DETERMINATION OF OPTIMUM DAM LOCATION IN AL-ABEDH BASIN UTILIZING REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM TECHNIQUES

L. A. Jawad **F.H. Mahmood** **Alaa H. Harif**
Lecturer **Assis.Prof** **Lecturer**
Unit of Remote Sensing, College of Sciences, University of Baghdad, Iraq.
laithazeez@scbaghdad.edu.iq faleh-sine@yahoo.com alaaharif@scbaghdad.edu.iq

ABSTRACT

The hard environmental factors of AL-Abedh basin region forced the native tribes to make multitude migrations in it around the year seeking for water and pasture lands . Existence of sufficient water supplement will settle these tribes down and enhancing their eco system. The real capability of GIS software to be a decisions making support tool or operations management assistant mean came from its ability of data integration and information analysis. This capability was invested in this research to determine the optimum location of a dam that confine huge amount of water in its lake which can be used to provide water for drinking, pasture irrigation and land reclamation along the valley banks, and hydroelectricity power generation. In this location one dam with two possible heights could be constructed with a medium to few permeability reservoir soil behind it having 77.781 km^2 and 1039.306 km^2 areas respectively.

Keywords: Data Integration, Digital Elevation Model, Drainage Density and soil Permeability

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تحديد موقع السد الامثل في حوض الأبيض باستخدام تقنيات التحسس النائي ونظم المعلومات الجغرافية

ليث عزيز جواد فالح حسن محمود علاء حسن هارف
مدرس استاذ مساعد مدرس
وحدة الاستشعار عن بعد، كلية العلوم، جامعة بغداد، بغداد، العراق
alaaharif@scbaghdad.edu.iq faleh-sine@yahoo.com laithazeez@scbaghdad.edu.iq

المستخلص

الظروف البيئية الصعبة لمنطقة حوض وادي الابيض اضطرت قبائل المنطقة الاصلية للقيام بالترحال المتكرر في هذه المنطقة على طول السنة طلبا للماء والمراعي. ان وجود كميات كافية من الماء سوف يسهم في توطين هذه القبائل وتحسين منظومتهم البيئية.القدرة الحقيقية لبرنامج GIS كأداة داعمة في صناعة للقرار او كوسيلة مساعدة في ادارة العمليات تتاتى من قابليته على تكامل البيانات وتحليل المعلومات، هذه القابلية استثمرت في هذا البحث لتحديد موقع السد الامثل والذي يخزن كمية هائلة من الماء في بحيرته من الممكن استعمالها للشرب، ري المراعي واستصلاح الاراضي على امتداد ضفاف الوادي، وتوليد الطاقة الكهرومائية. يمكن تشييد سد بارتفاعين محتملين في هذا الموقع بحيث يكون الخزان ذو تربة متوسطة الى قليلة النفاذية تقع خلفه وبمساحات هي 77.78 كم^{2}و1039.306 كم^2 بالترتيب

الكلمات المفتاحية: تكامل البيانات، انموذج الارتفاعات الرقمي، كثافة التصريف، ونفاذية التربة

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INTRODUCTION

The ends of the twentieth century witnessed the era of "the global warming phenomenon", this was indisputable result for warming gases rates increment. These gases (with CO_2 as the primer one) had three major origins; first of all the industrial revolution which begun in London at 1895 (10,16), second was urban island evaluation (14), and third the carbon gases extinctive elimination (i.e. The rainy forest elimination) (15). This phenomenon yields planet temperature rates increasing specially in the MENA region (i.e. Middle East and North Africa) (10). In Iraq the annual average of the maximum temperature upraised by 4.9% within thirty three years from 31.75 Cº in 1980 (7). In the same period (1980-2012) Iraq meteorologically arid area was upraised by 15 % from 73 % to be 88% of Iraq's totally area (8). According to these information water management projects are significantly important in the arid to semi-arid lands (6). The arid desert western of Al-Razazza Lake inhabited by nomads. Lately they suffered multitude migration in this region around the year because of water scarcity and pastures decrement. Confirmation of sufficient water supplement will settle these nomads down and enhancing their agro-eco system (11). Two schemes could be implement; 1st the wells drilling which coast time and money. 2nd dam building in optimum location to create suitable reservoir that collect water in rain storms season with a consideration of region permeability issue. This would be less consuming and more water harvesting would be made, as an example for 2nd scheme GIS was used to state dams position around Tabuk city in Saudi Arabia which utilized for flood preventing, water catchment, and groundwater recharching(5). Also the analysis of Dudhganga Dam environment impact was explained in (13). In Iraq southern plateau districts' geological and morphological aspects has been deeply studied due its geographic and economic importance, AL-Abeadh, Qurain AL-Thimad, and AL-Hirbas are essential valleys of the area, the second valley hydrology features were studied in (3), the third valley geological and geomorphological properties were determined in (4). Spectral reflectance of some remotely sensed imagery bands could be utilized for visual interpretation (subjective interpretation) with potential error rates (2), the adoption of Shuttled Radar Terrain Mission data and process in GIS environment (objective interpretation) could ensure accurate results such as region topographical characteristics, dam specific location, and constructed reservoir aspects.

