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Analysis of the Morphometric Characteristics of The Wadi Al-Safiya Basin in Western Iraq Using Geographic Information Systems

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ABSTRACT

The study dealt with the morphometric characteristics of Wadi Al-Safiya within the Western Plateau in Iraq and the extent of the influence of natural geographical factors represented by the geological situation, climate characteristics, water resources, soil and natural vegetation. The study was carried out according to the descriptive analytical approach and quantitative method using geographical information systems as well as field study and estimated the total area of the basin (2470.48 km^2) and its rocky and sedimentary formations date back to the Tertiary and Quaternary periods of sandstone, limestone and gypsum rocks. It shows that the basin is located within the stable shelf and that the basin is inclined to a rectangle with a broad base at the source. This reduces the possibility of its flooding, and it has a slight slope (3 m per 1 km) the basin is in the stage of maturity through the Hypsometric Integration and Ruggedness values was included through the analysis of the cadastral, morphological and topographic characteristics and the characteristics of the valley network using geographical information systems.

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تحليل الخصائص المورفومترية لحوض وادي الصافية في غرب العراق باستخدام نظم المعلومات الجغرافية

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الملخص

تناولت الدراسة الخصائص المورفومترية لوادي الصافية ضمن الهضبة الغربية في العراق ومدى تاثير العوامل الجغرافية الطبيعية والمتمثلة بالوضع الجيولوجي وخصائص المناخ والموارد المائية والتربة والنبات الطبيعي ،وتمت الدراسة على وفق المنهج الوصفي التحليلي وبأسلوب الكمي باستخدام نظم المعلومات الجغرافية فضلا عن الدراسة الميدانية وقدرت مساحة الحوض الكلي (2470.48 كم^2) وتعود تكويناته الصخرية والرسوبية الى الزمنين الثلاثي والرباعي من الحجر الرملي والصخور الجيرية والجبسية وتبين ان الحوض يقع ضمن الرصيف المستقر وبأن الحوض ذا يميل الى المستطيل قاعدته العريضة عند المنبع .وهذا يقلل من احتمالية فيضانه، ويكون انحدار طفيف (3م لكل 1كم) وان الحوض في مرحلة النضج من خلال قيمتي التكامل الهبسومتري والوعرة وقد تضمن من خلال التحليل الخصائص المساحية والشكلية والتضاريسية وخصائص شبكة الوديان باستخدام نظم المعلومات الجغرافية.

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Introduction

The valley basin represents an integrated geomorphological unit that contributed to the formation of the natural factors represented by the geological situation, the nature of the surface, the climate, the water resources, the soil, and the natural plant that witnessed during the Quaternary period most of the changes that occurred on the surface of the globe in general and the drawing the main features that are still discernible today.

Morphometric studies are one of the recent trends in the study of water basins. The river basin is the basic unit for conducting morphometric research, no matter how are these basins big or small, it is an area unit determined accordingly Indications and properties can be measured quantitatively, it is the basis for analysis, comparison and classification.

The importance of the geographic information systems has emerged as an advanced means of dealing with data in various scientific fields, the most important of which are geographical studies, and it helps in determining the shape of the basin, its erosive stage, and the resulting landforms, whether they are erosional or sedimentary, One of the most recent developments in the field of quantitative geomorphology, which uses statistical and mathematical analysis to explain landforms, is the measurement of the natural properties the valley basin. The morphometric expression means: all the standard and engineering basin characteristics that result from taking certain measurements of the water basin, including the cadastral, morphological, terrain characteristics, the water network, and drainage patterns, the

morphometric characteristics are the most quantitative geomorphological characteristics that depend on digital data related to measuring lengths and areas.

Study Problem: The problem of the study is summarized in the following question:

What are the morphometric characteristics of the Wadi Safia basin? What is the relationship of natural geographical factors and geomorphological processes in those characteristics?

Study hypothesis: The study's central hypothesis is that the morphometric characteristics of Wadi Al-Safia basin in Al-Anbar governorate differ according to its constituent factors.

Study goals: The goal of the study is to determine the most important natural geographical factors and the variation of morphometric characteristics of a valley in the province of Al Anbar through the effect of the valley on morphometric characteristics, as well as it aims to know the geomorphic processes, and how they affect the characteristics of the morphometric basin, as well as to study the quantitative analysis (morphometric) of the characteristics of the water drainage network of the basin of the study area.

The importance of the study: The importance of this study comes from the fact that it searches in applied geomorphology field, which is one of the branches of natural geography and is represented by the study of the morphometric characteristics of a valley and its basin in the plateau of the province of Al Anbar, in which various economic resources are available, this required determining its location, and it was necessary because many valleys within this plateau lacked prior morphometric studies.

Study methodology: The study used a quantitative approach, an analytical and descriptive approach, and many software programs that facilitate the researcher's work and provide accurate results, as well as climatic data and data relevant to the study area, in order to achieve its objectives. It also relied on a number of modern technologies to analyze its findings.

The boundaries of the study area: The study area is located in the southwestern part of Iraq within the administrative borders of Anbar Governorate and occupies an area of 1268.59 2km It is bordered from the north by Anbar Governorate, Najaf Governorate to the south, Karbala Governorate to the east, and from the northwest by Wadi al-Abyad basin. It extends astronomically between two latitudes (05" 34 32°) to (01" 09 33°) north and between longitudes from (58" 37 42°) to (01" 30 43°) east. (Fig.1.).

