Morphometric Toolbox: A New Technique in Basin Morphometric Analysis Using ArcGIS

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Abstract: Morphometric analysis of rivers basins is recognized prominently in hydrologic and geomorphic studies. Morphometric parameters give clear evidences for evolution of the basins, including the denudation, surface runoff and subsurface infiltration, as well as the impact of geological formations and structures on the basin evolution. Several causes control the accuracy of morphometric analysis, including the way of data collection, source of data, resolution of digital elevation model (DEM) and measurement technique. In spite of all the efforts in carrying out different morphometric measurement techniques, the morphometric analyses are still suffering from flaw in accuracy and time consumption to get the needed results. The main objectives of current study are the automation of morphometric analysis, increasing the space of ArcGIS in field of morphometric analysis, modifying and adopting some new morphometric parameters to improve the evaluating of basin development stage. To achieve these aims, a morphometric toolbox for ArcGIS v. 10.x has been developed using Python programming language, and it's efficiently is confirmed with many typical and field samples of basins before setting up the toolbox for end users. In current study the toolbox has evaluated by conducting morphometric analysis on several large basins including Dyala river basin; extended on area of 26627 square kilometres. The results show the importance of the new technique in calculation of morphometric parameters for large basins, as well as time saving, reducing the needed inputs and efforts, besides the flexibility of using different types of DEM data in the analysis.

Keywords: Basin, GIS, DEM, python, morphometric-toolbox.

1. INTRODUCTION

Evaluating the morphometric characteristics of any basin depends mainly on quality of the data and the performed measurement technique. Morphometric analysis is an important factor for studying and understanding the development of any river basin. Several authors like Pareta and Pareta (2011), Burrough, Thomas, Bailey and Davies [1], Ali and Khan [2], Ahmed [3] and Basavarajappa, Pushpavathi and Manjunatha [4], explained the morphometry as the measurement and mathematical analysis of configuring the earth's surface, shape, size, linear features, gradient of channel network with slope and dimensions of its landforms. The choice of basin as basic unit for morphometric analysis rests on the principle that all hydrologic and morphometric processes happen within the watershed, and morphometric characteristics measured with the watershed basin may give important indications about the formation and evolution of the basin itself [5]. Many authors like Rajpoot, Kumar, Goyal and Trivedi [6], Sindhu, Ravikumar and Shivakumar [7], Chandrashekar, Lokesh, Sameena and Ranganna [8], Ahmed [3], Khare, Mondal, Mishra, Kundu and Meena [9], Ali and Khan [2], Raj [10], Magesh, Chandrasekar and Soundranayagam [11], Krishnamurthy, Srinivas, Jayaraman and Candrasekhar [12] and Strahler [13] described the importance of morphometric analysis of river basin; through providing the valuable information for groundwater potential, runoff and geographic characteristics of the drainage basin, providing geometric and mechanical understanding of the relationship of various aspects of the river basin and give comparative evolution of basin in different geomorphological and topographic regimes.

Classification of stream order is the important step in morphometric analysis. Strahler's ordering system is widely used in the field of morphometric studies. In Strahler's classification system a stream segment with no tributaries that flows from the stream source is marked as a first order segment, a second-order segment is created by joining two first-order segments, a third order segment by joining two second-order segments, and so on [13, 14]. The accuracy of morphometric analysis depends on the measurement and calculation techniques. Recent advances in computing ability have enabled geographers to develop a powerful new tool to work with spatial data. Many new and exciting areas of geographic research are associated with geographic information systems, ranging from development of new ways to manipulate spatial data to model spatial processes using a GIS [15]. GIS techniques are used for assessing various terrain and morphometric parameters of the drainage basins, as they provide a flexible environment and a powerful tool for the manipulation and analysis of spatial information [16, 17]. Remote sensing and Geographical Information System (GIS) techniques are

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increasingly used for morphometric analysis of drainage basins throughout the world [18]. Magesh and Chandrasekar [19] referred to the possibility of delineation of drainage networks either by using traditional methods or using remote sensing and GIS techniques, but a tedious effort is needed to achieve the results by traditional approach, also for GIS analysis; manual corrections were made by merging the streams of the same order with separated nodes; otherwise, it will result in inconsistent stream order error.

In spite all the efforts carried out in performing different techniques in morphometric measurements, researchers still face many difficulties and challenges during the process of morphometric analyses represented by the flaw in accuracy and time consumption to get the expected results in large area basins. Added to that, the latest versions of ArcGIS software has only partially solved this problem, by extraction of stream orders network without giving the possibility of counting the numbers of stream orders. Therefore the users are still using the manual merging of stream order segments to calculate the number of streams at each order. To draw the longitudinal profile in ArcGIS, the user needs to trace the river or valley manually by clicking the points along profile that usually takes time and is not accurate. The main objectives of this study are; (1). Automate the morphometric analysis, (2). Simplify the calculation procedure of morphometric parameters *via* minimize the input layers and measurements, (3). Develop a new ArcGIS toolbox for morphometric measurements by write scripts using Python programming language, (4). Overcome the problem of calculation of the number of streams in each order using new GIS technique, (5). Modify some morphometric parameters by using surface area instead of map projected area, (6). Adopt new methods for evaluating the basin development based on hypsometric and volumetric measurements, (7). Write script for draw the longitudinal profile of any selected channel in the basin and (8). The accuracy and efficiency of the morphometric toolbox has proved in two steps (a). First: using typical samples during writing the scripts and (b). Second: using field samples for final evaluation.

