EVALUATION OF STORAGE FOR DEWERIGE WEIR AND CREATION A 3D MODEL USING GIS [+]

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Abstract :

This research is to study the estimated volume of a reservoir for DEWERIGE Weir in accordance with the design location of Weir and the distance of end of storage from the border line between Iraq and Iran using Digital Elevation Model (DEM).

DEM is used to create a topographic map using (Arc map) which is one of the software of GIS .Then contour map was created using contour period equal to 0.5m. A 3D model was also created for the topographic map using (Arc scene).

The data about DEWERIGE Weir was designed to store water at an elevation of 34m and a storage volume of 1870000 m^3 .However, it was found that for a storage level of 34m the actual storage volume is 426316.15m^3.

This means the actual storage volume is less than the design storage volume. Accordingly, it is not an economical storage when compared the cost of project with the actual storage.

The storage volume was estimated using different values of contour lines in order to obtain the suitable location for the structure and the optimum storage.

As a final conclusion using 3D model which created a new location for the weir; the coordinate of new center line of weir is (E 745597.176 N 3551191.005), (E 745597.176 N 3550192.145).

The crest elevation of weir was 34.5m and the length of weir was 998.86m. All previous values verify a storage value of 4164660.20 m^3 at the contour line 36 m. in addition, the distance between the end of reservoir and the border separating Iraq and Iran was 64 m. This represents the perfect and optimum storage.

تقييم الحجم الخزني لسد دويريج الغاطس وتكوين نموذج ثلاثي الابعاد باستخدام نظام المعلومات الجغرافية

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المستخلص :

يتضمن البحث تقدير حجم الخزان المائي لمنشأ دويريج استناداً لموقع السد وبُعد نهاية الخزان عن الحدود العراقية الايرانية باستخدام نموذج المناسيب الرقمية .

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تم استنباط خارطة طوبوغرافية من نموذج المناسيب الرقمية(DEM) باستخدام (Arc map) الذي هو احد برامج نظم المعلومات الجغرافية وتكوين خريطة كنتورية بفترة كنتورية تساوي (0.5m) ، كما وتم أنشاء نموذج ثلاثي الابعاد للخارطة الطوبوغرافي باستخدام (Arc scene) .

حسب المعلومات التصميمية لمنشا دويريج ان المنشأ صمم لخزن المياه عند منسوب (34m) وبسعة خزنية تصميمية تبلغ ($1870000\ m^3$) لكن وجد ان السعة الخزنية الحقيقية تساوي ($426316.15\ m^3$) لموقع المنشاء الحالي وبمنسوب خزني يبلغ (34m) .

وجد ان السعة الخزنية الحقيقية اقل من السعة الخزنية التصميمية لذا فهو خزن غير اقتصادي اذا ما قورنت السعة الخزنية الحقيقة مع كلفة المشروع.

تم حساب السعة الخزنية لقيم مختلفة للخطوط الكنتورية من اجل ايجاد موقع مناسب للمنشأ ومن اجل ايجاد السعة الخزنية المثلى.

اخيراً وباستخدام النموذج ثلاثي الابعاد تم تحديد موقع جديد للسد الغاطس حيث وجد ان احداثيات الخط المركزي الجديد للسد الغاطس عند (E745597.176 N3550192.145),(E745597.176 N3551191.005) ومنسوب القمة للمنشأ تساوي (34.5m) وطول السد الغاطس يبلغ (998.86m) ،ان جميع الابعاد السابقة الذكر تحقق سعة خزنية مقدارها ($4164660.20\ m^3$) وبخط كنتوري يساوي (34 m) وان المسافة بين نهاية الخزان والحدود العراقية الايرانية تبلغ (64 m) وهو افضل حجم خزني.

Introduction :

The object of all investigations for storage reservoir schemes is to locate, design, and construct most economical structures which will impound water [1].

This research focus on the object the locate of dam, the selection of a suitable site for a dam depends on many factors, one of these is topography and storage capacity.

"For economic feasibility of storage project should be as small as possible and for a given height it should store good volume of water. Hence the river valley at the dam site should open out upstream to provide a reservoir "as quoted as by GUPTA, V. [1].

Also the topography of the site is considered one of the most important rules to choose the type of dam [2]. So, engineering surveys should be investigated a site to create the contour map , that is map allow the designer to decided the location of dam or weir , length , height, and the volume of storage ,all these requirements its need time and cost. So should be use GIS analysis to found all above requirements, and also we can estimated "Area Capacity Curves".

Objective of the study :

The aim of this study is to evaluation the volume of storage for DEWERIGE weir at the recent location. The other aim is to estimate optimum volume of storage according to the location of weir, topographical area, and the location of border between Iraq and Iran.

Basic concepts:

Interpolation:

Interpolation predicts values for cells in a raster from a limited number of sample data points. It can be used to predict unknown values for any geographic point data, such as elevation, rainfall, chemical concentrations, noise levels, and so on. Some of the most common interpolation methods are all available in arc GIS software

1. Inverse distance weighted (IDW) interpolation this method should be used when the set of points is dense enough to capture the extent of local surface variation needed for analysis. It estimates cell values by averaging the values of sample data point in the neighborhood of each processing cell [3].
2. Is an interpolation method that estimates values using a mathematical function that minimizes over cell surface curvature, resulting in a smooth surface that passes exactly through the input point [3].
3. That is an advanced geostatistical procedure that generates an estimated surface from a scattered set of points with z-values (or elevations) [3].

Area capacity curves :

Are the relationships between the elevation of reservoir and 2D area [1] .

Study area :

DEWERIGE weir is located in maysan governorate in the south east of Iraq, it is located align the Iraq-Iran border as shown in Fig. (1).The purpose of the construction of the weir is to harvest water. The coordinate of center line of weir which is (E746239.862 N3551456.909),(E746256 N3550931),the length of dam is 512m, the elevation of crest is 32.5m , the max. Elevation for the design storage is 34m [4].The design storage is equal to (1870 000 m^3)[5].

