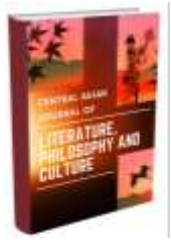

CENTRAL ASIAN JOURNAL OF LITERATURE, PHILOSOPHY, AND CULTURE

https://cajlpc.centralasianstudies.org/index.php/CAJLPC

Volume: 06 Issue: 01 | January 2025 ISSN: 2660-6828

Article

The Effect Of Climate On The Variation Of Water Cover Area In Lake Habbaniyah

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Abstract: Because of its social and economic effects on ecosystems, agriculture, and water supplies, drought risk assessment is crucial. This research tracked and assessed how climate change was affecting the water area of Lake Habbaniyah in western Iraq, particularly in the Anbar Governorate. In order to compare the findings of the index with the climatic factors for the months of the year, the Normalized Water Variation Index (NDWI) for the year 2023 was assessed using satellite photos taken by the Landsat satellite (8) for each month, with a total of (12) satellite images, When the water difference index values were extracted, it became evident that the area of lands without water cover reached its maximum area during the fall of September at approximately (195.37) km2 and a percentage of (59.16)%, while the area of water-covered lands reached its maximum area during the winter of February at approximately (184.51) km2 and a percentage of (55.87)%. The area of lands without water cover decreased to its lowest area during the fall of September at approximately (134.88) km2 and a percentage of (44.13)%.

Keywords: climate, climate change, NDWI, water area, Lake Habbaniyah

1. Introduction

The decline in the area of water cover in the lakes, which has manifested as drought, a lack of natural vegetation, a lack of rainfall, and extreme temperatures, is a result of significant environmental, climatic, and hydrological changes occurring in Iraq in general and Lake Habbaniyah in particular. Due to the scarcity of water, this condition has also resulted in a notable reduction in the areas of agricultural land. This is because the research region is impacted by a multitude of natural and human forces, creating a dynamic climate that is on the verge of drought. On the Tigris and Euphrates rivers and their tributaries, the upstream nations have set up numerous control and storage projects, This led to a worsening of the nation's environmental and human issues. Since the Euphrates River is the primary source of water for Lake Habbaniyah, the amount of water in the lake was correlated with the water supplied by the Euphrates River, which was reflected in the expansion or contraction of the surface water area and the ensuing environmental effects. Additionally, the discharges of Iraq's rivers varied from year to year and between seasons of the same year depending on the characteristics of the water year, whether it was wet or dry , This has a significant effect on soil, plants, surface and groundwater resources, and the economy because of the decline in agricultural activities, which in turn affects the country's food security. The impact of climate on the area of water cover in Lake Habbaniyah will be investigated in order to determine the magnitude of these impacts.

Citation: Al-Kulabi A. J. The Effect Of Climate On The Variation Of Water Cover Area In Lake Habbaniyah. Central Asian Journal of Literature, Philosophy, and Culture 2025, 6(1), 11-25.

Received: 10th Jan 2025
Revised: 11th Jan 2025
Accepted: 24th Jan 2025
Published: 27th Jan 2025

2. Materials and Methods

First: The research problem:

The research problem included (What is the role of climate impact on the variation of the water cover area in Lake Habbaniyah)?

Second: the hypothesis for the study:

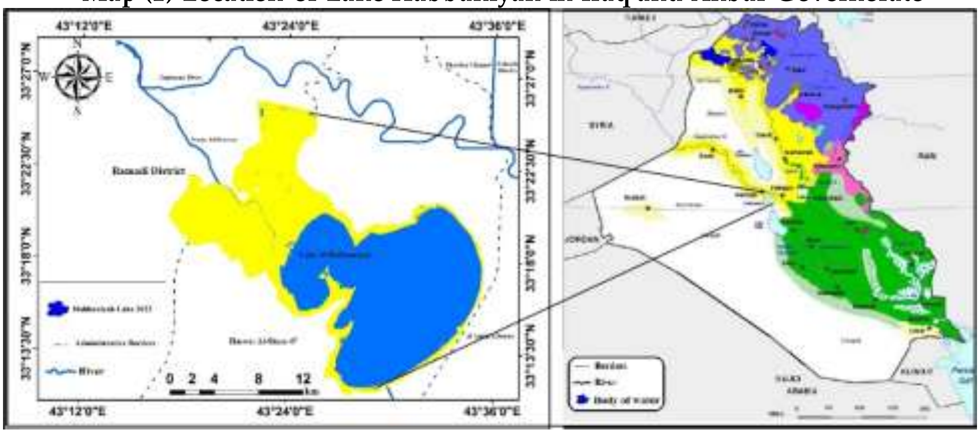
The way that the water cover area in Lake Habbaniyah varies throughout the year is influenced by the climate. This is particularly evident in the hot months, when there is less rainfall, high temperatures, a lot of evaporation, and low relative humidity, and the opposite is true in the cold months.

Third: Boundaries of research:

Geographically, Lake Habbaniyah is situated in the Anbar Governorate in western Iraq, on the right bank of the Euphrates River, southeast of the governorate's capital, Ramadi, and around 80 kilometers from Baghdad. It is administratively a part of the districts of Habbaniyah and Ramadi. As indicated by Map (1), astronomically, it is situated between latitudes (33,10 -33,48) north and longitudes (43,15 – 43,39) east. It has an overall size of 330.258 km².

Analyzing the research data for the year 2023 AD served as a representation of the study's temporal bounds.

Map (1) Location of Lake Habbaniyah in Iraq and Anbar Governorate



Source: Based on:

1- Republic of Iraq, Ministry of Irrigation, General Authority for Survey, Administrative Map of Iraq, scale 1/100,000 for the year 2000.

2- Satellite view of the satellite (8) LAND SAT for the year 2023 AD.

