UTILIZING INTEGRATION OF SOME REMOTELY SENSED MORPHOMETRIC ASPECTS AND HYPSOMETRIC ANALYSES TO DETERMINE THE GEOMORPHOLOGICAL CHARACTERSTICS OF AL-ABEADH VALLEY WATERSHED

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ABSTRACT

The precise extracting, studying, and interpretation of watershed morphometric database is the constitutional adobe for watershed accurate geomorphological comprehension building. In this work a new approach was adopted by utilizing three different schemes to extract morphometric database, in each scheme the principle of data integration used to define the optimum algorithm for database building; then after extraction; Principle of geographical information intersection applied to form factual geomorphological comprehension for the studied region. In the first scheme according to streams profile it was obvious that geomorphological age decrease with stream order increment (the period generally decrease when oncoming to the watershed sink). The second scheme shows by using some quantitative morphometric parameters that watershed's erosion power is slight and sediments are relatively remain near basin recharche zones (i.e. The basin is generally in youth period of geomorphological spectrum).in third scheme hypsometric analyses (factor and curve) utilized to determine basin geomorphological characteristics. each sub-zone area and age was stated according to hypsometric factor equation. The hypsometric curve clarify that diffusive erosion processes are dominated and less than basin half area was erosion yielding tons of deposit in lower parts of the valley.

Keywords: shuttle radar topographic mission, morphometry analysis, digital elevation model, erosion processes

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تكامل استعمال بعض السمات المورفومترية المستشعرة عن بعد والتحليلات الهبسومترية لتحديد الخصائص الجيومورفولجية لحوض وادي الابيض

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المستخلص

ان الاستخلاص، الدراسة،والتفسير الدقيق لقاعدة البيانات المورفومترية للحوض هو اللبنة الاساسية لبناء الفهم الجيومورفولوجي الصحيح حول ذلك الحوض. في هذا العمل تم طرح مقاربة جديدة تمثلت باستخدام ثلاث طرق مختلفة لاستخلاص قاعدة البيانات المورفومترية، في كل طريقة استعمل مبدا مكاملة البيانات لتحديد الخوارزمية الامثل لبناء قاعدة البيانات. ومن ثم بعد الاستخلاص تم تطبيق مبدا تقاطع المعلومات الجغرافية لتكوين فهم جيومورفولوجي واقعي لمنطقة الدراسة. في الطريقة الاولى وطبقا لمقطع الجداول كان من الجلي معرفة صغر العمر للجداول مع تقدم مرتبتها (الفترة التحاتية تقل عموما كلما تم الاقتراب من منخفض الحوض الرئيسي). الطريقة الثانية بينت وباستعمال بعض المعاملات المورفومترية المكممة بان قوة التعرية الحوضية قليلة والرواسب نسبيا تتواجد في مناطق التغذية (الحوض عموما في فترة الشباب من الطيف الجيومورفولوجي). في الطريقة الثالثة التحليلات الهبسومترية (المعامل والمنحني الهبسومتري) استخدمت لتحديد الخصائص الجيومورفولوجية للحوض.مساحة وعمر كل منطقة جزئية تم تحديدهما من خلال معادلة المعامل الهبسومتري. المنحني الهبسومتري اوضح بان عمليات التعرية العشوائية هي السائدة وان اقل من نصف مساحة الحوض قد تعرضت للتعرية مما يسبب ترسيب اطنان من الرواسب في الاجزاء السفلية من الوادي

الكلمات المفتاحية: المهمة الطوبوغرافية للمكوك الراداري، التحليل المورفومتري، انموذج الارتفاعات الرقمي، عمليات التعرية

