

## Informative accuracy investigation and updating map using remote sensing technique and GIS

Nawal K. Ghazal<sup>1</sup>, Khalid I. Hasson<sup>2</sup>, Mohammed Abdullah Lazim<sup>1</sup>

<sup>1</sup>Department of Physics, College of Science, University of Baghdad

<sup>2</sup>Remote Sensing Center, Directorate of Space Technology and Communications,  
Ministry of Science & Technology

E-mail: dr.nawal@yahoo.co.in

### Abstract

In this work, using GPS which has best accuracy that can be established set of GCPs, also two satellite images can be used, first with high resolution QuickBird, and second has low resolution Landsat image and topographic maps with 1:100,000 and 1:250,000 scales. The implementing of these factors (GPS, two satellite images, different scales for topographic maps, and set of GCPs) can be applying. In this study, must be divided this work into two parts geometric accuracy and informative accuracy investigation. The first part is showing geometric correction for two satellite images and maps.

The second part of the results is to demonstrate the features (how the features appearance) of topographic map or pictorial map (image map), Where it is highlight the different features with different scales to know the accuracy of information. Where can be noticed through graphics that features appear very close to each other at a certain scale and become detached at another scale and this problem can be solved by generalization method. Geodatabase in GIS program also have been used as a modern style store all data related to the project in one folder divisions with that data. In addition to storage in a shape file. Geographic Information Systems (GIS) uses Remote Sensing (RS) data for a lot of applications. One of the application areas is the updating of the GIS database using high resolution imagery. Finally, high resolution satellite imagery data is very important to obtain updating map for Kut city by implementation two methods geodatabase and shapefile.

### Key words

*Geodatabase, geographic information system, land cover map, natural resources, rangeland, remote sensing.*

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**التحقيق في الدقة العينانية وتحديث الخرائط باستخدام تقنيات الاستشعار عن بعد ونظم**

**المعلومات الجغرافية**

نوال خلف غزال<sup>1</sup>، خالد ابراهيم حسون<sup>2</sup>، محمد عبد الله لازم<sup>1</sup>

<sup>1</sup>قسم الفيزياء، كلية العلوم، جامعة بغداد

<sup>2</sup>مركز الاستشعار عن بعد، مديرية تكنولوجيا الفضاء والاتصالات، وزارة العلوم والتكنولوجيا

### الخلاصة

الهدف من هذا العمل هو للتحقق من مدى ملامة صور الاقمار الصناعية لتقييم مديات الدقة وتحديث الخرائط. وهذا يعتمد على تقنيات الاستشعار عن بعد و نظام تحديد المواقع العالمي (GPS). تم الحصول على الخرائط الطبوغرافية ذات المدى 1:250,000 و 1:100,000 وكذلك الصور الفضائية عالية الدقة كويك بيرد

ومنخفضة الدقة لاندسات. الجزء الاول يظهر عملية التصحيح الهندسي لصور الاقمار الصناعية وكذلك للخارطين الطوبوغرافية. اما الجزء الثاني فهو يبحث في النتائج التي تعتمد على الدقة المعلوماتية لبيان المعالم (شكل ظهور المعلم) من الخرائط المختلفة سواء كانت خارطة طوبوغرافية او خارطة تصويرية (Image map)، والعلاقة مع بقية المعالم وكيف يظهر كل منها عند مقاييس مختلفة (لمعرفة الدقة المعلوماتية من خلال شكل المعلم). بعد ذلك تم اجراء عملية التحديث للمعالم الارضية التي طرات على الخرائط الطوبوغرافية مع تحليل شكل ظهور المعالم في مقاييس مختلفة. هذا العمل تم بتطبيق نظام المعلومات الجغرافية (GIS)، من خلال رسم الطبقات المختلفة بطريقة ال (Shape file) وكذلك استخدام طريقة اكثر تطور للرسم وهي (geodatabase) والحصول على خارطة رقمية حديثة لمنطقة الدراسة.

## Introduction

Maps are fast information sources when we want to know, to study and to develop projects in any region. Users, when consulting a map, expect information to be found. Sometimes, information can not appear due to scale or to the not updating of the map. Keates (1982) affirms "all maps are selective". In this way, it is necessary to adapt the scale and content to the desired objective of the map. In Brazil, most of the available maps to users are in an unsatisfactory scale and not updated. Nowadays, we have developed different methodologies to updating maps, using especially orbital images from Landsat-TM and SPOTHRV. It is important to consider and evaluate questions such as area dimension, methodology quickness and easily, updating quality and change detection capacity through time. The detection capacity is associated to the informative content of the images used, whether they are aerial photographs or orbital images. This paper presents the continuation of results of the research done by Viadana (1995) where tests were performed with Landsat-TM and SPOT-P (panchromatic), showing the potential of orbital images to updating 1:50,000 topographic maps [1, 2].

Being the blood of the geography information system (GIS), spatial data

is the basement of the digital and information building. So the production of the spatial data never stops, and series database of different scales have been established. The currency of those databases would fade with time lapse if they cannot be updated timely. So the production and updating of the spatial data will be the central work all the time. With the help of GPS, GNSS and remote sensing (RS) image of high resolution, spatial data with good accuracy and currency can be acquired easily. Facing the increasing of big data, how to use them properly becomes a new problem. The technique of spatial data fusion is just the answer for the scientific use of existing data. Since different kinds of data are the abundant material of data fusion, then better data can be derived from the existing data through data fusion [3].