Fourth: The goal of the study :

In order to identify the causes, treatments, and suitable methods to lessen the effects of climate change, the research will first analyze climate data and its relationship to the variation in the area of water cover in Lake Habbaniyah. It will also determine the magnitude of the variations and identify the months when the water area increases as well as the months when it decreases.

Fifth: The purpose of the study:

1. The strategic significance of Lake Habbaniyah as a storage of water and a controlling element for the Euphrates River's flow, which many locals rely on for a variety of living purposes.
2. The fluctuation in the Euphrates River's water flow amounts and their effects on the lake's storage, particularly in light of climate change and the upstream nations' monopoly through storage projects, which is evident in the water's quality and quantity.
3. The paucity of research illustrating Lake Habbaniyah water cover area.

Sixth: Research Approach:

In order to arrive at the research findings, the researcher employed two methods: the descriptive approach, which relied on the region's existing data, and the analytical approach, which involved examining climate data and space visuals. The quantitative statistical method was then used to tabulate and process the data, and it was then extracted in a way that aligned with the research goals.

Seventh: Work methodology:

The Landsat OLI8 satellite images for the year 2023 were used to accomplish the research goals, the most crucial of which was to determine the condition of the water cover in Lake Habbaniyah. One image per month was used, and the following formula was applied to extract the water index:

NDWI = (NIR – SWIR) / (NIR + SWIR)

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

The data and information of the research region were processed and analyzed using Arc GIS (10.5), and the results were produced in a variety of formats according to the kind of data needed, including maps and tables.

Eighth: Research structure:

The study was divided into three chapters, the first of which addressed Lake Habbaniyah climatic features, the second of which examined the water cover index, and and the third chapter came to show the statistical relationship between the climatic characteristics and the water cover index in Lake Habbaniyah , in addition to the conclusions, recommendations and a list of sources.

3. Results

Chapter One
Climatic Characteristics of Lake Habbaniyah

Introduction:

The study area's climate is classified as a dry desert climate zone, which is distinguished by high temperatures, little precipitation, and significant temperature fluctuations. Therefore, in order to shed light on the role of climate factors and the extent of their impact on the area of water cover in Lake Habbaniyah, the research included the following analysis of climate data based on data from the Ramadi climate station for the year 2023 AD:

1- Solar radiation: -

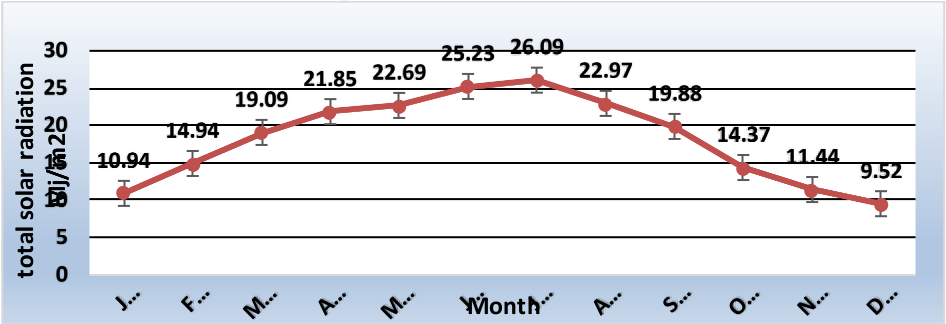
Analyzing the data in Table (1) and Figure (1) reveals that the monthly rates of total solar radiation peaked in July (26.09) mega joules/m2, then fell to their lowest point in December (9.52) mega joules/m2). The annual rate was 18.25 mega joules/m2.

Table (1) shows the monthly and yearly rates of total solar radiation Mj/m2 at Ramadi station from (1993-2023).

Month	Average	Month	Average
January	10.94	July	26.09
February	14.94	August	22.97
March	19.09	September	19.88
April	21.85	October	14.37
May	22.69	November	11.44
June	25.23	December	9.52
Annual average	18.25		

Source: Ministry of Transport and Communications, General Authority of Meteorology and Seismic Monitoring, Climate Department, unpublished data, 2023 AD.

Figure (1) Monthly rates of total solar radiation Mj/m2 for Ramadi station for the period (1993-2023)



Source: Based on Table (1)

2- Temperature:-

Temperature is the most significant climatic component. It causes changes in other elements such as wind, rainfall, evaporation, and atmospheric pressure, as well as the link between these and lake water volume. High temperatures cause increased evaporation, which depletes lake water and harms the aquatic ecology. Examining the Ramadi climate station's data on maximum, minimum, and usual temperatures reveals that the thermal ranges between the highest and lowest temperatures vary significantly throughout the year.

Table (2) and Figure (2) show that August had the greatest average temperature (36.55) degrees Celsius, while January had the lowest average (9.29) degrees Celsius. The yearly average temperature was 24.06 degrees Celsius.

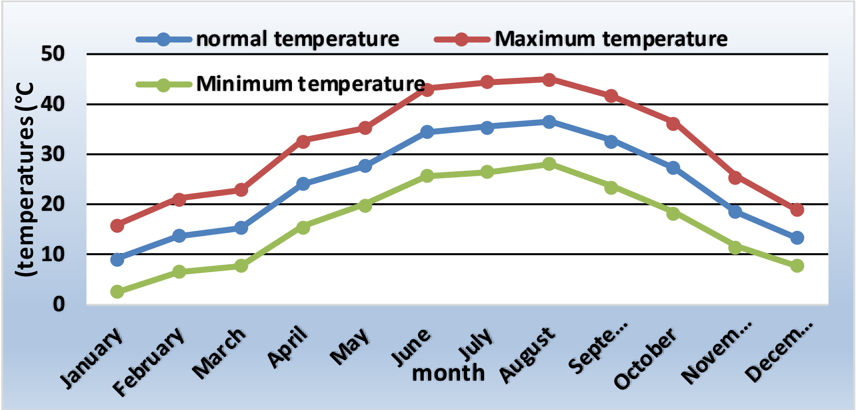
The minimum and maximum temperatures vary, with January having the lowest temperature of (2.56) degrees Celsius and August having the highest temperature of (45.03) degrees Celsius, making it the hottest month. According to this statistics, the region's climate is hot during seven months, from April to October, and slightly chilly for the remaining months.

