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Analysis of the Morphometric and Hydrological Characteristics of the Wadi Shaal Basin and its Secondary Basins

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Abstract:

This research aims to analyze the hydrometric morphometric characteristics of the Wadi Shaal Basin and its secondary basins. We conclude that all the secondary basins are still in the stage of maturity. The longitudinal section of the Wadi Shaal Basin stream appears in the form of steep gradients near the source and gradually decreases as we head towards the downstream. It is straight in its streams. This indicates Partial equanimity, and a very severe erosion rate was found according to the Strahler classification, as the number of basins that recorded very severe erosion were (100.2, 97.29, 91.52, 86.14) water basins, which are (11, 13, 19, 8) respectively, and the reason is due to the occurrence of the high area Adjacent to the northern Qara Jouk latitude and the slope of its valleys from the areas of water division from high ranges, as the values of this coefficient increase as the difference between the highest level and the lowest level within the drainage basin increases, which increases the slope rate leading to the activity of water erosion processes and the formation of multiple landforms.

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Introduction

The study of water basins is one of the studies that has an important space in hydrological and water research and studies because it has scientific indications that can be relied upon in its areas of existence. Therefore, the water drainage basin is a hydrological system that is controlled by its engineering properties and laws that have mutual functional relationships, which can be determined by studying a set of variables. Measured from data sources represented by topographic maps, aerial photographs, or satellite data. And that morphometric characteristics is the science of measuring the engineering characteristics of the earth's surface resulting from the system of river erosion, and

defined it as a measurement of shape, as morphometric studies depend on measuring and treating land features on stopping the foundations of quantitative analysis by applying mathematical equations and statistical methods on data derived from topographic maps, field measurements and images Aerial and satellite visuals, in order to use its results in classifying terrestrial features and identifying the factors and processes responsible for their emergence and development.

1-1 Research problem

- 1- What is the relationship between the morphometric characteristics of the basin and the hydrological variables affecting the study area?
- 2- Does the morphometric analysis represented by the spatial, morphological and topographic characteristics have a role in knowing the observed measurements by applying equations and laws for basin modeling?

1-2 Research hypotheses

- 1- There is a relationship that links the morphometric characteristics of the basin and the hydrological variables affecting the study area.
- 2- Morphometric analysis has a role in knowing the observed measurements by applying equations and laws to model the basin.

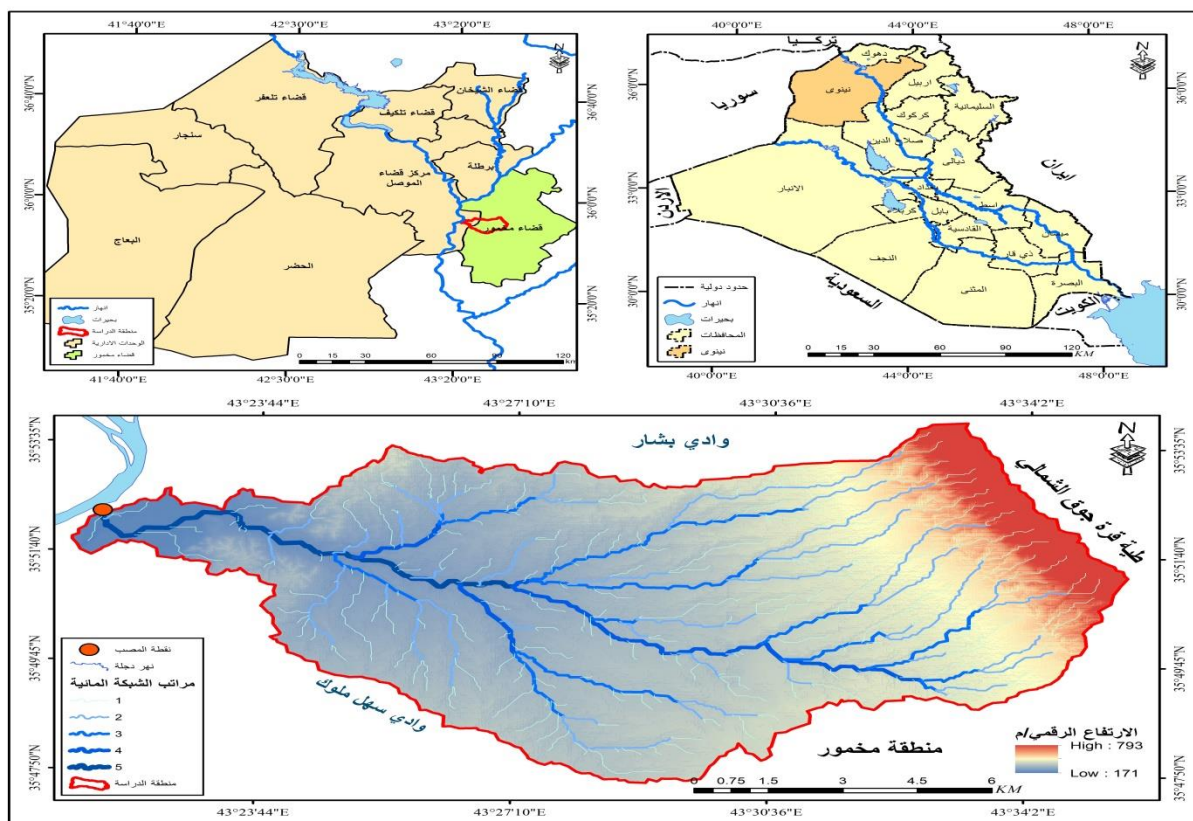
1-3 The justification and objectives of the research

The research aims to study the morphometric characteristics and quantitatively analyze the drainage network and the spatial, morphological and topographical characteristics of the Wadi Shaal Basin using modern technologies, and to build a geographical database that contains morphometric variables characterized by the accuracy of details that are not provided by topographic maps, due to the importance of these characteristics in hydrological studies.

