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A DIGITAL MAP OF THE APPROPRIATE ROUTE OF RIVER NAVIGATION IN THE TIGRIS RIVER OF BAGHDAD BASED ON THE SURVEY DATA OF LONGITUDINAL AND TRANSVERSE SECTIONS OF THE RIVER, REMOTE SENSING TECHNIQUES AND GIS

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ABSTRACT
In this study, a model of an integrated river navigation database was constructed in Baghdad and applied to regulate the path and assess the river's validity based on the data of the bottom-up bathymetric survey by using the Echo Sounder device. This may help to choose the appropriate signature for the stations of reception and departure near the bridges between Karkh and Rusafa and contribute to the reduction of traffic and the creation of alternative river streets and determine the points of the path of navigation and accessibility by building a set of layers built on detailed corrected maps and images of high and modern spatial accuracy of Ikonos And Quick Bird 2 for the year 2015. Then, a spatial analysis of the geographical database designed for application in the transport sector is conducted .The results of the spatial analysis were linked to the application of Itracking GPRS and Tracking GPS devices that connect to navigational vessels and transmit digital signals either via messages on the mobile or via a digital control system to regulate the navigation path. The study indicates the success of the integration of spatial analysis of field surveys of the river bed and space surveys, and the technique of Geographic information systems in the selection of accurate route for navigation and the selection of transport stations and submarine vehicles and the appropriate load for transport according to the validity of the river.

KEYWORDS: bathymetric survey, Echo Sounder, river, navigation, GPS.

INTRODUCTION

The problem of transportation in the cities of Iraq, especially the city of Baghdad, is a real complex problem, especially that "most of the cities of Iraq, including Baghdad, are characterized by horizontal expansion, which causes successive pressure on the service in addition to many other problems related to transportation and traffic jams. This might be complicated by the random importing of cars, all of which lead to complex difficult to solve problem. The problems of transport in the developed world has been disintegrating and almost fade through adapting plans, programs and scheduled strategies based on the use of scientific and technological research and the activation of its role in solving the problems of transport in and out of cities. The situation of Baghdad city on the banks of the Tigris River along the 49 km and the occurrence of the most crowded inhabitations on both sides of or close to the river banks has facilitated our study to find alternative paths of transport connected to land transport network and unloading traffic congestion and easy access as well as "to a high-level techniques help digitally" speed up access to the results, the data and information tabulated stored in databases of GIS Database GIS that open with any teacher of spatial phenomena (bitmap, linear, spatial) according to a specific reference map system that allows the possibility of spatial analysis and utilization of these data .The development of satellite systems, especially "GPS systems Which is characterized by its modernity and the amount of information it provides in the field of transportation by measuring distances, speed and time, GPS coordinates and the determination of land heights, as well as the possibility of interfering with GIS programs and also enable the possibility of deviating the shortest way to the wheels and turn the course and reduce the response time by directing Control Center, which allows the integration of the GIS & GPS system in one.

The problem of this research can be summarized in whether the Tigris River , especially the part passes through the city of Baghdad, is fit for river navigation or not?. Can remote sensing techniques and geographic information systems help to determine the extent to which the river is suitable for river transport and to determine the length of the route? And can stations be chosen to overcome traffic jams associated with the local land transport network.

Hypothesis

The availability of bottom river pathological scanners and modern techniques of remote sensing, like GIS and the global data systems have facilitated the process of river classification and selection of the appropriate routes. These systems also help in locating anchors, stations, waiting and departure and accessibility.

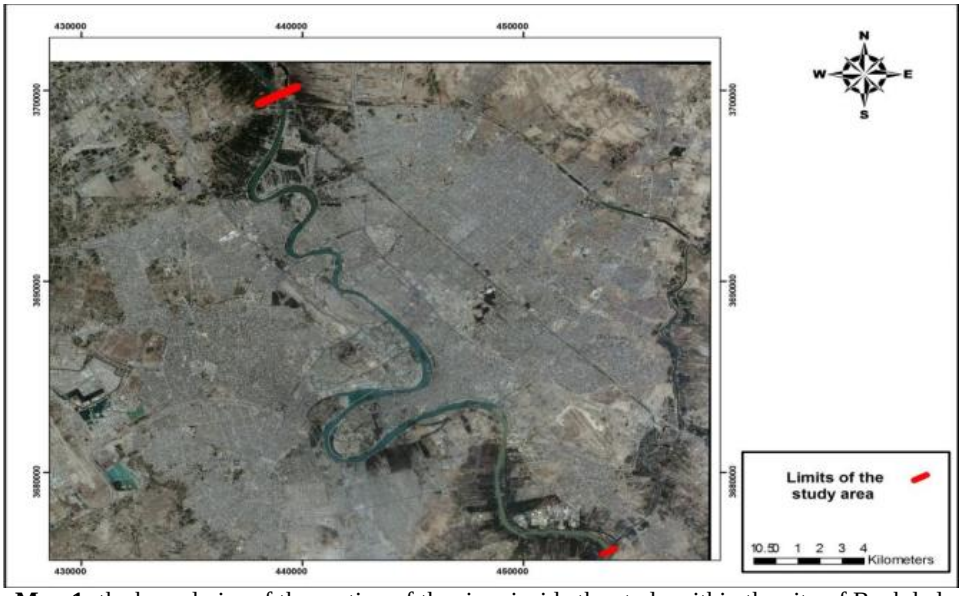
Aims

1. Assessing the current geomorphology of the Tigris River in terms of navigation.
2. Suggesting solutions to the obstacles of river navigation in Baghdad
3. Highlighting river transportation as a radical solution to the problem of traffic congestion in Baghdad

