How to Cite:
Al-Fatlawy, W. H. H., & Zamili, A. J. H. A. (2022). Morphometric characteristics of the northern basins folded behair using geographic information systems (GIS). *International Journal of Health Sciences*, *6*(S3), 11015–11033.
https://doi.org/10.53730/ijhs.v6nS3.8476

Morphometric characteristics of the northern basins folded behair using geographic information systems (GIS)

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***Abstract*---**The research aims to reveal the analysis of the morphometric characteristics of the northern mountain Bekhair basins within the Sulaymaniyah belt. Its area is estimated (264.22 km2). Its rocky and sedimentary formations date back to the triple and quadruple periods of sandstone, limestone and gypsum rocks located astronomically between two latitudes (31 01 00 – 31 08 00) north And longitudes (42 20 00- 42 50 00) east, while administratively in Dohuk Governorate it extends from Dohuk to Zakho along the village of Fishkhabur at the Iraqi-Turkish border, and lies within the semi-arid climate that is characterized by high temperatures and its average during the month of July (34, (33.7 centigrade, respectively, for the two stations of Dohuk - Zakho, and the annual average rainfall amounted to (512.7,559) mm respectively.The morphometric characteristics of the basins were studied and it was found that the basins have shapes that tend to elongate and this reduces the possibility of flooding, and it has a steep slope as the slope of the area reaches The study is (11.5) m/km and that the basins are in the youth stage through the values of the Hypsometric integration and the roughness, and the valleys of the basins are characterized by the fact that they have tree drainage and some have orthogonal drainage. The daily shepherds and the drinking of animals during the Chihod period, as well as the possibility of investing its natural resources represented in agricultural activity, natural plants and mineral resources such as (limestone, gypsum, gravel and sand), which are modern movable sediments and are of important economic importance if optimum exploitation is made due to their proximity to the investment plants In the province, as well as the possibility of exploiting the area for distinctive tourist Introduction: River drainage, basins are the basic spatial unit for conducting quantitative research

of river basins for the purpose of measuring the natural characteristics of river systems or valleys. Of the laws, most of which are based on Horton's 1945 laws, in addition to the different methods of many researchers such as Streller 1952, Shum 1965, Miller 1985 and others. The researcher used the descriptive and analytical method together, using the quantitative method and field work, and relied on topographic maps with a scale of 1:2,500,000 for the year 2010 and digital elevation maps (DEM) from which the water network was derived. Morphometry is defined as the science of measuring the geometric properties of the earth's surface resulting from river erosion factors and depends on the analysis of elevations and slope directions.

***Keywords*---**morphometric, basins folded, geographic information systems (GIS).

Introduction

A research extracted from a doctoral thesis entitled Geomorphology and hydrology of the northern basins and the possibilities of investing them using modern technologies, Wafa Hamid Hassan Al-Fatlawy, University of Kufa, College of Education for Girls.
1-The role of the natural factors represented by the geology of the area and the
First: The research problem: The study is the main and main axis in all studies, including geomorphological and morphometrics, which are drawn according to accurate scientific steps, the aim of which is to find treatments and possible solutions to them. The main research problem is (what are the prevailing geomorphological factors and processes in the study area and what is their role and impact in determining the morphometric characteristics of the basins. It can be focused on sub-problems of them

- What are the natural components that determined the characteristics of the northern basins of Jabal Bekhair?
- What are the morphometric characteristics of the basins of the study area?
- Are there potentials that can be developed and benefited from according to the characteristics of the study area?

Research hypothesis

A hypothesis is defined as a guess or conclusion reached by the researcher and temporarily adheres to it based on what he possesses of scientific Explanations and ideas related to the research problem.

- Characteristics of the surface, slope, climate, soil and water resources in determining the geomorphology of the study area.
- The characteristics of the basins of the study area vary in terms of extension, area, perimeter and network characteristics represented by the number of lengths of river tributaries, bifurcation ratio, river frequency, longitudinal and numerical density, and others.
- The potentials and their investment that can be benefited from in the study area were represented by rural stability, roads and mineral ores.

Research Objectives

- Knowing the natural and influencing factors in determining the geomorphology of the northern basins of Jabal Bekhair.
- Studying the quantitative analysis of the morphometric characteristics of the basins of the study area and highlighting their hydrological characteristics.
- Uncovering the potentials and investing them economically, as well as studying the human uses of the land and their relationship to the geomorphological characteristics of the study area.

