



RESEARCH ARTICLE

Using Digital Elevation Model to Select the Route for the Road Connecting Kirkuk and Jamchamal

Zuhair Abd AlWahab Al-Jwahery

Asst Prof, College of Engineering, Karbala University, Karbala, Iraq,

Manuscript Info

Manuscript History:

Received: 18 July 2014

Final Accepted: 22 August 2014

Published Online: September 2014

Key words:

*Corresponding Author

Zuhair Abd AlWahab Al-
Jwahery

Abstract

There is growing for digital elevation models because they can help in the selection of the best route for a location out of several suggested alternative routes in terms of the quantities of earth (in excavation and filling) as well as drawing their longitudinal sections, making it easier and faster to select the best route. The researcher has depended on the data provided by NASA through downloading the relevant data on the study area. He was able to conclude the coordinate from them. After carrying out some specialized processes, he was able to select the best route connecting Kirkuk (located in Kirkuk Province) and Jamchamal (located in Sulaymania Province). The two cities are in the north eastern Iraq.

Using the Digital Elevation Model already made for the study area, the selected route is represented taking into consideration the following points : the route, the quantities of earth removed or to be used in the filling, definition of coordinates, level of stations en route and drawing its longitudinal section.

Moreover, the current road between the two cities has also been represented so that it is compared the suggested route. Below are some conclusions drawn from the comparison:

- The length of the suggested route is 54.62 km while the current road is 55,96 km
- The quantity of earth to be removed in the suggested route is 9187171 cubic meters which is less than that moved in the current road which was 10079097 cubic meters. Certainly this difference has an economic impact.
- The quantity of earth to be filled in the suggested route is 918717 cubic meters which is less than that moved in the current road which was 9490653 cubic meters. No doubt, this difference has an economic benefit.
- The difference in level the lowest and highest points in the present route is 525 m which is more than that in the current road. No doubt, this difference has an effect on project cost.

Copy Right, IJAR, 2014., All rights reserved.

Introduction

A route between two towns is usually selected and determined in several stages (the normal used stages) (1). They are:

- Preliminary exploring the area to get firsthand knowledge of the area nature and conditions
- Making survey and topographic maps of the area, but first the available maps are studied. Then all possible routes are drawn. A comparison is made between all possible routes in terms of cost and nature,
- Taking aerial photos to get a comprehensive picture of the area

- Making field survey to define the suggest routes and find slopes if any and the quantities of earth to be removed or used in the filling. The level and locations of the main stations along the central road (equal distance separates them). Longitudinal sections are drawn for each.

Figure No (1) shows the flow chart of the planning, designing and executing stages of routes making which are shown in the red square. They can be neglected if radar topography data of the area are available (2)

Based on the above mentioned surveys, the best route for the road is selected that meets the following requirements (3)

- 1- The road should be as short as possible with least slopes and sharp curves , thus facilitating traffic flow
- 2- The total cost should be as low as possible, taking into consideration the future maintenance cost of the road. Certainly, this requires a comprehensive study of all economic and environmental factors which play a role in route selection. The cost can be reduced if building high bridges, trench and tunnel making and other high cost structures are avoided .

All above mentioned field surveys can be avoided if data from Digital Elevation Model are available which can supply all the required data.

Research Objective

The research aims to achieve the following objectives

- Building digital elevation model of the study area using topographic radar
- Defining topography of the area
- Selecting the best route and calculating the quantity of earth to be moved or used in filling
- Defining the coordinates and levels of the centerline of the selected route
- Shedding light on the importance of digital elevation model in determining and selecting routes for various roads

Research Problem

The research problem lies in the difficulty in finding the best route connecting cities (especially in bumpy terrain)

Research Materials

The researcher has depended on data supplied by Shuttle Radar Topography Mission (STRM) related to the northern region of Iraq including the study area, that is the area between Kirkuk and Jamchamal as well as on some specialized programs by means of which he was able to build a digital elevation model of the area and longitudinal sections of the road connecting the two cities

Research Procedure

The research consists of two parts. The first part is theoretical in which he reviews samples of digital elevation models. On the other hand, the second part is dedicated to building model for the study area and giving the conclusions and the recommendations

The first Part: Digital Elevation Model

Digital Elevation Model (DEM) is considered an important tool to represent the terrain by using Global Positioning System (GPS) programs which produce three dimensional representations (X,Y, and Z). The third dimension (Z) represents the height from sea level. This has several applications (4)

There are many sources to provide data on these models. Among these sources are radar topography data which are supplied by satellites orbiting the earth. Among these models is Shuttle Radar Topography Mission (STRM) (An American model) on which the current research has relied. It takes the form of a digital matrix and gives a clear representation of terrain as well as several known coordinates and levels. From this model one can easily calculate the quantity of earth to be removed or used in filling for any area, thus saving in cost and time compared with the traditional methods. The advances in providing data by Digital Elevation Mode (DEM) to every part in the world have made studies and applications that depend on these data completely different from those of the past (5) because now through the data provided by Digital Elevation Mode, simulations can be made of the virtual area topography after the data are processed by special GPS programs.(6)

Resources (7)

1-Arial photographs as well as space images (three dimensional) used with Stereoscopic instruments with accuracy of 1-10 m

2-Radar data in the form of bitmaps images such as SRTM and GTOPO (the researcher has relied on this type) which are characterized by their high accuracy compared with other resources.