MATERIALS AND METHODS

This study area is AL-Abeadh basin which represent one of the major western plateau endorheic alluvial fans with AL-Razaza sink as its discharging area. It locates between 40º 32' 42". 304 and 43º 46' 15". 134 eastern longitudes also between 31º 27' 29".222 and 32º 39' 15".134 northern latitudes. Basin area is 18608.924 km^2. 90.72% of AL-Abedh basin falling in AL-Anbar governorate and 4.76% in Karbala governorate , 0.85% in AL-Najaf one, and 3.6% of AL-Abedh basin locates in Saudia Arabia (i.e. it is a cross borderline drainage basin). AL-Abedh basin suffered from aridity with rare rainfall (less than 120mm.$year^{-1}$). Annually average of minimum and maximum temperatures were (18ºC) and (31ºC) respectively (9). There are non-permanent assemblage of wandering nomads in this region around the rivulets for drinking and livestock grazing. As can be seen in (Fig.1)

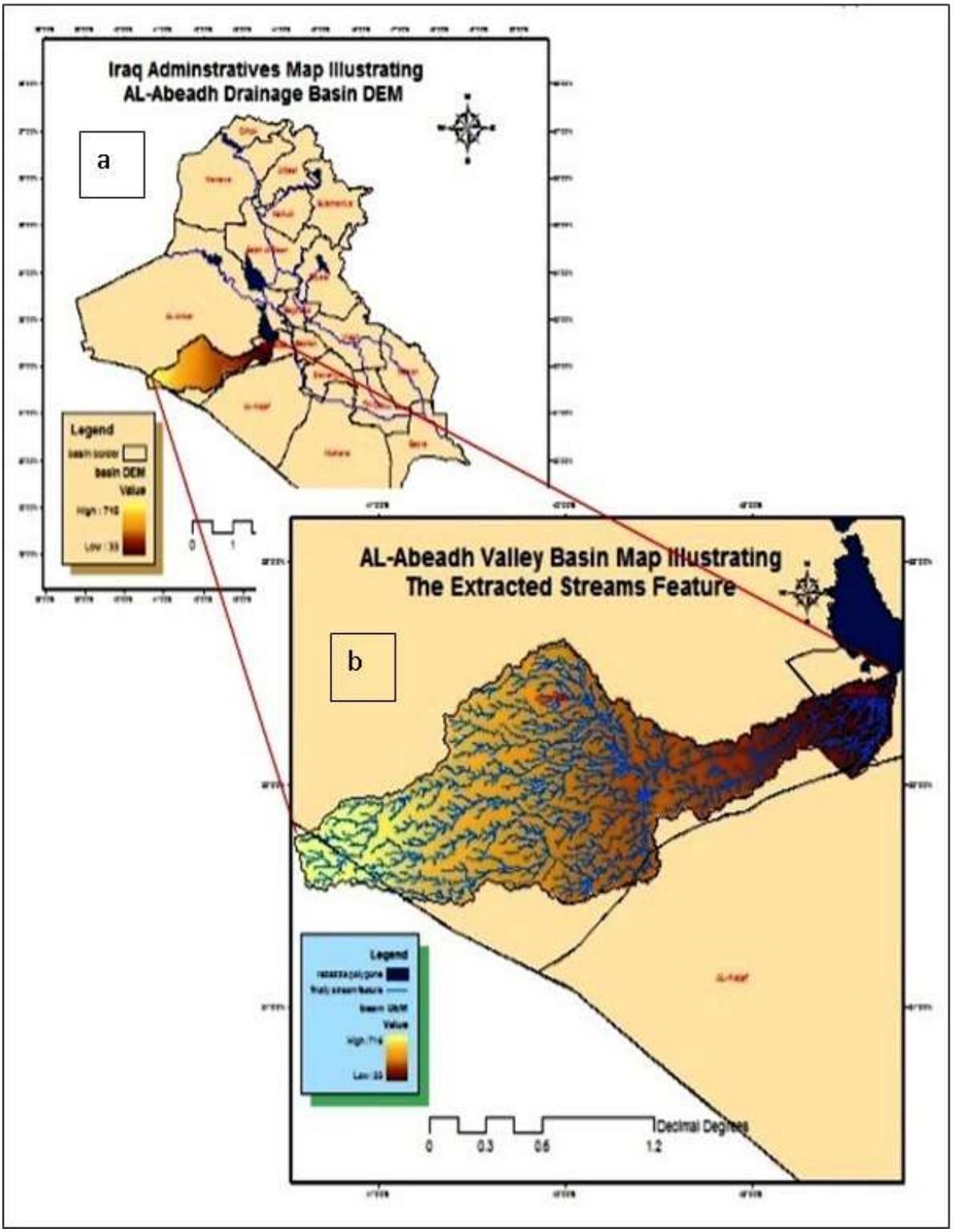

Figure 1a. Iraq administrative map illustrating AL-Abeadh basin DEM.
b: The extracted streams feature of the basin

In this work the information of three different methods will be integrated in (Arc GIS 10.3) environment after region topographical characteristics extraction from SRTM DEM with spatial resolution (90×90) m, these characteristics are slope, aspect, water accumulation, hillshade, and elevation contour lines to state the optimum location and characteristics for dam-reservoir construction, as follow: in the first method a new approach was submitted to the general criteria of dam building [which involve the properties merging of slope, aspect, water accumulation, and population settlements themes that stated in (1)] by adding two more themes of hillshading with 90º, 315º artificial illumination azimuth. This can be showed in (Fig. 2).

