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THE IMPACT OF CLIMATE ON THE VARIATION OF WATER AND VEGETATION COVER AREA IN AL-DALMAJ MARSH FOR THE YEAR 2024

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Abstract:

Since the study area is located within the borders of the semi-arid climate, which is characterized by a rare rainy season in the dry summer, a number of climatic factors vary the area of the water and plant cover of Al-Dalmaj Marsh. The most significant of these factors are solar radiation, temperature, wind, evaporation, relative humidity, and rain. Because it is dependent on rainfall patterns and the policies of some nations that have constructed dams on the rivers that supply parts of the marshes, its extent is always changing , Therefore, the area of water cover varies from one month to another, and from one season to another, which can affect the difference in the qualitative characteristics of water, which contributes to the creation of specific ecosystems. The results of the water cover index analysis showed that the maximum area of water reached (191.16) km2 during the month of November, while the lowest area reached (169.1) km2 during the month of August.

The study area's diversity of ecosystems is also impacted by the various climatic conditions, as evidenced by the vegetation cover that is compatible with the water available. This led to a monthly variation in the area of vegetation cover, which peaked in April at 209.67 km2 and then fell to 178.82 km2. The area of barren lands also increased in March, reaching a maximum of 209.58 km2 and a minimum of 177.03 km2.

Keywords: Climate, Vegetation Cover Index, Water Cover Index, Water Area, Vegetation Cover Area , Al-Dalmaj Marsh .

INTRODUCTION:

A natural geographical setting, Al-Dalmaj Marsh is rich in a variety of plants and animals. The major river serves as its water source, and it is situated between the governorates of Wasit and Al-Qadisiyah. Different water returns result in varying discharge rates and water quality. Water flows through a feeding channel from the river mouth. The loss of biodiversity is one of the problems that significantly impacts ecosystems' capacity to achieve ecological balance as a result of drought and the ongoing decrease in water returns brought on by high temperatures and evaporation rates. This has resulted in harm to the region and the environment.

1- Research problem:

The question posed by the study was: How does the climate affect the variance in the amount of water and plant cover in the Damlaj Marsh in 2024?

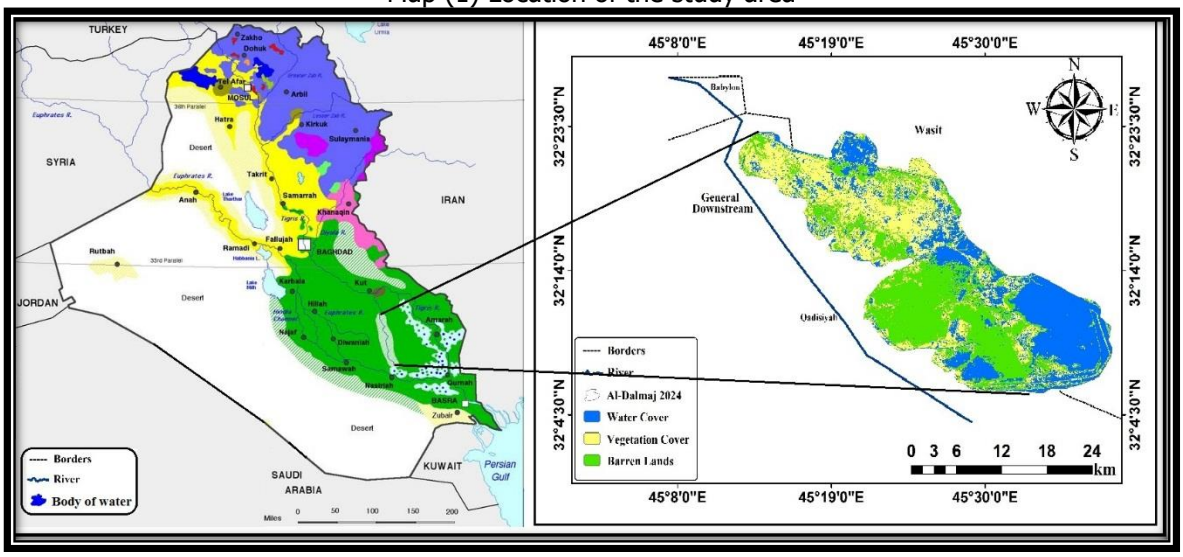
2- Research hypothesis:

(The climate affects the variance in the Damlaj Marsh's water cover and vegetation area in 2024.)

3- Research boundaries:

Geographical location: Al-Dilmaj Marsh is situated in the southwest of Wasit Governorate and in the eastern and southeast parts of Al-Qadisiyah Governorate. Although this territory is under the official jurisdiction of both the Wasit and Al-Qadisiyah Governorates, two-thirds of it is located inside the boundaries of the Wasit Governorate, with the remaining third being located inside the Al-Qadisiyah Governorate. Al-Numaniyah District lines the north of Al-Dilmaj Marsh, followed by Al-Muwafaqiyah District to the east, Al-Ahrar District in Wasit Governorate to the northeast, Al-Fajr District in Dhi Qar Governorate to the south, Al-Qadisiyah Governorate to the west, and Babil Governorate to the northwest. It is restricted astronomically between latitudes (08 32 – 25 32)° degrees north and longitudes (09 45 – 42 45)° degrees east. It has a 681,123 km2 area. View Map (1).

Map (1) Location of the study area



Source: Researcher's work based on:

1- Republic of Iraq, Ministry of Water Resources, General Survey Directorate, Administrative Map of Iraq, scale 1:1000000, for the year 2010.

2- Satellite image captured by Landsat (8) satellite, for the year 2024 and outputs of Arc GIS 10.5 program.

Objective and temporal boundaries: The NDWI and NDVI indices were used to evaluate how climate change affected the variance in the area of water and plant cover in the Damlaj Marsh in 2024.

4- Research objective:

The research aims to

1- the climatic characteristics of Al-Damlaj Marsh.
2- the area of water and vegetation cover to know the variation that occurs during the months.
3- the statistical relationships between the water and vegetation cover index and climatic elements, to know the extent of their relationship in the impact of climate on Al-Damlaj Marsh.

4- Importance of the research:

Due to the large area covered by the Dalmaj marais, which is home to a diverse range of plant and animal life, and the exposure of this water plan to the harsh climate that exists in both Iraq and the study area, this results in a change in the water plan and, consequently, its effects on these study area neighborhoods.As a result of the extensive area covered by the Dalmaj marais, which is home to a diverse range of plant and animal life, and the exposure of this water plan to the harsh climate that exists in both Iraq and the study area, the water plan varies, which in turn affects these study area neighborhoods.

5- Research Methodology:

By examining satellite images, reading the Normalized Water Cover Index (NDWI) and Normalized Vegetation Cover Index (NDVI) results, and calculating the correlation coefficient between these indicators and the climate data from the stations in the study area, the researcher employed both the inductive and analytical approaches.

6- Research Structure:

Three parts made up the study. Al-Damlaj Marsh's climate was covered in the first section, and the water and vegetation cover index was examined in the second. as well as the statistical link between the water and vegetation cover index and the meteorological factors , The final portion included the findings, suggestions, and list of references.

Chapter One
Climatic Characteristics of Al-Dalmaj Marsh

INTRODUCTION:

The study region has two different climatic types: semi-arid and arid. Because some of the hydrological features, like those pertaining to the marsh water levels, are seasonal due to the lengthy dry season and the total cessation of rainfall, which is followed by high temperatures and evaporation, this climate description has an impact on the water balance. Furthermore, the climatic zones in question dictate the type of ecosystem, which is among the most delicate and weakest systems , These natural environments are delicate, and their features change quickly in response to climate change, because the marshes, which are categorized as wetlands, are situated in regions with extreme climatic phenomena like temperature fluctuations and seasonal drought, which helps reduce the amount of water imported into the marshes.