1-4 Sijte study area

Wadi Shaal is located within the administrative boundaries of Makhmour district of the Nineveh governorate, from the east and north, and it is bordered by the Qayyarah district from the west of the Nineveh governorate, and is confined between the Great and Small Zabs, where the Great Zab separates the study area as a natural separator from the Nineveh governorate, as shown in Map (1), Yanbu From the northern heights of Qara Jouk and flows into the Tigris River, which penetrates the study area with a length of (25.7) km, and is confined between longitudes (43-34-02_43-20-44) east and latitudes (35-53-35_35-47-50) north. Its area is (138.6) square kilometers.

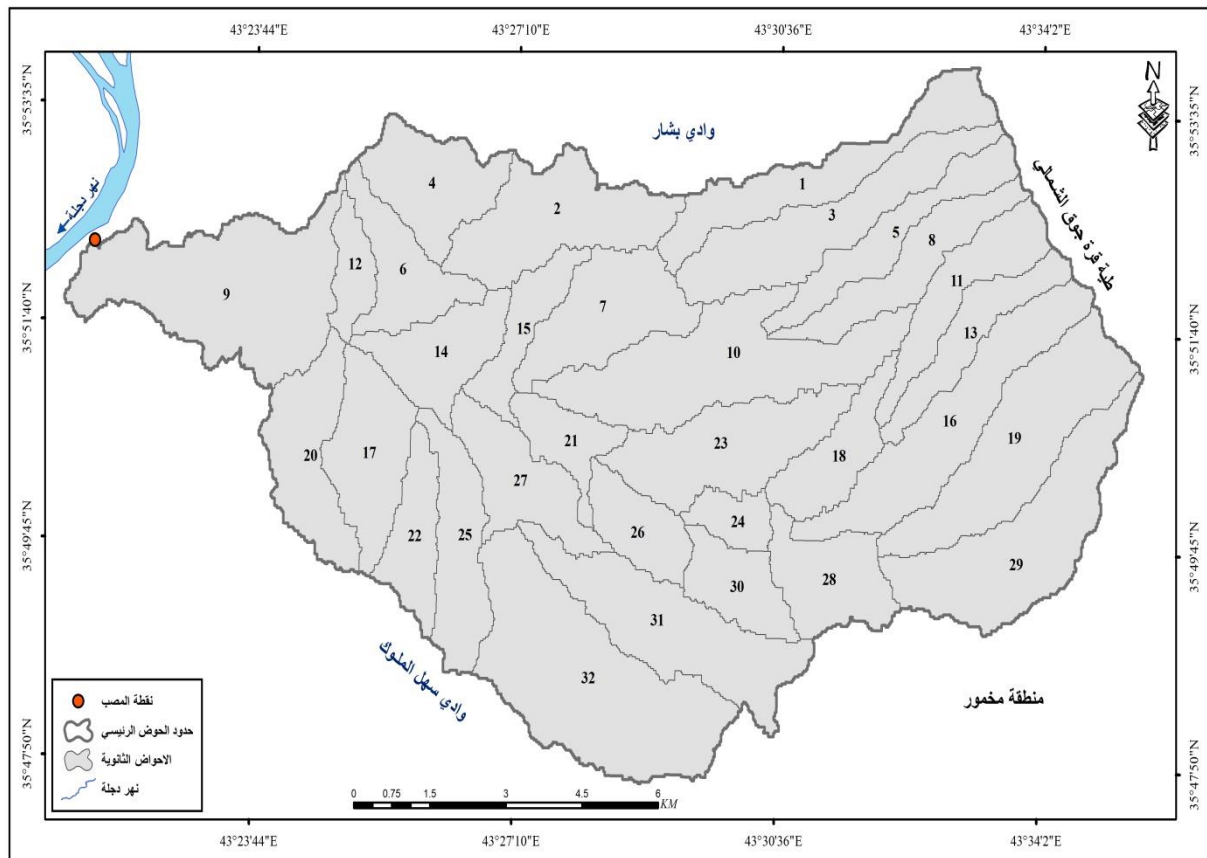
Map No (1) Location of the study area



Source: Based on the administrative map of Iraq at a scale of 1/1000000 and the digital elevation model (DEM), with a resolution of 12.5m, using the Arc Gis 10.8 I program.

Preface

Morphometric studies are one of the recent trends in the study of river basins, and for the purpose of studying the morphometric and hydrological characteristics of the secondary basins of the study area, it relied on morphometric analyzes of the Wadi Shall basin and extracting the water drainage network on many data sources, the most important of which are the digital elevation model (DEM) and satellite visuals (Land Sat8) for the year (2018) and the topographical map approved by the Survey Authority with a scale of 1/100000, by defining the borders of the basins and dividing them, then making comparisons between them to reach the results, then making an assessment that is the degree of risk and indicating its effects and risks on the study area. The region is characterized by the presence of a group of seasonal basins, which amounted to (32) basins, as shown in Map (2) and Table (1), descending from the northern Qara Jouk fold to flow into the Tigris River, relying on rain and fallen snow, and then formed by the branches of the surface water drainage network, all of which flow into Wadi head to be Wadi Shawl.