Study Structure:

- The research was divided into two axes:
- First - the natural characteristics of the study area
- Second - morphometric characteristics

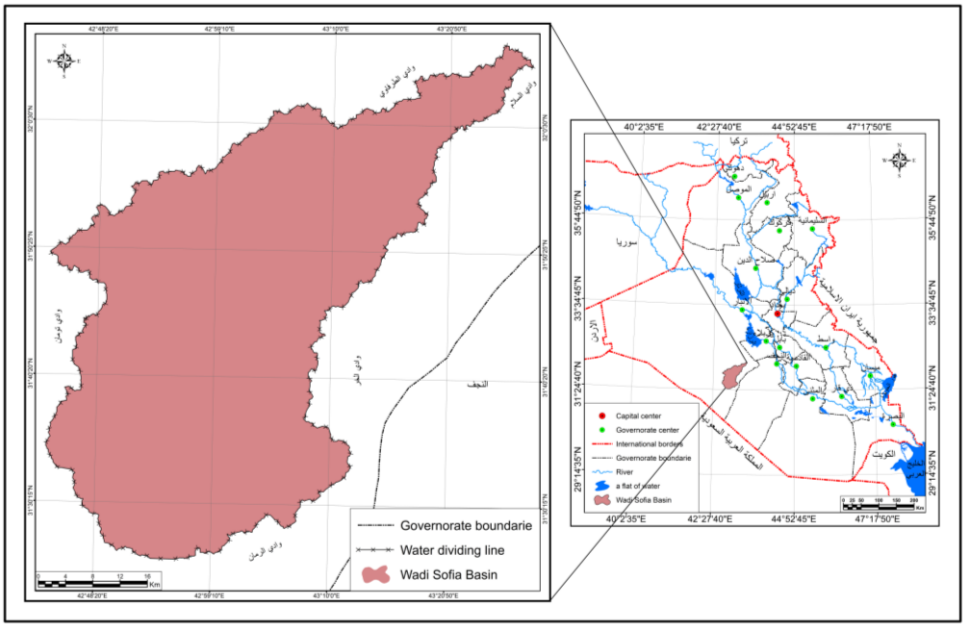

Fig.1. Location of the study area in Iraq

Source: Based on map legend 1- Ministry of Water Resources, General administration of Survey, Administrative Map of the Republic of Iraq, Scale 1:1,000,000, Baghdad, 2020. 2- Arc GIS 10.8 Application.

Previous studies:

Despite the lack of specialized morphometric studies for the study area or part of it, it is considered a field for various research and studies, especially geomorphic studies, which are related to this study in one way or another, with an indication of the difference between those studies and the current study.

Study of Azhar Ali Ghalib (geomorphological study of the Najaf plateau), in which it was shown that the Najaf-Karbala plateau is a sedimentary fan formed during the rainy period of the Pleistocene time as a result of the sediments of the Khar and Al-Abyad valleys, and it did not address the morphometric analysis of those valleys.

Study of Haifa Karim Khalil Al-Azzawi (geomorphological hazards and their impact on human activity in Anbar Governorate, an applied study using modern technologies), This study dealt with an applied model for the use of geographic information systems, and building a database of geomorphological risks, which included land cover, karst features, dune creep features, and morphometric characteristics of the valleys of Anbar Governorate.

Study of Qasim Yousef Shtait (Al-Najaf Sea Region's Geomorphology and Natural Resources), This study showed the environmental and geohydrological characteristics of Al-Najaf Sea for surface and groundwater and their characteristics. It divided the region into geomorphic units depending on their origin and dealt with some valleys that flow into Al-Najaf Sea.

Materials and Methods

First - the natural characteristics of the study area

Natural characteristics play a major role in morphometric characteristics, especially those related to geology and climate with its various elements, and have a very important impact on

the occurrence of various geomorphological processes, The basin of Wadi Al-Safia is part of the plateau, this study came to highlight the natural characteristics and the extent of their impact on the morphometric characteristics of the basin, and its role in the weathering and erosion processes of all kinds through what it does and the modification of the main features throughout the ages, which are as follows:

Geological situation:

The geological nature of the study area consists mostly of continental or marine deposits, as a result of the exposure of the sedimentary basin in the Western Desert to the change in location through different sedimentary cycles. The geological structure reveals to us the nature of the rocks in terms of their quality and movement, which also plays a major role in the formation of valleys and the movement of water.

The study of the geological structure constitutes an important part, that contributed to the formation of the soil and its prevailing physical and chemical characteristics, which can be determined by Understanding the development of this structure, in light of which the nature of topography and soil is determined, the influencing factor in determining the characteristics of any region, the geological formations exposed in the study area vary according to their sedimentary environment, where the tectonics of the study area is affected by the tectonic history of Iraq according to the geographical location, as the ages of these formations range between the lower Miocene era in the Tertiary time, and the Holocene era in the Quaternary time, where the eras that the study area went through (Wadi Al-Safia basin) are undoubtedly part of the geological eras that Iraq went through and contributed to the formation of its surface features in general.

Stratification of the study area:

The stratigraphic sequence is the rock deposits exposed in the area, there are several geological formations and surface deposits, dating back to the Tertiary and Quaternary periods. The study of rock formations and surface deposits are helpful factor in clarifying many characteristics that contribute to the formation of the land appearance. The following is a description of the exposed rock formations in the region (Fig.2).

Configuration of triple time:

Umm Erdmah configuration: This formation dates back to the Paleocene era of the Tertiary period, which included the sedimentation cycle (Middle Paleocene - Lower Eocene), as during this period there was a massive advance of Tish Sea water, which reached the outskirts of Rutba. The formation area is (220.39 km^2) and its percentage amounted to (8.92%) of the area of the study area. The formation is revealed within the middle of the study area shown in (Fig.2).

