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Morphometric Relief Aspects Identification of Khabour River Basin

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ABSTRACT

Relief Aspects provides data regarding erosion properties of the river basin, such as the morphological properties of the relief, overall slop, and erosion severity. The Khabour River Basin has severe slopes, resulting in high runoff and soil erosion. This creates large latent energy to move water and sediment downward per unit of length. Besides, the ruggedness number of the study area basin is (7.23). The high value indicates that the area is characterized by rugged relief soil erosion and structural complexity. Furthermore, the dissection index (Dis) of the study area which was 0.50, indicates that the basin is still in the youth stage and its reliefs are in constant development instead of morph-metrical Hezel and the sub-Khabour. Hezel River basin has relatively higher values than Al Khabour River main and sub-basin. For example, the slop of the Hezel River basin is (34.73), while the main Khabour Basin (23.7), compared to al- Khabwr sub-Basin (22.60) and the river canal slope (22.1) , while the slope of the sub-Khabour River canal (14.4). The Hezel Basin also has a significant increase in the relief number, relative relief ratio, and ruggedness number. The study area basin is characterized by the modern geomorphology, the activity of water erosion factors, the high proportions of both stripping and transferred materials and basin runoff speed which resulted in a decrease in the percentage of filtered water to the subsurface layers due to the complex nature of the mountain basin, the slop intensity and surface ruggedness.

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I. INTRODUCTION

Morphometric analysis is the measurement of the geometric shape of any natural shape, plant, animal, or relief aspect [1]. The morphometric study in recent decades, since the 1940s in particular, has been significantly involved in applied geomorphology studies according to the purpose and objective of the study, such as the analysis of sediment quantities, flood hazards, relief severity, age or degradation stage of the given area for three main reasons: identifying the river drainage basin as a basic geomorphic unit in studies of the evolution of the Earth shape, the urgent need for quantitative data to accompany processes in practical response models, and finally the philosophical and methodological transformation of geomorphology from self-paced and forward-looking science based on observations to objective and inductive science based on measurements [2]. One aspect of the morphometric study of aquatic basins is the analysis of the landscape, as it highlights the importance of the river basin relief study since it is a reflection of the increased effectiveness and activity of erosion processes and their impact on the formation of the Earth surface within the basin boundaries. This reverse their geomorphological history. Through this, the erosional stage can be determined, how it affects, and affected by the geological and structural differences in the activity of erosion factors [3]. We conclude [4] that there is a relationship between the slope of the basin and erosion rates, so the less the basin relief, the lesser sediments in the drainage basin, as they affect the movement of water and sediments. Moreover, relief aspects are also important and necessary to understand the spatial arrangement of the relief in the river basin or any area. This facilitates better investment and more rational use of certain regions. The study aims at understanding the extent to which these characteristics affect the speed of erosion and the development of the basin, and the corrasion stage of the river, because erosion and morphological characteristics of the terrain in any river basin are a reflection of the geomorphological phase of the basin. Studies of the study area were limited to [6],[5] and [7] of Mount Becheir in the north of Dohuk, which is passed by water division line of al Khabwr sub-Basin at the southern end of the study area and studying [8] climate changes and its impact on the water sources of the Khabour River in the Kurdistan region of Iraq, which in general did not mention the

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relief aspects and their characteristics of the Khabour basin from the source to its meeting with the Tigris River.

Study area:

The study area, Khabour Basin River, is located between longitudes 43º 30\` and 42º 20\`East, and latitude 36º 55\` and 37º 50\` N, Northwest of Dohuk Governorate, Kurdistan Region of Iraq. It is the first tributaries to the Tigris River at the Iraqi-Turkish-Syrian border triangle. The area is about (6024.42 km^2). The upper basin is located in the province of eastern Anatolia, Turkey which is a river crossing the Iraqi-Turkish borders including (2592.15 km2) in Iraq, and (3432.27 km2) in Turkey. It was mentioned by [8] that the average annual flow of Khabour is (68 m^3/sec) with a high seasonal influx in May and low seasonal flow from July to December. 30% of the basin is covered by wetland forests while 23% of the basin has agricultural activity. No dams or regulatory bodies were built on the Khabour River. The basin consists of two main tributes, the River Hezel (Hazel Soo), with an area of (2183.42 km2), and (36.24%) of the total area of the main basin, including (277.08 km2) in Iraq. It flows from Sirnak in Turkey to run south-west [9] forming the Iraqi-Turkish border. The river meets the second tributary Al Khabour (9.22) km west of Zakho city in Dohuk governorate. Sub-Khabour River is located at 42º 25\`- 43º 5\` N, 37º 10\` - 37º 50\` N). Its first sources consist of a group of tributaries and waterways sloping from the Polkar Mountains, Southeast Al-Hakkar in Turkish Uludere region [10]. Al Khabour sub-basin area is about (3508.27 km2), and it constitutes (58.23%) of the total basin area, of which (2198.68 km2) in Iraq (Table 1). It flows north-east-southwest passing through Zakho after the two tributaries meet, the river remains known as the Khabour River until it meets the Tigris River, at the Iraqi-Turkish-Syrian border triangle, north of Fish Khabour village at longitude 42º 20\` E, and a latitude of 37º 06 \` North, traveling 20 km along the Iraqi-Turkish border (Figure 1).

As a result of the lack of climate data on Turkey's Hezel basin, data from the Weather Service and Dohuk Agriculture Directorate (temperature, humidity, and rain) for 1980-2016 were collected. The region has been shown to have seasonal precipitation

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that is concentrated in the cold season while summer is a hot and dry season, making the region both within the Mediterranean climate and its effects (Table 2).

