# 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/Km² 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 الدراسـة فـي غرب العـراق فـي محافظـة الأنبـار اذ تبلـغ مسـاحتها ٢٧٥٤,٣٣ كلـم²، واحـداثياتها الجغرافيـة (٤٠ °، ٢٧ `E - ٣٢ °، ٤٧` N)، (٤٤ °، ٣٤ `E -- ٣٣ °، ٣٦` N). تـم اسـتخدام بيانـات الارتفاعـات الرقميـة بدقـة وضـوح (٩٠ م) واسـتخدمت أدوات الرسـم الموجـودة ببرنامج Arc GIS لرسم الحوض الكلي في منطقة الدراسة والجابيات. استنتجنا من البحث أن هنـاك ٣١ جابية في منطقة الدراسة. اما اهم العوامل التي تم حسابها من خلال البحث هي (مساحة الحوض، طـول الحـوض، قطـر الحـوض ، طـول المجـاري المائيـة ، والاختلافـات بـين اعلـى واوطـأ ارتفـاع ، الاستطالة، الاستدارة، وكثافة التصريف، وشكل الحوض، والتضرس). أظهرت الدراسـة بـان كثافة التصريف كـان مقدارها (٨,٤٨١٢٨٩٨٢٨) كم/كم²والـذي يعني أن منطقة الدراسة تمتاز بتصريف جيد للميـاه والرواسب ، واستطالة منطقـة الدراسـة هـي (٠,٥١١٥٤٩٤٤٢) وذلك يعنـي أن منطقـة 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).
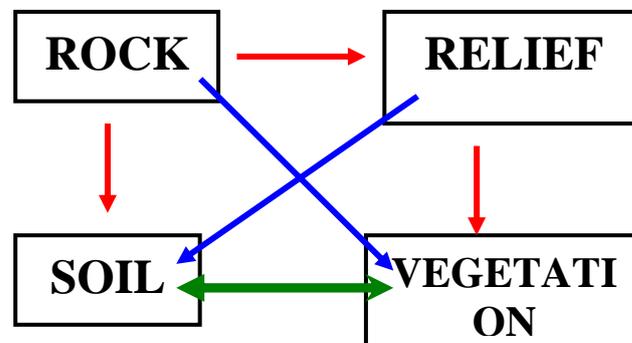
**Figure (1) Variables Defining the Characteristics
of Drainage Basin, and the Interrelations.**

**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).

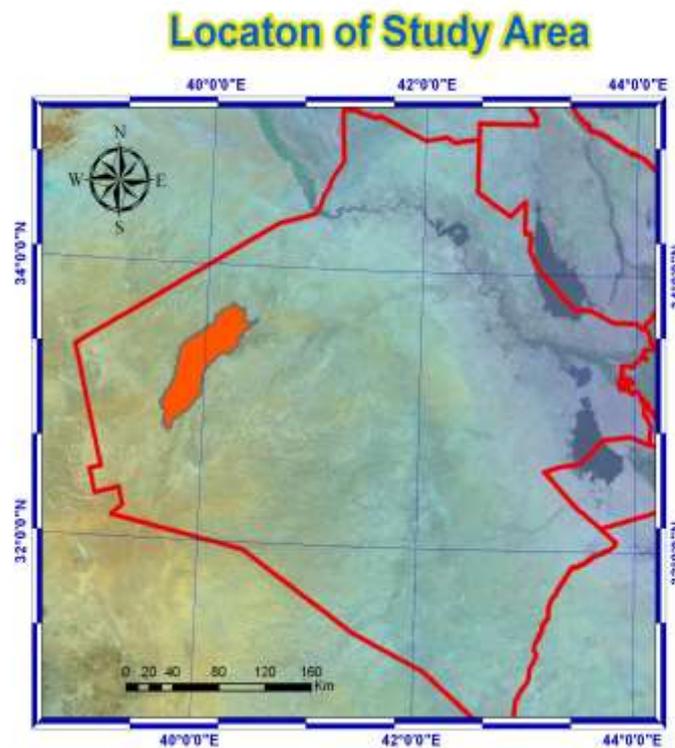With an area 2754.33 Km².