## Study area and materials used

### 1. Description of study area

Al Kut is a city in eastern Iraq, on the left bank of the Tigris River, about 160 kilometers (99 miles) south east of Baghdad. It has the coordinates (32°30'20"N 45°49'29"E). It has an area of (17012km<sup>2</sup>) which constitute 4% of total area of Iraq (441000km<sup>2</sup>).

**Table 1: The names of governorates of Iraq.**

ID	Names of governorates of Iraq
1	Dohuk
2	Erbil
3	Nineveh
4	Sulaymaniyah
5	Kirkuk
6	Salahaddin
7	Diyala
8	Baghdad
9	Anbar
10	Babylon
11	Karbala
12	Wasit
13	Qadisiyah
14	Najaf
15	Maysan
16	Dhi Qar
17	Muthanna
18	Basra



**Fig. 1: The Kut city laying in Wasit province in Iraq.**

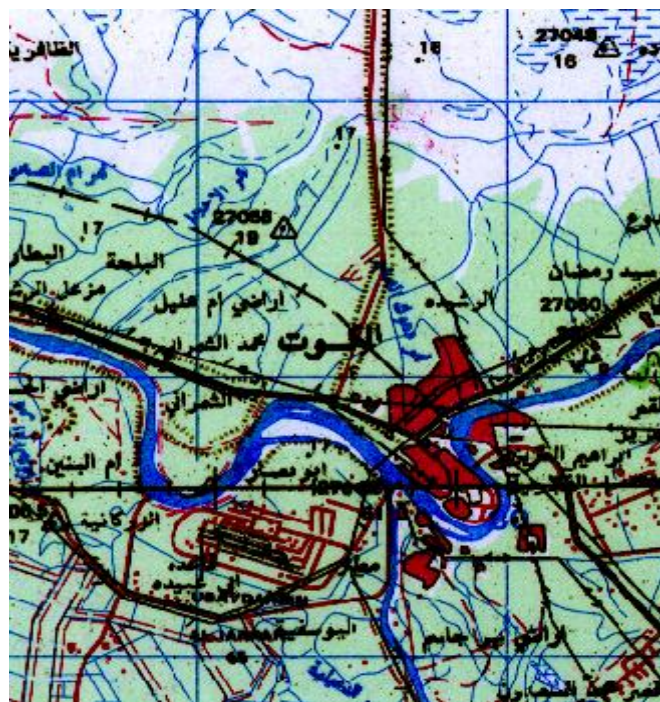
**2. Available data**

- 1- Old topographic map with scale 1:250,000 as a paper at 1978 Fig. 2.
- 2- Old topographic map with scale 1:100,000 as a paper Fig. 3.

- 3- Quickberd satellite image in 2006 Fig. 4 with Table 1 location of study area.
- 4- Landsat satellite image in Fig. 5, with Table 2 location of study area.
- 5-ERDAS Imagine, ArcGIS and GPS.

**Table 2: Producing area names of Wasit.**

Area names
Kut
Albelhh
Al-Bitar
Lands of Um Halil
Sayed wamadan
Rachida
Mazal



*Fig. 2: The map with 1:250,000 for Al Kut city West province in Iraq.*



*Fig. 3: The map with 1:100,000 for Kut city, West province in Iraq.*





*Fig.4: Producing QuickBird satellite image with high resolution.*



*Fig.5: Producing Landsat satellite image with low resolution.*

## Methodology of work

### 1. Steps of work

1-Scanning for the old topography maps with scales 1:250,000 and 1:100,000.

2-Geometric correction for these two maps.

3-Also applying geometric correction for Quick bird satellite image that has high resolution about 61cm by utilizing GPS to collect GCPs to study area, then analysing the errors showing by this technique.

4- Geometric correction is implemented for Landsat satellite image which has low resolution about 30m using GPS to study area and analysing the errors producing by this process.

5- After that, ArcGIS are using to draw new digital map to get update map for study area.

6- Building geodatabase for ground features using ArcGIS.

### 2. Geometric correction

Digital images collected from airborne or space-born often contain systematic and non-systematic errors that arise from the earth curvature, platform motion, relief displacement, non-linearities in scanning motion, and the earth rotation. Some of these errors can be corrected by using ephemeris of the platform and precisely known internal sensor distortion characteristics. Other errors can only be corrected by matching image coordinates of physical features recorded on the image to the geographic coordinate of the same feature collected from a map [4].

#### 2.1 Polynomials

A Polynomial is a mathematical expression consisting of variables and coefficients. A coefficient is a constant, which is multiplied by a variable in the expression, and the variables in polynomial expressions

can be raised to exponents. The highest exponent in a polynomial. A polynomial with one variable,  $x$ , is given in the following form [5]:

The following first-order polynomial transformation equation can be used to determine the required coefficients to transform pixel coordinate to the corresponding other coordinate value.

$$X_0 = a_1 + a_2 X + a_3 Y \quad (1)$$

$$Y_0 = b_1 + b_2 X + b_3 Y \quad (2)$$

where  $(X, Y)$  are the input pixel coordinates and  $(X_0, Y_0)$  are the output (geographic) coordinate.

The order of the polynomial used in this process is the order of the transformation. Polynomial equations are used to convert the source coordinate to rectify the coordinate. The pixel coordinate system has an  $x$  coordinate (column) and  $y$  coordinate (row). The relationship between the pixel coordinate system and the geographic coordinate system can be defined by polynomial transformation. The best order of transformation can be obtained using a trial and error process.

