land (77.6%) and percentage of vegetation cover (22.4%). Stating from this map, a surveying study for the percentage of forests in the total land area in Dhofar started. A field survey was done to the area, defining 11 main squares with an area of 1 hectare, then select 3 sub-squares in each main square with an area of 100 m². Total of 33 sub-squares were selected as representative samples. The locations were chosen based on how representative they were to the nature of vegetation and forest cover in each targeted region. In this study, inclusiveness of the variety of landscapes and environments in Dhofar was considered, as the 11 squares were selected carefully so the study covers mountains, wadies and plains. The areas with high existence of forests were selected based on the definition of forest which is the land of more than 0.5 ha, with a tree canopy cover more than 10%” (FAO, 2020). The field survey was carried out by surveying the targeted squares and collecting data regarding the quantity and species of trees. Also, the trees canopy was measured to calculate the percentage of forests in each square. The field survey data are shown in table 1, where SQ symbolizes the main squares.

Table1 : Data of the field survey.

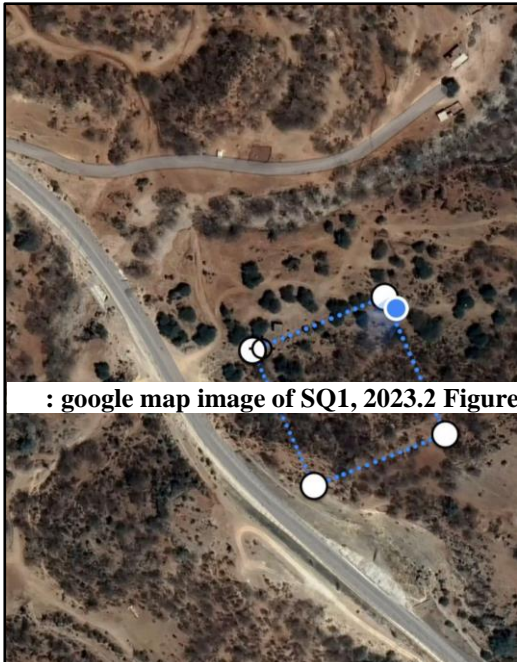
SQ1 Hasheer- Mirbat Coordinates: 17°03'51.5''N 54°36'13.2''E 17°03'48.7''N 54°36'14.8''E 17°03'49.5''N 54°36'17.9''E 17°03'52.6''N 54°36'16.9''E	 <p style="text-align: center;">: google map image of SQ1, 2023.2 Figure</p>
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Figure 3: image of SQ1 taken by a drone with sub-squares distribution diagram, 2023.

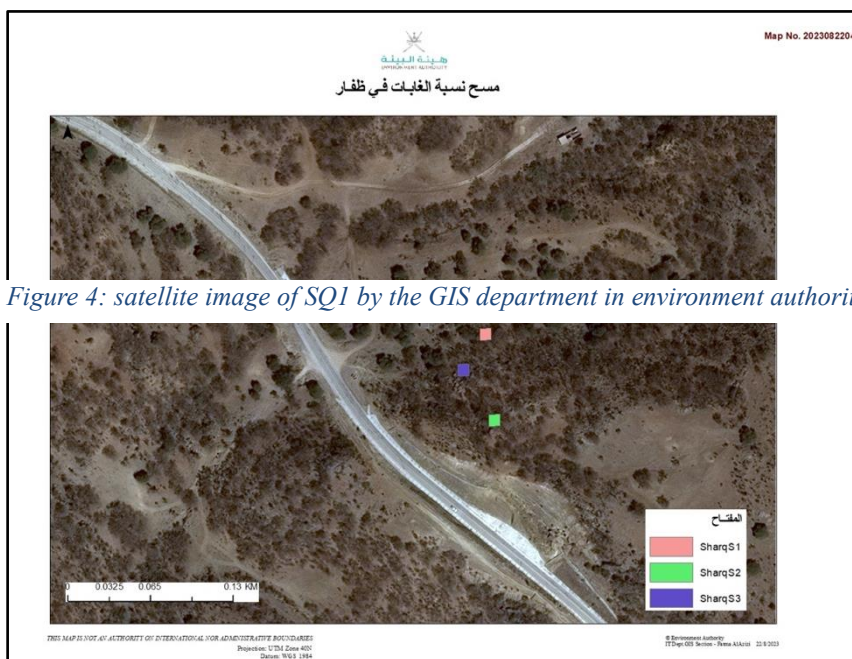


Figure 4: satellite image of SQ1 by the GIS department in environment authority, 2023.

Sub-squares	Coordinates	Date	Quantity and Species of Trees
1	17°03'51.5"N 54°36'15.9"E 17°03'51.8"N 54°36'15.9"E 17°03'51.8"N 54°36'15.6"E 17°03'51.5"N 54°36'15.6"E	Jun 2023	7 Anogeissus dhofarica. 1 Commiphora habessinica
2	17°03'49.3"N 54°36'16.1"E 17°03'49.6"N 54°36'16.1"E 17°03'49.6"N 54°36'15.8"E 17°03'49.3"N 54°36'15.8"E	Jun 2023	5 Anogeissus dhofarica.
3	17°03'50.6"N 54°36'15.3"E 17°03'50.9"N 54°36'15.3"E 17°03'50.9"N 54°36'15.0"E 17°03'50.6"N 54°36'15.0"E	Jun 2023	1 Anogeissus dhofarica. 1 Commiphora habessinica. 1 Commiphora gileadansis. 3 Belepharispermum hirtum.

1 Maytenus dhofarensis.

SQ2

Yasmeen mountain- Salalah

Coordinates:

17°12'02.3"N 54°06'09.8"E

17°12'03.9"N 54°06'10.4"E

17°12'06.0"N 54°06'07.9"E

17°12'03.6"N 54°06'06.3"E



5: google map image of SQ2, 2023. Figure



Figure 6: image of SQ2 taken by a drone with sub-squares distribution diagram, 2023.

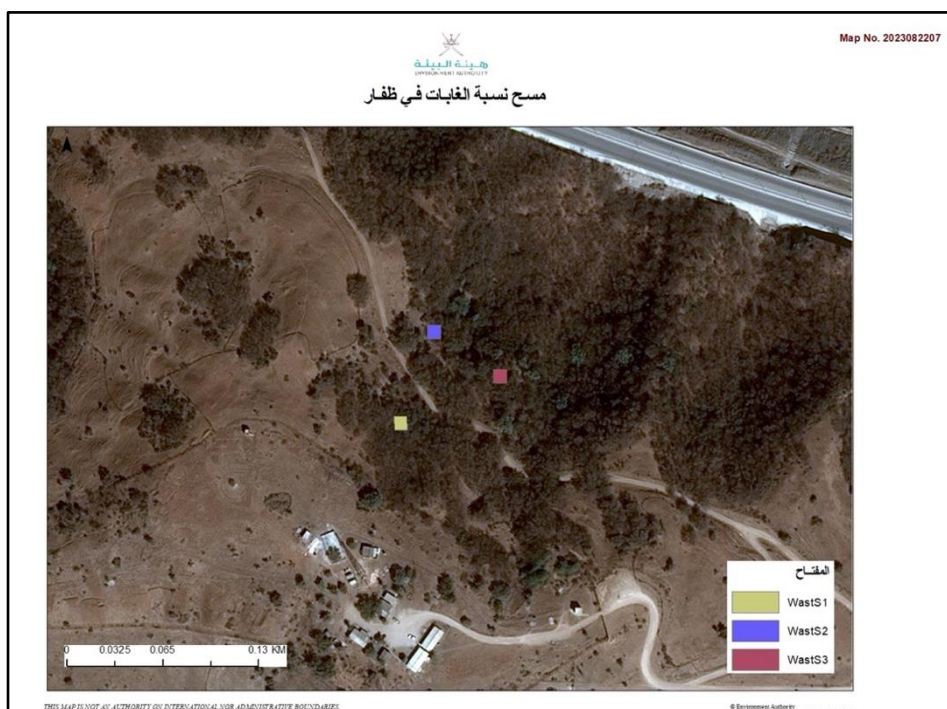


Figure 7: satellite image of SQ2 by the GIS department in environment authority, 2023.