Research Methodology and Stages

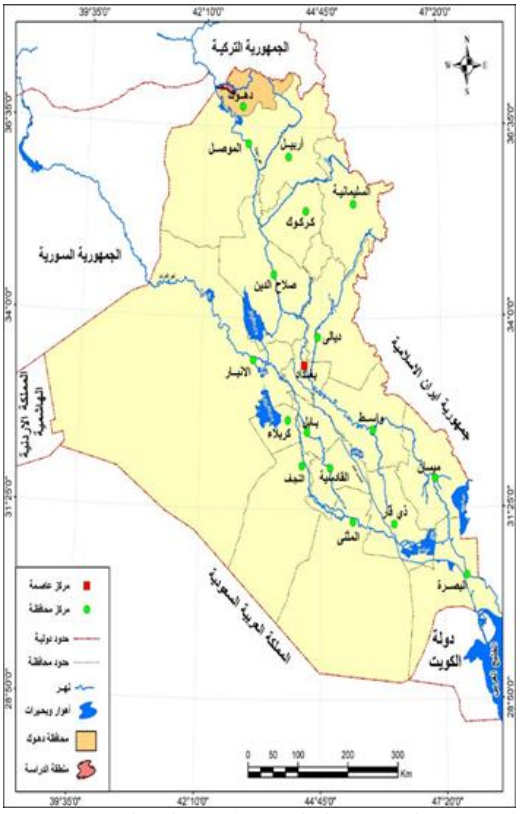
The study followed the descriptive and quantitative analytical method, and this methodology passed through several stages, Including: The first stage - data and information collection: Information and data were collected at this stage from scientific and international books and published and unpublished government statistics. Satellite images of the study area were collected by the American satellite (TM 2010 Land sat) and various thematic maps of the study area were collected. As for the second stage: work The field study is considered the main pillar of the research, and this stage was carried out through repeated field visits during the study period on (9/13/2021AD until 20/9/2021AD) and the second period from the date of(3/26/2022 until 1/4/2022AD).

Fifth- The area and limits of the research: The study area is located from the administrative side within the governorate of Dohuk, and it is limited to two latitudes (31 01 00 – 31 08 00) in the north and longitudes), 42 20 00- 42 50 00(to the east, but from the natural point of view the basins of the study area are In Dohuk and Zakho, an extension of the village of Fishkhabur on the Iraqi-Turkish border, and its area is (264.22) km2 (Map–). Natural factors affecting the morphometric characteristics of the basins of the study area: First - Geological Structure: (Map-2) The study of the geological situation is important in geomorphic studies, as the structure is the dominant factor in the development of the land forms that William Morris Davis referred to, that the forms of the land are controlled by the structure, process and stage, and that the stage is the factor Dominant over the development of the forms of dry land, while the structure shows the characteristics of the rocks and the extent of their exposure to the movements of torsion and fractures, and the cracks and breaks that appear on them (1). The ground movements were divided into three movements: A- Pre-Pleistocene movement: B- Pleistocene: C- Najd and Hijaz movement D- Quaternary age movement E- Hercynian movement F- Alpine movement C- The movement of the Quaternary ageP:

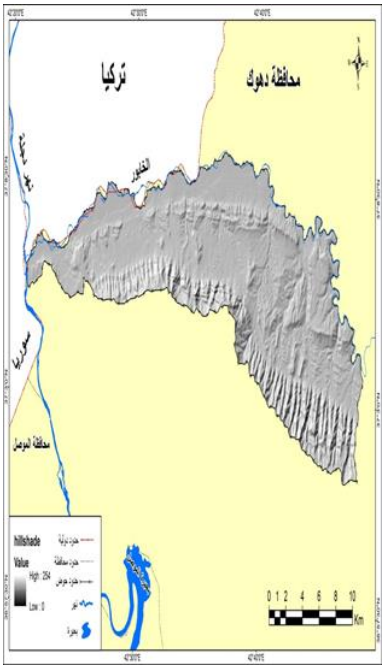
Linear phenomena: The study of linear structures is of great importance in hydrological and geological studies, and this importance lies in inferring the locations, movement and existence of mineral ores and groundwater, and that there is a link between network lines (Map-3). And that the different lengths of phenomena depend on the difference in the strength of the internal ground motion and the depth of extension, they are classified into

- First- Lines: They are straight phenomena, and they are divided into micro-liners and small lines with a length of up to (2) km. Liner big are the linear phenomena whose lengths range between (2- 10) km.
- Second - Lineaments): linear phenomena with wide extension and extending for long distances up to (10) km as a minimum and (100) km as an upper limit (2).

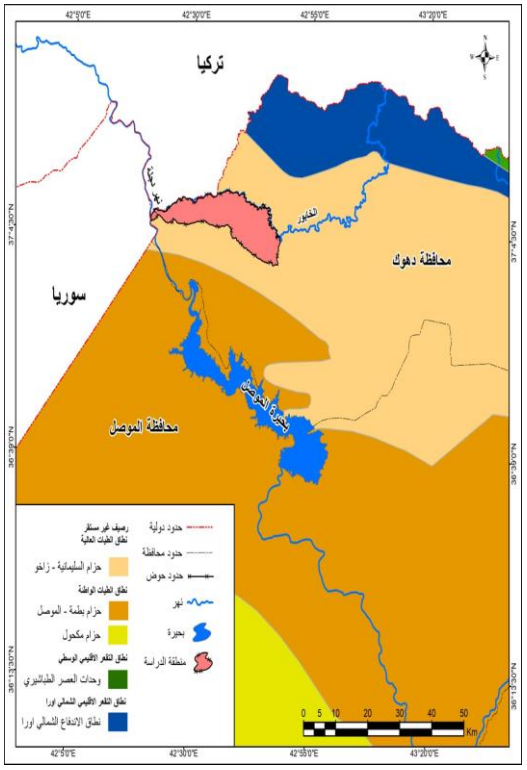
Geological formations in the study area: Geological Formations: the exposed rock formations in the study area vary according to the different environment of their deposition, as some deposited in continental conditions resulting from marine decline, while others were deposited under marine conditions resulting from marine progress, the ages of these formations range from what Between the Eocene and Middle Miocene in the Tertiary period and the Pleistocene and Holocene epochs in the Quaternary time. The following geological formations are revealed in the study area from the oldest to the



