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Analysis of the geometric and morphometric characteristics of Wadi Abu Jalud basin and their impact on water revenue using geographic information systems

Omar Mkhilif Hasson Jabr
University of Baghdad / College of Arts /Department of Geography& (GIS)
Omar.Mkhilif1107a@coart.uobaghdad.edu.iq

Ass. prof Dr suhailaalibrahimi
University of Baghdad / College of Arts /Department of Geography& (GIS)
alibrahimisuhaila@gmail.com

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Abstract

Geometric morphometric studies are of great importance in the study of hydrology through inputs and outputs represented by natural changes such as relative height, surface slope and river network density. Data extracted from topographic maps and satellite visualizations (DEM) in order to extract the results of the classification of surface features and to identify the factors and processes responsible for their emergence and development.

The Introduction

Geometric and morphometric characteristics work on clarifying and defining the forms of the river basin, as the drainage network for the basins of the study area was extracted based on the digital elevation model (DEM) and in light of it, the river ranks ((Stream Order) were extracted automatically based on topographic maps and GIS programs Arc Gis 10.8)) The spatial, morphological, topographical, and water drainage characteristics are calculated and analyzed through the use of several different mathematical equations to reach the outputs of the studies represented in understanding the hydrological significance of the morphometric characteristics of the water valleys.

The Study Problem

What is the effect of geometric and morphometric characteristics on the hydrology of the Abu Jaloud Valley basin?

Study Hypothesis

The geometric and morphometric characteristics of the Abu Jloud basin have a clear impact on the water revenue and the basin hydrology.

The importance of the study

Morphometric studies are of great importance in the study of hydrology through inputs and outputs represented by natural changes such as relative height, surface slope and river network density. mathematical data on topographic maps and satellite visualizations (DEM) in order to extract the results of the classification of surface appearances and to identify the factors and processes responsible for their emergence and development.