Sub-squares	Coordinates	Date	Quantity and Species of Trees
1	17°12'03.7''N 54°06'06.9''E 17°12'04.0''N 54°06'06.9''E 17°12'04.0''N 54°06'06.6''E 17°12'03.7''N 54°06'06.6''E	Jun 2023	6 Anogeissus dhofarica. 5 Zizphus spina christi.
2	17°12'05.7''N 54°06'07.7''E 17°12'06.0''N 54°06'07.7''E 17°12'06.0''N 54°06'07.4''E 17°12'05.7''N 54°06'07.4''E	Jun 2023	2 Anogeissus dhofarica. 2 Commiphora habessinica. 3 Allophylus rubifolius.
3	17°12'04.7''N 54°06'09.2''E 17°12'05.0''N 54°06'09.2''E 17°12'05.0''N 54°06'08.9''E 17°12'04.7''N 54°06'08.9''E	Jun 2023	8 Anogeissus dhofarica. 1 Acacia Senegal. 3 Commiphora habessinica. 4 Euclea schimper. 1 Allophylus rubifolius.

SQ3

Araf- Dhalkut

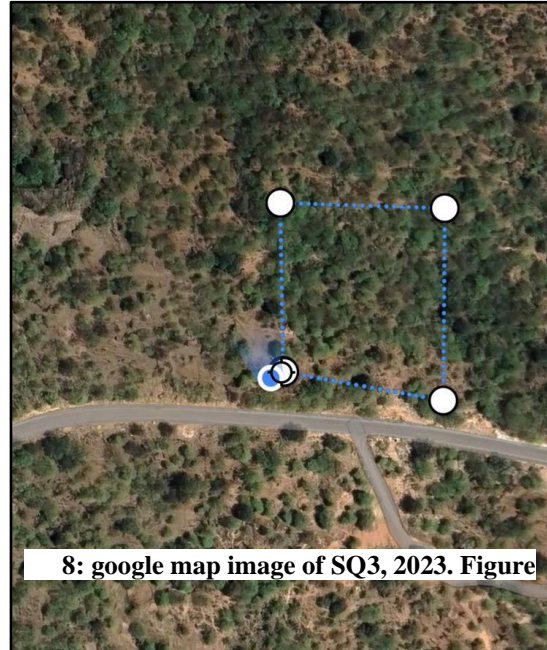
Coordinates:

16°43'08.5"N 53°15'33.7"E

16°43'12.0"N 53°15'33.6"E

16°43'12.6"N 53°15'30.6"E

16°43'09.2"N 53°15'30.0"E



8: google map image of SQ3, 2023. Figure



Figure 9: image of SQ3 taken by a drone with sub-squares distribution diagram, 2023.

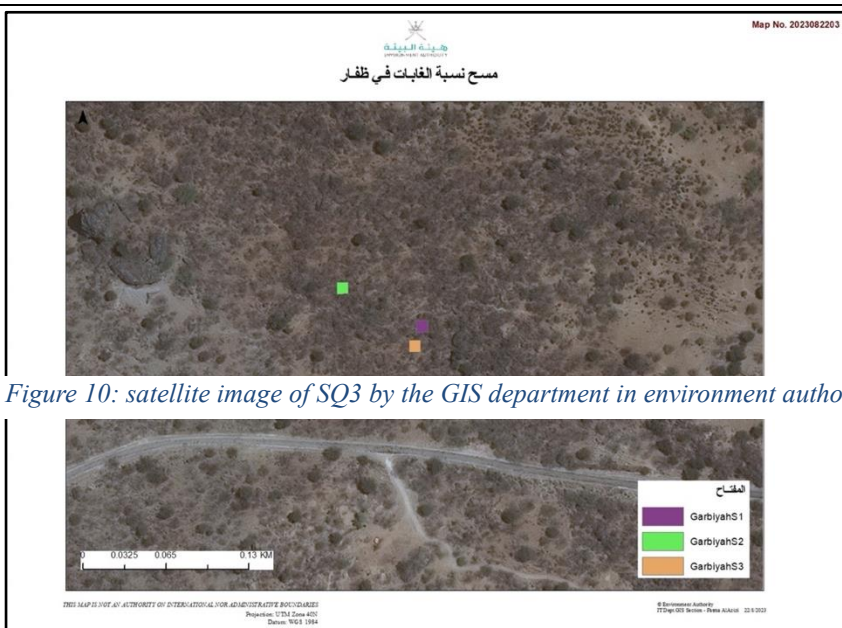
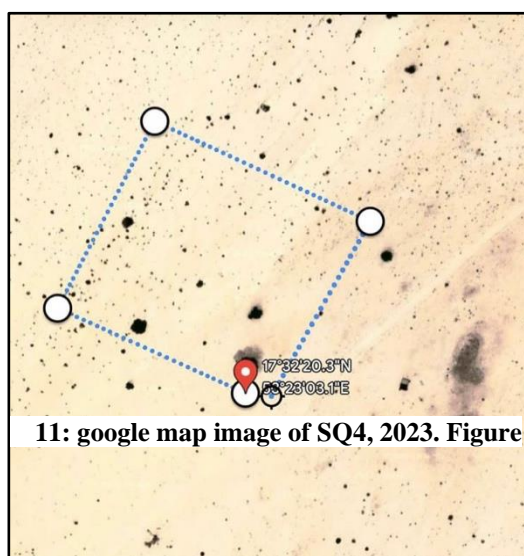


Figure 10: satellite image of SQ3 by the GIS department in environment authority, 2023.

Sub-squares	Coordinates	Date	Quantity and Species of Trees
1	16°43'11.1"N 53°15'33.0"E 16°43'11.4"N 53°15'33.0"E 16°43'11.4"N 53°15'32.7"E 16°43'11.1"N 53°15'32.7"E	Jun 2023	8 Anogeissus dhofarica. 3 Commiphora habessinica. 2 Acacia senegal. 2 Belepharispermum hirtum.
2	16°43'12.1"N 53°15'30.9"E 16°43'12.4"N 53°15'30.9"E 16°43'12.4"N 53°15'30.6"E 16°43'12.1"N 53°15'30.6"E	Jun 2023	8 Anogeissus dhofarica. 1 Acacia senegal. 1 Euphorbia smithii.
3	16°43'10.6"N 53°15'32.8"E 16°43'10.9"N 53°15'32.8"E 16°43'10.9"N 53°15'32.5"E 16°43'10.6"N 53°15'32.5"E	Jun 2023	2 Anogeissus dhofarica. 1 Allophylus rubifolius. 3 Euphorbia smithii.

SQ4
 Wadi Gharah- Thumrait
 Coordinates:
 17°32'20.3"N 53°23'03.1"E
 17°32'21.6"N 53°23'00.2"E
 17°32'24.4"N 53°23'01.9"E
 17°32'22.9"N 53°23'05.3"E



11: google map image of SQ4, 2023. Figure

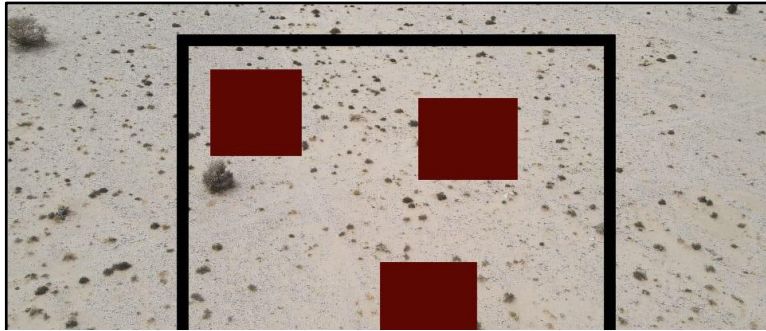


Figure 12: image of SQ4 taken by a drone with sub-squares distribution diagram, 2023.