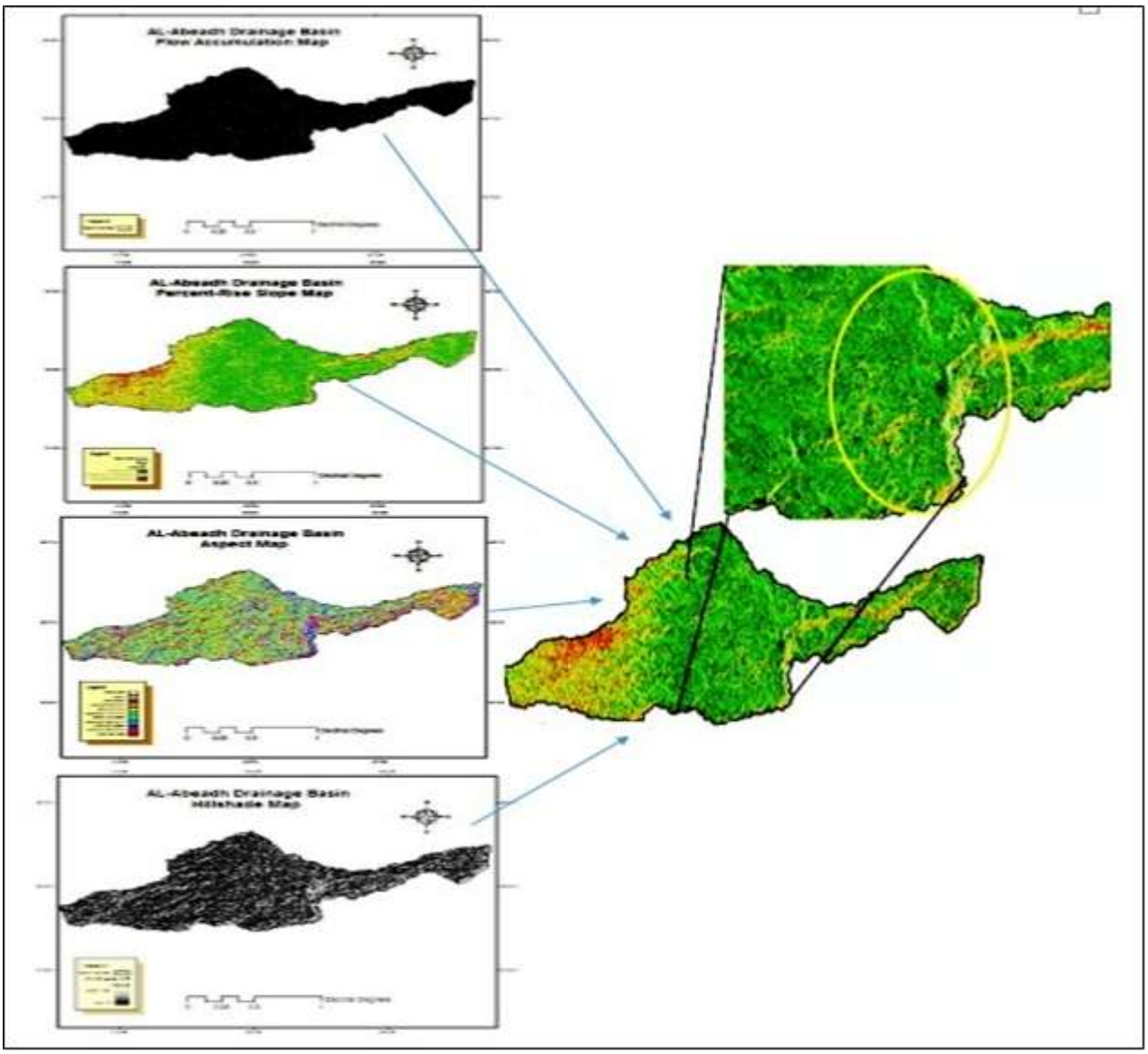

Figure 2. The overlapping of slope, aspect, water accumulation, and 90º, 315º hillshaded transparent themes using 90 m SRTM imageries.

The defect of this scheme is the generality, These criteria reduce search to select (dam region only) with no specification for dam and reservoir characteristics such as dam position, length, and height and reservoir shape, area, and volume. The second method was basin drainage network extraction and sorting according to orders as in (Fig. 3), then utilizing bifurcation ratio (R_b) (2) which is a quantitative morphometric analysis approach that determined from the division of lower order streams number to higher order streams number of each two successive orders in order to state the specific location of the dam.