(Map – 1) The location of the study area in



(Map - 2) Structure of the study area



Source: Space Shuttle Endeavour, radar visualization of the study area DEM, accuracy (30) based on (Global Mapper 18) program

Table 1
Linear phenomena in the study area

Percentage (%) of total length	length (km)	Percentage (%) of the total	the number	directionin degres	
13	46.87	11.7	37	0--10	
7.1	25.84	8	25	20-11	
4.1	14.99	5.7	18	30-21	
2.9	10.32	3.8	12	40-31	
2.7	9.86	2.8	9	50-41	
8.7	31.34	9.8	31	60-51	North East
7.8	28.37	7.9	25	70-61	
6.4	23	6.9	22	80-21	
3.1	11.2	3.3	11	90-81	
55.8	201.79	59.9	190	Total	
14.7	53.3	12	38	280-270	
12.5	45.15	10.1	32	290-281	
4.9	17.72	6	19	300-291	
3.4	12.36	3.2	10	310-301	
1.2	4.4	1.6	5	320-311	
2.7	9.61	2.8	9	330-321	
2	7.16	2.2	7	340-331	
1.7	6.28	1.3	4	350-341	North West
1.1	3.88	0.9	3	360-351	
44.2	159.86	40.1	127	Total	
100%	361.65	100%	317	total summation	

Source researcher's the work with accreditation (Map-3) most recent (Map-4)

Triple time formations

Five geological formations are revealed and they are as follows:

- First: The formation of the vent (Middle Miocene Fatha Formation) The geological age of the vent formation dates back to the Miocene era, whose date is set at (20) million years (3). It consists of gypsum, limestone, sandstone and clay. In the eastern part of the study area.
- Second: Mukdadyah formation (lower Miocene-Pliocene mukdadyah formation): Mukdadyah formation is revealed in simple parts from the western side, while the largest part is concentrated in the eastern part in the study area and consists of gravel sandstone and alluvial mudstone with complex rocks occupying an area of (42 km2). And the percentage (16%) (4).
- Thirdly, the Upper Miocene Engan Formation: This formation is revealed in the eastern part of the study area and in separate parts along the study area and occupies an area of (9 km2.9), and (3.8%) (5) consists of lead brown sandstone
- Fourth: The Bey Hasan Formation (The Upper Bakhtiari) Pleistocene: This formation is revealed in the east and north-east of the study area and consists of a thick layer of coarse dams with a thickness ranging between (50-80) m. It

contains a layer of brown mudstone and another of sandstone and forms an area. (29.8 km2 at a rate of (11.3%) (6).

- Fifth: Pilaspi formation (middle and late Eocene pilaspi formation): This formation unfolds in the southern part of the study area in the form of a strip extending from east to west, consisting of (7) applied limestone. The rocks of this formation are solid, non-porous, occupying an area of (51.22). km2 at a rate of (20%).

Quaternar Depsits

Quaternary time deposits in the study area are not strictly limited due to the lack of absolute age data for the ages of the main stratigraphic divisions. The sedimentation period goes back to the Pleistocene and Holocene eras. The sediments of the study area appear in the following forms, including:

- First - Slope deposits: Pleistocene and Holocene deposits: These deposits appear in the northeastern and central part of the study area and consist of silty clay materials and gravels of different sizes and occupy an area of (43.65 km2) and a percentage of (15.6% (8).
- Second - Mixed deposits (Pleistocene and Holocene): They are found in flat lands, slopes, and undulating plains, and they are of many types consisting of silt and clay with mixed sand, gypsum, large and small local rocks and some broken and crushed rocks and occupy an area of (73.42 km2) and a rate of (27.9%)(9)

Surface features

The surface features and the degree of its slope play an important role in knowing the speed of flow in the study area and the activity of geomorphic processes, as well as the influence on the elements of climate, soil composition, density and diversity of vegetation cover. The study area is located within the mountainous region in northern Iraq and within the alpine system.

Dividing the study area on the basis of height into three main units (Map-7).

- Plain land units: This unit occupies a large part of the study area as it reaches (150,62) by (57%) (10) of the total area, and the lands of this unit are confined between the elevation lines (330-608.3) m above the level The sea surface, and they are known as low areas formed by the sediments transported from the highlands and crossed by a network of valleys.
- Mountain foot units: they are lands with open terrain and their height reaches (600) meters above sea level. 866.7 meters above sea level and occupies an area of (89.41) km2 (11) and a percentage of (33.8%) of the total area of the study area.
- The unit of heights (high mountains): they are high areas with a height of more than (866.8-1125) meters. These lands form areas that divide water into the basins of the study area and are confined between two contour lines (970-1125) meters above sea level and occupy an area It reached (24.19) km2 or (9.2%) of the total area, and it consists of slopes that form many watercourses, especially the first and second lower riverine ranks because

they are areas with high altitudes, because they receive very high rainfall and are a source of superficial nutrition for valleys and basins. The study area occupies the southern part, which is in the form of a strip extending from east to west of the study area (`12).