Map (2) wadi shall basin and its secondary basins

The source is from the researcher's work depending on the digital elevation model (Dem) and Arc Map10.8 program.

2- 1Area Characteristics modeling of Wadi Shaal Basin

2-1-1 Basin Area (km²)

The area of the basin is one of the important morphometric characteristics that has a clear effect on the volume of water discharge, the river drainage network, as it has a close relationship with the river network system, which is related to the numbers and lengths of the sewage, because it directly affects the volume of water flow and the volume of sediment, as the larger the area of the basin, the greater the amount of precipitation ¹. It is clear from Table (1) that the area of the basin amounted to (138.6) km², and thus it is considered a basin of average area, which entails an increase in the amount of rain it receives, which leads to an increase in the volume of surface runoff, especially in periods of rainstorms, according to this The foundation can be evaluated, developed and utilized.

2-1-2 Basin Length

It is the distance between the axis of the basin measured from the source to the downstream. The basin may be measured from the downstream to the furthest point in its circumference ². The lowest length was (1.7) km in basin (24), while the highest length in basin (10) was (7.8) km. , as shown in Table (1), due to the fact that the water travels a long period of time to reach from the farthest point in the basin to the downstream point, which increases the volume of losses due to evaporation and leaching.

2-1-3 Basins Width

It is the average length of a group of lines perpendicular to a straight line that represents the length of the basin, and there is no limited number of these lines ³. The width of the basin will be determined by drawing parallel lines from the mouth to the source, or by relying on the following equation ⁴.

$$\text{Basins Width} = \frac{\text{Basin Area (km}^2\text{)}}{\text{Basin length}}$$

It ranged between (0.6) km as the lowest value in basin (13), and between (2.63) km as the highest value in basin (4), as shown in Table (1). The width of the basin increases in the water basins due to the activity of the watercourse network and its effectiveness in its expansion and growth through regressive and lateral erosion, in addition to the steepness in the slope and the increase in the amount of rain in the water division areas, which is reflected in the significant increase in the basin breadth.

2-1-4 Basins Cirum Scrimption

It is meant by the water dividing line that separates the basin from the adjacent basins ⁵. As the length of the basin circumference increases, the basin spread increases and its breadth increases, as the basin perimeter varies due to the geological environment and rock deposits, in addition to the variation in the number of river ranks of the basins. By observing table (1), it ranged between (7.0) km for basin (24) as the lowest value, and between (21.8) km for basin (1) as the highest value. We conclude that the larger the area of the basins, the greater the meandering of the water dividing line and the increase in the perimeter of the basin, which is reflected in the lengths of its circumferences, which were characterized by shortness.

Table (1): The spatial characteristics of the Wadi Shaal basin and the secondary basins

The offer/km	Height/ km	Ocean/km	The area is Km ²	T
0.72	7.1	21.8	4.7	1
1.9	6.9	17.7	5.6	2
0.9	6.9	20.3	5.6	3
2.63	2.3	12.2	3.8	4
0.7	5.7	17.1	3.2	5
1.9	2	13.2	3.0	6
1.6	3.8	13.8	4.5	7
0.8	5.7	16.4	3.3	8
1.75	5.2	24.0	9.5	9
1.25	7.8	25.7	8.4	10
0.62	4.9	15.0	3.3	11
0.9	2.5	7.9	1.4	12
0.6	4.8	14.5	2.7	13
1.9	2.3	11.9	3.2	14
0.6	3.2	12.3	2.2	15
1.1	7.2	21.8	6.2	16

1.63	3.75	12.0	4.0	17
0.9	3.7	11.9	2.7	18
1.5	5.9	19.0	6.9	19
1.14	4.3	14.3	4.1	20
0.92	1.9	10.2	2.0	21
0.87	3.1	10.4	2.5	22
1.5	5.4	17.4	5.4	23
0.81	1.7	7.0	1.3	24
0.91	4.4	13.4	3.6	25
1.12	2.63	8.7	2.3	26
1.2	4.1	13.9	3.5	27
1.8	3.1	11.4	3.4	28
1.47	6.65	20.0	7.1	29
1.2	2.9	9.5	2.4	30
1.42	5.9	21.1	6.4	31
2.3	5.9	21.0	10.5	32
8.8	25.7	82.4	138.6	Shale valley

Source: Outputs of (Arc Map 10.8) program based on the Digital Elevation

Model (DEM) with a discriminatory accuracy of 30m.

2-2 Modeling the morphological characteristics

2-2-1 Circularity Ratio

This coefficient indicates how close or far away the shape of the basin is from the circular shape, and we extract this ratio from the following equation ².

$$4 \times 22/7 \times \text{pelvic space}$$

$$\text{Circularity Ratio} = \frac{\text{Basin circumference square}}{\text{Basin circumference square}}$$

As the closer the result is to the correct (1), it indicates that the basin approaches a circular shape, while the closer it gets to (zero), the closer the basin is to elongation, and this indicates irregularity and tortuousness of the water dividing lines³. It is clear through the application of the equation and as shown in Table (2) that the ratio of roundness has reached (0.13) in the Wadi Shaal basin, which is a low value indicating that the basin is far from the circular shape. As for the secondary basins, the results varied, as the highest rate was recorded in the (26) basin. It was (0.38), this value (low) indicates the passage of the basin. As it moves away from the circular shape and the irregularity of the lines dividing the water between it and the surrounding basins.