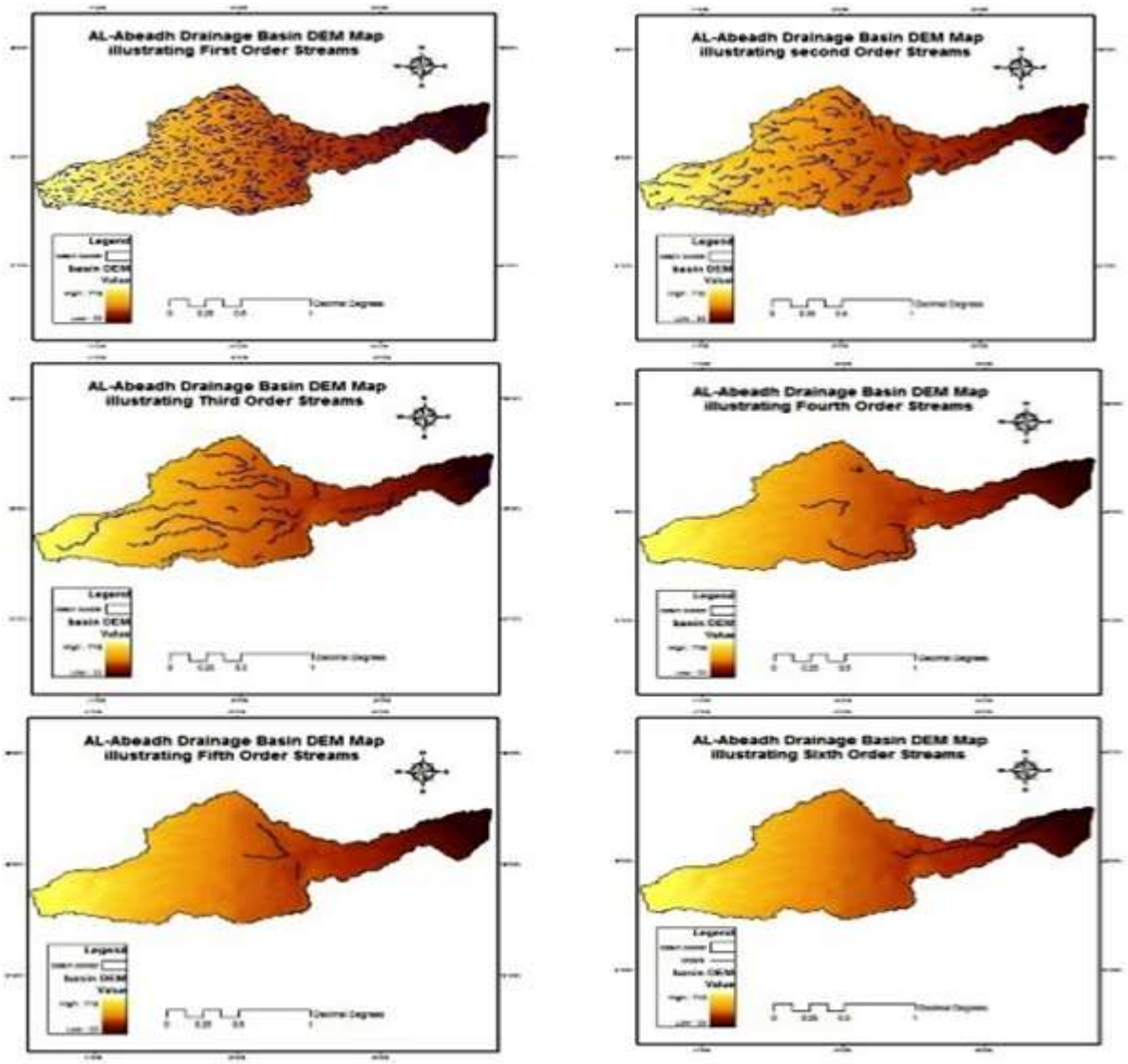

Figure 3. AL-Abeadh basin drainage network maps extraction and sorting according to orders

In AL-Abeadh basin there were (672 1st order streams, 321 2nd order streams, 213 3rd order streams, 59 4th order streams, 28 5th order streams, and 44 6th order streams). so that R_b's values were (2.093, 1.507, 3.61, 2.107, and 0.636) respectively. As it obvious R_{b1}, R_{b2}, R_{b3}, and R_{b4} values were more than unity referring to flood hazard absence in the regions of orders 1, 2, 3, 4, and 5. While R_{b5} value was less than unity indicating to flood risk along sixth order stream (which is AL-Abedh valley), this means huge water quantity in this valley during rainy season, so the benefit of this method is search range reducing to (undefined location along the valley only). The third method was basin soil permeability identification using longitudinal drainage density values of it; this was achieved by basin area partitioning into equal squares of (5×5) km side length for each, next step was extraction of all streams in each square then calculating their length summation and creating a point shapefile where each point locate in the center of a square with (Z-value) representing that length as illustrated in (Fig. 4).

