Modeling temperature extremes in Egypt and their impact on some ancient Egyptian monuments

Mossad Salama Mandour
Prof of Climate Geography, Department of Geography, Faculty of Arts, Mansoura University
Mosaad_3_70@hotmail.com

Rabab Abd Elhakeem Ebrahim
Assistant Lecturer, Department of Geography, Faculty of Arts, Mansoura University
rabababdelhakim@mans.edu.eg

MODELING TEMPERATURE EXTREMES IN EGYPT AND THEIR IMPACT ON SOME ANCIENT EGYPTIAN MONUMENTS

MOSSAD SALAMA MANDOUR [(1)]
Mosaad_3_70@hotmail.com

RABAB ABD ELHAKEEM EBRAHIM [(2)]
rabababdelhakim@mans.edu.eg

Abstract

The purpose of the study is to study the extreme temperatures in the Arab Republic of Egypt. Egypt extends between latitudes 22-31 degrees north and longitudes 25-37 degrees east in a dry climate characterized by extreme temperatures. Extreme weather events are defined as abnormal weather events that deviate greatly from their average value, as they are the highest and lowest temperature recorded during a day, month, year, or any time period in meteorological stations. The average maximum or minimum temperature for any time period can be used to indicate thermal extremes.

The study aims to monitor the cases of temperature extremes during the period from (1980 - 2020), determine the frequency and intensity of high and low extremes, and show the most important impacts and the correlation between temperature extremes and the prevailing weathering processes acting on ancient Egyptian monuments. The study addresses: First, modeling temperature extremes in Egypt; secondly, monitoring heat differentials on the surfaces of some ancient Egyptian monuments, and thirdly: the mechanical weathering patterns associated with ancient Egyptian monuments. The temples of Kom Ombo and Philae in Aswan were chosen as applied examples.

Keywords: Modeling, temperature extremes, ancient Egyptian monuments, Egypt.

Introduction:

The ancient Egyptian antiquities are the origin of civilization in the Arab Republic of Egypt, which extends between latitudes 22° - 36° 31°N, and longitudes 25° and 37°E Fig.(1). The climate of Egypt is that it is dry, in which the phenomenon of thermal extremes is repeated, which means that it is anomalous weather events that deviate strongly from its average value, which is the highest and lowest temperature recorded during a day, month or year.

Previous studies:

Taking into account the previous studies that focused on thermal extremes, such as studies (George, 2005; Korba, 2005; Mandour, 2009; Qurira, 2012; Freij, 2013; Mohsen, 2017; Abdel-Aal, 2018). Among the studies that dealt with ancient Egyptian antiquities (Selim, 1962; Jaber, 1985; Saleh, 1992; Nour El-Din, 2009).

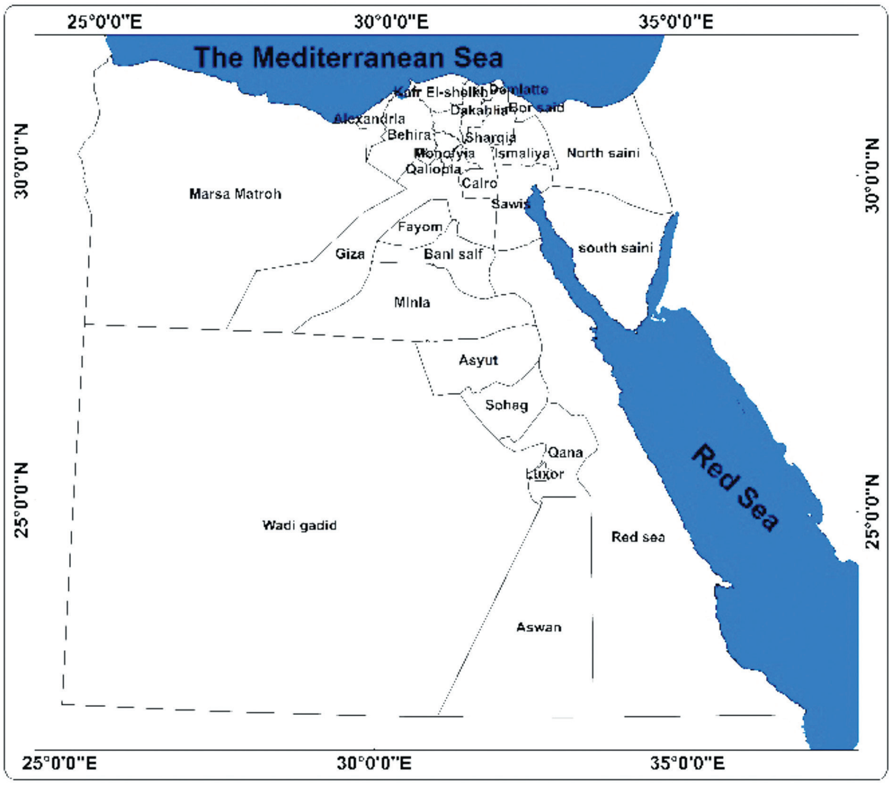
Objectives:

The study aims to monitor cases of thermal extremes during the period from (1980 - 2020), determine the frequency and intensity of high and low extremes, and show their most important effects and their relationship to the prevailing weathering processes in ancient Egyptian monuments.

Methods:

The approaches were used to achieve the objectives of the study by including inputs (data) to obtain outputs (information), and processing to develop proposed solutions. Among the study curricula: 1- The analytical

(1) Prof of Climate Geography, Department of Geography, Faculty of Arts, Mansoura University
(2) Assistant Lecturer, Department of Geography, Faculty of Arts, Mansoura University



Source: Planning Commission, 2017

Fig. (1) Location of the study area.