The Diwaniyah climate station was selected because it offers a good image of the types of spatial climatic variations that occur within the scope's geographic bounds :-

1- Total solar radiation:

The permanent subtropical pressure system (Azure) determines the study area's high sunshine hours. In June, when the sun is perpendicular to the Tropic of Cancer, the study area experiences 8.9 hours of sunshine on average per year, with a clear sky due to the interruption of pressure systems that aid in cloud formation, particularly low ones. Because the sun is perpendicular to the Tropic of Capricorn and far from the studyregion(1), the average is at its lowest in December, with an average of 6.33 hours.

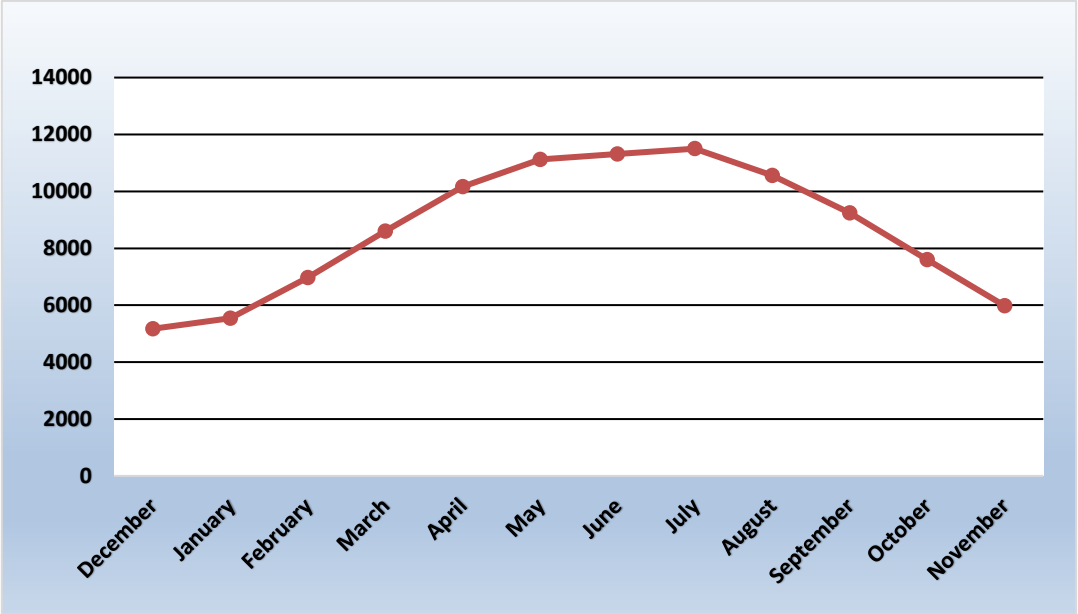
It is evident from Table (1) and Figure (1) that the annual average of total solar radiation was 8646.75) W.d/m², while the maximum monthly average was approximately (11500) W.d/m² in July. The highest value was recorded in December, when it was 5171) W.d/m².

Table 1 shows the Diwaniyah station's monthly rates and yearly average of total sun radiation W.d/m² for 2024.

month	Monthly average	month	Monthly average
December	5171	June	11313
January	5539	July	11500
February	6967	August	10558
March	8602	September	9242
April	10166	October	7595
May	11125	November	5983
Annual average	8646.75		

Source: Ministry of Transport and Communications, Meteorology and Seismic Monitoring Authority, Climate Department, unpublished data, 2024.

Figure 1 shows the Diwaniyah station's monthly total solar radiation rates W.d/m² for 2024.



Source: Table (1).

2- Temperatures:

A- Maximum temperature:

It is evident from the examination of Table (2) and Figure (2) that the year-over-year average of the maximum temperature was 32.43 degrees Celsius, with the highest monthly average occurring in July (45.61 degrees Celsius) and the lowest in January (17.7) months.

Table (2) shows the Al-Diwaniyah station's monthly rates and yearly average of the highest, normal, and lowest temperatures degrees Celsius for the year 2024.

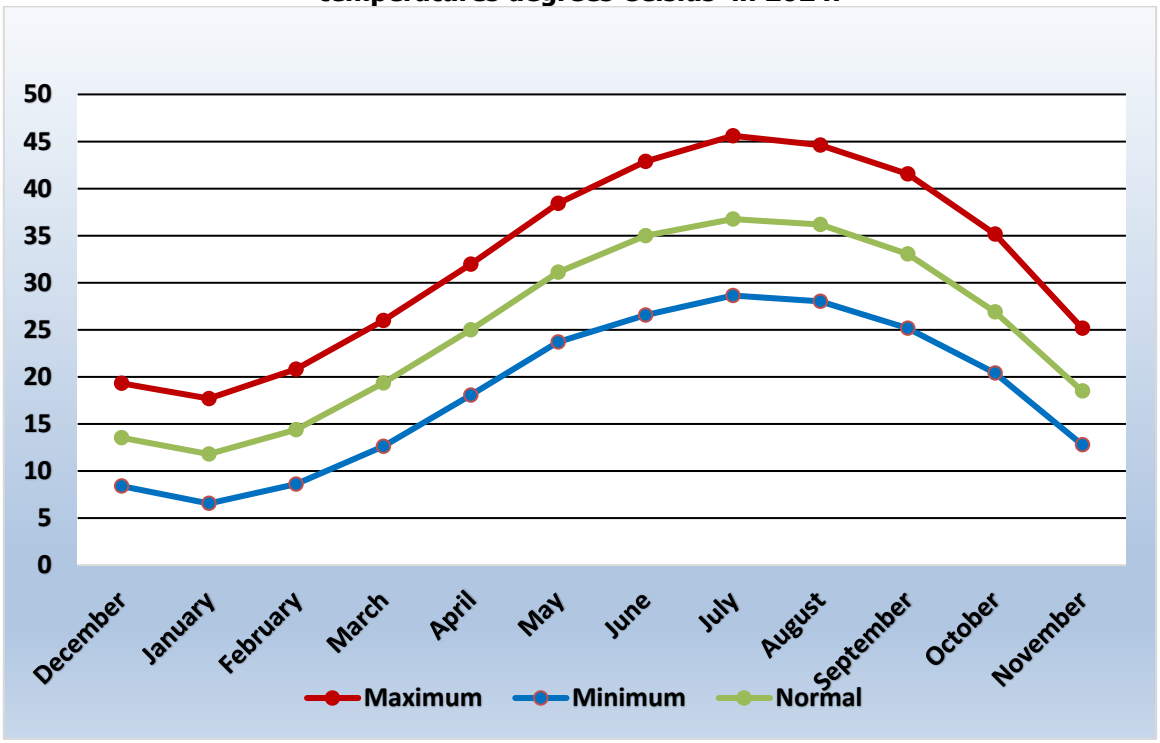
Temperature / month	Normal	Minimum	**Maximum**
December	13.55	8.39	19.33
January	11.8	6.55	17.7
February	14.37	8.59	20.8
March	19.36	12.61	25.98

(1)Hassan Sayed Ahmed Abu Al-Ainain, Fundamentals of Climate Geography, 1st ed., University House for Printing and Publishing, Beirut, 1981, p. 88.

April	24.98	18.06	31.98
May	31.13	23.7	38.42
June	34.98	26.57	42.88
July	36.76	28.64	45.61
August	36.17	28.03	44.6
September	33.05	25.16	41.55
October	26.91	20.41	35.15
November	18.5	12.79	25.17
Annual average	25.13	18.29	32.43

Source: Ministry of Transport and Communications, Meteorology and Seismic Monitoring Authority, Climate Department, unpublished data, 2024.

Figure 2 shows the Al-Diwaniyah station's monthly averages for the highest, average, and lowest temperatures degrees Celsius in 2024.



Source: Table (2).