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INTRODUCTION

The studies of basin's geomorphological characteristics (the geomorphological dominate processes and period) are considered as vital ones in the geological field because of their direct influence on the investment opportunities and hazard assessment of the basin (4,13). The main problem was the uncertainty of the deduced characteristics since the accuracy missing of basin principal acquired data such as elevation, area, borders, and stream longitudinal profile data (7). Nowadays remote sensing utilization overcome data accuracy problems, any basin aspect could be acquired either directly from remote sensed imageries or non-directly by using morphometric analyses on the extracted topographical data from these images (14,16). The optimum scheme to delineate a basin geomorphological characteristics is the utilization of hypsometric analyses, since it reveal quantitatively the dominant geomorphic activities that control basin morphometry (diffusive activity or fluvial one) and the geomorphic period for each basin zone (15). The hypsometric curve shape indicate to the dominant geologic process. Landslide, soil creeping, interrill erosion, or rainsplash are governing when curve shape is convex, while linear fluvial or alluvial processes are the governing ones if curve shape is concave.(1,8). Iraq western plateau regions' geologicy and morphology had been studied deeply because of their geographic and economic important role, AL-Abeadh, Qurrain AL-Themad, and AL-Hirbus were essential valleys of this plateau, Qurrain AL-Thimad valley hydrological aspects were stated in (2), while AL-Hirbus valley geomorphological features were studied in (3). This work aims to utilize three various spatial analysis schemes to delineate Abeadh valley drainage watershade geomorphological characteristics, then after delineation process the principle of geographical information intersection applied to build authentic geomorphological comprehension for this valley.

MATERIALS AND METHODS

AL-Abeadh watershade is an alluvial fan watershade that falls in Iraq's western plateau and considered as an endroheic watershade since it discharge in Abu Dibis depression (AL-Razaza depression). When the decimal degree scaling is used this watershade extends from 40.53 Longitude in the east to 43.76 Longitude in the west and from 31.45 Latitude In the south to 32.65 Latitude in the north. AL-Abeadh valley drainage watershade area is 18608.9 km^2; more than 90% of this area located in AL-Anbar district and about 5% located in Karbala district. 1% located in AL-Najaf district. The rest area located in Saudi Arabia (i.e. this is a cross borderline watershade). The rare annual precipitation value which less than 120 $mm.year^{-1}$ and high minimum and maximum mean annual temperature values (24c^o) and (36c^o) respectively refers that region climate is considered as arid to semi-arid one (10). The native people of this desert are the nomads who continuously wanders among AL-Abeadh valley's oasis seeking water for their livestock and themselves. As can be seen in (Fig.1)

