Using GIS Techniques to Study Morphometric Characteristics for Wadi Al-MLUSI/Western IRAQ

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ABSTRACT

Numerous quantitative relationships have been formulated to describe the nature of surface-drainage networks. These relationships have been used in various studies of geomorphology and surface-water hydrology, such as flood characteristics, sediment yield, and evolution of basin morphology.

The study area lies in west of Iraq, in Al-Anbar province. With an area of 2754.33 Km². And the geographic coordinates of the study area is (40°, 27\` E- 32°, 47\` N). (44°, 34\` E - 33°, 36\` N). DEM image were used with (90 m) resolution and the drawing tools in ARC GIS program to delineate the total basin of the study area and watersheds. We conclude that there were 31 watersheds in the study area and that group of parameters were calculated such as (Basin Area, Basin Length, Basin Diameter, Stream order Length, Differences between max and min Altitude, Elongation, Circularity, Stream Density, Basin Form, Relief). The study shows that the stream density was (8.481289828) Km/Km^2 which mean that the study area has a good discharge of water and sediments, the elongation in the study area is (0.511549442) and that mean the study area is closer to a rectangular shape, and the relief in the study area is (3.2816911) m/Km and it reflects that the study area had poor effects of erosion and weathering.

Keywords: Morphometric Characteristics, Digital elevation model DEM, watersheds.

استخدام تقنيات نظم المعلومات الجغرافية لدراسة الخصائص المورفومترية لوادي الملوصي/ غرب العراق

الخلاصة

لقد وضعت العديد من العلاقات الكمية لوصف طبيعة شبكات الجريان السطحي. وقد استخدمت هذه العلاقات في مختلف الدراسات الهيدرولوجية والجيومورفولوجية مثل خصائص الفيضانات ، وكمية الرواسب ، وتطور شكل الحوض.

تقع منطقة الدراسة في غرب العراق في محافظة الأنبار اذ تبلغ مساحتها ٢٧٥٤.٣٣ كلم²، واحداثياتها الجغرافية (٤٠ °، ٢٧ \`E - ٣٢ °، ٤٧\` N)، (٤٤ °، ٣٤ \`E -- ٣٣ °، ٣٦ \`N). تم استخدام بيانات الارتفاعات الرقمية بدقة وضوح (٩٠ م) واستخدمت أدوات الرسم الموجودة

ببرنامج Arc GIS لرسم الحوض الكلي في منطقة الدراسة والجابيات. استنتجنا من البحث أن هناك ٣١ جابية في منطقة الدراسة. اما اهم العوامل التي تم حسابها من خلال البحث هي (مساحة الحوض، طول الحوض، قطر الحوض ، طول المجاري المائية ، والاختلافات بين اعلى واوطأ ارتفاع ، الاستطالة، الاستدارة، وكثافة التصريف، وشكل الحوض، والتضرس). أظهرت الدراسة بان كثافة التصريف كان مقدارها (٨.٤٨١٢٨٩٨٢٨) كم/كم٢ والذي يعني أن منطقة الدراسة تمتاز بتصريف جيد للمياه والرواسب ، واستطالة منطقة الدراسة هي (٠.٥١١٥٤٩٤٤٢) وذلك يعني أن منطقة الدراسة لها شكل قريب من المستطيل، اما التضرس فبلغت قيمته (٣.٢٨١٦٩١١) م/كم و هو يعكس ان المنطقة تاثرت بمقدار قليل من التعرية والتجوية.

INTRODUCTION

The evolution of any landscape on our planet, and hence of any drainage basin, is the result of interactions between the flows of matter and energy entering and moving within its limits and the resistance of the topographical surface. Under normal conditions, precipitation is the major source of matter and solar radiation the major source of energy. The resistance of the topographical surface is determined by its altitude, the resistance to erosion of the constituent rocks, the percentage of plant cover, the presence of a layer of soil, etc. The interrelationships between these factors and their distributions in time and space govern to a great extent the evolution and present state of drainage-basin topography. In accordance with the discipline's mandate to deal with interrelationships between the components of the environment. The present surface of any drainage basin is the result of a long process of evolution, in the course of which dynamic equilibrium has been achieved between the general flows of matter and energy and the variables which define the behavior of the basin towards these flows. Generally, there are two groups of factors with differing tendencies: on the one hand, there are agents which, through the flows of matter and energy introduced into the system. [1].