B- Normal temperature:

The analysis of Table (2) and Figure (2) makes it evident that the annual average temperature was 25.13 degrees Celsius, with the highest average normal temperature occurring in July at 36.76 degrees Celsius and the lowest in January at 11.8 degrees Celsius.

C- Minimum temperature:

It is evident from Table (2) and Figure (2) that the monthly average minimum temperature peaked in January at 28.64 degrees Celsius, went down to a minimum of 6.55 degrees Celsius in August, and the annual average reached 18.29 degrees Celsius.

3- Wind speed:

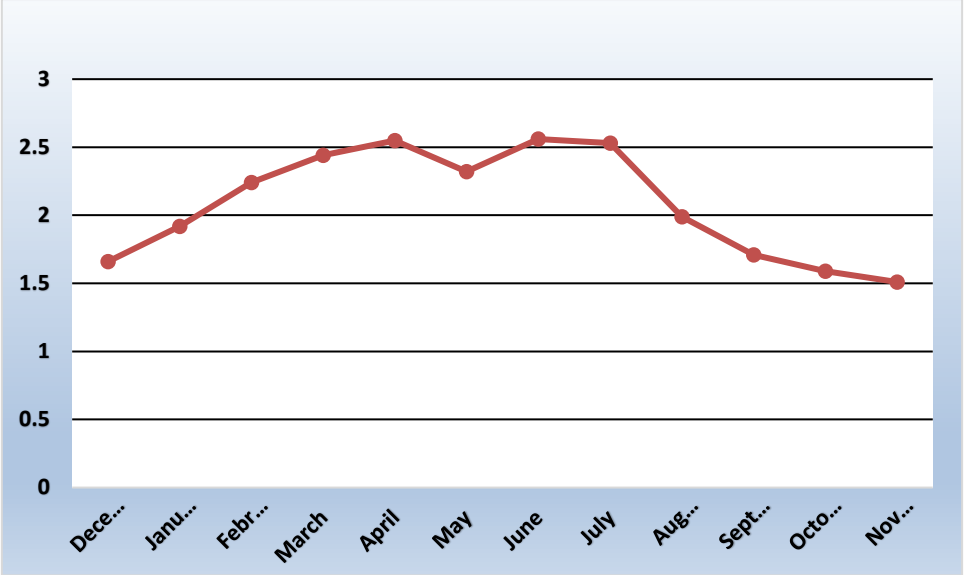
Table (3) and Figure (3) make it evident that the monthly average wind speed peaked in June at 2.56 m/s and fell to 1.51 m/s in November. The yearly average, on the other hand, was around 2.09 m/s.

Table (3) shows the Diwaniyah station's monthly rates and yearly average wind speed (m/s) for 2024.

month	**Monthly average**	**month**	Monthly average
December	1.66	June	2.56
January	1.92	July	2.53
February	2.24	August	1.99
March	2.44	September	1.71
April	2.55	October	1.59
May	2.32	November	1.51
Annual average	2.09		

Source: Ministry of Transport and Communications, Meteorology and Seismic Monitoring Authority, Climate Department, unpublished data, 2024.

Figure (3) shows the Diwaniyah station's monthly rates and yearly average wind speed (m/s) for 2024.



Source: Table (3)

4- Evaporation:

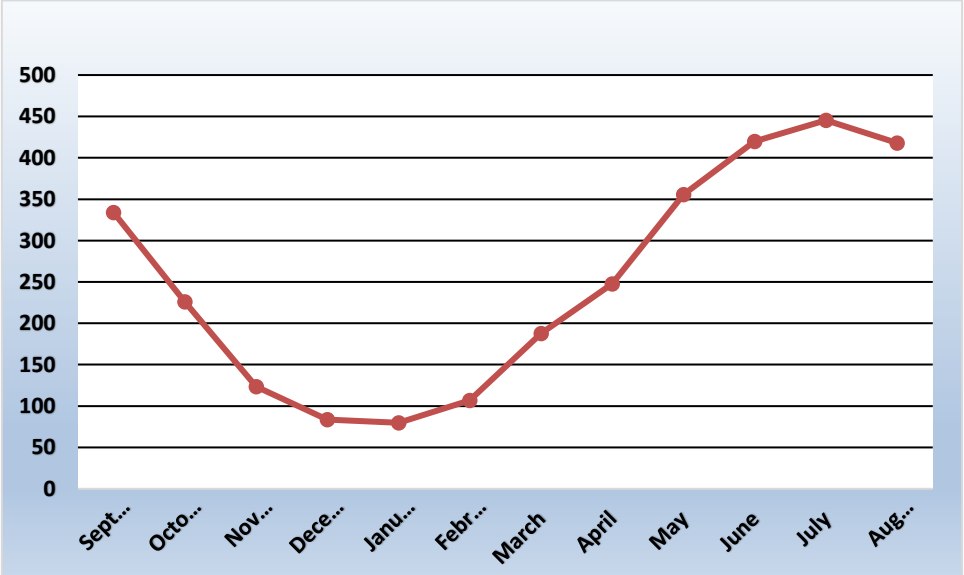
Table (4) and Figure (4) make it evident that the average monthly evaporation totals peaked in July at 445.41 mm and fell as low as 79.79 mm in January. The yearly total was 3028.36 mm.

Table (4) shows the Diwaniyah station's average monthly totals and yearly total evaporation (mm) for 2024.

month	Monthly average	month	Monthly average
September	334.14	March	187.88
October	226.16	April	247.69
November	123.54	May	355.73
December	83.58	June	419.81
January	79.79	July	445.41
February	106.74	August	417.89
Annual average	3028.36		

Source: Ministry of Transport and Communications, Meteorology and Seismic Monitoring Authority, Hydrological Implications Department, unpublished data, 2024.

Table (4) shows the Diwaniyah station's monthly evaporation totals (mm) for 2024.



Source: Table (4).

5- Relative humidity:

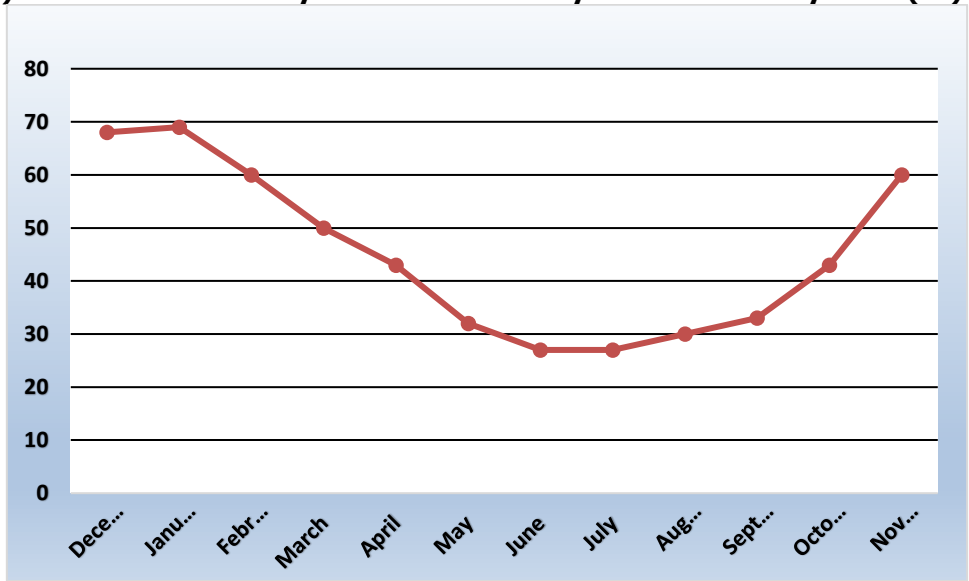
The analysis of the data in Table (5) and Figure (5) makes it evident that the monthly rates of relative humidity peaked in January at 69 %, and then fell to their lowest points in July and August at 27 %, while the annual rate reached 45 %.