Initially, a few (at least three for first-order polynomial) ground control point (GCPs) are required to determine six transform each set of row ( $X$ ) and column ( $Y$ ) pixel coordinate to output (Geographic) coordinates. In this work, second-order transformation equation (where at least 6 number of GCPs are required to determine 12 transformation coefficient) for  $X$  and  $Y$  are:-

$$X_0 = a_1 + a_2 X + a_3 Y + a_4 X^2 + a_5 XY + a_6 Y^2 \quad (3)$$

$$Y_0 = b_1 + b_2 X + b_3 Y + b_4 X^2 + b_5 XY + b_6 Y^2 \quad (4)$$

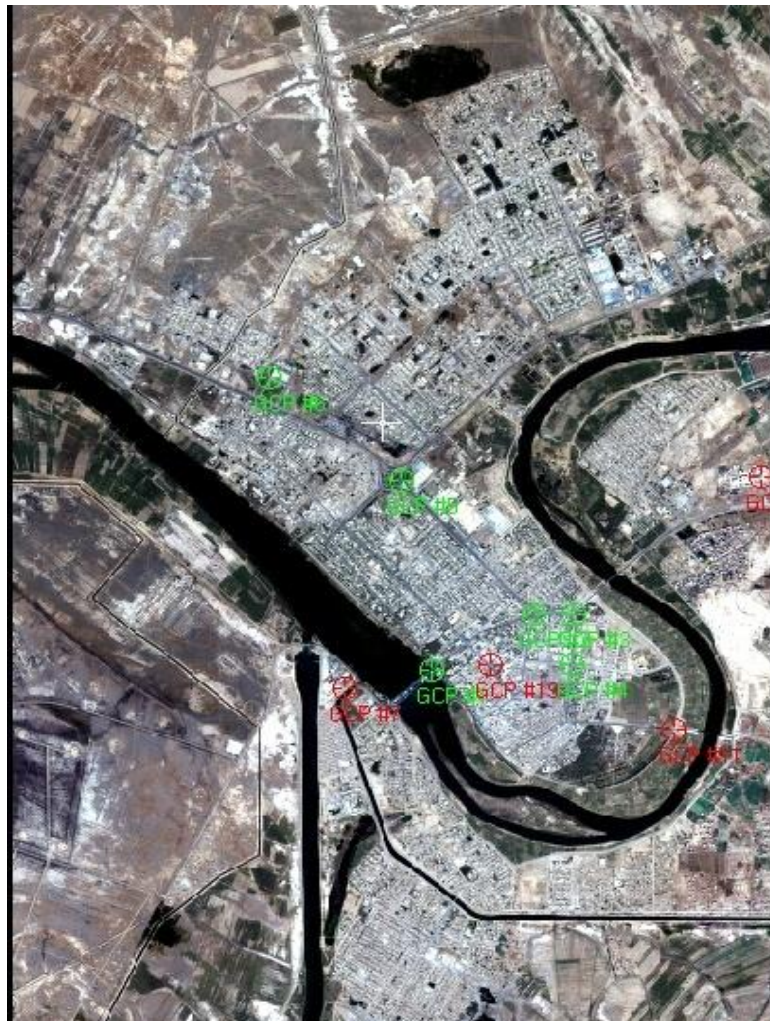
## Discusses the results

### 1. The first part of work (Geometric correction)

Tables 1, 2 and Figs. 6, 7 represent geometrical correction for six GCPs

for two different satellite images resolution, also this method applied for 1:100 000 map and 1:250 000 map to obtain corrected images and maps with

coordinates UTM (WGS84) can be used for drawing features in ArcGIS software.



**Fig.6: The location of 6GCPs with 4 check points.**

**Table 3: The coordinate of 6GCPs with residual and total errors.**

Point id	X input	Y input	X ref.	Y ref.	X residual	Y residual	RMS	CONTRIB
<b>GCP1</b>	577007.984	3596160.706	577010	3596161	0.164	0.18	0.243	0.486
<b>GCP2</b>	577922.618	3596693.143	577922	3596693	0.639	0.512	0.819	1.636
<b>GCP3</b>	578279.865	3596691.076	578280	3596692	0.538	0.491	0.728	1.455
<b>GCP4</b>	578260.863	3596219.922	578261	3596220	0.145	0.27	0.306	0.612
<b>GCP5</b>	576734.174	3597959.338	576734	3597960	0.17	0.287	0.333	0.665
<b>GCP6</b>	575539.375	3598932.847	575539	3598933	0.087	0.176	0.197	0.393
<i>control point Error for (x)</i>				0.361				
<i>control point Error for (y)</i>				0.3468				
<i>Total RMSE</i>				0.5006				





*Fig. 7: The location of GCPs & check points for low resolution image.*

*Table 4: The coordinates of 6 points and their residual errors for low resolution satellite image.*

Point id	X input	X input	X ref.	Y ref.	X residual	Y residual	RMS	CONTRIB	Type
<b>GCP1</b>	577010.746	3596162.021	577010	3596161	0.309	0.092	0.322	0.633	control
<b>GCP2</b>	577922.855	3596692.233	577922	3596693	0.274	0.607	0.666	1.307	control
<b>GCP3</b>	578279.685	3596691.434	578280	3596692	0.674	0.112	0.683	1.341	control
<b>GCP4</b>	578261.571	3596220.593	578261	3596220	0.284	0.57	0.637	1.25	control
<b>GCP5</b>	578215.475	3595708.593	578215	3595708	0.249	0.033	0.251	0.493	control
<b>GCP6</b>	576735.711	3597909.841	576734	3597910	0.483	0.386	0.619	0.799	control
total control point error for (x)				0.5971					
total control point error for (y)				0.4934					
total control point error				0.7746					

**2. The second part of work (Drawing by ArcGIS using shape file and geodatabase)**

The results in this work is to demonstrate the features (how the features appearance) of topographic map or pictorial map (image map), Where it is highlight the different

features with different scales to know the accuracy of information.