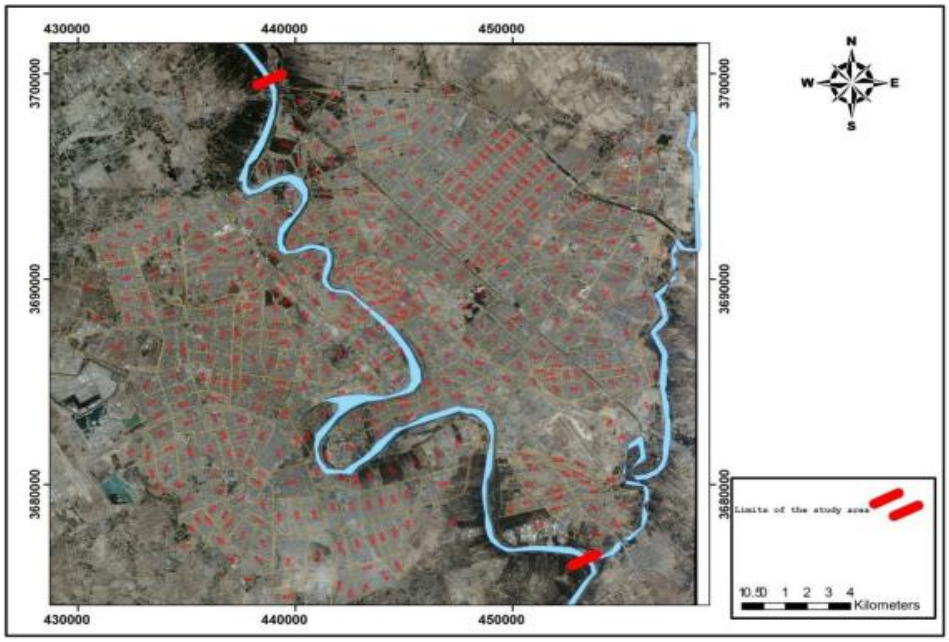
4. Introducing remote sensing data in the case study of the Tigris River and the testing and analysis of the data to determine the river's suitability for the flow of river vessels.
5. Preparing of maps indicating the transport routes to be followed for the transportation of boats according to the correct track by GPS.

Limits

This study is limited to the area of the Tigris river located between the Al Muthana bridge North and Zafarania south at the junction of the River Diyala 49 km (see map 1 and map 2). The astronomical site is located between (20 4344 ° "E 33° 25'42.737" N) And "30 2044° 6" E 33° 13'13.017 "N) Circuits.



Map 1: the boundaries of the section of the river inside the study within the city of Baghdad
Source: Geo database by Geographic information systems



Map (2) Location of the study area by residential area
Source: Geo database by Geographic information systems

The importance of river transport

The importance of river transport in the province of Baghdad lies in the fact that Baghdad is placed in a central situation for the provinces of Iraq in terms of urban, social, commercial, industrial and administrative aspects. Baghdad is the front of Iraq in which embrace the largest population in the country. In addition to that it is an important transport center for Iraq. The importance of river transport in Baghdad can be related to:

1. The economic feasibility: where river transport is the cheapest means of transport in the world. In this respect, the Tigris river represents the lifeline of Baghdad.

2. The social aspect: The Tigris River, if well exploited for transport, is a good means through which families and people can be linked and entertained.
3. The situation: The Tigris river is important because most of Baghdad's commercial, health, industrial, recreational and educational areas are located on it. It actually links most parts of Baghdad.
4. River transport does not require periodic maintenance, but river dredging in separated intervals.

Water discharge

The difference in water levels in the river has an important role in determining the suitability of the river for navigation. Water discharge is defined as the amount of water exists at a given moment and can be measured by unit (m3 / s). The river section in question in the study varies in water discharge from one year to another according to the amount of water released by the spring country (Turkey), not to mention climatic and other hydrological factors, and the scale of river discharges for the period from 1930 to 2015 Show that water discharges are highest during the period from January to June due to the amount of water received from increases in rain from the basin as well as the melting of ice. The water levels of the Tigris reach their peak in February, March and April, and fall to the lowest levels in September (see Table 1 and Figure 1). This seasonal water system affects the water level in the river and accordingly, it determines they type and size of the water transport method which can be used for navigation. So, it is necessary to study the level of water level and determine the deep places in the river and draw lines for navigation paths.

