

Spatial Multi-Criteria Assessment to Select Optimum Route To Improve Transportation Network in Al-Omarah City

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ABSTRACT

The present study is focusing on development the accessibility of (Baghdad-Basrah) highway through choosing a new route for segment near Omarah city center, in addition to improve the level of service of city center network through removing the (Baghdad-Basrah) traffic from the center.

To select the optimum route the Geographical Information System (GIS) with Multi Criteria Analysis (MCA) is used. The segment mentioned above is choosed due to the data availability required as an input for program, represented by control points coordinates, land use, and the existing ground elevation [Digital Elevation Model (DEM)].

As a result of this study the based model to suggest optimum route serving transportation movement and reducing congestion in AL-Omarah city is produced according to required criteria. So the obtained route is started and ended on the origin point of an approximate coordinate of (E695932, N3530317) and the destination point of an approximate coordinate of (E702400, N 3519760) receptively, with about 13 Km length. The main Importance of new route is not passing through city center which reduce the congestion, raising the level of service of center network, reducing the pavement deterioration due to remove the heavy vehicle from passing though the center and finally the new route is shorter than the existing one which in turn reduce the travel time, cost, pollution and noise.

Keywords: Geographic information systems, multi-criteria analysis, planning, best route.

التقييم المكاني المتعدد المتطلبات لاختيار المسار الامثل لتحسين شبكة النقل في مدينة العمارة

الخلاصة

تركز الدراسة الحالية على اختيار مسار جديد لطريق (بغداد-بصرة) الجزء المار بمركز محافظة العمارة و ذلك لتطوير قابلية الوصول للطريق بالاضافة الى تحسين مستوى الاداء لشبكة الطرق الخاصة بمركز المدينة من خلال استبعاد المرور الخاص بطريق (بغداد-بصرة).
لاختيار المسار الامثل فقد تم استخدام برنامج نظم المعومات الجغرافية التطبيق الخاص بالتحليل المكاني المتعدد المتطلبات، وقع الاختيار على المقطع المذكور وذلك لتوفر البيانات

الضرورية لبرنامج نظم المعلومات الجغرافية و المتمثلة باحداثيات نقاط السيطرة و طبيعة استخدامات الارض و كذلك مناسيب ارض منطقة الدراسة. ومن خلال نتائج هذه الدراسة، تم استنتاج موديل لافضل مسار يخدم حركة النقل و يقلل الازدحام في مدينة العمارة حيث كانت احداثيات نقطة بداية المسار المقترح هي (695932 شرقا و 3530317 شمالا) اما احداثيات النهاية فكانت (702400 شرقا و 3519760 شمالا) ويطول 13 كيلومتر تقريبا. الاهمية الرئيسية للمسار الجديد هو انه لا يمر بمركز مدينة العمارة مما يقلل من الازدحامات في المدينة و يرفع من مستوى الخدمة للتقاطعات الموجودة في المدينة و ايضا يقلل من تدهور طبقات التلبيط نتيجة لمرور شاحنات الحمل كما ان المسار الجديد اقصر من المسار القديم مما يقلل من استهلاك الوقود و يقلل من التلوث البيئي و الضوضاء.

INTRODUCTION

Planning a road path to cater for the need of the people is complex and time consuming considering the time taken to define ground rules, define roles and responsibilities and as well put into consideration the different opinion of the stakeholders involved in the planning process, social and environmental needs as well as community and governmental interest. This complex process of planning in most cases might lead to the possibilities of not completing the plan and getting on with the implementation of the proposed project. Because of the above reason, there is a growing need for a tool to design and evaluate urban road networks.

This can be accomplished by efficient computer simulation techniques to aid the analysis of routes traffic networks from various design and user related objectives. Since 1980's, GIS coupled with Multi Criteria Analysis (MCA) has helped to enhance multi-criteria decision making associated with planning process (Roy, 1996). The use of MCA and GIS has helped as a guide for decision makers towards actualizing a desired choice and coupled with geographic information systems to enhance multi-criteria decision making (Chakhar & Martel, 2003). The reason to that is owing to the ability of GIS to manage data spatially in layers and then overlay these layers to perform spatial land-use suitability analyses.

