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Digital Geomatics Trends for Production and Updating Topographic Map by Using Digital Generalization Procedures

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Abstract**—**An accuracy digital map must satisfy the users for two main requirements, first, map must be visually readable and second, all the map elements must be in a good representation. These two requirements hold especially true for map generalization which aims at simplifying the representation of cartographic data. Different scales of maps are very important for any decision in any maps with different scales such as master plan and all the infrastructures maps in civil engineering. Cartographer cannot project the data onto a piece of paper, but he has to worry about its readability. The map layout of any geodatabase is very important, this layout is help to read, analyze or extract information from the map. There are many principles and guidelines of generalization that can be find in the cartographic literature. A manual reduction method for generalization depends on experience of map maker and therefore produces incompatible results. Digital generalization, rooted from conventional cartography, has become an increasing concern in both Geographic Information System (GIS) and mapping fields. This project is intended to review the state of the art of the new technology and help to understand the needs and plans for the implementation of digital generalization capability as well as increase the knowledge of production topographic maps.

Keywords**—**Cartography, digital generalization, mapping, GIS.

I. Introduction and the Recent Studies

TOPOGRAPHIC map is essential for any study in the civil engineering and also for any studies that relate to various areas of life. the topographic maps can be defined as true representation of the terrain with showing both natural and man-made elements on the earth's surface, as it is possible within the limits of scale and show the configuration of the land surface [1]. If the base map has a scale of, e.g. 1:25000, all the other smaller scale maps can be derived from this base topographic map by reduction and generalization concept. The cartographers in Iraq have struggled for centuries with the difficulties of map generalization and the representation of Earth features.

This paper discusses the digital Geomatics trend in production and updating the small scale topographic map from the digital base map and from the raster satellite image with acceptable spatial resolution and all these trends by using automated generalization process, in which the manual map generalization is very difficult to be done due to the circumstances in trends of production maps in Iraq now days.

In literature, there are many studies in this trend. Some interesting studies that have helped this paper are listed as:

1) McMaster & Shea, Cartographic Generalization in a Digital Environment [2]: This study focuses on the two areas, to test why and when we need to generalize and how the spatial data and the attribute of geodatabase of any map will become different due to the generalization process.
2) Djebbar, Cartographic Generalization and Specificities of Geographical Domain in Algeria: This paper shows the difficulty of digital cartographic generalization in the designing of the algorithms for the processing [3].
3) William & Kate, Generalization Operations and Supporting Structures: This paper is depicting a case for automated generalization and reports on a set of generalization operators. The generalization operators are embedded within a larger scheme for a map design system which could be attached to a GIS [4].

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II. Concept Base

Geomatics process such as (terrestrial survey, photogrammetry, remote sensing, and GIS) is essential part in mapping process. Fig. 1 shows the essential parts in mapping process such as image satellite. In this part, there are many functions must be done to get the output of the production and the Updating of topographic map.

Fig. 1 Clip of satellite image

A. Georeferencing

One of the important functions of geomatics is to fit geometry all the features in the surface of the earth in a specific map surface with geographic location due to specific scale of reduction. This process is called georeferencing. It is the process of transforming a digital image from pixel (column, row) coordinates into map coordinate system to be compatible with other spatial data. [5]. Georeferencing raster data allow it to be viewed, queried, and analyzed with other geographic data. Fig. 2 shows the example of the coordinates.

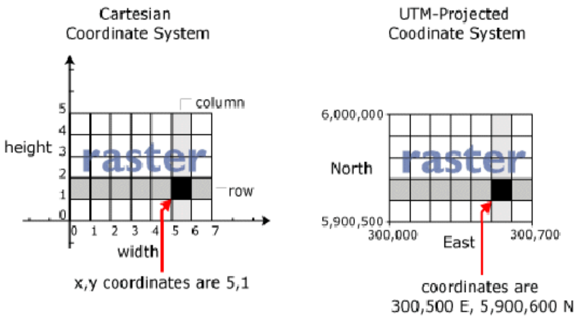


Fig. 2 Coordinate system in geomatics

B. GIS

GIS can be defined as ‘a system for capturing, storing, checking, integrating, manipulating, analyzing and displaying data which are spatially referenced to the Earth. This is normally considered to involve a spatially referenced computer database and appropriate applications software'. Fig. 3 shows the six basic components of GIS [6].