TABLE 1: River drainage in the city of Baghdad for the year 2015

Water discharge rate (m3 / s)	Month	Water discharge rate (m3 / s)	Month
497	7	935	1
425	8	1050	2
395	9	1399	3
553	10	1063	4
595	11	933	5
782	12	623	6

Source: Ministry of Water Resources, Baghdad River Irrigation Department, Monthly rates of discharge of rivers, water and sediments at Baghdad Saray station for 2015 unpublished data

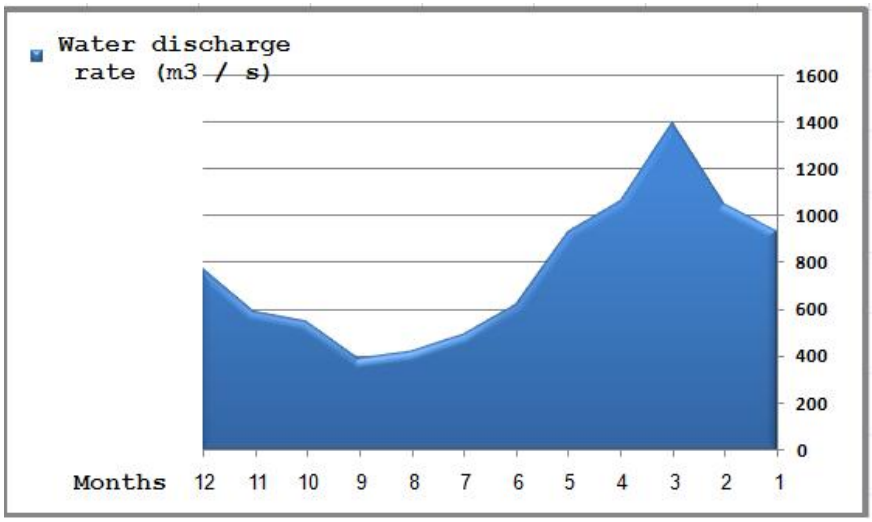


FIGURE 1: River drainage in the city of Baghdad for the year 2015
Source: Dependence on Table (1)

Reflection of electromagnetic radiation from water

Most of the radiation on the water is absorbed by the water and only few is reflected. Water absorbs most of the fallen radiation, which makes it different from other surface materials in the images taken within the range of nearby infrared radiation, as for radiation in the visible waves, most of it is carried out through water and reflected about 50% from him . The reflection of the water bodies is influenced by several factors, the most important of which is the depth of the water surface and the materials it contains. The radiation, which is reflected from the shallow water bodies, is reflected from the bottom materials. Therefore, the depth can be estimated in the net water which is less than 40 m depth, the suspended materials and chlorophyll existed affects the nature of the reflected radiation. Water containing large amounts of suspended sediments reflects the radiation of visible waves rather than pure water and the amount of suspended materials can be estimated by the remote sensing video analysis. If chlorophyll is available in large quantities, it provides a reflection of the radiation of the blue and red waves and the lower waves of 0.6 μm and increases the reflection of the green rays and this helps to know the concentration of plants. The higher the wavelength, the higher the radiation absorption rate, the less the reflection rate of the water surface and the reflection peak at the 0.45 μm wavelength. The water locations in the satellite images can be precisely identified and appear in the images in black.

Instruments of the Study

Remote sensing devices and programs

The data for the satellite Landsat 7 ETM + for the seven-channel study area was adopted for the purpose of conducting digital classification methods for the processing of visualizations in its two types (Supervised Classification and Unsupervised Classification) based on ERDAS IMAGEN 8.4. The researchers also utilized the topographic maps and geology after the process of engineering correction according to the reference basis ZONE 38 WGS 84 and also rely on government reports, surveys and previous studies. The data used to study land cover are of a different type of spatial data used in other studies in terms of satellite type and specification and the number of satellite spectral varied bands (Al-Anqari, 1989:15). In such a study, it is helpful to employ a pattern of digital processing of high and visual mechanism which depends on the spectral difference according to the amount and the quality of reflection of radiation. Materials differ according to the amount of radiation, plants, for example, reflect waves with 0.6 - 1.4 micrometers lengths, while water reflects waves with 0.4-1.4 micrometers lengths, so each material appears distinctly from the rest of the material and takes a specific reflective color. This is called spectral signature (Abd al-Hadi, 2000:33).

This spectral signature is accurately extracted when the spectral channels are multiplexed by the sensor. The sensor is a device that can receive and record the reflected radiation from the studied material or emitted from it within one spectral field or several spectral fields. Special sensors have been designed to study land cover from space to suit air windows. In special cases, sensors are designed to match the atmosphere or nature of the study. Sensors can be divided into video cameras, aerial photography, space cameras, radiometers Rays within spectral bands, spectrometers that record rays within a specific spectral area of the study area (Sabins, 1996: 281). These scans do not use imaging films to record the rays but scan a regular area of the earth. This system enables data to be recorded on magnetic disks using hypothetical numbers representing the different color intensity of the studied targets. The values vary between (0 – 255) degrees of gray color for the various spectral fields and the brightness intensity are recorded for the smallest area to be discerned on the ground.