Act as forces that tend to lower the basin surface continuously; on the other hand, there are factors which resist this process of erosion, lending unity to the whole basin and undergoing. The main elements contributing to the definition of a basin’s characteristics are rock type, relief, soil type and depth, and plant cover As in Figure (1).

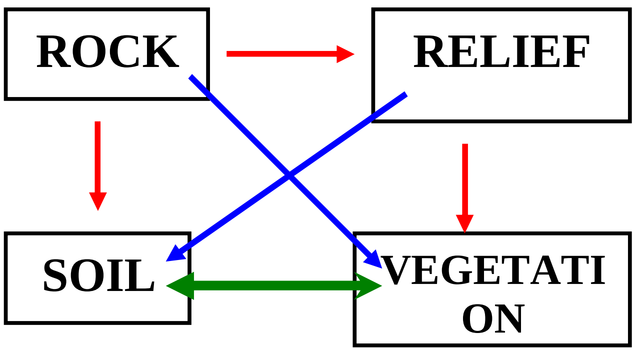


Figure (1) Variables Defining the Characteristics of Drainage Basin, and the Interrelations.

Geographic Location

Valleys are an important morphometric landscape feature for environmental modeling. For example, they are zones of transport for many materials, particularly fluxes of sediment and other entrained materials they represent zones through which cold air drainage moves and provide shelter from winds blowing across the valley axis. The characterization of valleys from DEMs is an important step in environmental, hydrological and ecological modeling. [2].

The study area lies in west of Iraq, in Al-Anbar province. The geographic coordinates of the study area is:-

(40°, 27\` E- 32°, 47\` N). (44°, 34\` E - 33°, 36\` N).

With an area 2754.33 Km².

As shown in Figure (2).

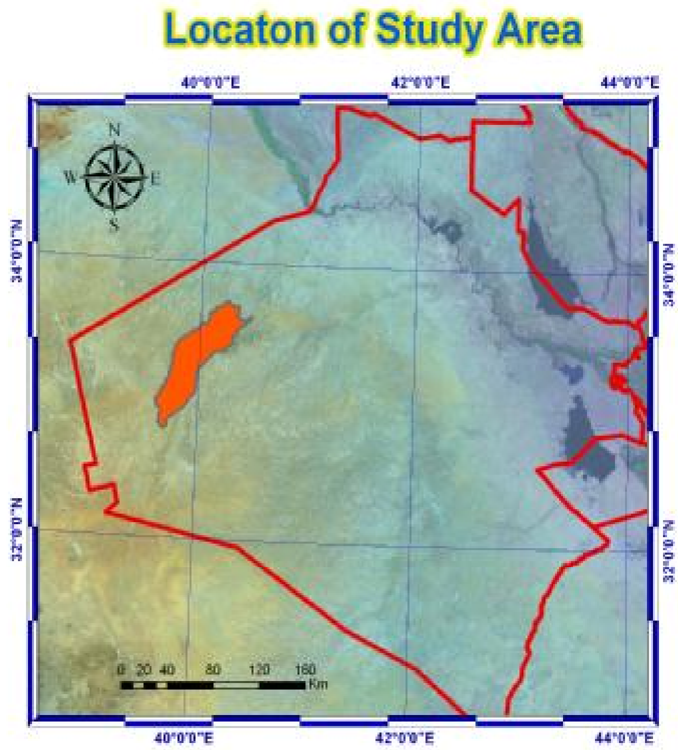


Figure (2) shows the location of the study area.

Pre-processing in search

DEM image were used with (90 m) resolution in research [3]. Two topographic maps with scale 1:100000 to the areas of (Jendli and Bir Ar-Rah) were georeferenced by using nearest neighbor polynomial correction within the ERDAS 9.1 software in order to determine the extent of the study area. The maps were carried out with WGS84 datum and UTM 38N projection.