Table (5) shows the Al-Diwaniyah station's monthly and yearly relative humidity rates (%) for 2024.

month	Monthly average	month	**Monthly average**
December	68	June	27
January	69	July	27
February	60	August	30
March	50	September	33
April	43	October	43
May	32	November	60
Annual average		45	

Source: Ministry of Transport and Communications, Meteorology and Seismic Monitoring Authority, Hydrological Implications Department, unpublished data, 2024.

Figure (5) shows the Al-Diwaniyah station's monthly relative humidity rates (%) for 2024.



Source: Table (5).

6- Rainfall:

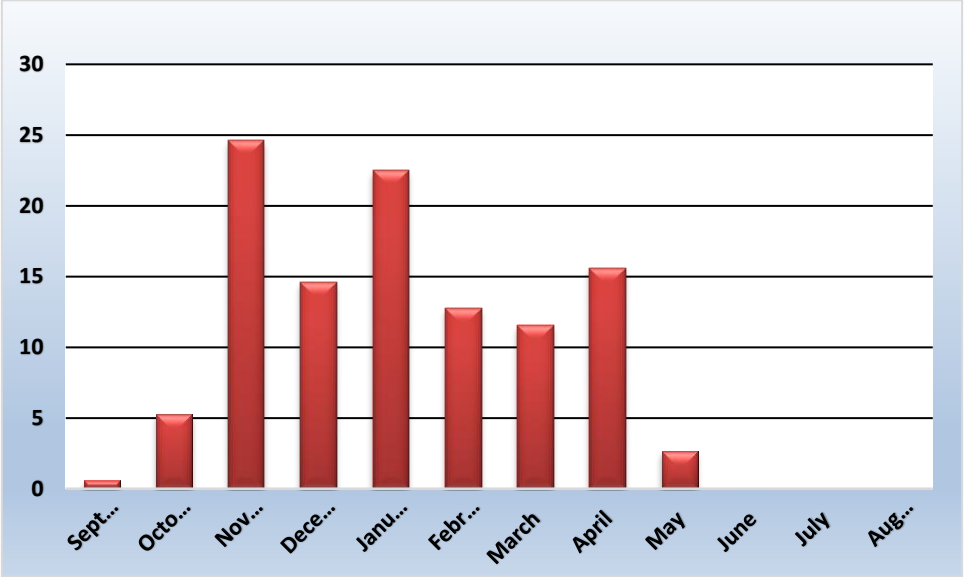
The analysis of the data in Table (6) and Figure (6) makes it evident that the average monthly rainfall totals peaked in January at 24.62 mm, and then fell to a minimum of 0 mm in July and August, while the annual total reached 110.05 mm.

Table (6) shows the Diwaniyah station's average monthly and yearly rainfall totals (mm) for 2024.

Monthly average	month	month	**Monthly average**
September	0.61	March	11.52
October	5.22	April	15.6
November	24.62	May	2.63
December	14.57	June	0.01
January	22.5	July	0
February	12.77	August	0
Annual average		110.05	

Source: Ministry of Transport and Communications, Meteorology and Seismic Monitoring Authority, Hydrological Implications Department, unpublished data, 2024.

Figure (6) shows the Diwaniyah station's average monthly rainfall totals (mm) for the year 2024.



Source: Table (6).

Section Two
Evaluation of Al-Dalmaj Marsh's water and plant cover index

Introduction:

The marsh areas alter in size in response to variations in water flows because they are directly correlated with the amounts of imported water. The above-mentioned rainfall climatic data suggests that the marsh areas grew during the winter months as a result of the heavy rainfall, which raises the water level of the rivers that flow into the Dalmaj Marsh from the Tigris River and other waterways. This, in turn, raises the water level in the general estuary that supplies water to the marsh. The study used satellite imagery taken by the Landsat 8 satellite over a 12-month period in 2024 to illustrate the fluctuation in the Dalmaj Marsh's water and plant cover area , The following formulas were used:

1- Normalized Water Cover Index (NDWI):

NDWI = (NIR – SWIR) / (NIR + SWIR(

For Landsat 8 data, NDWI = (Band 5 – Band 6) / (Band 5 + Band 6)

2- Normalized vegetation index (NDVI):

NDVI = (NIR – Red) / (NIR + Red(

For Landsat 8 data, NDVI = (Band 5 – Band 4) / (Band 5 + Band 4)

The following outcomes were obtained by evaluating the satellite photos using the aforementioned equations:

Table (7) shows the Al-Dalmaj Marsh's area covered by flora, water, and bare ground in 2024.

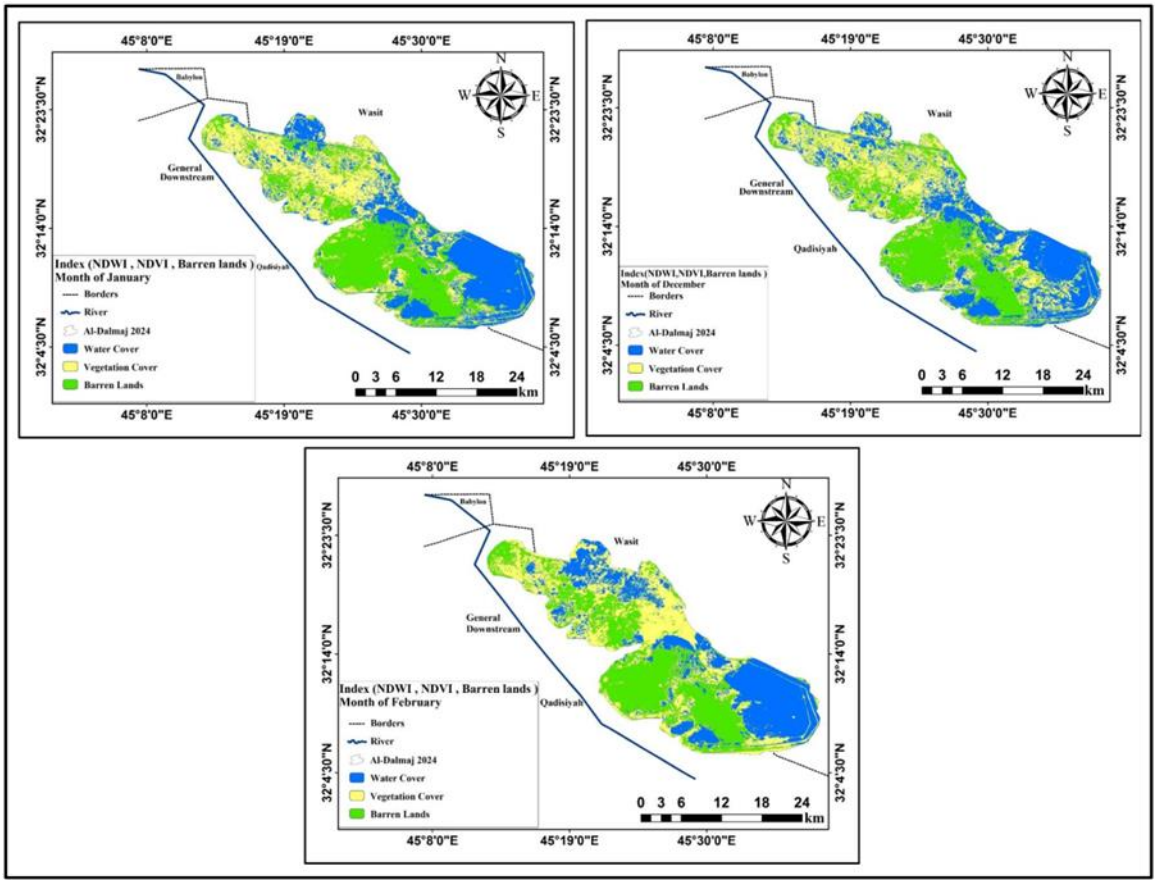
Area / month	Area (km2) of barren lands	Area (km2) of vegetation	Area (km2) of water cover
December	196.96	188.36	188.39
January	192.31	192.72	188.69
February	189.48	198.8	185.43
March	209.58	178.82	185.31
April	177.03	209.67	187.02
May	201.84	191.14	180.74
June	189.02	205.95	178.75
July	206.86	197.53	169.33
August	201.52	203.1	169.1
September	195.56	197.46	180.7
October	201.93	187.57	184.21
November	188.84	193.72	191.16

Source: The researcher's work based on Maps (2), (3), (4) and (5).