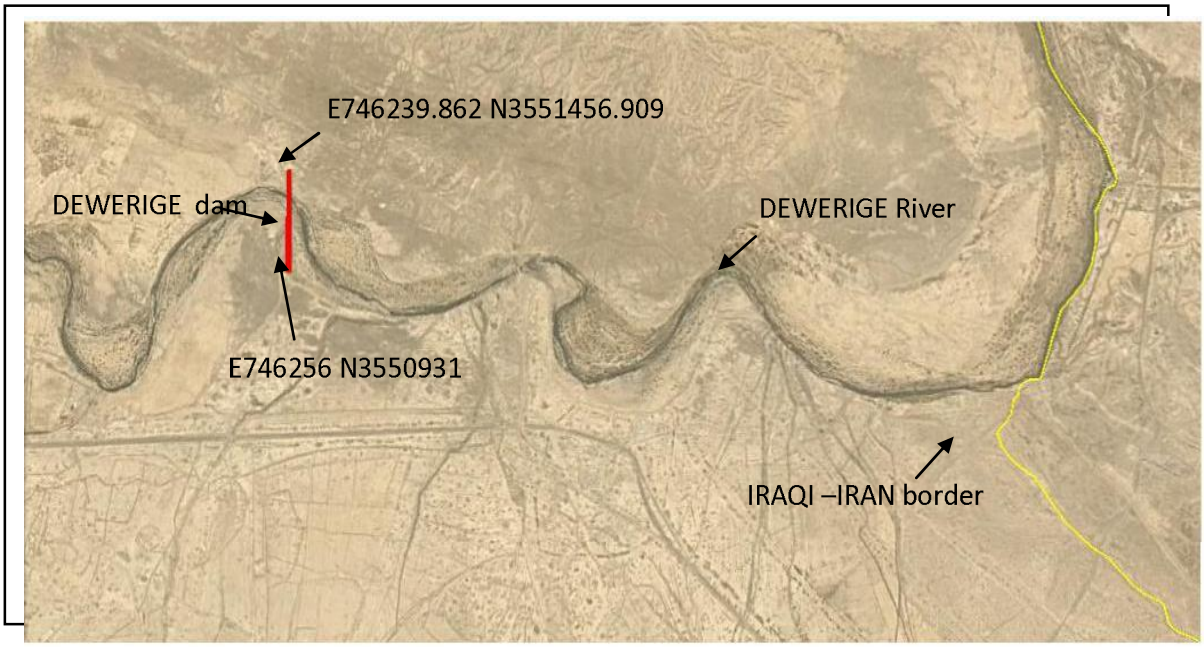

Figure (1): Image for the study area by using google earth

Data used :

Digital image contain DEM for the study area, it was downloaded from the website [6], also it was got that image from landsat by using earth explorer website[7].

Methodology :

Digital elevation model (DEM) is one of the main inputs of GIS in this study ,in arc map it was added the DEM to the defined layer Fig(2), after that it was extracted the DEM to the area of study as a rectangle [8],the rectangle has the coordinate that shown in able (1),by using spatial analyst tools and access to extraction and used extraction by rectangle its shown in Fig. (3).

Table (1): The coordinate study area.

Point No.	E	N
1	745106	3553149
2	745106	3549257
3	750366	3553149
4	750366	3549257

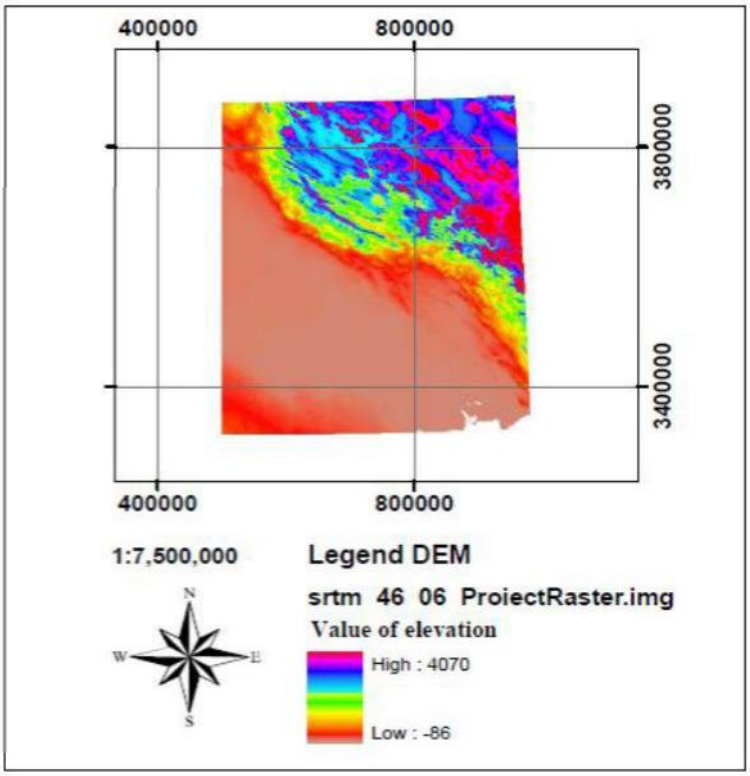

Figure (2): DEM that included study area.