Stages of Work

The work steps aim at preparing digital maps of the river navigation through a mapping system to perform the mapping tasks in the computer environment by entering, processing and outputting data in line with the map display, which helps the user to diagnose problems to provide solutions and then to make decisions (Al Qassab, 2010:54). The stages of the project of the fitness of the river navigation goes through several procedures, these are:

Subtraction of the study area from the image (subset image)

Determining the study area from the geometrically corrected image is done by selecting the AOI square of the Erdas imaging program for the desired area so as the data of the cut-off image become electronically determined after the previous geometric correction. Therefore, the system shows the coordinates and angles of the image according to the correction (see image 1)

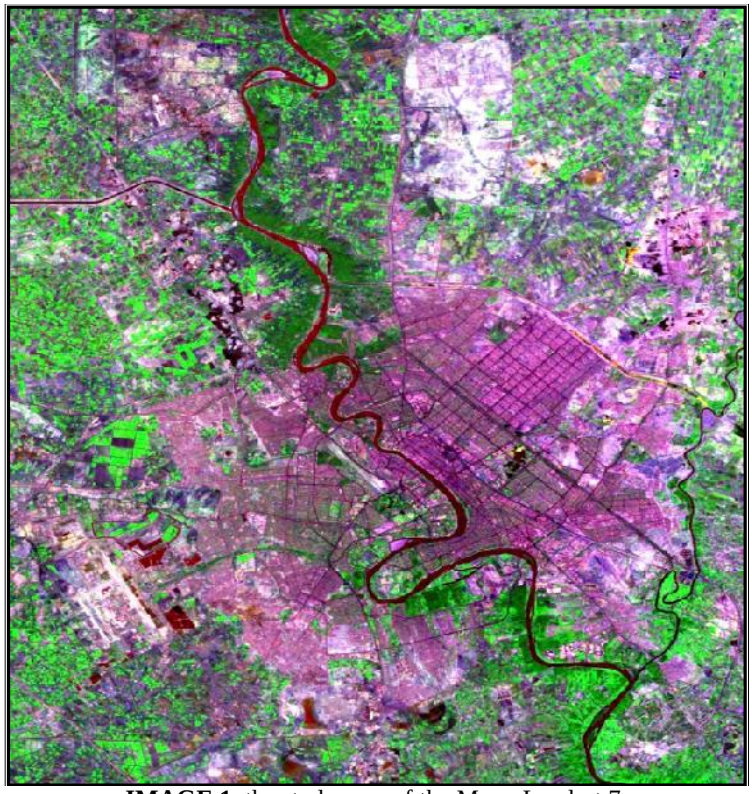


IMAGE 1: the study map of the Moon Landsat 7
SOURCE: US Landsat satellite visible for 2015

Software used in the study

Data was processed using ERDAS 8.4 software ARC GIS

Steps of constructing a GIS database

First: Indirect digital information

1- The stage of Classification, treatment, and analysis

Image classification

Classification means dividing the image into geographic regions according to the values of the image elements. The classification can be based on numerical values using the information of more than one zone of Landsat ETM+ satellite. However, there are two ways to classify the multivariate spectral image, the controlled and uncontrolled classification. Controlled classification requires ground measurements through spectral signature representing classification categories, while in the uncontrolled classification; the computer identifies and divides information into several categories based on the relationship between the numeric values of the ranges used. The uncontrolled classification is usually applied first and the validity of the categories is checked by applying the controlled classification with reference to the field work to determine the sample and then determine the signatures of the image to be applied by the computer on the information taken from the sample. Due to the difficulty of achieving field information related to the bottom of the Tigris and due to the limited time available, the main phenomena of The Tigris were analyzed dividing the area according to the application of the controlled classification into 6 categories as shown in the figure (2).The classification included deep water - shallow water - sedimentary deposits - silt and gravel.

The aim of images' classification is to isolate all components of the image in different types of land cover that adopt pixel values which record the spectral values of each object on the spectral pattern and spectroscopy. It is difficult for the human eye to interpret and classify the image according to the gradation of gray color. This process is used instead of the manual process isolation and the automatic classification and classification. This can be effective in drawing objective maps which in turn help in the process of creating database for the studied area.

However, there are two types of digital classification:

1. Unsupervised classification

This type of classification does not depend on extracting training samples, rather, it is a classification based on dividing the image into categories according to the statistics of mathematical equations based on image statistics through which similar values of spectroscopic intensity are isolated based on the cluster classification of values (Cluster Analysis). This method aims to determine the number of items to be classified and then after the completion of the classification process, the implications of categories are recognized by utilizing the topographic maps, previous field surveys, and work experience in visual interpretation and recognition phenomena by comparing the classification with nature.This classification is the most commonly used when the aim is to classify the land cover, especially for areas where it is difficult to obtain training samples or is difficult to access. The unsupervised classification of the study area with 6 categories is conducted by using the ISODATA∗ method (See Figure 2 and Figure 3). This method is based on the initial identification of the centers of the categories cluster in a space above the number of spectral channels, and it provides accuracy in the statistical distribution of the abnormal species. However, this method sometimes shows overlapping in the classified elements and some categories were reduced to produce a final objective map (see map 3)

2. Supervised classification

It is a classification and isolation process based on the determination of the spectral signature already achieved as a model and mathematical calculations of the ERDAS IMAGEN 8.4 program according to the classification of each of the image units based on its proximity, frequency and compatibility with the training samples in terms of spectral response.