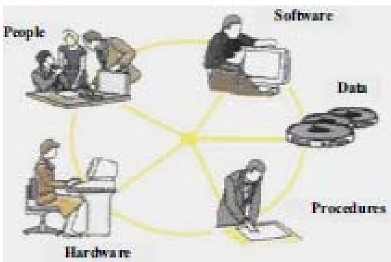


Fig. 3 The six basic components of GIS

C. Screen Digitizing Process

Digitizing refers to the conversion of analogue images into a digital representation. Screen digitizing is the best source of vector data input.

D. Topology Process

If a geospatial vector dataset is derived from a reference dataset either by digitizing or copying geometries, both datasets have a topological relationship. Topology represents how features share geometry according to rules. Topology deals with properties of spaces that do not change under certain transformations. Fig. 4 shows a simple example of what topology means [7]. So, topology is the numerical description of the relationships between geographic features, as may be symbolized by adjacency, linkage, inclusion, or proximity.

E. Generalization

The process of reduction and re-production of geodatabase of any map from large map scale to a smaller (less detailed) scale, by simplification, Smoothing Reclassification, Aggregation, Displacement, Elimination, Exaggeration and others elements is Generalization. The scale of the map is an essential factor in this process. Fig. 5 shows the geomatics steps in generalization [8].

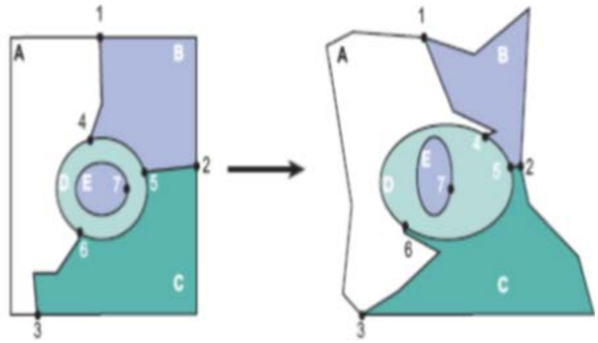


Fig. 4 Topology procedure in geomatics

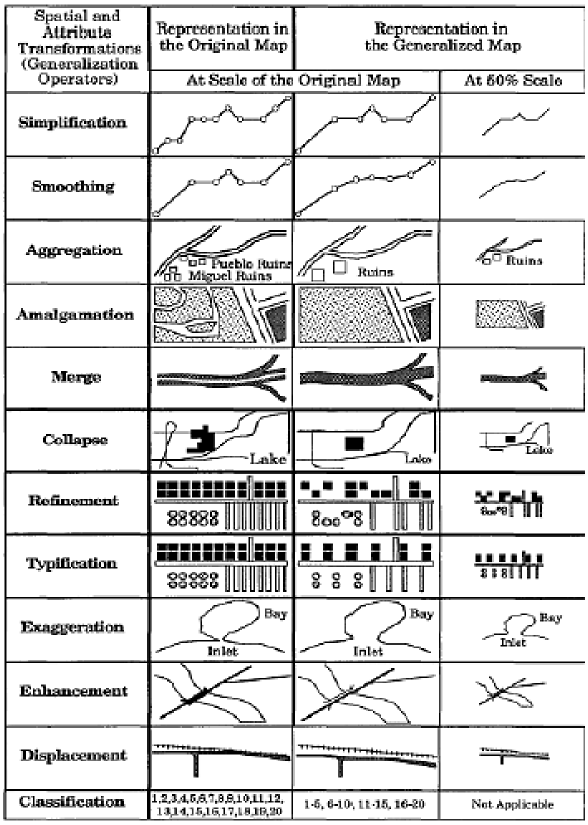


Fig. 5 Representation of the most important operation in generalization

III. Application of the Method on the Study Area

The study area is located in the south of Iraq as shown in Fig. 5.