2. STUDY AREA

Evaluation of the morphometric toolbox needs to be conducting the analysis on basin samples from the field. In current study the Dyala river basin was selected to curry out the morphometric analysis. Dyala river flowing into Tigris river south of Baghdad province in middle part of Iraq (Figure **1**). The basin is extend on sharing boundaries between Iraq and Iran countries with area of 26627 square kilometres and bounded between latitudes 33° 20' - 35° 48'N and longitudes 44° 35' - 46° 48'E.

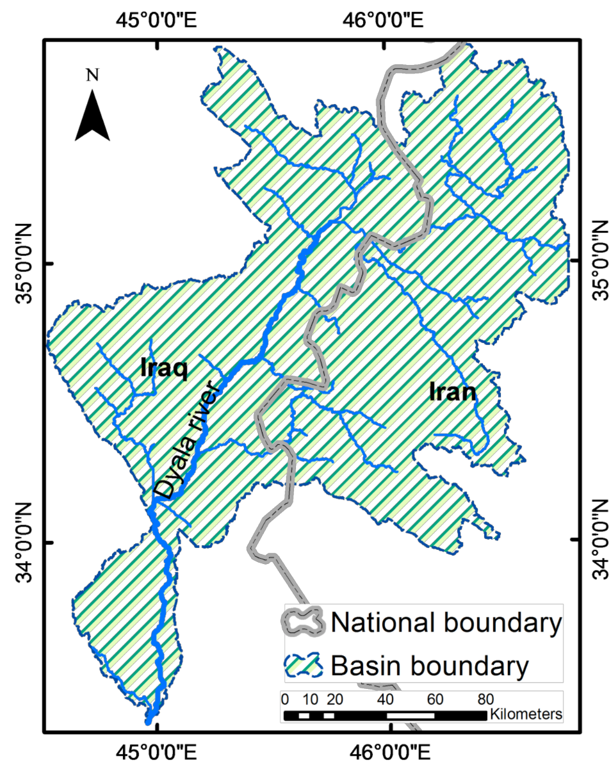

Figure 1: Location map of Dyala river basin.

3. METHODOLOGY

Developing of ArcGIS morphometric toolbox using Python language requires essentially many principles. The first one is the least input parameters and layers, processing and calculation equations and formulas used in the analysis algorithm need to be reliable and taken from their original references; the second is that the outputs of the analysis must meet needs of the most users, and finally the execution steps of the toolbox must be easy and obvious for the users. Accordingly, the algorithms of toolbox developing for morphometric analysis starts by selecting the equations and formulas for processing and calculating the morphometric parameters, is followed by defining the outputs of the analysis, then writing the scripts *via* python programming language for automation of the morphometric analysis. The toolbox includes three scripts i.e., morphometric script, hypsometric script and profile script. The scripts was proved on typical sample, followed by evaluating the toolbox with analysis of several large river basins, including Dyala river basin.