Training stage

It is the basic stage on which the categorized classification is based exclusively by extracting the spectral response by taking the training samples for each type of image land cover and their number and storing them in a table called contingency table. The success or accuracy of the classification depends on the accuracy and realism of spectral signature extraction and the number of spectral channels of the image through the work experience of the classifier or through previous maps of the region showing some categories or through reference data source for topographic maps and preliminary field surveys .The samples were taken for the study area and the image was classified into 6 categories of land cover or more and the levels and degree of desertification (see Figure 2). However, there are several factors on which the accuracy and selection of categories for classification is based, these are: the environmental nature from which the samples are drawn, desert, forest, Barren land, coastal, water, etc.),

The ability of spatial discrimination is the smallest area the sensor can distinguish on the surface of the earth called the pixel image element, as well as the ability to distinguish the time which is the interval between a survey and another of the same region,i.e., the time period between a visit and another of the area by the satellite (Saleh, 1972:56). There are different types of supervised classification; this study utilizes the maximum likelihood classification which depends on the calculation of the amount of correlation and the approach of the spectral model by isolating the unknown pixel and comparing it with the pre-determined spectral signal based on its reflectivity, similarity and model values. Respond to any class entirely through the mean vector and the covariance matrix (see Figure 2). It is worth mentioning that a large number of varieties are taken and work on the integration of the most similar and similar types through the consolidation of Recode any consolidation and reduction of some items and then produce an objective map.

The study concludes that the data extracted from the images of remote sensing can determine the natural extension in the sea water with acceptable accuracy, and the most important factors that helped to apply the level of the threshold on the shore of The Tigris is the normality of topography and free images of sensing problems. To evaluate the classification process to distinguish between

water and others of land categories, it can be judged as successful and this study constitutes the ground for the proposal of several studies including:-

- Classification of natural resources in the Tigris River area of Baghdad through remote sensing images.
- Identifying sites suitable for entertainment and tourism activities according to the requirements of each activity.
- Assisting in selecting suitable places for stations through remote sensing data.

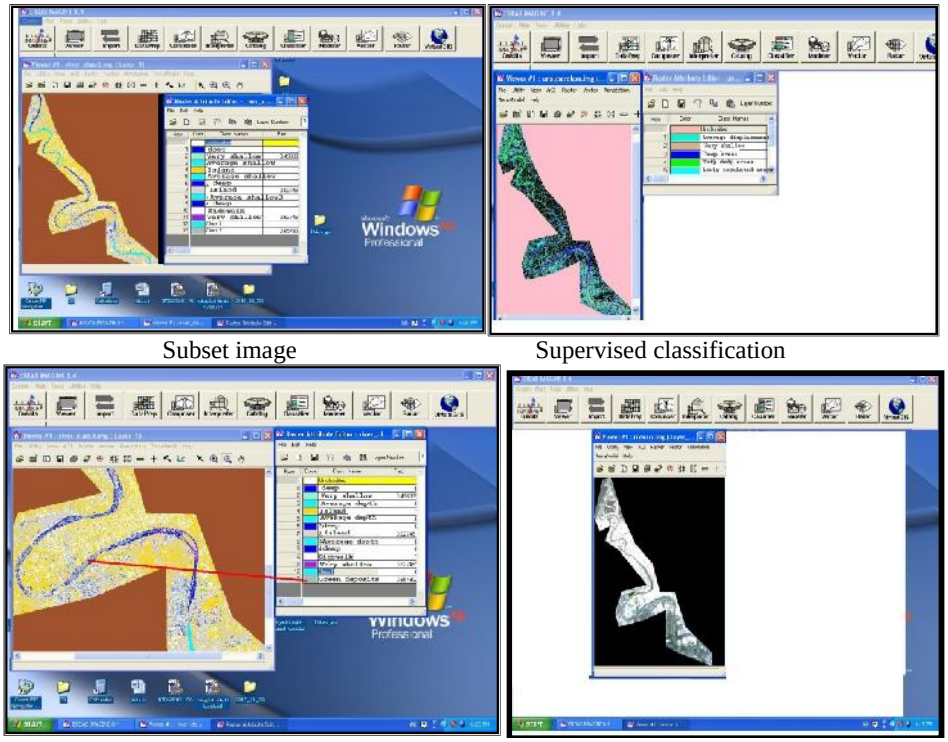


FIGURE 2: Contingency table for spectral signature
Unsupervised classification unsupervised classification Source: Of the work of the researchers based on classification image Sat satellite Landsat 7

2-Stage of using field surveys of cross-section and longitudinal river

The phase of the field surveys is one of the complementary stages of the remote sensing survey using the data taken by the Ecoho Sounder for selected sections and points of the river in order to find the depth of the river (see Figure 3 and 4) which illustrates models of cross-sectional and longitudinal sections adopted in the study, which are 7 out of 155 sections covering the study area.