2-2-2- Elongation Ratio

The elongation ratio is considered one of the most accurate morphometric parameters in measuring the shapes of drainage basins that control the elongation characteristic of the amount of water that supplies the valley stream. The numerical value is between (0-1), and if the result is close to the number (zero), it indicates that the basin is close to the rectangular shape. It can be calculated according to the following equation 5.

The area of the basin is km^2

$$\text{Elongation ratio} = \frac{\text{The area of the basin is } \text{km}^2}{\text{Trough length km}}$$

From the application of the equation, the elongation rates according to Table (2) indicate that the elongation ratio for Wadi Shawl basin was (0.46), and for the secondary basins, as it reached the highest value in basin (6), (0.86) and the lowest value in basin (31), (0.21), this indicates This indicates that the value is far from the correct one. This indicates that the basin is close to the rectangular shape. This affects the length of the waterways as well as the main sewers in where the lengths of the lower ranks decrease and their numbers increase with the increase in the elongation coefficient, which works to decrease the water discharge due to the length of the distance that the stream travels. Which results in evaporation and leakage in its water.

2-2-3 Basin form factor

It is an indicator of how typical the shape of the basin is, and how close the shape of the water basin is to the triangular shape or moving away from it, and its value is limited to (0-1). Its shape is a triangle. The coefficient of the shape of the basin is calculated according to the following mathematical formula:

The area of the pond is sq km

$$\text{Pelvic shape parameter} = \frac{\text{The area of the pond is } \text{sq km}}{\text{The square of the length of the tub}}$$

When applying the treatment to the Wadi Shall basin, it was found (0.21) that the basin is close to the triangular geometric shape due to a decrease in value as shown in Table (2) and the map. as the highest trough value (6) trough values range. This indicates the small area of these basins in relation to their lengths and their closeness to the triangular shape.

2-2-4 Circumference Consistency Ratio

It is a measure to know how close or far the basin is from the circular shape. If its value increases, it indicates that the shape of the basin is farther away from the round shape and is more elongated, and vice versa. That is, the closer the value is to number (1), the greater the possibility of flooding and vice versa. The percentage of cohesion of the basin circumference can be extracted from The following equation ².

$$\sqrt{1}$$

$$\text{perimeter cohesion ratio} = \frac{\sqrt{1}}{\text{Area cohesion ratio (roundness)}}$$

It is clear from the application of the equation to the basins of the study area that it has a variable value, as it reached (2.77) in the Wadi Shall basin and (3.16) in the (8) basin as the highest value, while it was recorded in (26) basin (1.62) as the lowest value, as shown in the table (2) Refers to the basin's distance from the circular shape, and this means weak interconnection between the parts of the

river basin, tortuous water dividing lines, the dominance of regressive erosion processes, and an increase in the proportion of sediment transported.

2-2-5 Diffraction index

The deflection coefficient expresses the geometric shape of the drainage basins, i.e. it does not take the perfect circular shape. The value of the deformation coefficient is calculated by the following equation 2:

$$\text{Diffraction index} = \frac{\text{basin length km}}{\text{pelvic space km}}$$

The low values of the bending coefficient indicate an increase in the deflection of the shape of the basin, which indicates an increase in the lengths and numbers of sewers in the lower ranks, with the dominance of the exponential and lateral carving processes, while the high values of the buckling coefficient indicate an increase in the elongation of the drainage basin and the dominance of the vertical carving processes and more than the lateral carving. After applying the equation, we note from Table (2), that the deformation coefficient of the Wadi Shawl basin is (0.19) km and the basins in the study area ranged between (1.81) km as the highest value for basin (5) and between (0.55) km as the lowest value for basin (9).

Table (2) The morphological characteristics of the Wadi Shaal basin and its secondary basins

Diffraction index	Perimeter cohesion ration	Pelvic shape parameter	elongation	Turn around	T
1.50	2.88	0.09	0.3	0.12	1
1.23	2.13	0.12	0.34	0.22	2
1.24	2.42	0.12	0.34	0.17	3
0.60	1.77	0.71	0.84	0.32	4
1.81	2.77	0.09	0.31	0.13	5
0.66	2.18	0.75	0.86	0.21	6
0.84	1.86	0.31	0.55	0.29	7
1.73	3.16	0.1	0.31	0.1	8
0.55	2.23	0.35	0.59	0.2	9
0.93	2.58	0.13	0.37	0.15	10
1.50	2.35	0.13	0.36	0.18	11
1.73	1.88	0.22	0.47	0.28	12
1.79	2.5	0.12	0.34	0.16	13
0.71	1.88	0.6	0.77	0.28	14
1.48	2.35	0.21	0.46	0.18	15
1.16	2.5	0.12	0.34	0.16	16
0.93	1.71	0.28	0.53	0.34	17
1.39	2.08	0.19	0.44	0.23	18
0.85	2.04	0.19	0.44	0.24	19
1.05	2	0.22	0.46	0.25	20
0.97	2.04	0.55	0.74	0.24	21
1.25	1.85	0.26	0.5	0.29	22
1.00	1.74	0.18	0.42	0.33	23
1.35	1.74	0.45	0.67	0.33	24
1.22	2	0.19	0.42	0.25	25
1.14	1.62	0.33	0.57	0.38	26
1.16	2.13	0.21	0.45	0.22	27
0.91	1.76	0.35	0.59	0.32	28

0.94	2.13	0.16	0.4	0.22	29
1.20	1.74	0.29	0.53	0.33	30
0.93	2.35	0.18	0.21	0.18	31
0.56	1.85	0.3	0.54	0.29	32
0.19	2.77	0.21	0.46	0.13	Shale valley

Source: Outputs of (Arc Map 10.8) program based on the Digital Elevation Model (DEM).