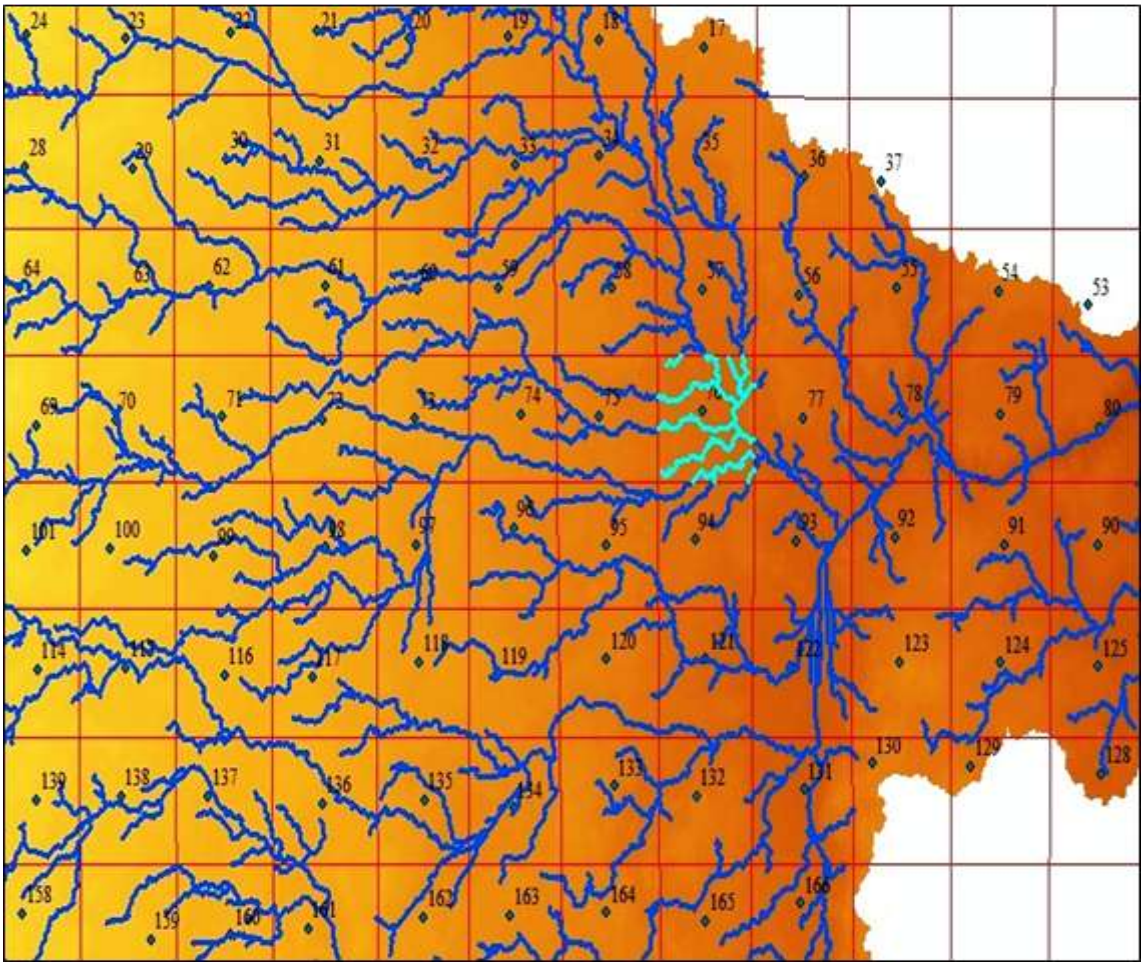

Figure 4. study area partitioning into equal squares of (5×5) km side length and extraction of all streams in each one

Then after the drainage density raster image created using "Inverse Distance Weighted" interpolation scheme from these points, as illustrated in (Fig. 5).