Table (2) Monthly and yearly average temperatures (°C) at Ramadi station throughout the period (1993-2023)

month	normal temperature	Maximum temperature	Minimum temperature
January	9.29	16.03	2.56
February	13.87	21.11	6.64
March	15.36	22.91	7.81
April	24.06	32.64	15.49
May	27.68	35.34	20.01
June	34.48	43.13	25.82
July	35.49	44.47	26.51
August	36.55	45.03	28.07
September	32.66	41.73	23.58
October	27.36	36.27	18.46
November	18.59	25.55	11.63
December	13.35	18.96	7.73
Annual average	24.06	31.93	16.19

Source: Ministry of Transport and Communications, General Authority of Meteorology and Seismic Monitoring, Climate Department, unpublished data, 2023 AD.

Figure (2) Monthly average temperatures (°C) at Ramadi station throughout the period (1993-2023)



Source: Based on Table No. (2).

3- Wind Speed:

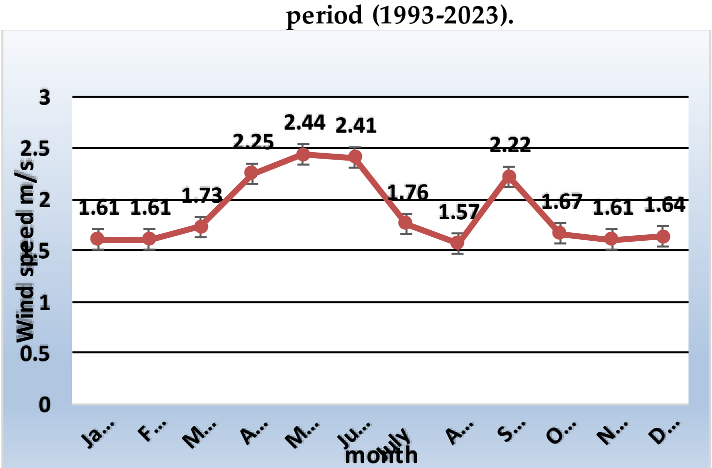
Wind is necessary for moving and spreading climatic elements such as humidity, temperature, and pollution from one location to another. Winds carry the attributes and characteristics of the place they travel through, influencing the volume of water. Hot and dry winds create higher evaporation, which affects water both quantitatively and qualitatively. The results in Table (3) and Figure (3) show that wind speed rates in the research region vary. The maximum wind speed rate was recorded in May at (2.44) m/s, while the lowest wind speed ever measured was in August at (1.57) m/s, with an annual average of (1.88) m/s.

Table (3): Monthly and yearly average wind speed (m/s) at Ramadi station from (1993-2023).

Month	Average	Month	Average
January	1.61	July	1.76
February	1.61	August	1.57
March	1.73	September	2.22
April	2.25	October	1.67
May	2.44	November	1.61
June	2.41	December	1.64
Annual average	1.88		

Source: Ministry of Transport and Communications, General Authority of Meteorology and Seismic Monitoring, Climate Department, unpublished data, 2023 AD.

Figure (3) Monthly averages of wind speed (m/s) at Ramadi station throughout the period (1993-2023).



Source: Based on Table No. (3).

4- **Evaporation:**

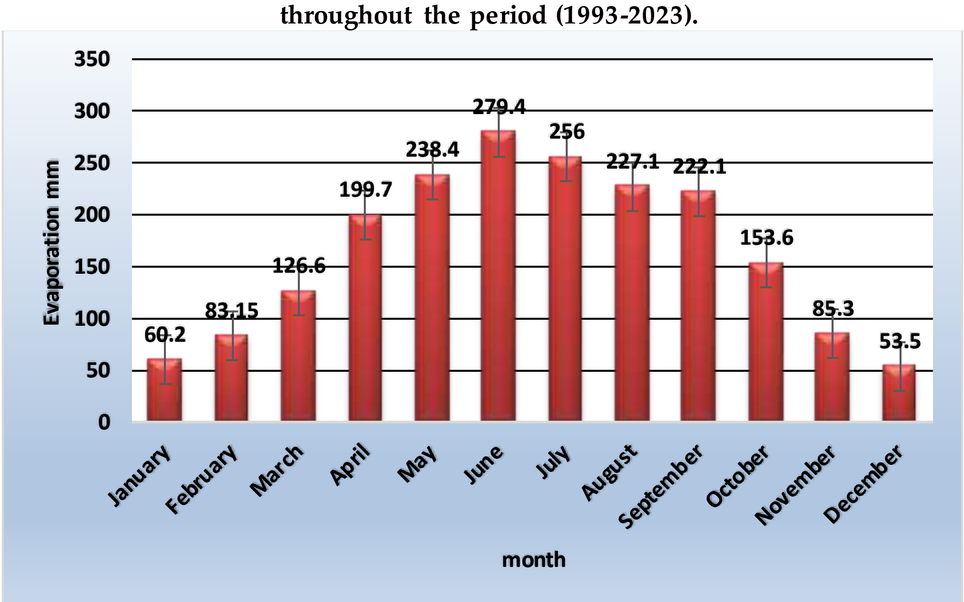
Evaporation is a fundamental component of the water cycle and a significant role in controlling lake water volume, making it a very relevant study issue. Table (4) and Figure (4) show the monthly variations in evaporation levels. Summer saw the greatest values, with June recording the maximum value of 279.4 mm, while winter, particularly December, saw the lowest value of 53.5 mm. This might enhance the rate of evaporation , This is due to an increase in the number of daylight hours during the summer and an increase in temperatures caused by the sun's rays at an almost vertical angle, as the average overall evaporation rate during the research years was (165.42) mm. Because the lake's short depth, breadth, and position in a dry environment all contributed to elevated evaporation rates, which influenced the amount of water, these high values are just a reflection of the climate in the research region.