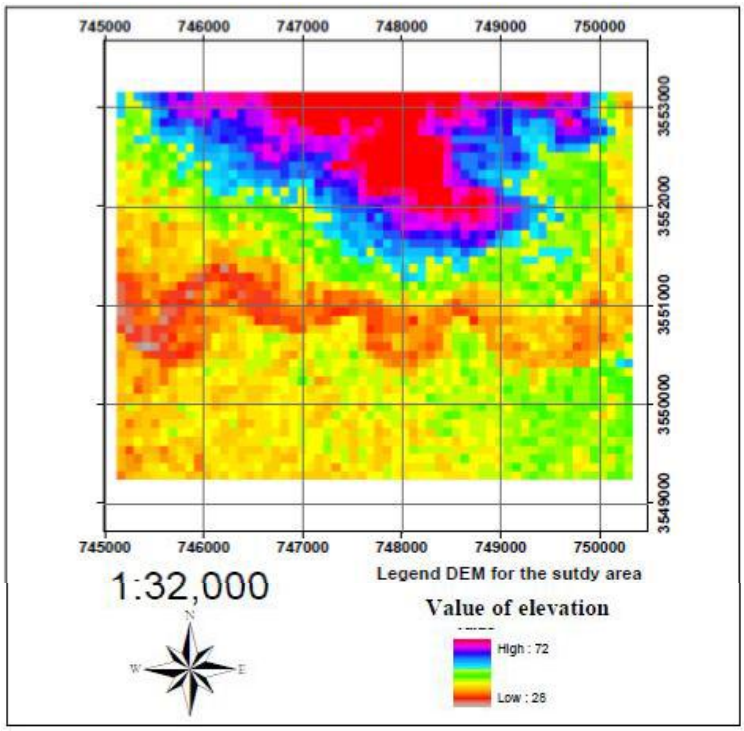

Figure (3): DEM for study area

It was converted the raster extraction in Fig.(3) to points(grid) [9] , raster data records spatial information in a regular grid or matrix organized as a set of rows and columns , the extraction raster is shown in Fig. (4).

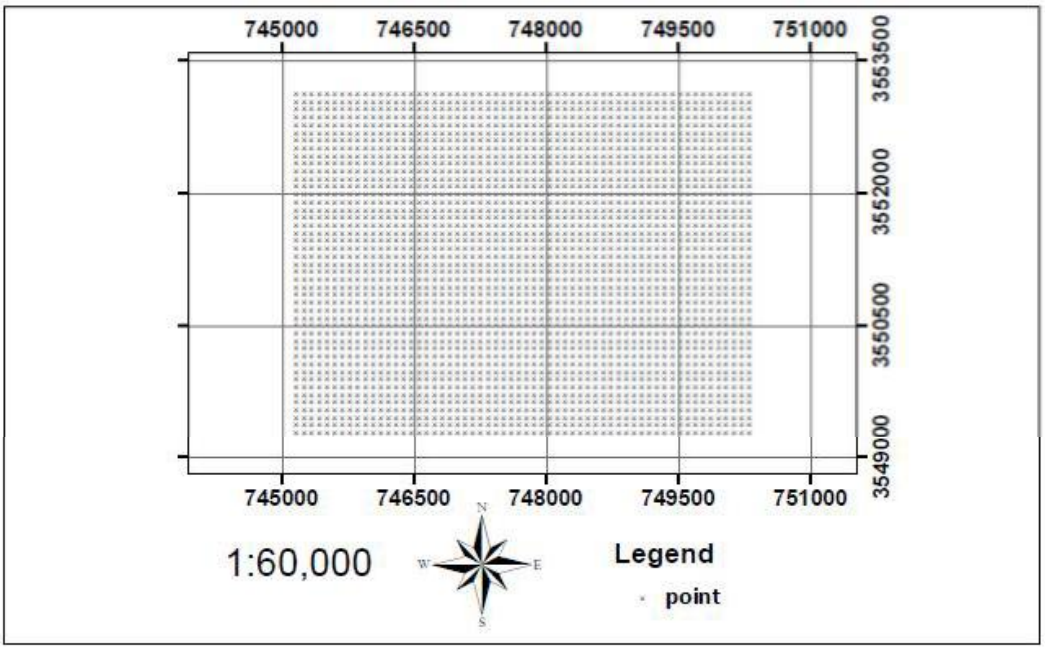

Figure (4): Matrix points for the study area

It was accessed to 3D analyst tools and used spline interpolation to created spline contour raster for the study area by using contour period is equal to 0.5m ,see fig(5) and fig(6).