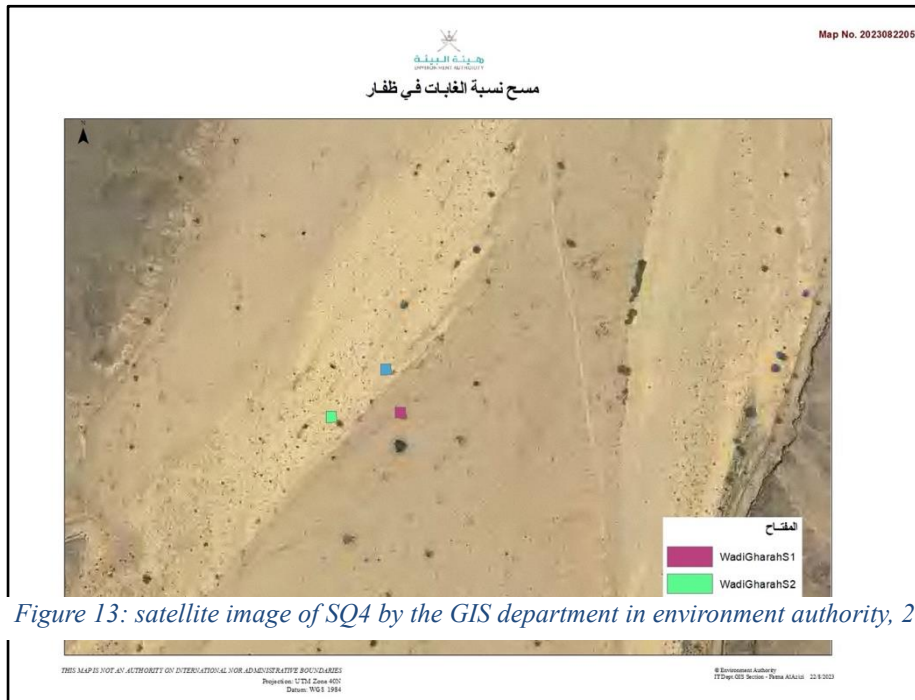


Figure 13: satellite image of SQ4 by the GIS department in environment authority, 2023.

Sub-squares	Coordinates	Date	Quantity and Species of Trees
1	17°32'21.5''N 53°23'03.4''E 17°32'21.8''N 53°23'03.4''E 17°32'21.8''N 53°23'03.1''E 17°32'21.5''N 53°23'03.1''E	Jul 2023	1 Acacia tortilis.
2	17°32'21.4''N 53°23'01.4''E 17°32'21.7''N 53°23'01.4''E 17°32'21.7''N 53°23'01.1''E 17°32'21.4''N 53°23'01.1''E	Jul 2023	1 Acacia tortilis.
3	17°32'22.7''N 53°23'03.0''E 17°32'23.0''N 53°23'03.0''E 17°32'23.0''N 53°23'02.7''E 17°32'22.7''N 53°23'02.7''E	Jul 2023	None

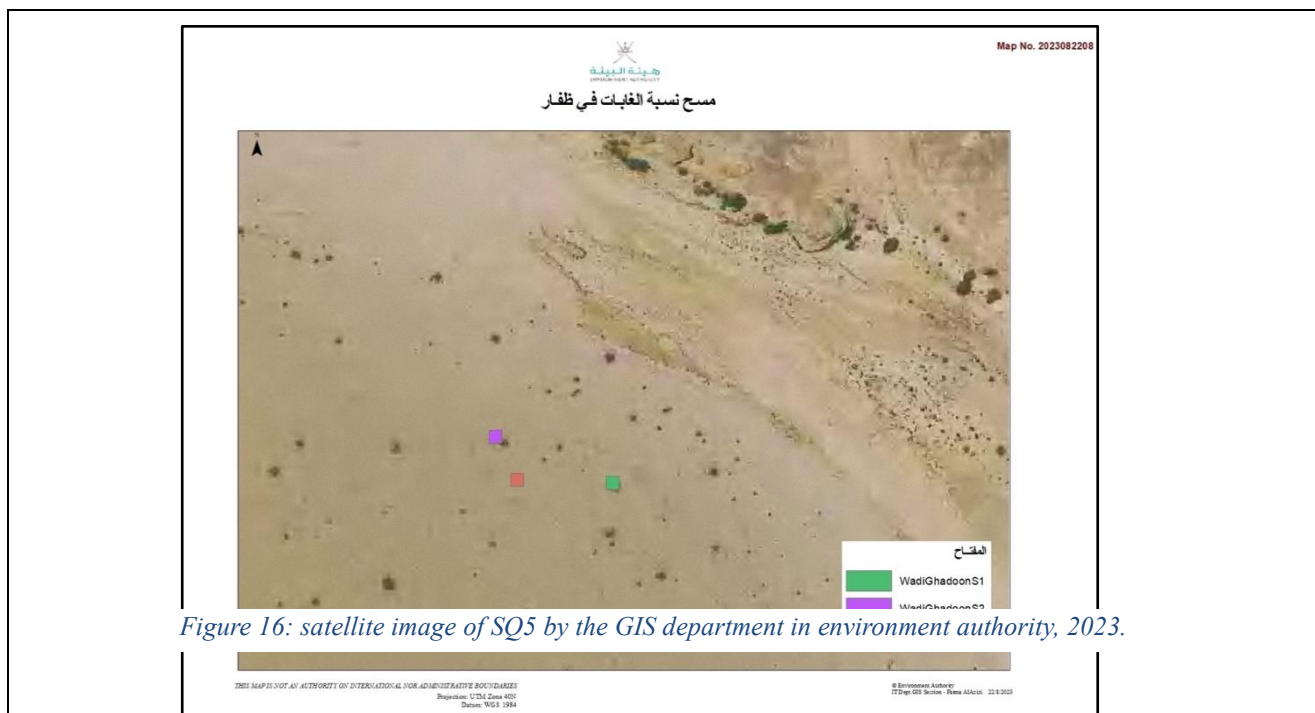


Figure 16: satellite image of SQ5 by the GIS department in environment authority, 2023.

Sub-squares	Coordinates	Date	Quantity and Species of Trees
1	17°37'34.0''N 53°34'00.9''E 17°37'34.3''N 53°34'00.9''E 17°37'34.3''N 53°34'00.6''E 17°37'34.0''N 53°34'00.6''E	Jul 2023	1 Acacia tortilis.
2	17°37'35.1''N 53°33'58.1''E 17°37'35.4''N 53°33'58.1''E 17°37'35.4''N 53°33'57.8''E 17°37'35.1''N 53°33'57.8''E	Jul 2023	1 Acacia tortilis.
3	17°37'34.1''N 53°33'58.6''E 17°37'34.4''N 53°33'58.6''E 17°37'34.4''N 53°33'58.3''E 17°37'34.1''N 53°33'58.3''E	Jul 2023	None

SQ6

Wadi Dhahbon- Thumrait

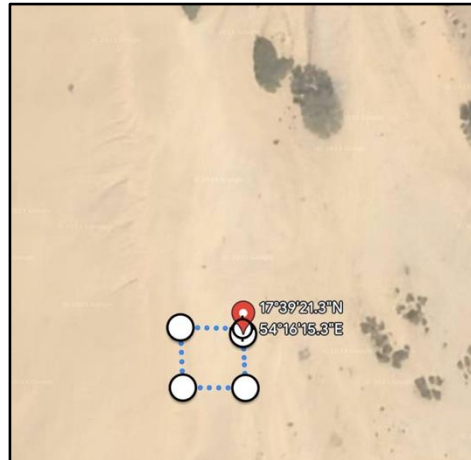
coordinates:

17°39'21.3"N 54°16'15.3"E

17°39'23.0"N 54°16'17.9"E

17°39'26.9"N 54°16'15.9"E

17°39'25.3"N 54°16'13.3"E



17: google map image of SQ6, Figure 2023.