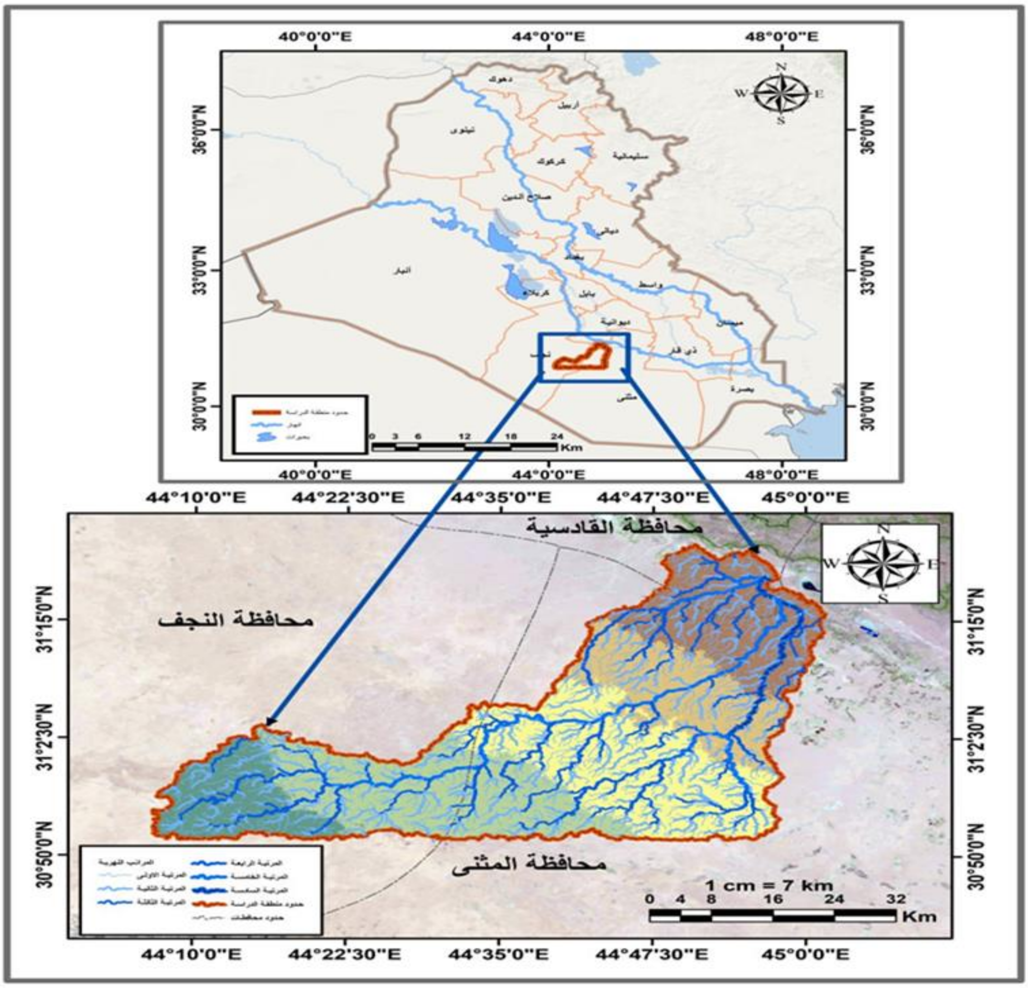
The aim of the study

Describe the geometric dimensions of the boundaries of the water basin itself, regardless of the formation of the valleys and tributaries of drainage in it, and the use of geometric specifications of the water basins in evaluating the mechanism of spatial water drainage from the tributaries of small ranks to the main stream, and then it is possible to estimate the time periods for water continuity between the different tributaries as well as calculating the flow volume.

Location of the study area

First: The astronomical location (coordinate): The Abu Jalud basin is located in the southern desert of Iraq between longitudes (00-99-44) and (45-49-00) to the east, and latitudes (29.3-29). 31,38) and (31-70-00) north.

Second: The geographical location: The basin is bounded from the north and northwest by the basin of Wadi Qurain al-Thamad, and from the south and southeast by Wadi Shuaib Abu Murays. From the north-eastern side, it flows into Lake Sawa. Administratively, it is located in three governorates: Al-Qadisiyah, Al-Muthanna, and Najaf, as shown in map (1- 1), and the satellite view of map (1-1). With an area of (3175.72) square kilometers.