Table (4): Average monthly totals and yearly evaporation rate (mm) at Ramadi station from (1993-2023).

Month	total	Month	total
January	60.2	July	256
February	83.15	August	227.1
March	126.6	September	222.1
April	199.7	October	153.6
May	238.4	November	85.3
June	279.4	December	53.5
Annual total	1985.05		

Source: Ministry of Transport and Communications, General Authority of Meteorology and Seismic Monitoring, Hydrological Implications Department, unpublished data, 2023 AD.

Figure (4) shows the monthly evaporation total rate (mm) for the Ramadi station throughout the period (1993-2023).



Source: Based on Table No. (4).

5- **Relative humidity:**

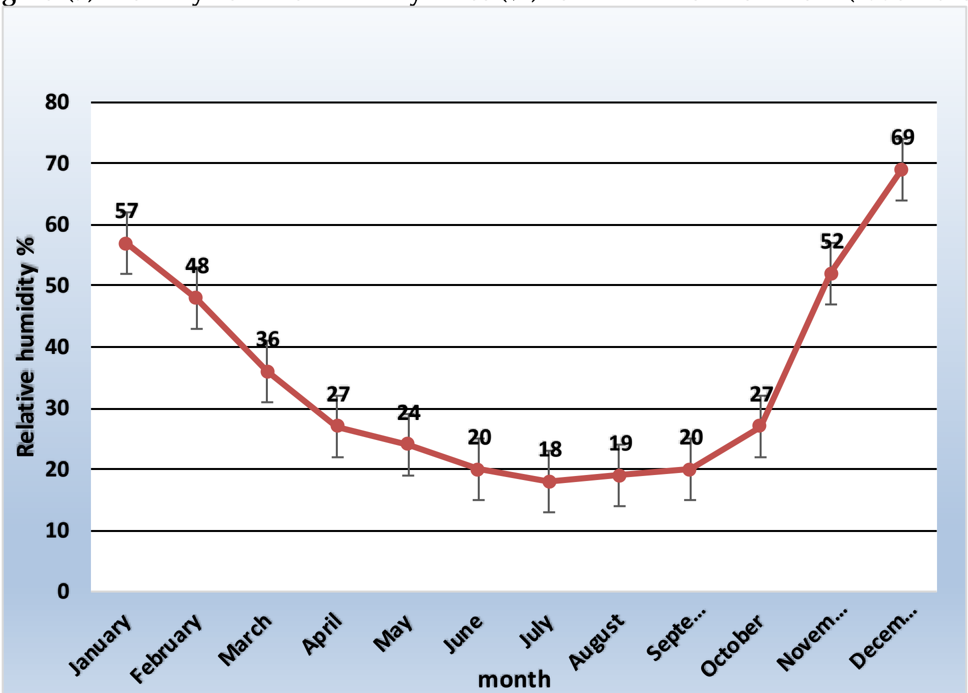
Relative humidity is significant because it impacts the amount of water since it creates rainfall, and its presence in the atmosphere limits the amount of solar radiation that reaches the lake's surface, lowering the evaporation rate. Examination table (5) and figure (5) demonstrate that the winter month of December had the greatest humidity rates, reaching (69)%, while July had the lowest monthly rate, reaching (18)%, with an annual average of (34.75)%. This implies that the region has a dry climate, which has influenced the pace of water evaporation from the lake and increasing demand for water, both of which have an impact on Lake Habbaniyah water content.

Table (5) shows the monthly and yearly relative humidity rates (%) at Ramadi station from (1993-2023).

Month	Average	Month	Average
January	57	July	18
February	48	August	19
March	36	September	20
April	27	October	27
May	24	November	52
June	20	December	69
Annual average	34.75		

Source: Ministry of Transport and Communications, General Authority of Meteorology and Seismic Monitoring, Hydrological Implications Department, unpublished data, 2023 AD.

Figure (5) Monthly relative humidity rates (%) for Ramadi station from (1993-2023).



Source: Based on Table No. (5).

6- Rain:

Rainfall in the research region is scarce and low. Ramadi is known for its shifting climate since it is located in a dry desert climatic area with yearly rainfall levels varying from (150) to (50) mm, According to the data analysis in Table (6) and Figure (6), the Ramadi climate station received the most rainfall in December, totaling (22.2) mm, while the months of June, July, August, and September saw no rainfall , The yearly total hit 126.4 mm. Because of the rarity of rain and the difficulty to foresee it, the alternatives for feeding the lake in the research region were limited, with the exception of small amounts that reach the lake via streams carried by valleys after rains in certain years.