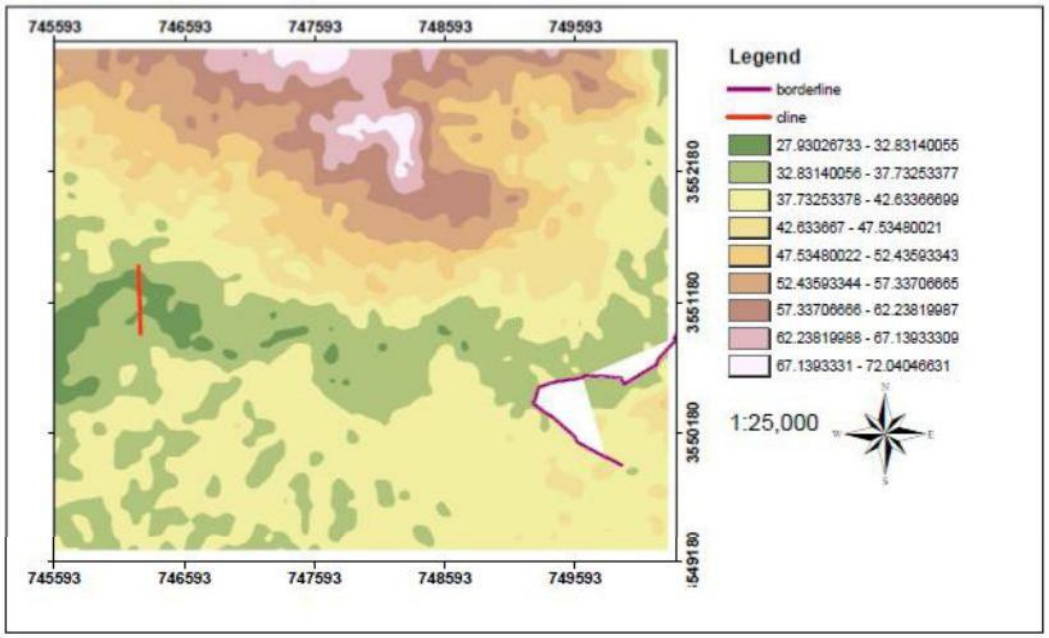

Figure (5): Spline interpolation raster to the study area

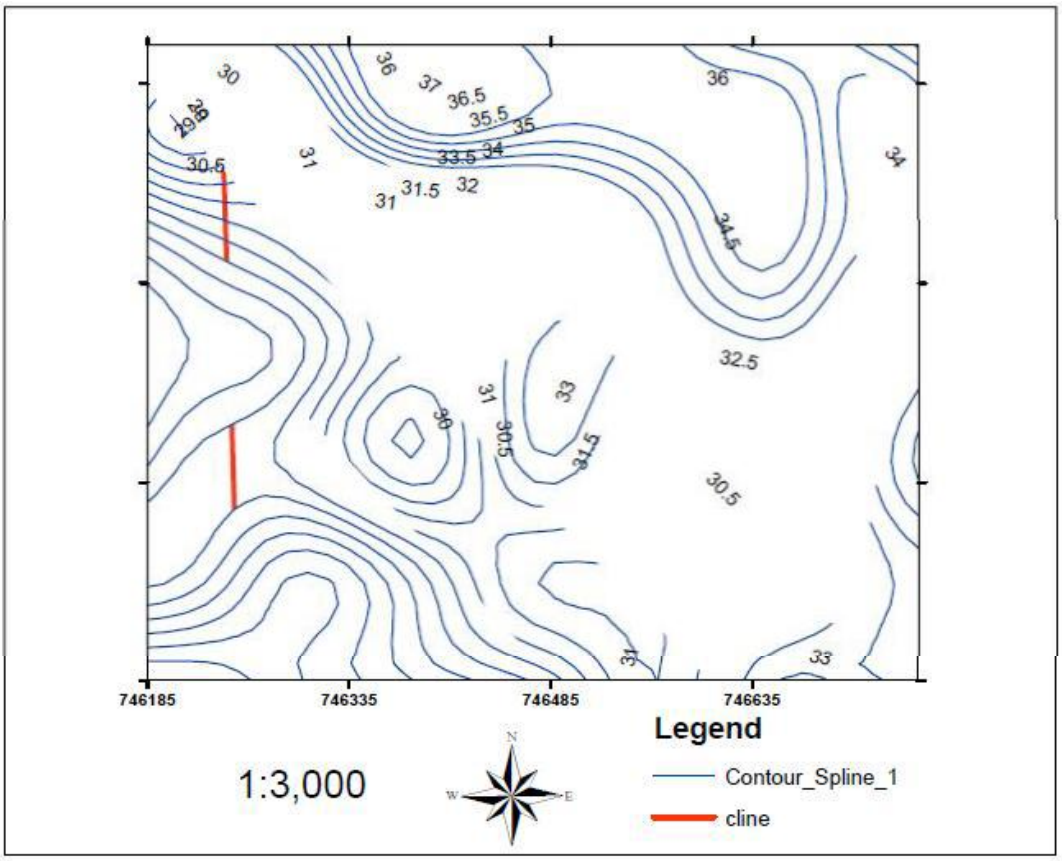

Figure (6): contour lines for the study area near the weir

In arc catalog it were created shape files such as the position of dam(cline) as a polygon and the border between Iraq and Iran(border& events) as a polyline shape file , and added in layer by using arc map are shown in fig(5&6).

In fig. (6) it has all the data to analysis the relationship between the volume of storage ,location of dam , and the elevation of storage.

By choosing the order "select by attributes" to create boundary of reservoir that is enclose between contour line and the location of dam , boundaries were created for different values such as (33,33.5,34,34.5,35,35.5,36m) to found optimum storage .

It were created different extraction raster for each boundaries by using spatial analyst tools/extraction by mask [10] see figs.(7 to13).