Dammam configuration

This configuration back to the Eocene time, it is exposed in the western part of the study area. This formation surrounds a part of the Euphrates Formation. It occupies an area of about (1313.52/km2) i.e. (53.17%) of the total area of the study area.

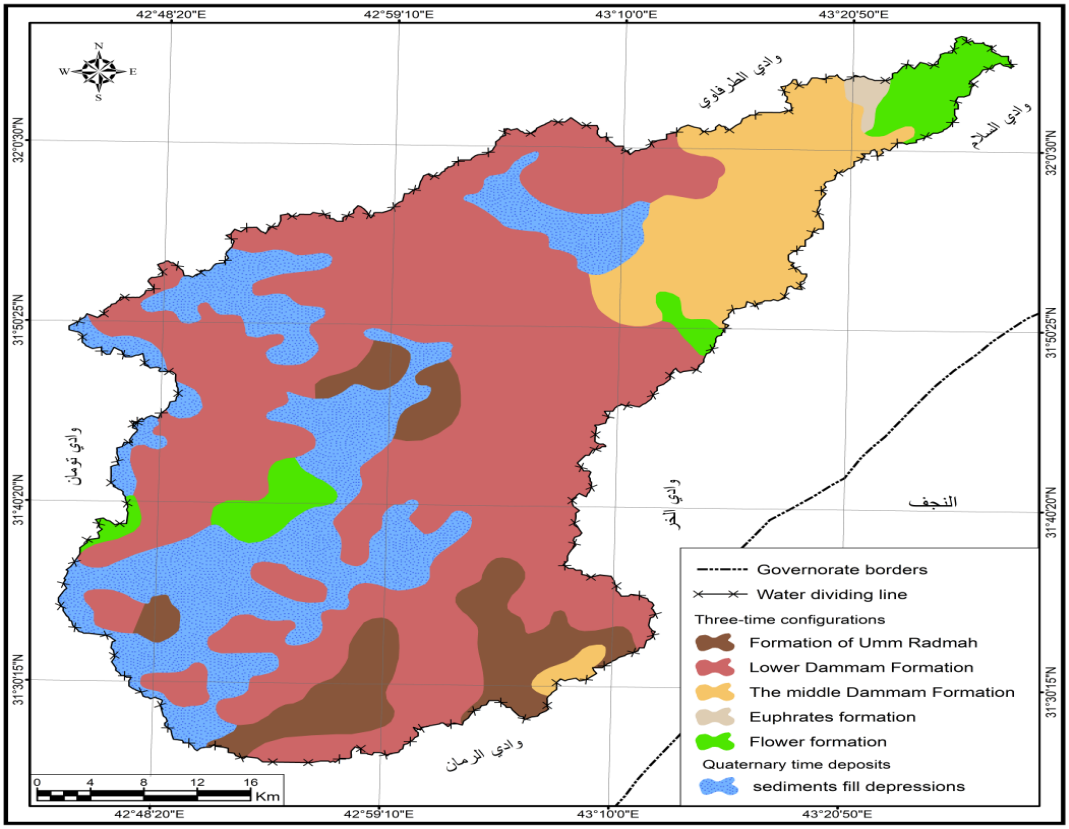

Fig.2. geological formations exposed in the study area

Source / Republic of Iraq, Ministry of Industry and Minerals, General Establishment of Geological Survey and Mineral Investigation, Iraq Geological Map, for the year 2000, scale 1:1,000,000, and outputs of Arc Map 10.8 Application.

Euphrates configuration

This configuration is back to the time of the lower Miocene, which is located within the stable platform, and this appears in the western part, and the northwest of the study area in terms of Al-Nukhaib, the area of this formation is (10.71/ km^2 i.e. (0.43%) of the total area of the study area.

Flower configuration

This configuration back to the Pleistocene-Pleistocene era within a shallow sedimentary environment represented by the lakes of its shore. It consists of white reddish limestone and sandy and clay deposits. It contains fossilized remains of reed plants, which indicates that the environment in which they are formed are closed lakes, the area of this formation is (114.7 km^2) and it is (4.65%) of the total area of the study area.

The age of formation back to the middle Paleocene era, which included the sedimentary cycle (Middle Paleocene - Lower Eocene), during this period there was a huge progression of the Tish sea water reached the outskirts of Rutba in western Iraq, and after a period of decline that finished the Cretaceous era and the second time, the formation occurred within a non-gonian coastal marine environment consisting of anhydrite, limestone and white porous dolomite with an area of (220.39 km^2) its percentage reached to (8.92%) of the study area.

Medium Dammam configuration

This configuration extends almost from the source to the center of the basin, also it extends from the northeast of the basin and ends at its first quarter. It constitutes the largest part of the region's area, i.e. an area of (288.15 / km^2), and is characterized by its sandy and pebble rocks, and limestone.

Quaternary Sediments (Pleistocene-Holocene)

It consists of sediments of the Pleistocene and Holocene periods, the Holocene can be considered the time of ice receding, the sediments of the floodplain go back to the Pleistocene sediments, while the Holocene sediments are represented by the sediments of filling the depressions (floods) in addition to the sediments of the internal sediments and the wind sediments. The sediments of the Quaternary time include the following:

Sediments of Filling Depressions

These sediments are located in the northeastern part of the study area, which is close to the western coast of Al-Razzaza Lake. These sediments consist of clay and silt sediments rich in aluminum oxides, which are considered as river sediments of origin, occupying an area of (523.51 / km^2), at a rate of (21.17 %) of the total area of the study area.

Surface appearances

Most of the study area is located within the lower valleys and a few parts of the stones area. (340 m) above sea level in the far southeast at the headwaters, while the lowest surface elevation was (160 m) above sea level in the far northwest at the mouth.