Fig. 6 Study area in south of Iraq

TABLE I
PRODUCTION AND UPDATING MAP WITH GENERALIZATION

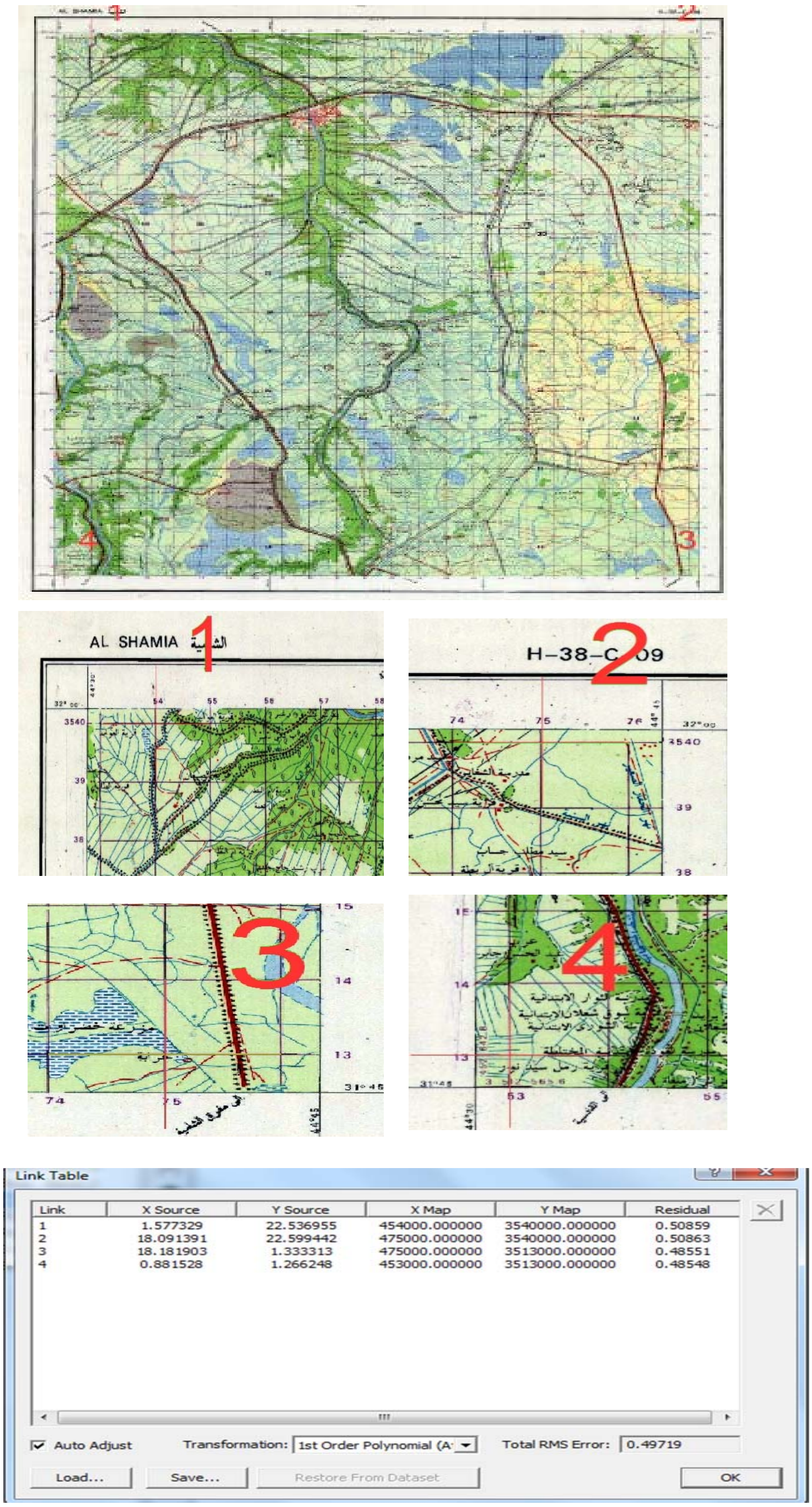
Item	Description
1.	Acquiring medium resolution 2.5 m/5m satellite
2.	Establishing a good GPS ground control network
3.	Measuring image control points to tie satellite imagery to international UTM projection
4.	Orthorectification process
5.	Scanning the existing 1:50000 topographic maps including the rubber sheeting and georeferencing
6.	Generation of the Digital Terrain Model "DTM" by digitizing the elevation information from the 1:50000 existing maps such as contours, spot height
7.	Generation of the digital ortho-image using orthorectification
8.	Image enhancement, mosaicking and matching for all scenes to produce image the study area
9.	Screen digitizing of the topographic features from the orthorectified map in addition using the 1:50000 existing as a reference to map all features pertaining to this scale using the generalization procedures
10.	Conversion of the digitized topographic features into the geodatabase GIS layers
11.	Adding up the annotation and carry out the GIS linkage of all the attributes
12.	Adding other available boundary layers such as municipal, district.
13.	Preparing the plotting templates to allow immediate and automatic plotting with different data layer sets (such as Othoimagery with/without Attributes, Vector GIS layers with/without attribute)
14.	Quality control of all the work and in every step and map layout