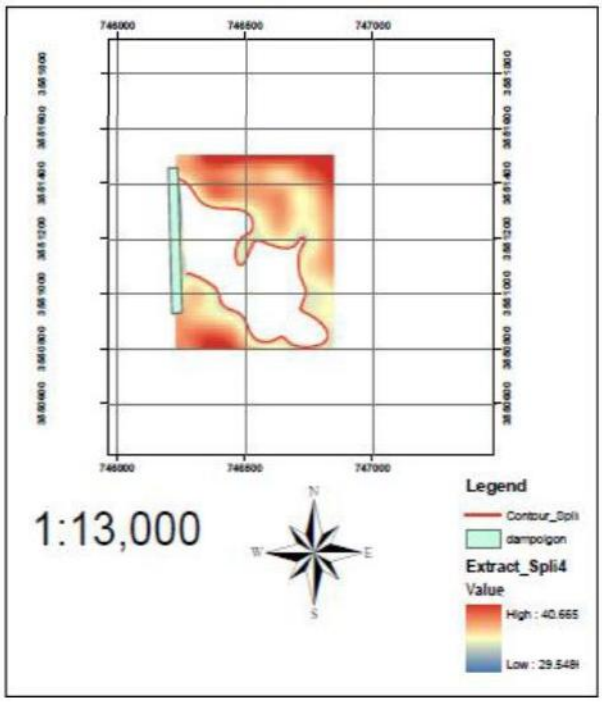

Figure (7): boundary of reservoir using elevation 33m

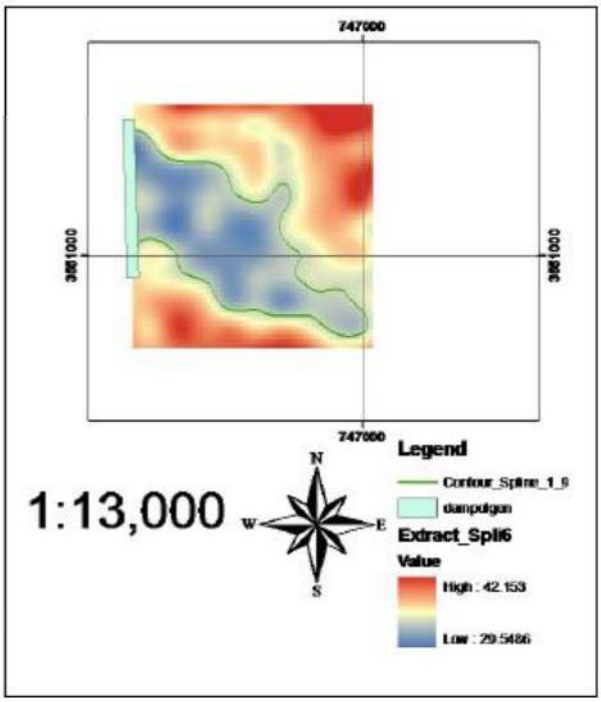

Figure (8): boundary of reservoir using elevation 33.5m

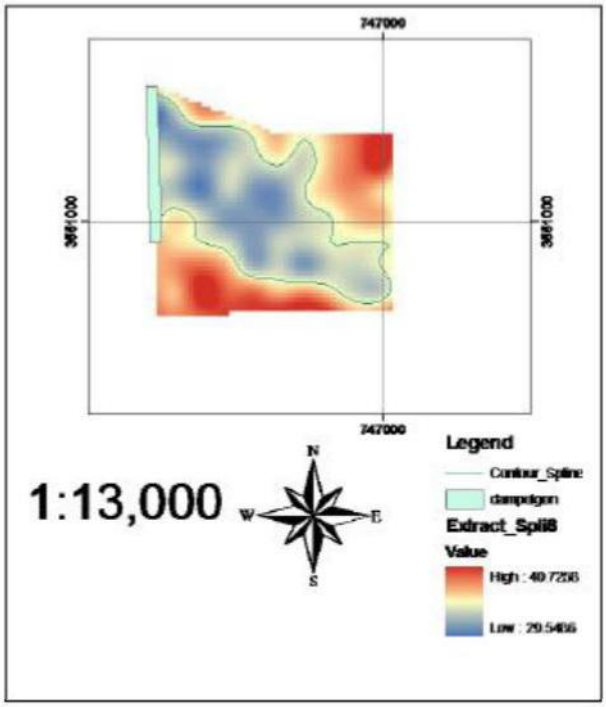

Figure (9): boundary of reservoir using elevation 34m

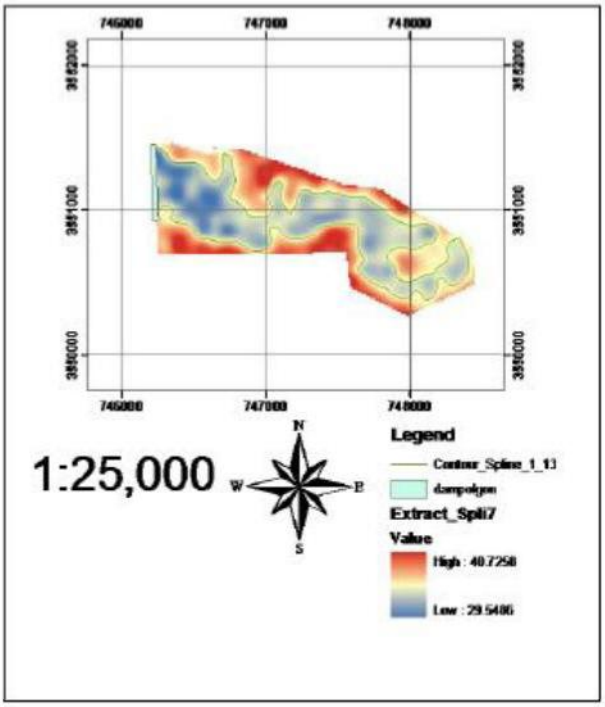

Figure (10): boundary of reservoir using elevation 34.5m

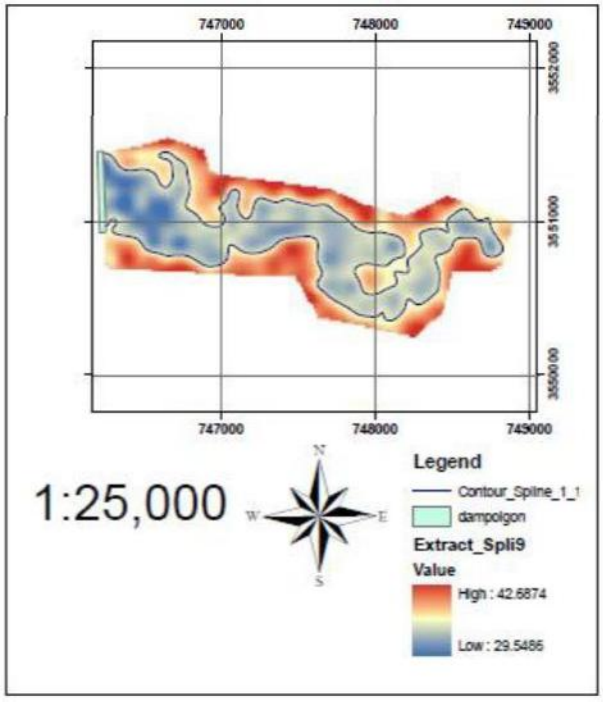

Figure (11): boundary of reservoir using elevation 35m

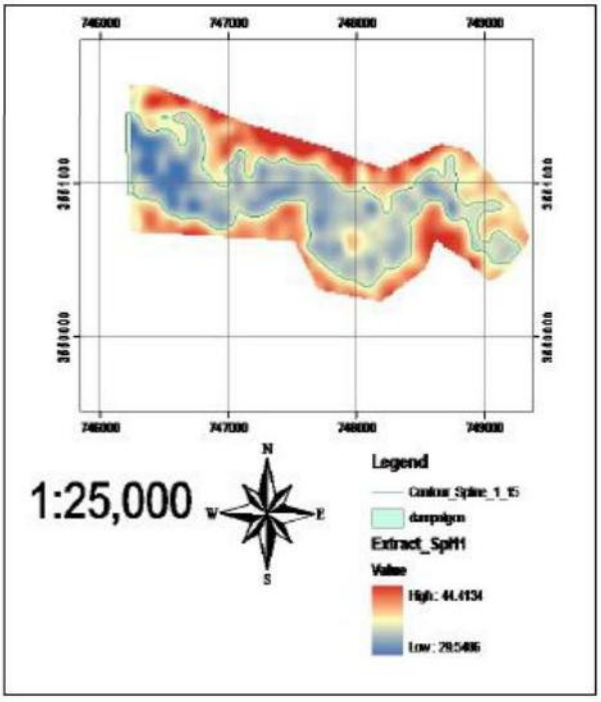