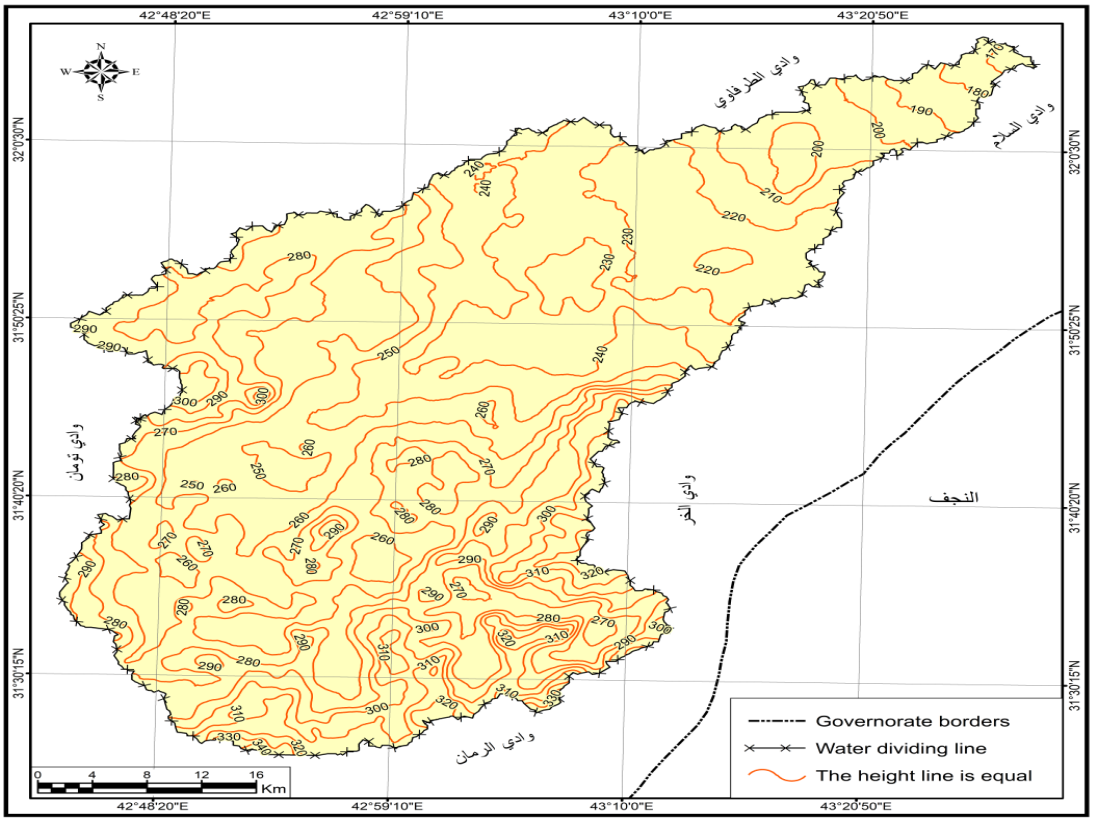

Fig.3. contour lines in the study area

Source: DEM digital elevation model with an accuracy of 30 meters using Arc Map 10. 8

Climate

Climate is defined as a study and analysis of the rate of weather elements such as solar radiation, temperatures, winds, rain, and atmospheric pressure for a specific area and for a period of time that exceeds the year, Therefore, climate is the general rate to the weather The climate elements have a significant effect on the different geomorphological aspects, Where the amounts of precipitation exceeded their amounts at the present time to a very large extent, while the current climate (dry desert), which prevails mostly the processes that are subject to the influence of the winds, which led to the modification and change in the features of these geomorphic aspects until they became what they are now as a result of the influence of different climate elements.

In general, the Wadi Al-Safia basin is characterized by high temperatures, For the stations of the study area for the period from (1990 to 2021), It is clear that the temperatures begin to rise gradually in the months (of May, June, July, August) until September. Especially since the months represent the summer season in the region, where Karbala station recorded the highest average temperatures in the three months of June, July and August (44.8, 44.9, 42.423), respectively, While the average minimum temperatures in the same three months were (23.4, 23.3, 21.2) C, respectively and that there is a variation in the general average temperature between the months of the year, as the highest average was in July (39.2, 42.8, 42.4, 44.9) C for the stations of (Karbala, Al-Ramadi, Al-Nukhaib, Al-Rutba) respectively, while the lowest average normal temperature was recorded in January, when it reached (13.7, 15.7, 15.5, 16) C for the successive stations (Karbala, Al-Ramadi, Al-Nukhaib, Al-Rutba).

The term "wind" refers to the horizontal and parallel movement of air over the flat or nearly flat surface of the earth. As well as the wind is one of the climatic factors that have an effective impact in shaping the features of the earth's surface, The monthly averages (m/s) for the stations of the study area (Karbala, Ramadi, Al-Nukhaib, and Al-Rutba) reached their maximum speed in the summer months, especially in July, estimated at (3.2, 4.6, 2.9, 3.5) m/s, respectively, While wind speed rates decreased in the winter months due to low temperatures and high atmospheric pressure, This variation in wind speed rates affects the percolating water to the core of the earth, The lowest wind speed was recorded in December, reaching (1.7) m/s at Ramadi station, while the annual average wind speeds, they were limited to (3.7, 2.5) m / s, as a maximum within Karbala station, and the lowest is Al-Nukhaib.