2-3 Topological Characteristics Modeling

The terrain characteristics are represented by the following data:

2-3-1 Relief Ratio

It expresses the extent of expression in the height and depression on the surface of the earth, the higher the ratio of intrusion in the basin, the decrease in the concentration time of surface water runoff, and thus the height of the flood peak and vice versa, as it is directly proportional to the slope, as the difference between the highest point within the water division area and the lowest point, which is usually the downstream 1. It is calculated according to the following equation ².

The difference between the highest and lowest point in the basin/m

Wear ratio = -----

Basin length

When applying the equation, we notice that the rate of erosion for the Wadi Shall basin amounted to (24.20) m / km. This value indicates that the rate of erosion in the main basin is very severe, according to the classification of Strahler (*), as the number of basins that recorded very severe erosion reached (97.29, 100.2). , 91.52, 86.14) water basins are (11, 13, 19, 8) respectively, as in Table (3), and the reason is due to the occurrence of the elevated area adjacent to the northern Qara Jouk fold and the slope of its valleys from the water division areas of high ranges.

2-3-2 The ruggedness value

The degree of ruggedness is one of the roads that show the discontinuity of the surface of the basin that makes the sewers, and the closer the number is to the correct (1), this indicates the severity of the ruggedness, and vice versa. This indicates an increase in the inclination of the basin and an increase in the lengths of waterways at the expense of the area of the basin. The value of the coefficient can be obtained through the following equation 2. When applying the equation to the basins of the study area, as in Table (3), we note that the value of the ruggedness of the main Wadi Shaal basin amounted to (0.05) m / km².

Basin topography/m x discharge density km/km²

Roughness value = -----

1000

As there is a variation in the value of ruggedness between the basins, as it ranged between (0.23) m / km² for basins (11 and 19) as the highest value and between (0.01) m / km² as the lowest value for basins (2, 28, 31 and 32).

Table (3) Topographical characteristics of the Wadi Shaal basin and its secondary basins

Hypsometric integration	Roughness value	Wear ration	Lowest height/m	Highest height/m	T
0.068	0.15	68.3	230	715	1
0.78	0.01	7.1	206	255	2
0.078	0.16	71.15	230	721	3
0.17	0.05	21.3	206	255	4
0.037	0.22	85.08	246	731	5
0.086	0.08	34.5	187	256	6
0.39	0.02	11.31	204	247	7
0.038	0.20	86.14	246	737	8
0.62	0.03	15.38	171	251	9
0.74	0.03	11.28	206	294	10
0.03	0.23	100.2	261	752	11
0.06	0.05	21.2	185	238	12
0.03	0.19	97.29	260	736	13
0.22	0.03	14.78	187	221	14
0.16	0.03	13.43	197	240	15
0.08	0.17	69.72	240	742	16
0.41	0.02	9.6	190	226	17
0.24	0.02	11.08	238	279	18
0.07	0.23	91.52	249	789	19
0.41	0.02	10	185	228	20
0.15	0.03	13.15	202	227	21
0.24	0.02	10.32	201	233	22
0.62	0.02	8.7	217	264	23
0.14	0.02	9.41	228	244	24
0.44	0.02	8.18	202	238	25
0.31	0.02	7.22	217	236	26
0.41	0.02	8.53	197	232	27
0.43	0.01	7.74	238	262	28
0.08	0.20	81.5	249	791	29
0.26	0.02	8.96	228	254	30
0.85	0.01	7.45	212	256	31
1.58	0.01	6.61	211	250	32
5.73	0.05	24.20	171	793	Shale valley

Source: Outputs of (Arc Map 10.8) program based on the Digital Elevation Model (DEM).

2-3-3 Hypometric integral

It expresses the value of the relationship between the basin area and the basin topography, as high values indicate an increase in basin areas and a decrease in its topography, while low values indicate the advancement of the basin in the erosion cycle and an increase in the basin topography ¹. The hypometric integral can be extracted from the following equation ².

Pelvic space/km

Hypsometric integration= -----

Topography of the basin

When applying the equation, we notice that the values of the hipsometric integration of the main Wadi Shall basin amounted to $(5.73) \text{ km}^2 / \text{m}$ and that there is a variation in the values of integration from one basin to another as in Table (3), which ranged between $(1.58) \text{ km}^2 / \text{m}$ for basin (32) as the highest value between $(0.03) \text{ km}^2 / \text{m}$ for basins (11 and 13) as the lowest value. We note that the values are low, and the reason is due to the fact that the basins are represented by small areas and hessian at the beginning of their life cycle.