Figure (12): boundary of reservoir usingelevation35.5m

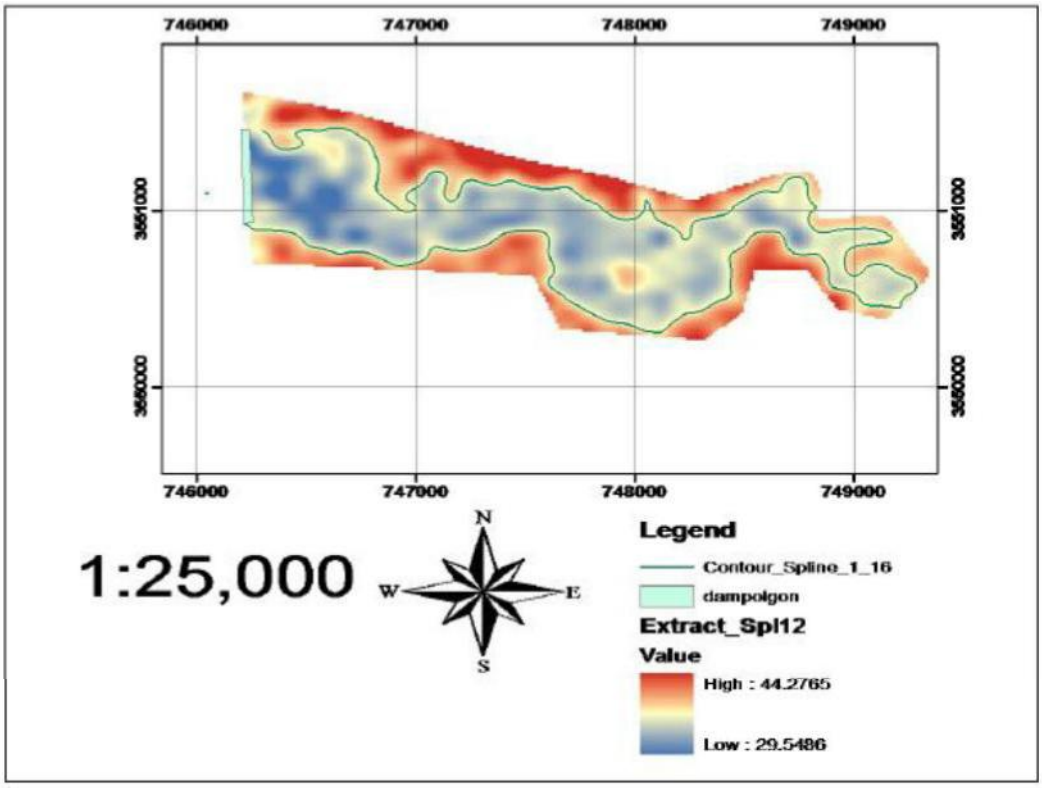

Figure (13): boundary of reservoir using elevation 36m

In arc scene , the first was created 3D model for study area is shown in fig.(14).after that adding all rasters that are shown in fig.(7 to 13), and shape files(weir & border) that were created in arc map, to visualization 3D mode.

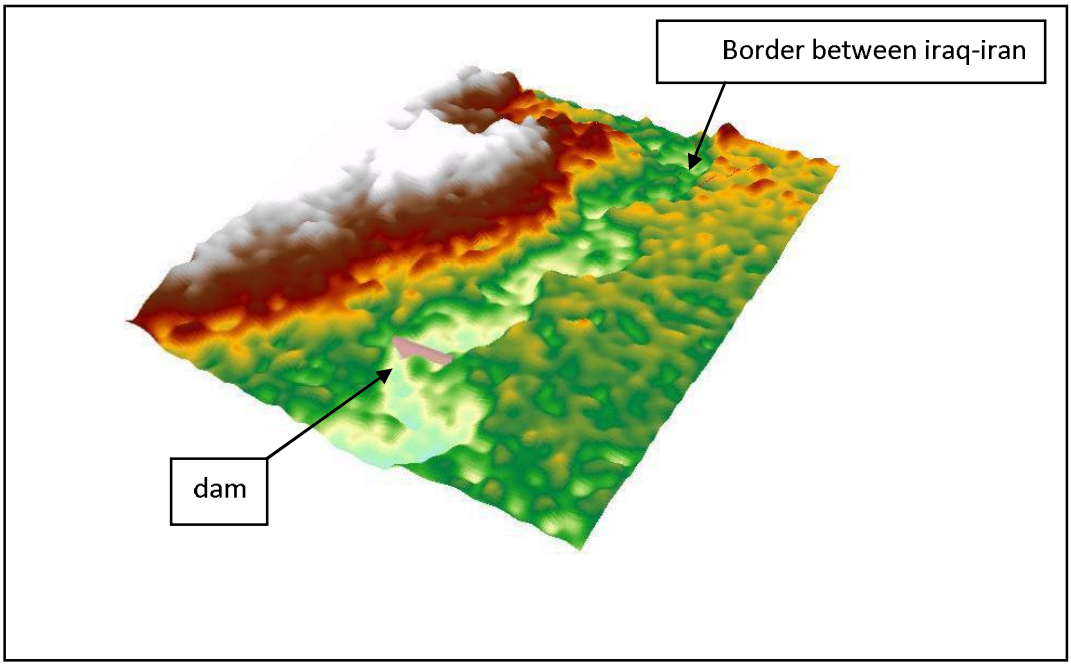

Figure (14): 3D Modeling for study area

Results and discussion :