Where we noticed through graphics that features very close to each other and become detached at a certain scale and this problem can be solved by generalization method and also have been used geodatabase in GIS program, as a modern style store all



data related to the project in one folder divisions with those data. In addition to storage in a shape file. Finally been a process of modernization of the landmarks that have occurred on the ground and production updating topographical maps with the emergence of this form of analysis features. In order to draw land use map, the topography map and digital layers with the scale of 1:25000 created in ArcGIS 9.3 and also QuickBird and Landsat satellite images taken from Landsat Satellite are used. The resolution of a map is the accuracy with which the location and shape of map features can be depicted for a given map scale. In larger-scale map, the resolution of features more closely matches real-world features because the extent of reduction from ground to map is less. In smaller scale map, the map resolution diminishes because features must be smoothed and simplified, or not showed at all.

1- Comparing the network of roads which draws from QuickBird (high resolution), Landsat (low resolution) satellite images, and map with scale

1:100,000, and map at scale 1:250,000 such as the following examples below which showing with different scales.

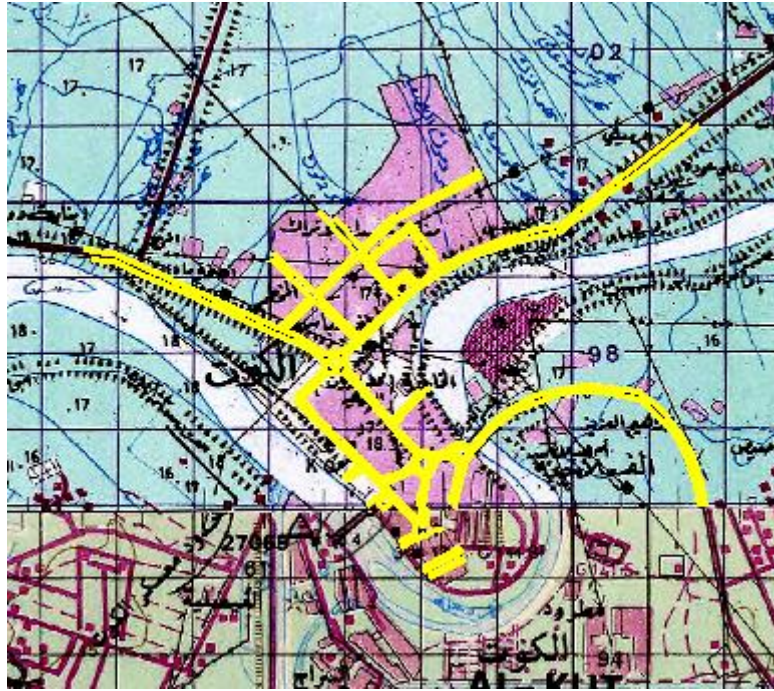
#### **A- The results of features accuracy at 1:100,000 scale.**

When drawing a road network of the topographic map and two different resolutions satellite images by geographic information systems at the scale fixed 1: 100, 000. Through these drawings can be showing that the roads network is more pronounced in the high-resolution image [When producing high resolution image with scale 1:100,000, the net of roads features are showing little closely (more clear than the others)].

And then comes the drawing with less obvious from topographical map [In the map with scale 1:100,000 most of these features would be omitted from these maps, these maps cover more area while retaining a reasonable level of detail]. While the road network drawn from low resolution satellite image, the roads merged and close with each. Showing Figs. 8-12.



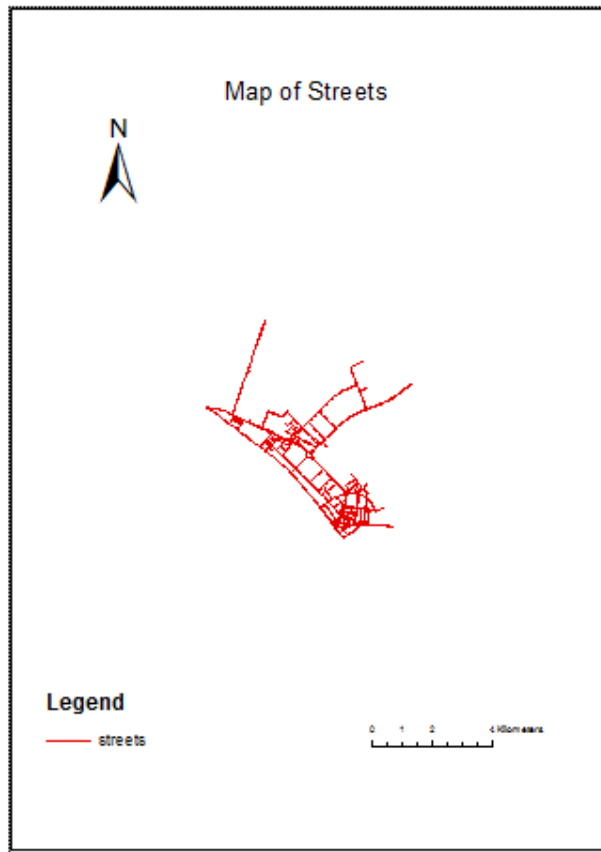
**Fig.8: The network of roads from high resolution image at scale 1:100,000.**