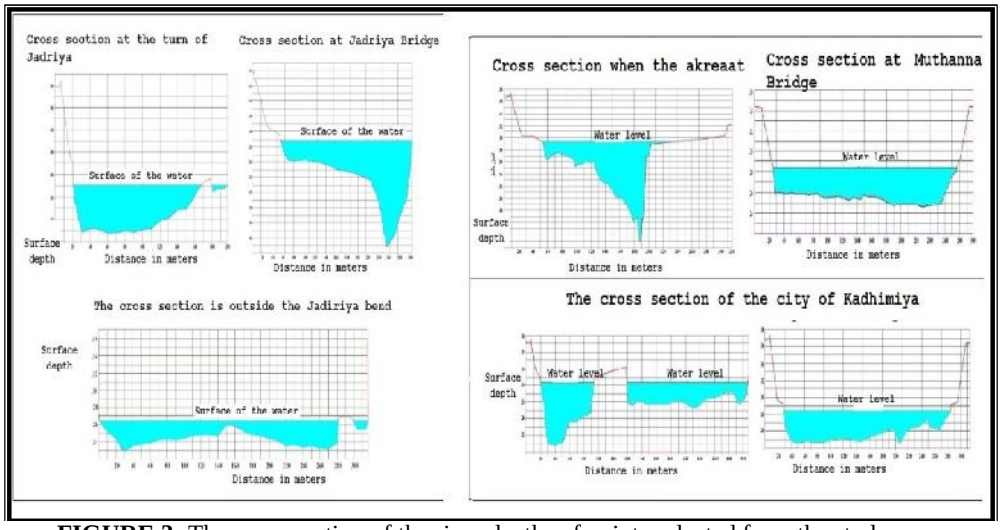


FIGURE 3: The cross-section of the river depths of points selected from the study area
Source: Depth meter (ECHO SOUNDER)

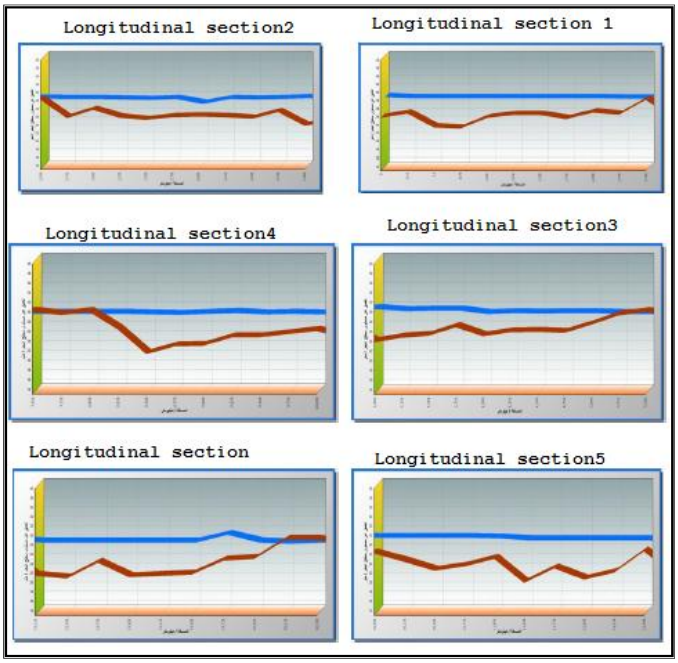
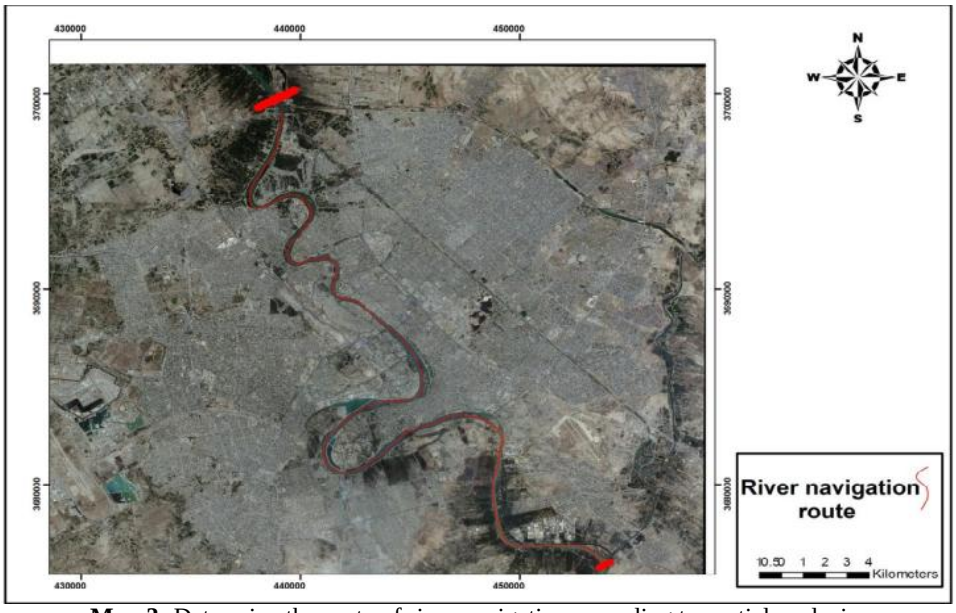


FIGURE 5: The longitudinal section of the river depths in the study area of the selected points
Source: Depth meter (ECHO SOUNDER)