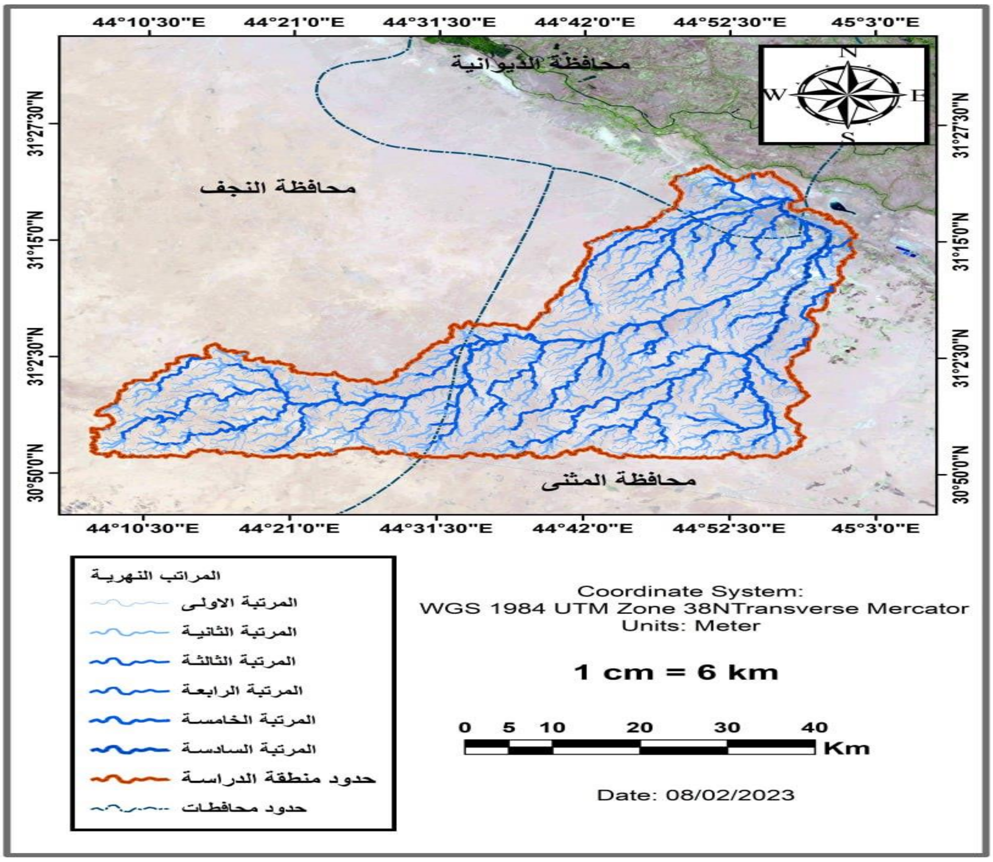


Map (1-1) of the location of the study area from Iraq
Source: The researcher, based on the Landsat 8 satellite imagery and the topographic map of Iraq for the year 2017, at a scale of 1:250,000, using Arc Map 10:8.

Chapter One

Water resources (surface and groundwater) for the study area basin

First: Surface water: It means all the water resulting from the hydrological cycle of water, which is represented in all types of precipitation, snow melting, and semi-surface water, which constitute the sustainable revenue of rivers throughout the year (Al-Saadi, 2017, p. 182). The valleys of the study area are characterized by steepness and are characterized as dry, semi-barren valleys in the summer, but in the winter they are filled with rain water forming torrential torrents, especially if the rain storm covers most of the basin due to the lack of hydrological stations to measure the volume of runoff in the valleys during the rains, shown In the map (1-2).



Map (1-2) of the surface water network of the study area basin
Source: The researcher, based on the Landsat 8 satellite imagery and the topographic map of Iraq for the year 2017, at a scale of 1:250,000, using Arc Map 10:8.

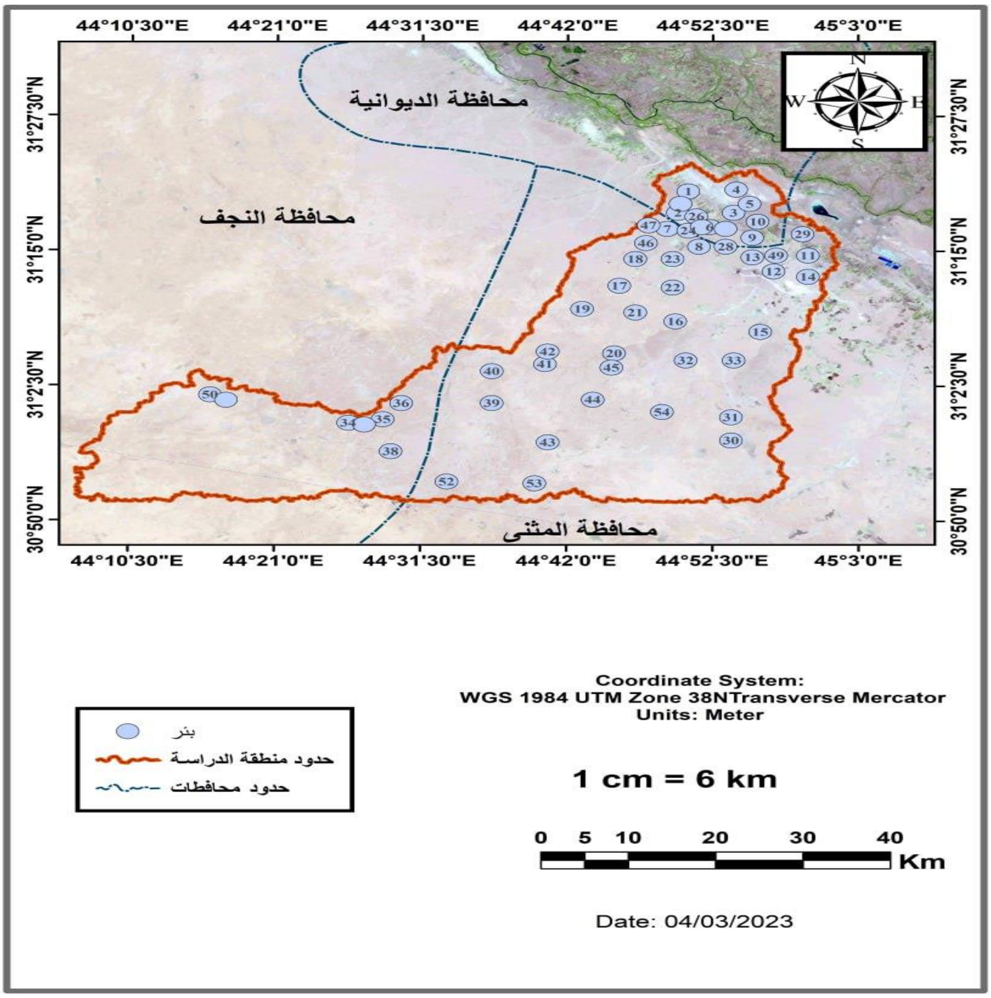
2- Groundwater: It is that water under the earth's surface that penetrates between cracks and environmental distances of soil and rocks and is part of the water cycle in nature, as the rain that falls on the earth's surface filters part of it into the soil, forming groundwater (Al-Ansari, 102, 1979) .