Surface water:

Falling rain is an important and essential factor in groundwater recharge, especially in dry and semi-dry regions, as well as the role of the rain in increasing the dryness content of the soil and achieving field sufficiency for it, Therefore, the groundwater levels rise, especially in the winter season, essentially if the geological formations have high permeability, allowing water to pass with high efficiency to the aquifers' storage layers, While the groundwater levels decrease with the decrease in rainfall, especially in the summer, so the area is devoid of permanent surface water that always flowing.

The Soil

It is the crumbly and brittle surface layer that covers the Earth's surface, It is a mix of mineral and organic ingredients, Soils differ in their rocky components as a result of the interactions of the four layers of the Earth's surface, such as the hydrosphere, the atmosphere,

the lithosphere, and the biosphere, while the soils of low thickness, they are found in the sloping areas, because of their exposure to erosion by running water, and there is a difference in the thickness of the soil, as they differ according to the different areas in which they are located, as well as the thick soils are found in depressions, there is a relationship between the type of soil and the rocks on which it rests. If the soil is local, the color of the soil comes from the color of the rocks from which the soil was formed, but if the soil's color is dark, the reason is due to the wetness of the soil in addition to the organic materials and metal components from which the rocks are formed and formed the soil, while the types of soils in the study area are the main soils of the region, and these types will be identified in terms of their area and its location in relation to the region and their percentages as follows:-

stony desert soil:

This soil appears in the eastern part and the northeastern part of the study area and occupies an area of (1782.46 / Km^2), i.e. (72.15%) of the total area of the region, as the surface of these soils covers flint and limestone, and the color of the soil tends to be black.

Mixed gypsum desert soil:

It is a different shallow soil with a coarse and incoherent texture and occupies an area of (81.63Km^2), i.e. (3.3%) of the total area of the study area, this soil consists of gypsum transported by erosion, while the basic material from which the soil was formed is gypsum, sandstone and limestone.

Salt desert swamp soil:

It occupies an area of (13.68/Km^2) at a rate of (0.55%). The reason for the formation of this soil is due to the presence of bituminous springs, which affect the groundwater, causing the rise of that water through the capillary property to the surface of the soil, which will increase the presence of the local layer, especially when the temperature is accompanied by an increase

Natural plant:

A natural plant is defined as a plant that grows on its own without human intervention in its germination and is greatly affected depending on the different amounts of rain, temperature, and soil quality, The natural plant in the study area is characterized by being a desert plant that adapts to the environment in which it lives, including perennial shrubs and annuals, which are plants that are resistant to drought by converting their leaves to leaves to wrapping their leaves to reduce evaporation processes, such as wild sidr, coleus, and saplings, including perennial herbs such as hibiscus and rue, and it may be in the form of weeds Annual herbs that appear during the rainy season and die when it ends.

It works on the soil from the processes of erosion and drift and increases the rates of water leaking into the ground through the permeability of the soil, while the plant in the area depends on the amount of effective humidity, the difference in balance between the plants that make up the vegetation cover is due to overgrazing and cutting, The vegetation cover is one of the living organisms that spread over the surface of the earth, but it varies from one place to another depending on the different climatic regions.

Second - the morphometric characteristics of the Wadi Safia basin

Morphometric studies are one of the recent trends in the study of water basins. The river basin is the basic unit for conducting morphometric research, Whether these basins are large or

small in size, as it is an area unit according to which indicators and characteristics are determined that can be quantitatively measured, and is a basis for analysis, comparison and classification, The term "morphometric expression" refers to all of the engineering and standard basin features that may be determined by measuring the water basin, such as the topographical, morphological, and spatial characteristics, as well as the water network and drainage patterns. Morphometric characteristics are among the most quantitative geomorphological characteristics that depend on digital data related to measuring lengths and areas.

Spatial characteristics: The study of the spatial characteristics of basins is of great importance in geomorphological and hydrological studies, this is through its relationship to the development of the numbers and lengths of the river network, and its impact on the volume of water discharge, where there is a direct relationship between the area and the drainage basin. The water basins vary in size according to climatic and geological conditions, ground movements, in addition to the time factor, as well as other factors, The total area of the Wadi Al-Safia basin is (2470.48Km^2), as for the relative area, it is also different from one basin to another, the water basin tend to increase their area with increasing erosion activity, When exposed to tectonic movements that contribute to lowering neighboring lands or raising others, the result is a change in the path of some valleys, The variation in the areas of the basin is due to the variation in the rocky nature, the climate and the slope factor.

There are characteristics related to the area, including basin's (length, width, and circumference) pelvic circumference), the length of Wadi Al-Safia has reached (40.6 km). It is one of the important morphometric variables, which is associated with many other characteristics of the drainage basin. The basin was measured from the outlet to the furthest point in its circumference, according to the proposed method of Geogorg and (Walling), The width of the basin is the transverse straight area between the two furthest points on the circumference of the basin. The average basin width was according to the following equation:

$$\boldsymbol{average\ width = \frac{basin\ area\ /\ 2km}{basin\ length\ /\ km}}$$

The average width of the Wadi Al-Safia basin reaches (13.18) km

Table 1: The spatial characteristics of Wadi Al-Safia basin

Area /km^2	2470.48
Real Length/Km	125.38
Ideal Length /Km	84.92
Basin Circumference/ Km	380.89
Average Width/km	13.18

Source: Based on outputs of Arc GIS 10.8 software.