1- Winter months:

Map (2) and Table (7) make it evident that the area of water cover peaked in January at approximately 188.69 km2, then declined in February to reach 185.43 km2, and the area of vegetation cover peaked in February at 198.8 km2, then fell to 188.36 km2 at its lowest in December. Regarding the extent of barren lands, it peaked in December at 196.96 km2, and then declined to its lowest point in February, when it was 189.48 km2, throughout the winter season.

Map (2) shows the Al-Dalmaj Marsh's water cover, vegetation, and bare areas in the winter of 2024.

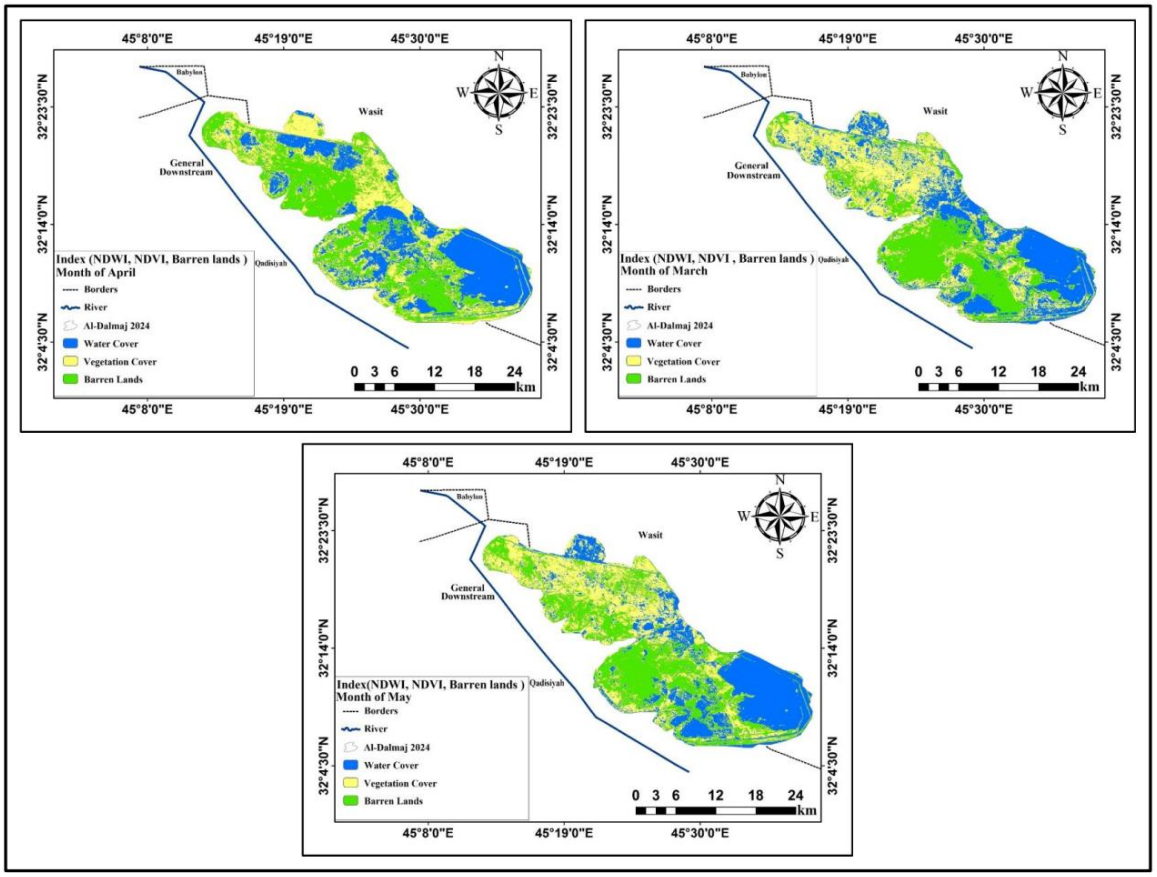


Source: Researcher's work based on satellite imagery captured by Landsat 8 satellite for the month December, January and February and the outputs of Arc GIS 10.5 program.

2- Spring months:

Map (3) and Table (7) make it evident that the maximum area of water cover reached approximately 187.02 km2 in April and then decreased to 180.74 km2 in May. Meanwhile, the area of vegetation cover reached a maximum of 209.67 km2 in April, the largest area of vegetation cover in 2024, and a minimum of 178.82 km2 in March, the lowest area of vegetation cover in 2024 , During the spring season, the area of barren lands reached its lowest point in April, reaching 177.03 km2, the lowest area of barren lands in 2024. The area of barren lands reached its maximum in March, reaching 209.58 km2, the largest area of barren lands in 2024.

Map (3) Al-Dalmaj Marsh's water cover, vegetation, and bare earth areas in the spring of 2024

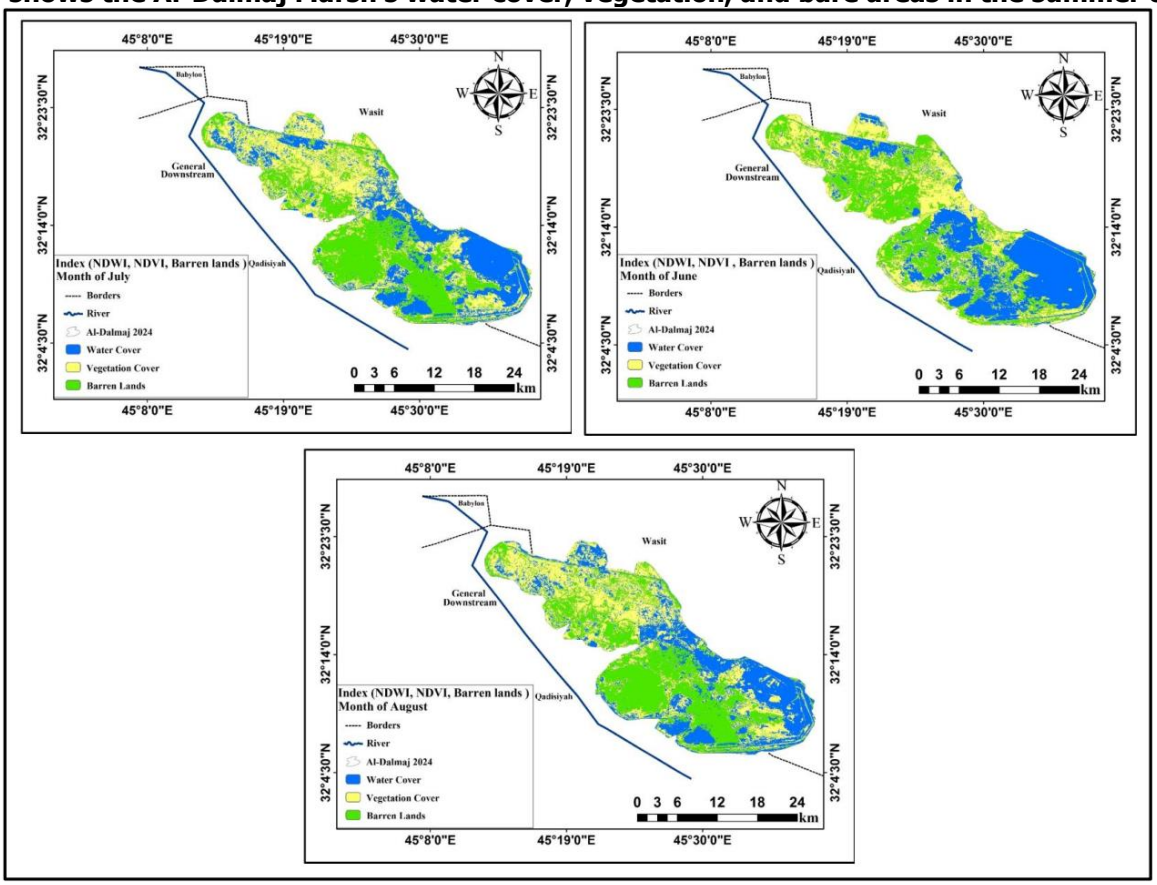


Source: Researcher's work based on satellite imagery captured by Landsat 8 satellite for the month March, April and May and the outputs of Arc GIS 10.5 program.