1- Groundwater movement, direction and depth: Groundwater moves according to hydraulic laws in the form of two movements, one of which is a downward movement or an upward movement, and the other is horizontal, and its horizontal movement is more important in the variation of the characteristics of groundwater (Al-Shammari, 2006, p. 2- Groundwater aquifers: the groundwater is concentrated in the reservoirs of the formation of both the Euphrates Formation and the Ghar Formation, which are characterized by their lack of groundwater in addition to being of high salinity. As for the recent deposits (sediments of the Quaternary era), they did not constitute important water reservoirs due to their limited spread. Its thickness is small and its water is scarce. Among the most important reservoirs within the basin of the study area are:

1- Euphrates Aquifer :This aquifer is located within the sediments of the Tertiary era (Miocene), and above the Dammam aquifer, as its waters are exposed to pressure that leads to artesian raising, being of the confined type, and it consists of limestone with sand, gravel rocks, and limestone and is fed by rainwater, and reaches a thickness of between (30- 50m)

2- Ghar Aquifer :This aquifer is interconnected with the Euphrates aquifer and is fed by rain water filtered over exposed areas in the northeastern parts and a few parts of the northwest in the study area and the areas near Lake Sawa, as it consists of different layers of clay, sand, limestone sandstone and shale, and it reaches a thickness between (20- 25 m).

3- The ground water appearance :Groundwater appears on the surface of the earth in an area in the form of springs and artesian wells, and through the data of the Ministry of Water Resources in Al-Muthanna Governorate, the number of wells reached (1335) wells. (Al-Shammari, 2006, p. 17) and as shown in the map (3-11) for geographical distribution Groundwater wells in the study area.



Map (11-3) Geographical distribution of groundwater wells in the study area basin.

Source: The researcher, based on the Landsat 8 satellite imagery and the topographic map of Iraq for the year 2017, at a scale of 1:250,000, using Arc Map 10:8.

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Chapter II

Geometric analysis of Wadi Abu Jalud basin

These characteristics are represented in describing the geometric dimensions of the boundaries of the water basin itself, regardless of the formation of the valleys and tributaries of drainage in it. The geometric specifications of the water basins are used in evaluating the mechanism of spatial water drainage from the tributaries of small ranks to the main stream, and then through them it is possible to estimate the time periods for water communication. between the different tributaries, as well as calculating the flow volume.