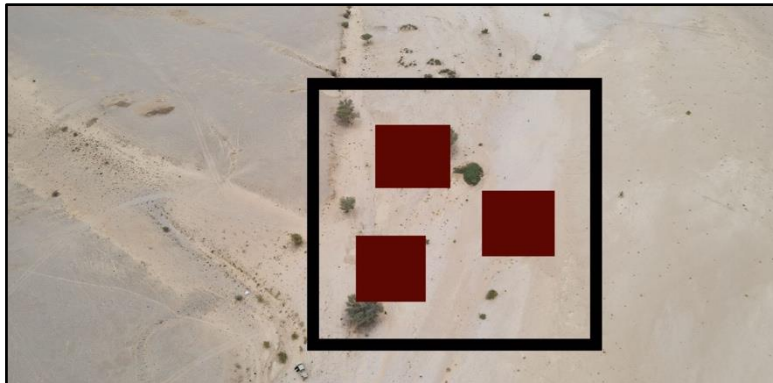


Figure 18: image of SQ6 taken by a drone with sub-squares distribution diagram, 2023.



Figure 19: satellite image of SQ6 by the GIS department in environment authority, 2023.

Sub-squares	Coordinates	Date	Quantity and Species of Trees
1	17°39'26.3''N 54°16'15.8''E 17°39'26.6''N 54°16'15.8''E 17°39'26.6''N 54°16'15.5''E 17°39'26.3''N 54°16'15.5''E	Jul 2023	1 Acacia tortilis.
2	17°39'24.5''N 54°16'14.4''E 17°39'24.8''N 54°16'14.4''E 17°39'24.8''N 54°16'14.1''E 17°39'24.5''N 54°16'14.1''E	Jul 2023	None
3	17°39'23.3''N 54°16'16.0''E 17°39'23.6''N 54°16'16.0''E 17°39'23.6''N 54°16'15.7''E 17°39'23.3''N 54°16'15.7''E	Jul 2023	1 Acacia tortilis.

SQ7
Shaaboon- Mirbat
Coordinates:
17°02'41.1''N 54°37'47.2''E
17°02'41.6''N 54°37'43.4''E
17°02'38.4''N 54°37'43.7''E
17°02'38.1''N 54°37'47.1''E

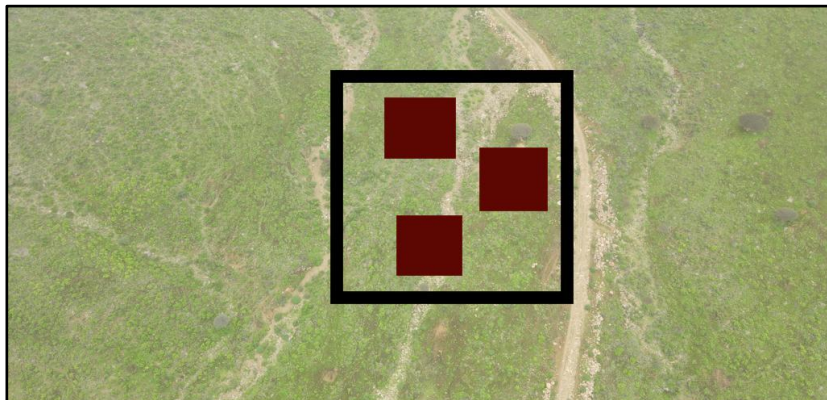
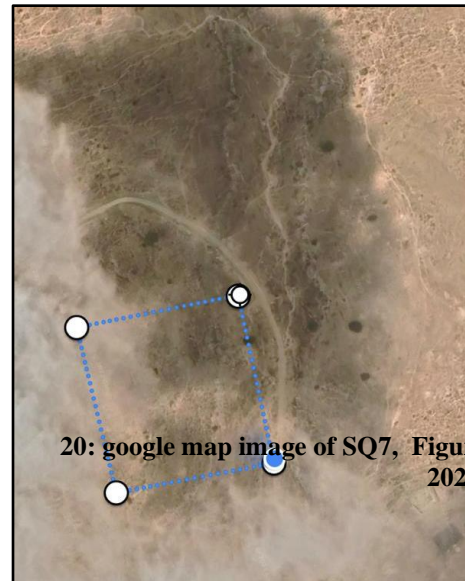


Figure 21: image of SQ7 taken by a drone with sub-squares distribution diagram, 2023.

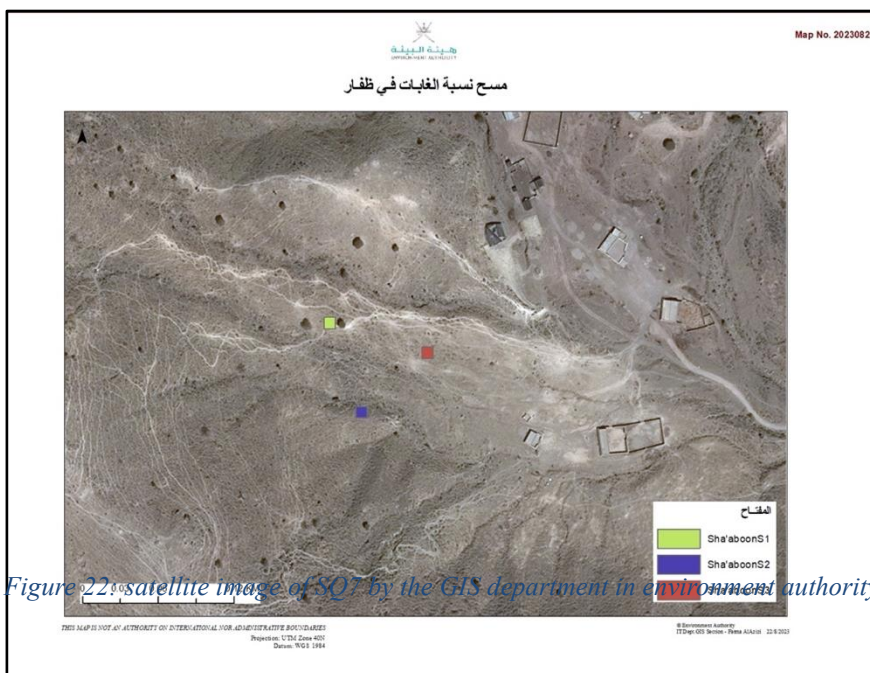


Figure 22: satellite image of SQ7 by the GIS department in environment authority, 2023.