The area and volume order for calculating volumes, 2D area, and surface area for different rasters which have different contour lines have been obtained via accessing 3D analyst menu in GIS. Those values are shown in figures (7 through 13) and the results are shown in Table (2).

Table (2): values of volume, 2D, and surface area for each reservoir by different elevation

raster name	Fig. No.	cntour line(m)	volume(m3)	2Darea(m2)	surface area(m2)
extract_spli4	7	33	203028.69	162919.93	163003.2
extract_spli6	8	33.5	305396.28	221870.76	221979.37
extract_spli8	9	34	426316.15	262438.24	262570.83
extract_spli7	10	34.5	941727.39	710849.28	711135.05
extract_spli9	11	35	1418258.38	917076.68	917496.62
extract_spl11	12	35.5	1948590.18	1136464.48	1137001.79
extract_spl12	13	36	2560250.14	1289280.17	1289937.13

From table (2) it is obviously noticed that the actual storage volume of DEWERIGE weir according to the design level and recent location is equal to 426316.15 m^3, when the crest

level for weir is 32.5 m, the max. storage elevation is 34 m , and the length of weir is 510 m [4].This means that the actual storage is less than the design storage ,which equal 1870000 m^3 [7] and therefore it is not an effective storage.
Accordingly, the weir position should be modified using the condition applied for selecting the selecting the dam location. In addition, the storage elevation should also be modified according to the distance end of reservoir from the border line between Iraq and Iran. So, it is suggested that the new location and coordinate for the weir are resemble to the ones shown in table (3).

Table (3): coordinates of new location weir

Point no.	E	N
1	745597.176	3551191.005
2	745597.176	3550192.145

From table (3), it is noticed that the length of weir is equal to 998.86 m. to calculate the new storage for new weir location and the length of storage according to the distance between the end of reservoir and Iraqi border, the raster is first created in order create a 2D reservoir area using an elevation of 36m as shown in fig (15).
Next, 3D model for the new suggestion is created using arc scene and shown in fig (16). Then, a 3D model for the new storage is created and shown in fig (17). The results are illustrated in table (4).