1- The spatial characteristics of the basin

The area of the basin was extracted based on water dividing lines based on the topographic maps and the digital elevation model (DEM) for the area with a resolution of (30 meters) and the total area of the Abu Jaloud Basin is (3175.72 km2) (Ashour, 1986, p. 470).

2- Length of the Basin: It is clear that the total length of the basin was about (106.441) km, while the ideal length was (52.77) km, which is represented by the main stream. as a result of evaporation and seepage,

3- The width of the basin: It has a great effect on surface runoff. The width of the basin can be measured from the source to the downstream, taking measurements for each of them, and finding the average width of the basin by dividing the area of the basin by its length. The benefit of knowing the width of the basin is to determine the shape of the basin through the ratio between length to width. for the basin (calculated, 2001,150) and by applying the equation:

$WB=A\div LP$

WB = average width of the basin, = A = area of the basin in km2 LP, = length of the basin in km

The average width of the basin for the study area was (29.8) km.

4- Basin Perimeter: The pelvic perimeter is one of the basic morphometric variables due to its association with many other morphometric characteristics. As for the total lengths of the pelvic perimeter, it reached (603.985) km. The pelvic circumference is one of the basic measurements in morphometric studies, and it represents the boundary between one basin and another.

Topographic measurements of the basin:-

Among the most prominent geometric standards within the topographic measurements are:

Topographical characteristics: The importance of studying the terrain characteristics of the river basins appears in the hydrological aspect by knowing the type of processes that contributed to the emergence of the basin and the extent of its effectiveness, and then determining the stage that the river basin went through in its erosion cycle (Ali Abdel-Zahra Al-Waeli, 2012, p. 106).

Topographic features of river basins include:

1- Relief Ratio: The indentation rate is a measure to know the topography of the water basin and determines the extent of the difference between the highest and lowest points in the basin measured in meters to the length of the basin in kilometers, and is a measure to know the amount of sediment transferred (Al-Omari, p. 409) It is measured according to the following equation (Salama, 102, 1980).

RHI=H/LB
As RHI = molarity ratio
H = topography of the pelvis
LB = pelvic length

As the rate of erosion in the total basin of Wadi Abu Jaloud is (2m/km).

1- The ruggedness value: It is one of the important measures that express the relationship between the topography of the basin and the longitudinal drainage density of the basin and to indicate the severity of the cutting of the surface of the basin and is calculated according to the equation (Stannley, 1956,612).

RN=Dd x H/1000
Since RN = roughness value
Dd = density of drainage
H = pelvic molar

According to the results of applying the equation, the ruggedness value of the study area basin reached (00.2), as the ruggedness value decreases in the stages of the erosion cycle and then increases until it reaches its maximum at the beginning of the maturity stage, and this indicates that there is severe erosion in the basin and the predominance of water erosion that transports rocky materials From areas of high terrain to areas of low erosion, which represent estuaries.

3- Relative Relief: It is a measure of the severity of the erosion of the basin, as it represents the relationship between the topography and the periphery of the basin, as there is a negative correlation between the relative topography and the degree of rock resistance to erosion processes when the climatic conditions are similar and measured according to the following method (Calculated, 2001, p. 209)

RHP=H×100/p
Since RHP = relative topography
H = topography of the pelvis
P = pelvic circumference

It is clear from the application of the equation on the perimeter of the basin and Wadi Abu Jaloud that the relative topography values reached (0.40 m / km) for the whole basin

4- Hypsometric integration: Hypsometric integration is also considered one of the main factors in the hydrological drainage of the basin and the shape and size of the topography, as these basic factors largely determine the direction of surface runoff changes and then determine the type and efficiency of runoff on land, which has an important role in the emergence and development of Forms of water

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erosion, especially in soft rock structures, which have little resistance to erosion factors and heavy precipitation, and are extracted from the following equation. (Annab, 2006, p. 45)

Hi=A÷H
Hi=hypsometric integration
A = Basin area km2
H = topography of the pelvis

As the value of the hipsometric integration of the basin of the study area was (13.06 km 2 / m), which are low values, and the reason for the decrease is due to the fact that the basin is at the beginning of the stage.