The Methodology

This research achieved by number of steps as in the scheme Figure (3):

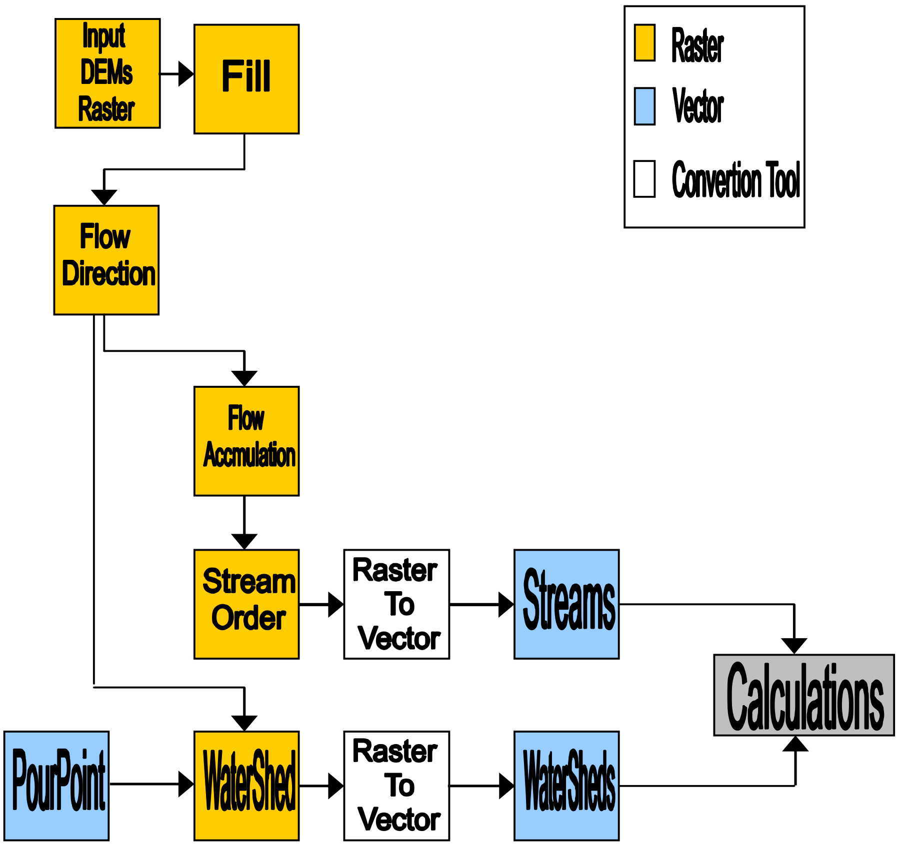


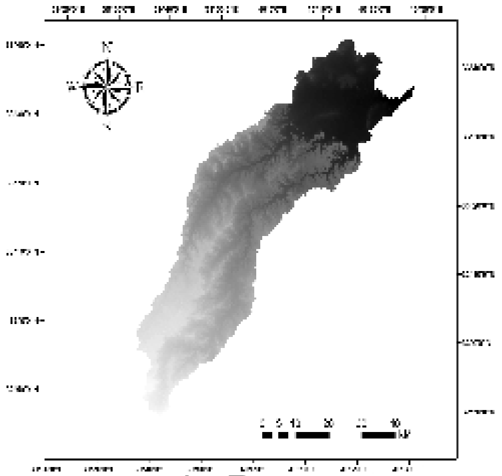
Figure (3) shows the methodology of the study.

Morphometric Characteristics

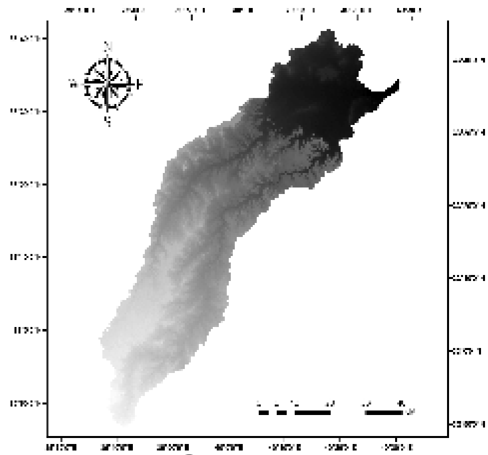
Morphometrical analysis of any river or valley network demands first of all the adoption of a classification system. Then, each stream segment and drainage basin may be assigned according to the principles of the system and to the extent to which the network has developed. The size of drainage basin influences the amount of water yield, the length, shape, and relief affected the water and sediments yield and the character and extent of the channels affect sediments availability and rate of water yield. [4].