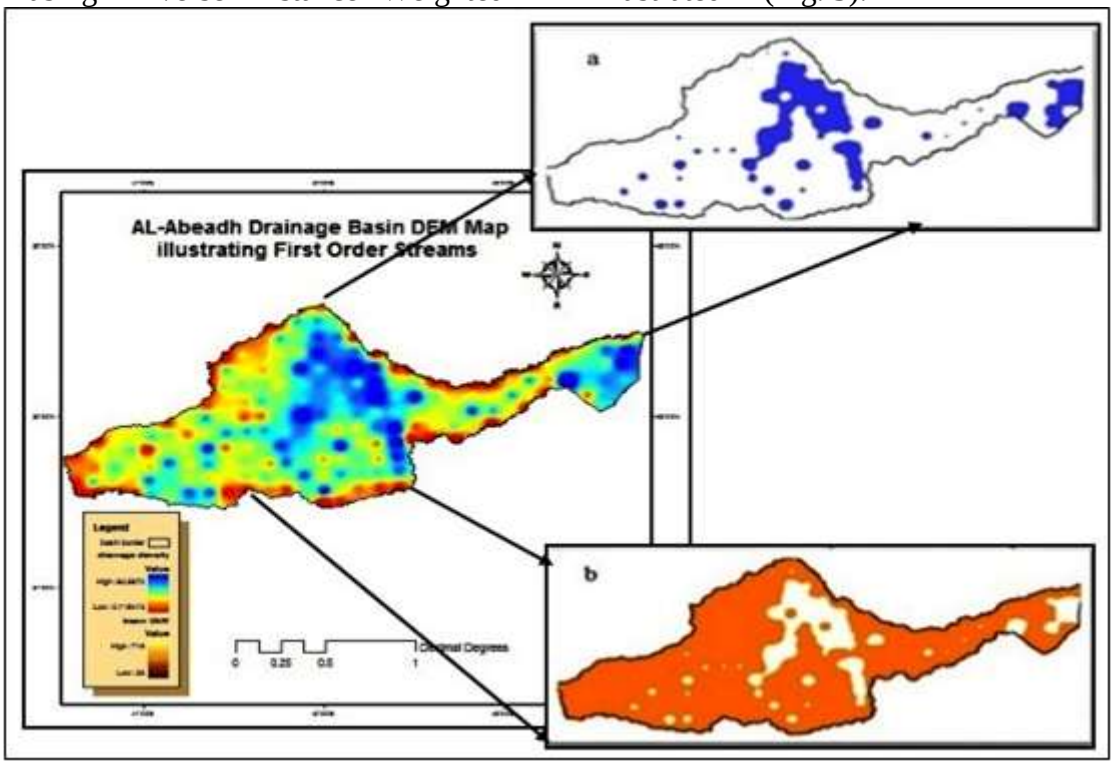

Figure 5a. high drainage density regions creation using IDW interpolation scheme
b. low drainage density regions creation using IDW interpolation scheme

As can be seen regions of high drainage density represent places of less permeability soil plus high valued water accumulation, these places stand for suitable reservoir ones.

RESULTS AND DISCUSSION

The first scheme involves a new approach which is the adding of hillshading with 90º, 315º artificial illumination azimuth to overlapped themes of slope, aspect, and water accumulation. This method clarify the dam region generally.

*The second scheme involves the adoption of bifurcation ratio values for drainage network streams in the basin to identify the streams with flood hazard in rainy seasons, in AL-Abeadh basin only the 6th order streams suffered from flood. This means the possibility of dam building along the region valley.

* In the third scheme the regions with less permeability soil and high valued water accumulation were determined. these places stand for suitable reservoir creation, this step identify basin's dam location without dam/reservoir construction properties. Integrating of all themes (layers) information using GIS techniques states one location of dam is with two different aspects, as follow:

In stage (A) 280 m Isopleth contour line was used which intersect high drainage density polygon as can be seen in (Fig. 6), so that suggested dam length is 67.8 m with 12 m height since depression bed height is (268 m A.S.L) resulting a reservoir of 77.781km^2 area.