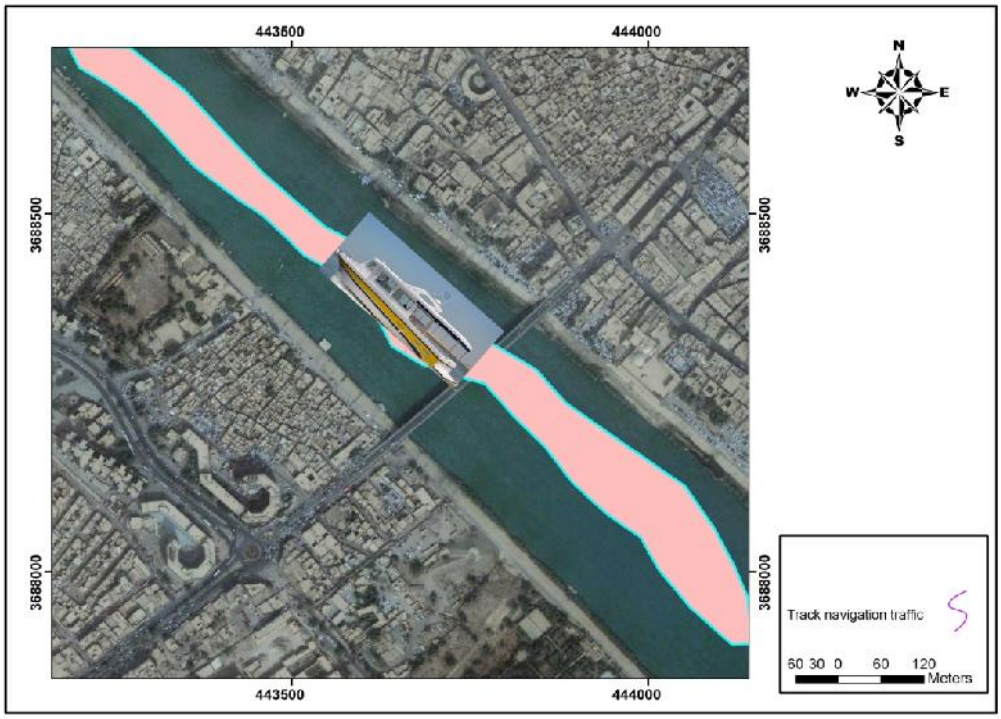
The analysis of cross-sectional and longitudinal sections of the Tigris river indicates that the topography of the river bottom is not equal as it differs in depth and width. It is found that the minimum depth of the river in Baghdad is 4 meters which can be used to determine the type of navigation mode, while the deepest point in depth is about 21 meters especially in the river turns. With respect to the width, within the range of this depth, it is found 140-280 m which is suitable for all types of river transportation boats. The path of the river is accordingly drawn. However, the advantage of turns is that the entrance of the river turns should be close to the concave bank of the turn, i.e., any boat should be not farer than 25 m so as not to enter the shallow water.

Spatial Analysis Results

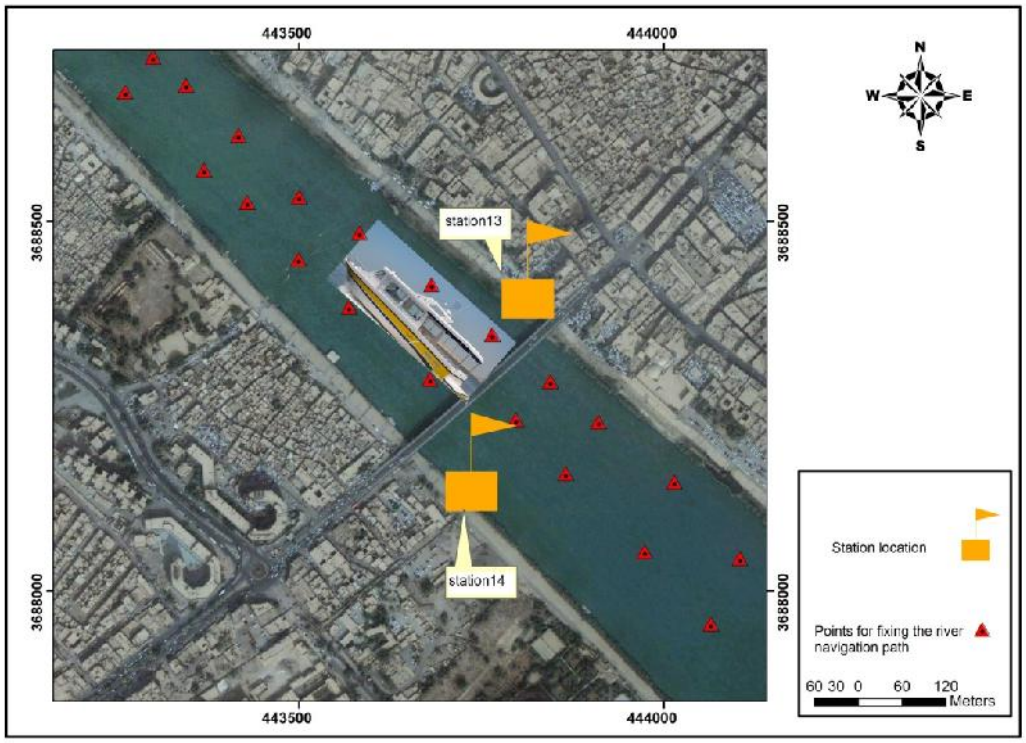
In this study, all previous research data represented by the results of the digital classification of the image as well as to the introduction of field surveys of selected points of the river have been included. The depth of the depths was illustrated in longitudinal and longitudinal manners. These results were entered into a geographic database for processing and analysis. The result is a navigation digital map for the river route in Baghdad. The route is defined as an average navigation distance of only 140-280 meters, which is the width distance suitable for navigation after dredging some of the islands that obstruct the navigation route (see map 3 , map 4 and map 5).