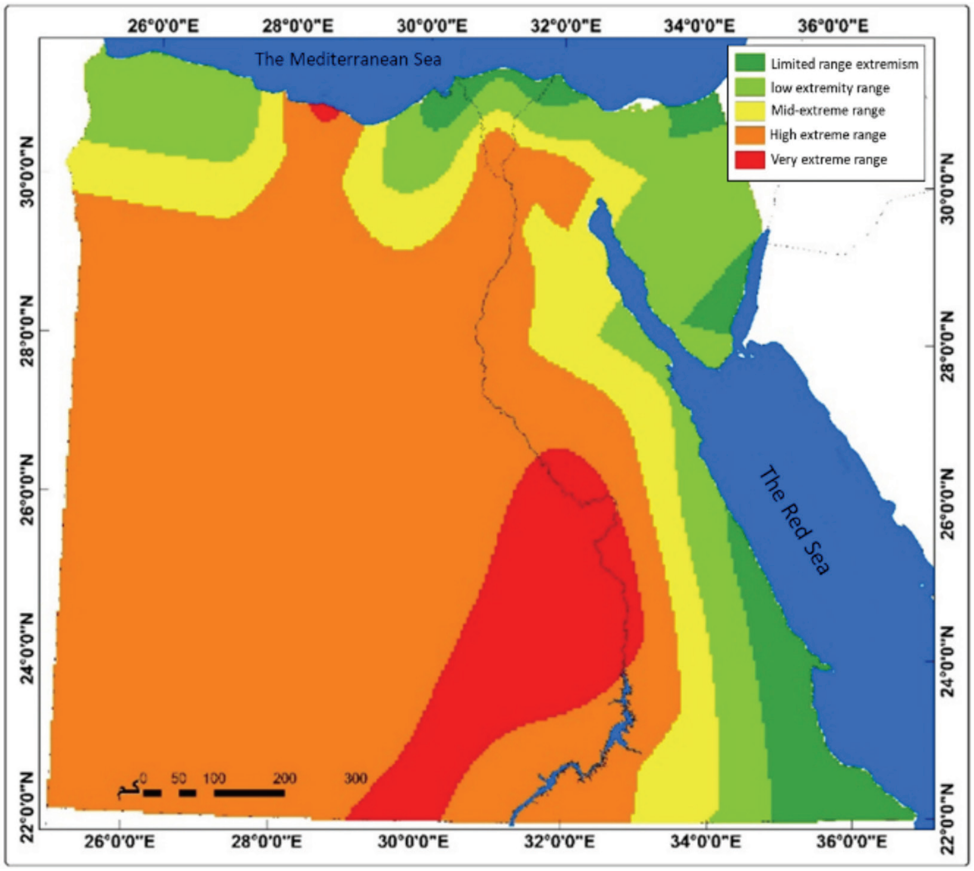
descriptive approach: it is the presentation and analysis of climatic and archaeological data. 2- The quantitative approach: This is done through statistical analysis of data and information and their scheduling to find relationships between information and statistical data and linking them to various factors.

One of the methods used is the "cartographic method", which aims to present and analyze a set of maps and diagrams. A number of statistical programs were used to process and analyze climatic and archaeological data, and the "field work" method was used to apply it to the subject of the study. Among the programs used in the processing are Microsoft Excel 2016 and its additional components (Kutools for-excel16.5), IBM SPSS Statistics 23 pr, and the ArcGIS software package. The study relied on 28 stations to analyze the temperature component to extract and analyze the phenomenon of thermal extremes. Climatic data from the NASA website was used.

Results:

1-Modeling of thermal extremes:

After applying the steps to model the layers of thermal extremes, which began with the process of deriving a classification commensurate with the weight, it becomes clear that the extreme and extremely extreme ranges are characterized in the southern region and the Western Desert, and are not found in the eastern region due to the nature of the warmth of the Red Sea, and the thermal extremes increase as we head south, and decrease as we head. Northward with increasing very low-lying area on the northern coast of the Mediterranean Sea. The sea and the Sinai Peninsula, fig.(2).



Source: Based on input from Annex (1) in the ARCGIS 10.2 environment.

Fig. (2) Ranges of thermal extremes in the Arab Republic of Egypt.

It turns out that the thermal extremes are distributed over the study area in five categories, as the highest ranges rise in the south of the study area and decrease as we head north. Under the influence of the low and limited phenomena in the study area, Table No. (1) shows that Egypt is under the influence of the areas of high extremism, where the total area of the very high extremism area is 93,585 square kilometers, and the extreme region is 607,353 square kilometers. A total of 700,938 km2 of the total area of Egypt (1,019,600 km2, or 69.6%), and the area of low extremism is 136,592 km2.

1 -1 -Thermal Range:

In the study area, the temperature difference between the maximum and minimum temperatures increases in the south of the study area, where the Tropic of Cancer passes. The cold season of the year due to its flat surface, which reduces thermal differences, which is greatly reflected in the variation in the temperature range.

Table (1) The area of thermal extremes in the study area.

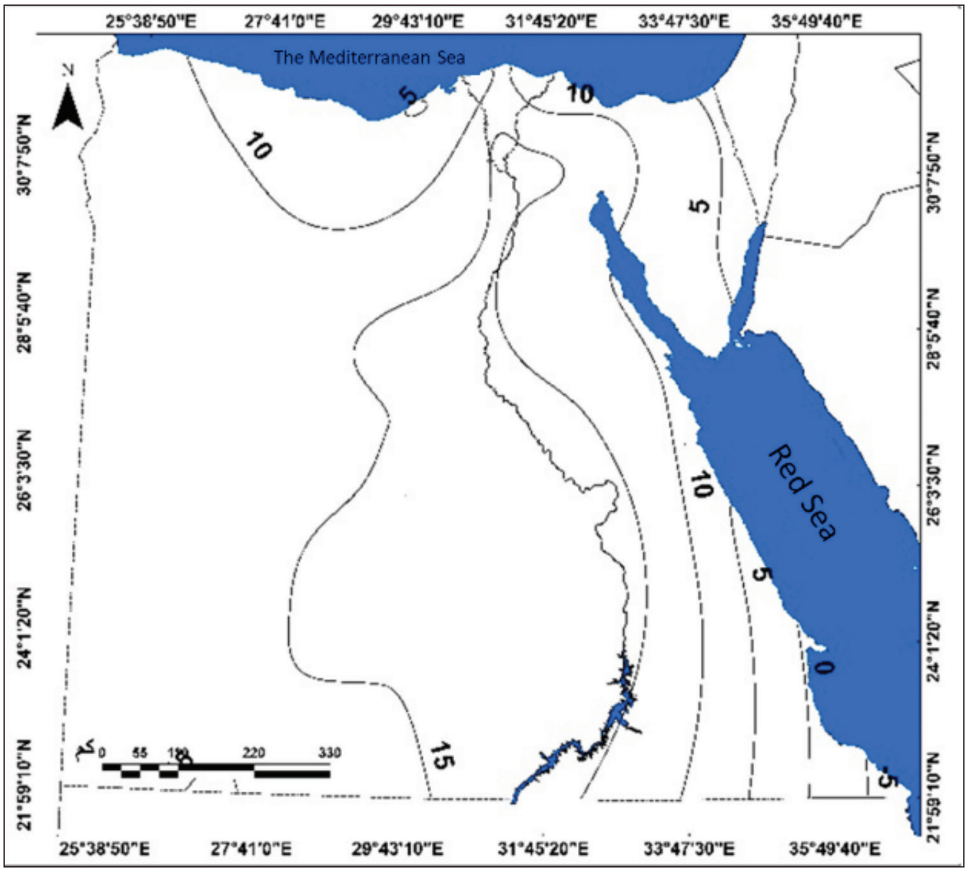
Serial	The range	Area (km^2)	Percentage
1	very extreme range	93,585	9.3
2	extreme range	607353	60.3
3	Mid-extreme range	114,639	11.4
4	low extremity range	136592	14
5	Limited range extremism	51618	5
The Total	-	1003787	100%

Source: output arcgis10.4.

Also, the water bodies in the north of the study area (the Mediterranean Sea) and its east (the Red Sea) affect the thermal range, and the proximity to it leads to an increase in humidity levels and the predominance of the marine character. The thermal range is large as we move away from the coast and the continental character prevails, due to its distance from the source of moisture from the seas, which works to reduce the differences between the maximum and minimum temperatures. Also, there are significant temperatures ranging between day and night during summer and winter, especially in the south of the study area.