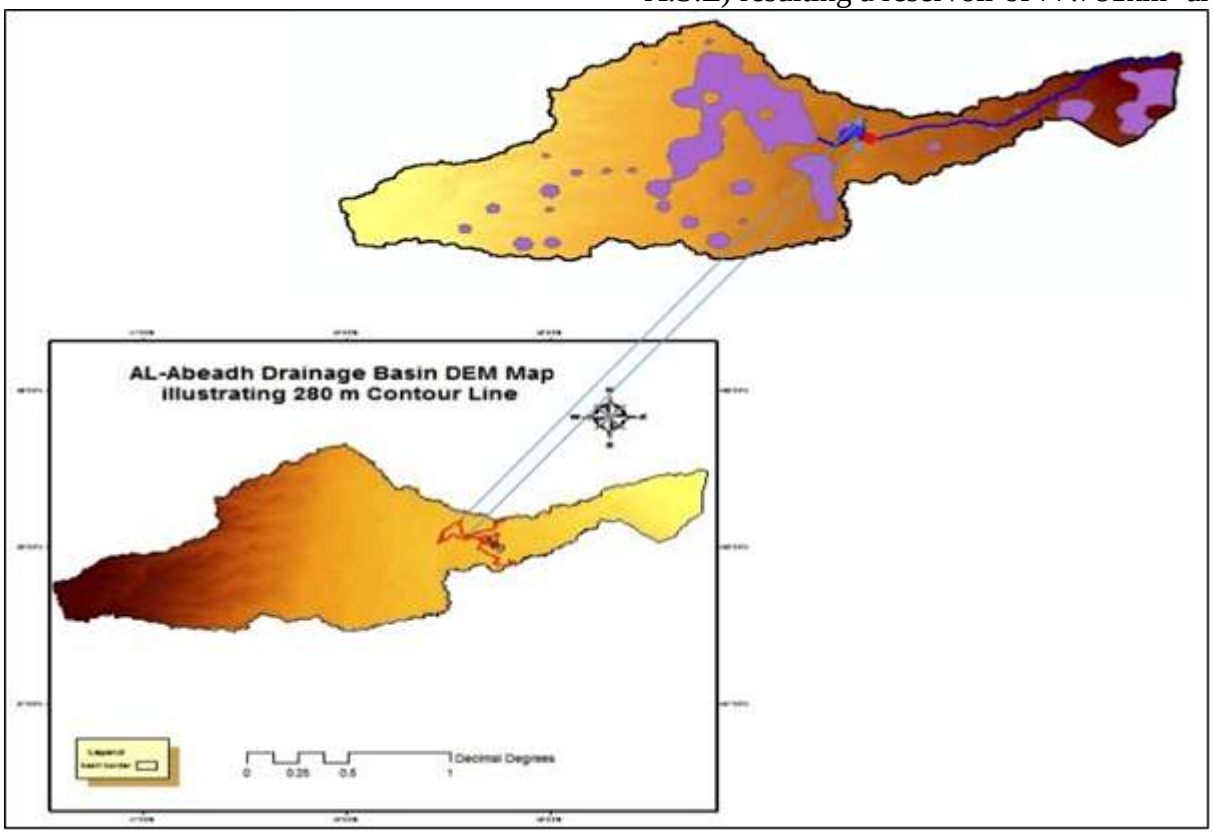

Figure 6. first suggested dam location using 280 m Isopleth contour line intersection with high drainage density polygons

While in stage (B) 300 m Isopleth contour line utilized that intersect high drainage density polygon as shown in (Fig. 7), so the suggested dam is in the same location of stage (A) with 112.6 m length and 32 m height resulting a reservoir of 1039.306 km^2 area. The use of data / information integrative technique is proved to be successful one for spatial analyses and decision making. This technique was adopted in this work to state the dam optimum location in AL-Abedh basin. the bifurcation ratio of its sixth order stream was 0.636 indicating the existence of great water quantity during the rainy season. The high drainage density regions (non-permeable soil regions) intersections with the 6th order stream identify accurate dam site while isopleth contour lines state its physical properties and reservoir shape and capacity, two potential dams could be built in same position; a (67.8 m) length and (12 m) height dam with 77.781km^2 reservoir area or (112.6 m) length

and (32 m) height dam 1039.306 km^2 reservoir area. The primary aim of this dam is drinking and pasture irrigation water supply, the secondary one is eco system improvement based on land reclamation along the valley banks and hydroelectricity power generation.