Map 3: Determine the route of river navigation according to spatial analysis
Source: Geo database by Geographic information systems



MAP 4: Determine the route of river navigation according to the spatial analysis of the selected section
Source: Geo database by Geographic information systems



MAP 5: Determination of the route of river navigation according to spatial analysis of a selected piece of **GPS**
Source: Geo database by Geographic information systems

Proposed stations for river navigation

The identification of sites for the establishment of stations and berths for river navigation in the area in question depends mainly on the suitability of the river and the appropriate depths, as well as the connection of the river transport network to the land transport network, i.e., the streets of the city. The river network of transport must be integrated with the land network. Accordingly, field study conducted on the banks of the Tigris River in the study area is adopted to determine the appropriate places for the establishment of stations or anchors and using the GPS device and take points and record them on the table of ARCMAP9.3 program. Then, maps of the stations are drawn(see Figure 8).

FIGURE 8: Proposed stations for departure and arrival based on the GPS program
Source of the work of the researchers based on the field study

Applications of the geographical database in the management of transport and regulation of the traffic of river boats

Source: Based on field study

Applications of the geographical database in the management of transport and regulation of boats traffic

There are a large number of applications elicited from GIS databases that benefit from the spatial signature feature in the coordinate systems through GPS technology, which has enabled the development of many transport management equipments, which are called many names but the working principle of which is almost common in their employment of databases, system and high resolution satellite imagery and their adoption of digital maps prepared in GIS programs. However, these devices may differ in naming and in the type of services they provide, which are determined by the amount of subscription, the type of services and the type of device connected to the river in terms of its smallness and the characteristics of its use and the possibilities of these devices and their use in transportation and human comfort and their contribution to sustainable development. Among these services are the devices of tracking and organizing river vehicles.

Applying the experience of vehicle and people tracking device in river navigation (GPS, GPRS)

The application of these techniques is not new in the world, but it is new in Iraq and it is also limited and confined to the private sector which uses GPS, GPRS. The process of locating the vehicle on Google Earth (Iraq digital map) is directly done or through preparing in advance layers of Baghdad. The user, then, can determine the type of digital maps to be used in tracking the vehicle (see Figure 9).

FIGURE 9: Principle of the operation of tracking systems based on the global signature system and GIS

The vehicle's current and previous traffic is directly displayed and monitored if it has information storage system which can provide the following:

1. Calculations of the number of miles traveled by boats.
2. Vehicle condition (parked / moving).
3. Engine condition (on / off).
4. Continuous checking of boat performance during the journey.
5. The speed at which boats move.
6. Sending instant and accurate reports which can be downloaded and printed, either on video format, or printed on papers for the purpose of keeping reports and refer to them when needed.
7. Determining the area of boats work, for example the capital Baghdad, in the case of the boat leaving the navigation lane, a report or alert is sent that the boat passes the navigation limits.
8. Determining the position and speed of the boat by GPS.
9. Real tracking of boats (every second with continuous updating) or as per the beneficiary request tracking system with dates installed.
10. Special tracking enables that help to track the boat or fleet of boats according to a special secret number.
11. An integrated and efficient system to identify the captain and ease of installation and operation.
12. Create rules and alerts by specifying the route of the boats on the map.
13. All the details of the boats (engine number, boat number, type, model) are entered into the information system. Full observation of the cars is also possible with periodical reports of the hours, day, week and month of the routes.
14. Saving about 15% to 40% of fuel and spare parts, car consumption and value of fines at the annual renewal.
15. Regular and irregular drivers in the work can be easily identified. Reports are provided of the violations carried out by the vehicle for speed in place and time.
16. Vehicles that consume fuel or spare parts above the normal rate can easily be detected.

CONCLUSION

1. The study indicates the efficiency of maps produced by geographic information systems (GIS) in representing spatial relations and establishing the relationship between river suitability and river navigation easily, with great clarity and accuracy.
2. The study also refers to the possibility of expanding the experiment of using GPS systems expressed in the organization of boats movement and the tracking of ships in the governmental departments, as this technique helps to reduce the time and effort and provide the cartography quickly and accurately. The application of this system supported by geographical database is likely to contribute in building sustainable development.
3. Data, information and corrected digital maps give precise spatial location information and thus speed of access, traffic jam reduction and provide alternative streets to the city of Baghdad and thus contribute to sustainable development.
4. The integration of tracking and geographic information systems may provide great potential service for the transport sector and thus may regulate public resources and help to provide comfort for humans.
5. The observation and control system of vehicle may allow the introduction of new modes of river transportation systems linking the streets of the studied area.
6. The analysis of cross-sectional and longitudinal sections of the Tigris River indicates that the topography of the river bottom is not equal as it differs in depth and width. It is found that the minimum depth of the river in Baghdad is 4 meters which can be used to determine the type of navigation mode, while the deepest point in depth is about 21 meters especially in the river turns. With respect to the width, within the range of this depth, it is found 140-280 m which is suitable for all types of river transportation boats. The path of the river is accordingly drawn. However, the advantage of turns is that the entrance of the river turns should be close to the

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