Table 1. Some of the spatial properties of the Khabour River basin and its sub tributes

Basins	Area Km²	Total Area Percentage %	Basin Area in Iraq Km²	Basin Area Percentage %	Basin Area in Turkey Km²
Hazel	2183.42	36.24	277.08	12.69	1906.34
Sub Khabour	3508.27	58.23	2198.68	62.67	1309.594
Main Basin	6024.42	----	2592.15	43.03	3432.27

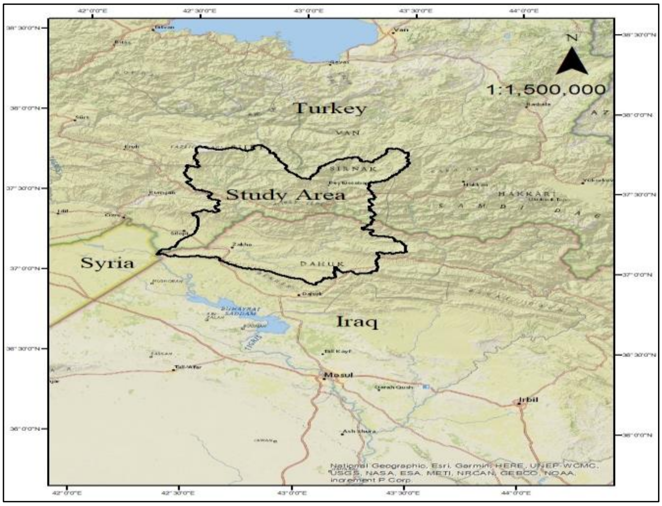

Figure 1. Study area location
Source: Researcher's work using GIS

Table 2. Rainfall (mm) and seasonal temperature rates of the climate stations in the study area of the period (1980-2016)

Season station	winter		spring		Summer		Fall	
	rain	temperature	rain	temperature	rain	temperature	rain	temperature

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Zakho	319.4	7	198.6	15	105.4	26	2.9	16
Dohuk	285.9	8	172.4	20	88.8	27	0.8	17
Amede	380	10	292	16	159.3	24	4.1	14
Simil	248.7	5	152.3	15	80.4	22	0.3	15
Total Rate	1234	7.5	815.3	16.5	433.9	24.7	8.1	15.5

Source: Researcher's work depending on

1. Iraqi Kurdistan Region, Ministry of Transport and Communications, Department of Weather, Dohuk Station, unpublished data for the period (1980-2016).
2. Iraqi Kurdistan Region, Ministry of Agriculture and Irrigation, Dohuk Agriculture Directorate, Agricultural Climate Department, unpublished data for the period (1980-2016).

The geological formations in the study area vary from the Paleozoic to the Mesozoic and the Cenozoic. These formations extend to Turkey's southeast Anatolia, where the River Hezel basin is located [7&11]. The largest formations of the study basin and the most age-old (Urduveshi) is Khabour Quartzite Formation which is characterized by the high proportion of sand and parasite materials while its sedimentary environment is a shallow marine environment, covered by a layer of red volcanic eruptions, called the formation of red Bersebeki and the formation of volcanic Halki (Devonite era)[11& 12]. It is also characterized by application, fossils, and sedimentary structures, for sedimentation in various environments, rivers, deltoid, slopes, and flat basins [13]. The formation of the (Triassic era), limestone, Marley limestone, shale stone, and the oolitic limestone is weak in resistance to dissociation, erosion by high permeability and solubility [12, 14, 15 &16].

As for Cenozoic formation, they consist of Marl, clay Marl, Dolomite Marl, clay-limestone, red claystone, Alluvial and sandy stone, mostly converted to Dolomite evaporations (gypsum, anhydrates and salt rocks), crystalline chalky limestone and knots of lime. It is more vulnerable to various erosional and weathering factors, so it has many cracks and cavities and is a good reservoir of groundwater [14, 16, 17, and 18].

The formations of the Pliocene era are the thick basin layers clay, Celtic, sandy, thick-filled blocks of mammals, and coarse river materials. These materials have resulted from the erosion of high mountain areas in basins below these mountains. The fourth era increased water erosion [12], with which river sedimentation, erosion, and the deposition of erosion products in different forms and sizes, down valleys, around the waterways, in the vines and the lowlands (Figure 2).

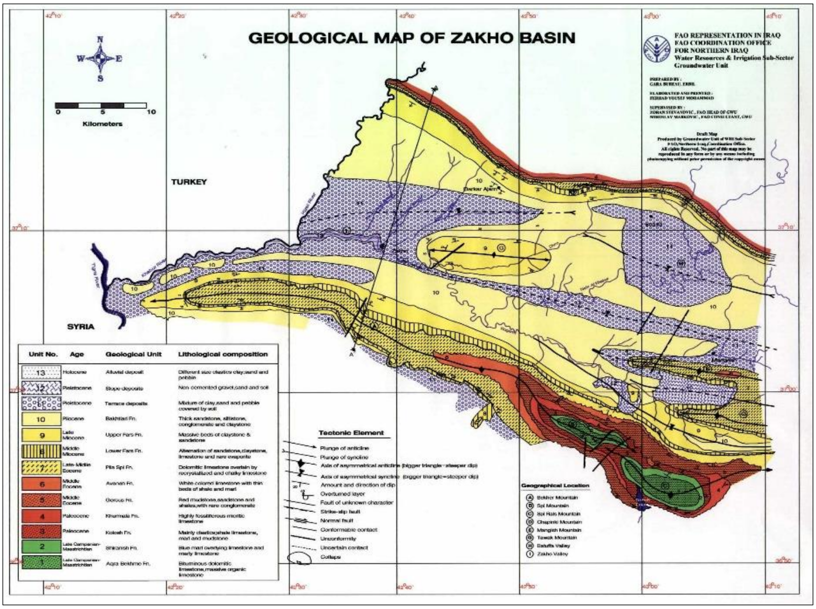

Figure 2. Khabour Basin geology in Iraq.

Methodology:

GIS (ArcGIS 10.4.1) and remote sensing techniques have been used as a tool for morphometric analysis, climate data collection and use of the Digital Elevation Model (DEM) to build a morphometric and hydrological database of the main basin of Al Khabour using the latest modern radar techniques, spatial analysis, and relief assessment through relevant morphometric indicators, analysis of the structure of the water drainage system and knowledge of the topography development of the study area. Also, topographic and other natural properties are linked to the

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hydrological characteristics and behavior of the aquarium. The study also adopted the topographic maps of the Zakho area (NJ 38-9) and (NJ38-13), issued by the Military Survey Directorate - Baghdad, on a scale of 1: 250,000 for the year 2000. Also, the laws of geomorphologists pioneers such as Stirler, Milton, Miller, Schum and others have been implemented (Table 3).