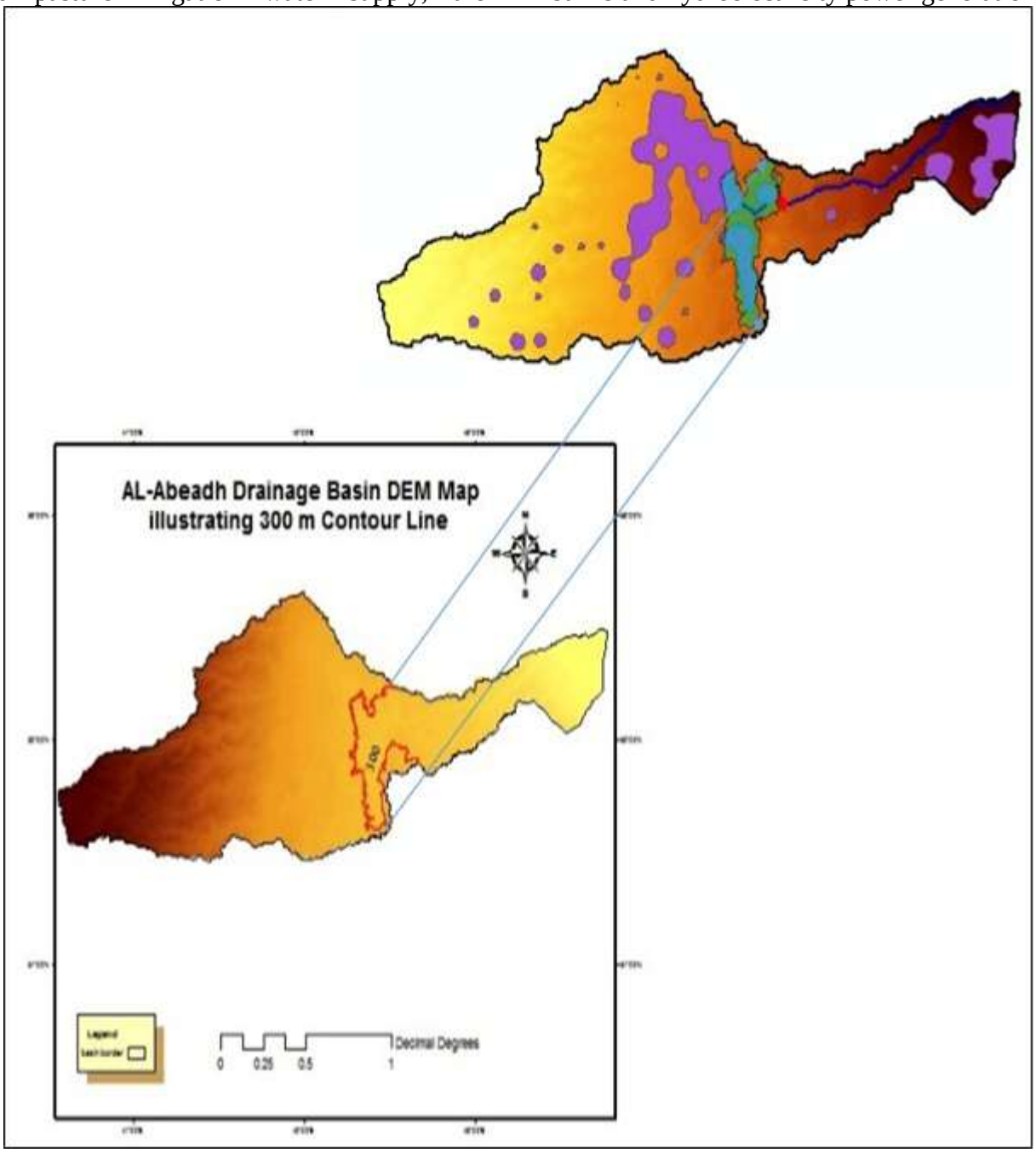

Figure 7. second suggested dam location using 300 m Isopleth contour line intersection with high drainage density polygons

REFERENCES

1. AL-Ansari, N., A., Nasrat, E. Issa, K. Varoujan, and S. Knutsson. 2016. Mystery of Mosul dam the most dangerous dam in the world: dam failure and its consequences . Journal of Earth Sciences and Geotechnical Engineering. 12(3):312-323

2. AL-Juraysi, S. M. F., and A. KH. M. Al-Obaidy. 2017. Spectral reflectance properties of soil taxonomy units dominants in saqlawiyah. The Iraqi Journal of Agricultural Sciences. 48 (4): 1004-1009

3. Al-Kafaji, S. 2015. The morphometric and hydrologic features to Qarin Al-Thimad valley in the southern desert of Iraq _ Al-Najaf desert.geographical research journal. 26 (1): 616-639

4. Al-Kafaji, S., and A.O.,AL-taee. 2016. Evaluation hydromorphomtry for the basin of um khshaf valley Rabes in Najaf Province. Journal of College of Basic Education for

Educational and Human Sciences. 22 (2): 293-333

5. Eyad A., and S. Alatawi. 2015. Dam site selection using remote sensing techniques and geographical information system to control flood events in Tabuk City, Hydrology Current Research 6 (1):1-13

6. Howsam, P. and R. Carter. 1996. Water Policy: Allocation and Management in Practice. the International Conference on Water Policy Held at Cranfield University, Silsoe, Bedfordshire, United Kingdom, at 23-24 September:13-28

7. Jawad, L. A. 2016. The use of geographic information system facilities to estimate the evapotranspiration in Iraq according to thornthwaite adjusted formula, Iraqi Journal of Science. 57(4A): 2566-2574

8. Jawad, L. A. 2016. The climatic quality index determination for Iraq using meteorological stations data. Iraqi Journal of Science. 57 (4C): 3005-3016

9. Karim, S.A., and K. S. Al-Bassam, K. S. 1997. The ratga formation: a new name for the eocene lithostratigraphic unit in the western desert of Iraq. Iraqi Geol. Jour.,30 (1)1: 46 – 60

10. Kiely, R. 2011. Industrialization and Development: a Comparative Analysis. UGL Press Limited, 25-26 July: 33-45

11. Miller, D.J. 2007. Nomads of the Tibetan Plateau and Himalaya. Published by Vajra Publications, Kathmandu, Nepal pp:67-86

12. Muhaimeed, A.S., Ibrahim, A., and R. K. Abdulateef. 2017. Using of remote sensing for monitoring geomorph_ ological temporal changes for Tigris river in Baghdad city. Iraqi Journal of Agricultural Sciences. 48 (1): 215-221

13. Nagarajan, R. 2000. Environmental impact analysis of dudhganga dam in India-a multi-temporal remote sensing approach. International Journal of Remote Sensing, 21 (3): 483-497

14. Nuruzzaman. M. D. 2015. Urban heat island: Causes, effects and mitigation measures - A Review. International Journal of Environmental Monitoring and Analysis. 3 (2):24-35

15. Roddy, S. and D. Moss. 2017. Deforestation and its extreme effects on Global Warming. Scientific American Journal. 22(4):123-134

16. Saloom, H. S. and I. A. M. Oleiwi 2017. Evaluation of irrigation water quality index (IWQI) for main Iraqi rivers (Tigris, Euphrates, shat AL-Arab, and Diyala) The Iraqi Journal of Agricultural Sciences, 48 (4): 1010-1020