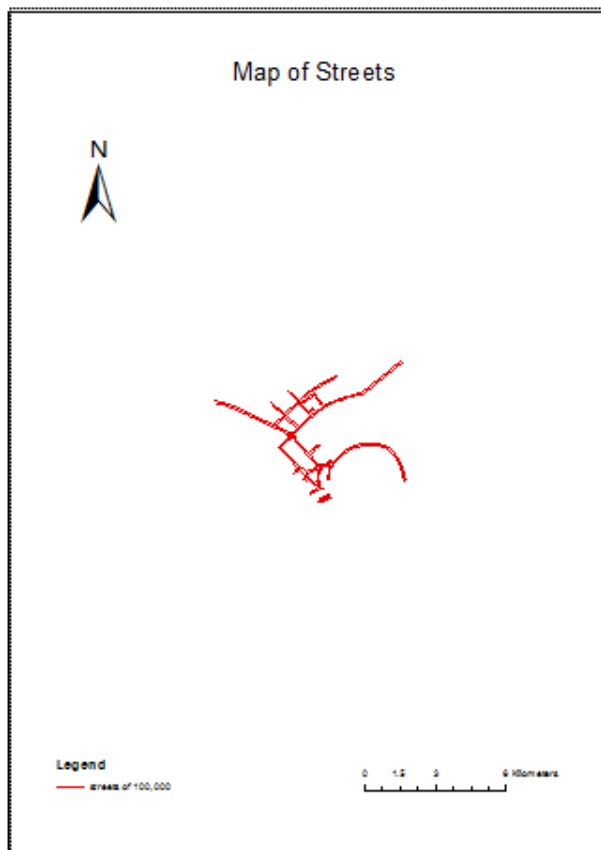
*Fig.9: Illustrated the network of roads from map at scale 1:100,000.*



*Fig.10: Producing the network of roads from low resolution image at scale 1:100,000.*



*Fig.11: The network of roads map for high resolution image at 1:100,000 scale.*



*Fig.12: Illustrated the network of roads map from map at scale 1:100,000.*



**B-The results for 1:250,000 scale.**

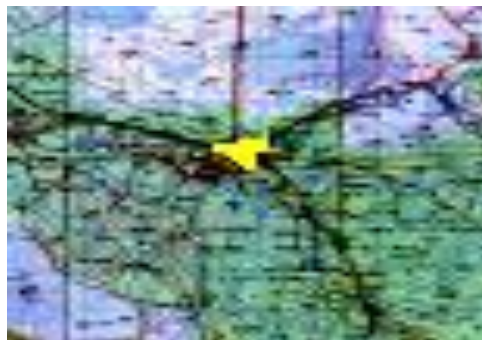
Small-scale maps (1:250,000) show large areas on single map sheets, but details are limited to major features, such as boundaries, parks, airports, major roads, railroads, and streams.

When drawing the same road network scale of 1: 250,000, note that the

features are converging to each other more in the high-resolution image and that is almost be appearing as a single block in the topographic map (1:100,000), but in the low-resolution image be reduced to half, see Figs. 13-18.



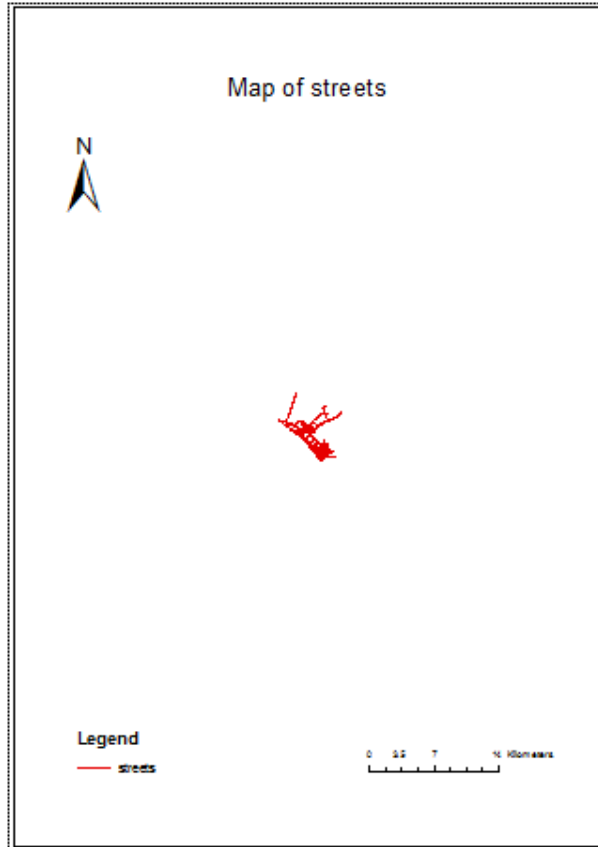
*Fig.13: Illustrated the network for high resolution image with 1:250,000 scale.*