Sub-squares	Coordinates	Date	Quantity and Species of Trees
1	17°02'41.2''N 54°37'44.6''E 17°02'41.5''N 54°37'44.6''E 17°02'41.5''N 54°37'44.3''E 17°02'41.2''N 54°37'44.3''E	Aug 2023	1 Bosica arbica.
2	17°02'38.9''N 54°37'45.4''E 17°02'39.2''N 54°37'45.4''E 17°02'39.2''N 54°37'45.1''E 17°02'38.9''N 54°37'45.1''E	Aug 2023	None
3	17°02'40.4''N 54°37'47.2''E 17°02'40.7''N 54°37'47.2''E 17°02'40.7''N 54°37'47.9''E 17°02'40.4''N 54°37'46.9''E	Aug 2023	None

SQ8

Razat- Salalah

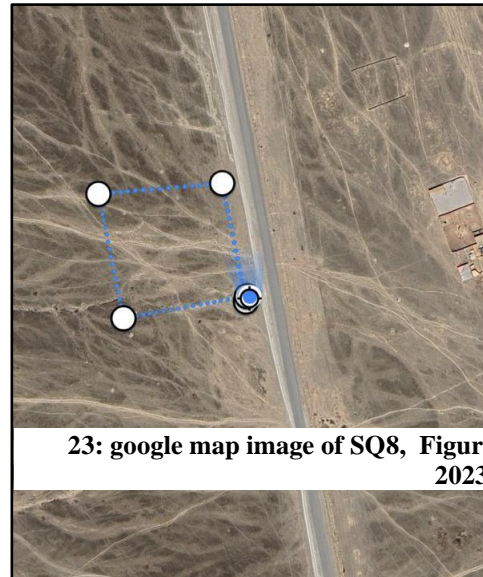
coordinates:

17°06'12.9"N 54°14'44.8"E

17°06'14.2"N 54°14'42.0"E

17°06'11.3"N 54°14'40.2"E

17°06'10.0"N 54°14'43.4"E



23: google map image of SQ8, Figure 2023.



Figure 24: image of SQ8 taken by a drone with sub-squares distribution diagram, 2023.

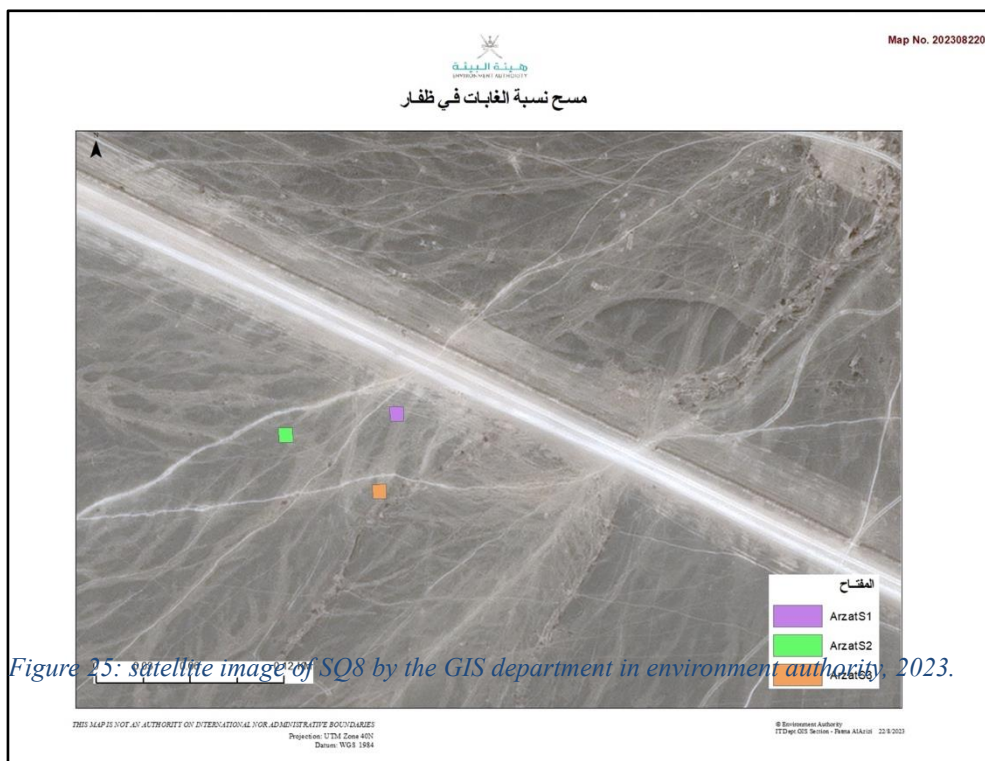


Figure 25: satellite image of SQ8 by the GIS department in environment authority, 2023.

Sub-squares	Coordinates	Date	Quantity and Species of Trees
1	17°06'12.5''N 54°14'43.8''E 17°06'12.8''N 54°14'43.8''E 17°06'12.8''N 54°14'43.5''E 17°06'12.5''N 54°14'43.5''E	Aug 2023	None
2	17°06'12.1''N 54°14'41.4''E 17°06'12.4''N 54°14'41.4''E 17°06'12.4''N 54°14'41.1''E 17°06'12.1''N 54°14'41.1''E	Aug 2023	None
3	17°06'10.9''N 54°14'43.4''E 17°06'11.2''N 54°14'43.4''E 17°06'11.2''N 54°14'43.1''E 17°06'10.9''N 54°14'43.1''E	Aug 2023	None

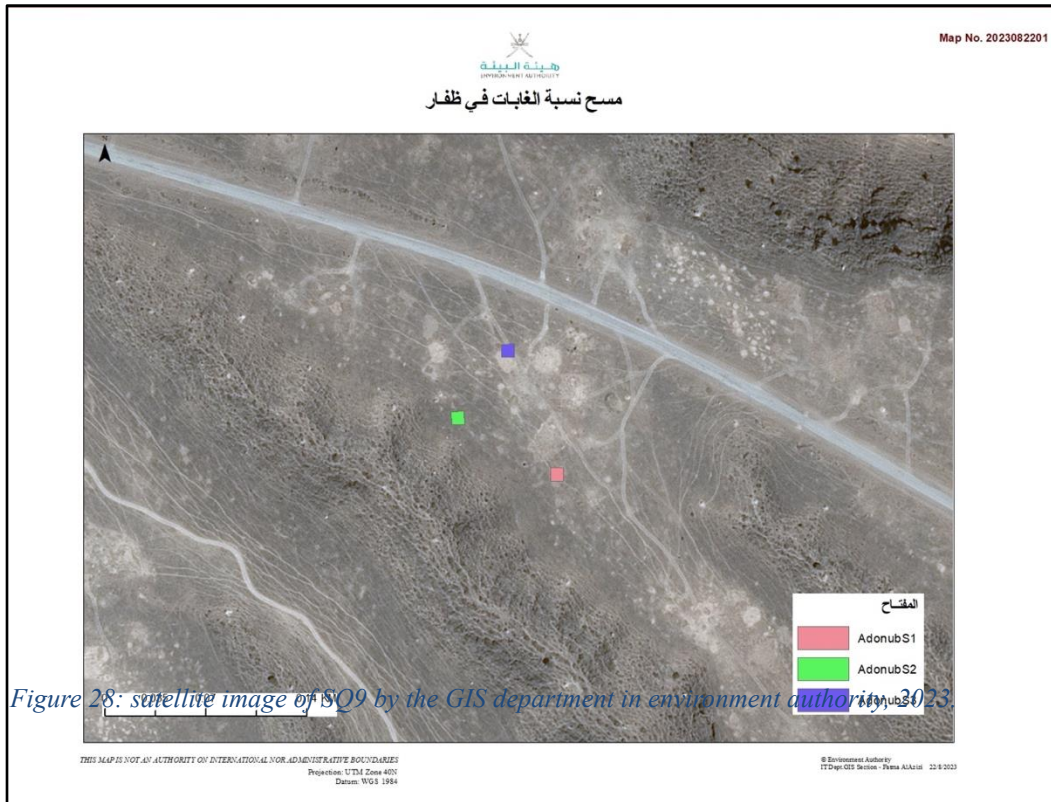


Figure 28: satellite image of SQ9 by the GIS department in environment authority 2023.