3-Interpolation methods which are mathematical algorithms depending on a sample of bitmaps Then all elevations of the area can be calculated.(accuracy is not high)

Types

There is a variety of digital elevation models but the researcher has relied on digital elevation model type SRTM which is characterized by its high special accuracy (90 m). It is available at

<http://srtm.csi.cgiar.org/SELECTION/listImages.asp>

This site belongs the NASA. It is of three types depending on special accuracy, that is, (10 m) which is restricted to American users, (30) which is characterized by its high accuracy but it provides the information at high price. The third type (90 m) provides the information free of charge on the site with accuracy of (0 m). This means the pixel dimensions within the digital elevation model are $90*90$. This does not mean that the error value is more or less 90 m. It is the average terrain level within the pixel that will be used in model representation (8)

Applications

Digital Elevation Modes are used in a variety of fields as an aid to evaluate and analyze data related to different projects

- Making roads between towns (in which the researcher has used the model)
- Laying water and sewerage network pipes between main and branch stations. Also it is used in deciding on the routes canals and drainage systems
- Selecting the appropriate sites for new towns to be built especially in mountainous areas
- Defining the areas and volumes water depressions

Programs of Geographical Information Systems (GIS)

Geographical Information Systems is defined as a computer program which collects, manages, processes, and analyzes spatial related data. It involves different branches of science. Diagram (1) shows the different branches of science involved in it

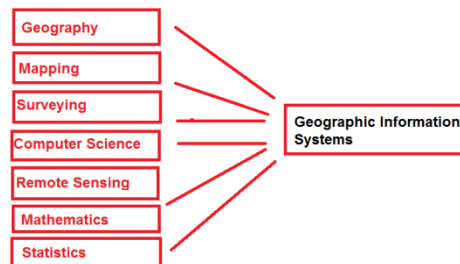


Diagram (1) showing the different branches of science involved in Geographical Information Systems

The Programs of Geographical Information Systems are many and characterized by many features including information retrieval, spatial interpolation, building buffer and corridors(11). The researcher has adopted the following programs from the Programs of Geographical Information Systems: Global Mapper, Google earth , Surfer which are concerned with spatial digital data in terms of collection, storage, and retrieval depending the geographical location

The Second Part: Building the Digital Elevation Model for the Area under Study

Description of the Area under Study

The area under study lies in the region between Kirkuk and Jamchamal in the North West of Iraq and within the administrative boundaries of Kirkuk and Sulamania provinces. It is rugged area with mountain ranges having the lowest and highest points at 350 m and 850 m respectively. The current road connecting the two cities is 55 km long, starting from Kirkuk whose coordinates are (N 3925765.0m, E 445540.0m) and ending in Jamchamal whose coordinates are (N 3932388m, E484773.0m)

Photo (1) shows a map of Iraq and the location of two cities and photo (2) shows the location of the area under study

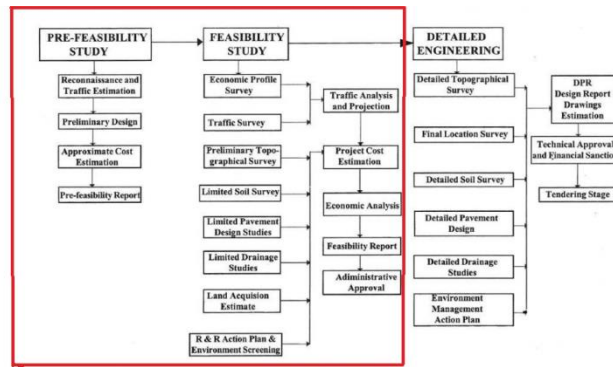


Fig (1) The flow chart of the planning, designing and executing stages of route making



Photo (1) shows a map of Iraq and countries bordering it Source Google Earth

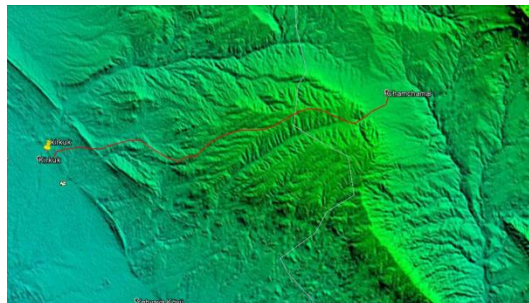


Photo (2) shows the location of the area under study and the current road connecting the two cities

Source: The Researcher

The Procedure to Build Digital Elevation Mode and Select the Appropriate Route for the area under study There are several methods to build the model. The Researcher has adopted the following one which involves:

1- Visiting the site

<http://srtm.csi.cgiar.org/SELECTION/listImages.asp>

which provides spatial data (coordinates and levels).