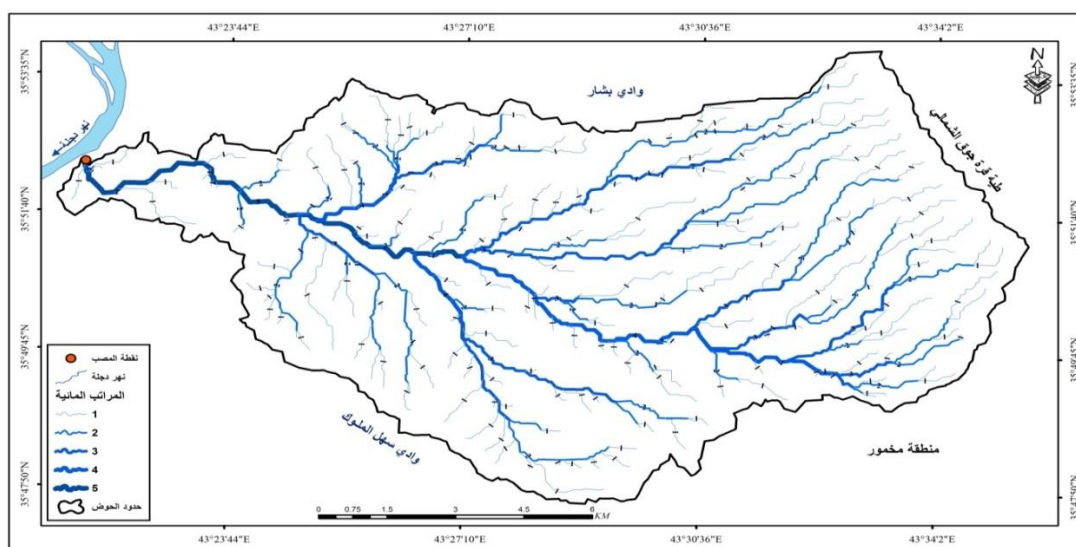
2-4 Modeling the characteristics of the water network (drainage)

These characteristics are as follows:

2-4-1 Stream Orders

As the water basins, as in Map (3), were applied to river beds, depending on the method of Strahler (1952)¹. Being the most easy and applied in the study of river basins, as it indicates that the small river streams, which do not have any secondary tributaries, are considered from the streams of the first order, and when two tributaries from the streams of the first order converge, they form a stream of the second order, and the convergence of a stream of the second order with A stream of the same rank becomes a stream (of the third rank), and when two streams of the third rank meet, it forms a stream of the (fourth) rank, and so on until it reaches the main stream that carries the higher rank. According to this classification, the river ranks of the Wadi Shal basin and the valleys of the basins of the region show that they ranged between the first rank and the sixth rank, according to Table (4). , and the sewers of the third rank (113), and the sewers of the fourth rank (31), and the sewers of the fifth rank (2), in which the basin ends.

Map (3) River beds of the study area basin and its secondary basins



Source: The researcher's work based on Arc GIS 10.8.

2-4-2 Stream Lengths

The lengths of the sewers are the lengths of the tributaries that feed each tier separately. It is clear from Table (4) that the total lengths of sewers for all ranks amounted to (293.2179) km, as the first rank with the highest reached (151.15) km, while the second rank reached (81.99) km, followed by the third rank (49.84) km, and then the sewers of the highest rank The fourth, with a total length of (10.24) km, and then the fifth and last place, which reached (0.005). We conclude from the foregoing that the courses of these ranks are the first formation of the water network, and what is meant by it is the largest percentage of the lengths occupied by it (the first rank), as it develops in large numbers and in random directions according to the slope of the land.

2-4-3 Bifurcation Ratio

It means the ratio between the number of streams belonging to a certain rank and the number of streams belonging to a rank directly above it, as the bifurcation ratio is affected by the ratio, geological structures, and climatic conditions, as Strelra determined it, as he gave a second bifurcation ratio between the salary of its streams, and these ratios often range between (/5) 2. The bifurcation ratio is calculated through the following equation ³.

The number of ducts for a mattress

Bifurcation Ratio = -----

Number of sewers for a lster order

As a percentage higher than (3-5) determined by Strelra indicates that the valley has reached an advanced stage of erosion. If the values are lower than (3-5), it results from the lack of slope of the upper parts, so the erosion activity becomes weak. After applying the equation, we find that the bifurcation ratio In the main basin of the study area, as in Table (5), the bifurcation ratio in the Wadi Shall basin amounted to (58.59), and that there was a discrepancy between the ranks of the valleys of the study area basins, and this was reflected in the variation in the general ratios that ranged between (6) as the highest bifurcation ratio For the basin (31) and between (0.2) as the lowest bifurcation ratio for the basin (14 and 27), and the rest of the values ranged between those limits. The rate of bifurcation at the level of the ranks in the drainage basins varied in height and depression as a result of the nature of the rocks, the difference in the degrees of slope, the variation in area, and the size and amount of runoff.