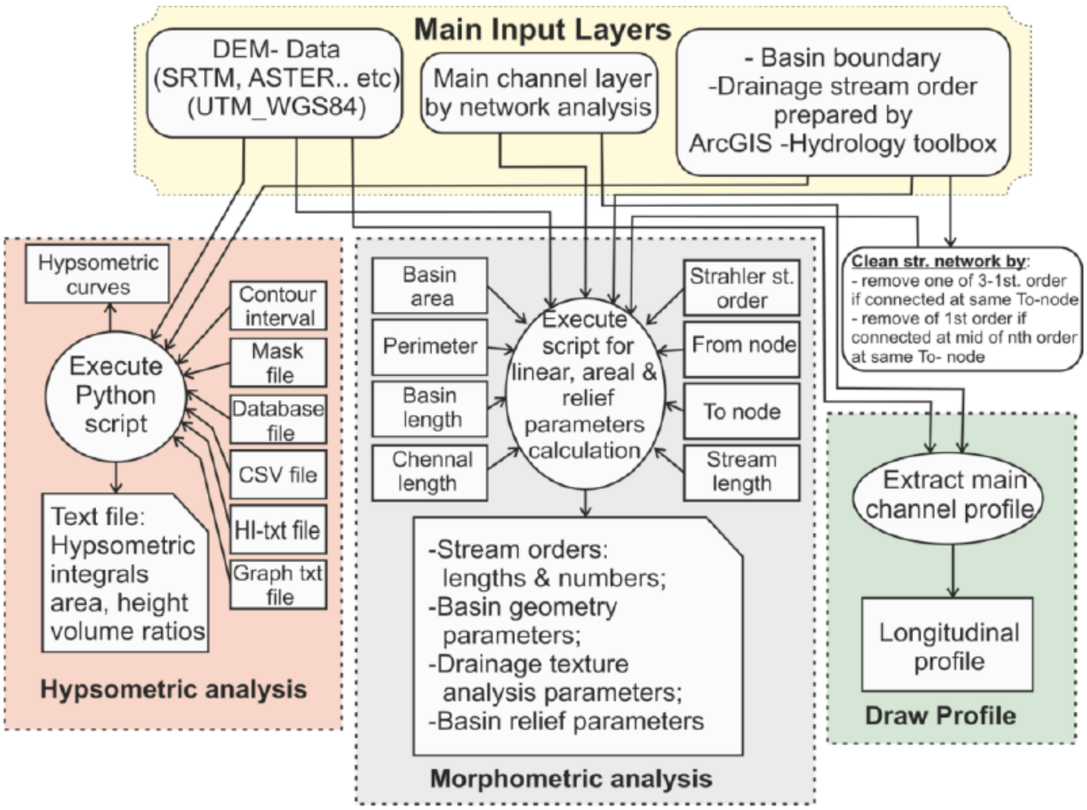

Figure 2: Flowchart of morphometric toolbox model.

3.1. Developing Morphometric Toolbox

The geographic information systems give a vital technique in the fields of spatial analysis, but still there remain some obstacles facing the researchers. Current study will explain the steps of developing ArcGIS-morphometric toolbox using python programming language; including three scripts i.e., morphometric, hypsometric analysis and profile scripts based on algorithm described in the flowchart shown in Figure **2**. The toolbox is published on ESRI website[1].

3.1.1. Script of Morphometric Analysis

The script is developed to calculate the main morphometric parameters including the drainage network, basin geometry, drainage texture, and basin relief according to the methods and formulas given by several authors as mentioned in Table **1**. In the current study, many parameters are modified i.e., drainage density, stream frequency, constant of channel maintenance, infiltration number and, average length of overland flow. A new parameter named Terrain undulation index (TUi) is the result of divide of basin surface area (As) by basin map projected area (A), the index adopted to measure the degree of terrain undulation and give an idea about the topography and structural features of the basin. Value of terrain undulation index will be near to 1.0 when the basin is flat and become more than 1.0 with increase of the undulation in basin terrain.

3.1.2. Script of Hypsometric Analysis

Hypsometric analysis is the study of development stages of the basin based on ratios of horizontal cross-sections to basin area and their relative elevations ratios. Langbein [33] introduces the hypsometric analysis to express the overall slope and the forms of drainage basin. To achieve the needed hypsometric analysis; python script is developed to carry out calculating hypsometric parameters based on three types of ratios i.e. relative height to each of relative area, relative surface area and relative volume ratios as follows:

Height ratios = h/H; where h is a relative elevation of contour with basin outlet, H is the maximum relative elevation in the basin [30].

[1] ArcGIS –Morphometric toolbox: available at: http://www.arcgis.com/home/item.html?id=1953627829a64102a7183327b4727056

