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Application of Remote Sensing Techniques in the Study of the Mediterranean Frontal Air Depressions in Iraq

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Abstract

The study aims to digitally model air depressions in Iraq using the Python language. The boundaries of the study were represented by the regional borders of Iraq located between latitudes (29°.5) and (37.22) north, between longitudes (38.45) and (48.45) east, and between latitudes (29.5). And (37°.22) north. It was based on programming languagePython, including the Satpy library, which is concerned with processing satellite images in the field of weather and climate studies and extracting phenomena and Meteosat-8 satellite data for several years, and the year 2021 and climate station data was chosen. The study aimed to detect frontal depressions (Mediterranean depressions), and determine their places of origin, speed, and direction. In addition, drawing air fronts. The study also relied on the inductive and analytical approach in narrating and explaining the geographical phenomenon.

The study also proved that color satellite visuals have the ability to identify and diagnose frontal depressions based on spectral color fingerprints, and thus this helps in giving a true picture for understanding dynamic movements in the atmosphere.

The study recommends relying on modern technical methods to monitor and track pressure systems in their various forms, especially upper atmospheric phenomena and those close to the Earth's surface.

Keywords: *Remote Sensing Techniques, Python language, air depressions.*

Introduction

Technological progress in all scientific fields is an important factor in enriching scientific research and studies in various applied fields. This technological progress is represented in computer programming languages, satellites and data type.Format Data issued by it, as this technical progress has helped in the development of scientific research studies in monitoring weather and climate changes, whether in the short or long term, which gives a unique opportunity to study climate phenomena in a more detailed and more aware manner with the real reality, with an explanation of the places of their origin, the mechanism of their formation, and the causes. Which helped to cause weather phenomena, and as a result of this technical progress, the researcher chose depressions as a case study in Iraq using this computer technology and satellite images, which give more accurate, comprehensive and clear results in terms of diagnosing and identifying depressions, the causes of their formation, and dynamic follow-up. Its movement, as well as knowing its speed within a time period of every 15 minutes, and these extracted data

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and images are more comprehensive and contain climate phenomena in terms of detail and understanding.

the study Problem:

The problem of the study lies in the fact that the Mediterranean depressions have meteorological effects on the climate and weather of Iraq, which work to cause meteorological changes and disturbances in the country. These are weather disturbances such as heavy rain, low temperatures, and atmospheric pressure levels.

Study hypotheses:

- The Mediterranean depressions work to reduce temperatures in Iraq.
- Depressions in the Mediterranean Sea lead to rainfall and fog phenomena.

Objectives of the study:

- Highlighting the role of remote sensing data in identifying Mediterranean sea depressions in Iraq.
- Statement of the weather conditions in Iraq when affected by the Mediterranean depression.
- Identifying the dynamic characteristics of the Mediterranean lows in Iraq.

Boundaries of the study area:

- Astronomical location: Iraq is located between latitudes (29.5°) and (37.22) north, and between longitudes (38.45) and (48.45) east, and between latitudes (29.5) and (37°.22° north, looking at the administrative map of Iraq (1).
- Geographical location: The borders of the study area are represented by the Republic of Iraq, which is located on the continent of Asia, within the southwestern part of it, and it is one of its affiliated countries, as it contains eighteen (18) administrative governorates, shown in Map No. (1). The area of Iraq is 434,317 km2. Our homeland, Iraq, is bordered to the north by Turkey, to the west by Syria and Jordan, and to the south by the Kingdom of Saudi Arabia, Kuwait, and the Arabian Gulf. To the east, it is bordered by Iran, as shown in Map No. (1). (6) climate stations were used to match remote sensing data with data from ground climate stations.