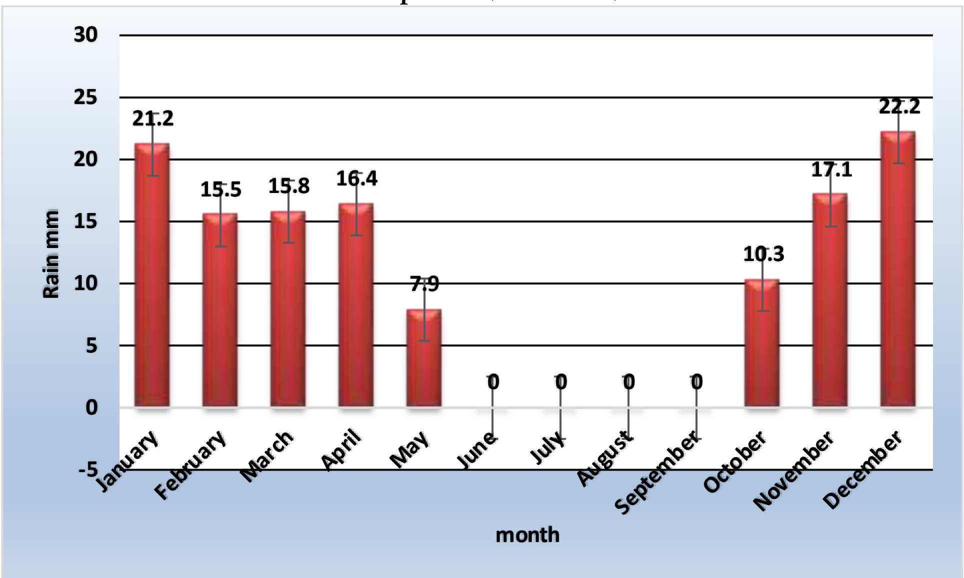
Table (6): Average monthly totals and yearly rainfall average (mm) for Ramadi station from (1993-2023).

Month	total	Month	total
January	21.2	July	0
February	15.5	August	0
March	15.8	September	0
April	16.4	October	10.3
May	7.9	November	17.1
June	0	December	22.2

Annual total	126.4

Source: Ministry of Transport and Communications, General Authority of Meteorology and Seismic Monitoring, Hydrological Implications Department, unpublished data, 2023 AD.

Figure (6) Average monthly rainfall totals (mm) at Ramadi station throughout the period (1993-2023).



Source: Based on Table No. (6).

Chapter Two

Analysis of the Normalized Water Cover Index (NDWI) for Lake Habbaniyah

Introduction:

Landsat 8 satellite pictures were utilized to distinguish water regions from other areas, as well as surface features of the research area, using the normalized water difference index. The following formula may be used to calculate this index:

$$\textbf{NDWI} = \frac{Band\ Green - Band\ NIR}{Band\ Green + Band\ NIR}$$

Indices like this one aid in identifying surface water bodies, monitoring their status, and distinguishing them from other surface characteristics. Water normally has a low spectral reflectance in the near-infrared wavelength range (0.90-0.76), but a high spectral reflectance in the green wavelength range (0.60-0.52). Values less than or equal to (0) indicate non-water surfaces, while values larger than (0) indicate water surfaces, resulting in an index value between (1-0)) .

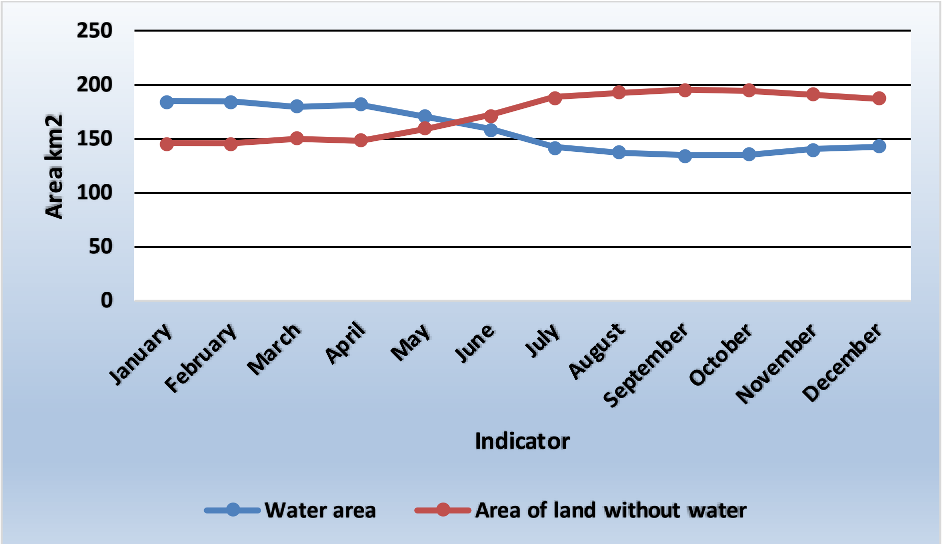
Table (7) shows Lake Habbaniyah area in km2 and water cover % in 2023.

month	Water area	percentage of water	Area of land without water	Percentage of land area that has no water
January	184.24	55.79	146.02	44.21
February	184.51	55.87	145.74	44.13
March	179.75	54.43	150.51	45.57
April	181.58	54.98	148.68	45.02
May	171.01	51.78	159.25	48.22
June	159.02	48.15	171.24	51.85
July	141.86	42.96	188.39	57.04
August	137.16	41.53	193.09	58.47
September	134.88	40.84	195.37	59.16
October	135.28	40.96	194.98	59.04
November	139.71	42.3	190.55	57.7
December	143.35	43.41	186.91	56.59

Source: Based on Maps (2), (3), (4) and (5).

Applying the water cover index made it evident that the water area varied significantly throughout the study period. As Table (7) and Figure (7) show, the water cover's maximum area in 2023 was approximately 184.51 km2 with a percentage of 55.87 percent during the winter season in February, while it fell to its lowest area in September, reaching approximately 134.88 km2 with a percentage of 40.84 percent , The area of land without water cover peaked in September during the autumn season at around 195.37 km² and at a rate of 59.56%, and then fell to its lowest level in February during the winter season at 145.74 km and a rate of 44.13%.

Figure (7) shows the extent of Lake Habbaniyah water-covered and non-water-covered areas (km2) in 2023.