Table 1: Formulas Used in Calculation of Morphometric Parameters

Morphometric Parameter	Formula	Author
Number of stream orders (Nu)	Nu=N1+N2+...+ Nn	Horton [20]
Length of stream orders (Lu)(ms)	Lu=L1+L2+…..+ Ln	Horton [20]; Strahler [13]
Bifurcation Ratio (Rb)	Rb=Nu/Nu+1	Schumm [21]; Strahler [13]
Mean bifurcation ratio (Rb_m)	$Rb_m = \frac{\frac{N1}{N2}+\frac{N1}{N2}+..+\frac{Nn-1}{Nn}}{n-1}$	Strahler [22]
Total Basin Area (A) (Kms^2)	Projected Area enclosed by basin boundary	Schumm [21]
Total Basin Surface Area (As) (kms^2)	Integrated surface area enclosed by basin boundary	
Total Basin perimeter (P) (Kms)	Length of horizontal projection of basin water divide	Schumm [21]
Basin Length (Lb) (Kms)	Distance from outlet to Farthest point on basin boundary	Schumm [21]
Main Channel Length (Lc) (Kms)	Lc= Length of longest water course from outlet to upstream	
Fitness ratio (Rf)	Rf = Lc/P	Melton [23]
Form factor (Ff)	Ff = A/Lb2	Horton [24]
Shape Factor (Sf)	Sf = Lb2/A = 1/Ff	Strahler [13]
Relative perimeter (Rp)	Rp = A/P	Schumm [21]
Length Area Relation (Lar)	$Lar = 1.4 \times A^{0.6}$	Hack [25]
Rotundity coefficient (Rc)	$Rc = L_b^2 \times \pi / 4A$	Strahler [13]; Zavoianu [26]
Mean Basin Width (Wb)	$W_b = A / L_b$	Horton [24]
Drainage Texture (Dt)	$D_t = N_u/P$	Horton [20]
Compactness Coefficient (Cc)	$Cc = 0.282 \times P / \sqrt{A}$	Horton [20]
Circularity ratio (Rc)	$Rc = 4\pi A / P^2$	Miller [27]
Elongation ratio (Re)	$\text{Re} = \frac{D_c}{L_b} = 1.129 \times \sqrt{A} / L_b$	Schumm [21]; [28]
Drainage density (Dd) (km/km2)	$Dd = \sum_{i=1}^{k}\sum_{i=0}^{N} Lu / A$	[24]; Strahler [13]
Stream frequency; (F) (number/km^2)	$F = \sum_{i=1}^{k} Nu / A$	Horton [24]
Constant of channel maintenance (Ccm) (km^2/km)	$Ccm = \frac{1}{Dd} = A / \sum_{i=1}^{k}\sum_{i=0}^{N} Lu$	Schumm [21]; Strahler [13]
Infiltration Number (Ifn)	$Ifn = F \times Dd$	Faniran [29]; Pareta and Pareta [17]
Drainage Intensity (Di)	$Di = F / Dd$	Faniran [29]; Pareta and Pareta [17]
Average Length of Overland Flow (Lg) (Kms)	$Lg = 1/2 \times Dd$	Horton [20]
Height of basin outlet (m)	Selected point elevation from DEM	
Maximum Height of basin(m)	Selected point elevation from DEM	
Total Basin Relief (H)	$H = Z - z$	Strahler [30]
Relief Ratio	Rhl=H / Lb	Schumm [21]; Melton [23]
Relative Relief Ratio	Rhp=H * 100 / P	Melton [23]
Gradient Ratio	$Rg = (Z - z) / Lb$	Sreedevi, Subrahmanyam and Ahmed [31]; Pareta and Pareta [17]
Ruggedness Number	Rn=Dd * (H /1000)	Strahler [13]
Melton Ruggedness Number	MRn=H/A 0.5	Melton [32]
Terrain Undulation Index	TUi=As/A	Adopted by Author
All modified parameters	Same original formulas with substitution of Area (A) by Surface area (As)	Modified by Author

Area ratio= *a/A*; where a= area above the contour and enclosed by basin boundary, A is the basin area [30].

Surface area ratio= *as/As*; where as= surface area above the contour and enclosed by basin boundary, A is the basin surface area (Adopted by Author).

Volume ratio= *v/V*; where v= volume above the contour and enclosed by basin boundary, V is the total volume of the basin (Adopted by author). In current study the hypsometric and volumetric integrals are calculated using trapezoidal rule (Figure **3**) as follows [34]:

$$I=[f(a)+f(b)]^{\frac{h}{2}} \text{..... trapezoidal equation ,}$$

Where $I = \text{Area}, \quad h = \Delta x = b - a$,

By substitution the $f(x)\ with\ f(h/H)\ and\ \ h\ with(a/A)_i - (a/A)_{i+1}\ or\ with(v/V)_i - (v/V)_{i+1}$,

Substitution in trapezoidal equation yields.

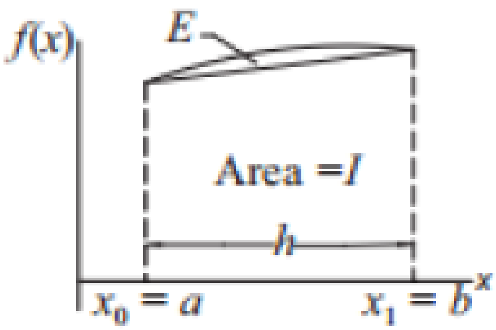

Figure 3: Trapezoidal rule.

$$\text{Hi(Area)} = \left(\sum_{i=1}^{n} \left(\left(\frac{h}{H}\right) i + \left(\frac{h}{H}\right) i+1 \right) \times \frac{\left(\frac{a}{A}\right)_i - \left(\frac{a}{A}\right)_{i+1}}{2} \times 100 \right)$$

$$\text{Hi(surface area)} = \left(\sum_{i=1}^{n} \left(\left(\frac{h}{H}\right) i + \left(\frac{h}{H}\right) i+1 \right) \times \frac{\left(\frac{as}{As}\right)_i - \left(\frac{as}{As}\right)_{i+1}}{2} \times 100 \right)$$

$$\text{Vi(Volume)} = \left(\sum_{i=1}^{n} \left(\left(\frac{h}{H}\right) i + \left(\frac{h}{H}\right) i+1 \right) \times \frac{\left(\frac{v}{V}\right)_i - \left(\frac{v}{V}\right)_{i+1}}{2} \times 100 \right)$$

where *n* = number of rows in hypsometric ratios table.