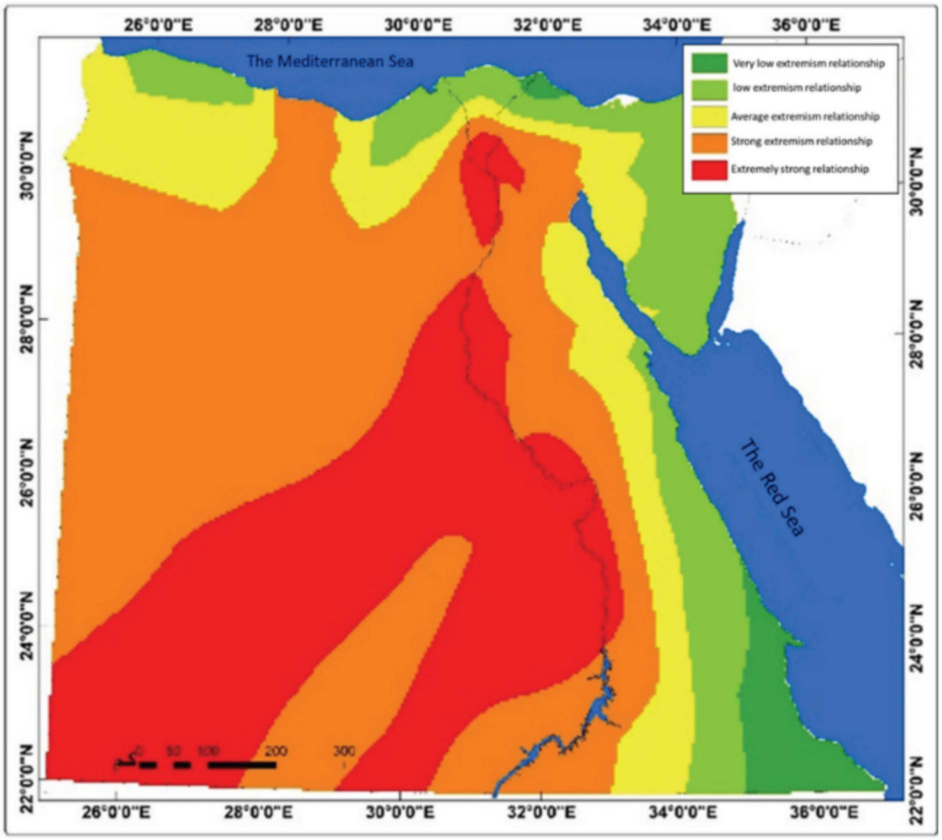
And through Figure (3) for the distribution of the annual range of temperatures, a line equal to 10 degrees Celsius passes in the range of the northern coast of the study area. Sinai Island and coastal areas.

And by examining the extent of correspondence between the results of the frequency of thermal extremes and the thermal range, it becomes clear that the thermal range coincides with thermal extremes, as it increases the thermal range in high thermal extremes and decreases in low thermal extremes in the northern and eastern range of the study area. And that the delta, middle and south of the study is under the influence of high extremes fig.(4).



Source: (https://power.larc.nasa.gov/.)

Fig.(3) Distribution of the annual temperature range in the study area during the period 1982-2019 (°C).



Source: Based on the inputs of Appendix (2) in the ARCGIS 10.2 environment.

Figure (4) Modeling the relationship between the ranges of thermal extremes and the thermal range in the Arab Republic of Egypt.

1 – 2 - The effect of thermal range on rock ormation:

The study of thermal extremism leads us to ask, does thermal extremism affect the nature of the rocks from which the ancient Egyptian antiquities originated? How does this affect the formation of these rocks? Is this effect cumulative or a sudden effect?

If thermal extremism here is an independent factor, then here we need the connection through which it causes an effect on the rock, and this effect will not occur except by knowing what is the degree of response of this rock to geomorphological processes, and if the issue is confined to the thermal effect part, then the geomorphological forms that may be caused by the influence of climate on The rock is the occurrence of mechanical weathering.

Here we need to link between mechanicalweathering(geomorphology) and thermal extremes (climatology), so this point is limited to climate geomorphology, and to study this effect, we need to study the ancient climate in order to understand the nature of the climate of the study area because of its importance in influencing the Geomorphological phenomena (determine their role in the type of weathering).

Through the study of the ancient climate the study area has been exposed to intermittent climatic periods, sometimes with a low temperature and other times with a high temperature. This, in turn, has a role in the effectiveness of mechanical weathering and its activity through expansion and contraction of rock minerals, or by increasing the crystal growth of deposited salts as a result of dehydration within the cracks and joints of rocks, which can lead to the disintegration of rocks through the widening of the sizes of cracks inside them (Abdul Hussein, no year). We also need to know the degree of response of the rock to weathering, as the degree of response of the rock varies according to the mineral homogeneity in the rock. for rays, as this effect does not exceed more than a few inches within the substratum.

In the case of different rock-forming minerals, the degree of expansion and contraction is not at a homogeneous degree for the surface of the rock because of the different expansion coefficient for each mineral in the rocks, and this leads to varying rates of expansion and contraction. Occurrence of varying pressures and then separation in the rock granules (Abdul-Hussein ,no year).

Hence, another question prompts us: What is the link between thermal extremes and mechanical weathering of rocks? Here, if the element of heat is the main element for the occurrence of mechanical weathering processes, then the presence of thermal energy from solar radiation acquired by the rock is necessary, and this energy varies according to the angle of inclination of the sun’s rays for each latitude, and through the study it becomes clear that the indicators of thermal extremism increase as we go south High thermal indices) and decrease as we head north (high thermal indices decrease) with the exception of the Egyptian Delta, in which high thermal indices also rise in the summer and decrease in the winter. Here, a big difference occurs in the temperature range, which is the independent factor in the occurrence of mechanical weathering. Due to the continuation of the sun's rays, the values of the thermal ranges rise, especially if the situation is vertical, in addition to the heat accumulation resulting from the summer months, which affects the temperature rise in the south and its reflection on the values of Thermal range rates in the study area. Since the study area increases the continental climate whenever we go from the north to the inside of the region, this leads to a widening of the seasonal temperature range between the winter and summer seasons, and a widening of the daily temperature range, which increases the effectiveness of the mechanical weathering processes.

2 -field study to monitor the thermal variation of the surfaces of some ancient Egyptian monuments:

The field study aimed to find out the extent to which the rock retains and acquires temperature. The application was carried out in the temples of Kom Ombo and Philae to make some measurements, an attempt to know the extent to which the rock retains temperature and whether the rock loses its heat directly or not, and an attempt to understand the nature and heating of the rock in the field field. The locations of the samples were chosen, and the 4 in 1 Soil Survey instrument (Pic. 1) was used to monitor the temperature of the rocks in the field at different location inside the two temples.

Pic. (1) The 4 in 1 Soil Survey instrument used to measure the surface temperature of the rocks in the temples of Kom Ombo and Philae2020.