The four traditional maps with standard scales of 1/50000 will be generalized to get the full digital map with scale 1/100000 as in the logical Geomatics steps as follows:

1) Capturing data that represent the real world from the remote sensing or photogrammetry and the scanned maps.
2) Georeference process for raster images.
3) Digital image processing by Erdas software.
4) Building geodatabase using GIS with higher accuracy of topology.
5) Screen Digitizing process.
6) Generalization procedure.
7) Updating vector and attribute information.
8) Map layout due to the scale of generalization.

The main steps for the production and updating map with generalization from scale 1/50000 to scale 1/100000 are shown in Table I.

The practical works with the Geomatics software such as ERDAS, ARCGIS 9.3 occurs as shown in Figs. 7-14.



Link	X Source	Y Source	X Map	Y Map	Residual
1	1.577329	22.536955	454000.000000	3540000.000000	0.50859
2	18.091391	22.599442	475000.000000	3540000.000000	0.50863
3	18.181903	1.333313	475000.000000	3513000.000000	0.48551
4	0.881528	1.266248	453000.000000	3513000.000000	0.48548

Fig. 7 Adding control points in georefrenceing step

Fig. 8 The mosaic corrected raster 1/50000 maps

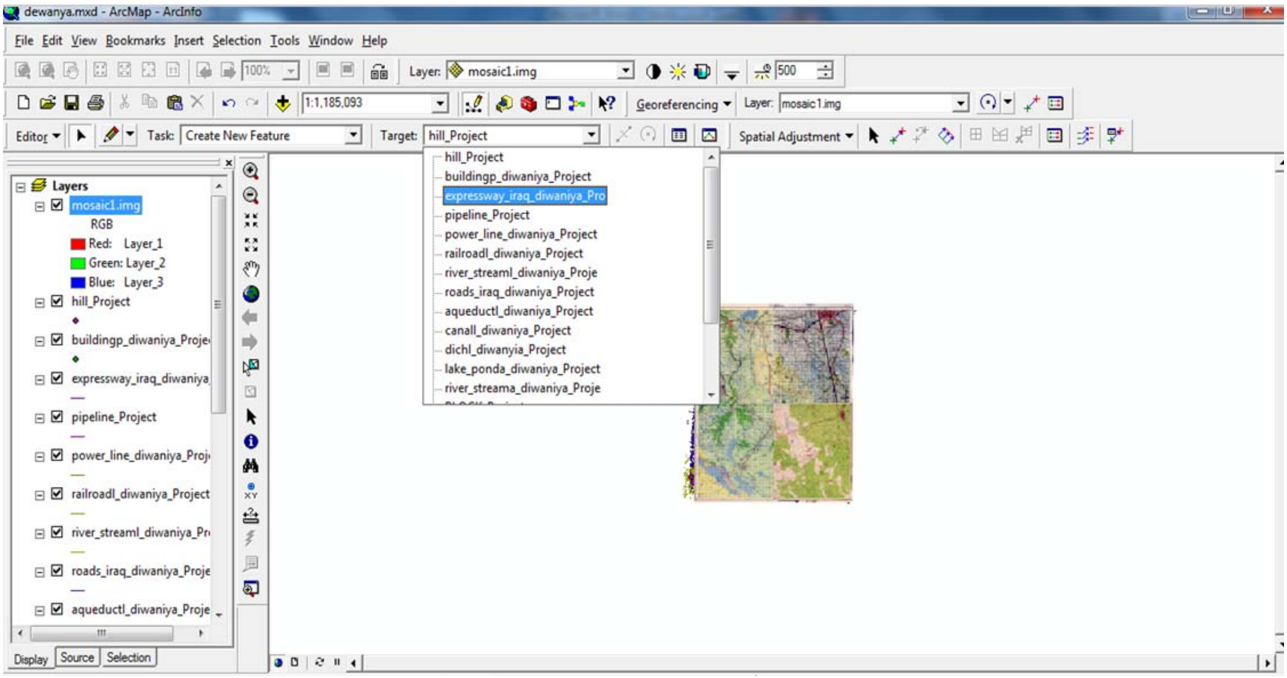


Fig. 9 The geodatabase for the mosaic

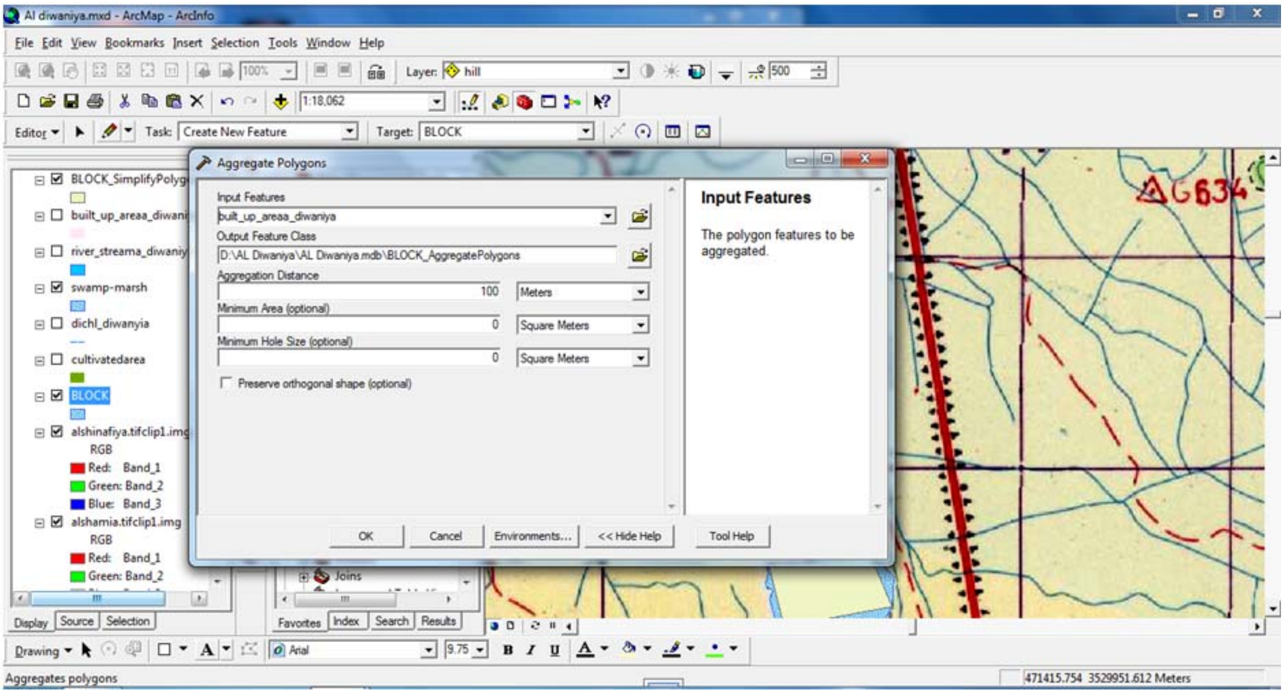


Fig. 10 The automated generalization (aggregate)