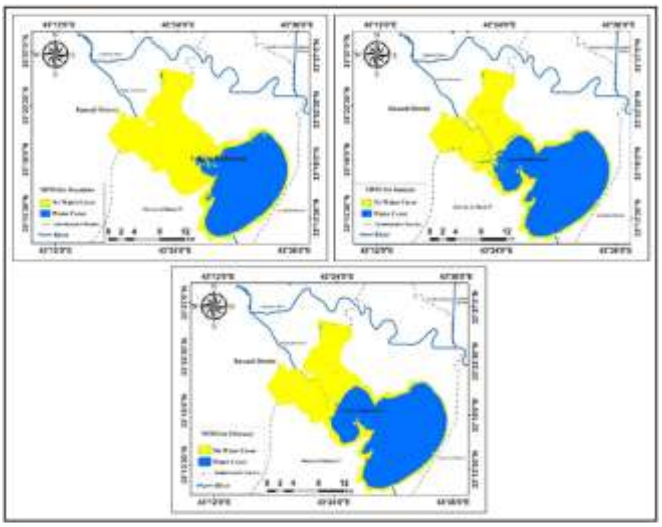
Source: Based on Table No. (7).

During the research period, the water cover index varied as follows over the seasons and months:

1- Winter:

The data analysis in Table (7), Figure (7), and Map (2) makes it evident that the water cover's highest area was 184.51 km2 in February, while it fell to its lowest point of 143.35 km2 in December. This is because of the drop in temperature, rise in relative humidity, drop in evaporation, and reduction in rainfall, all of which increase the area of water in Lake Habbaniyah.

Map (2) Lake Habbaniyah water cover area in the winter of 2023

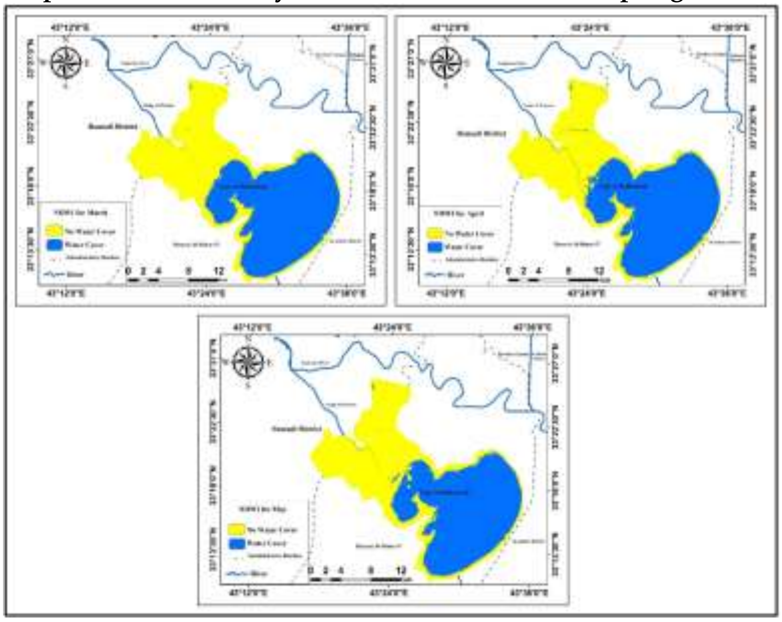


Source: The researcher's work is based on the satellite image captured by the Landsat 8 satellite on (12/4/2013), (1/10/2023), and (2/11/2023) and the outputs of the Arc GIS 10.5 program.

2- Spring:

Table (7), Figure (7), and Map (3) make it evident that the area of water cover gradually declines throughout the spring months, reaching its maximum in April at approximately 181.58 km2, which also happens to be the month with the highest spring rainfall (16.4) mm. In May, the lowest area was approximately 171.01 km2.

Map (3) Lake Habbaniyah water cover area in the spring of 2023

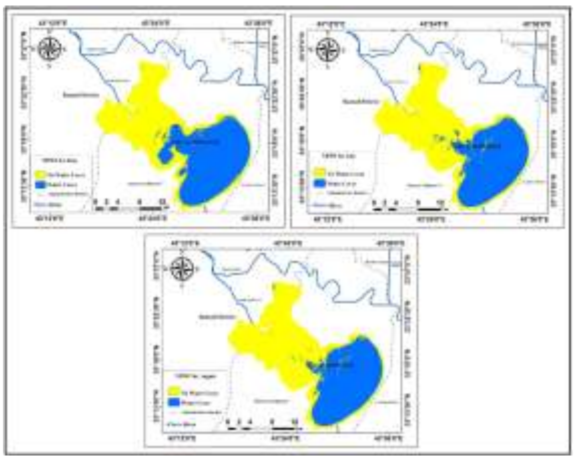


Source: The researcher's work is based on the satellite image captured by the Landsat 8 satellite on (3/7/2013), (4/16/2023), and (5/10/2023) and the outputs of the Arc GIS 10.5 program.

