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Building a Digital Elevation Model for Razaza Lake by Using GIS

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Abstract-The research involves getting aid from NASA through downloading the data relevant to the area under study and inferring the coordinates after several modifications on them have been carried out, using specialized programs.

Razaza Lake(In Iraq) has been selected in order to reach several details such as the number islands in the lake, terrain survey, lake boundaries and nature of the land bordering it, the lake water level at the time the radar readings are taken when the lake surface area is calculated. and also find:- Radar readings are not useful for areas submerged in water- The lowest and highest elevations of the area under study are 19 and 159m respectively- The surrounding areas are inclined gradually towards the Lake , except those on the south east (which are located in Kerbala province, which are characterized by sharp rise whose elevation reaches 100 m- It is easy to plan for making roads and for urban housing projects through visual inspection of area solid model

Keywords-

1. PART ONE: DIGITAL ELEVATION MODELS AND THEIR APPLICATIONS.

1.1. INTRODUCTION

DEM is an acronym of Digital Elevation Model. It is characterized by its capability to deal with terrain levels and its many sources of collecting data on coordinates and levels of definite point in a terrain. This information is necessary to build digital elevation models. Among these sources radar topographic data which are considered one of the main pillars used in many programs specialized in location analysis which is used in drawing, building, and studying features of a specific terrain. Such information will be useful in many engineering projects such as dams and natural reservoirs and road building etc. Data sources with the type of satellite used (2). This research will adopt the American system SRTM

Digital Elevation Models are considered the latest developments in terrain surveys The model consist in a three-dimensional digital matrix connected by (x, y, and z) coordinate system .the third dimension , they is, (z) represents the height value from sea level[1]

Dams and natural reservoirs are regarded as the main terrain features which can be represented in three dimensions as well as they are one of the meansfor water storage (whether river water or rain water) to be maintained and used with efficiency when necessary. Building this model will save in time and cost compared with the traditional methods for building such a model

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1.2. REASEARCH AIM

The research aims to achieve the following

- Building a DEM for the area under study using radar topographic data
- Study the topography of the area and draw its contour map

1.3. RESEARCH PROBLEM

The research problem in the difficulty in drawing contour maps of different areas and building solid models of them in the known traditional methods

1.4. REASEARCH METHODS AND MAIN

The researcher has relied on radar topographic data (srtm_45_06) for the Middle Area of Iraq including the area under study that is Razaza Lake. The data was obtained from NASA space shuttle as well as on some specialized programs whereby the digital elevation model for Razaza Lake and its neighborhoods was made

1.5. REASEARCH METHOLOGY

The research consists of two parts the first one of which reviews digital elevation models and their applications. The second part involves building a model of the area under study and giving the conclusions drawn and recommendations

The first part: Digital elevation models and their applications.

First: Types

There are a number of internationally known digital elevation models available such: SRTM, ACE, GLOBE, GTOPO30. The main differences between them are[2]

A. Data from which the model can be inferred

B. Location accuracy (both horizontal and vertical) of the model

Below is a brief comparison between them[3]

Both SRTM model and GTOPO30 model are of American origin. GTOPO30 model was made in 1996 and SRTM model in 2004. It is important to note the type of data each model provides. For example, GLOBE provides data on land only while other models provide data on both land and sea. A model may have specifications and applications incorporated during its development. ACE , for example, has been developed after correcting the measurements of the American satellite in terms of measurements of sea levels made by land stations, they are, therefore, Altimetry-Corrected DEM. Thus, it has its own uses or applications.

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A. As for horizontal resolution accuracy ,the three models, that is, GTOPO30 , GLOBE and ACE have the same accuracy which is about 1km. In words, the distance between two consecutive points in the model is 1 km (for distance between these points, interpolation can be used rather than actual survey). On the other hand, SRTM uses three types of data in the digital elevation model which differ in horizontal resolution accuracy(There is no difference in terms of levels) which is 10m, 30m, 90m

The first type (10m) is used only by the American Authorities because of its high accuracy and cost. The second type (30) is characterized also by high cost and accuracy. It is open for sale. The third type is free of charge and can be downloaded from http://srtm.csi.cgiar.org/SELECTION/listImages.asp which is beholden to National Aeronautics and Space Administration, NASA The researcher has adopted this type because it is available free of charge.

The accuracy of the 90 type means the dimensions of a single cell, the pixel within the digital elevation model are (90*90 m).This does not mean that the error value is not or less than 90m.The terrain level within the cell will be used in model representation.

B. The other factor which is more critical is vertical resolution accuracy. The aim of a model is to get the elevation. But at what level of accuracy?. In other words what is the expected error value from the elevation we obtain from any of these models?. SRTM is the most accurate of these models, while, on the other hand, SRTM10 is the most accurate of all models but unfortunately it is unavailable.