2 – 1 - Kom Ombo Temple:

On March 2, 2020, the student visited Kom Ombo Temple and took some measurements inside the temple, fig (5), for surfaces exposed to the sun and surfaces not exposed to solar radiation. The student measured the air temperature at a flat surface, and it recorded 33°C and 29°C in the shade, at eleven o'clock in the morning. It was found from a table (2) of the sites of different samples in the temple that the humidity was 20% in parts of the temple, while the site (7) had a humidity of 20.8%. The air temperature was measured and it ranged between 26°C in (3-b) and 33.2°C in (6-a) location. And the temperatures of the outer rock reached the lowest temperature in (3-B) site and 29°C in (6-B) site in the shade of the sun. The lowest temperature was 31°C in (4) site and 36°C in (7) site facing the sun.

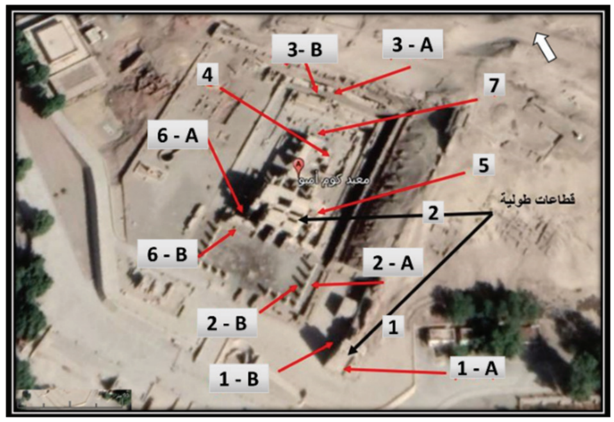
Table (2) Sample locations for temperature measurement in Kom Ombo Temple 2020.

Location	shadow/ face	longitude	latitude	moisture %	Air temperature (°C)	External rock temperature (°C)	Color temperature (°C)	Notes
1 – a	to the sun	55° 32 ´ 19.42˝	27° 24´ 5.58˝	20.2%	33°	33°	42.4°	-
1 – b	opposite			20%	26.6°	25°	24.4°	-
2 - a	Shade	55° 32 ´ 41.74˝	27° 24´ 6.28˝	24%	33°	32°	32°	-
2 – b	opposite			20%	26°	26°	22.9°	-
3 - a	Shade	55° 32 ´ 43˝	27° 24´ 8.63˝	20%	33°	32	38.3°	-
3 - b	opposite			20%	26°	20°	20.5°	-
4	Shade	55° 32 ´ 42.81˝	27° 24´ 7.64˝	20%	32.8°	31°	-	-
5	opposite	55° 32 ´ 42.38˝	27° 24´ 7.12˝	20%	31.8°	28°	19.4°	The temperature inside one of the cracks was measured at 24°C
6 - a	Shade	55° 32 ´ 41.38˝	27° 24´ 7.36˝	20%	33.2°	36°	36.6°	-
6 - b	opposite			20%	31.5°	29°	30.5°	-
7	Shade	55° 32 ´ 42.85˝	27° 24´ 7.36˝	20.0%	32.3°	36°C	47.6°	The temperature inside one of the cracks was measured at 31.9°C

o The temperature was measured on a level surface facing the sun (33°C) and in the shade of the sun (29°C) at exactly eleven o'clock in the morning in the temple yard.

Source: A field study conducted by the student on 3/2/2020.

Pic. (2) Recording the temperatures of the outer surface of the granite rock in Kom Ombo Temple 2020.



Source: Google Earth 2021.

FIg. (5) A picture of the Kom Ombo Temple for the locations of temperature-measured samples for the Kom Ombo Temple 2020.

Source: A field study conducted by the student in March 2020.

Pic. (4) Recording the temperatures of the outer surface of the rock in one of the walls of Kom Ombo Temple, site (3) 2020.

Surface temperatures exposed to sunlight were measured and temperature values were recorded on a vertical sector level. In sector (1), the temperature of a main wall was measured at the entrance to the temple, picture (3), and it was found that the upper parts of the wall have higher temperatures and decrease in the lower direction of the wall in the shade of the sun. The temperature value increases as we go down the wall, and this indicates that The rock continues to retain heat, and the upper parts exposed to wind movement are most susceptible to heat loss. Which is accompanied by different manifestations of weathering even at the same vertical level in the walls of the temples, so mechanical weathering prevails in the upper surfaces and chemical weathering prevails in the areas near the surface of the earth.

Source: A field study conducted by the student 2020.

Pic. (5) The location of (1) a wall at the entrance to Kombu Temple.

The parts exposed to sunlight were measured, and the values were recorded at the level of the sector (32.5 ° C, 29.1 ° C, 28.2 ° C, 26.8 ° C), and the corresponding part under the sun was measured, and the temperature of the surface of the rock was recorded (34.4 ° C). ,(36°C, 38.4°C, 43.6°C), so there was a question, how does the temperature rise in the sun's shadow part of facing the sun?. she measured again the sector (2), which is represented by two adjacent walls, represented by one wall exposed to the sun and the other exposed to the shadow. Picture (6) and compared to the location of the temple and the direction of the angle of the sun's rays. When it was in the shade of the sun at (2:20).p.m.) was the same temperature as the temperature facing the sun, which means that pole (2) was facing the sun before the sun moved towards pole (1) fig.(6).

The temperature of column (2) did not change when measured again compared to column (1), but rather that column (1) the rock begins to gain heat from the sun's rays compared to its counterpart.

Table (2) Some measurements of the sectors by using a color temperature inverter.

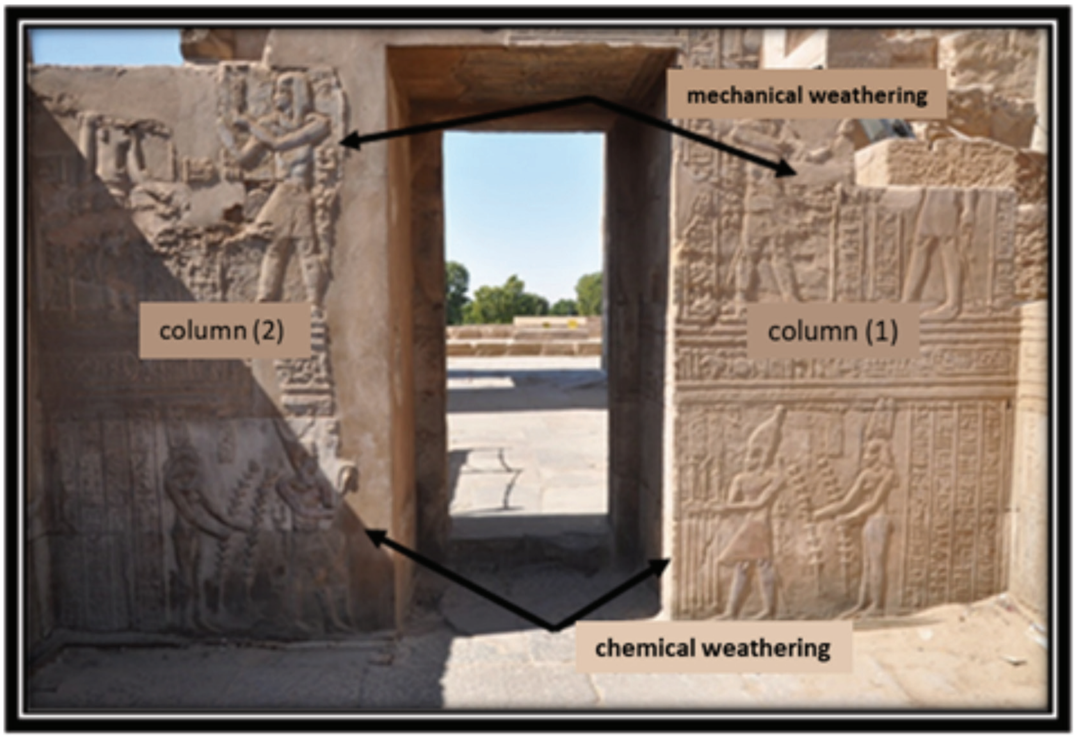
Sector (2)		Sector (1)	
Sun Shade Temperature (٢) (°C) Column	Sun-facing temperature (١) (°C) column	Sun shade temperature (°C)	**Sun-facing temperature (°C)**
34.4°	32.5°	17.1°	40.1°
36°	29.1°	17.3°	37.5°
38.4°	28.2°	17.7°	36°
43.6°	26.8°	17.9°	35.6°