Formal characteristics:

There are several geometric shapes for valleys, including circular, triangular, or rectangular shapes, where these shapes affect the nature of the water discharge, the round shapes differ from rectangular shapes, through giving an indication of flooding significantly, because flood waves quickly reach to circle round shapes more than other shapes, the reason for this is that the pattern and spread of the water drainage network and its final shape are determined by factors including geological structure, shape of the terrain, climate, soil, and existing natural vegetation, as well as the role of the human factor, the current picture is production of all these factors, the reason is the discharge waves are exposed to the factors of leakage and evaporation during the flow from the source to the downstream, There are several methods for measuring the shape of the basin, although many of them lead to the same geomorphological or

hydrological significance, there is the area cohesion ratio, the circumference cohesion ratio, and the elongation rate, all of which indicate how close or far the basin shape is from the circular shape. As for the coefficient of the shape of the basin, it indicates how close or far the basin is from the triangular shape (triangle).

Circularity Ratio

The circularity ratio means how close or far the shape of the basin is from the circular shape, and its value ranges between (0-1), as well as the circularity ratio of the basin's shape increase when the value of the equation approaches one and vice versa, also can express it mathematically:

$$circularity\ ratio = \frac{basin\ area\ (Km^2)}{area\ of\ a\ circle\ whose\ circumference\ is\ equal\ to\ the\ circumference\ of\ the\ basin\ itself\ (Km^2)}$$

By applying the equation to the Wadi Al-Safia basin in the study area, we find that the circularity ratio was (0.10), this indicates that the basin is far from the circular shape, and it was found that the risk of flooding in a rectangular basin is less than the risk of flooding in a circular basin, especially when the amount of rain falling on the basin is small and fluctuates from year to year.

Circumference Cohesion Ratio

This ratio is always higher than (one) true, whenever this ratio is greater than (one), this indicates that the basin is far from the circular shape, while the values approaching one true indicate that the shape of the basin is close to the circular shape. This ratio is extracted through the equation:

$$Circumference\ Cohesion\ Ratio = \sqrt{\frac{1}{Circularity\ Ratio}}$$

By applying the equation, we find that all the basin is far from one, it reached the basin (3.16), thus indicating that it is far from the circular shape, which means weak interdependence and irregularity of the water division lines, but they pass through clear zigzags in this basin.

Elongation Ratio:

It is the ratio of the diameter of a circle whose area is equal to the area of the basin (km) to the length of the basin (km), the elongation ratio expresses the extent of the extension of the basin compared with the rectangular shape, as the geomorphological indication indicates that whenever the number is one true or close to it, the shape of the basin is circular if the number is far from the one true, this means that the basin is close to the rectangular shape. The elongation coefficient for the basins of the study area was calculated, and this ratio is extracted from the following equation.

$$Elongation\ Ratio = \frac{The\ diameter\ of\ a\ circle\ \ whose\ area\ is\ equal\ to\ the\ area\ \ of\ the\ basin\ (Km^2)}{Real\ Length\ for\ basin\ (Km)}$$

By applying this equation, it appears that the elongation ratio for the Wadi Al-Safia basin has reached to (0.41), so this basin is close to a rectangular shape.

Length ratio to the Width:

It is one of the simplest morphometric transactions for measuring the elongation of the river basin. The high values of this ratio indicate that the shape of the basin is close to the

rectangular shape. The length-to-width ratio of the basin of the study area was extracted according to the following equation:

$$\textbf{Length ratio to the Width} = \frac{\textbf{basin length } (\textbf{Km})}{\textbf{basin width } (\textbf{Km})}$$

The length-to-width ratio of the Wadi Al-Safia basin is (9.5) km, this is a high value, which indicates that the basin tends to be more elongated than round.

Form factor:

The coefficient refers to the consistency of the relationship between the length and width of the basin in relation to the area of the basin, this coefficient is obtained through the relationship between the area of the basin and the square of length of the basin, so the low values, irregularity of the basin, and its tendency to the triangular shape describe this coefficient of regularity in the width of the water basin, along its extension, starting from the upstream area to the estuary, The values of this coefficient are extracted according to the following equation:

$$\textbf{basin Shape Parameter} = \frac{\textbf{basin area } (\textbf{Km}^2)}{\textbf{Square of basin length}(\textbf{Km})}$$

By applying the equation to the Wadi Al-Safia basin, it appears that the ratio of the basin shape coefficient is low, as it reached (0.13), this means that the basin shape is close to the triangular shape.

Compactness Coefficient:

This coefficient is useful in knowing the erosive stage of the basin, as its high values indicate that the basin has a high percentage of tortuousness in its circumference and decreasing degree of consistency in shape, while its low values indicate that the basin has come a long way in the stages of its development thus becomes more regular and consistent in its shape, it is calculated by dividing the circumference of the basin by the circumference of the circle whose area is equivalent to the area of the basin, as in the following equation:

$$\textbf{Inclusion Coefficient} = \frac{\textbf{basin circumference } (\textbf{Km})}{\textbf{Circumference of a circle whose area is equal to the area of the basin } (\textbf{km})}$$

Table (2), notes that the values of the integration coefficient for the Wadi Al-Safia basin amounted to (0.30), through this low percentage we conclude the study area basin tends to have a low meandering ratio in the circumference and a high degree of consistency of shape.

Lemniscate Ratio

The Deformation coefficient represents the relationship between the square of the drain basin to four times the area of the basin, it shows the similarity between the drain basin and the pear shape, the value of the Deformation coefficient is directly related to the elongation of the drainage basin, where the rise in the value of the Deformation coefficient indicates an increase in the elongation of the drainage basin and the dominance of vertical carving over lateral carving, And vice versa, where a lower value indicates an increase in the pelvic shape deformation. Increasing the lengths of the sewers and their numbers in the lower ranks, with increasing the vertical and lateral carving operations. The value of the deformation coefficient for the basin of the study area was extracted based on the following equation:

$$\textbf{Deformation Coefficient} = \frac{\textbf{Square length of basin } (\textbf{Km})}{\textbf{4} \times \textbf{basin area } (\textbf{Km}^2)}$$

After applying the equation, it became clear that the Lemniscate Ratio in the Wadi Al-Safia basin was (1,8255.28), so if the result is less than (2), then the shape of the basin is not dented. But if it is higher than (2), then the shape of the basin is dented. It turns out that the shape of the basin is not dented.