3- Summer:

Table (7), Figure (7), and Map (4) make it evident that the area of water cover gradually declines during the summer months. This is in line with rising temperatures, falling relative humidity, increased evaporation, and a lack of rainfall. The area of water cover reaches its maximum in June, at approximately 159.02 km2, and its lowest in August, at approximately 137.16

Map (4): Lake Habbaniyah water cover area in the summer of 2023

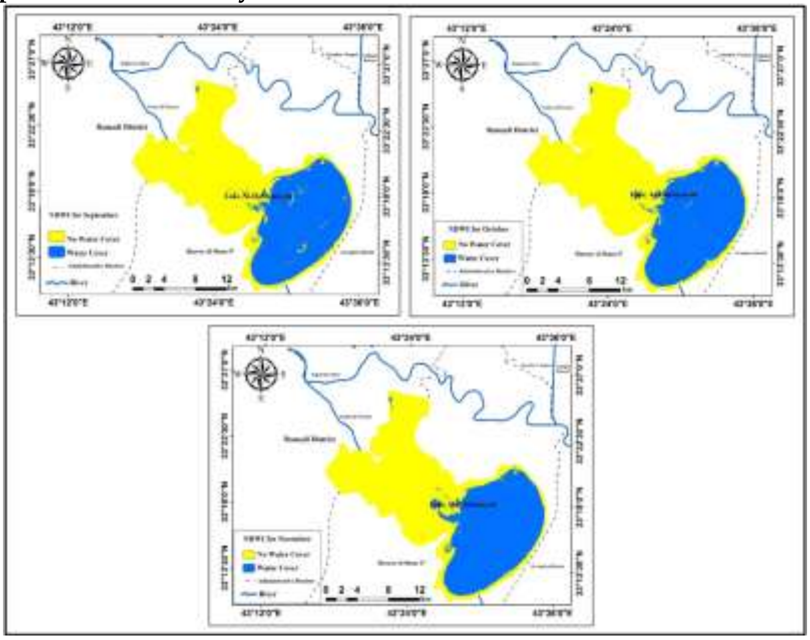


Source: The researcher's work is based on the satellite image captured by the Landsat 8 satellite on (6/11/2013), (7/13/2023), and (8/6/2023) and the outputs of the Arc GIS 10.5 program.

4- Autumn:

The data in Table (7), Figure (7), and Map (5) clearly show that the area of water cover starts to gradually increase. It peaked in November at approximately 139.71 km2, but it fell at the start of the autumn season in September to record (134.88) km2, which is its lowest area during this season.

Map (5): Lake Habbaniyah water cover area in the Autumn season of 2023



Source: The researcher’s work is based on the satellite image captured by the Landsat 8 satellite on (9/7/1013), (10/9/2023), and (11/22/2023) and the outputs of the Arc GIS 10.5 program.

Chapter Three:
The Statistical Association between Lake Habbaniyah Water Cover Index and Climatic Features

Introduction :

The researcher used a statistical relationship to determine how climate affected the area of water cover in Lake Habbaniyah. The statistical relationships between the climatic elements (temperature, wind speed, evaporation, relative humidity, rain, and solar radiation rates) and the area of water cover in Lake Habbaniyah were displayed in Tables 1, 2, 3, 4, 5, and 6 and Table (7), respectively, to confirm the statistical relationship under the significance level (0.05) and the confidence level (0.95). The correlation's strength was extracted using Pearson's correlation coefficient, and the regression coefficient and the degree of the independent element's effect on the dependent element were interpreted using the interpretation or determination coefficient (R2).

1- The statistical correlation between Lake Habbaniyah water cover index (NDWI) and climate factors in 2023:

Table (8) demonstrates that the average temperature and the water cover index have a moderate inverse correlation with a statistical significance below the significance level (0.05) and a confidence level (95%). In contrast, the correlation values for total solar radiation and evaporation showed very weak inverse correlations, reaching -0.025 and -0.24, respectively, while wind speed and relative humidity showed very weak Directional correlations, reaching 0.16 and 0.22, respectively, and rain showed a weak direct correlation of approximately 0.48.

The presence of significant differences is shown by the (ANOVAa) analysis's value of (Sig.) equal to (0.02), which is smaller than (0.05), as can be seen in Table 9.

Table (8) shows the statistical correlation between Lake Habbaniyah water cover index (NDWI) and climate factors in 2023.

Correlations								
		NDWI	radiation	Temperature	Wind	Evaporation	humidity	Rain
Pearson Correlation	NDWI	1.000	-.025-	-.556-	.161	-.243-	.228	.480
	radiation	-.025-	1.000	.813	.599	.944	-.899-	-.810-
	Temperature	-.556-	.813	1.000	.453	.928	-.897-	-.946-
	Wind	.161	.599	.453	1.000	.683	-.544-	-.410-
	Evaporation	-.243-	.944	.928	.683	1.000	-.938-	-.893-
	humidity	.228	-.899-	-.897-	-.544-	-.938-	1.000	.876
	Rain	.480	-.810-	-.946-	-.410-	-.893-	.876	1.000
Sig. (1-tailed)	NDWI	.	.469	.030	.309	.223	.238	.057
	radiation	.469	.	.001	.020	.000	.000	.001
	Temperature	.030	.001	.	.069	.000	.000	.000
	Wind	.309	.020	.069	.	.007	.034	.093
	Evaporation	.223	.000	.000	.007	.	.000	.000
	humidity	.238	.000	.000	.034	.000	.	.000
	Rain	.057	.001	.000	.093	.000	.000	.
N	NDWI	12	12	12	12	12	12	12
	radiation	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) ANOVAa study of Lake Habbaniyah water cover index (NDWI) and meteorological factors for 2023

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4408.118	6	734.686	7.715	.020[b]
	Residual	476.153	5	95.231		
	Total	4884.271	11			

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 regression coefficient for Lake Habbaniyah water cover index (NDWI) and meteorological factors in 2023.

Coefficients[a]									
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	220.748	77.395		2.852	.036			
	radiation	1.835	3.020	.505	.607	.570	-.025-	.262	.085
	Temperature	-4.918-	2.192	-2.264-	-2.244-	.075	-.556-	-.708-	-.313-
	Wind	-2.488-	27.309	-.041-	-.091-	.931	.161	-.041-	-.013-

	Evaporation	.265	.505	1.026	.525	.622	-.243-	.228	.073
	humidity	-.514-	.527	-.425-	-.975-	.374	.228	-.400-	-.136-
	Rain	.044	1.096	.018	.040	.969	.480	.018	.006

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

Regarding the regression coefficient, Table (10) shows that there is an inverse regression between temperature, wind speed, and relative humidity, with regression values of -4.918, -2.488, and -0.514, respectively, and a direct regression between total solar radiation, evaporation, and rainfall, with regression values of 1.835,.265, and.044, respectively. This indicates that an increase in temperature, wind speed, and relative humidity results in a decrease in the area of the water cover.