3.1.3. Script of Profile Drawing

Longitudinal profile; is the graph of distance versus elevation and its construction provides an interpretation of surface history as they are the erosional curves and the river course flows from the upstream to the outlet of the basin at any stage of evolution [6]. Longitudinal profile is one of the important sections for morphometric analysis; shows the characteristics of the river or valley along the water flow direction. Because of difficulty of getting accurate longitudinal profile using ArcGIS cross-section drawing tool, the current study has been developed a python script for drawing the longitudinal profile based on the tracing the river flow direction by route selection of network analysis method, then tracing line will be used for drawing the profile from DEM data.

3.2. Building of Geo-Database

The morphometric analyses of any basin using developed morphometric toolbox required preparing the main input layers by building geo-database projected as UTM-WGS84 or any projected coordinate system give the measurement of the area and distance in metric system. The required layers are Digital Elevation Model (DEM) data; in current study SRTM-

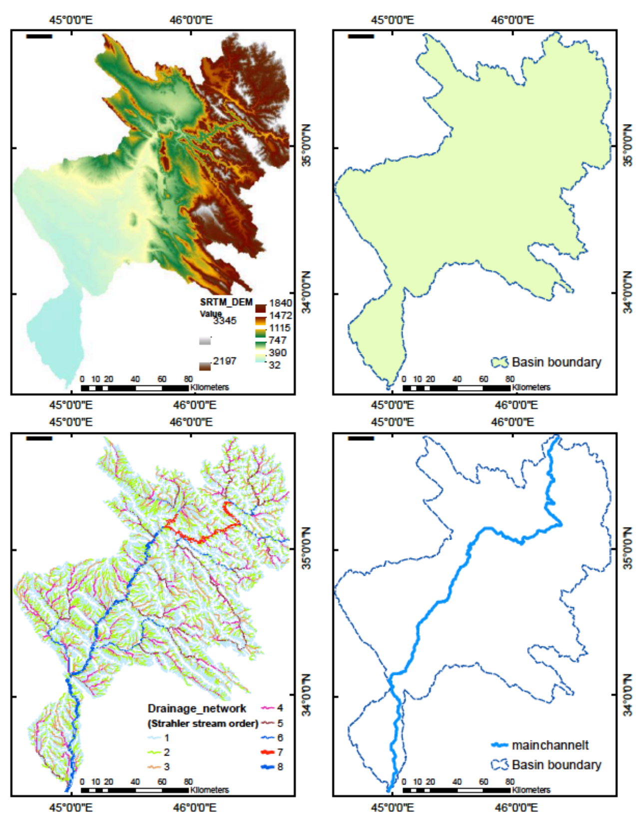

Figure 4: Input layers of Dyala river basin used for execution of morphometric toolbox.

DEM at 3-arc-seconds (about 90-meters) pixel spacing are used [35], basin boundary with defined area and perimeter; main channel profile extracted by route selection with network analysis toolbox, basin length in meters, and drainage network classified according to Strahler's stream orders using ArcGIS hydrology toolbox (Figure **4**).

3.3. Checking the Layer of Drainage Network

The dynamic of drainage tributaries development, scale and resolution of DEM data may lead to junction of more than two same order streams with the same end node. Thus, because the calculations of streams number for the second and higher orders will be calculated based on any two segments of order's-1 having the same end node (To-node), so if any more than two segments connected with the same end node will be calculated twice. Consequently, to overcome such error; the drainage network needs to be checked manually and deleted the extra drainage segment from that node before continuing to the next step of analysis as shown in Figure **5**.

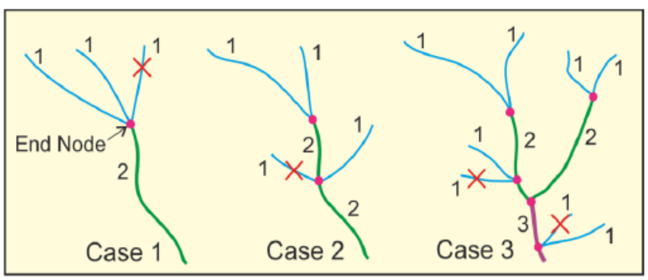

Figure 5: Cases of stream junctions lead to processing error.

3.4. Execution of Morphometric Toolbox

Execution of morphometric toolbox within ArcGIS software starts by adding the toolbox either from Arctoolbox as adding new toolbox or from catalogue by opening the folder containing the toolbox and the scripts. Execute any script of toolbox to get the required morphometric analysis (Figure **6**). The main input layers needed to execute the script of morphometric analysis are DEM-data, drainage network (classified for Strahler's stream orders), basin boundary, main channel length and basin length. While the layers of DEM-data and basin boundaries are the input layers for execution of hypsometric analysis script. For execution of profile script the layers of DEM data and profile line are needed.