The application of GIS and MCA as a decision making tool has helped in reducing the problems faced by decision makers. This means that the framework adopted during the evaluation must be made explicit so as to allow tracking of the influence of each factor on the evaluation results. This is optimally achieved with the use of GIS and MCA (Geneletti, 2004).

This research aims to investigate the application of computer modeling and graphical simulation techniques for supporting the suggestion of new optimum route in Al-Omarah city from a range of design and user related perspectives, and present a multi-criteria based approach to prototyping road networks in that place.

AIM OF THE STUDY

The main goals of this research are to:

- 1) Describe an attempt for route planning using spatial analysis. The objective is to help decision makers and planners to find the optimum location of the route through a quantitative spatial evaluation and verification process. The

research investigates the options for site selection of a route in a framework of given decision rules. The analysis was carried out by ARCGIS9.3 and decision rules.

- 2) Select the best route location for the (Omarah-Basrah) roadway. Hence, the multi criteria assessment of Geographical Information System (GIS) is used.
- 3) Produce a digital map showing the optimum road path over the area of study.

STUDY AREA

The study area for this research is the city of Al-Omarah, which is one of the cities being in Maysan government in the south part of Al-Iraq. Figure 1 shows the study area.

The Tigris River divides the city into two parts (east & west), one of the main roads that act in the west part is (Omarah-Basra) road that connect among the middle and south Iraqi governments, Figure 2 show the main roads being in AL-Omarah city.

The intersections being along the (Omarah-Basra) road suffer from heavy congestion because of high traffic volume, in addition to that the passing of heavy axle loads that using this road.

The necessary intersections that being in Al-Omarah city is:

Al-Jumhoori Intersection: connect between (Omarah-Btaira) road & Al-Jumhoori Bridge, Al- Jumhoori Bridge connect between the west parts of the city with the east parts (city center). Figure 3 shows Al- Jumhoori Intersection.

Al-Sadder Hospital Intersection: adjacent to the Al-Sadder hospital, Figure 4 shows Al-Sadder Hospital Intersection.