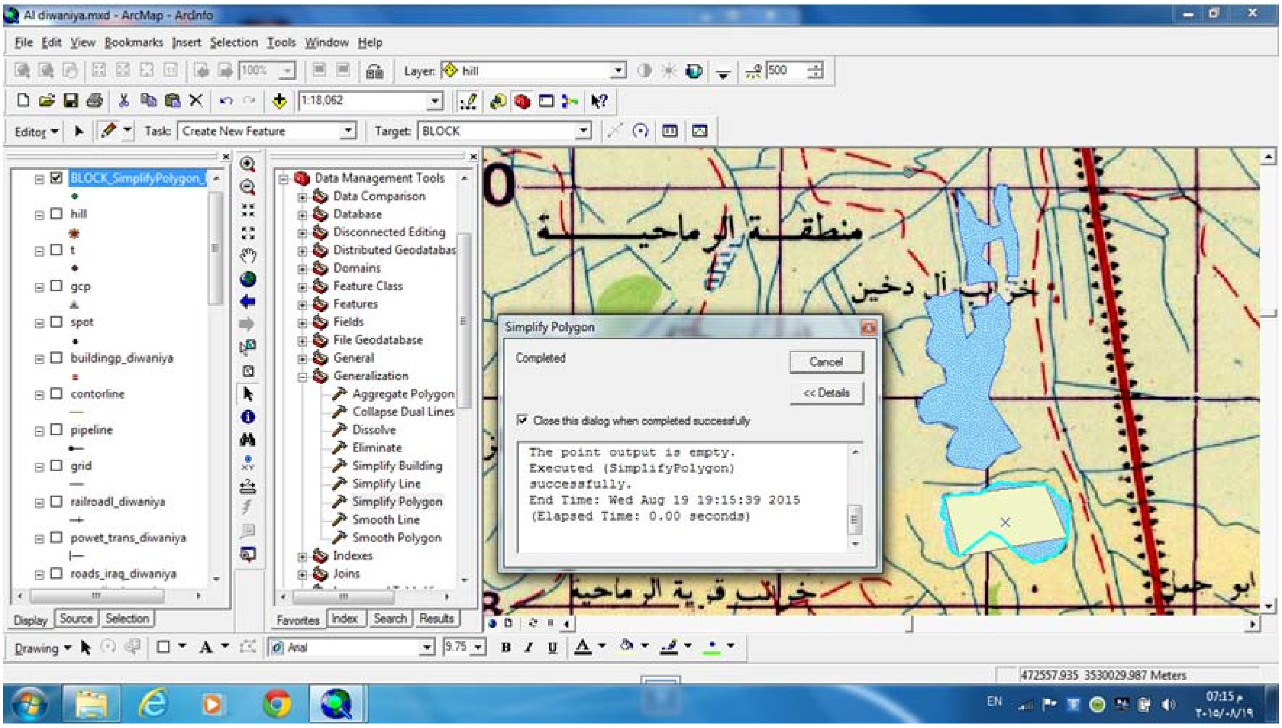


Fig. 11 The automated generalization (simplifying)