4. RESULTS AND DISCUSSION

The study will not discuss the results of the measured morphometric parameters, but to cast light on evaluation of the toolbox, procedure of calculation and the outputs of a new morphometric analysis technique. The analysis of Dyala river basin as a sample from the analysed basins will be used for discussion the results of toolbox scripts execution. The results of execution of morphometric script are as given in Table **2**, including most of the wanted morphometric parameters i.e., lengths and numbers for each stream order, bifurcation ratios, geometry parameters, drainage texture parameters, and basin relief parameters. Results of calculating the number of each stream order especially for a second and higher order

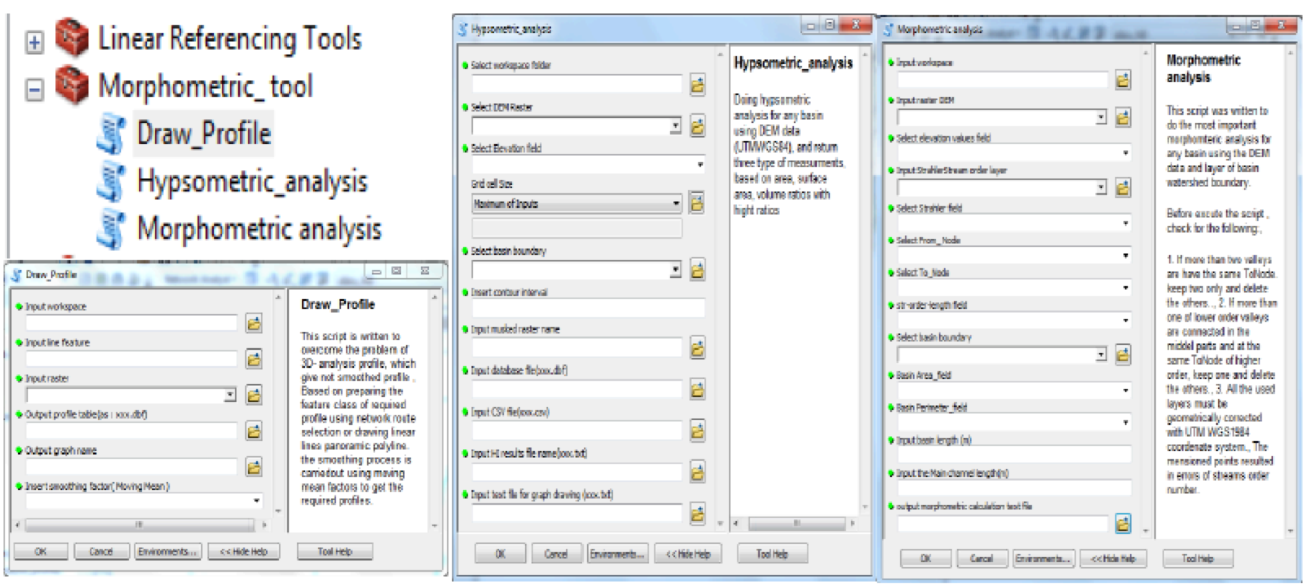

Figure 6: Execution Panels of Morphometric toolbox.

Table 2: Analysis Result of the Morphometric Parameters of Dyala River Basin

===Drainage Network Parameters=== Number of stream order 1 = 10110 Number of stream order 2 = 2344 Number of stream order 3 = 535 Number of stream order 4 = 129 Number of stream order 5 = 29 Number of stream order 6 = 8 Number of stream order 7 = 2 Number of stream order 8 = 1 Total no. of stream order = 13158 Length of stream order 1 = 13462062.3 m Length of stream order 2 = 6076328.4 m Length of stream order 3 = 2798000.8 m Length of stream order 4 = 1455923.1 m Length of stream order 5 = 786706.2 m Length of stream order 6 = 367709.9 m Length of stream order 7 = 130987.4 m Length of stream order 8 = 290147.2 m Total length of streams = 25367865.6 m Rb for 1:2 = 4.31313993174 Rb for 2:3 = 4.38130841121 Rb for 3:4 = 4.14728682171 Rb for 4:5 = 4.44827586207 Rb for 5:6 = 3.625 Rb for 6:7 = 4.0 Rb for 7:8 = 2.0 Average Bifurcation ratio = 3.845 ===== Geometry Parameters ===== Total Basin Area(Kms^2) = 26627.31 Total Basin Surface Area(Kms^2) = 27628.39 Total Basin perimeter(Kms) = 1416.04 Basin Length (Kms) = 299.478 Main Channel Length (Kms) = 475.128 Fitness Ratio = 0.33 Form factor = 0.29	Shape Factor Ratio = 3.368 Relative perimeter = 18.80 Length Area Relation = 632.88 Rotundity coefficient = 2.65 Mean Basin Width = 88.91 Drainage Texture = 9.292 Compactness Coefficient = 2.46 Circularity ratio = 0.167 Elongation ratio = 0.615 ==Drainage Texture Analysis== Drainage density = 0.95 (km/km2) Modified Drainage density = 0.92 (km/km2) Stream frequency = 0.494 (number/km2) Modified Stream frequency = 0.476249190194 (number/km2) Constant of channel maintenance = 1.052 (km2/km) Modified Constant of channel maintenance = 1.09 (km2/km) Infiltration Number = 0.470781067151 Modified Infiltration Number = 0.44 Drainage Intensity = 0.518687705184 Average Length of Overland Flow (Kms) = 0.52 Modified Average Length of Overland Flow (Kms) = 0.545 =======Basin Relief====== Height of Basin outlet (m) = 32.0 Maximum Height of basin(m) = 3345.0 Total Basin Relief (H) m = 3313.0 Relief Ratio = 0.011 Relative Relief Ratio = 0.234 Gradient Ratio = 0.011063 Ruggedness Number = 3.156 Melton Ruggedness Number = 20.30 Modified Melton Ruggedness Number = 19.93 Terrain Undulation Index = 1.03759583827