Figure (1) Study area



Figure (2) Main roads being in AL-Omarah city



Figure (3) Al- Jumhoori Intersection

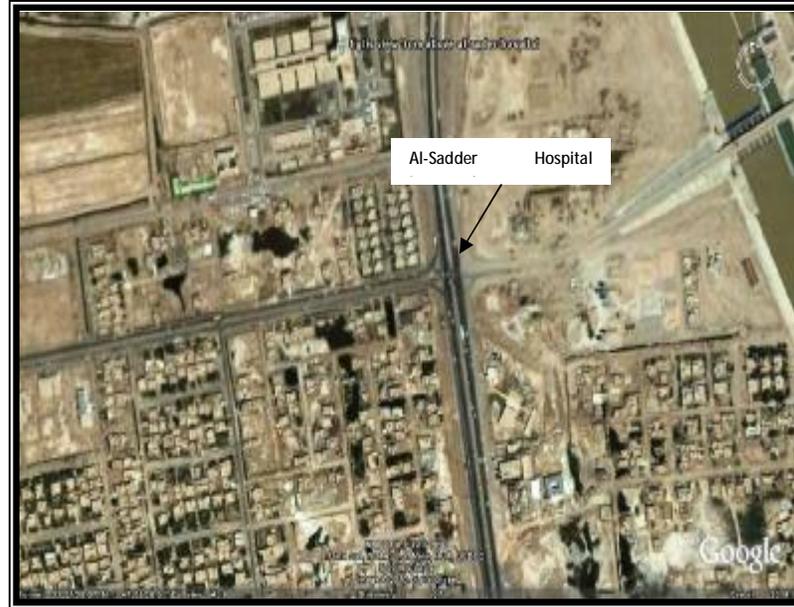


Figure (4) Al-Sadder Hospital Intersection

The flow in the two above intersections is over saturated and about 40% of moving vehicle is north-south (Baghdad-Basra), so that we have to solve the problem in that place. The best solution for solving that problem is construct outer road connect between (Omarah-Baghdad) road (northern Omarah) with (Omarah-Basra) road (southern Omarah) without inter to the city center. Since the majority of the passing vehicles are heavy vehicle that effect in the road like: environmental pollution, noise, the deterioration in pavement layers that effect in pavement performance. The using of GIS tool for solving that problem is the main goal of this research.

RESEARCH METHODOLOGY

New raster-based GIS model that combines multi-criteria evaluation and least-cost path analysis was developed to determine the optimal routes.

The analyst might take the following steps

- 1-Identify the relevant map layers
- 2-Reclassify maps to indicate good or bad area
- 3-Perform a weighted analysis on the map layers

For reaching to research goal

- 1) Visiting the study area, collect the necessary traffic and geometric data, and by using Google earth the necessary image for the study area is produced.
- 2) Land use map was obtained from Ministry of Municipalities and Public Works, the land-use over the area of study is classified into ten different classes. The different land-use classes are used to present the different

terrains over the area of study and these was used in the final judgment to determine the best route path. Land-use map is classified into ten classes which include open spaces/recreational, date palm groves, residential, administration & security, industrial area, commercial area, river, health area, educational area, cultural/ tourism, as shown in Figure 5.

- 3) Digital Elevation Model (DEM) is used to represent a ground surface or a terrain. DEM is downloaded from Global Mapper software. It presents the elevations in a form of raster. DEM required in a variety of applications and in most cases are common basis for digitally-produced relief maps that are used in geographic information systems (Gallant & Hutchinson, 2006). DEM of the study area is shown in Figure 6.

In this implementation, the best route is found. The steps to produce such path are outlined below and shown in Figure 7. Path is performed using ARCGIS 9.3 Spatial Analysis Module.

- 1- Create source, destination and cost datasets
- 2- Generate a thematic cost map (classify and weighting)
- 3- Perform cost weighted distance
- 1- Create direction datasets and perform shortest path

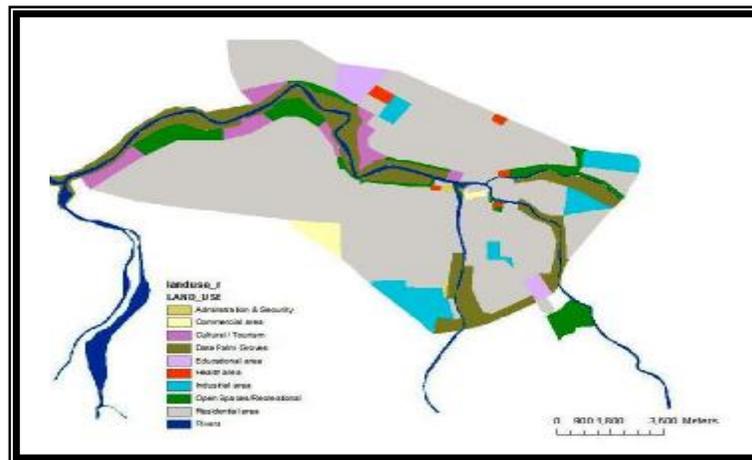


Figure (5) Land use within the study area (Ministry of Municipalities and Public Works)