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):

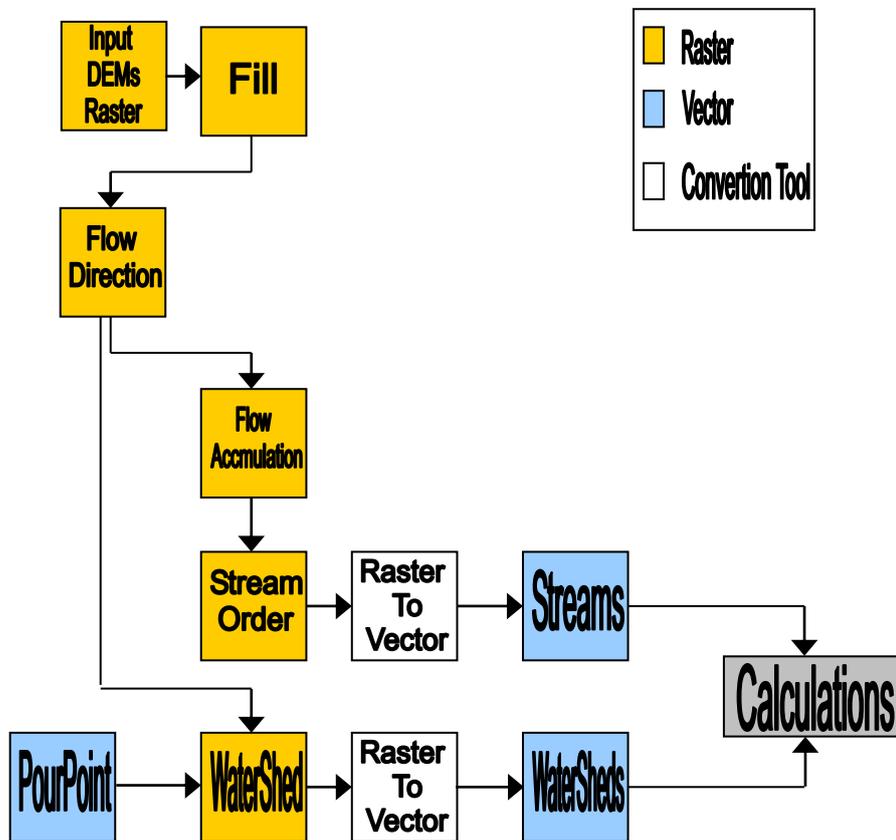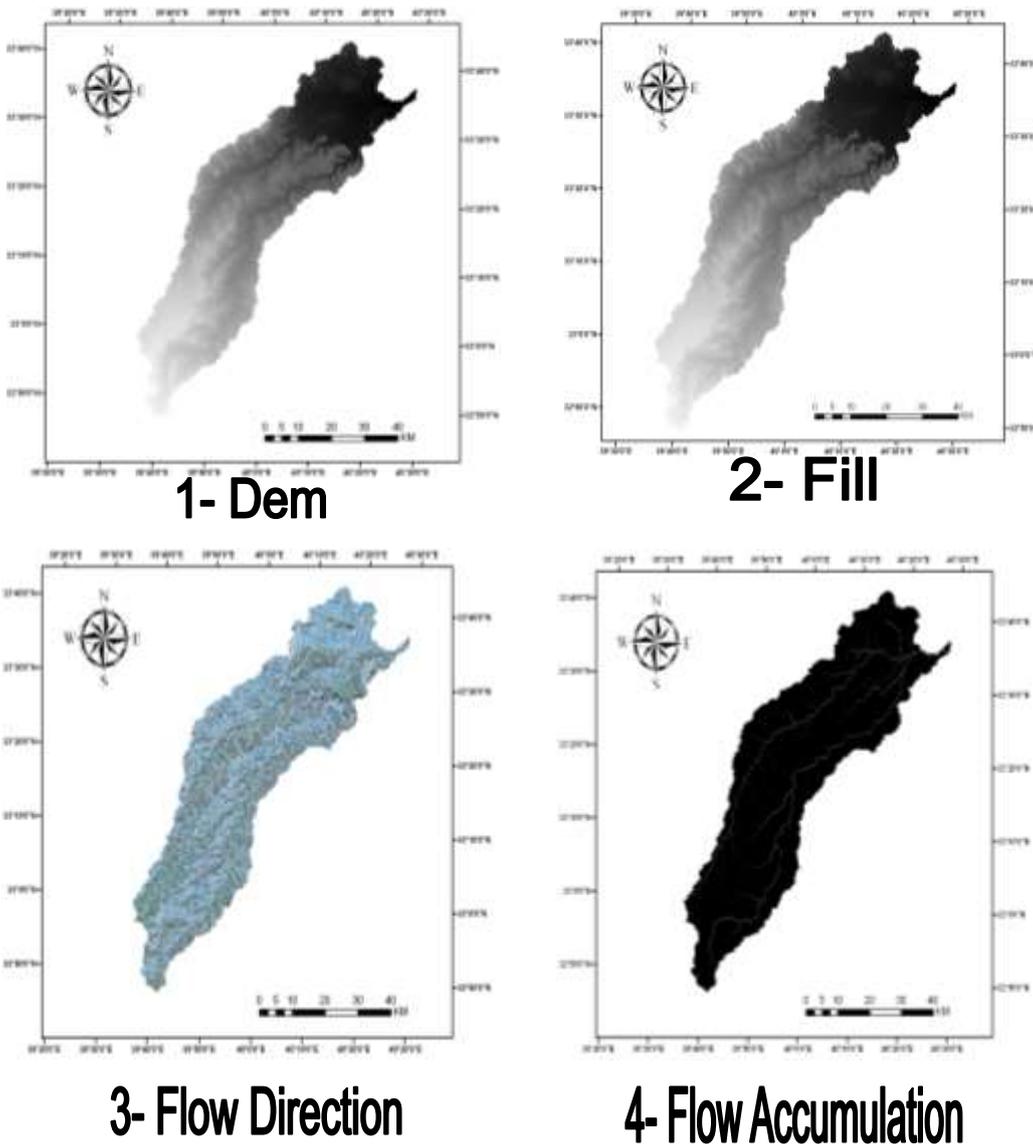**Figure (3) shows the methodology of the study.**