shows the importance of the toolbox scripts in solving this problem. Usually, each second and higher stream order in the drainage network layer are represented by many segments in attribute table, due to tributary junctions, consequently most of the researchers goes to manual calculation of the numbers of stream orders. Regarding, the results of modified formulas are different from original formulas, because the drainage network and overland flow are related to surface area rather than projected area used in previous studies. Moreover, high spatial resolution of DEM data will shows the superior of the modified among the original parameters. In case of hypsometric analysis, the results are given as relative height (h/H), relative area (a/A), relative surface area (as/As) and relative volume (v/V) ratios (Table **3**). The results of hypsometric integrals and curves calculated based on map projected area and surface area are approximately similar and depend on the terrain undulation and DEM resolution, but the volumetric integral value and the shape of the volumetric curve shows more accurate evidences about the amount of the remaining rock mass waiting for denudation in the basin compared to the hypsometric integral values. The difference between the three types of hypsometric measurements is clear from the shape of the curves shown in Figure **7**. The longitudinal profile of the main river in the basin is shown in Figure **8** give clear and representative profile compared to that used for interpolate line by 3D analyst toolbar of ArcGIS.

5. CONCLUSIONS

Analysis of the results shows accuracy of the new technique in calculating of morphometric parameters, as well as saving of processing time, reducing the measurements, inputs, and efforts. Moreover, modified morphometric parameters give values more reliable