Table 3. The relief characteristics, laws, and sources of the study area

Indicators	Equation	Source
The top of the basin/ M	GIS Software Analysis	------
The bottom of the basin/ M	GIS Software Analysis	------
Absolute Relife (AR)	GIS Software Analysis	------
Basin relief (R)	R=H-h	Schumm (1956)
Relief ratio Rh	Rh=R/Lb	Schumm (1956)
(Rhp) Relative Relief Ratio	Rhp= R/P*100	Melton (1958)
(Rn) Ruggedness number	Rn= R*Dd/1000	Schumm (1956)
MRn	MRn =R/A0.5	Melton (1965)
(Gn) Geometry Number	(Gn)= Rn / Rh	Abo reya (2007)
(Dis) Dissection index	Dis= H-h/H	Sing & Dubey (1994)
(Sb)Basin Slope	Sb= R /Lb	Miller (1953)
(Cg) Channel Gradient	Cg= R/ {(π/2)*Lb}	Singh et al. (2014)
(Rg) Gradient ratio	Rg= R /Lr	Sreedevi et al. (2009)
Total Contour Length (Ctl) Kms	GIS Software Analysis	------
(L1+L2) Km	GIS Software Analysis	Strahler (1952)
Contour Interval (Cin)	GIS Software Analysis	-------
mean slope of overall basin (Ɵs)	Ɵs = (Ctl * Cin) /A	Chorley (1972)
Average Slope (S)	S = (Z*(Ctl/H) /(10*A)	Wenthworth (1930)
(Swc)	Swc = A/{(L1+L2) / 2}	Strahler (1952)

Results and discussions:

Morphometric studies of river basins are important for studying river behavior, slope, river sedimentation, river change, riversides’ erosion, etc. To address erosion and related problems through statistical analysis of the studied river basin data, the study found the following findings, which are shown in Table (4):

Relief ratio (Rh) & Basin relief (R)

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Basin relief (R) represents the difference in vertical distance between the top height and the lowest height in the basin in meters [19]. The main basin relief is (2999 m), (2943 m) for the Al-Khabour sub-basin, and (8222 m) for the Hezel basin. The basin relief has an important role to play in developing the features of the land, the drainage system, the surface and groundwater flow, the permeability as well as the corrosive properties of the terrain.

The rate at which the basin is to the maximum length in meters is called Relief ratio (Rh) [19]. The main basin relief is about (2999m), (2943m) of Al Khabour sub-basin, and (8222m) for the Hezel basin. The basin relief has an important role to play in developing land features, the drainage system, the surface and groundwater flow, the permeability characteristic, and also the erosional properties of the landforms.

The basin relief ratio to the maximum basin length in meters is called the Relief ratio (Rh) [19]. It is an indication of the severity of the erosion that slopes the basin and thus it is a measure of the overall slope of the drainage basin [20]. According to [21] there is a close correlation between the loose sediments in the area unit and the rate of the relief ratio. It affects understanding the topology of the basin and contributes to the formation of different forms of geomorphology, as well as estimating the size and quality of the transported sediment and its impact can be extended far beyond it. Furthermore, it contributes to the rapid arrival of water output, reflected in the increased effectiveness of river erosion and associated large-scale sediment transport. In this study, the RH reached for the main Khabour river basin (29.14). Lower values indicate moderate slope, low reliefs resulting from underground resistance to erosion [22]. The relief ratio increases as the basin area decreases [23]. Due to the small size of the Hezel river sub-basin, the length of the basin is short from the main basin and the Khabour sub-basin with a difference of approximately 177m and 121m, respectively, of the two basins, which are not striking and important, the RH value of the Hezel River basin is the highest (34.0). The relief ratio in khabour river basin is (21.5). This has made the Hezel River Basin one of the most important study areas in terms of the activity of eroding and retreating towards the sources, its surface runoff is more effective and strong in the transmission of sediment production (Figure 3).

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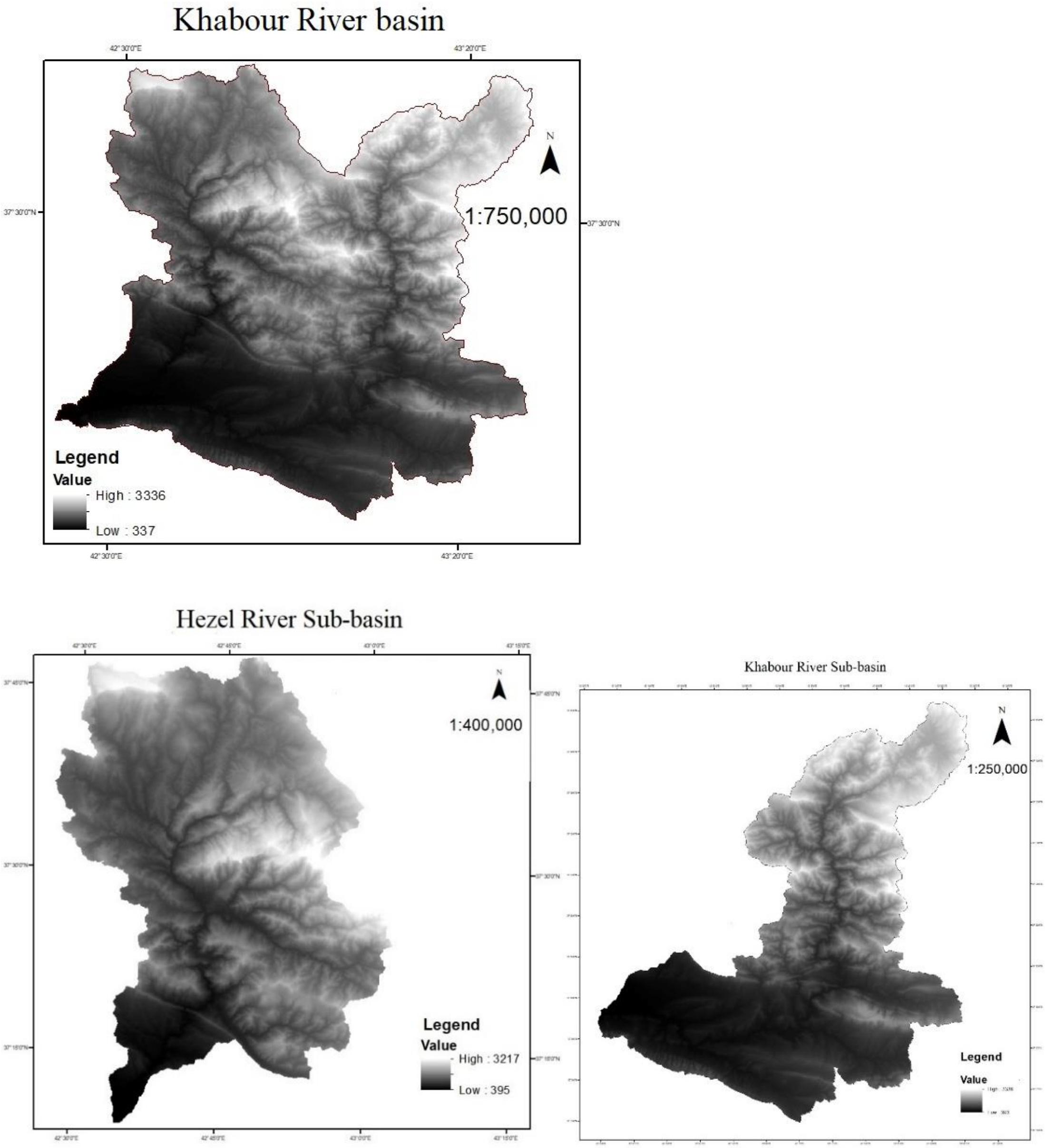