**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

## 5-Stream order          6- Pour Point



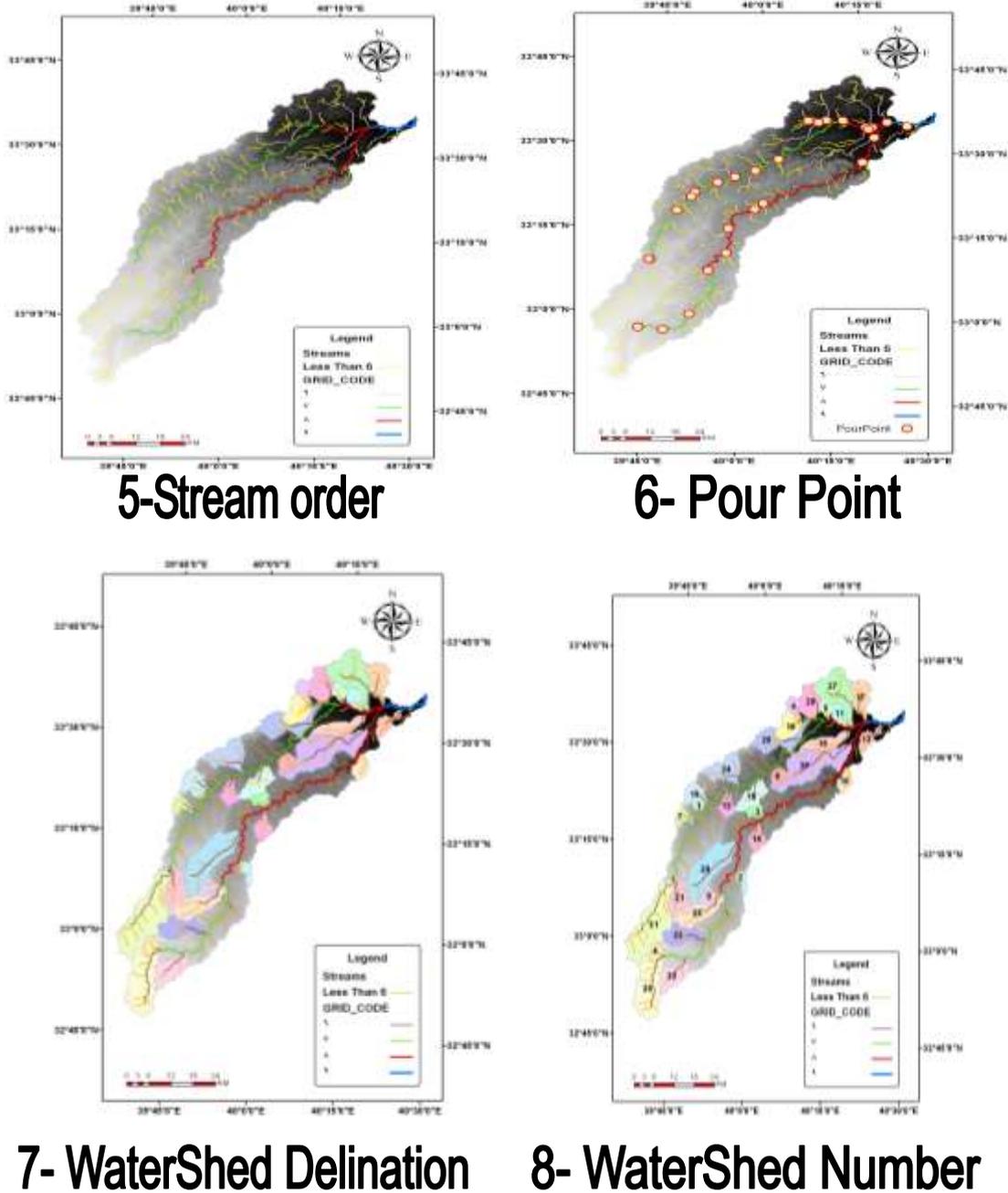## 7- WaterShed Delination     8- WaterShed Number