Sub-squares	Coordinates	Date	Quantity and Species of Trees
1	16°59'20.7''N 53°49'17.3''E 16°59'21.0''N 53°49'17.3''E 16°59'21.0''N 53°49'17.0''E 16°59'20.7''N 53°49'17.0''E	Aug 2023	None
2	16°59'22.0''N 53°49'15.0''E 16°59'22.3''N 53°49'15.0''E 16°59'22.3''N 53°49'14.7''E 16°59'22.0''N 53°49'14.7''E	Aug 2023	None
3	16°59'23.5''N 53°49'16.2''E 16°59'23.8''N 53°49'16.2''E 16°59'23.8''N 53°49'15.9''E 16°59'23.5''N 53°49'15.9''E	Aug 2023	None
SQ10 Marmul- Shaleem and Al Halaniyat Islands Coordinates:			

18°15'45.4"N 55°20'18.7"E
18°15'42.4"N 55°20'19.8"E
18°15'44.2"N 55°20'23.1"E
18°15'47.0"N 55°20'21.7"E

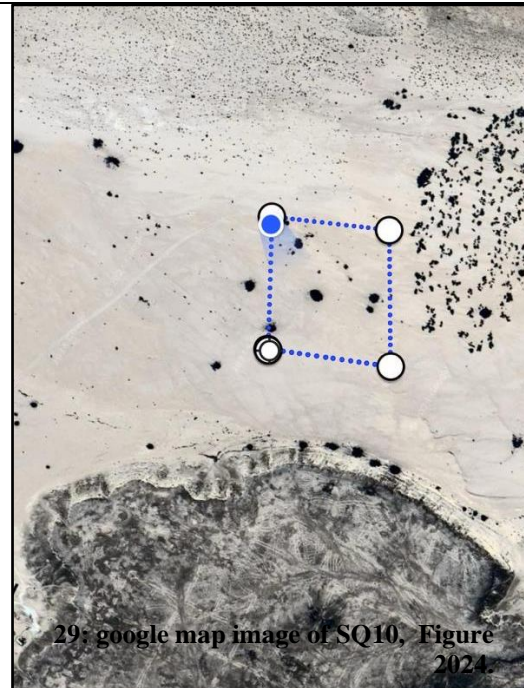




Figure 31 satellite image of SQ10 by the GIS department in environment authority, 2024.

Sub-squares	Coordinates	Date	Quantity and Species of Trees
1	18°15'45.6''N 55°20'19.4''E 18°15'45.6''N 55°20'19.0''E 18°15'45.3''N 55°20'19.0''E 18°15'45.3''N 55°20'19.3''E	Feb 2024	1 Prosopis cineraria.
2	18°15'45.1''N 55°20'21.2''E 18°15'45.1''N 55°20'20.8''E 18°15'44.8''N 55°20'20.8''E 18°15'44.8''N 55°20'21.2''E	Feb 2024	1 Acacia tortilis.
3	18°15'45.0''N 55°20'22.5''E 18°15'45.0''N 55°20'22.2''E 18°15'44.7''N 55°20'22.2''E 18°15'44.7''N 55°20'22.5''E	Feb 2024	None

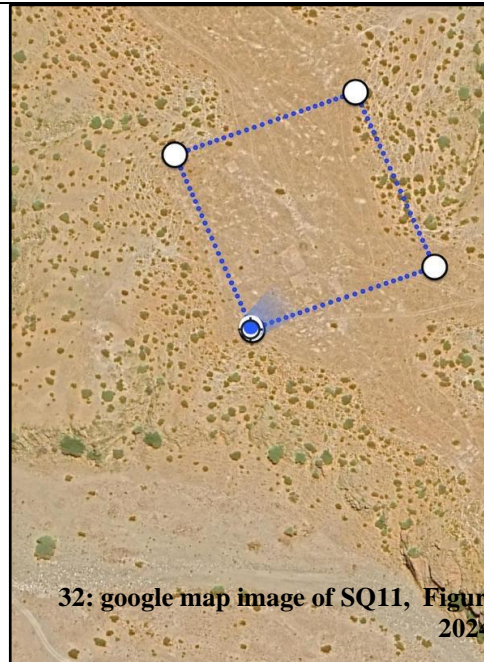
SQ11
Laja Shelyon- Sadah
Coordinates:

17°09'41.4''N 55°00'34.2''E

17°09'42.9''N 55°00'31.7''E

17°09'45.4"N 55°00'33.3"E

17°09'44.1"N 55°00'36.1"E



32: google map image of SQ11, Figure 2024.

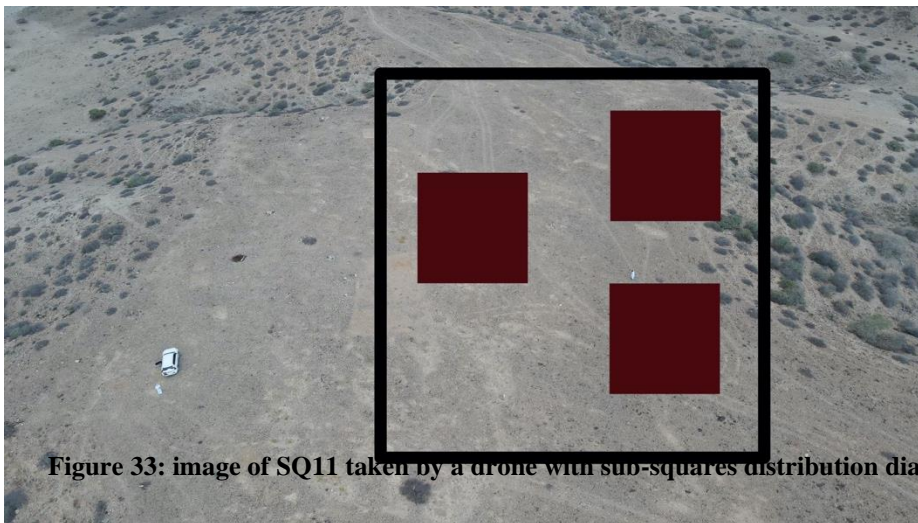


Figure 33: image of SQ11 taken by a drone with sub-squares distribution diagram, 2024