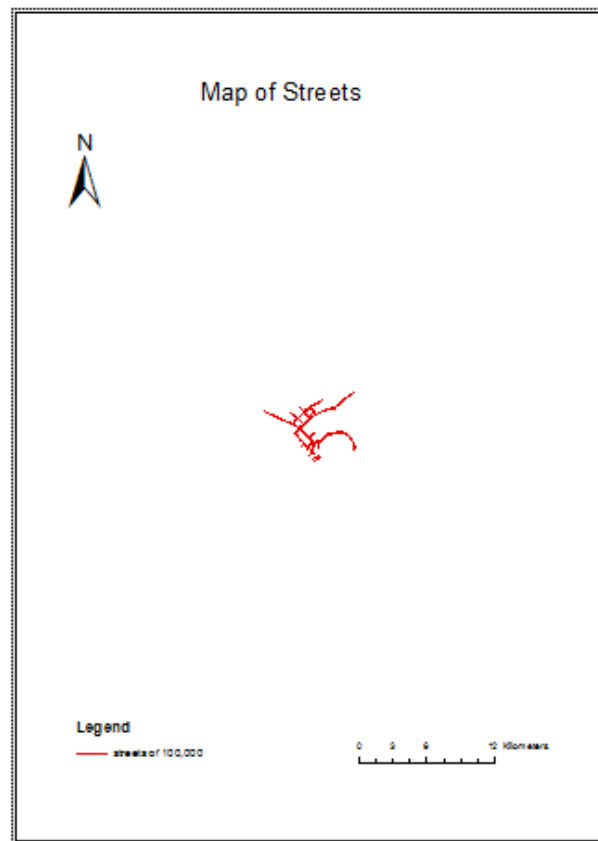
*Fig.14: Illustrated the network for map with 1:250,000 scale.*



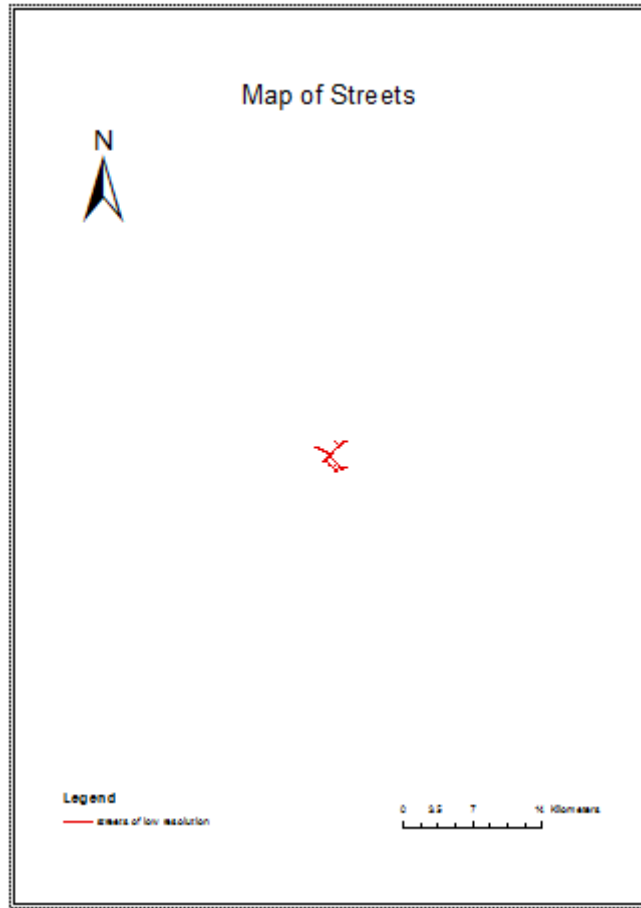
*Fig.15: Presented the network for low resolution image with 1:250,000 scale.*



*Fig.16: The network road map for high resolution image with 1:250,000 scale.*



*Fig.17: The network of roads map from (map at 1:100,000) producing with 1:250,000 scale.*



*Fig.18: Presented the network road map for low resolution image with 1:250,000 scale.*

**C- Discusses the results for map of some features extracted from high resolution satellite image at specific region.**

Maps at 1:25,000 scale are fairly large and provide detailed information about features of an area, including the locations of important buildings and most campgrounds, ski lifts, and water-

mills. Footbridges, drawbridges, fence lines, and private roads are also shown at this scale. Usually these features would be omitted from maps in the 1:50,000- to 1:100,000-scale range; these maps cover more area while retaining a reasonable level of detail, showing the Figs.19, 20.





Fig.19: Presented some features containing high resolution image.