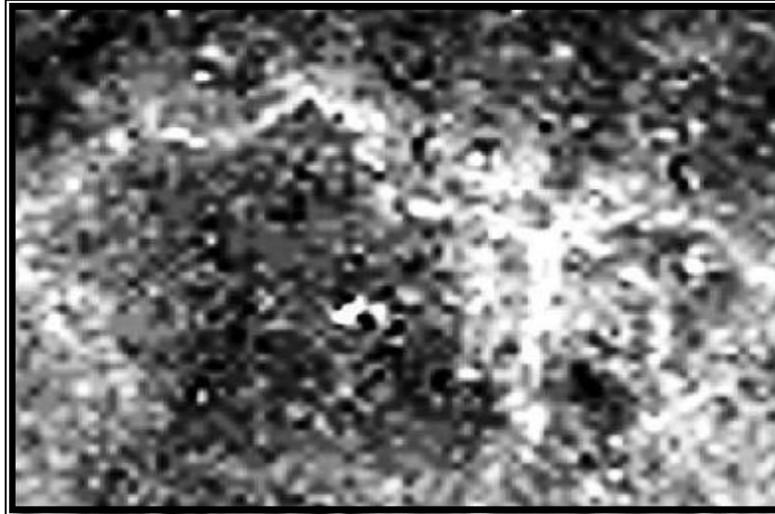


Figure (6) Digital elevation model (DEM) for the study area downloaded from Global Mapper software

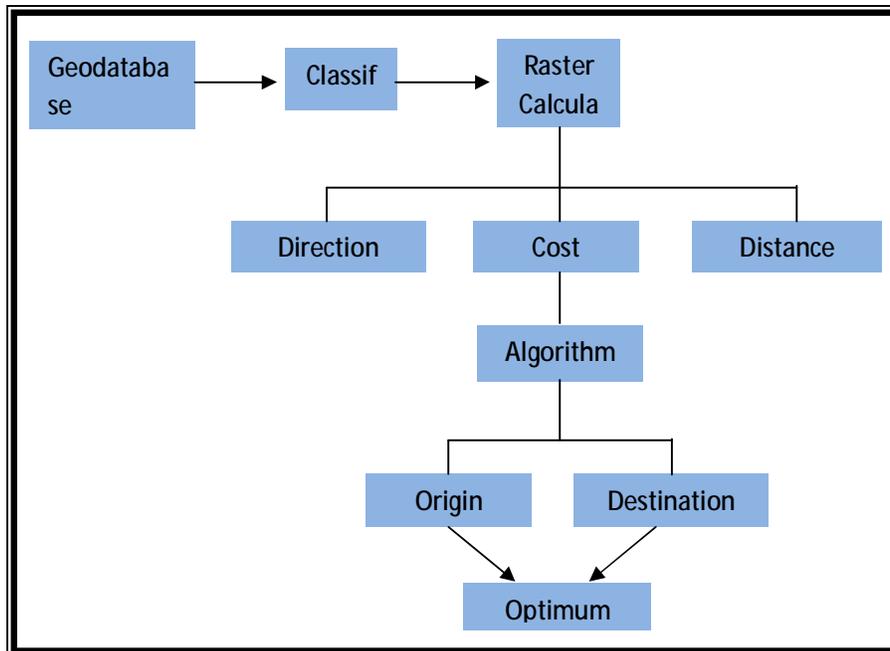


Figure (7) Algorithm of conceptual model for optimum route (Jill Wilson (2008))

The model logic can consider multiple criteria simultaneously (i.e. land use, elevation, distance). Digital Elevation Model (DEM) and land use data are overlaid in GIS to generate cost dataset, so all processes are made on raster format. The start and destination points for the road path were created using ArcMap9.3. The reclassified map helps to differentiate a bad area from a good one to build a road path. In the reclassified map, 10 values was used to represent good areas with low cost value to build a road while 1 represents bad, on which it a high cost to build a road. Program dialogue box for reclassified maps for land use, and distance to existing intersections are shown in Figure (8), and (9). In this model, reclassifying the distance to existing intersection is shown in Figure (10). The optimum route produced from the research is shown in Figure (11). MCA-Model obtained from GIS for the optimum route is shown in Figure (12).