Source: A field study conducted by the student on 2/3/2020.

This means that the rock retained its temperature for half an hour. Also, the rock loses its heat in the upper parts of the column more quickly than the lower parts, and that the upper parts facing the sun gain heat more than the lower parts. These differences in temperature in the rock and on the one side, they act on the different weathering processes on the vertical level of the rock as well.

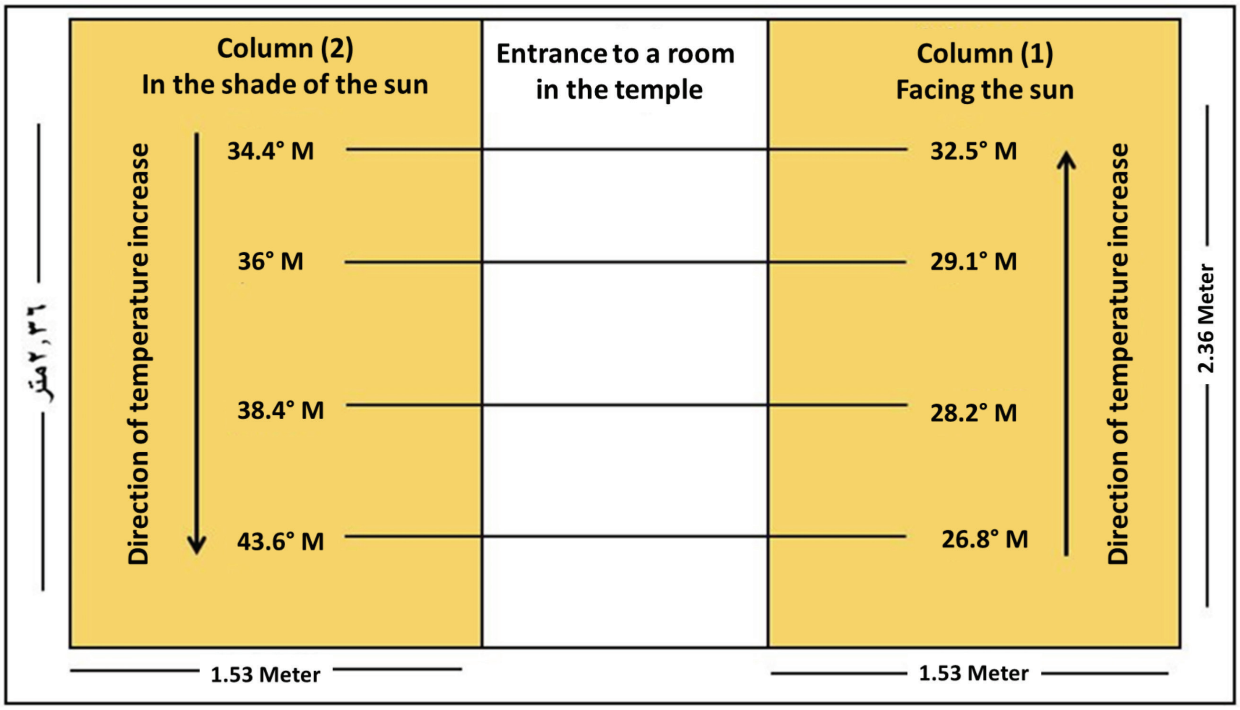
2 – 2 - Philae Temple:

The student made a field visit on 3/3/2020 to the Philae Temple table (4), and some separate locations were chosen in Temple 3, the other one is located in the shade of the sun. In the site of an inner room in the temple made of sandstone, it is far from sunlight from the inside, so the air temperatures, humidity, and the temperature of the outer surface of the rock were measured. And it turned out that the internal atmosphere of the room is almost close to each other, and the air temperature was recorded at 27.2 ° C, the outer surface temperature was recorded at 24 ° C, and the humidity was 24%, and through measurements in the middle room, we find that the temperature is lower than room (1), and this is due Because room (1) its walls are exposed to sunlight from the outside, unlike this room, its ceiling is only exposed to sunlight, and the humidity rises to 26%, and the temperature is lower than room.



Source: A field study conducted by the student, March 2020.

Picture (6) One of the walls inside the Kom Ombo Temple 2020.



Source: The drawing was made based on a field study conducted by the student for the temple on 2/3/2020

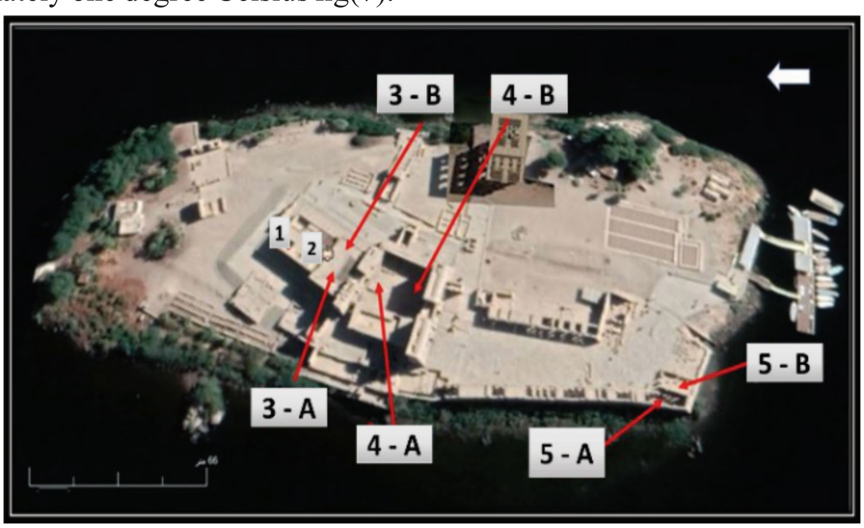
Fig. (6) Illustration of a wall in Kom Ombo Temple showing the temperatures measured in the sector.