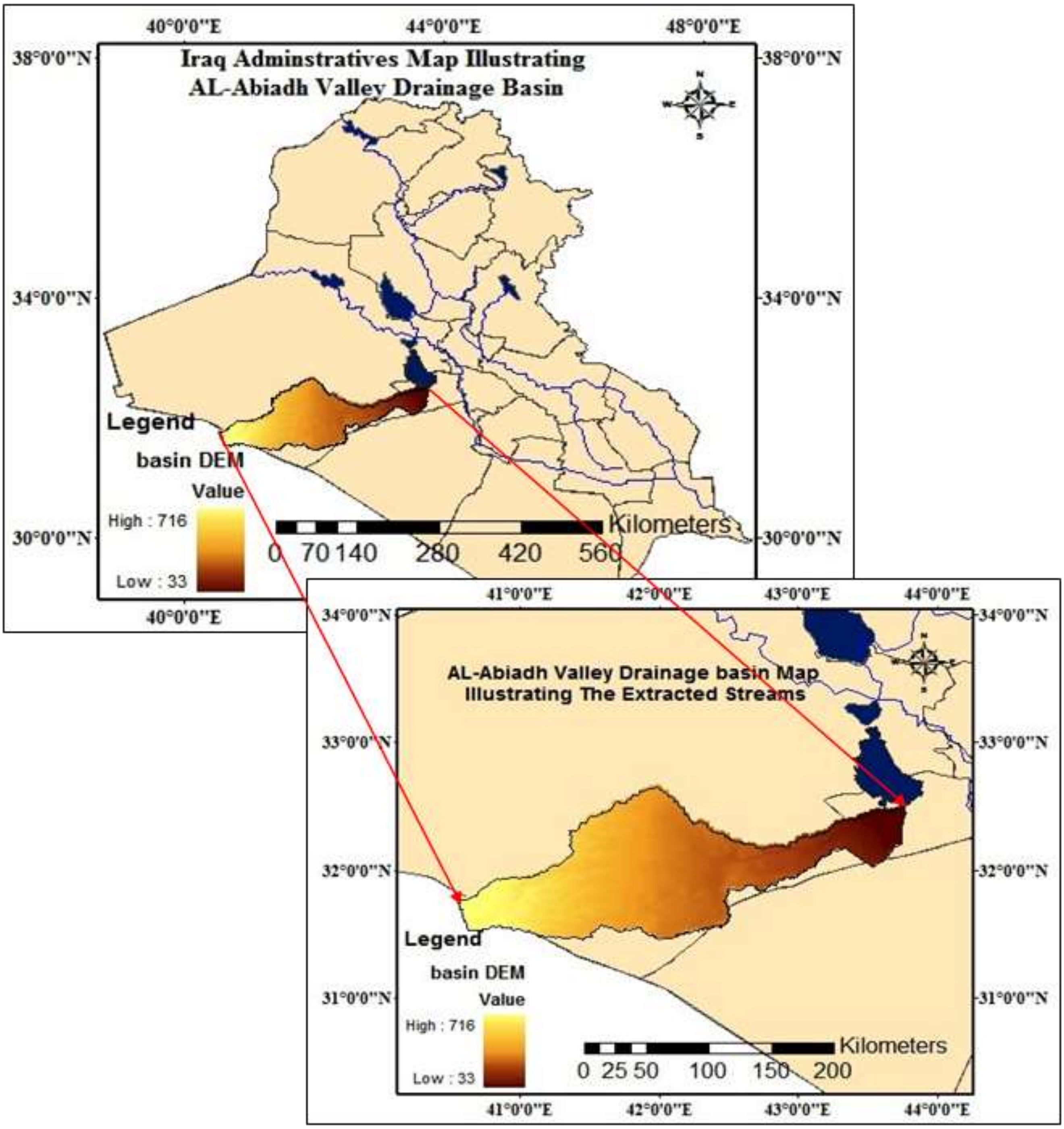

Figure 1. Iraq Administratives with AL- Abeadh valley drainage watershade maps

In this article Shuttle Radar Topographic Mission imageries were adopted as raw data and Arc GIS was used as measurements and analyses environment; article work was partitioned into four phases:

A- The basin borders delineation using corrected SRTM_ DEM imageries with spatial resolution of (90 m), then after the studied region each zone (sub-area) would be determined by utilizing the isopleth contour lines of the same DEM.

B- The subjective classification of basin streams according to their channels wideness and gradient.

C- The determination of basin morphometric aspects that are used in geomorphological interpretation utilizing empirical mathematics equations and/ or Arc GIS facilities.

D- The state of each basin's sub-zone geomorphology period and determination of dominate geology process using hypsometric analysis.

The first phase was achieved by following the steps illustrated in (Fig.2).

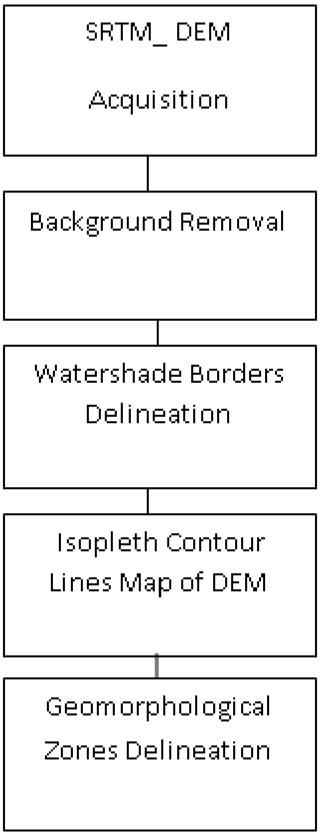

Figure 2. The block diagram of the steps needed for watershade borders and sub-zones delineations

Basin corrected DEM and each zone (sub-area) was determined by using the isopleth contour lines map of the 90 m SRTM DEM, this can be seen in (Fig.3).