5- Hypsometric Index: It means that it is an arithmetic measure that expresses the stage that the water basins pass through or any section within the water basin. The following equation (Streller, 203):

HiLa=V÷HA
HiLa=Hypsometric coefficient
V = relative height
HA = relative area

As the shape of the convex hyposometric coefficient in the river basin indicates that the basin is still in the stage of youth, while the parts with moderate slopes indicate that the basins have reached a stage of balance and it is called the stage of maturity (Horton, p275).

Measurements of the morphological characteristics of the basin of the study area:

1- Elongation Ratio: It is an indicator of the percentage of the basin approaching or moving away from the rectangular shape, as its ratio falls between (0-1), as the closer the rate is to zero, this indicates that the basin shape is close to the rectangular shape, but in the case of a higher value The rate and its closeness to one indicates that the shape is far from the rectangular shape (Salama, 2004, p. 179). This percentage is calculated by applying the equation (Strahler 1964, p.415), which is as follows:

Elongation coefficient = diameter of a circle having the same basin area / basin length

The basin elongation coefficient was (0.59 km2 / km), which means that the basin is close to the rectangular shape.

2- Circularity Ratio: The circularity ratio of the water basin indicates the proximity or distance of the basin from the circular shape (Al-Naqash, p. 552).

Rc=4пA/p2
Rc=Ratio Ratio
A = area
P2 = pelvic circumference squared

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Where it reached in the basin of the study area (0.10 km 2 / km), which means that the basin is far from the regular circular shape, due to the low percentage of roundness of the basin, which means that the perimeter of the basin is slightly tortuous and is due to the youth stage in the process of erosion and water erosion.

3- The coefficient of the shape of the pelvis

It is inferred from the basin shape coefficient how close or far the basin is from the triangular geometric shape, as (Horton 1945) developed an equation by which the shape of the basin can be determined based on the relationship between the area of the basin and the length of the basin, (Al-Rawashdeh, 2017,975). It is extracted by the following equation:

Basin shape coefficient = Basin area km2 / Basin length km square

We conclude from this that the coefficient of the shape of the basin was (0.28) km 2 / km, and through the application of the equation, it is clear that the basin of the study area is far from the circular shape and close to the shape

We conclude from this that the coefficient of the shape of the basin was (0.28) km 2 / km, and through the application of the equation, it is clear that the basin of the study area is far from the circular shape and close to the shape

4- The compactness factor of the perimeter: It means the ratio of the perimeter of the basin to a circle whose area is the same as the area of the basin of the watercourse, as the ratio, if it is greater than one, indicates a higher proportion of the periphery's cohesion, which moves the basin away from the regular round shape. In the basin of the study area, it reached (3.1).) This means an increase in the cohesion of the pelvic circumference.

Chapter III

Morphological analysis of the pelvis

The general shape of the river tributaries of Wadi Abu Jalud basin is a reflection of the relationships between the characteristics of the rocks of the region and their structural forms on the one hand and the conditions of the current and ancient climate on the other hand, as it reflects the characteristics of the rocks in terms of the degree of permeability, hardness, general slope of the surface, and structural images of cracks, joints, fissures, and others (calculated, 2001, 210).

The morphological characteristics of the water drainage network, which are:

1- River stream Number Order: The river streams are a numerical arrangement of the tributaries that make up the water drainage network. The methods of classifying and distributing the river network differ to its ranks and can be summed up as each pair of first-rank streams is determined to be a second-rank stream, which in turn extends to connect In another stream of the second order, forming a stream of the third order, and so on until we reach the main stream (Stahler, 1954, p341). It is possible to take advantage of the riverine ranks in estimating the capacity of the sedimentary and sedimentary basins, and then limit the impact of the different land uses adjacent to the basin, as the higher ranks indicate that they run in a region with a low slope and with (Al-Ajili, p. 349).