Table (4) Sample locations for temperature measurement in Philae Temple 2020.

Location	shadow/ face	longitude	latitude	moisture %	Air temperature (°C)	External rock temperature (°C)	Color temperature (°C)	Notes
1	Shade	53° 32´ 3.35˝	24° 1´ 32.96˝	24%	27.2°	24°	21.4°	The difference between the sample site (1) and site (2) is 3.66 meters.
2	Shade	53° 32´ 3.15˝	24° 1´ 32.64˝	Cat%	26.6°	24°	22°	-
3 - a	opposite	53° 32´ 2.75˝	24° 1´ 32.30˝	21%	32.5°	35°	47.3°	-
3 - b	Shade			20%	30.5°	28°	23.7°	-
4 - a	opposite	53° 32´ 2.65˝	24° 1´ 31.49˝	22%	32.5°	34°	40.1°	-
4 - b	Shade			20%	32.5	32°	33.1°	-
5 - a	opposite	53° 32´ 2.61˝	24° 1´ 28.10˝	27%	34°	34°	38.6°	The difference between the two walls, models (5-a) and (5-b), is a distance of 4.72 meters.
5 - b	Shade			21%	33.8°	31°	30.1°	The difference between the sample site (1) and site (2) is 3.66 meters.

Source: A field study conducted by the student on 3/2/2020

(1) by approximately one degree Celsius fig(7).



Source: Google Earth 2021.

Fig. (7) A picture of the Temple of Philae. The locations of the temperature-measured samples for the Temple of Philae 2020.

At the exit from this room towards the temple yard, the temperature was measured for an open room (3-a, b). The ceiling part of it was exposed to the sun's rays and the other part was in the shade of the sun. It turned out that the part exposed to the sun recorded an air temperature of 32.5 ° C, and the humidity decreased to 21% and increased. The value of the temperature of the outer surface of the rock reached 35°C, and the temperature of the color of the rock was recorded as 47.3°C, in contrast to sector (3-b), where the humidity decreased from the other part by about 1%, and the temperature of the rock surface decreased by about 7°C compared to its counterpart in the sun. And the temperature in the shade is 30.5°C.

And in site (4) in the temple yard, where the student chose an open place in the open air, part of which is exposed to sunlight and the other part is in the shade of the sun. Humidity became 22% in the part facing the sun and 20% in the part facing the shadow, and the rock kept two degrees Celsius in the sun in the open range. In the site (5-a, b), a site was chosen close to the river on the right side of the main entrance to the temple on the eastern side of the Nile River. It was noted that the humidity was high in the part facing the sun, which was 27%, and the air temperature was 0.2°C different from it, except that the outer surface The rock has gained heat by 3°m from the shadow area, but this area had walls full of moisture, and this led to a decrease in the color temperature reflection.

From the foregoing, it is clear that the air temperature in the temple differs in the areas facing the sun, unlike in the shadow areas, and the percentage of reflection of the color of the rock increases in relation to the gain of heat by the rock, meaning that the higher the temperature of the rock, the greater the increase in the percentage of heat according to the color of the rock, and vice versa if the temperature decreases. rock. Likewise, whenever the rock is saturated with moisture, the percentage of heat reflection decreases according to the color of the rock. Likewise, the speed of heating the rock increases in the parts that are not open, just as in the site (3-A), where the site was not exposed to air or high humidity, which led to the rapid heating of the rock, while the temperature of the rock decreased in the parts far from the sun. Rather, the surface of the rock gains a degree The air temperature near it is a simple decimal difference. It is clear from this that the difference between the temperatures of the air and the surfaces is variable. The surfaces located in the shade often find their temperature lower than the surrounding air, while the surfaces facing the sun have a higher temperature than the temperature of the surrounding air, which helps in the chances of damage to the free surfaces facing the sun. And atmospheric air, but rather reach a difference in the dominance of weathering processes from the outer surfaces in which mechanical weathering prevails, while chemical weathering prevails in the inner surfaces of the monuments.

3- Patterns of Mechanical Weathering in Ancient Egyptian Antiquities:

3 – 1 - Peeling:

The rock crust appears in the form of separate crusts and falling parts of the outer layer of the walls of temples and tombs, including inscriptions and drawings, which is evident during the weathering process on the granite rocks in the study area. Pic. (7) Whereas, granite is an igneous rock composed of quartz, feldspar, and mica minerals, and the three differ in coefficients of thermal expansion, which leads to the occurrence of very small cracks in the minerals when subjected to heating and cooling for long periods.

Source: A field study conducted by the student, January 2019.

Pic (7) peeling off one of the statues in Karnak Temple 2019.

2-3- Excessiveness:

Granular disintegration appears in all or most of the archaeological areas in the study area, where the continental climate is in its clearest form, including the difference in the daily temperature range significantly, where the temperature of the rock increases during the day and decreases at night, which exposes the rock to disintegration and falls, and the single grains can be isolated.

3-3- Mass Dissociation:

Mass disintegration leads to the fall of parts of the archaeological building, especially with the presence of gravity as an auxiliary factor in that, and the danger of these blocks lies in the event that they are associated with the process of granular disintegration, where the granules fall to the ground with gravity and the blocks are exposed after the mortar layer falls with the drawings and inscriptions that bear it, which is what constitutes Difficulty in the restoration process, as in the picture (8 - 9).

Source: A field study conducted by the student, January 2019.

Pic (8) shows the "granular disintegration" of one of the walls in Karnak Temple 2019.

Source: A field study conducted by the student, January 2020.

Pic (9) showing mass disintegration and flaking of a stone in Kom Ombo Temple 2020.

4- Managing archaeological sites from a geographical perspective:

The concept of managing archaeological sites comes as a development of the term archaeological site preservation as one of the main solutions that work to reduce damage and deterioration of antiquities, which is traditionally associated with restoration and maintenance of the elements of an archaeological site only, as well as understanding the nature of the archaeological site, and the concept of archaeological site management expands to include treatment, stability and protection from natural hazards Documentation, registration, reassembly of scattered elements, renewal, revival, re-employment or re-use and upgrading to include the archaeological area and its surroundings, both archaeological and non-archaeological areas, with the aim of preserving and protecting archaeological sites and taking the necessary measures to preserve the sites (Al-Zahrani,2012). You will obey the knowledge of physical geography with the tools it possesses that can contribute in a strong and effective manner to the management of archaeological sites, which are represented in the following means:

4 – 1- Documenting archaeological sites:

Documentation is the first stage of managing archaeological sites. It is intended to record all information and data related to the archaeological site, document all details of the site, draw detailed maps for it, and create a geographical database that includes the coordinates of the site and its plan, whether historical at construction or what remains of it, and indicating the geological and topographical characteristics of the site. And linking them to satellite visuals with high spatial accuracy, topographic maps and historical maps that show the developments that the site was exposed to, and all the details of the archaeological site to create a geographical database of sites.