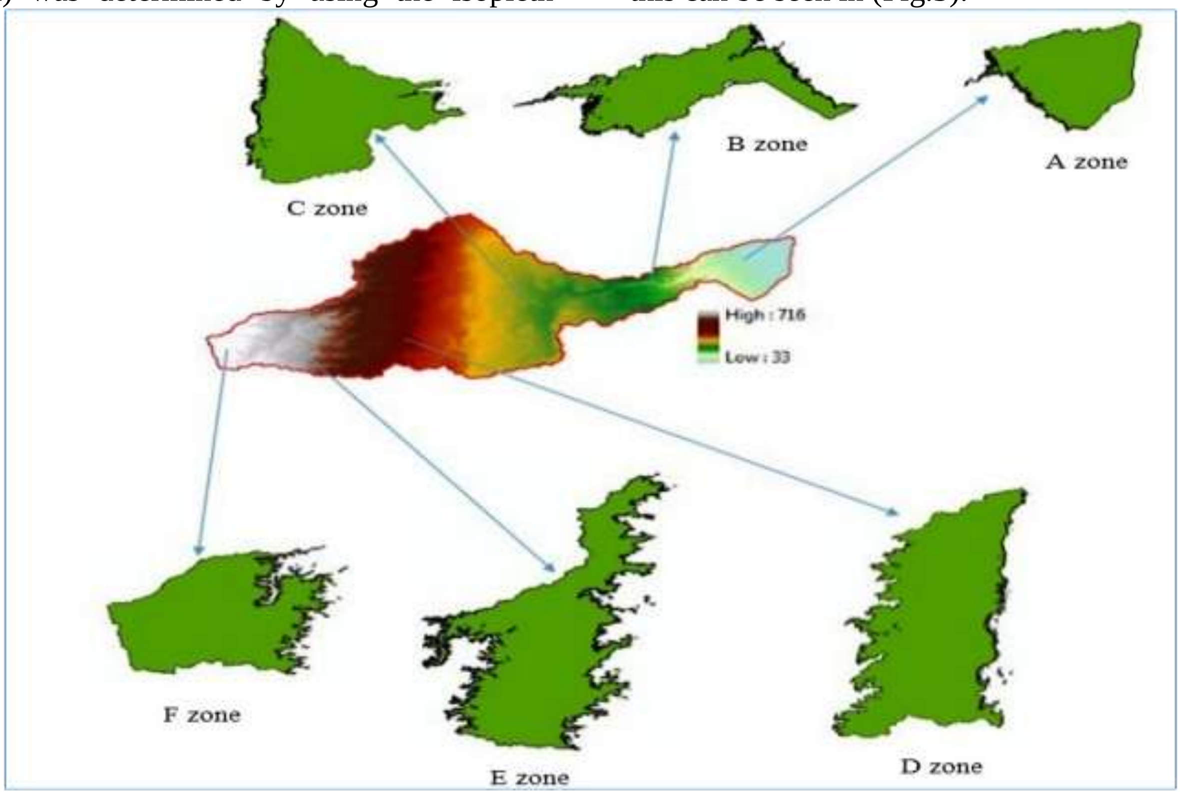

Figure 3. AL-Abeadh basin digital elevation model raster with each distinctive geomorphological zone polygon of it

RESULTS AND DISCUSSION

To implement the rest phases of this article basin's drainage network must be defined, this was done using following classical steps illustrated in (Fig.4).

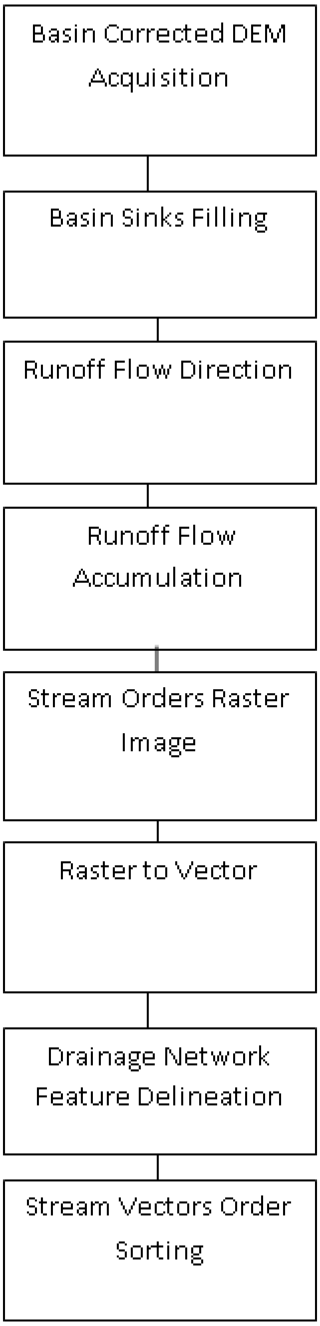

Figure 4. The block diagram that demanded traditional steps to define watershed drainage network