Figure (3) shows the digital model of the main river basin of Khabour and its two sub-basins

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It is one technology that can effectively introduce the relief characteristics with consideration of sea level [24] and due to the relation of its values with rock resistance, erosion factor activity, and basin size. Some [25] have classified relief ratio into three categories: Low 0-100m, moderate 100-300m, and high if more than 300m. The higher the value, the more rock resistance increases with the weaker erosion factors and smaller basin indicating that the basin is still in the early stages of the river erosion cycle. Conversely, low values are associated with the activity of the sculpture process, regression toward sources, undermining water-splitting areas and thus the possibility of river capture indicates the stage of youth. The relative relief numbers of the study area basin are generally very high, as they are (585.6), for the main Khabour basin, (696.1), and (1015.1) for Khabour sub-basins and Hezel basin respectively. Depending on [25] the basin is still at the beginning of its erosion cycle due to its mountainous nature and resistant to its rocks for erosion factors. The RHP is the highest in the Hezel sub-basin due to its very complex reliefs compared to the small basin area and Khabour sub-basin

Melton ruggedness number (MRn) and Ruggedness number (Rn)

The ruggedness number is closely related to the reliefs, water dynamics, and water drainage basin development. Numbers are very high when variables, the relief, and the drainage intensity are large. This happens when slopes are not only too steep but also long [26]. The ruggedness number is therefore reduced at the beginning of the basin's life cycle and then begins to increase to its maximum level at the beginning of the maturity phase and then begins to decrease again at the end of the life cycle. This means that the ruggedness number increases with the increased basin relief along with the increase in the length of the river waterways at the expense of the basin area and thus the increase in water-degradation and sediment transfers [27]. The study area was characterized by mean ruggedness number reaching 3.5 for the study area, while 3.4 and 3.2 for Khabour and Hezel sub-basins respectively. Thus, all these numbers indicate that the main basin (with its sub-basins) is still at the beginning of its erosive cycle, and there is ample time to complete its cycle and the short length of its waterways concerning the basin area. The ruggedness number of the study area and its sub-basins correspond to melton ruggedness number (MRn) which is an indication of the spatial representation of the relief in the basin [28] that reached in

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the study area (80.7) and (49.4) and (60.25) for Khabour and Hezel sub-basins respectively. This refers that the clinical sediments are dominant in the basin according to [29] classification due to the basin's slope and complex relief.

Geometry Number (Gn)

The geometric number measures the relationship between the ruggedness number and relief ratio and thus the composite correlation between the drainage density, the basin relief, and its surface slope degree [30]. The geometric number for the study area basin is (0.12), (0.16) for Khabour sub-basin, and (0.09) for Hezel sub-basin. This indicates the relative modernity of the basins and their reduced drainage density.

Dissection index (Dis)

It is an indicator of dissection index or vertical erosion and the development stages of the relief or surface topography in any given physiographic area or river basin [31]. [32] indicated that (Dis) numbers are basically a percentage between 0 and 1 (i.e. 0% -100%) divided into three groups of (Dis) numbers 1% -10%, 2% -30% and 30% or more. Although Khabour main and sub-basins (Dis) numbers are very close, they are very high, reaching (0.90) for the main Khabour basin and (0.88) for its sub-basins. These very high numbers indicate that the basin's relief is still evolving due to the relief intensity resulting from the mountainous nature of the area, and thus its vertical erosion activity.

Basin Slope (Sb)

Based on [26] the basin slope (Sb) is a measure of the ratio of surface water filtration to the subsurface layers of the region, and a general indicator of the intensity of the basin slope and the intensity of erosion processes operating on the surface of the basin. The more the slope of the basin is, the more erosion and a lower percentage of filtered water and vice versa. Accordingly, the basin slope was determined in several ways. The slope of the main basin according to [33] is (29.1), the Khabour sub-Basin (21.5), and the (34.0) of Hazel River Basin. As for the Average Slope (S), a method [34] was used. The slope number was (0.34) for the studied basin and

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Khabour sub-basin, but this rate rises in the Hazel basin to (0.42). While the mean slope of the overall basin (Ɵs) presented by [35] for the main basin, (613.5), (602.4), and (734.2) for Khabour and Hezel sub-basins respectively.

Depending on ASTER-DEM, the studied basin was divided into 7 slope classes and the areas occupied by each class were determined. It was found that the steepest areas occupy the largest area, with a percentage of (50.9%) for the study area basin, (47.8%) and (60.1%) for Khabour and Hezel sub-basins, see Table (5) and Map (4).

Channel Gradient (Cg) and Gradient ratio (Rg)
[36] Considers that Channel Gradient (Cg) slope helps determine the drainage increase of the downstream, or its ability to move slope sediments. The higher its value, the more channel can transmit sediments. The result was for the study area basin (18.6), (13.7), and (21.7) for Khabour and Hezel sub-basins. The Gradient ratio (Rg) [37], which allows the assessment of surface runoff volume [38], was (22.2) for the main Al-Khabour basin, (14.4) and (25.7) for Khabour and Hezel sub-basins respectively.

Since it is impacted by the slope of the basin and the properties of the rock its high and low values indicate the nature of the area if it was mountainous or plain [39]. In general, the main basin is characterized by mountainous nature, mainstream slope intensity, and high flow velocity. Also, Hezel river channel is steeper due to its more complex mountainous nature, its small area, and the shorter basin length, which is reflected in the severity of its slope. As for Khabour sub-basin, it is despite its high number but its large area and the length of its basin made its course less steep. Accordingly, the Hezel Basin is the most used basin for its drainage and sediment transport capacity.