Third: Terrain characteristics:

The study of the terrain characteristics is of great importance in the study of water basins and geomorphological, and their morphometric characteristics because of their role in knowing the bore capacities of waterways, being a reflection of the number of elements such as the geological formation and the geological structure, through which the topography of the region and the nature of the landforms associated with it are defined, estimating the volume of the transferred sediment, as the amount of transferred sediment increases with the increase in the degree of erosion, and several measures are used to know these characteristics, as follows:

1- Terrain Ratio: It is one of the important measures to know the topography of a region or any basin, this ratio indicates the mutual relationship between the value of terrain (the difference between the highest and lowest point in the basin), the terrain ratio is calculated according to the following equation:

$$\boldsymbol{Terrain\ Ratio} = \frac{\boldsymbol{basin\ Terrian\ \ (the\ difference\ between\ highest\ and\ lowest\ point\ in\ the\ basin)(m)}}{\boldsymbol{Actual\ length\ of\ the\ basin\ (km)}}$$

This is a good indicator for estimating the volume of transported sediment, as its percentage increases with the increase in erosion, the increase in the degree of terrain contributes to the quick arrival of water waves to the estuary and the associated increase in the effectiveness of the structural activity of water and in the formation of various geomorphological forms, including slime fans, the erosion rate in Wadi Al-Safia basin reached to (2.00 m/km).

2-Relative Terrain: The relative relationship between the relative indentation value and the pelvic circumference, in a relative form indicating the degree of pelvic indentation, note that there is a negative correlation between the relative terrain and the degree of rock resistance to erosion factors when the climatic conditions are similar, i.e. the steepness of the pelvic surface slopes, this ratio expresses the degree of topographical erosion, the relative terrain is measured according to the following equation:

$$\boldsymbol{Relative\ Terrain} = \frac{\boldsymbol{basin\ Terrain\ (m)}}{\boldsymbol{basin\ Cercumference\ (Km)}}$$

After applying the above equation, it was found that the amount of relative terrain amounted to (0.50 m/km), it is noted in Table (3), that it is of low proportions, and this is due to the nature of the surface of the valley and its lack of slope and indentation, which was reflected in the ground forms intruded in the basin.

3-The roughness Value: This coefficient shows the relationship between the terrain of the basin surface and the length of the drainage network streams. Shows the relationship between streams and discharge intensity, then how slope waterway in it, depending on the calculated longitudinal drainage density Drainage density = total lengths of valleys km ÷ basin area km^2 of the basin, the higher this value means the intensity of erosion and dominance of water erosion, which works to erode and transport rocky materials from the upper sources to the bottom of the slopes and low areas of the basin, to get the coefficient value through the equation below:

Table 2: Topographical characteristics of the Wadi Safia basin

Source: Based on outputs of Arc GIS 10.8 software.

Terrain Ratio	2.00
Basin Texture	15.06
Relative topography	0.50
Hypsometric Integral	6.57
Roughness Value	1.07

$$\boldsymbol{Roughness\ Value} = \frac{\boldsymbol{basin\ Terrain\ \times Longitudinal\ Density} *}{\mathbf{1000}}$$

The value of ruggedness in the study area was recorded in the Wadi Al-Safia basin as (1.07), it indicates it indicates the severity of erosion and the prevalence of water erosion

4- Hypsometric Integral: This coefficient is considered one of the best morphometric parameters used for measuring the degree of erosion of the surface of the basin, in addition it determines the time period that the drainage basin traveled from the erosion cycle, By integrating the relationship between pelvic space and pelvic topography, as the increase in area is accompanied by an increase in the density of drainage and a decrease in the topography of the basin, That is, there is a direct relationship between the values of hipsometric integration and the period that the basin traveled from the erosion cycle, Which indicates the age progression of these basin.,

$$\boldsymbol{Hipsometric\ Integration} = \frac{\boldsymbol{basin\ area\ (Km^2)}}{\boldsymbol{basinmolars(m)}}$$

By observing Table (2), it was found that the value of the hypsometric integration amounted to (6.57), which means that the basin is in the stage of maturity of the basin, due to the lack of rainfall that results in a weak activity of erosion processes.

5- Basin Texture: This coefficient is an indicator to know the extent of the erosion and cutting of the land surface and the density of drainage in it. It is possible through knowing the size of the erosion to which the land was exposed, the intensity of its cutting, and the extent to which the river drainage network converged or diverged without taking into account the lengths of the valleys, and find it according to the following equation:

$$\boldsymbol{Basin\ Texture} = \frac{\boldsymbol{number\ of\ basin\ valleys}}{\boldsymbol{Basin\ circumference\ (km)}}$$

The Basin Texture is considered coarse if the tissue rate is less than (4) valleys/km, medium between (4-10) valleys/km, and soft if the tissue rate is more than (10). The Basin Texture of Wadi Al-Safia basin reached (15.0) valleys/km.

As shown in the Table.2, we notice the area of the basin in the study area is large, and this results in a large erosion due to the lack of progress of the earthen cycle as a result of the drought that prevails in the study area.