For AL-Abeadh basin case, it is found to be a six order basin with (672 streams for the first order, 321 streams for the second order, 213 streams for the third order, 59 streams for the fourth order, 28 streams for the fifth order, and 44 streams for the sixth order). Its drainage network classified into three categories (dendritic, parallel, and deranged). (Fig.5) explains the main implemented steps to extract basin's feature drainage network and orders.

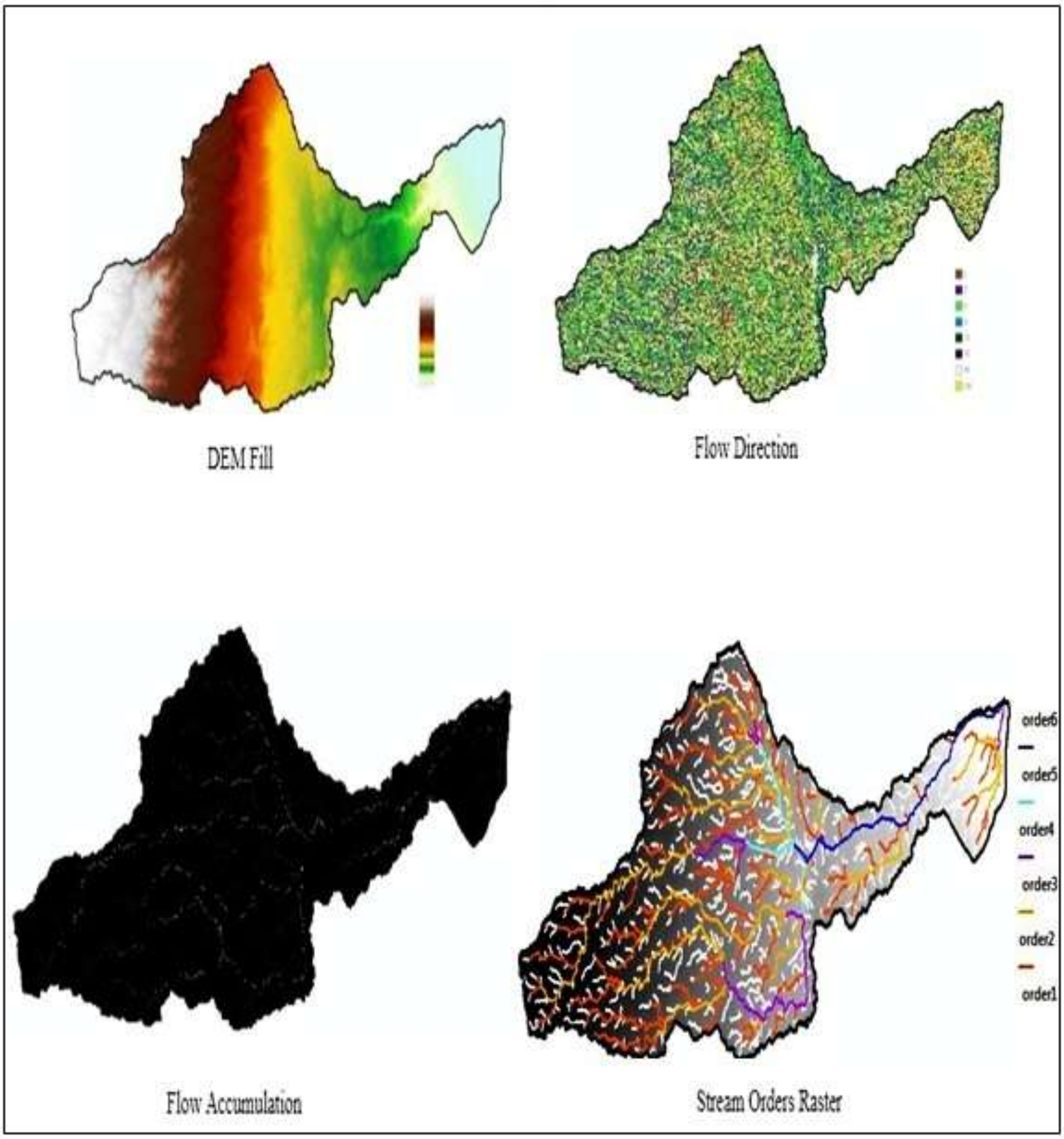

Figure 5. The main executed stages to extract AL-Abeadh basin drainage network stream features

The second phase involves the approach of basin streams classification, as follow:

Visual classifying of the streams according to their channels widens and gradient. To achieve this task (the interpolate line tool and the create profile graph tool) which are 3D analyst tools of Arc GIS program were utilized. For AL-Abeadh valley drainage basin the stream wideness increases as the order increases too, also the stream channel gradient increases with the increment of stream order, There is one exception only for the 6^{th} order stream which represent the basin valley stream (without affecting the maturity period of the district), the wideness of this valley is very low because of the high runoff water accumulation during rain seasons in it. Those situations could be shown in (Fig.6)