All the above mentioned models are of DEM type whose interface is in the form of grid. Every cell in the grid is represented by a certain level as shown in Figure (1). One the other hand, there is another type of digital elevation model which is (TIN) which is an acronym of Triangulated Irregular Network which consists of a number of triangles as shown in Figure (2)

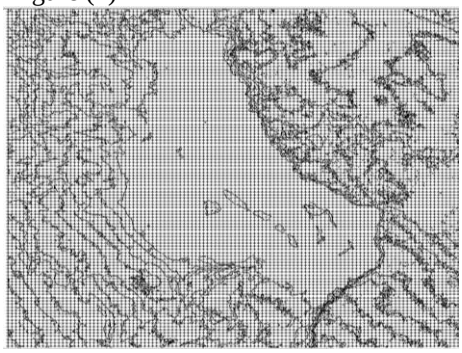

Fig (1) Squared grid of DEM type points

Source: the researcher

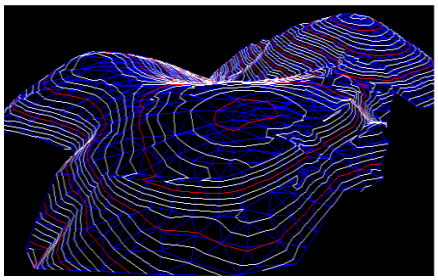

Fig (2) Triangular grid of TIN type points

Source: http://commons.wikimedia.org/wiki/File:Digitales_Gel%C3%A4ndemodell.png

Second: Uses

Digital elevation models have several applications as aid tools in evaluation and assessment of data on various projects. Among these applications are

1- Urban Planning
   These models are used before a new town is built on a large area. Road networks are made between towns, water and laying sewers networks between main and branch pumping stations depending on contour maps[4]
2- Hydrology
   These models are used in defining the areas f elevation and depression in order to decide the possible location for building a dam and water depressions as well as deciding on the water storage capacity in these locations. These models are used to specify flooding areas when water level in the river is More than scheduled and also to specify areas where erosion is taking place[5]
3- Geomorphology
   These models are also used to draw three dimensional clear images of any area so that we can analyze all geomorphologic processes taking place within a particular area [6]
4- Geology
   Digital elevation models are used in this field in defining the fissures taking place within a particular area within the geological interface, by using GPS[7]

Third: Resources

There are several resources to build digital elevation model among which are

A. Administrative data such as coordinates and levels of visible points produced by specialized institutions such as SRTM, ACE, GLOBE, GTOPO30 which were already mentioned. Their data are characterized by high accuracy compared with other resources (The researcher has relied on such resources[8]
B. Atmospheric and space images which are also characterized by high accuracy[9]
C. Topographic maps from which data are obtained by using special techniques and software. Unfortunately, they are less accurate than the previous ones
D. Interpolation in which several landmarks whose elevation is known. Then prediction is made and other points are calculated. The method is characterized by low accuracy [10]

Geographical Information Systems (GIS):

By Geographical Information Systems (GIS) is meant a number of software such as Global Mapper, Surfer, Arc,Gis which deal with digital location data in terms of collection, storage, analysis and display, depending on their geographical location. (The researcher has relied on such software in representing the model [11]

Geographical Information Systems depend on two types of resources

A. Spatial data which cover radar data(on the researcher has relied on) space and airs views in addition to maps
B. Non spatial data which cover descriptive data such as tables and statistical data

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1.6. SUMMERY

The Digital Elevation Models have many applications which are not limited to making contour maps. The digital model gives a topographic description of a land surface in the form of digits which a computer can easily deal with in many applications. They can be used to assess the rise and fall in sea and lake level and in urban planning studies to find out the relation between land topography and a certain geographical phenomenon (whether human or natural) in a region. They can be used also to define depression where rain water or torrent can be stored. An emergency plans are made to utilize it when the quantity of water becomes excessive

2. The second part: Al Razaza Lake (the study area in Iraq) and building its Digital Elevation Model

Al Razaza Lake is located within the administrative boundaries of Karbal and Anbar provinces. And is fed with water from Habanya Lake Its northern part lies within Anbar province and its southern part is in Karbal province

The magnitudes of its coordinates (according to UTM) in terms of its four boundaries are

From the north 3650720 m

From the south 3601075 m

From the east 395340m

From the west 355275m

Photo no (1) shows the Lake location

Photo no (1) shows the Lake location and its neighborhoods

Source: the Internet

The Lake Area:

The surface area of Al Razaza Lake varies with the variation in its water level. Whenever the water level rises, its surface area increases and vice versa. Table (1) shows the surface area and the quantities of water stored in terms of water level. It is noted that the lake bottom (the lowest point) of Al Razaza Lake is at level (17)m from the sea level. On the other hand, the highest water level of the lake is (40)m at which the quantity of water is 25.75 billion meter. The table shows also the surface area of the Lake varies with the variation in its water level. For example, at (35) m, also the surface area of the Lake is _(1620) sq km