3- Summer months:

Map (4) and Table (7) make it evident that the water cover's maximum area was approximately 178.75 km2 in June, and that it decreased in August to reach 169.1 km2, the smallest area of water cover in 2024. Meanwhile, the vegetation cover's area peaked in June at 205.95 km2, and then fell to 19.53 km2 at its lowest in July. The barren lands' area peaked in July at 206.86 km2, and then fell to its lowest area of the summer in June, reaching 189.02 km2.

Map (4) shows the Al-Dalmaj Marsh's water cover, vegetation, and bare areas in the summer of 2024.

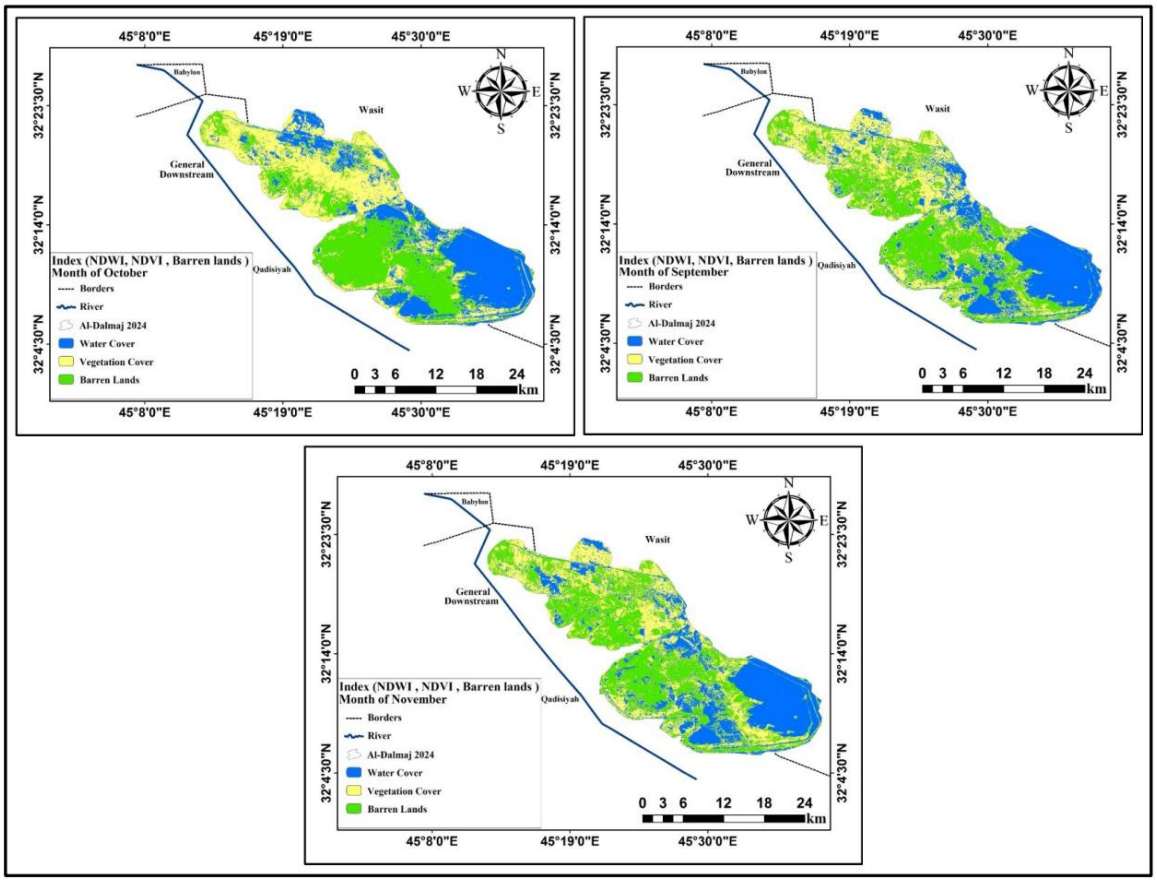


Source: Researcher's work based on satellite imagery captured by Landsat 8 satellite for the month June, July and August and the outputs of Arc GIS 10.5 program.

4- Autumn months:

Map (5) and Table (7) make it evident that the largest area of water cover in 2024 was approximately 191.16 km2 in November, and that this area decreased to 180.7 km2 in September. The area of vegetation cover reached a maximum of 197.46 km2 in September, and a minimum of 187.57 km2 in October. The area of barren lands reached its maximum in October, reaching 201.93 km2, and then decreased to its lowest area during the fall season in November, reaching 188.84 km2.

Map (5) shows the Al-Dalmaj Marsh's water cover, vegetation, and bare areas in the summer of 2024.



Source: Researcher's work based on satellite imagery captured by Landsat 8 satellite for the month September, October and November and the outputs of Arc GIS 10.5 program.

Section Three: Relationships in Statistics The statistical correlation between the water cover index (NDWI) and vegetation index (NDVI) in Al-Dalmaj Marsh for 2024 and Climate factors

Introduction:

In order to demonstrate how climate influences the variance of the water cover area and plant cover in Al-Dalmaj Marsh, it was important to identify which climatic components had the most impact, as some have a direct effect while others have an indirect one. Furthermore, statistical techniques were required to ascertain the magnitude of this variance. Because some of them have a positive influence—that is, a direct association that results in an increase in the variation of the water and vegetation area—the direction of the climatic element's effect is also demonstrated , In the research region, some of them have a negative effect, which means that the connection is inverse and they lower the area of water and plant cover.

The statistical relationships between the climatic elements (temperature, relative humidity, rainfall, evaporation, monthly solar radiation rates, and rainfall) in Tables 1, 2, 3, 4, 5, and 6 were connected with the area of water cover, vegetation cover, and barren lands in Al-Dalmaj Marsh in order to determine the statistical relationship under the significance level (0.05) and confidence level (0.95). The correlation's strength was extracted using Pearson's correlation coefficient, and the regression coefficient and the quantity of the dependent element's influence on the dependent element were interpreted using the interpretation or determination coefficient (R2).

1- The statistical correlation between Al-Damlaj Marsh's water cover index (NDWI) and climate factors in 2024:

Table 8's data analysis reveals a strong inverse correlation with statistical significance below the significance level (0.05) and confidence level (95%). The monthly average of temperature, evaporation, total solar radiation, and the water cover index (NDWI) had correlation values of -0.77, -0.84, and -0.81, respectively, while the monthly average of wind speed had a weak inverse correlation, with a correlation value of -0.38. Additionally, a statistically significant strong

direct link was found between the monthly average of relative humidity and the monthly total rainfall, with correlation values of 0.81 and 0.84, respectively.