Table 3: Results of hypsometric analysis of Dyala river basin

```
Minimum Height(m) =32.0
Maximum Height(m) =3345.0
Incremental Elevation Interval(m) =100
Total Basin Height(H)(m) =3313.0
Total Basin area(Km^2) =26627.3171271
1.Hypsometric Integral (Height_Area Ratios) =25.62
2.Hypsometric Integral (Height_Surface Area Ratios) =26.32
3.Hypsometric Integral (Height_Volume Ratios) =20.75
=========================================
 (h/H)ratio (a/A)ratio (as/As)ratio (vol/VOL) ratio
=========================================
0.0000000 I 1.0000000 I 1.0000000 I 1.0000000
0.0301200 I 0.8817300 I 0.8859900 I 0.8918500
0.0602500 I 0.7660700 I 0.7744500 I 0.7962900
0.0903700 I 0.7109100 I 0.7211700 I 0.7096100
0.1205000 I 0.6608400 I 0.6727500 I 0.6295000
0.1506200 I 0.6031800 I 0.6168700 I 0.5551600
0.1807400 I 0.5481200 I 0.5631500 I 0.4879000
0.2108700 I 0.4994100 I 0.5153000 I 0.4265100
0.2409900 I 0.4537000 I 0.4700200 I 0.3707600
0.2711100 I 0.4175100 I 0.4336200 I 0.3198200
0.3012400 I 0.3868400 I 0.4023600 I 0.2727200
0.3313600 I 0.3590400 I 0.3737700 I 0.2290600
0.3614900 I 0.3329300 I 0.3466100 I 0.1885200
0.3916100 I 0.2999800 I 0.3126200 I 0.1513200
0.4217300 I 0.2619400 I 0.2734800 I 0.1183500
0.4518600 I 0.2231100 I 0.2334500 I 0.0899700
0.4819800 I 0.1855000 I 0.1944700 I 0.0660400
0.5121100 I 0.1430100 I 0.1506300 I 0.0468300
0.5422300 I 0.1045700 I 0.1107700 I 0.0324100
0.5723500 I 0.0749400 I 0.0797600 I 0.0219800
0.6024800 I 0.0530400 I 0.0566500 I 0.0145500
0.6326000 I 0.0363000 I 0.0389400 I 0.0093800
0.6627200 I 0.0242100 I 0.0261000 I 0.0058800
0.6928500 I 0.0155900 I 0.0168800 I 0.0035800
0.7229700 I 0.0097400 I 0.0106100 I 0.0021200
0.7531000 I 0.0060200 I 0.0065900 I 0.0012200
0.7832200 I 0.0036100 I 0.0039700 I 0.0006600
0.8133400 I 0.0020700 I 0.0023000 I 0.0003400
0.8434700 I 0.0010500 I 0.0011800 I 0.0001600
0.8735900 I 0.0005400 I 0.0006100 I 0.0000700
0.9037200 I 0.0002700 I 0.0002900 I 0.0000300
0.9338400 I 0.0001000 I 0.0001100 I 0.0000100
0.9639600 I 0.0000200 I 0.0000200 I 0.0000000
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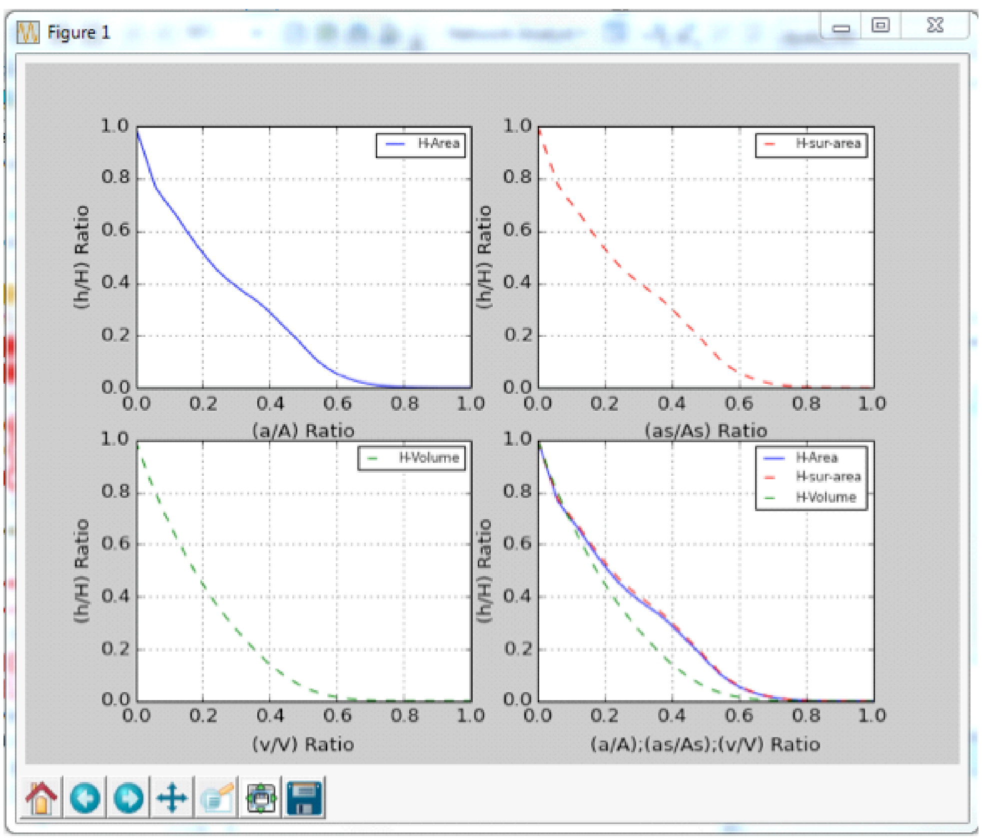

Figure 7: Graphs of hypsometric and volumetric curves of Dyala river basin.

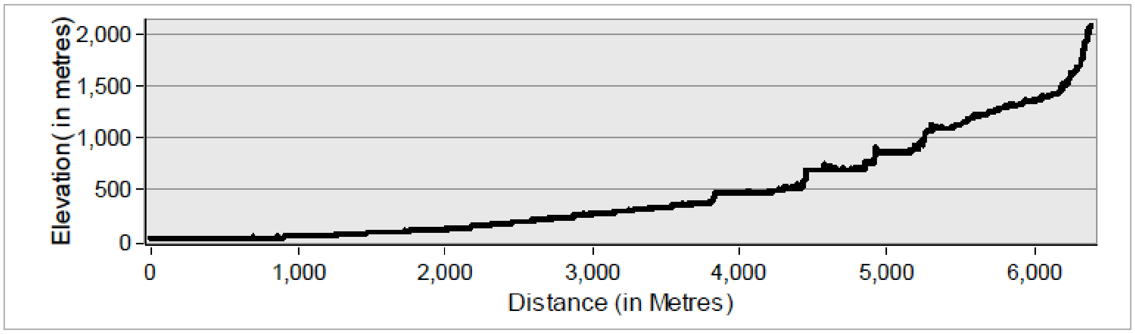

Figure 8: Longitudinal profile along the main channel of Dyala river.

than the original parameters and their accuracy depend on resolution of DEM data. Volumetric curve and volumetric integral are more suitable for evaluating the development stage of the basin, and give clear idea about the rock mass, which are waiting for denudation. The errors in morphometric calculations may happen in case of presence of more than two segments of same orders are connecting with same end-node. The toolbox gives flexibility of using different sources of DEM data projected as UTM-WGS84 or any projected coordinate system with metric measurements. Processing time depend on the basin size and density of the drainage network. Adopting of the new technique will improve and increase the accuracy of the morphometric analysis. The new technique solves the problem of calculating the numbers of the second and higher stream orders without the need for manual connecting of the stream segments or manual counting. Moreover, the toolbox will open space for mass morphometric analyses of the large river basins abroad the world.

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