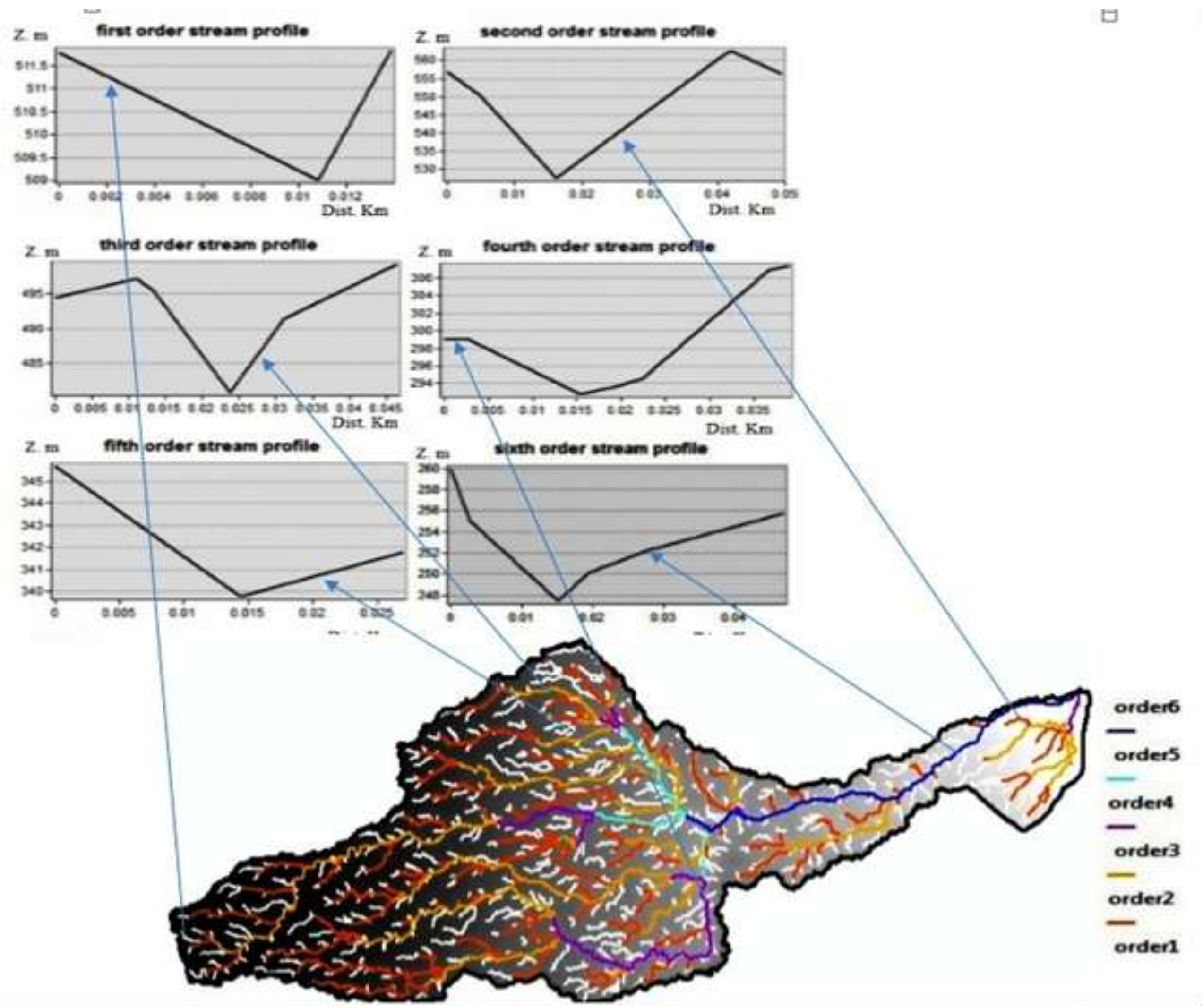

Figure 6. The cross profile for each stream order in AL-Abeadh drainage basin
a) 1st order stream cross profile, b) 2nd order stream cross profile,
c) 3rd order stream cross profile, d) 4th order stream cross profile,
e) 5th order stream cross profile, f) 6th order stream cross profile

According to subjective classification of basin streams in phase (2), streams maturity age decrease as moving from inlet to outlet of AL-Abeadh valley basin. In the third phase of this work AL-Abeadh basin morphometric aspects that are used in geomorphological interpretation were defined using mathematical equations and/ or Arc GIS techniques, as follow:

Form factor (R_f)

It is the prevalent index to present the shape of catchment area. The range of R_f extend between 0.1 to 0.8, when R_f converge from 0.8, the flow peak is high and the discharge duration is short and vice versa (5). R_f formula can be illustrated using the following equation:

$$R_f = {}^{A}/_{L_{b^2}} \quad \text{......(1)}$$

Where (A) is the basin area in (km^2) and (L_b^2) is the maximum basin length in (km). AL-Abeadh valley's basin form factor is 0.193 referring to basin elongated shape with low peak flow, long duration, and flood risk absent.

Relief ratio (R_e)

R_e is the ratio between the longest distance parallel to the main drainage river to the basin relief, also known as (Relative Relief). R_e states the potential energy transformation into kinetic one for water draining along the valley, so that it controls erosion activity working on the valley declination (6). R_e formula can be illustrated using the following equation:

$$R_e = {}^{(P_1 - P_2)}/_{L_B} \quad \text{.....(2)}$$