**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

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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 (Km²) | 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 ($\Delta H$) to length of the basin (L) [5] . as in the equation:

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

### 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].

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

### 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:

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

### 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:

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

### 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:

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

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 |

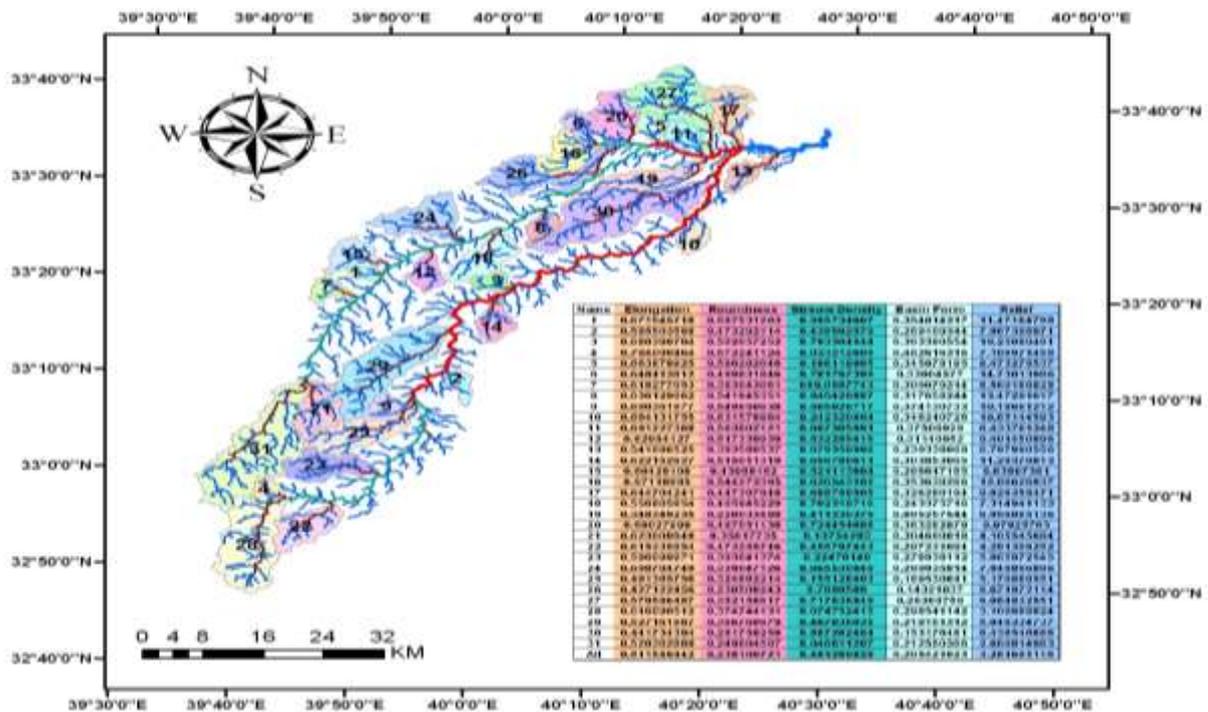| 28 | 0.616690512 | 0.374744 | 8.074752415 | 0.298541142 | 3.1098888 |
| 29 | 0.527161987 | 0.366761 | 8.407836035 | 0.218151312 | 5.0463347 |
| 30 | 0.441734394 | 0.281759 | 8.887262484 | 0.153176481 | 6.4365467 |
| 31 | 0.520362889 | 0.249605 | 8.046611207 | 0.212560366 | 2.660815 |
| Mlusi basin | 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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