Stages of extracting drainage net

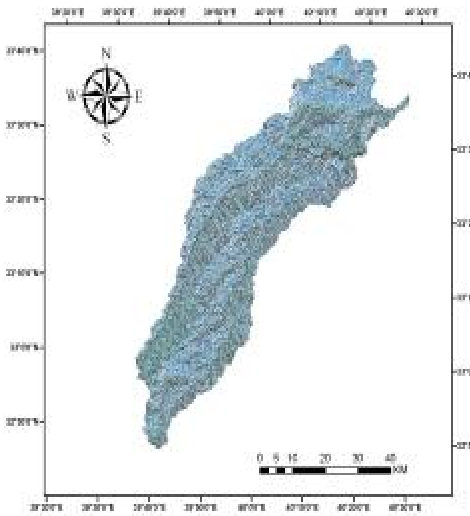
Many steps were done in order to extract the drainage net for the study area as in Figure (4).



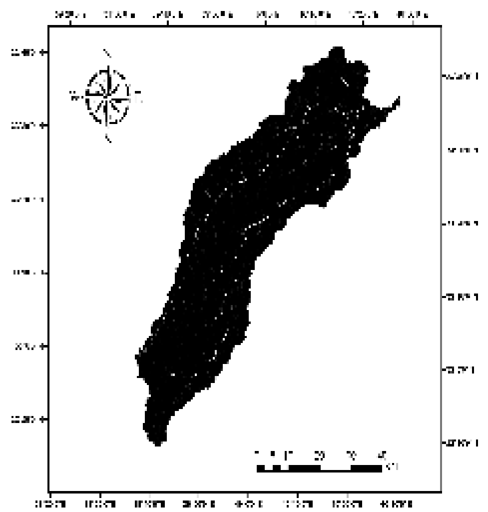
1- Dem



2- Fill



3- Flow Direction



4- Flow Accumulation

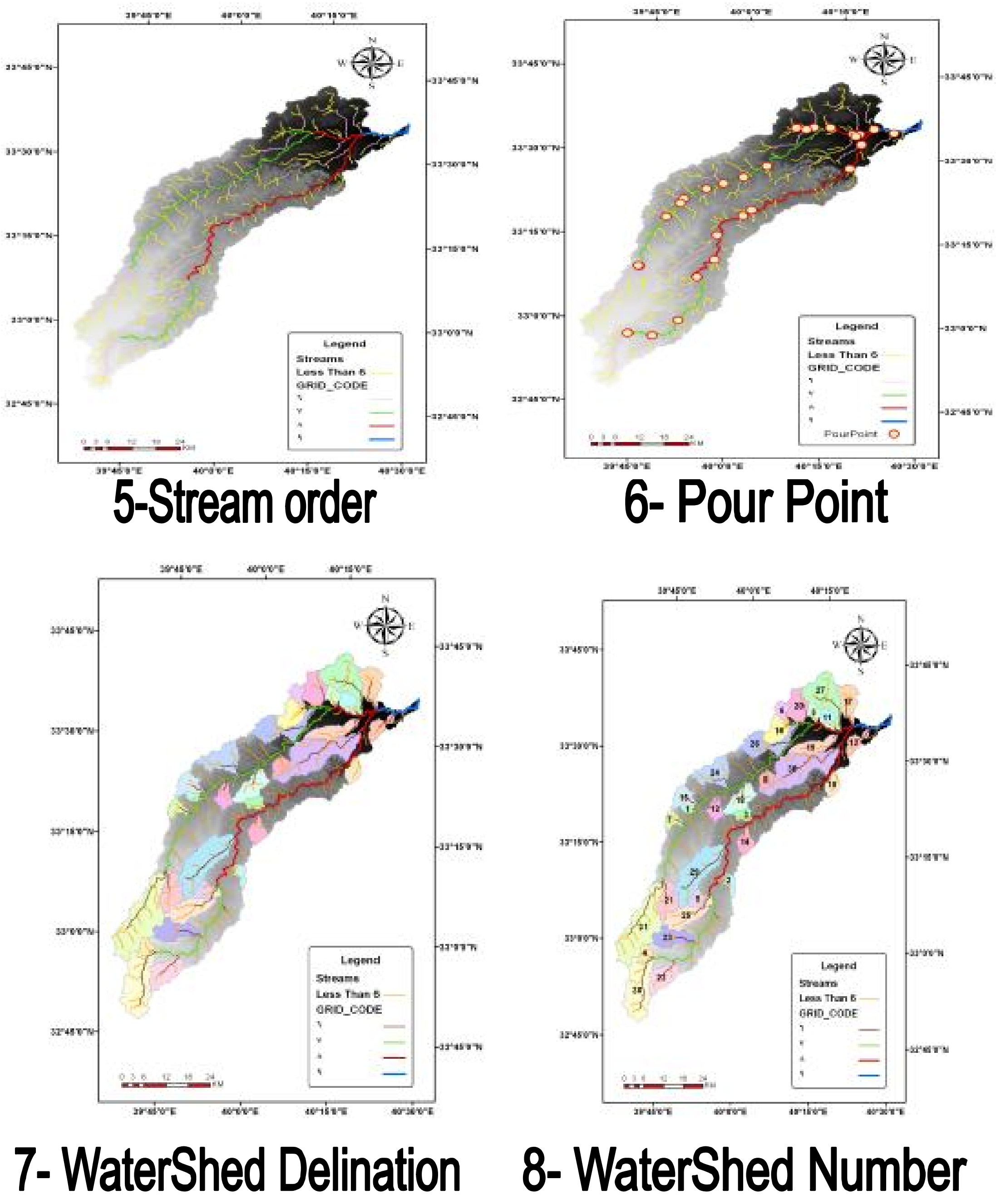


Figure (4) Stages of extracting the drainage net.

Calculations of Morphometric parameters

From Figure (4) the step no. (5) There were 10 stream orders, we took the stream order no. (6). Because this stream order is suitable between High-density streams net and Low-density streams net. There were (31) watersheds as in step no. (8). some of the parameters were calculated by using calculation geometry, Clip Raster Tool and measuring tool in Arc GIS program such as (the basin area, basin length, basin diameter, stream length, and the differences between max and min altitude).As in Table no.(1).

Table no.(1). Shows the input parameters.

Name	Basin Area (Km^2)	Basin Length (Km)	Basin Diameter (Km)	Streams Length (Km)	Differences between max and min Altitude (m)