As can be shown in Table 9, the coefficient of regression indicates that the rate of change in the water surface coverage due to changes in climate elements reached 504,265, indicating the presence of a direct relationship. Regarding the interpretive factor, the amount of change brought about by climate factors in the water coverage zone is evident from table (10) and has reached 81%, meaning that the remaining 19% of the change is caused by other factors modifying the area , Ceci explains how the climate's factors affect the variance in the water's surface coverage and are connected by both direct and inverse correlations. It demonstrates the validity of the researcher's hypothesis that climate factors have an impact on the water's surface coverage. coverage of water in Dalmaj's district.

Table (8) shows the statistical correlation between Al-Dalmaj Marsh's Normalized Water Cover Index (NDWI) and climate factors in 2024.

Correlations								
		NDWI	Solar	temperature	Wind	Evaporation	Humidity	Rain
Pearson Correlation	NDWI	1.000	-.767-	-.839-	-.377-	-.879-	.809	.839
	Solar	-.767-	1.000	.895	.693	.939	-.948-	-.789-
	temperature	-.839-	.895	1.000	.327	.983	-.983-	-.874-
	Wind	-.377-	.693	.327	1.000	.462	-.454-	-.325-
	Evaporation	-.879-	.939	.983	.462	1.000	-.980-	-.876-
	Humidity	.809	-.948-	-.983-	-.454-	-.980-	1.000	.886
	Rain	.839	-.789-	-.874-	-.325-	-.876-	.886	1.000
Sig. (1-tailed)	NDWI	.	.002	.000	.114	.000	.001	.000
	Solar	.002	.	.000	.006	.000	.000	.001
	temperature	.000	.000	.	.150	.000	.000	.000
	Wind	.114	.006	.150	.	.065	.069	.151
	Evaporation	.000	.000	.000	.065	.	.000	.000
	Humidity	.001	.000	.000	.069	.000	.	.000
	Rain	.000	.001	.000	.151	.000	.000	.
N	NDWI	12	12	12	12	12	12	12
	Solar	12	12	12	12	12	12	12
	temperature	12	12	12	12	12	12	12
	Wind	12	12	12	12	12	12	12
	Evaporation	12	12	12	12	12	12	12
	Humidity	12	12	12	12	12	12	12
	Rain	12	12	12	12	12	12	12

Source: The researcher's work based on Table (1), (2), (3), (4), (5), (6), (7), and the outputs of the IBM SPSS program.26

Table (9) shows the 2024 regression coefficient between Al-Dalmaj Marsh's Normalized Water Cover Index (NDWI) and meteorological factors.

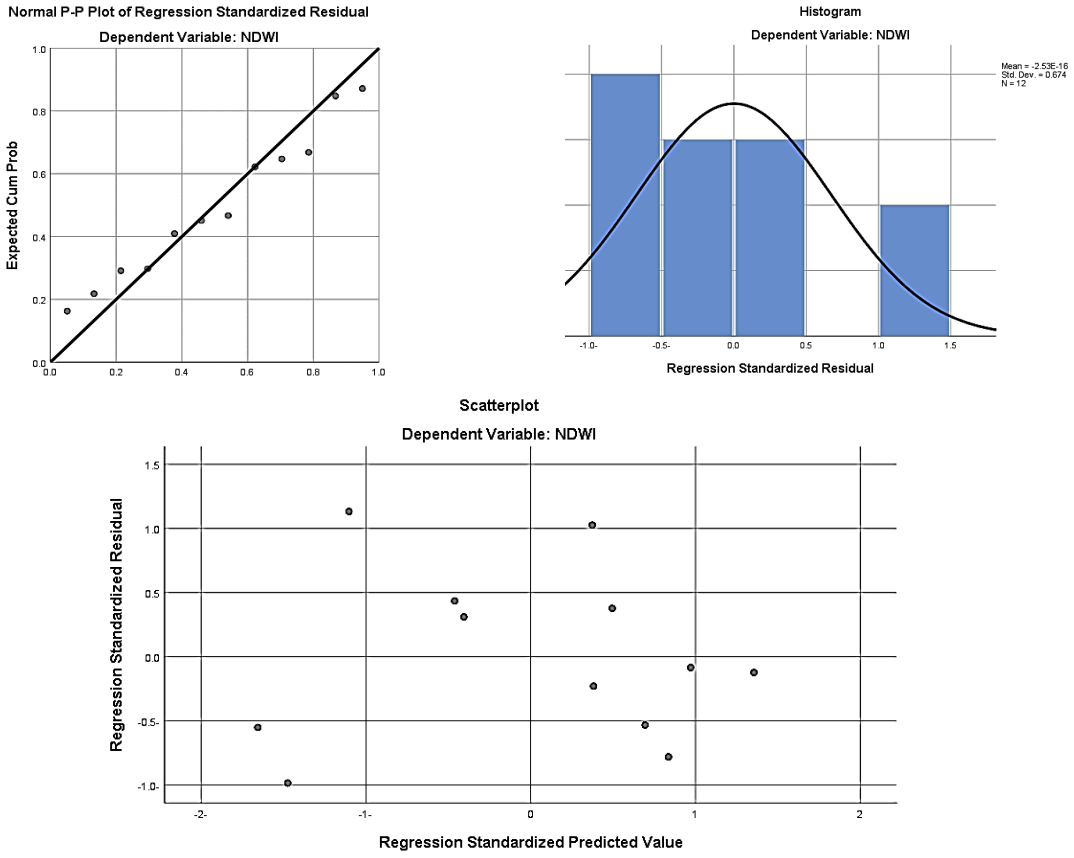
ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	504.265	6	84.044	7.389	.022[b]
	Residual	56.870	5	11.374		
	Total	561.134	11			
a. Dependent Variable: NDWI						
b. Predictors: (Constant), Rain, Wind, temperature, Solar, Evaporation, Humidity						

Source: The researcher's work based on Table (1), (2), (3), (4), (5), (6), (7), and the outputs of the IBM SPSS program.26

Table (10) shows the explanation coefficient (R2) for the 2024 impact of the water cover index (NDWI) and climate factors in Al-Dalmaj Marsh.

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.948[a]	.899	.777	3.37253
a. Predictors: (Constant), Rain, Wind, temperature, Solar, Evaporation, Humidity				
b. Dependent Variable: NDWI				

Source: The researcher's work based on Table (1), (2), (3), (4), (5), (6), (7), and the outputs of the IBM SPSS program.26



2- The statistical correlation between Al-Damlaj Marsh's vegetation index (NDVI) and meteorological factors in 2024:

According to the data analysis in Table (11) there is a weak inverse correlation without statistical significance for each of the monthly averages of relative humidity, with a correlation value of -0.40, and a very weak inverse correlation for rainfall, with a correlation value of -0.21. The correlation values between the monthly averages of total solar radiation and temperature, wind speed, evaporation, and vegetation index (NDVI) were 0.46, 0.43, 0.34, and 0.44 respectively , As can be seen in Table (12), there is a direct correlation even though the regression coefficient indicates that the rate of change in the area of plant cover as a result of the change in climatic components reached (391.285). Regarding the interpretation coefficient, Table (13), it is evident that the amount of change in the area of plant cover that was produced by climatic conditions reached 48%. This indicates that other variables were responsible for the remaining 52% of the change in the area , This clarifies that there are direct and inverse relationships between climatic factors and the fluctuation in the area of plant cover. This demonstrates that the researcher's hypothesis—that climate factors influence the amount of plant cover in the Dalmaj Marsh is correct.

Table (11) shows the statistical correlation between Al-Dalmaj Marsh's vegetation index (NDVI) and meteorological factors for 2024.