Contour Lines

As a result of the surface complexity and intensity of elevations, the study area was divided into 15 areas, with a contour separation of (200) m. See Figure (5) and extract the contour lines. Table (6) shows the average Slope Width of Contour (Swc) to

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analyze basin relief by extracting the sum of the lengths of two adjacent contour lines (L1 + L2) [1]. The Swc of the main Al-Khabour basin was (2.4), (3.02) and (1.58) for Khabour and Hezel sub-basins respectively.

Curve and heptometric integration

The hyposometric curve (Hc) is related to the size of the surface mass and the amount of erosion that occurred in a basin, against the remaining mass [40]. The hematometric integration (Hsi) is the area below the curve, and it is also an indication of the erosion cycle, the total time needed to reduce the area of the Earth to the base level where the lowest level is as a percentage [41]. It is the remains of the current size compared to the original size of the basin [42]. Pike and Wilson's (1971) method was used in [43] to determine the heptometric integration of the study area, which was (0.61) for the study area basin, (0.63) for Khabour sub-basin and (0.64) for Hezel sub-basin. This indicates that the main basin and its sub-basin are in the youth and balance stage, where the water basin is subject to severe erosion and [41, 44]. Figure (6).

Table (4) Results of the measured indicators of Khabour main and sub-basins

Basin indicators	Main Khabour	Sub Khabour	Hezel
Area in Km^2	6026.8	3550.3	2193.8
perimeter Km	512.1	422.8	278
Basin length / km (Lb)	102.9	136.95	82.9
Length of main river km (L)	135.02	204.09	101.0
Total water group lengths / km (Lu)	7020.8	4066.4	2456.3
Drainage density km / km^2 (Dd)	1.2	1.1	1.1
Highest Height (H)	3336	3336	3217
Lowest Height (H)	337	393	395
Basin relief (R)	2999	2943	2822

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Relief ratio (Rh)	29.14	21.5	34.0
Relative Relief ratio (Rhp)	585.6	696.1	1015.1
Ruggedness number (Rn)	3.5	3.4	3.2
Melton ruggedness number (MRn)	80.7	49.4	60.25
Geometry Number(Gn)	0.12	0.16	0.09
Dissection index (Dis)	0.90	0.88	0.88
Basin Slope (Sb)	29.1	21.5	34.04
Channel Gradient (Cg)	18.6	13.7	21.7
Gradient ratio (Rg)	22.2	14.4	25.4
Total lengths of contour lines	18488.6	11140.3	8053.54
The length of two contiguous contour lines L1+L2	5050.810469	2348.2	2779.61
Contour interval Cin	200	200	200
Mean slope of overall basin (ϴs)	643.6	627.6	734.2
Slope rate	0.36	0.36	0.42
Average Slope Width of Contour (Swc)	0.6	3.03	1.58
Integral Hypsometry	0.61	0.63	0.64

Table 5. Slope classes and mean slope of the study area and sub-basins

Basin	classes	5-0	12-5	18-12	24-18	32-24	44-32	100-44
Main basin	Area km^2	523.0	928.4	797.7	709.0	784.9	912.9	1370.9
	%	8.7	15.4	13.2	11.8	13.0	15.1	22.7
Basin slope average	32.0							

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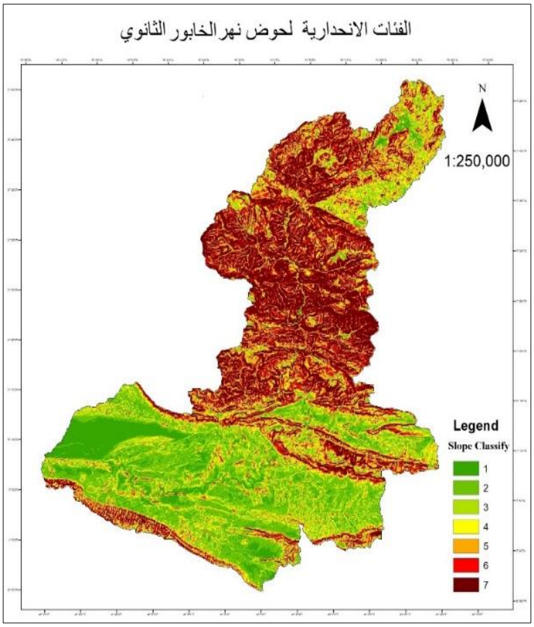
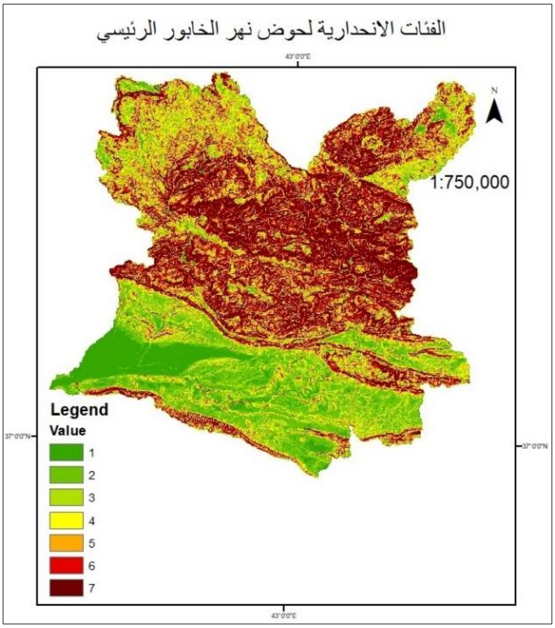
Khabour sub-basin	Area km^2	312.36	674.32	489.14	379.16	398.96	491.43	804.93
	%	8.8	19.0	13.8	10.7	11.2	13.8	22.7
Basin slope average	31.1							
Hezel sub-basin	Area km^2	69.6	204.7	284.7	314.8	371.7	405.2	541.6
	%	3.2	9.3	13.0	14.4	17.0	18.5	24.7
Basin slope average	35.5							





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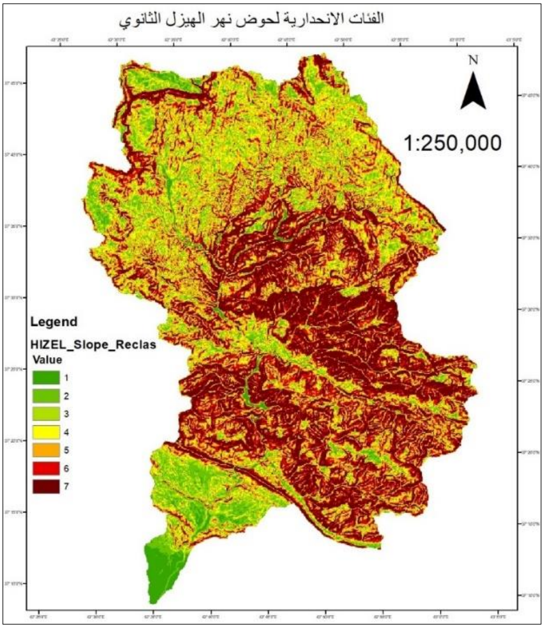