Second - Climatic characteristics: To show the impact of the climate in the study area, the available data were analyzed in the two climatic stations of Dohuk - Zakho for the period from (1990-2019) according to the elements of the climate and my agencies:

Solar Radiation

It is evident from the data (Tables 2-3) for the two stations of Dohuk - Zakho. The climatic elements vary. We note that the monthly average of the angle of incidence of solar radiation varies, as it was recorded in December (30.5 and 29.92) degrees, respectively, and the highest values during The months of June reached (77, 76.42) degrees, respectively, due to the fall of the rays perpendicular to the orbit of cancer in the month of June. While we note that the monthly average of the amount of solar radiation varies between the months of the year, where during the month of December it reached (4.7, 4.1) milliwatts / cm2 and in the month of June it amounted to (11.5, 11.4) milliwatts / cm2, respectively. As for the theoretical brightness hours, we notice an increase in the monthly average of the theoretical brightness hours starting from the month of March for the transmission of the sun's rays to the equator, as the number of theoretical brightness hours reached (11.23, 11.1) hours / day in a row, and it continues to increase during the month of June to reach (12.44, (12.4 hours / day) respectively due to the vertical fall of the solar rays, and then begins to decrease during the month of January 9.45, 9.6) hours / day respectively, given Due to the presence of clouds and weather changes, the number of hours of actual brightness was (4.5 .). , (3.09 hours / day in a row for the month of March, and continues to increase during the month of June to reach (10.4, 10.48) hours / day in a row, due to the vertical fall of the raysThe average annual temperature reached (20.35, 20.3) Celsius, respectively, while the average maximum temperature reached (26.12, 26.4) Celsius, respectively, and the average minimum temperature (14.54 and 14.3 Celsius, respectively, being the lowest monthly average The maximum temperature in January was (11.5, (12) Celsius, respectively, while the highest monthly average of the maximum temperature in July was (41.5, (41.3 Celsius) respectively, and the lowest monthly average for the minimum temperature reached (3.1, 3.2 Celsius, respectively. As for the highest monthly average of the minimum temperature, it was recorded in July as well (26.5, 26.1 Celsius, respectively, while the highest average monthly temperature range was in July, 15.2 Celsius, and the lowest in the month In January, it reached (8.3, 8.6) Celsius, respectively, while the annual temperature range was recorded (11.48, (11.9). As for the winds, we note that the wind speed varies in the study area, as its monthly rates range according to the months of the year, and the highest speed is in months Summer (April and May-June), it reaches (1.6, 1.6, 1.7) m/s respectively for the Dohuk station in When the Zakho station recorded less for those months (1.24, 1.62, 1.62) m/s, while during the winter season, the lowest months were recorded for the month of December for the Dohuk - Zakho station (1.2), (0.87 m/s, while the annual amount of rain

amounted to (512.7, 559 mm respectively, as rain falls in the month of September and ends in July and is absent in the summer months because the region falls within the semi-arid climate, which is characterized by high amounts of solar radiation and temperatures. As for the relative humidity recorded during the winter season, the highest percentages were in the month of January, as it reached (67% and 55%) respectively, while the relative humidity decreases during the summer due to the high temperatures, the increase in wind speed and the lack of rain so that it is less valuable during the summer in the month of August, when its lowest rates were recorded (24, (20.07) respectively, while the total Annual evaporation (1861.9, (1914.78 mm) respectively and to calculate evaporation / transpiration rates and apply Najib Kharoufa equation as follows(13).

ETO= P/3 C^(1.31).

Table 2
Dohuk Climatic Station for the year (1990 – 2019)

RATE OR SUM	K 2	OCTOBER 2	OCTOBER 1	SEPTEMBER	FATHER	JULY	JUNE	MAY	APRIL	MARCH	FEBRUARY	K 2	MONTHS/ ITEMS
53.28	**30.5**	**35.1**	**43.3**	**57**	**67.9**	**75.2**	**77**	**72.1**	**62.9**	**51**	**40.5**	**32.5**	RADIATION ANGLE DEGREE
7.8	**4.7**	**5.8**	**7.3**	**9,9**	**11.1**	**11.6**	**11.5**	**9**	**6.7**	**5.9**	**5.6**	**4.3**	AMOUNT OF RADIATION IN MILLI WATTS/CM2
12.56	**9.34**	**10.56**	**11**	**13.12**	**14.43**	**13.25**	**12.44**	**12.30**	**11.86**	**11.23**	**10.12**	**9.45**	THEORETICAL BRIGHTNESS RATE H/DAY
8.6	**4.1**	**6.2**	**6.5**	**8.6**	**12.2**	**11.9**	**10.4**	**9.9**	**9.3**	**5.6**	**4.9**	**4.5**	AVERAGE HOUR/DAY FOR ACTUAL BRIGHTNESS
26.12	**14.2**	**19.6**	**28.9**	**35.3**	**40.3**	**41.5**	**37.4**	**30.1**	**22.6**	**18.5**	**13.6**	**11.5**	AVERAGE MAXIMUM TEMPERATURE (C)
14.54	**5.2**	**9.6**	**16.7**	**21.7**	**26.2**	**26.5**	**23.09**	**17.4**	**12.7**	**8.5**	**4.9**	**3.1**	AVERAGE MINIMUM TEMPERATURE (C)
20.35	**9.7**	**14.6**	**22.8**	**28.6**	**33.1**	**34**	**30.2**	**23.7**	**17.6**	**13.5**	**9.2**	**7.3**	AVERAGE MONTHLY TEMPERATURE (C)
11.48	**9**	**10**	**12.2**	**13.6**	**14.1**	**15**	**14.31**	**12.7**	**9.9**	**10**	**8.7**	**8.3**	RANGE (M)
1.5	**1.2**	**1.2**	**1.4**	**1.4**	**1.5**	**1.5**	**1.7**	**1.6**	**1.6**	**1.5**	**1.4**	**1.4**	WIND SPEED M/S
512.7	**86.6**	**53.3**	**22.6**	**1.5**	**0**	**0.1**	**0.8**	**15.8**	**50.1**	**80.7**	**82.4**	**118.8**	RAINFALL (MM)
3.7	**1.88**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.40**	**0.65**	**0.77**	ICE QUANTITY
45	**64**	**55**	**39**	**29**	**24**	**24**	**28**	**40**	**53**	**58**	**64**	**67**	RELATIVE HUMIDITY%
1861.9	**41.4**	**73.2**	**144.5**	**219.9**	**295.8**	**322.1**	**285.8**	**206.4**	**127.3**	**75.3**	**40.6**	**29.6**	EVAPORATION (MM)
1669.9	**57.5**	**99.8**	**208.4**	**311.6**	**431.1**	**486**	**398.6**	**290.5**	**172.7**	**116**	**55.5**	**42.1**	LATENT EVAPOTRANSPIRATION(MM)