Table (4) Number of sewers and their basin lengths for all ranks in the secondary basins

The total		fifth place			fourth place			third place			second place			First place		docs
Their length s	Num der of sewer s	Bifurcat ion ration	Thei r lengt hs	Num der of sewer s	Bifurcat ion ration	Thei r lengt hs	Num der of sewer s	Bifurcat ion ration	Thei r lengt hs	Num der of sewer s	Bifurcat ion ration	Thei r lengt hs	Num der of sewer s	Thei r lengt hs	Num der of sewer s	
10.423	18	-	-	-	-	-	-	8	0.003	1	1.12	6.23	8	4.19	9	1
9.79	23	-	-	-	-	-	-	0.57	2.36	7	3	2.36	4	5.07	12	2
12.62	23	-	-	-	-	-	-	0.57	2.99	7	3	2.41	4	7.22	12	3
9.01	17	-	-	-	-	-	-	3	0.34	2	1.5	3.13	6	5.54	9	4
8.35	18	-	-	-	-	-	-	-	-	-	1.25	4.77	4	3.58	5	5
6.66	10	2.5	0.005	2	0.4	2.34	5	0.5	0.05	2	5	1.10	1	3.17	5	6
8.92	16	-	-	-	4	0.41	2	0.13	3.77	8	7	0.03	1	4.71	7	7
7.61	7	-	-	-	-	-	-	-	-	-	1.33	3.93	3	3.68	4	8
17.78	31	-	-	-	-	-	-	0.23	6.34	13	5	2.31	3	9.13	15	9
19.5609	24	-	-	-	7	0.0009	1	1	5.58	7	1.42	5.20	7	8.78	10	10

7.6	7	-	-	-	-	-	-	-	-	-	1.33	4.19	3	3.41	4	11
3.085	8	-	-	-	0.5	0.45	2	2	0.005	1	1.5	1.28	2	1.35	3	12
5.34	7	-	-	-	-	-	-	-	-	-	1.33	2.89	3	2.45	4	13
6.48	11	-	-	-	-	-	-	0.2	2.69	5	3	0.84	1	2.95	5	14
4.59	11	-	-	-	0.75	1.17	4	0.33	0.05	3	3	2.18	1	1.19	3	15
15.19	19	-	-	-	-	-	-	0.8	2.61	5	2.5	4.40	4	8.18	10	16
8.04	12	-	-	-	-	-	-	0.4	1.89	5	2.5	0.54	2	5.61	5	17
6.06	9	-	-	-	-	-	-	0.5	2.77	4	1.5	0.06	2	3.23	3	18
17.25	19	-	-	-	2	0.01	2	1	3.54	4	2.25	4.14	4	9.56	9	19
7.62	17	-	-	-	-	-	-	3.5	0.54	2	1.14	3.18	7	3.90	8	20
The total		fifth place			fourth place			third place			second place			First place		docs
Their length s	Num der of sewer s	Bifurcat ion ration	Thei r lengt hs	Num der of sewer s	Bifurcat ion ration	Thei r lengt hs	Num der of sewer s	Bifurcat ion ration	Thei r lengt hs	Num der of sewer s	Bifurcat ion ration	Thei r lengt hs	Num der of sewer s	Thei r lengt hs	Num der of sewer s	
4.32	8	-	-	-	-	-	-	-	-	-	1	2.04	4	2.28	4	21
5.33	7	-	-	-	-	-	-	-	-	-	1.33	2.09	3	3.24	4	22
11.607	17	-	-	-	1	0.007	2	2.5	1.04	2	1.6	3.70	5	6.86	8	23
2.53	7	-	-	-	0.33	1.99	3	1	0.03	1	2	0.15	1	0.36	2	24
6.941	11	-	-	-	-	-	-	5	0.001	1	1	3.45	5	3.49	5	25
4.9	13	-	-	-	-	-	-	0.14	2.43	7	5	0.02	1	2.45	5	26
6.47	11	-	-	-	-	-	-	0.2	2.39	5	5	0.85	1	3.23	5	27
6.25	14	-	-	-	0.5	2.69	5	1	0.03	2	2.5	1.14	2	2.39	5	28
17.78	29	-	-	-	1	1.17	4	1.5	1.89	4	2.5	5.56	6	9.16	15	29
4.42	7	-	-	-	-	-	-	-	-	-	1.33	1.28	3	3.14	4	30
11.041	16	-	-	-	6	0.001	1	0.5	4.08	6	3	2.62	3	4.34	9	31
19.65	37	-	-	-	-	-	-	1	2.42	9	2.11	3.92	9	13.31	19	32
293.2179	484		0.005	2		10.24	31		49.84	113		81.99	113	151.15	277	Shal e vall ey

Source: Outputs of (Arc Map 10.8) program based on the Digital Elevation Model (DEM).

Table (5) Drainage characteristics of the secondary basins in the study area

Numerical Density	Longitudinal Density	Bifurcation ration	Branch lengths	Numder of branches	mattress	T
3.79	2.20	8	10.423	18	3	1
4.09	1.74	0.57	9.79	23	3	2
4.13	2.26	0.57	12.62	23	3	3
4.43	2.35	3	9.01	17	3	4
5.71	2.65	1.25	8.35	18	2	5
3.28	2.19	2.5	6.66	10	5	6
3.55	1.98	4	8.92	16	4	7
2.13	2.31	1.33	7.61	7	2	8
3.25	1.87	0.23	17.78	31	3	9
2.87	2.34	7	19.5609	24	4	10
2.15	2.33	1.33	7.6	7	2	11
5.55	2.14	0.5	3.085	8	4	12
2.62	2.00	1.33	5.34	7	2	13
3.39	2.00	0.2	6.48	11	3	14