Figure 4. Khabour main and sub-basins slope classes

Table (6) study area basin and the sub-basin contour lines lengths and areas between them

Hezel sub-basin		Khabour sub-basin		Khabour main basin		
Contour Length km	Con. Area km²	Contour Length km	Con. Area km²	Min.-Max.	Contour Length km	Con. Area km²
337-500	213.1	285.7	(393-500) 121.3	97.8	(395-500) 62.4	36.3
500-700	756.8	629.7	516.2	472.1	171.3	102.9
700-900	1296.2	699.4	900.5	561.1	345.0	109.4
900-1100	1782.3	624.7	1054.6	437.7	679.6	173.7
1100-1300	2340.9	638.6	1128.4	298.8	1182.6	329.9
1300-1500	2633.1	654.0	1135.1	257.9	1457.5	386.2
1500-1700	2540.3	627.2	1206.2	256.1	1322.1	363.2
1700-1900	2061.9	488.4	1094.6	230.3	963.5	254.4
1900-2100	1480.5	321.1	866.3	172.4	619.8	147.8
2100-2300	1234.7	302.1	805.9	200.2	437.2	101.5
2300-2500	1106.3	270.6	774.9	189.7	353.6	80.1

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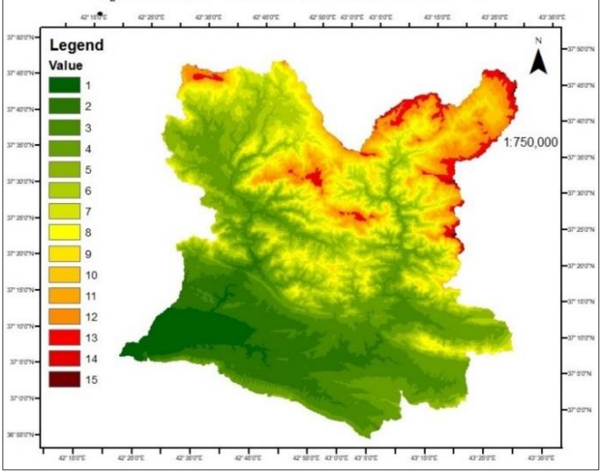
2500-2700	913.4	233.0	666.4	172.7	257.5	59.4
2700-2900	640.6	179.5	517.3	140.9	139.0	37.8
2900-3100	317.5	59.5	282.0	51.5	46.5	5.0
3100-3336	78.0	12.7	70.4	11.2	- (31003217)15 .9	4.3
	19395.5	6026.3	11140.3	3550.3	8053.5	2192.0

النطاقات الكنتورية لحوض نهر الخابور الرئيسي.



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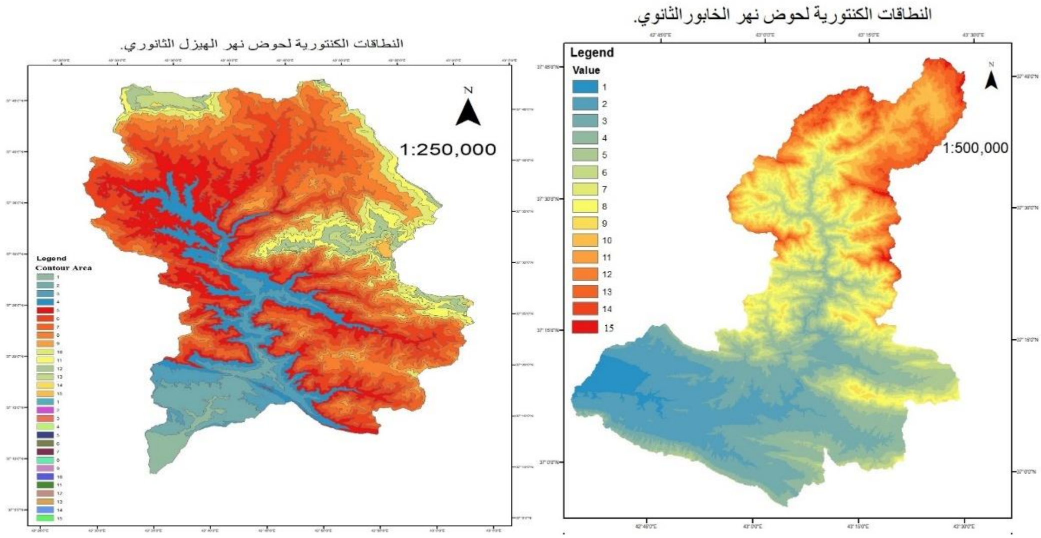
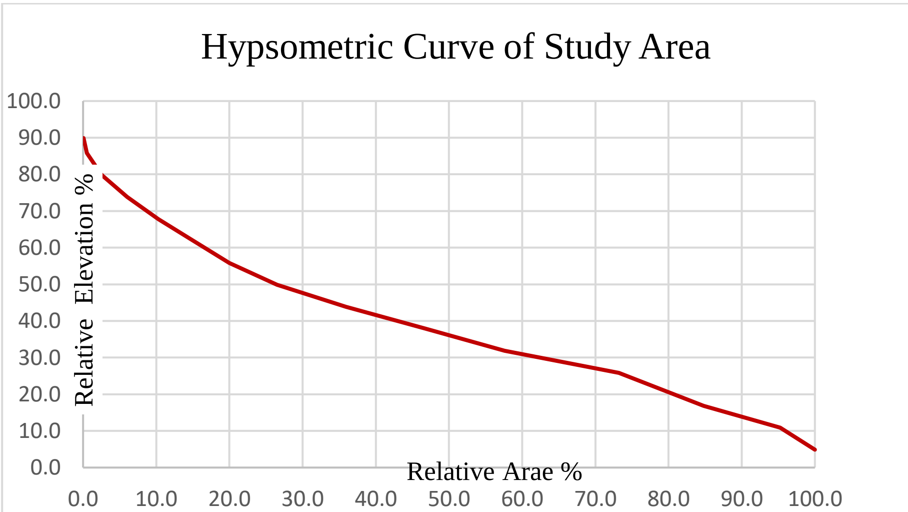