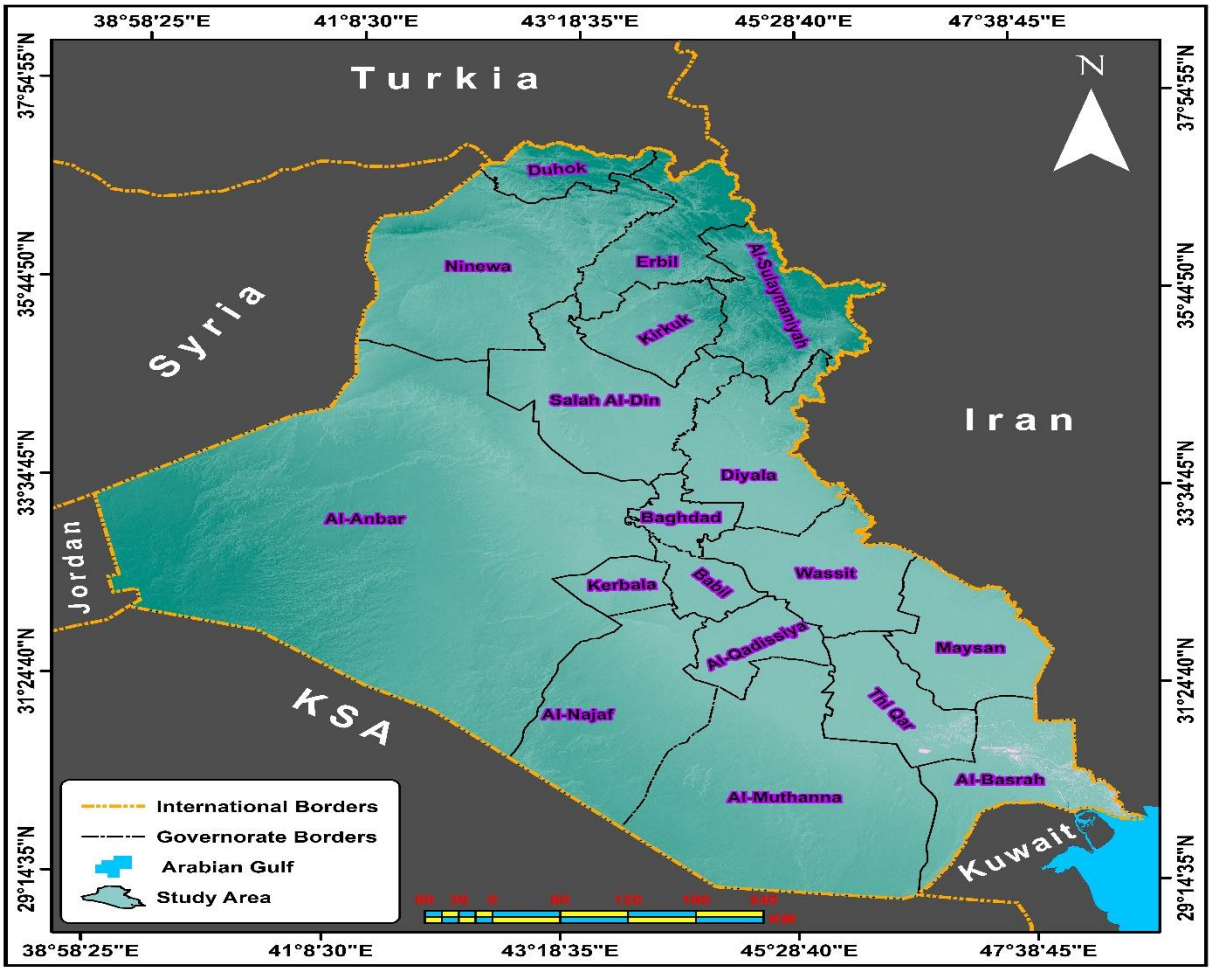
Table No. (1) Represents the climatic stations in the study area.

Governorate	Height above sea level (m)	longitude (east) Longitude(E)	latitude (north) Latitude(N)	Station number globally	name Climatic station	T
Baghdad	31	44.23	33.23	650	Baghdad	1.
Basra	2	47.47	30°.34°	689	Basra	2.
Wasit	17	46°.02°	32.08	665	District	3.
Anbar	630	40°.17°	33°.02°	642	wet	4.
Nineveh	223	43°.15°	36.32	608	Mosul	5.

Dohuk	433	42.43	37°.08°	605	Zakho	6.

Source: Iraqi General Authority for Meteorology and Seismic Monitoring, Climate Department, unpublished data.

Map No. (1): Shows the boundaries of the study area and the signature of climate stations.



Source: Based on the administrative map of Iraq with a scale of 1:1000000, and the outputs of the programArc GIS (Map) V 10.8.

Mediterranean frontal depressions

- Mediterranean low (Mediterranean low):-

The Mediterranean depression is created by the meeting of air masses through the meeting of two air masses with different thermal and humidity characteristics. When cold air coming from the North Pole collides with warm tropical air, it leads to the formation of an air front. This is due to the fact that the cold air is heavier than the warm air, which helps the warm air to rise above the cold air. The area of control for this frontal depression is along the Mediterranean Sea from east to west and from north to south, and the direction of the Mediterranean depression is from west to east. In addition, the Mediterranean low increases in depth and area of influence over the areas of influence with the arrival and activity of the Atlantic lows over the Atlantic Ocean, as the Mediterranean low begins its impact on Iraq from the month of October to the month of May, and therefore most of the precipitation is represented by rain on the face of it. This

is due to the influence of Iraq in the Mediterranean Low. Moreover, Mediterranean depressions over the Mediterranean Sea are formed in a number of the following locations, which are as follows:

1. Genoa Depressions (western Mediterranean depressions):It originates in the region extending from the Balearic Islands and the Gulf of Leon to the Gulf of Genoa, the Po River, and the northern Adriatic Sea, and approximately (52) depressions form over it, constituting (74.3%) of the total depressions that form over the Mediterranean Front.