Table (1) shows the storage capacity and the surface area of the Lake depending on every water level

1	elevation	area(km)	capacity مليار متر مكعب
2	17	0	0
3	18	180	0.125
4	19	260	0.3
5	20	350	0.55
6	21	460	0.9
7	22	580	1.4
8	23	700	2.1
9	24	830	2.8
10	25	940	3.8
11	26	1050	4.85
12	27	1140	5.9
13	28	1230	7.05
14	29	1320	8.2
15	30	1430	9.4
16	31	1465	10.75
17	32	1510	12
18	33	1550	13.5
19	34	1585	15.25
20	35	1620	16.87
21	36	1660	18.5
22	37	1700	20.25
23	38	1740	22.12
24	39	1770	23.75
25	40	1810	25.75

Source: Al-Hakim, AbdulWahab. A Study on the Morphological Characteristics and Sexual Maturity of Al-Bun and Shaboot in Al Razaza Lake, MSc thesis (unpublished), College of Sciences, University of Baghdad, 1976 p 7(In Arabic)

Steps in Building Elevation Model of Al Razaza Lake:

There are several ways to build the model. Below are the steps

A. Go to the following site http://strm.csi.cgiar.org/SELECTION/listImages.asp which deals with location data *coordinates and levels) where the area under where study and its neighborhoods are defined. Then the related data in the form of SRTM Model can be downloaded. It has already been dealt with, Figure (3) shows the site homepage

2-In order to use these data and represent them in the form of maps, the program Global Mapper was used which can deal with STRM model because by means of this program data related to area under study can be stored in the form of Digital Elevation Models after carrying out certain modifications on them and specifying the value of elevation magnitude (the value of contour duration). Fig (4) illustrates this

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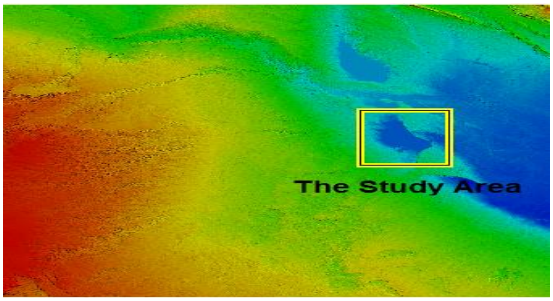

Fig (4) illustrates the area under study which is represented by (DEM) by using Global Mapper

Source: the researcher

3-Operate the program (Surfer) and retrieve the already stored DEM program. After downloading it is noted that the data are a network of points. Each point has coordinates and elevation as shown in below

For example, the red point on the north western beach of the Lake shows the coordinates of Easting, Northing and its Elevation as well as its position within the total matrix of the area under study which is (Column 268 and Row 705)

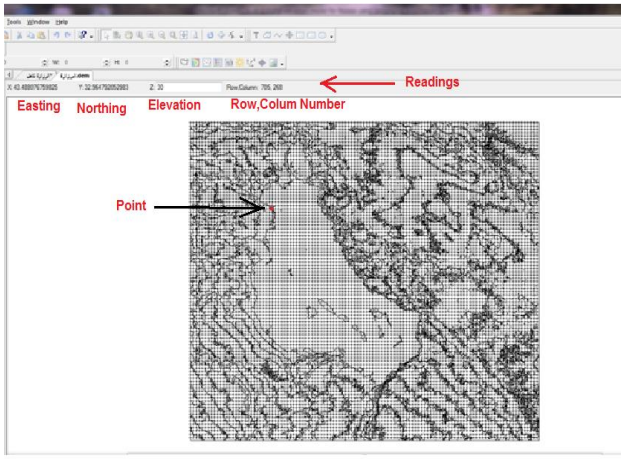

Fig (5) illustrates a network of squares type SRTM for Al Razaza Lake and its neighborhoods

Source: the researcher

4-The information about this network is illustrated in Table no (2) where it can be seen the network is composed of (960) lines and (1147) columns and the total number of points in the matrix is 1101120

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Grid Information

Sat Sep 21 15:55:34 2013

Grid File Name:          C:\Users\Acer\Desktop\بحث نموذج الارتفاع\dem1\طلبات البحث\الرزازة.dem
Grid Size:       960 rows x 1147 columns
Total Nodes:     1101120
Filled Nodes:    1101120
Blanked Nodes:   0

Grid Geometry

X Minimum:       43.265576759825
X Maximum:       44.220576759825
X Spacing:       0.00083333333333333

Y Minimum:       32.378125386317
Y Maximum:       33.177292052983
Y Spacing:       0.00083333333333333

Grid Statistics

Z Mean: 51.860015257193
Z Standard Deviation:    23.1166493274
Z Variance:      534.379476126