Table 3
Zakho Climatic Station for the year (1990 – 2019)

rate or sum	K 2	October 2	October 1	September	Father	July	June	May	April	March	February	K 2	months/ items
53.33	29.92	34.52	44.72	56.42	67.32	74.62	76.42	71.52	62.22	50.42	39.92	31.92	Radiation angle degree
7.7	4.1	5.9	7	10	10.8	11.7	11.4	9.01	7.9	6	5.6	3.8	Amount of radiation in milli watts/cm2
11.5	8.9	10.3	12	13	14.11	12.3	12.4	12.9	11.3	11.1	510	9.6	Theoretical brightnessrate h/day
7.01	4.33	5.32	6.73	9.21	10.57	11.02	10.48	8.77	5.51	5.11	3.99	3.09	Average hour/day for actual brightness
26.4	14.3	19.8	28.4	36.2	40.9	41.3	37.6	30.7	24.1	18.1	13.6	12	Average maximum temperature (C)
14.3	5.2	10	16.3	21.4	25.8	26.1	22.5	16.8	12.6	7.8	4.9	3.2	Average minimum temperature (C)
20.3	9.7	14.9	22.3	28.8	33.37	33.7	29.9	32.7	18.3	12.9	9.2	7.6	Average Monthly Temperature (C)
11.9	9.1	9.8	12.1	14.8	15.1	15.2	15.1	13.9	11.5	10.3	8.7	8.8	Range (m)
0.93	0.87	0.87	0.96	0.98	1.9	1.23	1.62	1.62	1.24	1.16	1.11	0.97	Wind speed m/s
559	96.48	58.17	24.65	1.8	0.03	0.00	2.11	21.19	65.96	76.77	94.35	117.61	Rainfall (mm)
8	0.4	0	0	0			0	0		0.2	5.2	2.2	Ice quantity
38.63	54.86	47.64	35	24.71	21.07	20.07	21.36	33.93	46.29	48.5	55.21	55	Relative humidity %
19.14.78	35.12	62.25	146.72	228.21	313.06	343.95	298.539	149.38	113.49	93.7	48.7	36.7	Evaporation (mm)
2736	57.5	102.5	202.4	314.5	435.8	480.4	393.4	290.6	168.9	109.3	55.5	44.2	Latent Evapotranspiration (mm)

Source: Directorate of Meteorology and Seismic Monitoring in Dohuk, in Zakho District, Governorate, Climate Department, unpublished data, monthly and annual statistics 2021

ETO: latent evapotranspiration (mm), P: the percentage of the number of hours of sunshine per month in relation to the number of hours in a year. C: the average monthly temperature (°C).It is clear according to Najib Kharoufa's equation for the study area, the total evaporation / transpiration amounted to (2669.9), 2736 mm, respectively, and to determine the type of climate, the following Köppen equation (14) was applied. R=(0.44T-14)/2 R: dryness indicator, T: average annual temperature (F) = (76,82) The drought index reached (8.09 and (8.07), respectively, according to Köppen classification, so the study area is a semi-arid area.Source: Directorate of Meteorology and Seismic Monitoring in Zakho District, Climate Department, unpublished data, monthly and annual statistics 2021 Soil properties: (charactristics): a developed natural body with certain chemical, physical and biological characteristics. The formation of the soil from the interaction of multiple factors, some of which are geomorphic and others are related to soil science, and the soil is the direct product of various weathering processes and the word soil is called on the upper layers of the surface (15).