5.09	2.13	0.75	4.59	11	3	15
3.06	2.45	0.8	15.19	19	3	16
2.97	1.99	0.4	8.04	12	3	17
3.38	2.28	0.5	6.06	9	2	18
2.75	2.49	2	17.25	19	4	19
4.17	1.87	3.5	7.62	17	3	20
4.09	2.21	1	4.32	8	3	21
2.82	2.14	1.33	5.33	7	2	22
3.16	2.16	1	11.607	17	4	23
5.55	2.00	0.33	2.53	7	4	24
3.06	1.93	5	6.941	11	3	25
5.61	2.12	0.14	4.9	13	3	26
3.11	1.83	0.2	6.47	11	3	27
4.11	1.84	0.5	6.25	14	4	28
4.10	2.51	1	17.78	29	3	29
2.89	1.82	1.33	4.42	7	2	30
2.52	1.74	6	11.041	16	4	31
3.52	1.87	1	19.65	37	3	32
3.49	2.12	58.59	293.2179	484	5	Shale valley

Source: Outputs of (Arc Map 10.8) program based on the Digital Elevation Model (DEM).

2-4-4- Density of the river drainage network

It expresses the drainage density, which is the extent to which the earth's surface is cut by watercourses, as the length of the watercourses increases with the increase in the amount of rain. And the decrease in the percentage of what leaks from it due to the steepness of the slope and the decrease in the permeability of the rocks 1.. The drainage density of the basin includes:

2-4-4-1 Longitudinal Draining Density

Means the ratio of sewage lengths in the trough for all mattresses to the area of the feeding trough, and its value can be calculated according to the following equation

The total length of the watercourses in the basin/km

Longitudinal Draining Density = -----

Pelvic space/km

When applying the equation to the main Wadi Shall basin, Table (5), we notice that the longitudinal density amounted to (2.12) km / km², and it also appears that the basins of the region vary in values between one basin and another, as it ranged as the highest value (2.65) km / km² in Basin (5).) and the lowest value (1.74) km / km² in basin (2 and 31). We note that the values are low, and this indicates that the basins are still at the top of their climax, in addition to the large area of the basin as there is an inverse relationship between the area of the basin and the longitudinal density, and the reason is Until the small area, the extensions of the sewers are close, unlike the large areas, in which we often find the space vacant.

2-4-4-2 Stream Frequency

It expresses the numerical drainage density of the total number of water valleys or tributaries per unit area within the feeding basin¹. The density of the number of watercourses in terms of their development and change in value is related to the changes that occurred through the stages of development of the water network, and it is expressed in the following equation 2.

Preparing sewers of all ranks

Stream Frequency = -----

Pelvic space/km

Through the application of the equation, it was found that the numerical drainage density of the main Wadi Shawl basin amounted to (3.49) streams / km², as shown in Table (5), which is a low value for which the parts of the basin vary. In the small area, the highest value (5.71) streams/km² was recorded in Basin (5), and the lowest value was recorded (2.13) streams/km². In basin (8), the reason for the decrease in the longitudinal and numerical density values is due to the fact that the basins that run in areas with little slope and far from the high areas.

2-4-4-3 Detour Factor

It expresses the relationship between the length of the real stream, which represents the distance that the valley water travels from the beginning of its collection to its mouth, and the length of the ideal stream, which represents the shortest distance that the stream travels from the beginning of its collection to the downstream, as the greater the degree of inflection of the valley, the higher the filtration and evaporation processes, while the lower the degree of The reverse occurs as a result of the speed of flow and the arrival of water to the estuary in a short period of time, according to the following equation 1.

True stream length

Detour Factor= -----

Ideal duct length

After applying the above equation, table (5), we note that the inflection coefficient for the Wadi Shall basin amounted to (1.29), and there is a discrepancy in the values of the inflection coefficient, as it reached (1.41), the highest value in basin (2), and the lowest value was recorded (0.71) in basin (6). 2. These basins are tortuous because of the geological formations over which the valleys of these basins run.

Conclusions:

1- It is clear from the morphometric analysis that there are (32) water basins in their entirety with varying area represented in their morphological characteristics to elongation with low erosion values. This means that the rainwater travels a short distance to reach the outlet of the basin, thus increasing the flood indication.

2- The study of the morphological characteristics showed that most of the basins of the studied valleys are towards elongation, and with the emergence of a state of irregularity in the width of the basins, which made the coefficient of the shape of these basins in a triangular geometric shape, which caused

this hydrologically with regular surface runoffs.

3- The average longitudinal discharge density for all basins of the region was (2.12) km / km², ranging between (2.65) km / km² for basin (5) and between (1.74) km / km² for basins (2 and 31). As for the numerical discharge density, it recorded a general average for all basins by (3.49) stream / km. It showed the highest values in ponds with small areas, as well as those that are characterized by a high ratio of indentation.

Recommendations

1- The researcher proposes the establishment of hydrological measurement stations on the course of the basin for the purpose of knowing the volume of water drainage of the study basin in order to know the real quantities of those discharges, and then it is possible to determine the The possibility of investing in the development of the region, whether in the field of water harvesting or other uses, with the need to carry out preliminary studies for projects to be developed in the region.

2- The need to take advantage of the high runoff water caused by these basins during times of rainfall, as the results of the current study reinforced the importance of harvesting water within the spatial space of each basin, by establishing water dams on the main valleys that can be used in developing and developing basins and reducing the risk of floods.

3- Developing a plan to benefit from the valley's water by building dams and benefiting from its water in agricultural and pastoral projects.

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