Correlations								
		NDVI	Solar	temperature	Wind	Evaporation	Humidity	Rain
	NDVI	1.000	.460	.426	.343	.441	-.407-	-.213-

Pearson Correlation	Solar	.460	1.000	.895	.693	.939	-.948-	-.789-
	temperature	.426	.895	1.000	.327	.983	-.983-	-.874-
	Wind	.343	.693	.327	1.000	.462	-.454-	-.325-
	Evaporation	.441	.939	.983	.462	1.000	-.980-	-.876-
	Humidity	-.407-	-.948-	-.983-	-.454-	-.980-	1.000	.886
	Rain	-.213-	-.789-	-.874-	-.325-	-.876-	.886	1.000
Sig. (1-tailed)	NDVI	.	.066	.083	.138	.076	.095	.253
	Solar	.066	.	.000	.006	.000	.000	.001
	temperature	.083	.000	.	.150	.000	.000	.000
	Wind	.138	.006	.150	.	.065	.069	.151
	Evaporation	.076	.000	.000	.065	.	.000	.000
	Humidity	.095	.000	.000	.069	.000	.	.000
	Rain	.253	.001	.000	.151	.000	.000	.
N	NDVI	12	12	12	12	12	12	12
	Solar	12	12	12	12	12	12	12
	temperature	12	12	12	12	12	12	12
	Wind	12	12	12	12	12	12	12
	Evaporation	12	12	12	12	12	12	12
	Humidity	12	12	12	12	12	12	12
	Rain	12	12	12	12	12	12	12

Source: The researcher's work based on Table (1), (2), (3), (4), (5), (6), (7), and the outputs of the IBM SPSS program.26

Table (12) shows the 2024 regression coefficient between the vegetation index (NDVI) and meteorological factors in Al-Dalmaj Marsh.

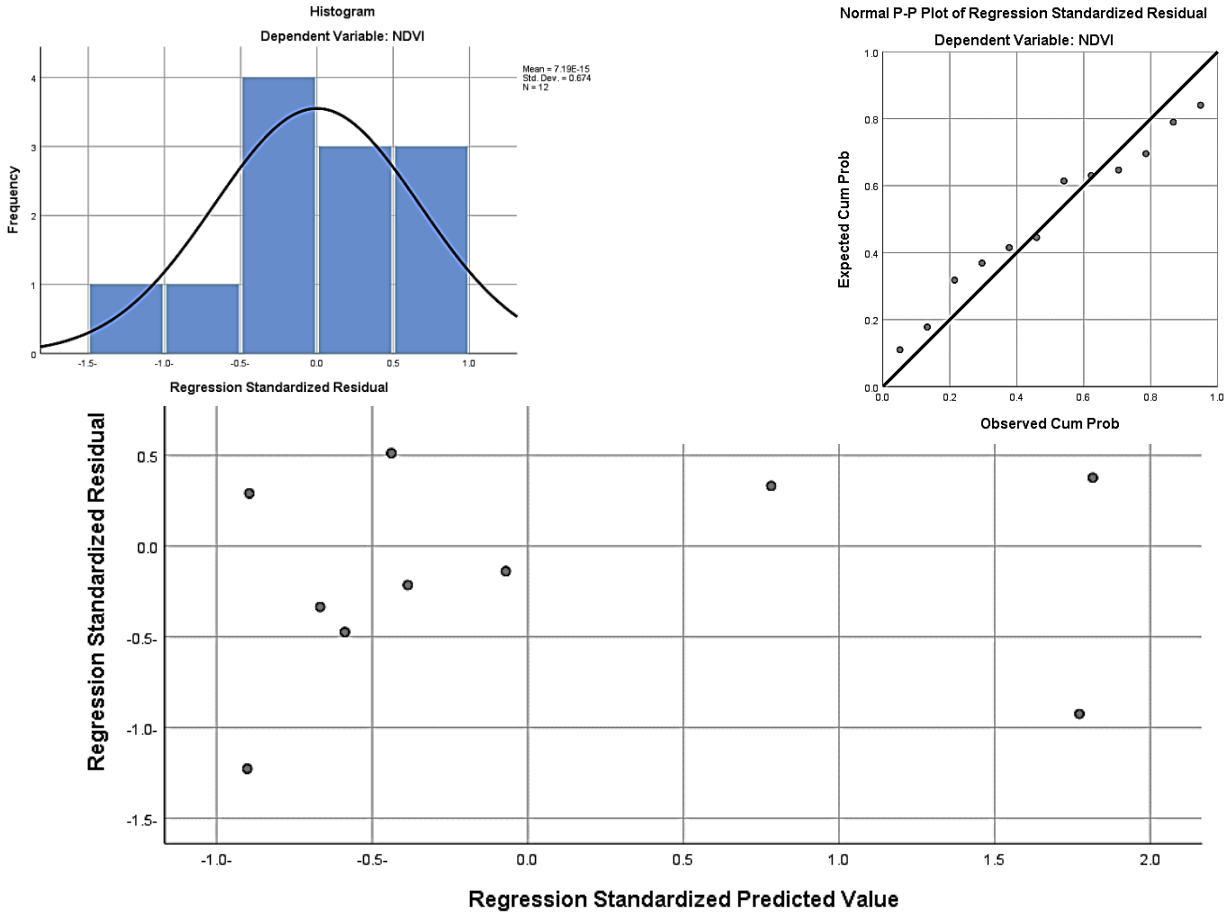
ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	391.285	6	65.214	.782	.619[b]
	Residual	417.201	5	83.440		
	Total	808.485	11			
a. Dependent Variable: NDVI						
b. Predictors: (Constant), Rain, Wind, temperature, Solar, Evaporation, Humidity						

Source: The researcher's work based on Table (1), (2), (3), (4), (5), (6), (7), and the outputs of the IBM SPSS program.26

Table (13) shows the explanation coefficient (R2) for the 2024 impact of the vegetation index (NDVI) and meteorological factors in Al-Dalmaj Marsh.

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.696[a]	.484	-.135-	9.13456
a. Predictors: (Constant), Rain, Wind, temperature, Solar, Evaporation, Humidity				
b. Dependent Variable: NDVI				

Source: The researcher's work based on Table (1), (2), (3), (4), (5), (6), (7), and the outputs of the IBM SPSS program.26



CONCLUSIONS:

1- According to the findings of the water cover index investigation, the water area achieved its highest in November (191.16) and its minimum in August (169.1) within the same month. In terms of the vegetation cover area, it peaked in April at 209.67 km² and then fell to 178.82 km² in March. The area of barren lands saw a drop in April, reaching a low of 177.03 km2, and a rise in March, reaching a high of 209.58 km2.

2- The monthly average of temperature, evaporation, and total solar radiation and the water cover index (NDWI) had a weak inverse correlation with the NDWI, whereas the monthly average of wind speed showed a strong inverse correlation with the NDWI, with statistical significance below the significance level (0.05) and confidence level (95%). Both the monthly average of relative humidity and the monthly total rainfall showed a significant direct association with statistical significance .

3- Regarding the vegetation index (NDVI), the monthly average of temperature, wind speed, evaporation, total solar radiation, and NDVI have a weak direct link with no statistical significance below the significance level (0.05) and confidence level (95%). There was also a very weak negative link for rainfall and a weak inverse correlation for each of the monthly averages of relative humidity that was not statistically significant.

RECOMMENDATIONS:

1. Using water collecting technologies, making the most use of the water resources that are available, and constructing reservoirs and dams to minimize water loss and provide the marsh with nutritious water.
2. In order to create tourist attractions and lessen the harm caused by dust and other phenomena that impede environmental development because they also alter some of the characteristics of swamp water and its area, concentrate on reforestation in swamp areas and enhancing the surrounding environment.
3. Natural reserves must be created to safeguard the biodiversity found in the wetlands being studied.

SOURCES :

1- Ministry of Transport and Communications, Meteorology and Seismology Authority, Climate Department, unpublished data, 2024.

2- Ministry of Transport and Communications, Meteorology and Seismology Authority, Hydrological Implications Department, unpublished data, 2024.

3- Satellite images captured by the Landsat 8 satellite