First the area under study and neighboring areas are defined, then the related data are downloaded which are in the form (Model SRTM) already referred to. Photo (3) shows the window of the above mentioned site



Photo (3) shows the home page of the site from which SRTM can be downloaded
 2-In order to read the data and represent it in the form of maps, use has been made of Global Mapper which can deal with SRTM model because with the help of this program, data on the area under study is stored in Digital Elevation Model (DEM)--Digital Elevation Mode after it was processed. Photo (4) shows this is a deaf map where road routes can be seen.

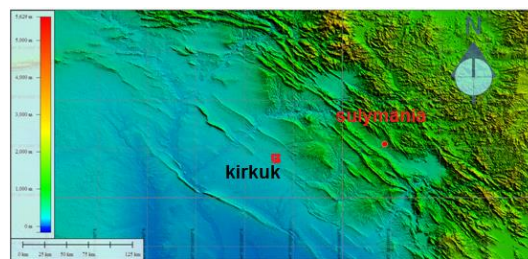


Photo (4) shows the area under study represented by DEM through Global Mapper

Source: The Researcher

3-In order to show the route of the current route which runs from Kirkuk to Jamchamal in the Digital Elevation Model of the area under study has been made of Google Earth. The route is shown in Photo (5). It is represented by DEM through Global Mapper. It matches that of Google Earth

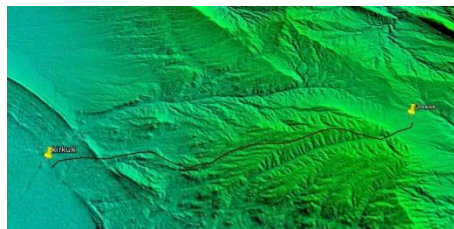


Photo (5) shows the area under study

Source: The Researcher

4-The route for the road suggested to runs from Kirkuk to Jamchaml is based on the Digital Elevation Model which the Researcher has built for the area under study. This route has been selected because it passes through lower land so that an appropriate slope for the road can be achieved and economic feasibility is also accomplished in terms of earth to be removed or used in filling. Also for comparison purpose the current road has been represented
 Photo (6) shows the suggested route (in red color) and the current road (in black color)



Photo (6) shows the suggested route and the current road

Source: The Researcher

5-A longitudinal section has been drawn and the earth to be removed or used in filling is calculated for both to current and suggested roads. Photo (7) shows a longitudinal section and the earth to be removed or used in filling to the current road and Photo (8) shows a longitudinal section and the earth in be removed or used in filling in the suggested route

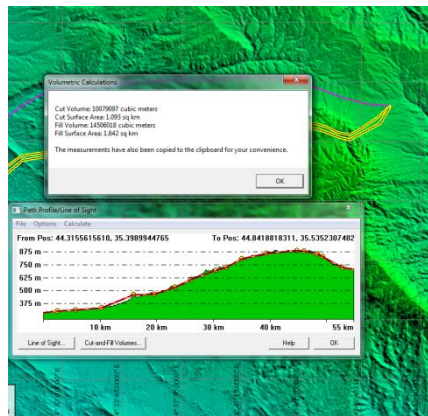


Photo (7) shows a longitudinal section and the earth to be removed or used in filling to the current road

Source: The Researcher

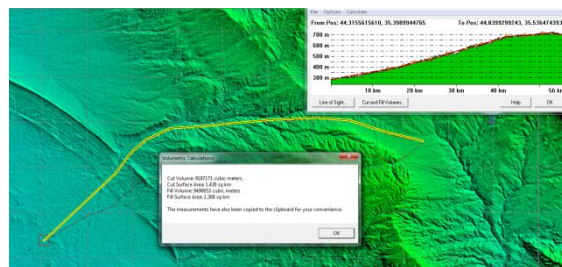


Photo (8) shows a longitudinal section and the earth in be removed or used in filling in the suggested route

Source: The Researcher

6-Table has been made showing coordinates and level of stations along the center line of each road and the distance between one station and another as well as the number of stations. Table (1) lists the information about the current road. It shows some of the early stations and some of last the stations. The total number of stations from the road beginning to its end is 1025. The length of the road is 55.96 km and the distance between one station and another is 54.96 as shown at the end of the table.