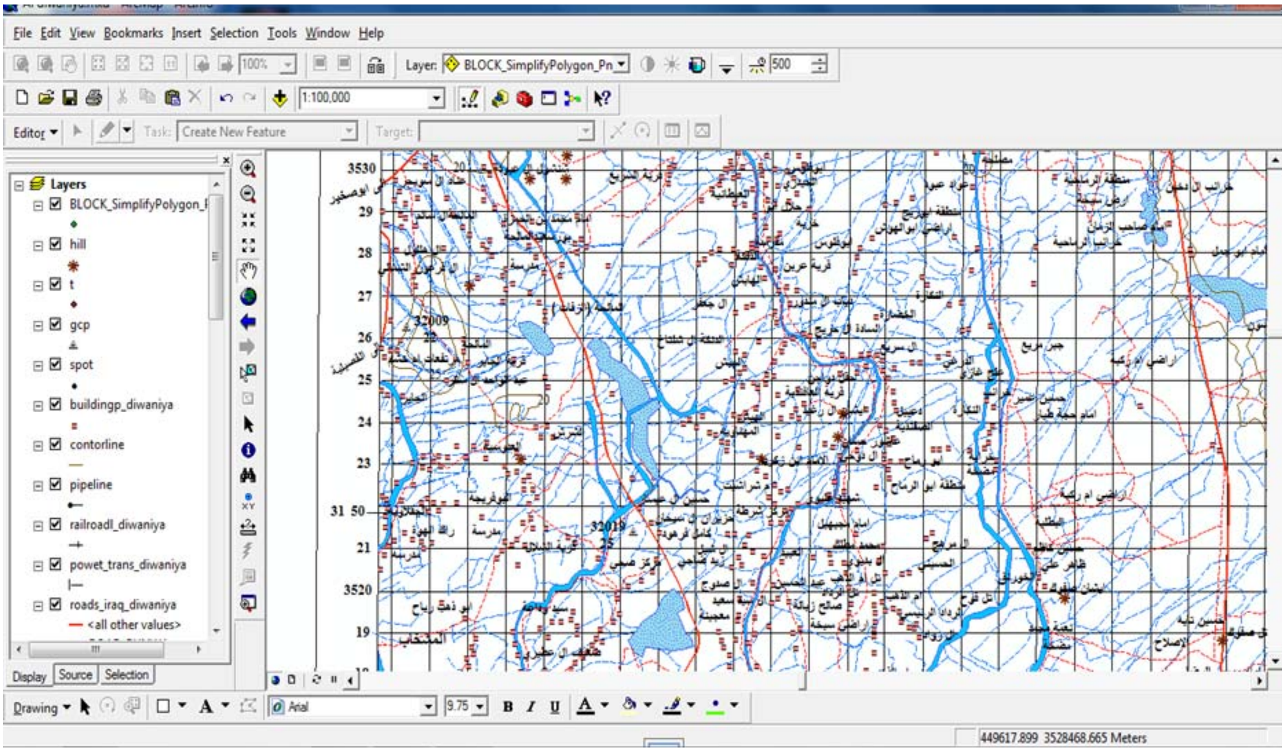


Fig. 12 The vector map with scale 1/100000

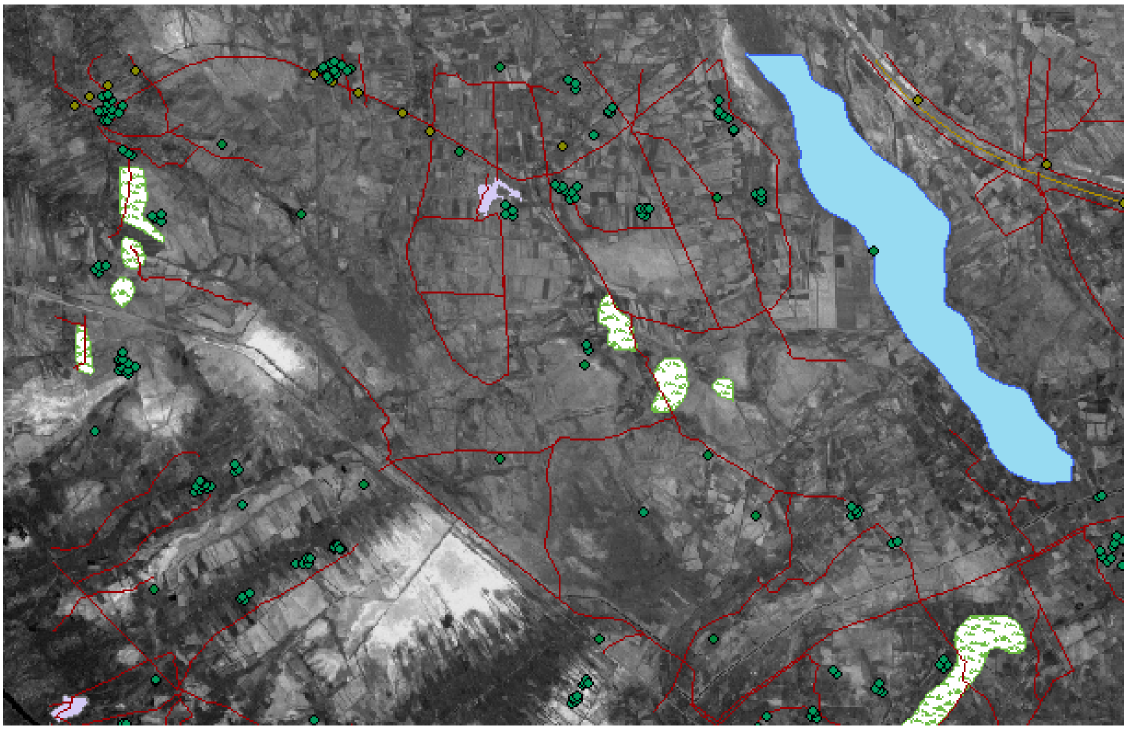


Fig. 13 Updating from Satellite image of 5 m resolution

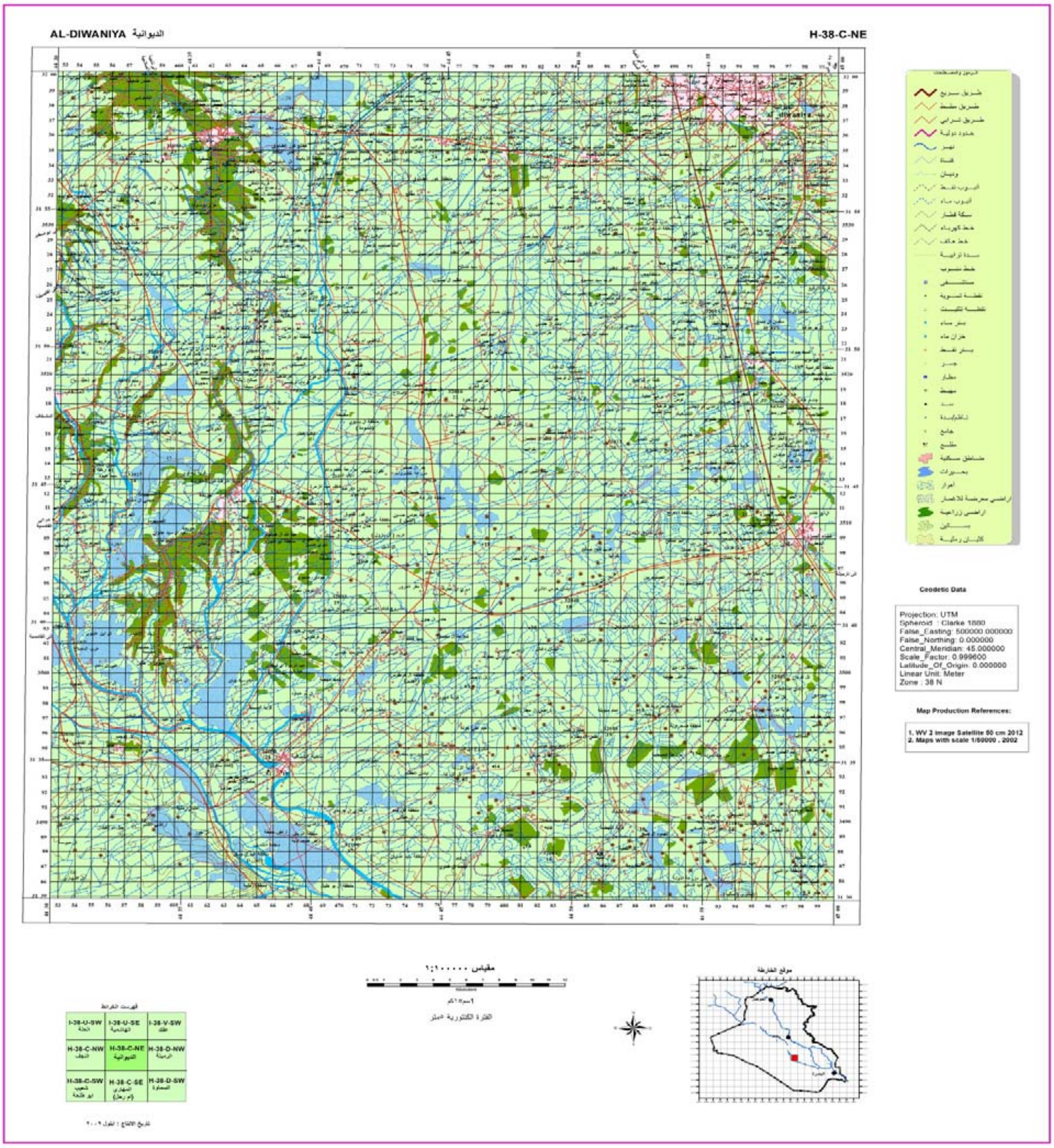


Fig. 14 The final map layout of the study area with Scale 1/100000

IV. Conclusions

This paper has observed the technique of the digital generalization process through the explanation of main components and concepts.

In this study, technological development in the field of map and spatial database generalization is very fast. On the other hand, map generalization is an important part of spatial data gathering, representation and access. Most generalization algorithms have been developed and employed in several Geomatics software.

A major advantage of digital generalization is reduction in the cost, time and workload of the manual process once the database is highly structured and attributed.

The use of digital mapping technology is changed to extract the information from satellite image. The information from these high resolution satellite images can be actually used to update acceptable topographic map. The updating of these base maps became a necessity; their creation should consider the latest developed techniques in the mapping technology advancement.

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