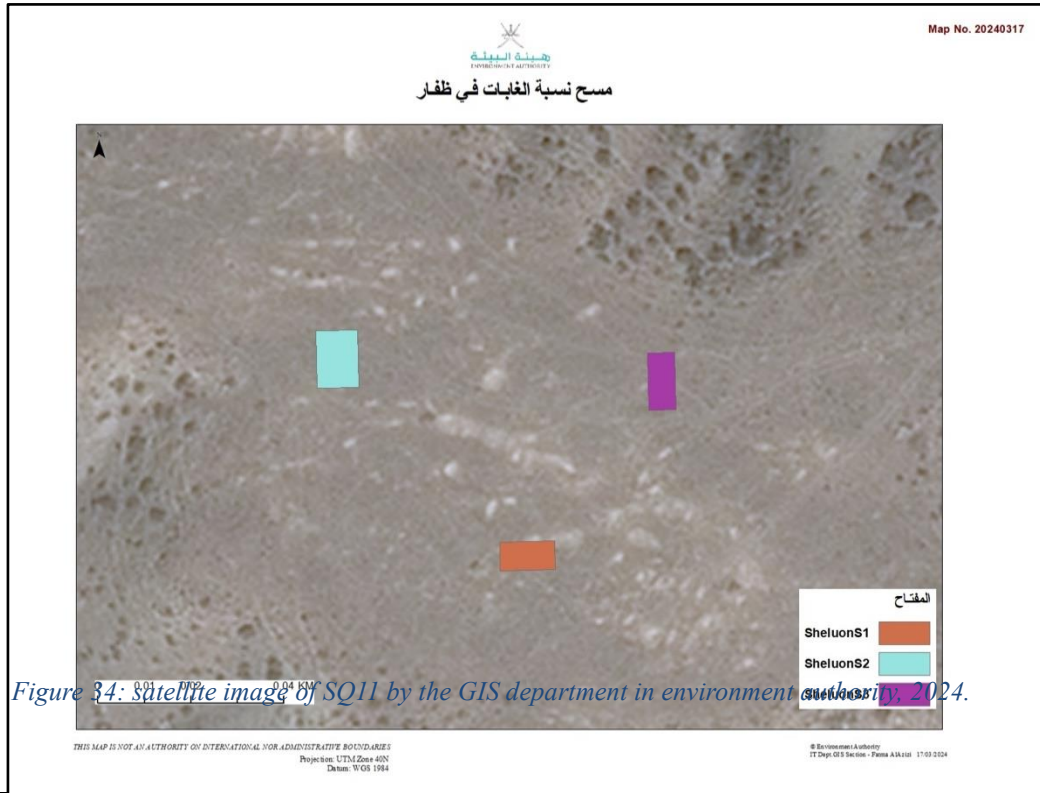


Figure 34: Satellite image of SQ11 by the GIS department in environmental authority, 2024.

Sub-squares	Coordinates	Date	Quantity and Species of Trees
1	17°09'42.3''N 55°00'34.2''E 17°09'42.3''N 55°00'34.0''E 17°09'42.0''N 55°00'34.0''E 17°09'42.0''N 55°00'34.3''E	Feb 2024	None
2	17°09'43.8''N 55°00'32.7''E 17°09'43.8''N 55°00'32.5''E 17°09'43.5''N 55°00'32.5''E 17°09'43.5''N 55°00'32.9''E	Feb 2024	None
3	17°09'43.7''N 55°00'35.0''E 17°09'43.7''N 55°00'34.9''E 17°09'43.4''N 55°00'34.9''E 17°09'43.4''N 55°00'35.2''E	Feb 2024	None

4.Result and Discussion

The final percentage of forests out of the total land area in Dhofar Governorate is calculated based on the data gained from the field survey, as the percentage of forests is calculated mathematically given the number of trees and the diameter of the tree canopy in meters by finding the area of each tree as a circle (where Area of the circle: $A = \pi r^2$). The diameter of the tree canopy was also taken by calculating the distance from the tree trunk in one direction, considering it as the radius, then multiply the distance by 2 to get the diameter of the circle (the tree), As shown in Figure 35. The calculations are shown in Table 2, where SQ symbolizes the main squares, and sq symbolizes the sub-squares.

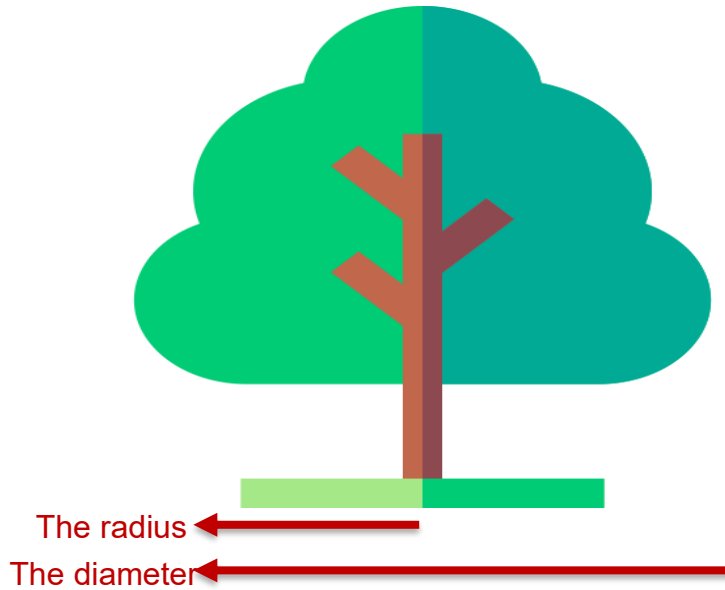


Figure 35: The method used to find the radius and diameter based on the tree canopy.

Table2 : Forest areas in the field survey squares.

SQ1 Hasher -Mirbat		
sq1	sq2	sq3
average area of Anogeissus dhofarica : $A = \pi(4)^2 = 50.24 m^2$ average area of Commiphora habessinica: $A = \pi(3)^2 = 28.26 m^2$ average total area of forests= $78.5 m^2$ area of the sub-square $=100 m^2$ percentage of forest out of land area = $\frac{78.5}{100} * 100 = 78.5\%$	average area of Anogeissus dhofarica: $A = \pi(6)^2 = 113.04 m^2$ average total area of forests = $113.04 m^2$ area of the sub-square $=100 m^2$ percentage of forest out of land area = $\frac{113.04}{100} * 100 = 113.04\%$	average area of : Anogeissus dhofarica $A = \pi(5)^2 = 78.5 m^2$ average area of Commiphora habessinica: $A = \pi(2.5)^2 = 19.625 m^2$ average area of Commiphora gileadansis: $A = \pi(2)^2 = 12.56 m^2$ average area of Belepharispermum hirtum: $A = \pi(3)^2 = 28.26 m^2$ average area of Maytenus dhofarensis: $A = \pi(1)^2 = 3.14 m^2$ average total area of forests= $142.1 m^2$

		area of the sub-square $=100 m^2$ percentage of forest out of land area = $\frac{142.1}{100} * 100 = 142.1\%$
average percentage of forest out of land area in SQ1 $\frac{78.5 + 113.04 + 142.1}{3} = 111.2\%$		
SQ2 Yasmeen Mountain- Salalah		
sq1	sq2	sq3
average area of Anogeissus dhofarica: $A = \pi(8)^2 = 200.96 m^2$ average area of Zizphus spina christi: $A = \pi(4.5)^2 = 63.585 m^2$ average total area of forests = $264.545 m^2$ area of the sub-square $=100 m^2$ percentage of forest out of land area = $\frac{264.545}{100} * 100 = 264.545\%$	average area of Anogeissus dhofarica : $A = \pi(5)^2 = 78.5 m^2$ average area of Commiphora habessinica: $A = \pi(4)^2 = 50.24 m^2$ average area of Allophylus rubifolius: $A = \pi(4)^2 = 50.24 m^2$ average total area of forests = $178.98 m^2$ area of the sub-square $=100 m^2$ percentage of forest out of land area = $\frac{178.98}{100} * 100 = 178.98\%$	average area of Anogeissus dhofarica: $A = \pi(4.5)^2 = 63.585 m^2$ average area of Acacia senegal: $A = \pi(4)^2 = 50.24 m^2$ average area of Commiphora habessinica: $A = \pi(2)^2 = 12.56 m^2$ average area of Euclea schimper: $A = \pi(3)^2 = 28.26 m^2$ average area of Allophylus rubifolius: $A = \pi(2)^2 = 12.56 m^2$ average total area of forests = $167.205 m^2$ area of the sub-square $=100 m^2$ percentage of forest out of land area = $\frac{167.205}{100} * 100 = 167.205\%$
average percentage of forest out of land area in SQ2 $\frac{264.545 + 178.98 + 167.205}{3} = 203.58\%$		
SQ3 Araf- Dhalkut		
sq1	sq2	sq3
average area of Anogeissus dhofarica: $A = \pi(6)^2 = 113.04 m^2$ average area of Commiphora habessinica:	average area of Anogeissus dhofarica: $A = \pi(7)^2 = 153.86 m^2$	average area of Anogeissus dhofarica: $A = \pi(7)^2 = 153.86 m^2$