4- 2 - Monitoring natural hazards on archaeological sites:

It includes the study of all risks that may affect the archaeological site and its surrounding environment, whether risks related to the geological characteristics related to the rock formation of the site and building materials, or risks related to the terrain characteristics of the site such as its presence on a slope, as well as the dangers of floods, or risks related to the ground cover such as increased soil moisture or Groundwater level rise, sea level change, or weathering-related hazards, specifying the degrees of these hazards and ways to confront these hazards or reduce their impact on archaeological sites.

4–3- Developing a map to discover possible new archaeological sites:

In the light of understanding the nature of the current archaeological sites in the region and trying to know the nature of the civilizations that left their traces in the region and the uses of the various archaeological sites while realizing the nature and characteristics of the study area, a map of sites that may have antiquities can be drawn up within the framework of the previous information, and then recommend the work of archaeological excavations and surveys in specific sites Which adds to the map of archaeological sites in the region and saves time and effort by narrowing the search.

4 – 4 –Develop accessibility maps:

Some sites need illustrative maps of accessibility, especially the sites that are located in mountainous areas with rugged terrain and are not reached by equipped roads, indicating the distance between cities or between known sites and archaeological sites, clarifying the access paths, the nature of the terrain, a visualization of the areas that these paths pass through, and clarifying the areas of interest. The steep slopes and ground cover that the different paths pass through, with the aim of being guided by them to reach the sites.

4 – 5 -Setting a vision for the management and use of archaeological sites:

Developing a vision for the management of the archaeological site in the light of the available information and according to its current condition and the risks it is exposed to in the short and long term, and the possibility of adding a new use to the site or benefiting from the natural phenomena in the surrounding environment or what is related to the built constructions or even the management of visitors (Al-Satiha, 2018). The role of dealing with sites in archaeological areas is embodied by understanding the policies of dealing with them, the most important of which are:

1 - Restoration, Preservation and Protection Policy: This policy reflects the symbolic and moral value of these sites.

2 - The policy of replacement and removal, and the policy of urban renewal. These policies reflect the utilitarian value of ancient archaeological sites.

3 - Rehabilitation and upgrading policy. This policy reflects the utilitarian and moral values of archaeological sites and is characterized by some basic steps:

A - Documentation: It is providing information, data and descriptive maps of the current state of the sites, as well as the condition of the buildings and their urban fabric, and documenting them all.

B - The legislative and institutional framework: It is a set of laws and procedures related to controlling and monitoring various construction works within archaeological sites, as well as the availability of official and popular institutions and an administrative structure capable of drawing plans and directions for their development.

C - Funding: which aims to find the hall and various economic resources to carry out the implementation of the planning objectives approved by the concerned institutions and departments.

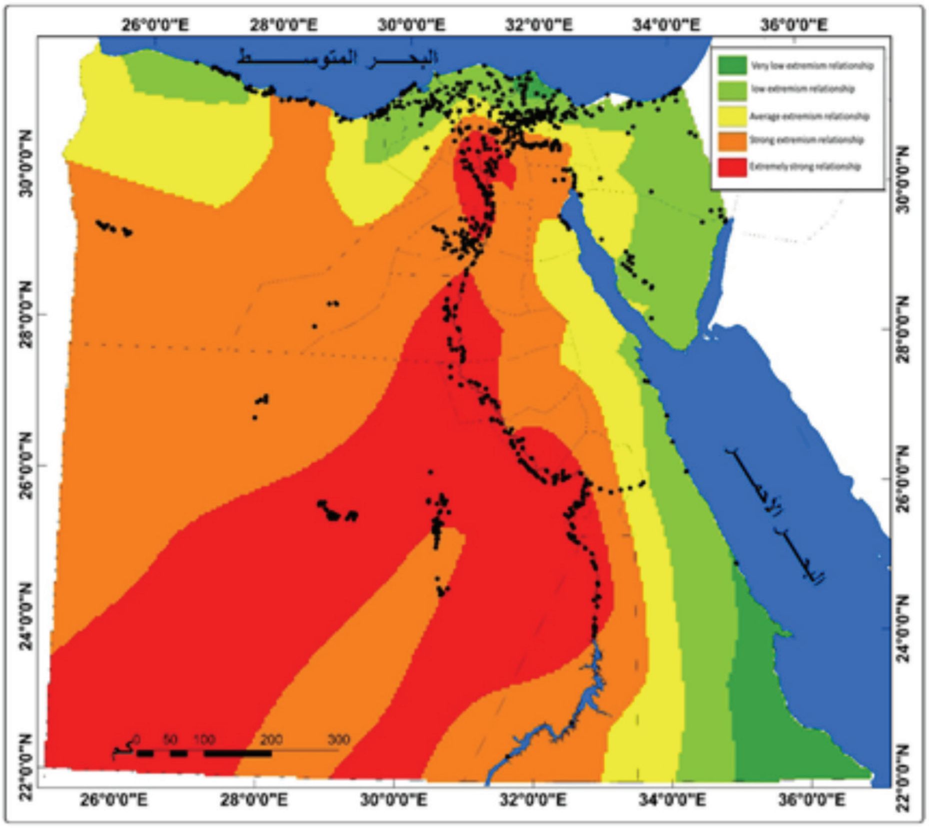
D - Sustainability: which depends on the development of mechanisms for maintenance and preservation of archaeological sites, and deepening the sense of the importance of national and national belonging by protecting and highlighting the distinctive personality and identity of the ancient city (Cultural and Natural Heritage Documentation Center, Bibliotheca Alexandrina, 2009).

4 –6- Distribution of archaeological sites in the ranges of thermal extremes:

From what has been previously studied to model thermal extremes and applied to ancient Egyptian archaeological sites, it has been shown from the outputs of the ARCGIS program, Table (5) and Fig.(8), the number of archaeological sites that fall under the influence of each of the thermal extreme zones.

It is clear that the scope of extremism is very low. A smaller number of ancient archaeological sites are exposed, with a total of 18 sites distributed in the governorates of Damietta, Port Said, Dakahlia, and the Red Sea. It turns out that the low range is exposed to 261 sites, and this range runs along the east of the study area and the northern coast. The sites of the entire Alexandria governorate are under the influence of this range, followed by North Sinai, Beheira and Sharkia.

It is clear that 132 sites are exposed to the medium range, and this range runs parallel to



Source: ARCGIS 10.4 program output.

Fig. (8) Distribution of archaeological sites in the ranges of thermal extremes.

the low range, and this range is intermediate between it and the high range. In the high range, it is clear that the number of sites is 271 sites under the influence of this range. This high range is of great influence, as it controls 14 governorates within the Nile Valley and west of the study area. In the high range, 460 sites are exposed to the influence of this range, and this range is the most severely affected, passing through 14 governorates. The governorates of Cairo, Qalyubia, Minya, and Luxor are completely under the influence of this range.

Through the study of thermal extremes, the area southeast of the Egyptian Delta, the Nile Valley, and the west of the study area is the most subject to the influence of the high and very high range of thermal extremes, and that mechanical weathering is the most influential in the range of high and very high thermal extremes.