Figure (5) contour areas of Khabour River main and sub-basins



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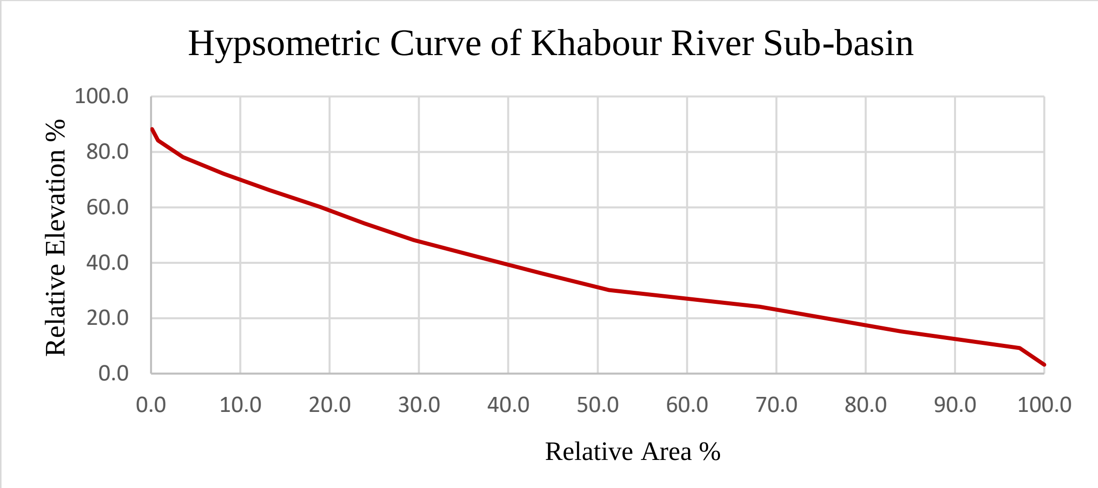

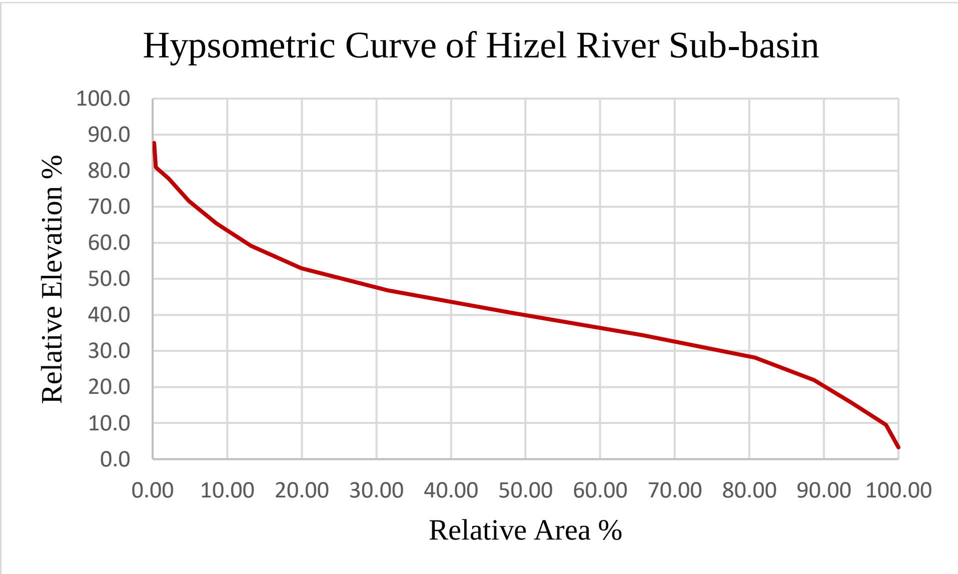

Figure (6) the heptometric curve of the study area and its sub-basins.

conclusion

The relief aspects play an important role in the development of basins, surface and subsurface water runoff, permeability, development of basin landforms, and characteristics of rocks erosion [45]. Landform relief increase, surface complexity, and severity of slope cause water drainage increases that resulted in an increase in runoff speed, lower rates of water leakage, deeper cannula and drainage, degradation, and sedimentary output[46]. Based on the data and results of the relief aspects of the Khabour River basin and sub-basins, it has been concluded that the study area basin is characterized by high relief numbers, complex mountain nature, and severe slopes. It is therefore a modern basin, which still has a great deal of time to go to its degradation. These numbers differ between their two sub-basins. The low-rate-of Relief ratio numbers of Hezel sub-basin indicate that it is more powerful and effective in transporting the product of erosion from sediment from Khabour sub-basin because there is a close correlation between the disassembled sediment in the area unit with the relief ratios so that the complex topography is associated with its small basin area based on [20]. Ruggedness number (Rn) which refers to relief structural complexity according to [45]. It is either in the main basin or its sub-basins reflecting erosive activity and that its basins are in the stage of development, as they are still in the youth stage. This trend is supported by the Geometric number (GN), whose low values indicate that the basin is still at the beginning of its geomorphologic phase, as well as the activity of erosion and sedimentary transport in the basin. Furthermore, slope indicators in the study area, whether related to the river channel or river basin, indicate the recent geomorphological age of the studied area and erosion activity. Topographic factors such as steep slope and ruggedness factors associated with the quality of rocks, especially limestone, which exacerbate the aquatic capacity of erosion and associated mass sediment transfers, form different geological forms in addition to guessing the quantity and quality of sediment transported, and increase the speed of water product.

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پوختە:

ئاماژەکانی بەرزونزمی داتا لەبارەی خەسیەتەکانی داماڵینی ڕووباریی وەک خەسیەتە مۆرفۆلۆجیەکانی بەرزونزمی و لێژیی گشتیی حەوز و توندیی کردارەکانی داخوران دەخەنە بەردەست. درێژیی ڕووبارەکە دەگاتە ١٣٢.٢٦ کم، هەرچی بەرزیی ڕووی زەویی حەوزەکەیە دەگاتە ٢٩٩٩م. ئەمەیش ئاماژەیە بۆ ئەوەی کە ڕووبارەکە لە دووریێکی زۆردا لەناوچەیەکی سەختدا ڕێدەکات. هەرچەندەیش درێژیی ڕووبارەکە و بەرزیی حەوزەکە زیاتربێت ، ئەوا هێزی داماڵین لە ڕێکردنی سەرڕووی ئاوەکەدا زیاتردەبێت. هەریەک لە لێژی و ڕێژەی بەرزیی ناوچەی لێکۆڵینەوە دەگەنە (٢٣.٧) بەهۆی پەیوەستییی زۆریان بە بەرزیی حەوزەکەوە، کە ئاماژەدەدات بەوەی حەوزی ڕووباری خابور لێژیی توندی هەیە و ڕێکردێکی بەرز و داخورانێکی بەرچاوی خاکی لێوە دێتەدی. بەمەیش وزەیەکی پەنگخواردووی گەورە بۆ گواستنەوەی ئاو و نیشتووەکان بەرەو خوارەوە بۆ هەر یەکەیەکی درێژی دروست دەکات. لەمەیش زیاتر، پلەی سەختیی (Ruggedness Number) حەوزی ناوچەی توێژینەوە (٧.٢٣)یە، کە بە بەهایەکی بەرز دادەنرێت و ئەمەیش بەڵگەیە لەسەر تایبەتمەندیی ناوچەکە بە بەرزونزمییێکی سەخت و کەوتنەبەر داخورانی خاک و ئاڵۆزی لە پەیکەرەکەیدا .

هەروەک ئاماژەپێدەری، التشریح (Dis) DissectionIndex ی ناوچەی توێژینەوە، کە دەگاتە (٠.٥٠)، ئاماژە بۆ ئەوە دەکات کە حەوزەکە هێشتا لە قۆناغی لاوێتی دایە و هێشتا بەرزونزمییەکەی لە پەرەسەندنێکی بەردەوام دایە. سەرەڕای لەیەکچونی هەندێک لە ئاماژە مۆرفۆمەترییەکانی تۆڕی حەوزی خابوری سەرەکی لەگەڵ دوو حەوزە لاوەکییەکانی، هیزل و خابوری لاوەکی، بەشێوەیەکی گشتی، کەچی حەوزی ڕووباری هیزل تاڕاددەیاک بەهاکانی بەرزترن لە حەوزی ڕووباری خابوری سەرەکی و لاوەکی. بۆ نمونە، لێژیی حەوزی ڕووباری هیزل دەگاتە (٧٣.٣٤)، لەکاتێکدا، لێژیی حەوزی خابوری سەرەکی ((٢٣.٧) ە و بە بەراورد بە حەوزی خابوری لاوەکی (٦٠.٢٢) ە و لێژیی جۆگەی ڕووبارەکە (٢٢.١) ە. کەچی لێژیی جۆگەی ڕووباری خابوری لاوەکی دەگاتە (١٤.٤). هەروەک حەوزی ڕووباری هیزل بە بەرزییێکی زۆری بەهاکانی ڕێژەی بەرزونزمی و ڕێژەی بەرزونزمیی ڕێژەیی و پلەی سەختی جیادەکرێتەوە. بۆیە، حەوزی ناوچەی توێژینەوە بە نوێییی تەمەنە جیۆمۆرفۆلۆجییەکەی و چالاکیی فاکتەرەکانی داماڵینی ئاوی و بەرزیی ڕێژەی هەریەکێک لە ماددە ڕامالڕاو و گوێزراوەکان و خێراییی ڕێکردنی ڕووی ئاو لە حەوزەکە دا جیادەکرێتەوە، کە لێیەوە دابەزینی ڕێژەی ئاو بۆ چینەکانی

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ژێر ڕووی زەویی بەهۆی سروشتی حەوزی شاخاویی ئاڵۆز و بەهێزیی لێژی و سەختی ڕووەکەیەوە بەرهەم دێت.

کلیلی وشەکان: خەسیەتە بەرزونزمییەکان، حەوزی ڕووبار، داماڵینی ڕووباری، نیشتووەکان

التحديد المورفومتري للجوانب التضاريسية لحوض نهر الخابور

الملخص:

توفر المؤشرات التضاريسيةRelief Aspects بيانات عن خصائص التعرية للحوض النهري، كالخصائص المورفولوجية للتضاريس، الانحدار العام للحوض وشدة عمليات التاكل. يبلغ طول النهر (132.26) كم، اما تضرس الحوض فيبلغ (2999م)، مما يدل أن النهر يتدفق مسافة طويلة في منطقة وعرة التضرس. فكلما زاد طول النهر وتضرس الحوض، كلما زادت قوة التآكل في الجريان السطحي. يبلغ كل من الانحدار ونسبة التضرس في منطقة الدراسة (23.7)، لارتبطهما ارتباطًا كبيرًا بتضرس الحوض، مما يشير إلى أن حوض نهر الخابور يشتمل على منحدرات شديدة، ينتج عنها جريان سطحي عالي وتآكل التربة، مما يخلق طاقة كامنة كبيرة لنقل المياه والرواسب الى الاسفل لكل وحدة طول. علاوة على ذلك، لحوض منطقة الدراسة درجة الوعورة Ruggedness number (7.23)، والتي تعتبر قيمة مرتفعة، مما يدل على تميز المنطقة بالتضرس الوعر، التعرض لتآكل التربة وتعقيدها هيكليا.

كما ان مؤشر التشريحDissection index (Dis) لمنطقة الدراسة، والذي بلغ (0.50)، يشير إلى أن الحوض مازال في مرحلة الشباب ومازالت تضاريسه في تطور مستمر. رغم تشابه بعض المؤشرات المورفومترية لشبكة حوض الخابور الرئيسي مع حوضيه الثانويين، هيزل والخابورالثانوي، بشكل عام، الا ان حوض نهر هيزل يتمتع بقيم اعلى نسبيا من حوض نهر الخابور الرئيسي والثانوي، على سبيل المثال، انحدار حوض نهر هيزل يبلغ (34.73)، في حين أن حوض الخابور الرئيسي (23.7)، مقارنة مع حوض الخابور الثانوي (22.60). وانحدار قناة النهر (22.1)، بينما يبلغ انحدار قناة نهر الخابور الثانوي (14.4) كما يتميز حوض الهيزل بارتفاع كبير لقيم نسبة التضرس، نسبة التضاريس النسبية ودرجة الوعورة. وعليه، فإن حوض منطقة الدراسة تتميز بحداثة عمره الجيومورفولوجي، نشاط عوامل التعرية المائية، ارتفاع نسب كل من المواد المتعرية والمنقولة و سرعة الجريان السطحي في الحوض، والذي ينتج عنه انخفاض في نسبة المياه المترشحة الى الطبقات التحت السطحية، بسبب طبيعة الحوض الجبلية المعقدة، شدة الانحدار ووعورة سطحها.