Regarding the coefficient of determination or interpretation, Table (11) illustrates the amount of change it causes to the statistical relationship between the climatic elements and the water cover index, reaching 0.90 percent. This indicates that other factors in the change in area are responsible for the remaining 10% of the change. This clarifies how the climatic factors influence the fluctuation in the water cover area and are connected to it through both direct and inverse correlations, This proves the validity of the researcher's hypothesis that climatic elements have an impact on the area of water cover in Lake Habbaniyah.

Table (11) shows the explanation coefficient (R2) for the 2023 impact of the water cover index (NDWI) and climate factors in Lake Habbaniyah.

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.950[a]	.903	.786	9.75862

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

4. Discussion

The analysis of the climatic characteristics of Lake Habbaniyah and their statistical relationship with the Normalized Difference Water Index (NDWI) provides critical insights into the dynamic interaction between climatic variables and the lake's water cover. The findings reveal that temperature has a moderate inverse correlation with the water cover index ($r = -0.556$, $p < 0.05$), indicating that as temperatures rise, the area of water cover decreases. This is primarily due to the increased evaporation rates driven by higher temperatures, which accelerates water loss from the lake's surface. This pattern aligns with the seasonal variations observed, where the water cover significantly decreases during the hot summer months (June to August) and expands during the cooler winter months (December to February).

Interestingly, rainfall showed a weak but positive correlation with the NDWI ($r = 0.480$), suggesting that even limited precipitation events contribute positively to maintaining the lake's water cover. This is evident from the peak water cover recorded in February, coinciding with higher rainfall levels. Conversely, solar radiation and evaporation exhibited very weak inverse correlations with the NDWI (-0.025 and -0.243, respectively), which can be attributed to the complex interplay between these factors and other climatic variables such as humidity and wind speed. Although high solar radiation typically enhances evaporation, its direct effect on the water cover was minimal, likely due to compensatory factors like cloud cover during certain seasons.

Wind speed and relative humidity displayed weak directional correlations (r = 0.161 and r = 0.228, respectively). While wind can influence evaporation rates by promoting surface water movement, its impact appears limited in this study, possibly due to the relatively low average wind speeds observed throughout the year. Similarly, higher relative humidity tends to reduce evaporation, yet its weak correlation with the NDWI suggests that humidity alone is not a dominant factor affecting water cover without considering other climatic conditions.

The regression analysis further supports these findings, with temperature, wind speed, and relative humidity showing inverse regression coefficients, indicating their negative impact on water cover. In contrast, solar radiation, evaporation, and rainfall demonstrated direct regression coefficients, although the statistical significance of these relationships varied. Notably, the coefficient of determination ($R^2 = 0.903$) indicates that approximately 90% of the variance in the water cover index can be explained by the climatic factors analyzed, underscoring the significant role of climate in influencing Lake Habbaniyah's hydrological dynamics.

In conclusion, the study confirms the researcher's hypothesis that climatic elements significantly impact the water cover area of Lake Habbaniyah. Temperature and rainfall emerge as the most influential factors, with their effects moderated by interactions with other variables such as solar radiation, wind speed, humidity, and evaporation. These insights are crucial for developing sustainable water resource management strategies, particularly in arid regions where climate variability poses a significant challenge to maintaining stable water bodies.

5. Conclusion

1. Lake Habbaniyah total area was 330.258) km2, with the water cover reaching its maximum area in 2023 at approximately 184.51 km2 and a percentage of 55.87 percent during the winter season in February. It then drops to its lowest area in September, reaching approximately 134.88 km2 and a percentage of 40.84 %.
2. During the autumn season in September, the area of lands without water cover peaked at around 95.37 km² and at a rate of 59.56%. During the winter season in February, it fell to its lowest area at 145.74 km² and at a rate of 44.13%.
3. Climatic factors influence the variation in the area of water cover and are Directional and inversely related to it; the greater the temperature, total solar radiation, and amount of evaporation, the smaller the area of water cover; conversely, the greater the relative humidity and rainfall, the larger the area of water cover.

Recommendations:

1. To maintain the greatest number of natural water features, pay attention to the lake's water storage process by putting precise water management into place to track the qualities of the water entering and leaving the lake.
2. Shade balls, which are plastic balls composed of high-density polyethylene and have been employed in many developed nations, can help minimize the quantity of water lost via evaporation.
3. To stabilize the soil, restrict the quantity of water evaporating from the lake surface, decrease wind speed, and lessen dust storms, a green belt of trees that can withstand local circumstances has to be established around the lake coastline.

REFERENCES

[1] A. H. Alshalash, *The Climate of Iraq*. Amman, Jordan: The Cooperative Printing Press Workers Society, 1960, p. 16.

[2] L. Shimeri and Z. Munim, "Climate," *Arab Journal*, no. 150, pp. 103, Riyadh, 2014.

[3] M. W. H. Al-Issawi, "Projecting the effects of climate change on maximum temperatures at Baghdad station based on climate models (CMIP5) and radiative impact scenarios," *Journal of Education College, Wasit University (RCP)*, vol. 1, no. 54, pp. 289–300, 2024.

[4] Ministry of Transport and Communications, General Authority of Meteorology and Seismic Monitoring, Climate Department, *Unpublished Data*, 2023.

[5] *Satellite Images Captured by the Landsat 8 Satellite for the Year 2023*.