5 - Conclusion:

5-1-Thermal range is one of the pillars in the occurrence of the mechanical weathering process, as the expansion and contraction process inside the rock contributes to the stress of minerals that characterize the rock and the speed of the weathering phenomenon.

5-2- From the field study, it appears that the rock retains heat for a longer period, especially in the shade of the sun, in sedimentary rocks such as sandstone, unlike igneous rocks such as granite that loses its heat faster. Through laboratory experiment, it is found that the higher the temperature of the rock, the higher the temperature of its color, which leads to the speed of the rock's loss of heat in dark-colored rocks from light-colored rocks.

5-3- There are many patterns of weathering within the study area between chemical weathering, mechanical weathering and weathering by living organisms, and mechanical weathering is the most active, especially in southern Egypt.

5-4- Natural geography, with its tools, can contribute in a strong and effective way to the management of archaeological sites, specifically in the documentation and production of maps for these sites, the identification of the land cover and the environment surrounding the impact, as well as monitoring the natural hazards that threaten the sites, determining the types and degrees of risks and ways to confront or reduce these risks. As well as producing accessibility maps for sites of rugged nature, as is the case for most study sites, for which there are no equipped roads, in order to contribute to the management of archaeological sites.

6 - References:

6-1- Abu Al-Fadl, Tarek Mohamed (2014). Modeling climate change in Egypt, "A study in applied climate geography using GIS and remote sensing." Ph.D. Unpublished. South Valley University, Qena.

6-2- Al-Badri, Abdel Hakim Ahmed (2008). A comparative study of the effect of weathering processes on the rock-recording inscriptions in the eastern and western deserts and methods of treatment and preservation. Master Thesis. Unpublished. Cairo University. Faculty of Archaeology. Department of Antiquities Restoration.

6-3- Doueiri, Duha Muhammad (2010). The effect of weathering on some surface forms, monuments and installations in selected regions of Egypt. A magister message that is not published. Ain-Shams University. college of Literature. Department of Geography.

6-4- Abdel Hussein, Hussein Ali (no date). The effect of the widening of the thermal range on the formation of some geomorphological features in the western Iraqi plateau, "a study in climatic geomorphology". Al-Qadisiyah University. college of Literature.

6-5- Abdel-Aal, Mohamed Mohamed (2018). Long-term trends of daily temperature extremes in the Egyptian delta during the period 1960-2010 "climate study." Geographical Research Series. Egyptian Geographical Society. Issue (111).

6-6- Noureddine. Abdel Halim (2009). Sites of ancient Egyptian antiquities from the earliest times until the end of the ancient Egyptian dynasties. Part One. Eighth Edition. Cairo.

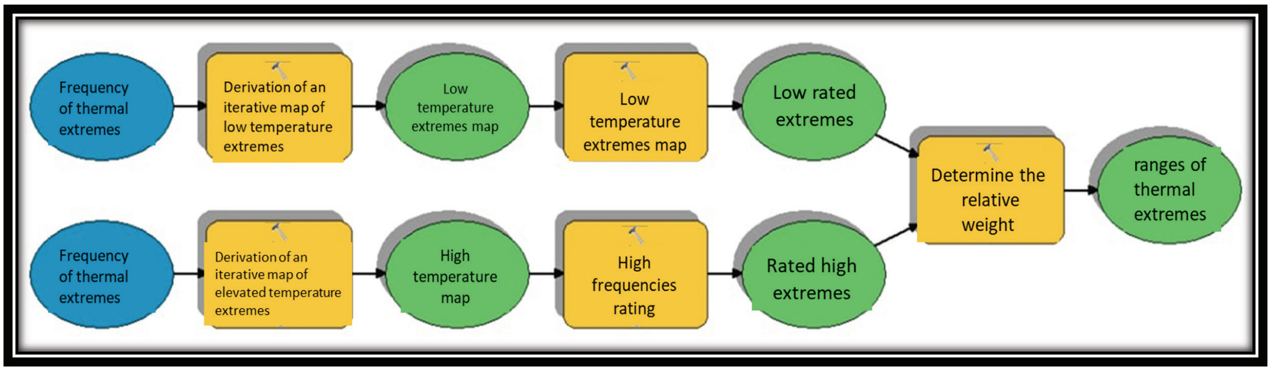
6-7- Zhang, X. (2005). Trends in Middle East climate extreme indices from 1950 to 2003. Journal of Geophysical Research, Vol. 110, D22104.

6-8- Politano, L. (2008). Extreme Temperature Events in the Mediterranean. Master's Thesis. Facutly of science. University of Bern.

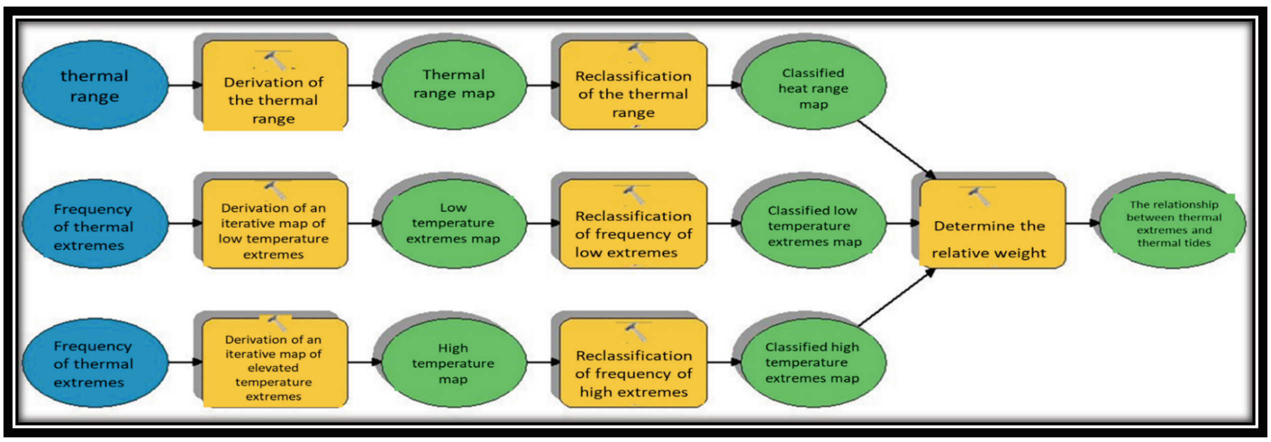
6 -9- Michael Wehner(No Date). Changes in Daily Precipitation Scientific omping Group and Surface air temperature extremes in the IPCC.

6-10- Alexander L.V. & Coauthors (2006). Global observed changes in daily climate extremes of temperature and precipitation. Journal of Geophysical Research, 111, D05109, doi:10.1029/2005JD006290.

6-11- Ali,A. (1994).Relation between climatic variables and maize yieled in Egypt .Egypt.



accessory (1) Scheme of the thermal extremes classification model.



accessory (2) A diagram of a model of the relationship between thermal range and thermal extremes.