2. Cyprus Depressions (Central and Eastern Mediterranean Depressions):The annual average of these depressions is (28) depressions, of which (3-4) depressions are formed over the region and constitute (5.7%) of the Mediterranean depressions.

3. Khassinian depressions:This type of depression is formed in the region south of the Atlas Mountains, and its formation rate reaches (14) depressions, at a rate of (20%) of the Mediterranean depressions, as they affect Iraq in the months of March and April. Due to the decline of the air high in North Africa, it often unites with the Sudan lows and moves eastward along the southern coast of the Mediterranean Sea.

Note that the names of these frontal depressions (Mediterranean depressions) were developed according to analytical observations and visual observations through satellite images and the application of the scientific spectral approach through spectral colors in color climate satellite images. Also, depending on the value (Value) reflectivity of the characteristics of spectral bands that reflect the state and characteristics of atmospheric components in the atmosphere, such as the characteristics of the air in terms of temperature and humidity characteristics. In addition, it allows knowledge of atmospheric levels. This in itself adds a cognitive character to understanding the geographical phenomenon to be studied properly and accurately.

Also, digital models of frontal depressions are an excellent and extremely important tool in climate studies and other environmental studies, such as warning of the occurrence of floods, torrents, thunderstorms, and dust storms. Because it contains very many details for all of the weather geographical phenomena. This leads to protecting and taking safety measures for citizens and government departments, as well as protecting livestock and agricultural resources from these environmental risks. Therefore, the study was detailed and complex, and it is the first of its kind in this field of knowledge, and this is directly linked to the technical development in the field of development of satellite sensors and the development of algorithms and tools in technical programs in the field of studying geography and environmental fields. As well as the development of the type of remote sensing data that carries several characteristics of objects and phenomena.

1. Mediterranean frontal low model.

The Mediterranean depression is one of the depressions that affect Iraq's climate during its arrival. Among these effects are changes in the rates of weather elements, such as a drop in temperatures, a drop in atmospheric pressure levels, or the occurrence of forms of precipitation such as rain and snow, the occurrence of fog phenomena, and other weather phenomena. Its effects on Iraq vary between seasons and months, and this is due to the activity of the atmospheric pressure system in the middle and upper latitudes, depending on the movement and rotation of the Earth and the apparent movement of the sun, which leads to a difference in the values of the atmospheric pressure centers in the world, which leads to the shifting and movement of the pressure systems between parts of the Earth’s surface. . It can be seen in Model No. (1), which shows the stages of the emergence of a Mediterranean depression from its beginning to the stage of its end or disappearance. Its stages are divided into four stages:

- phase (A):This stage shows the beginning of the formation of a frontal depression, which begins during the advance of the warm air front that formed over the Sahara Desert, especially over Libya, due to a desert region with high temperatures, with

the advance of a cold front coming from the upper latitudes, as it represents cold air. When the two fronts develop and move towards each other, it leads to a type of collision, and this collision is called the (front line), which is a dividing line between the two fronts. Therefore, the warm air coming from the tropical latitudes, specifically northern Africa, is warm air with less density, while the cold air coming from the North Pole is cold, heavier air, which makes it close to the surface of the Earth. Therefore, warm air rises above cold air; A state of thermal friction occurs, which traps the hot air. A thermodynamic state occurs, represented by a rise in temperature, which creates a turbulent weather condition, which is the formation of a frontal air depression due to the two air fronts, and this condition results in a full air front. This frontal depression reached a speed of between (90-130) knots/hour. As the weather condition in Iraq during this stage (A) It is represented by the dominance of the incoming high pressure systems in the subpolar circle. In addition, Table No. (2 and 3) shows the weather condition inferred from the spectral reflectivity of satellite images and selected climate stations, which reflects the weather condition. It represents that Iraq during this period is characterized by a state of stability, such as clear skies, while the study stations recorded a decrease in temperatures and an increase in At atmospheric pressure levels. It indicates the control of high atmospheric pressure. When ground data is matched with spectral interpretations, they match perfectly with all details, and this proves the reliability of the similarity of information.