Z Coef. of Variation:    0.44575091643835
Z Coef. of Skewness:     1.2344364927891

Z Root Mean Square:      56.778875108637
Z Mean Square:   3223.8406586022
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Table no (2) illustrates the information related to network matrix of the area under study

Source: the researcher

5-After making some steps related to network matrix, we obtain a three dimensional solid shape of the area under study as shown in Fig (6)

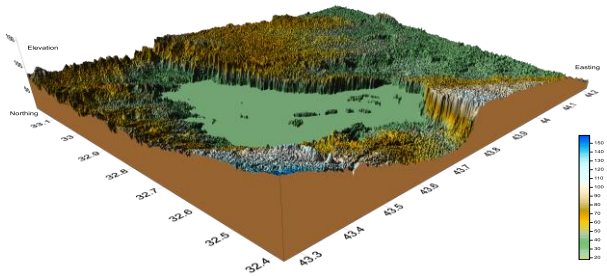

Fig (6) illustrated building a three dimensional solid shape of Al Razaza Lake and its neighborhoods

Source: the researcher

6-With the help of this program, a contour map of the area under study was made which can be used for most projects. Fig (7) illustrates this

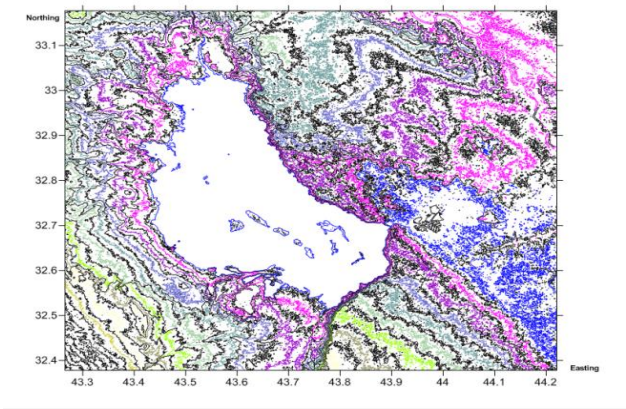

Fig (7) illustrates contour lines of the area under study

Source: the researcher

7- On looking into the contour lines of elevation. It can be seen the elevation of contour line parallel to the Lake water (and of the islands in the middle of the Lake) is 30 m as shown in Fig (8). This means water level in the Lake is 30 m. When calculating the Lake surface area at this elevation, it is found that its value is 1415 sq. km while the area at this elevation according to Table (1) is 1430. In other words the difference is 15 sq. km. This difference is about 1%

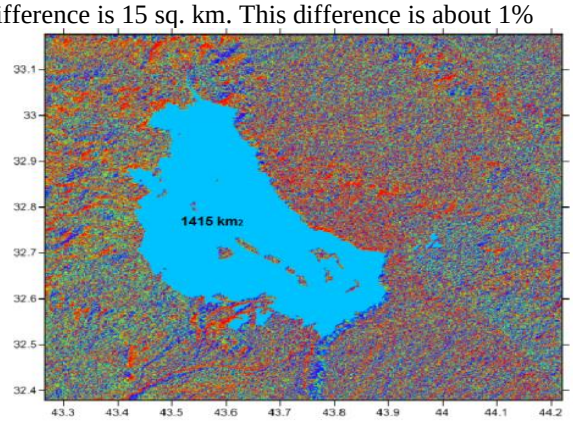

Fig (8).illustrates the Lake surface area

Source: the researcher

The Third Part: Conclusions and Recommendations

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CONCLUSION

A. Radar readings are not useful for areas submerged in water. They are useful only for defining their boundaries, and the topography of their surrounding areas
B. The lowest and highest elevations of the area under study are 19 and 159m respectively
C. Radar readings taken by NASA were made when the Lake level 30 m and area1415 sq km while its area according to Table (1) is 1430 sq km. this difference is very small, considering its large area, that is the difference is 0,01%
D. The surrounding areas are inclined gradually towards the Lake , except those on the south east (which are located in Kerbala province, which are characterized by sharp rise whose elevation reaches 100 m
E. Several islands have appeared in the Lake, indicating that their elevation is more than30 m
F. Any sudden rise in the Lake elevation can be controlled (without the need to over flood the surrounding areas) through finding out the rise elevation because can be made of the coordinates of the surrounding areas which can be subjected to over flood with the Lake waters without the need for visual inspection
G. It is easy to plan for making roads and for urban housing projects through visual inspection of area solid model

RECOMMENDATIONS

A. It is important to encourage the use of modern techniques and software related to digital elevation models of the areas to be used as sites for urban housing projects, making roads between towns and water storage in natural depressions
B. It is necessary that a relevant government body should purchase data with 30 m accuracy and distribute them among other government bodies so that these data can be manipulated in all projects instead of buying the data individually which will not be cost effective

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