1	9.049	5.056	13.909	77.78449686	58
2	15.774	7.656	20.460	133.1130716	61
3	15.991	6.634	20.001	140.6137187	68
4	16.482	5.844	19.020	132.4030539	42
5	16.793	6.967	18.903	154.4667656	66
6	18.742	7.536	21.701	164.5842671	111
7	18.936	7.944	24.918	13047.98104	68
8	19.294	7.793	21.146	170.5645993	105
9	21.377	7.559	22.102	183.0940028	77
10	22.100	7.989	20.964	204.2534744	157
11	23.671	7.944	22.964	205.1637208	67
12	23.690	8.722	23.982	202.132059	82
13	24.424	10.297	27.918	211.9830651	70
14	27.786	9.563	26.032	240.5406535	108
15	32.509	10.649	30.474	277.0099375	92
16	41.871	10.881	31.084	361.366734	140
17	46.710	11.965	36.212	405.854901	108
18	47.321	13.944	35.715	411.8043679	102
19	47.909	22.426	52.295	402.9823143	156
20	48.244	11.524	34.915	420.9035658	115
21	48.879	12.666	41.517	397.7557101	52
22	50.853	13.080	36.737	430.0033793	56
23	51.746	13.620	40.634	425.5989228	69
24	63.015	14.717	48.316	558.6639742	117
25	65.327	18.565	50.256	532.7484281	96
26	69.455	22.022	61.518	610.4442082	213