Buring classified the soil of the study area into the following sections (Map-5) (16) pression soils: the largest part of it is concentrated within the northern central part of the study area,

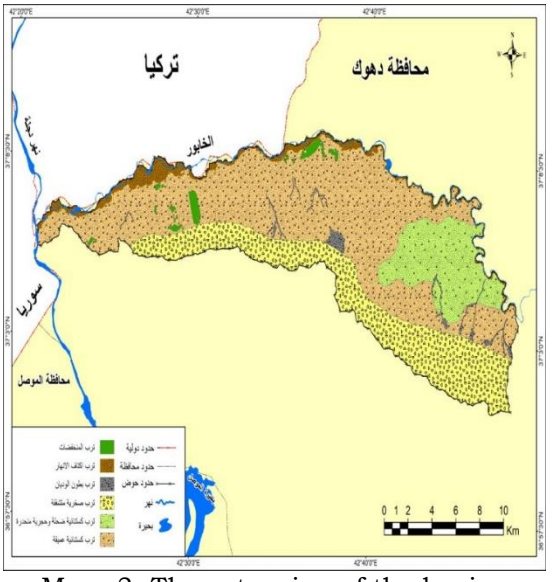
- while other parts are located within the southwestern part of the study area, occupying an area of (3.4 km2) and a percentage of (1.3% of the total area.

- River shoulder soils: They are located in the north of the study area, which extends from the northeastern part to the northwestern part in the form of a strip. (5.6%) (18) of the total area.
- Soils in the stomachs of valleys: This type of soil is found in the northwestern part and some scattered parts are scattered in the study area. It is characterized by the presence of clay, silt and sand, and because it is movable soils that are deposited in the mouths of the valleys, occupying an area of (3.63 km2 and a percentage of (1.4%) (19).) of the total area.
- Cracked rocky soils: They are cracked rugged, shallow, shallow rocky soils that are newly formed, with a dark brown color that tends to several changes in the sloping areas and increases slightly at the feet of the mountainous slopes, forming an area (65.13 km2) and a percentage (24.6%) of the total area (20).
- Chestnut shallow stony sloping soil: characterized by its dark brown color in its upper sections, its thickness (0-3 cm), and it is fragile and contains organic matter, and it occupies an area (35.16 km2) and a percentage (13.3%) of the total area (21).
- Deep chestnut soils: These soils have developed in areas with little rain, as the vegetation cover is in the form of short weeds and is rich in calcareous materials, minerals and calcareous materials, and occupied an area (141.18 km2) and a percentage (53.8%) of the total area (22).

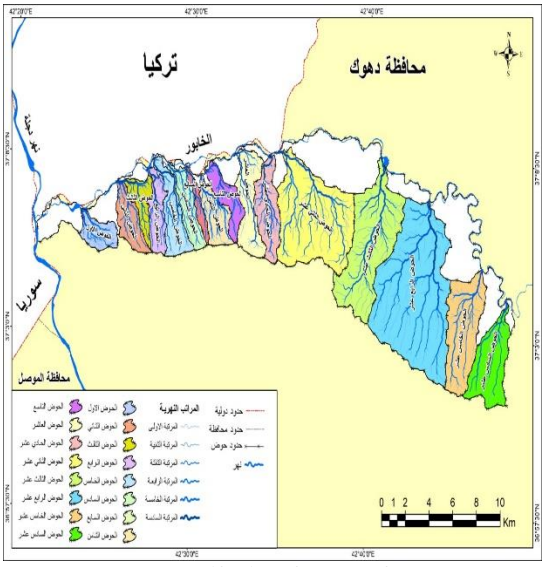
Morphometry

Is defined as the science of measuring the geometric properties of the earth's surface resulting from river erosion factors and depends on the analysis of elevations and slope directions (23). The study of the morphometric characteristics of the basins of the study area was based on the digital elevation model (D.E.M) of the system (SRTM, with a precision of (90) m, analyzed and processed in (10.4 ARC GIS) and using morphometric tools, as the drainage basins were identified for the north of Jabal Bekhir and the valley network was drawn foreach basin and from Then calculate all the morphometric characteristics of the basins of the study area, which amounted to sixteen basins, which originate from the south towards the north to flow into the Khabur River (Map – 5). Geographical and spatial characteristics.

- Geographical extensions of the basins of the study area: The extensions of the valleys of the study area vary spatially according to the basins in which they take place.
- Form Characteristics: The aim of studying the formal characteristics of the basins is to 3-understand the geomorphological development and the processes that formed them, as well as to indicate the extent of the effect of the shape on the volume of river discharge.



Map -3. The extension of the basins



Map-4. Soils in the study area

Source: Ministry of Industry and Minerals, General Organization for Geological Survey and Mining, geological map of Dohuk and Zakho at a scale of 1: 25000, Dohuk, 2012, based on Bjornck classification