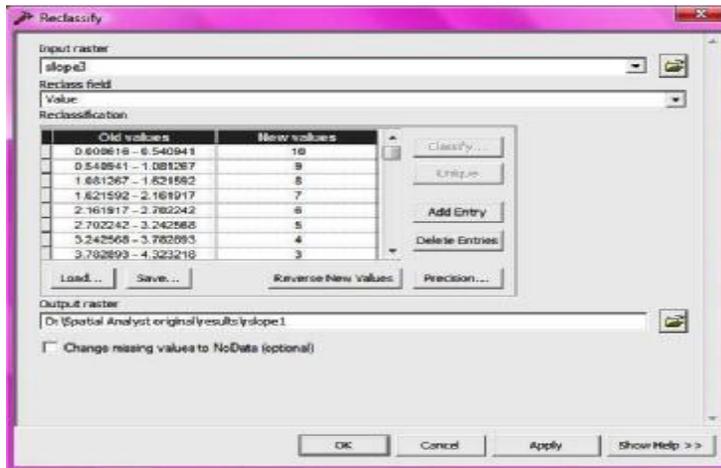


Figure (8) Program dialogue box for reclassified map of slope output

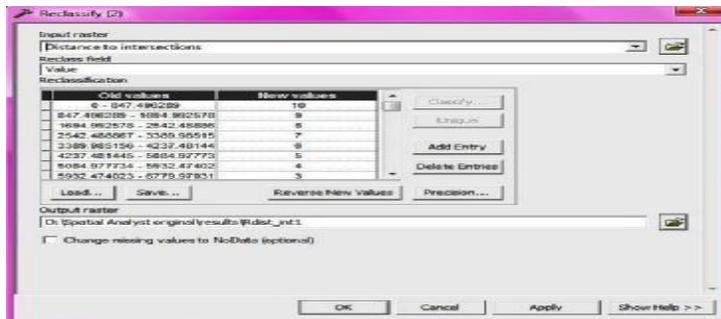


Figure (9) Program dialogue box for reclassified map of (distance to existing intersections)