27	**97.495**	**19.228**	**58.968**	**849.9421323**	**117**
28	**118.658**	**19.936**	**63.063**	**958.1357757**	**62**
29	**125.423**	**23.978**	**65.538**	**1054.53426**	**121**
30	**144.949**	**30.762**	**80.383**	**1288.203955**	**198**
31	**164.406**	**27.811**	**90.955**	**1322.907235**	**74**
All	**2754.334**	**115.794**	**381.174**	**1323.907235**	**380**

Five parameters were calculated as follow:

3.3.1. The Relief

The Relief ratio (R_R) can be defined as the ratio between max and min altitude (ΔH) to length of the basin (L) [5] . as in the equation:

$$R_R = \frac{\Delta H}{L} \text{ m/Km} \qquad 1\text{-}1$$

3.3.2. The Stream Density

Stream density (SD) is defined as the combined length of all streams in a basin ($\sum$ L) divided by the area of the basin (A). [5].

$$SD = \frac{\sum L}{A} \text{ Km/Km}^2 \qquad 1\text{-}2$$

3.3.3. The Elongation

The Elongation (E) defined as the ratio of Diameter of circle that it's area equal the basin area (D) divided by length of the basin (L) [6]. as in equation:

$$E = \frac{D}{L} \text{ (no unit)} \qquad 1\text{-}3$$

3.3.4. The Circularity

The Circularity(C) may define as the ratio of Basin area (A) divided by Area of a circle that has a Diameter equal's basin Diameter (D) [6]. As in equation:

$$C = \frac{A}{D} \text{ (no unit)} \qquad 1\text{-}4$$

3.3.5. The Form

The Form (F) may define as the ratio of Basin area (A) divided by (length of the Basin)^2 [6]. As in equation:

$$F = \frac{A}{(L)^2} \text{ (no unit)} \qquad 1\text{-}5$$

As in Table no.(2).

Table no.2. Shows the calculated parameters

Name	Elongation	Circularity	Stream Density Km/Km^2	Basin Form	Relief m/Km
1	0.671545718	0.587531	8.595734667	0.354014317	11.471848
2	0.585503588	0.473292	8.438502579	0.269109344	7.967399
3	0.680380704	0.502057	8.793304144	0.363390554	10.250804
4	0.784090464	0.572241	8.033212609	0.482616316	7.1869715
5	0.663879925	0.590292	9.198119905	0.345978195	9.4732785
6	0.648413812	0.499832	8.781767399	0.33004577	14.73014
7	0.618277053	0.383043	689.0587743	0.300079214	8.5601888
8	0.636129062	0.541945	8.840429887	0.317658244	13.472916
9	0.690361977	0.549651	8.565028717	0.374130733	10.186612
10	0.664131755	0.631579	9.242320404	0.346240726	19.651446
11	0.691227368	0.563802	8.667305991	0.37506929	8.4337813
12	0.62984127	0.51734	8.532285416	0.31140952	9.4014509
13	0.541686525	0.393587	8.679359996	0.230338069	6.7978906
14	0.622152627	0.515011	8.656786611	0.303853005	11.293788
15	0.60428108	0.439682	8.521113664	0.286647165	8.6389738
16	0.67118895	0.544273	8.630543102	0.353638266	12.866269
17	0.644704241	0.447398	8.688758505	0.326280194	9.0263585
18	0.556805854	0.465945	8.702319716	0.243375716	7.3149411
19	0.348349235	0.220033	8.411330379	0.095257544	6.9560651
20	0.68027999	0.497051	8.724454686	0.363282979	9.979257
21	0.623008949	0.356177	8.13754283	0.304690018	4.1055457
22	0.615335954	0.473256	8.455797443	0.297231094	4.2813083
23	0.596099971	0.393641	8.22470149	0.278938112	5.0659725
24	0.608784749	0.339047	8.865530949	0.290935814	7.9498969
25	0.491365756	0.324862	8.155128403	0.189530641	5.1708896
26	0.427122456	0.230508	8.7890589	0.14321037	9.6719721
27	0.579586487	0.352159	8.717836849	0.26369759	6.0848326
28	0.616690512	0.374744	8.074752415	0.298541142	3.1098888
29	0.527161987	0.366761	8.407836035	0.218151312	5.0463347