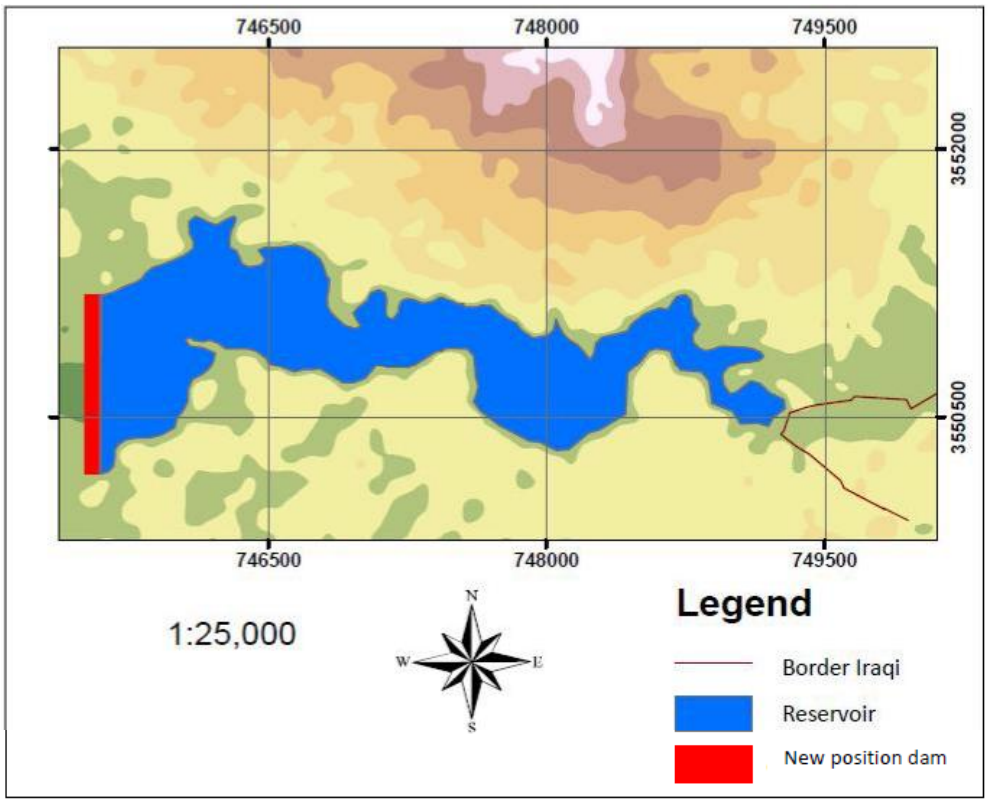

Figure (15): 2D modeling raster for new suggestion

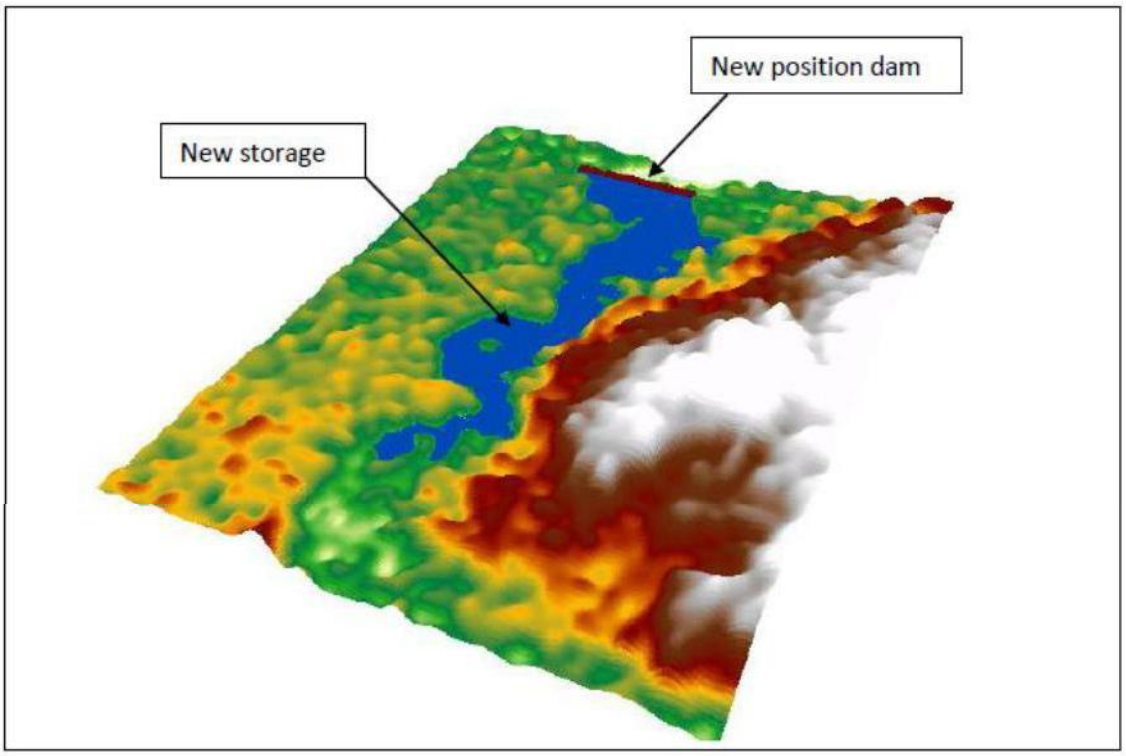

Figure (16): 3D modeling for new suggestion

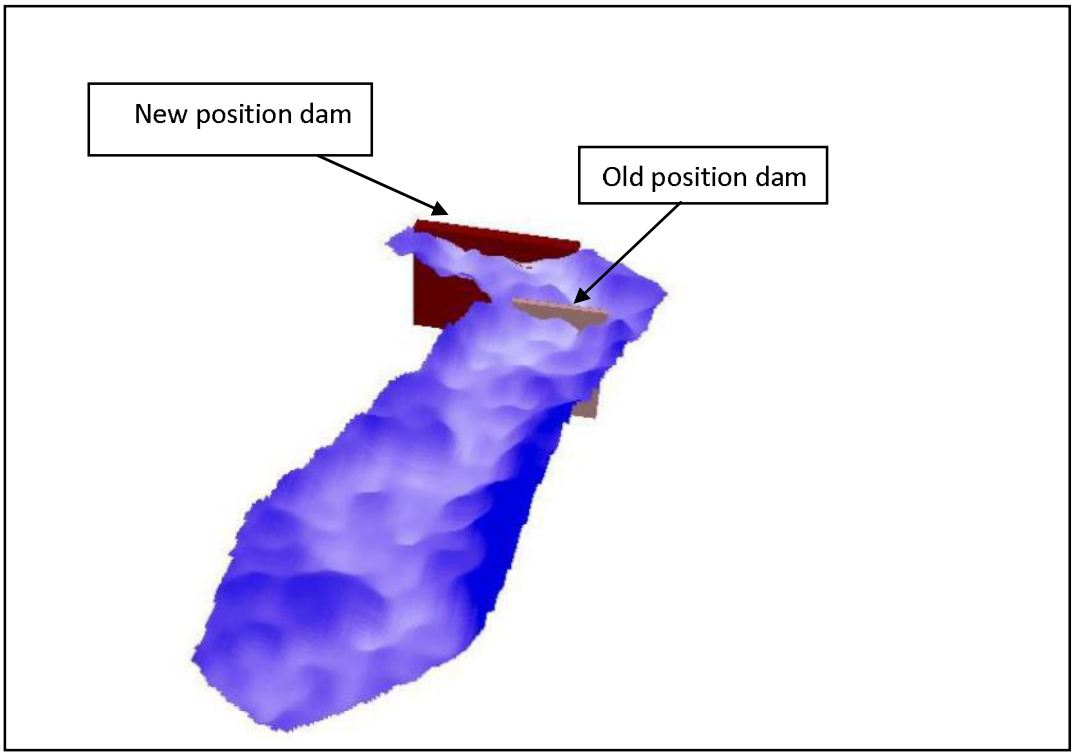

Figure (17): 3D modeling for new reservoir

Table (4): resulted calculation for new suggestion

raster name	Fig. No.	cntour line(m)	volume(m3)	2Darea(m2)	surface area(m2)
extract_spl13	17	36	4164660.2	1856503.99	1857482.06

From table (4) it is well noticed that the new suggestion verifies storage of 4164660.20 m^3 in a contour line of 36 m and a distance between the end of reservoir and border line of 64m. This is the perfect and optimum storage. The area capacity curve can be easily drawn using the values in table (2).

Recommendations :

The recent location of weir was not corrected ,so should be located in new position that given effect storage.

References :

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