Drainage Network Characteristics:

River basins mean the area in which the river drains its waters, through its tributaries, and the river valley descends towards it or towards one of its tributaries, and it is expressed as the area that surrounds the river and its tributaries, and the general direction of the slope is towards it. Its structural forms on the one hand and the climate conditions on the other hand, whether it was the ancient or the current climate, and the characteristics of the rocks are reflected in terms of the degree of their permeability and the areas of rock weakness as well as the general slope of the surface. These characteristics have a clear impact on modifying the general appearance of the river drainage network at the stage of geomorphic development of the valley basin.

River mattresses:

River discharge characteristics are measured through the ranks of watercourses, their numbers, bifurcation ratios, and lengths of watercourses in the studied valley basins. The water network of a basin in the study area has been analyzed, depending on the Streller / 1952 method, which is summarized as small streams and watercourses that do not flow into any other streams or valleys. They are considered watercourses of the first rank, rivers of the second rank are formed from the assemblage of rivers of the first rank, and the rivers of the third rank are formed from the assemblage of rivers of the second rank, and so on until they move to the main river that carries the highest rank.

Table 3: Rank and number of watercourses in the Al-Safia Basin

pelvis	Rank 7	Rank 6	Rank 5	Rank 4	Rank 3	Rank 2	Rank 1	Total number of sewers
net tub	1	6	36	160	739	1432	3365.75	573975

Depending on (DEM) and the outputs of the program (Arc, Gis 10,8).

The lengths of the waterways:

The total length of the watercourses in Al-Safia Basin and for all levels has reached ((km). As for the level of the river ranks, the first rank was recorded as a length of (4041.1) and of the total lengths of the watercourses in the second rank (1534.46) km and the third rank was (784.11) long. Sewers ranked fourth (344.81), and so on (Table 4).

Table 4: The lengths of the watercourses, according to their rank order, for the Safia Basin

pelvis	Rank 7	Rank 6	Rank 5	Rank 4	Rank 3	Rank 2	Rank 1	Total number of sewers
net tub	106.21	81.22	162.12	344.81	784.11	1534.46	4041.1	705421

Conclusions

1- Wadi Al-Safia Basin is located within the formations of triple time, and its rocks are characterized by the fact that most of them are limestone rocks and sediments of quadruple time, and have a dry climate. And between the two lines of equal height (160-310).

2- The study reached results related to the areal and formal characteristics of the basin and the large basins. The area of the basin is (2470.48) km^2, the length is (125.38) km, and the average width is (13.18) km. The basin tends to a rectangular shape and approaches a triangular shape at the source. This has a function that indicates that the valley does not flood during rainstorms that it has a rough texture, and that the basin is at the beginning of the mature stage of its pluvial cycle. It also turns out that the ruggedness value in the study area was recorded in the Wadi Al-Safiya basin as it reached (1.07), here it indicates the severity of the erosion and the prevalence of erosion. Water.

3- The research concluded that the surface of the basin is a plateau sloping in a general direction from the southwest toward the northeast

4-The number of valleys in the basin was calculated as (573,975) streams, with a length of (705,421) km, representing seven levels.

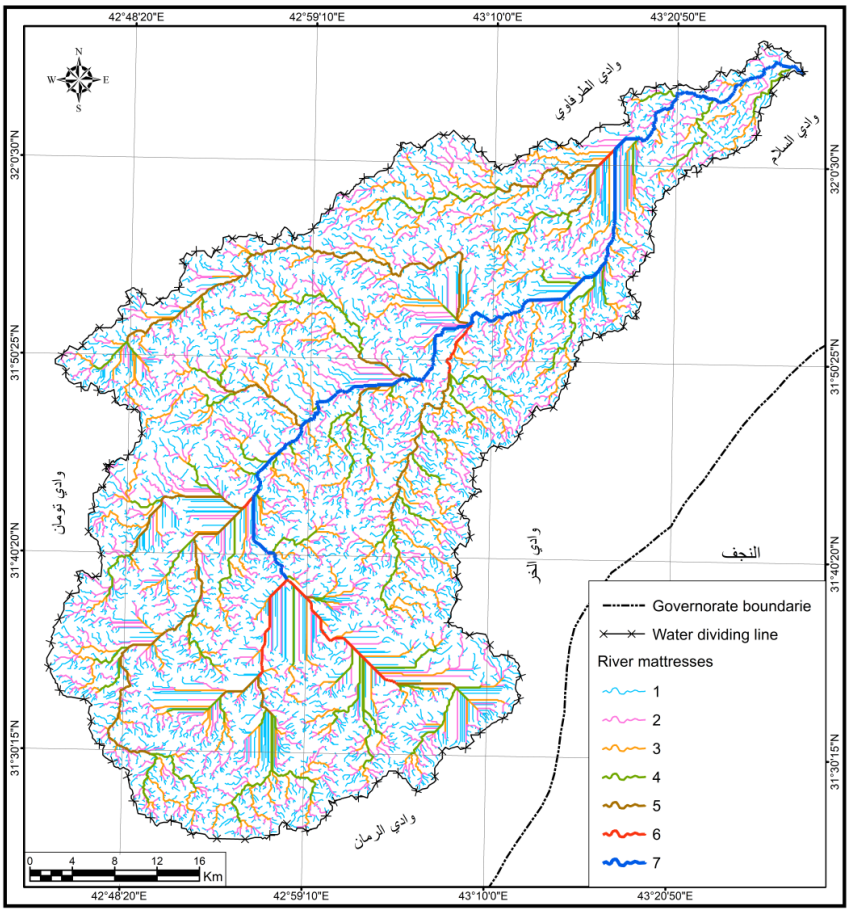

Fig. 4. The network of watercourses in the main basin of Wadi Safia

Source: Based on the digital elevation model Dem and the output of the program (Arc gis10.8)

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