2- The lengths of the sewers: The total lengths of the valleys for all ranks in the study area amounted to (2636) km, as the first rank was recorded (1568 km) of the total lengths of the total sewers with a rate of (59.4%), while the lengths of the sewers in the second rank amounted to (396 km) with a rate of (15%)) ranked third (273 km), with a rate of (10.3%), and the lengths of the river ranks were recorded within the fourth rank (213 km), with a rate of (8%). (43) at a rate of (2%).

3- Bifurcation Ratio: It means the ratio of the number of streams of a given rank to the number of streams of the next rank. The bifurcation ratio of waterways is affected by several factors, including the structural and geological composition and climatic conditions. (Abu Al-Enein, p. 436), which is calculated by the following equation:

Rb=Nu/Nu+1
Rb = bifurcation ratio
Nu = the number of streams for a given rank
Nu+1=Number of streams in the next rank

As it becomes clear that the bifurcation ratio for the first rank was (3.78), while the bifurcation ratio for the second rank was (5.34), while the bifurcation ratio for the third rank was (5.53), while the fourth rank had a bifurcation ratio of (3.75), and the bifurcation ratio for the fifth rank was (4).), As for the total bifurcation ratio of the basin, it was (3.9 km2).

4- Longitudinal drainage density: It refers to the ratio of the total lengths of sewage in its various ranks within the study area to the area of water recharge (Abu El-Enein, pg. 452).

Dd=∑ki=1 ∑k i=0 Lu/A
Dd = longitudinal drainage density
Lu = the sum of the lengths of the streams in the ranks of a river
A = area km2

It is clear from the application of the equation for the longitudinal drainage density = the total lengths of the water network / km / basin area / km 2. We conclude from the application of the equation that the longitudinal drainage density reached (1 km / km 2), which is very low according to the approved classification as in Table (3-22).

Table (3-22) Assessment of discharge intensity levels for the study area

evaluation	value
2.5-4	Is Too low
5-14	sec
15-24	Medium
25-49	Is good

evaluation	value
50-100	Is high
More than 100	is too high

Source: Khalaf Hussein Ali Al-Dulaimi, Topography (an applied practical geomorphological study), previous source, p. 274.

From the foregoing, it is clear that the study area has a rough topographic texture, and the increase in these lengths comes with an increase in the length of the waterways in the basin.

5- Numerical drainage density or river frequency (Stream Frequency): The numerical drainage density is the ratio of the number of watercourses of all ranks to the total area of the study area.

The numerical exchange density is extracted according to the following equation:

Numerical drainage density = total number of watercourses/m/basin area km2

As it becomes clear after applying the equation, we find that the value of the numerical drainage density or river frequency of the study area amounted to (0.7) stream / km 2

6- The maintenance rate of the stream is important with regard to the coefficient of survival of the stream, since it determines the area unit (km 2) and through it one longitudinal unit (km) can be fed from the waterways to the drainage network as a minimum, so that the drainage channel remains in continuity and development (Turab, p. 274)

The survival rate of the stream (km 2 / km) = basin area / km 2 / total lengths of waterways / km

It is clear from the application of the equation that the survival rate of the stream for the total basin has reached (1.2) km 2 / km.

Conclusions

1- It is clear that there is a correspondence between the river network on the one hand, and the geological formation and linear structures on the other hand.
2- The river network is consistent in its extension and direction with the less solid geological formations, as well as its compatibility with the linear structures.
3- The effect of geometric characteristics directly on the formation of tributaries and drainage valleys within the Abu Jaloud Basin
4- The effect of morphometric characteristics on the water drainage network and its tributaries.

proposals

1- Construction of earthen dams to store water and benefit from it in times of floods and torrents
2- The possibility of benefiting from the rectangular shape that characterizes the river basin to invest water for agricultural purposes

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