Table 4
morphological characteristics in the study area

evaporation coefficient	fusion coefficient (km/km2)	Basin shape factor (km2/km)	Length to width ratio	ocean cohesion ratio	rotation coefficient	Elongation modulus (km2/km)	space (km)2	Basins length(km)	Basins
1.03	1.3	0.24	4	1.3	0.60	0.56	4.75	4.43	first basin
1.4	1.5	0.18	5.8	1.5	0.44	0.48	5.93	5.87	second basin
2	1.9	0.13	7.5	1.9	0.29	0.4	4.54	5.96	The third basin
1.5	1.7	0.17	5.9	1.8	0.32	0.46	5.88	5.92	Fourth basin
1.6	1.8	0.15	6	1.8	0.31	0.44	7.86	7.15	Fifth pelvis
2.1	1.7	0.12	8.9	1.7	0.33	0.39	5.99	7.08	Sixth Basin
3	1.9	0.08	12.1	1.9	0.28	0.32	2.25	5.19	Seventh Basin
7.6	1.5	0.03	30.3	1.5	0.46	0.20	6.12	13.63	The eighth basin
8.4	1.7	0.03	34.1	1.7	0.35	0.19	5.5	13.62	ninth basin
1.4	1.7	0.18	5.7	1.7	0.34	0.48	9.83	7.63	tenth pelvis
16.9	1.5	0.01	68.7	1.5	0.44	0.14	9.04	24.97	the eleventh basin
0.99	1.4	0.25	4	1.3	0.55	0.57	31.76	11.21	twelfth pelvis
1.08	1.5	0.23	4.3	1.6	0.39	0.54	26.5	10.71	thirteenth basin
0.79	1.4	0.32	3.2	1.3	0.53	0.63	48.7	12.43	The fourteenth basin
1.1	1.4	0.22	4.6	1.4	0.52	0.53	16.69	8.71	The fifteenth basin
1.2	1.5	0.21	4.8	1.5	0.43	0.52	12.46	7.67	Sixteenth Basin

Source: the researcher's work based on digital elevation maps (DEM) and the program(ARC GIS 10.4 Map)

- Elongation Ratio: It is a parameter that represents the approach of elongation as the shape of the basins approaches or moves away from the rectangular shape (24). (km) the basin is an area whose area is the diameter of which the circle is length)/((km) for the basin the maximum length) = the elongation) coefficient

- Roundness coefficient: (Circularity Ratio): A criterion that shows how close the basins are to the circular shape or away from it, and it is calculated through the ratio of the basin area to the area of the circle (25) (km2) the area of the basin) / (km2) itself the basin the perimeter of its perimeter is equal to (the area of a cicrcie)
- Circumference Tenacity Ratio: It is a measure that shows how close or far away the shape of the basin is from the circular shape. Perimeter coherence ratio=√(1/(area cohesion ratio)((
- The ratio of length to width (Langth Width Ratio): It shows how close or far the shape of the basins from the rectangular shape, the higher values indicate the approach of the basins to elongation (27). (km) ponds length)/(km)(ponds width) = (width to length ratio)
- The shape factor of the basins Form Basin Factor: It shows the consistency of the shape of the basin parts through the ratio between the basin area over the square of the basin length (km2) basin area)/((km2) basin length square) = shape parameter) (28)
- Compactnees Factor: The purpose of this coefficient is to know the substrate phase of the basins, which is the relationship between the basin circumference and the circumference of the circle (29). (km) basin perimeter)/((km)(basin area whose area is equivalent to that of the circle circumference)
- Lemniscate factor: This factor shows the negatives that appear in the ratio of roundness, and the basins may be pear-shaped or elliptical, and when the values are high, they indica).square-meter square(the lack of flatness of the basins(30)

Topological Characteristics

The topographical characteristics of the basins are among the important characteristics in geomorphic and hydrological studies.

- 1-Relief ratio: it means the difference between the highest and lowest point in the basins(31)
- (m) troughs at the lowest and highest point between the difference)/((km) troughs length) = molar ratio).(
- 2-Basin Texture Ratio: It is one of the important parameters related to the natural factors represented by climatic conditions, rainfall, type of soil, its ability to filter and the type of rocks(32). basins valleys number)/ (km) (basins circumference) =(basin tissue

Table 5
Topographical characteristics in the study area

Hypsometricintegratio (km2/m)	ruggedness value	Relative terrain (m/km)	Basin topography(m)	Minimum equal line height	highest equal line height	basin fabric stream/km	Gear Ratio (m/km)	Basins
0.02	0.1	17.5	175	350	525	6.8	39.5	first

								basin
0.01	1.7	26.9	350	350	700	6.4	60.6	second basin
0.01	2.1	28.6	400	350	750	5.3	67.1	The third basin
0.01	2	28.3	425	350	775	5	71.8	Fourth basin
0.01	2.3	26.4	475	350	825	6.1	66.4	Fifth pelvis
0.01	3.3	40	600	350	950	5.3	84.7	Sixth Basin
0.003	3.7	60	600	350	950	3.4	115.6	Seventh Basin
0.01	3.2	46.2	600	400	1000	8.2	44	The eighth basin
0.008	3.1	44.6	625	375	1000	5.7	45.9	ninth basin
0.01	1.6	34.2	650	375	1025	1.9	88.3	tenth pelvis
0.01	2.9	39.1	625	400	1025	8.1	25.3	the eleventh basin
0.05	1.6	22.2	600	400	1000	4.7	53,5	twelfth pelvis
0.05	1.3	18.1	525	425	950	3.7	49	thirteenth basin
0.08	1.21	16.2	550	475	1025	4.4	44.2	The fourteenth basin
0.03	1.3	27.5	550	550	1100	3.05	63.1	The fifteenth basin
0.02	1.4	31.6	600	525	1125	2.4	78.2	Sixteenth Basin

Source: the researcher's work based on digital elevation maps (DEM) and the program(ARC GIS 10.4 Map)