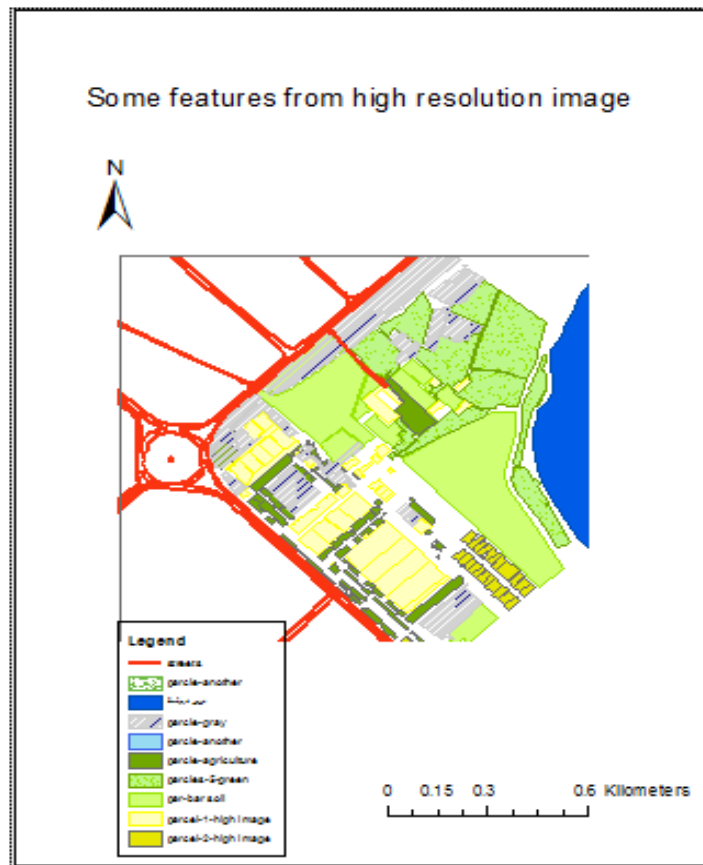


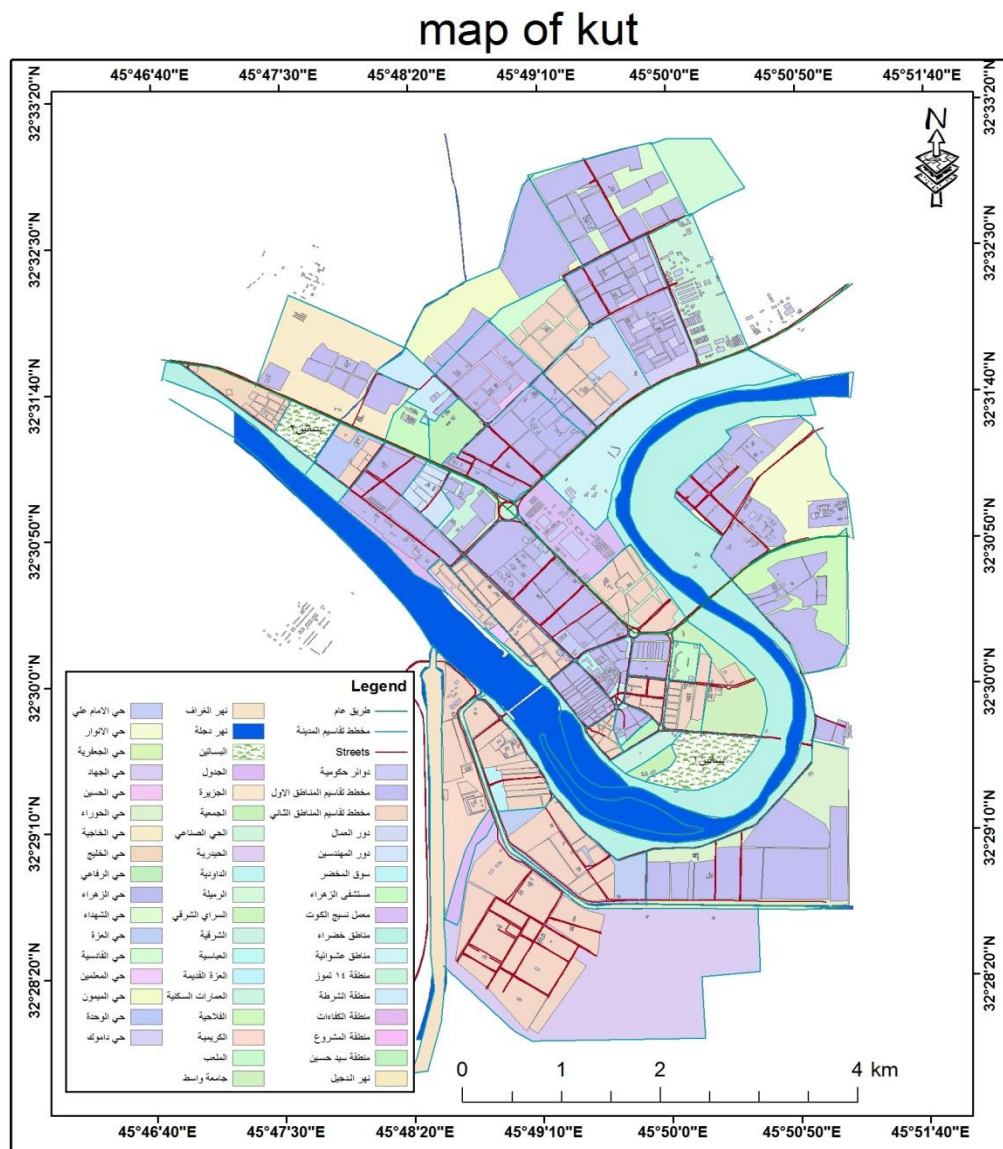
Fig.20: Showing Map at 1:10,000 scale for features producing in high resolution image.

**D- Digital Update map for Kut city from high resolution satellite image which has 1:24,000 scales drawing as layers and using geodatabase.**