$A = \pi(2)^2 = 12.56 m^2$ average area of Acacia senegal: $A = \pi(3)^2 = 28.26 m^2$ average area of Belepharispermum hirtum: $A = \pi(2)^2 = 12.56 m^2$ average total area of forests = $166.42 m^2$ area of the sub-square = $100 m^2$ percentage of forest out of land area = $\frac{166.42}{100} * 100 = 166.42\%$	average area of Acacia senegal: $A = \pi(3)^2 = 28.26 m^2$ average area of Euphorbia smithii.: $A = \pi(3)^2 = 28.26 m^2$ average total area of forests = $182.12 m^2$ area of the sub-square = $100 m^2$ percentage of forest out of land area = $\frac{182.12}{100} * 100 = 182.12\%$	average area of Allophylus rubifolius: $A = \pi(3)^2 = 28.26 m^2$ average area of Euphorbia smithii.: $A = \pi(2.5)^2 = 19.625 m^2$ average total area of forests = $201.745 m^2$ area of the sub-square = $100 m^2$ percentage of forest out of land area = $\frac{201.745}{100} * 100 = 201.745\%$
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average percentage of forest out of land area in SQ3

$$\frac{166.42 + 182.12 + 201.745}{3} = 183.43\%$$

SQ4 Wadi Gharah- Thumrait

sq1	sq2	sq3
no trees found. percentage of forest out of land area = 0%	average area of Acacia tortilis: $A = \pi(3.5)^2 = 38.47 m^2$ average total area of forests = $38.47 m^2$ area of the sub-square = $100 m^2$ percentage of forest out of land area = $\frac{38.47}{100} * 100 = 38.47\%$	average area of Acacia tortilis: $A = \pi(3.5)^2 = 38.47 m^2$ average total area of forests = $38.47 m^2$ area of the sub-square = $100 m^2$ percentage of forest out of land area = $\frac{38.47}{100} * 100 = 38.47\%$

average percentage of forest out of land area in SQ4

$$\frac{38.47 + 38.47 + 0}{3} = 25.65\%$$

SQ5 Wadi Gadon- Thumrait

sq1	sq2	sq3
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no trees found. percentage of forest out of land area = 0%	average area of Acacia tortilis: $A = \pi(3.5)^2 = 38.47 \text{ m}^2$ average total area of forests = 38.47 m^2 area of the sub-square $=100 \text{ m}^2$ percentage of forest out of land area = $\frac{38.47}{100} * 100 = 38.47\%$	average area of Acacia tortilis: $A = \pi(3.5)^2 = 38.47 \text{ m}^2$ average total area of forests $= 38.47 \text{ m}^2$ area of the sub-square = 100 m^2 percentage of forest out of land area = $\frac{38.47}{100} * 100 = 38.47\%$
average percentage of forest out of land area in SQ5 $\frac{38.47 + 38.47 + 0}{3} = 25.65\%$		
SQ6 Wadi Dhahbon- Thumrait		
sq1	sq2	sq3
average area of Acacia tortilis: $A = \pi(3.5)^2 = 38.47 \text{ m}^2$ average total area of forests = 38.47 m^2 area of the sub-square $=100 \text{ m}^2$ percentage of forest out of land area = $\frac{38.47}{100} * 100 = 38.47\%$	no trees found. percentage of forest out of land area = 0%	average area of Acacia tortilis: $A = \pi(3.5)^2 = 38.47 \text{ m}^2$ average total area of forests $= 38.47 \text{ m}^2$ area of the sub-square $=100 \text{ m}^2$ percentage of forest out of land area = $\frac{38.47}{100} * 100 = 38.47\%$
average percentage of forest out of land area in SQ6 $\frac{38.47 + 0 + 38.47}{3} = 25.65\%$		
SQ7 Shaaboon- Mirbat		
sq1	sq2	sq3
no trees found. percentage of forest out of land area = 0%	no trees found. percentage of forest out of land area = 0%	average area of Bosica arbica: $A = \pi(2.5)^2 = 19.63 \text{ m}^2$ average total area of forests = 19.63 m^2 area of the sub-square $=100 \text{ m}^2$ percentage of forest out of land area = $\frac{19.63}{100} * 100 = 19.63\%$

average percentage of forest out of land area in SQ7		
$\frac{19.63 + 0 + 0}{3} = 6.54\%$		
SQ8 Razat- Salalah		
sq1	sq2	sq3
no trees found. percentage of forest out of land area = 0%	no trees found. percentage of forest out of land area = 0%	no trees found. percentage of forest out of land area = 0%
average percentage of forest out of land area in SQ8		
$\frac{0 + 0 + 0}{3} = 0\%$		
SQ9 Adonub- Salalah		
sq1	sq2	sq3
no trees found. percentage of forest out of land area = 0%	no trees found. percentage of forest out of land area = 0%	no trees found. percentage of forest out of land area = 0%
average percentage of forest out of land area in SQ9		
$\frac{0 + 0 + 0}{3} = 0\%$		
SQ10 Marmul- Shaleem and Al Halaniyat Islands		
sq1	sq2	sq3
average area of Prosopis cineraria: $A = \pi(2.5)^2 = 19.63 \text{ m}^2$ average total area of forests = 19.63 m^2 area of the sub-square = 100 m^2 percentage of forest out of land area = $\frac{19.63}{100} * 100 = 19.63\%$	average area of Acacia tortilis: $A = \pi(3.5)^2 = 38.47 \text{ m}^2$ average total area of forests = 38.47 m^2 area of the sub-square = 100 m^2 percentage of forest out of land area = $\frac{38.47}{100} * 100 = 38.47\%$	no trees found. percentage of forest out of land area = 0%
average percentage of forest out of land area in SQ10		
$\frac{19.63 + 38.47 + 0}{3} = 19.37\%$		
SQ11 Laja Shelyon- Sadah		
sq1	sq2	sq3
no trees found. percentage of forest out of land area = 0%	no trees found. percentage of forest out of land area = 0%	no trees found. percentage of forest out of land area = 0%
average percentage of forest out of land area in SQ11		
$\frac{0 + 0 + 0}{3} = 0\%$		

(Cont.) Calculations:

Average percentage of forest for the total field survey sites:

$$(111.2+203.58+183.43+25.65+25.65+25.65+6.54+0+0+19.37+0)/11= 54.64\%$$

$$\text{Area of field survey sites} = 110,000 \text{ m}^2 = 11\text{ha}$$

Area of the study area = Area of the study area in 2021 based on the data given by the GIS department in Figure 1 + area of the squares located outside the study area (Wadi Gharah, Wadi Gadon, Wadi Dhahbon, Marmul) = 4537.24 km²

Tree cover percentage in Dhofar Governorate 2021 based on the data given by the GIS department in Figure 1 = 22.4%

To calculate the percentage of forests out of the total land area in Dhofar:

$$\frac{4537.2 \text{ km}^2}{98249.8 \text{ km}^2} : 22.4\%$$

$$\frac{0.11 \text{ km}^2}{4537.24 \text{ km}^2} : 54.64\%$$

$$0.04618025 \text{ km}^2 : 22.4\%$$

$$0.00002424 \text{ km}^2 : 54.64\%$$

$$\frac{1905.12583}{0.40994107} : \frac{0.40994107}{0.40994107}$$

$$4647.31632 : 1$$

According to Dhofar Governorate area which is 98249.8 km²:

$$\frac{4647.31632}{98249.8} = 0.04730103 * 100 \approx 4.73\%$$

Which approximately represents 4647.22 km² \approx 464722 ha of the total area of Dhofar Governorate.'5.Acknowledgements

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