30	**0.441734394**	**0.281759**	**8.887262484**	**0.153176481**	**6.4365467**
31	**0.520362889**	**0.249605**	**8.046611207**	**0.212560366**	**2.660815**
Mlusi basin	**0.511549442**	**0.238101**	**8.481289828**	**0.205421023**	**3.2816911**

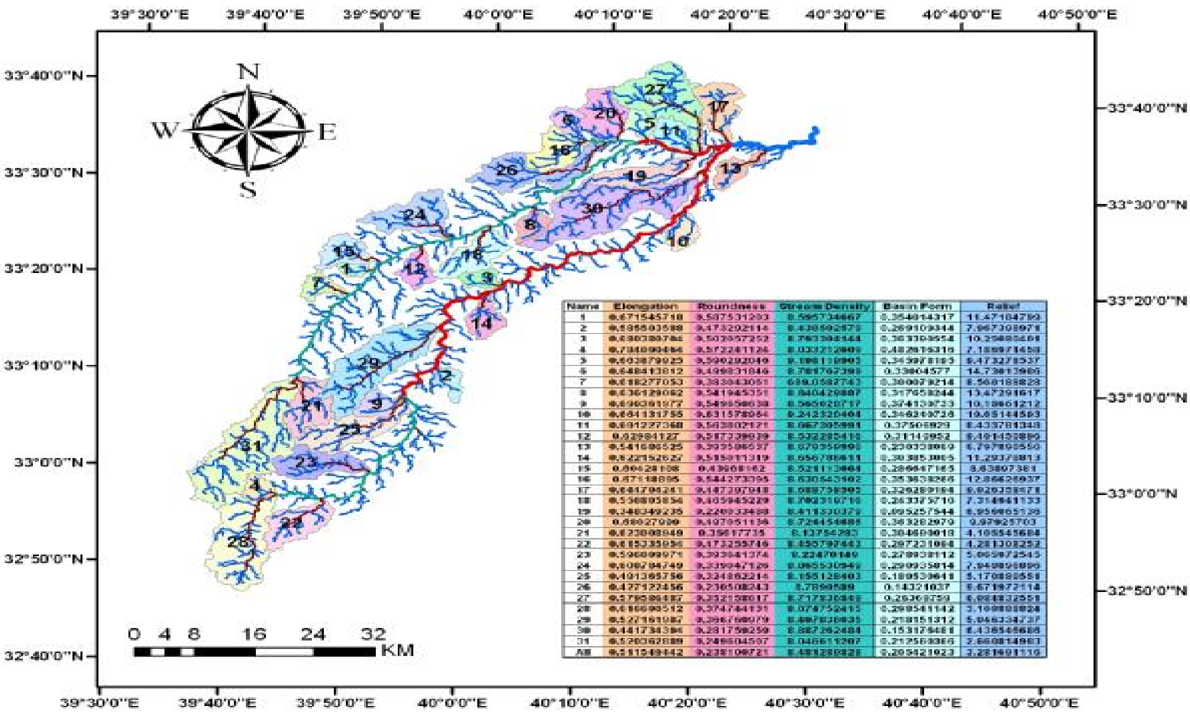


Figure (5) the estimated parameters in the study area

The Conclusion

1- The present study shows that the purposes of morphometric Characteristics is to derive information in quantitative form about the geometry of the fluvial and geomorphological system.

2- The using of DEM images with 90m resolution is very effective and accurate in the results.

3- From the Table no.(2) we conclude that the stream density in the study area is (8.481289828 Km/Km^2) which means that the study area has a good discharge for water and sediments.

4- From the Table no.(2) we conclude that the elongation in the study area is (0.511549442) and that means the study area is closer to a rectangular shape.

5- From the Table no.(2) we conclude that the relief in the study area is (3.2816911 m/Km) and it reflects that the study area had poor effects of erosion and weathering.

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