Table 6
the density of longitudinal and numerical drainage, the survival rate of the stream and the inflection coefficient in the study area

inflection coefficient	duct length(km)	basin length(km)	Stream survival rate)km2/km(	scalar density)stream/km2(	Linear density (km/km2)	Space)km2(	Basins
1.2	3.79	4.43	0.176	14.3	0.8	4.75	first basin
1.1	5.1	5.87	0.205	14	4.9	5.93	second basin
1.2	4.89	5.96	0.192	16.3	5.2	4.54	The third

							basin
1.1	5.16	5.92	0.209	12.8	4.8	5.88	Fourth basin
1.1	6.28	7.15	0.206	14	4.9	7.86	Fifth pelvis
1.3	5.5	7.08	0.182	13.3	5.5	5.99	Sixth Basin
1.1	4.83	5.19	0.165	15.1	6.1	2.25	Seventh Basin
3	4.47	13.63	0.187	17.3	5.3	6.12	The eighth basin
2.8	4.81	13.62	0.200	14.5	5	5.5	ninth basin
1.1	6.46	7.63	0.397	3.7	2.5	9.83	tenth pelvis
4	6.26	24.97	0.216	14.4	4.6	9.04	the eleventh basin
1.3	8.72	11.21	0.381	3.9	2.6	31.76	twelfth pelvis
1.1	9.63	10.71	0.402	4	2.5	26.5	thirteenth basin
1.14	10.88	12.43	0.458	3.1	2.2	48.7	The fourteenth basin
1.2	7.52	8.71	0.428	3.7	2.3	16.69	The fifteenth basin
1.2	6.49	7.67	0.421	3.6	2.4	12.46	Sixteenth Basin

Source: the researcher's work based on digital elevation maps (DEM) and the program(ARC GIS 10.4 Map)

- Ruggedness value: It is the relationship between the topography of the basins and the lengths of the longitudinal drainage density.
- (Longitudinal drainage density x basins terrain) / 1000 = ruggedness value)
- Hypsometric Integration: It expresses the relationship between the area of the basins and the topography of the basins.
- (km2) basin area)/ (m) basin topography) =(Hypsometric integration)
- Water Drainage Density: It means the spread and branching of the river network within the basin area.
  - Linear Drainage Density, which is expressed by the following equation (35) km) basins in aqueous drains total lengths) / (km2) basins area) = longitudinal drainage density).
  - Density of numerical discharge is expressed by the following equation (36) .((Wadi arranged by all valleys, total number)/(km2), basins area) = numerical, drainage, density)
- Sinuosity factor: It is defined as the degree of deflection of the valley from the straight course and the severity of its bending. It is measured by the following equation (37). (km) basin length)/(km) duct length) = bend coefficient)

- Ratio Stream Remains: It is the ratio between the area of basins needed to supply the network to the wadi streams with water to the total lengths of the streams (38). (km2)Area/ (km)Sewage lengths total)=(Sewage survival rate)

Conclusions

- It is clear from the physiogeographic divisions that the study area represented by the northern basins of Mount Bikhair within the unstable or untortured sidewalk of the Arab Nubian surface of the high mountain range (Sulaymaniyah-Zakho belt), which has an area of (263.22) km2 from the study area, as most of the rocks and sediments of the area The study dates back to the Tertiary and Quaternary periods.
- The morphometric characteristics of the northern basins of Jabal Bekhir were affected by the current climate, and the abundance of rains in the ancient climate stimulated the erosion and sedimentation processes, and the semi-dry basins scattered in the region, which are the outcome of water erosion processes that deepened those streams, as well as the role of The climate in determining the features of the surface of the earth prevailing in the region, and the winds for most days of the year are winds (southeast and northwest) for the stations of Dohuk and Zakho, and just as the rise in temperature and the lack of falling rain and the increase in evaporation during the hot season, which leads to the drying of the surface layer in the study area, In addition, the presence of groundwater that appears in the form of (eyes and wells) varying in hydraulic, physical and chemical properties, and this is due to the large number of fissures and cracks within the geological formations and the rocky unit (of the reservoir, Al-Fath - Muqdadiya - Anjana - Bay Hassan Belasbi) during the triple and quadruple time that The study area passed through it, in addition to that, the role of soil and its types in affecting the morphometric properties, as it was classified into six types of soil with different properties.
- The study concluded, through the formal characteristics, that the shape of the basins of the study area is close to elongation, so it is characterized by regular and successive water flow and with relatively small drainage quantities, in addition to that it is characterized by an increase in surface water losses through torrential, filtration and evaporation, due to the long height of Areas with steep slopes that made them short in lengths of basins, as well as rock formations in which cracks and separations abound, and that the area is semi-arid, with variations in temperatures and the difference in the daily and annual temperature rang
- The study area consists of sixteen basins, as the ranks of the basins vary from one basin to another in their preparation and this is due to the different rock characteristics that the basins of the study area pass through.
- The study of the topographic features is one of the important characteristics in the morphometric and geomorphic studies, and the study showed that the study area has a steep slope, as the slope was recorded (11.5 m/km, being a very mountainous area, the sprouts of the basins intensify as the hardness of the rocks increases.
- The bifurcation ratio of the basins of the study area was (2.3, 4.1, 2.9, 4, 4.6, 4.5, 5.7, 4.5, 4, 3.2, 4.8, 3 (4, 3,02, 3,4, 3.7, 3,66) respectively, and the

proportions are close, and this indicates that the homogeneity and similarity in the natural characteristics and geomorphic processes, as well as the moderation of the speed of water drainage from the lower ranks to the higher ranks The upper estuary (Khabour River).

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