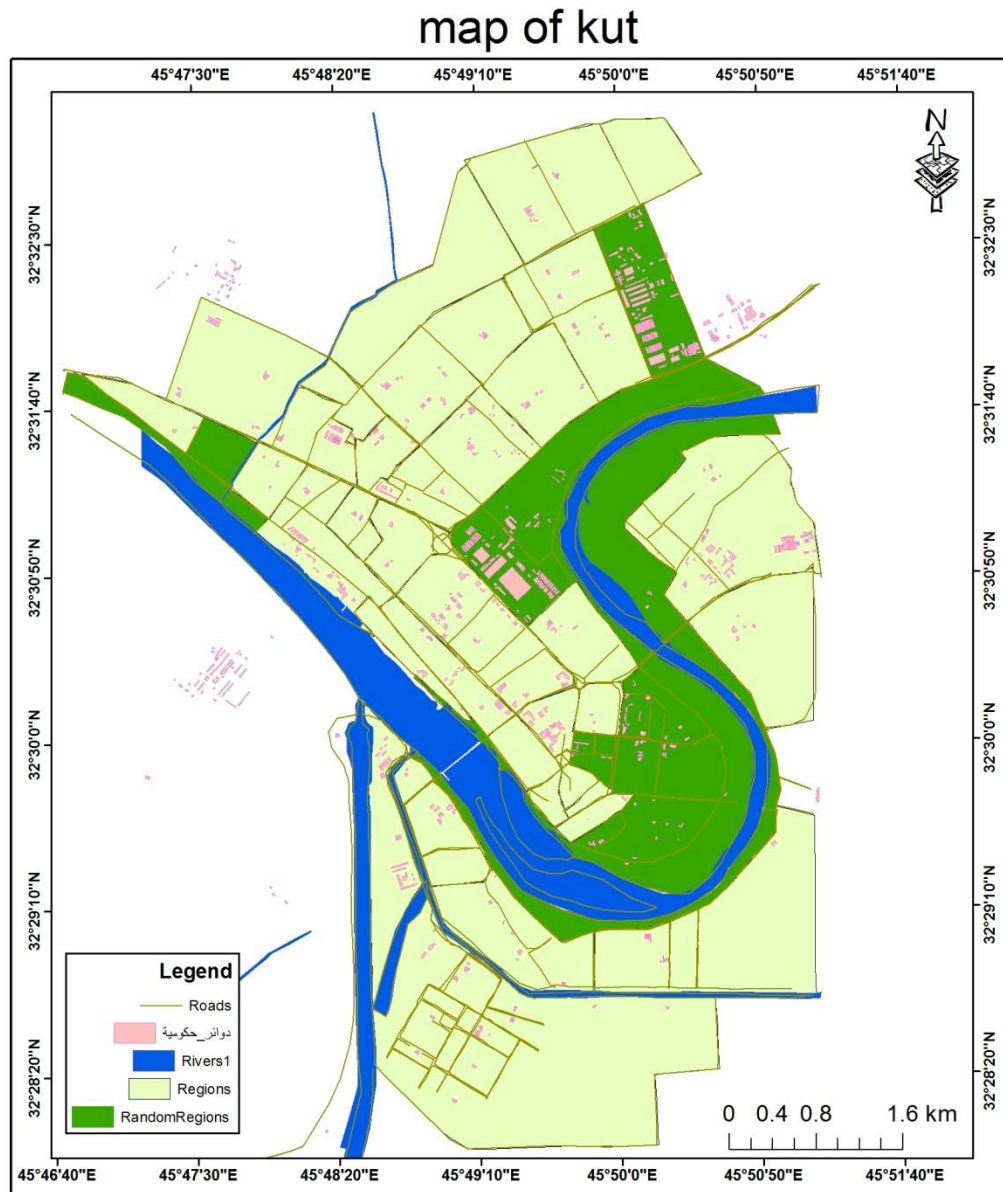
In the geometric accuracy and feature compilation assessment results show that the high resolution image can be used in scale (1:24,000) mapping processes and can identifying of small features. Fig. 21, showing the update map of Kut city from high

resolution image, this map producing many layers which represented smaller areas. The resolution of a map is the accuracy with the location and shape of map features can be depicted for a given map scale.

These Figs. 21, 22, showing the update map for kut from high resolution satellite image by using shapfile and geodatabase respectively.



**Fig.21: Producing update map of Kut which draw from high resolution satellite image using layers from GIS.**



*Fig.22: Producing Update map using geodatabase for Kut from high resolution satellite image.*

**E- Digital update map for Kut city from topographic map at scale 1:100,000 and low resolution satellite image which has 1:24,000 scales drawing as layers.**

In the Fig. 24 satellite image with low resolution been invoked, which previously corrected and the GeoDatabase drawn from corrected map with scale (1:100000) invoked as well. And as the low resolution image and the map corrected previously by

using geometric correction in (Erdas) program, the image and map are of the same coordinates system UTM(wgs84) which is the system used in the study area (Kut city), that mean the drawn layers from corrected map coincide the updated low resolution satellite image. After that features are drawn, which was not clear in the map of sale (1:100000) depending on updated satellite image which covered study area.





These map production have been compared within each other by using ArcGIS software and compiled features have been controlled in field. In the comparison studies, firstly, the numbers of features in text, line, polygon and point layers have been detected, controlled and compared. In this stage, high resolution satellite image can be selected as the best because the feature numbers of the compiled data are more than the others. And the feature layers have been evaluated in detail.

### Conclusions

1-In general, the best location of GCPs led to reduce the errors and increasing the accuracy.

2-For high resolution satellite image, when using the set of GCPs which is producing a closed errors in both x and y axes, while the root mean square error (RMSE) is decreased (0.5) and showing high accuracy.

3- The low resolution Landsat satellite image shows high RMSE (0.77) and low accuracy.

4- Database (maps) should be updated every time to give the real changes in study area.

5- A new updated digital topographic maps of the study area (Alkut city) have been obtained by using satellite images of different resolutions and maps of different scales (old maps) as a reference maps can be applied.

6- By using ArcGIS can be replace shape files database with feature class database (geodatabase) to ease invoking and transfer data from hard disc to hard disc and from computer to computer.

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