Table (1) Information about the current road

Source: The Researcher

Table (2) gives information about the suggested route. The total number of stations from the road beginning to its end is 1026. The length of the road is 54.59 km and the distance between one station and another is 53.26 as shown at the end of the table.

Table (2) Information about the suggested route

Source: The Researcher

7-To the real benefit obtained from Digital Elevation Model, Table (3) has been made in order to compare between the characteristics of the two roads (current and suggested ones)

Table (3) shows a comparison between the characteristics of the two roads (current and suggested ones)

The characteristics of the Road	Current Road	Suggested Road
Road length (km)	55.95	54.62
No of stations along the road center line	1025	1026
Distance between one station and another	54.62	53.24
Road width from one kerb to another (m)	100	100
Lowest level (m)	350	350
Highest level (m)	875	700
Difference between lowest and highest points	525	350
Earth removed (cubic meter)	10079097	9187171
Surface area (cut) (sq.m)	1.093	1.426
Earth fill (cubic meter)	14506018	9490653
Surface area (filled)(sq.m)	1.642	1.368

Source: The Researcher

Part Three: Conclusions and Recommendations

: Conclusions

- 1- The lowest level in both roads is 350 m. The highest level in the current road is (875) m and in the suggested road (750)
- 2- The two roads have nearly the same length. The current road is 66.96 km while the suggested road is 54.63 km long
- 3- The road width and the distance between stations can be change.
- 4- The difference in elevation between the lowest and highest points in the current road is 535 m while in the suggested road it is 350 m. This difference will certainly have an impact on the project total cost.
- 5- The amount of the earth to be removed from current road is 10079097 cubic meter while in the suggested road it is 9187171 cubic meter. This difference will also have an impact on the project total cost. It is worth mentioning the area is rocky in nature and excavation in such soil is expensive compared with sandy or clay soil
- 6- The amount of earth removed from current road is (14506018) (cubic meter) while from suggested road is (9490653) (cubic meter). This difference will also have a great impact on the project total cost
- 7- Surface area in which earth is filled or removed from varies depending on level of the station through which the road center line passes
- 8- The routes for roads between towns can be easily determined by using Digital Elevation Model for each route
- 9- Radar data with 90 m accuracy can be used to calculate the estimated quantities for road projects

Recommendations

- 1-The use of modern technologies and programs related to Digital Elevation Models in execution of roads between towns because of their economic importance in terms of cost and duration
- 2-For optimum accuracy, it is necessary to procure data with 30 m accuracy which will have good economic results in the long run.

References

- 1-Hago, Dafallah Hamdan, Introduction to Road Surveying , Available at <http://www.kutub.info/library/book/598> Internet. Feb,2014 (in Arabic)
- 2-Ete,Bora. Manual for Survey Investigation and Preparation of Road Projects, IRC-SP:19-201
- 3-Kamal, Sultan, Available at A Forum on Planning and Road, Internet August 2013(in Arabic)
- 4-Seeruttum,S.and Crossley, C.P, "Use of Digital Terrain Modeling for Farm Planning for Mechanical Harvest of Sugar Cane in Mauritius", Computers and Electronics in Agriculture,18,pp,29-42,1997
- 5-Al Hamami,AhidThoonShhaab, Building, Building Cells Devoid of Data.in Digital Elevation Models, Journal of Education and Science, University of Mosel, Vol `7 no 2, 2010, p319 (in Arabic)
- 6-Al Shebnni, Ibrahim Naji, Use of Digital Elevation Models to Produce Elevation Map for Diwanya Using Global Mapper, Journal of the College of Educationm University of Qadissiya Vol 6,No 3, 2007, p179 (in Arabic)
- 7-Saed,Haala, the Importance of Studying Digital Elevation Model and Its Different Applications, Journal of Diyala University No 43, 2010 p179 (in Arabic)
- 8-Al Azzawi, AltAbid Abaas, Analysis of Terrain Surface by Using Digital Elevation Models with GIS Programs , Available at <http://www.gisclub.net> ,Mosel University 2000,p1(in Arabic)
- 9-Al-Jawahriy Zuhair Abdul Wahab,,BuildingA Digital Elevation Model forRazaza Lake by Using GIS, International Journal of Engineering and Advanced Technology ,Volume-3, Issue-1, October 2013,p293
- 10- Available at <http://www.startimes.com>, Engineering Science Archive June 2011
- 11-Christopher, J."Geographical I nformation Systems and Computer Cartography",Addison Wesley Longman Limited,1999,pp.19-38s