Where $P_1$is the basin highest altitude, P_2 is the basin lowest altitude, and L_B is the basin maximum length. Abeadh valley R_e is 0.458. This value means lower erosion power and sediment yield towards basin's mouth.

Circularity ratio Rc:

This ratio is important due its role in reveling basin average geomorphic period and lineaments control of drainage pattern , it is calculated using ratio between basin area to the circle area with similar circumference as basin one, It normally extends in (0-1) range (2). R_c formula can be illustrated using the following equation:

$$R_c = {4\pi A}/{P^2} \quad .....(3)$$

Where (A) is the basin area in (km^2) and (P) is the basin perimeter. Al-Abeadh valley's basin Rc is 0.258, this means that Al-Abiadh valley's basin is far away from the circular shape and its drainage pattern is controlled by the lineaments and the fracture traces, in addition to that watersheds partitioning lines are irregular and the basin is generally in youth stage of geomorphic period. These morphometric aspects prove the fact of Al-Abiadh valley watershade primary stage of maturity evolution. In the fourth stage the hypsometric analysis is used to estimate the maturity stage of each sub-area in AL-Abeadh basin, as follow: Hypsometric Analysis can be defined as the interpretation of the undulated land area according to the altitude. Surface topography mainly affected by two opposite factors that determine the evaluation and morphology of landscape; the down wasting due to erosion and the uplifting due to tectonic activity (12). The knowledge acquiring about basin morphology evaluation is obtained using hypsometric factor which considered as time scale one, this factor equation is:

Factor = (h/H)/ (a/A)..(4), (11)

Where (h) is each zone altitude difference m, (H) is each zone maximum altitude m, (a) is each zone area km^2, and (A) is the accumulated area of each zone and lower zones km^2. The zone Hypsometric Factor value illustrate quantitatively its position in geomorphic cycle spectrum, so that for AL-Abeadh basin the required calculations and the Hypsometric Factor for each basin sub-area are explained in table (1), as follow:

Table 1. The Hypsometric Factor of AL-Abeadh basin's zones

zone	height interval (m)	height average (m)	area (km^2)	norm. acc. area	norm. height	relative height	relative area	hypsometric factor
A	33 -146.84	89.92	1237.072	0	0	0.953	1	0.953
B	146.84 - 260.68	203.76	1398.667	0.080	0.2	0.794	0.933	0.85
C	260.68 - 374.52	317.6	7073.258	0.486	0.4	0.635	0.858	0.74
D	374.52 - 488.36	431.44	4767.684	0.760	0.6	0.476	0.478	0.995
E	488.36 - 602.2	545.28	2456.048	0.90	0.8	0.317	0.222	1.427
F	602.2 - 716.04	659.12	1715.465	1	1	0.158	0.0907	1.742

and finally the hypsometric curve was utilized to calculate the erosional area of the region and determine the governing geomorphic process in the basin. It is plotted using normalized accumulative height as y-axis and normalized accumulative area as x-axis. As can be seen in (Fig.7), the area under curve was calculated to be 0.45424 (i.e. **non-erosional basin's area was 45.424%**)

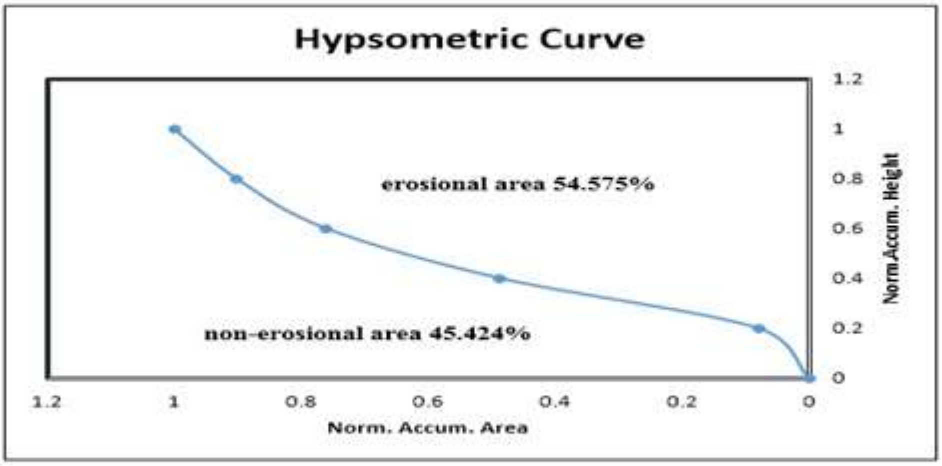

Figure 7. AL-Abeadh watershed hypsometric curve

The value of the Hypsometric Factor state that zone(A and D) is in mature interval of geomorphological period, while zone(B and C) are in youth interval of it, finally zone(E and F) are in monadnock interval of this period. The hypsometric curve shows that Al-Abeadh valley's basin erosional rate was **54.575 %** from total basin area. Also it clarify that the diffusive processes are the ruling ones in the region. The spatial analysis technique integrates and / or intersects geographical information to support decision making or data management. In this work three different spatial analysis approaches were implemented to extract Abeadh valley drainage basin geomorphological characteristics, in the first approach streams maturity age were proved to be increasing as getting close to basin recharge zones. In the second approach the water erosion was proved to be the dominating one with few kinetic energy to move sediments towards the outlet (AL-Razaza depression), this means the primer stage of basin evaluation generally, in the third approach the specific geomorphological interval for each zone was determined using hypsometric factor; E and F zones are in monadnock (old) period, A and D zones are in mature period, and B and C zone is in youth period. The convex curve indicate to the domination of diffusive activities along basin area.

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