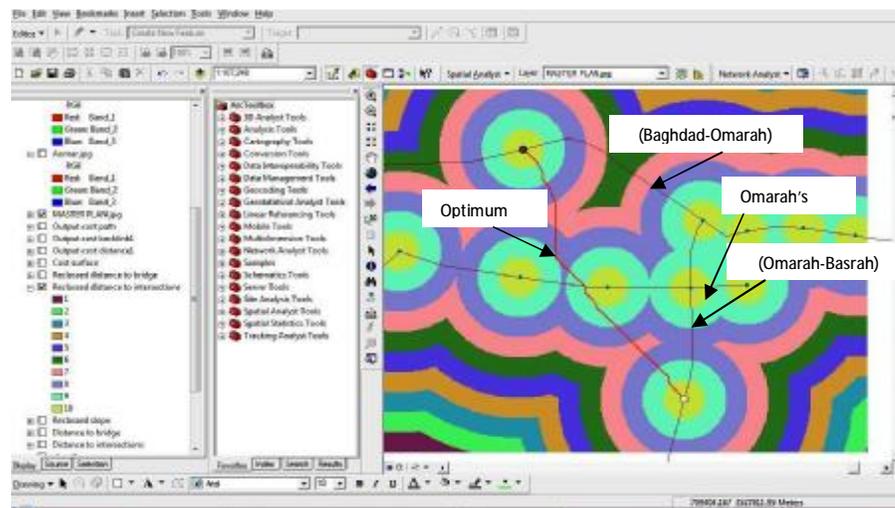


Figure (10) Reclassified distance to existing intersections

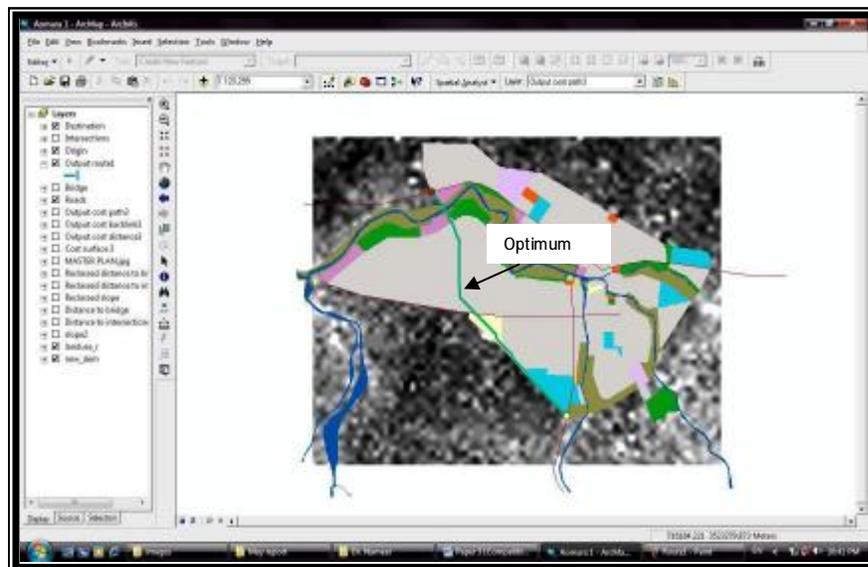


Figure (11) Optimum path over land use map and DEM

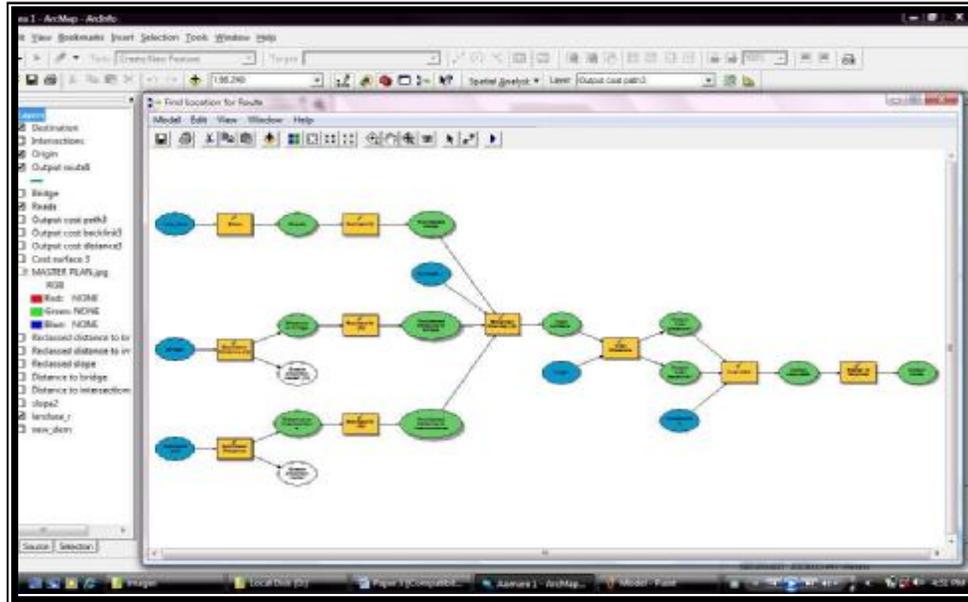


Figure (12) MCA-Model obtained from GIS for the optimum route

CONCLUSIONS

This research investigates how non-spatial and spatial data can be integrated within a multi criteria decision framework to formulate and select best suitable route. The selected roadway is started on the origin of an approximate coordinate of (E695932, N3530317) and the destination of an approximate coordinate of (E702400, N 3519760), with 13 Km length.

The GIS based analysis as applied to the present research demonstrated that; multi-criteria approach is recognized to be used as a tool for the optimum route selection by considering different factors those affecting decision-maker selections. Finally, it saves money, time and effort.

The main advantage of the new route is that not passing through the city center which reduce the congestion and improve the level of service of intersections at center due to removing the trucks which pass through the center currently. Furthermore the new route length is 13 Km which less than the current route in about 3 Km.

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