- Phase (B): This stage describes Iraq falling under the influence of the Mediterranean frontal depression. Among the clues and interpretive keys are the weather symbols represented by the symbols of air fronts, spectral colors, wind codes, and the pattern and shape of the frontal air depression, all of which describe and indicate its confirmation and definition of its type. When looking at tables (2 and 3), which show the weather condition in Iraq according to data from climate stations and spectral interpretive evidence from satellite images. The following two tables indicate that climate stations recorded rainfall and a decrease in atmospheric pressure levels. In addition, there is a decrease in temperatures caused by the Mediterranean frontal depression. Accordingly, the weather condition during this stage is unstable because Iraq is under the control of the depression, which leads to the formation of high rain clouds, especially in the central and northern parts of Iraq, while the southern parts are devoid of them because they are located at the end of the depression. Moreover, the speed of the depression reached between (80 - 145) knots/hour.

- Phase (C):This situation is described according to the satellite visualization and Tables (2 and 3) that Iraq at this stage emerged from the influence of the Mediterranean depression because the Mediterranean depression disappeared and moved towards the east. The weather condition is characterized by a kind of stability, and the Iraqi sky is free of clouds except for a few parts of the northern part of Iraq. Consequently, climate stations and spectral color interpretations recorded a decrease in temperature and an increase in atmospheric pressure values.

- Phase (D): This stage describes the weather condition of Iraq based on visual rays that show stable and unstable areas. In addition, it provides information about clouds and their density in their natural color. When looking at the model of this stage, it is clear that the clouds are thick in the central and northern parts of Iraq and that the southern parts are free of that. This indicates that the Mediterranean depression is heavy in the central and northern parts of Iraq. When numerical and spectral matching was performed, it was found that there was a great match in terms of information and interpretations. It must be noted that the Mediterranean low affects all three seasons, with the exception of summer, due to the decline of the Siberian high and the advance of the tropical low.

Table No. (2): It represents the reality of the weather stations and the spectral interpretation of climate satellite images for the year 2021 AD.

Data and history of ritual elements									Climatic station	T
Rain (mm)			Pressure (hpa)			temperature (°C)				
21/29/1	12/29/1	17/28/1	21/29/1	12/29/1	17/28/1	21/29/1	12/29/1	17/28/1		
0.69	0	0	1008.4	1007.2	1008.6	12.4	22.45	12.54	Baghdad	1.
0.17	0.02	0.02	953.4	953.5	955.1	3.4	13.87	9.04	Zakho	2.
0.26	1.45	0	982.8	981.6	982.1	2.05	15.53	12.76	Mosul	3.
0	0.01	0	931.6	928.9	930.8	3.99	11.74	9.58	wet	4.
0.02	0.01	0	1010.6	1010.5	1011.8	12.65	23.3	17.9	District	5.
0	0	0	1010.4	1009	1012.2	15.15	23.75	19.42	Basra	6.

Source: Based on hourly climate data from NASA for the year 2021 AD.

Table No. (3): Atmospheric evidence is represented by spectral interpretation of climate satellite images for the year 2021 AD.

Optical and digital spectral interpretation						Climatic station	T
wether situation			Spectral color				
21/29/1	12/29/1	17/28/1	21/29/1	12/29/1	17/28/1		
Semi cloudy sky	Cloudy sky	a clear sky	Reddish brown	Reddish brown	light green	Baghdad	1.
Moderately humid clouds	Thick, moist clouds high	High, humid clouds	Reddish brown	Bright white	Off white	Zakho	2.
Moderately humid clouds	Thick, moist clouds high	a clear sky	White + brown	Bright white	Bluish green	Mosul	3.
a clear sky	Moderately humid clouds	a clear sky	Bluish green	White + brown	light green	wet	4.
a clear sky	Moist scattered clouds	a clear sky	green	Reddish brown	green	District	5.
a clear sky	a clear sky	a clear sky	Light orange	Greenish brown	green	Basra	6.

Source: Based on Model No. (1).

Conclusions.

1. Color satellite visuals confirmed and diagnosed Mediterranean frontal depressions based on spectral color fingerprints that helped determine the type of frontal depression. This proves the ability of satellite images to identify and diagnose frontal depressions.

2. Data from climate stations in Iraq proved that the weather phenomenon was consistent with analyzes of the thermal and visible satellite images used.

3. The study revealed the patterns of pressure distribution, represented by when the weather condition is stable in Iraq, this indicates the dominance of the polar high air

coming from the north and thus is reflected in the air condition with cold weather and an imbalance in the values of atmospheric pressure levels.

4. The study also created a drawing of air fronts based on the temperature and humidity differences in satellite images based on following the scientific spectroscopic approach.

Recommendations.

1. The necessity of using space visualization in meteorological and applied studies within multiple spectral fields.

2. The study recommends relying on modern technical methods to monitor and track pressure systems in their various forms, especially upper atmospheric phenomena and those close to the Earth's surface.

3. The study recommends conducting similar studies to study climate phenomena such as (steam, fog, atmospheric dust, etc.).

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