# Updating Urban Cadastral Map and Database Designing by GIS Using Aerial Photos

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## ABSTRACT

For the time being most of the countries around the world trying to update their Urban Cadastral Map with the unified well known system this is the WGS84 UTM system. The coordinates systems in Iraq are divided into two systems: the first system was known as the "Third system" and the reference point located in AL-NAHRWAN south-east of Baghdad city and CLARK1880 was used, the second system was established terrestical topocentric coordinate system by "Pole Service Company "during 1979-1974,the reference point located in KARBALA ,and CLARK1880 UTM was used.
In our case study the Amana Baghdad Base Map having several coordinates systems which are not known specifically. In this research has been used an approach for the updating of the maps with WGS84 system regardless their original coordinates system to produce a photomap ; which would be considered as a base map and consisted of all characteristic of base map then use this base map as a reference map to update the Amana Baghdad base maps and produce an Urban Cadastral Map.
The study area was chosen in Baghdad city, Hay Al-Wahda, Mahala 906 including University of Technology Area. Database design will be done through using ArcGIS programme. A precision assessment of the updating approach for Urban Large Scale Cadastral Maps used in this research were done and founded the root mean square error is equal to ∓ 0.115 m ; which is complied within ASPRS standards.

## تحديث الخرائط الكادسترائية و تصميم قواعد البيانات بنظام المعلومات الجغرافية باستخدام الصور الجوية

**الخلاصة :**

نظرا لاهمية خرائط الكادسترا بشكل عام و خرائط الكادسترا للمناطق الحضرية بشكل خاص لذلك تسعى غالبية دول العالم الى تحديث خرائطها ضمن اطار مرجعي موحد لكل العالم خاص بنظام الاحداثيات هوWGS84 بالنسبة للعراق تفتقر معظم دوائر الدولة الى خرائط منتظمه و مربوطه بنظام احداثيات وطني و عالمي. تقسم المراحل التي مرت بها انظمة الاحداثيات في العراق الى اولا النظام الانكليزي القديم او الثلاثي (في فترة الثلاثينيات) و الذي تم استخدامه في انتاج خرائط الملكيه (الكاديسترا) و تشير بعض المصادر الى ان النقطه المرجعية تقع في منطقة النهروان NAHRWAN جنوب شرق بغداد و تم استخدام



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المفلطح CLARK 1880 . ثانيا الفترة الممتدة من 1974-1979 حيث قامت شركة ( Pole Service Company) بأنشاء شبكة ضبط افقية رئيسية من الدرجة الاولى و تشير المصادر الى ان النقطة المرجعية تقع في مدينة كربلاء المقدسة و تم اختيار المفلطح CLARK 1880 و المسقط UTM.
في هذا البحث تم اعتماد طريقة لتحديث الخرائط بنظام WGS84 UTM بغض النظر عن النظام المرجعي لتلك الخرائط و استخدامها كخارطة صوريه Photomap التي ستعتبر كخارطة اساس Basemap و تحمل كل خصائص الخارطة الاساس و استخدام تلك الخارطة كخارطة مرجعية لغرض تحديث الخرائط الاساس لأمانة بغداد و انتاج خارطة كاديسترا حضريه Urban Cadastral Map.
تم اختيار منطقة الدراسة في مدينة بغداد ضمن بلدية الكرادة - حي الوحدة، محلة 906 التي تقع ضمنها الجامعة التكنلوجية ، سيتم ايضا تصميم قاعدة بيانات Database التي ستملىء لاحقا بالمعلومات التي يتم الحصول عليها من ديوان امانة بغداد و تربط بالخارطة الكاديسترائيه الحضرية بأستخدام برنامج Arc GIS ، ان المحصلة من ربط قاعدة البيانات مع الخارطة الصوريه هو خارطة اساس Basemap. اخيرا سيتم اعادة انتاج الخارطة الكاديسترائية الحضرية حيث وجد ان معدل مربع الخطا القياسي هو ∓ 0.115 متر مع الاخذ بنظر الاعتبار المعايير القياسية عند الاخراج الكارتوغرافي لها.

## INTRODUCTION

The base maps provides the primary medium by which the locations of property parcels can be related to the geodetic reference frame work to major natural and man-made features such as bodies of water, roads, building, fences, and municipal and political boundaries. Base map also provide the means by which all land –related information may be related graphically to property parcels **[1].**

For Urban development plans the base maps are to be drown on a large scale and show all or part of the physical, topography and cultural features and administrative and planning boundaries, in most of the Urban area this map may not be available readily and where available **[2].**

In the absence of accurate base map, no planning exercise can be undertaken. The first step therefore, would be to get any available map on a scale in which individual parcel with their survey numbers are be shown and then proceed to check that map from part to whole **[2].**

With development of Technology Digital Photogrammetry that has been started to be used widely in all most area about mapping. Especially digital orthophotos which are a Photogrammetry products. Aerial photography is used for preparation of base map. Large scale aerial photography is being used for generation of base maps and other thematic maps for urban area as it proves to be cost and time effective and reliable. Wealth of information pertaining to land features, land use, built-up area, city structure, physical aspect of environment...etc is available from aerial photography **[2].**

### Study Area

The study area is chosen in Baghdad city, Hay (district) Al-Wahda, Mahala906 which includes the University of Technology. The study area has a trapezoidal shape of (1750m×1500m) approximately as shown in figure (1). The elevation in this area ranging in between (31.113 m-31.822 m) according to coordinates of the ground control points (GCPs) measured using GPS type (GO-Xt).Therefore the study area can be considered as flat area.


**Figure (1): The study Area**

The study area divided to twenty sector and each sector consist of about five blocks, each block consist of about thirty (30) houses, which means that the Mahala of our study area include about 3000 houses, so that the population estimation of Mahala 906 are about 10000 persons.

## DATA COLLECTION

Updating any urban cadastral map can be done through the use of large-scale aerial photo. In the case study the existing urban cadastral maps in general and the urban cadastral map for study area in specific are considered having no georeference. Consequently the aerial photo map will be considered as a base map for updating the currently available urban cadastral map. Therefore; the data collection includes two parts the first represent the aerial photos and the second represent the urban cadastral maps developed by Amana Baghdad.

## AERIAL PHOTO

Aerial photo represents the basic reference for the data needed to updating urban cadastral maps, because of the fact that the photo represents the current reality of all existing artificial man made features. The main problem in updating cadastral maps is the daily changes in urban area which can be considered as continuous problem with no end. Consequently the aerial photos represent the best reference for detecting and checking any changing that might happened [1]. The aerial photos which are used in the research are aerial photos taken in 2008 having a ground resolution of 10 cm.

## BASE MAP

The base urban cadastral maps were developed by Amana Baghdad, which was executed by Pole Serves Company (1979-1989). Base maps were developed with scale

1:500 from aerial photos according to Clark 1880 UTM system [11]. Regarding the base map which were obtained from Amana Baghdad the following items:

1. Satellite image shows the boundary of Quarter (Mahala 906) as well as the neighboring Quarters.
2. Twenty base maps of the study area (Mahala 906) with scale 1:500, with their indexes.

## PRODUCTION of BASE MAP

## GEOMETRIC CORRECTION

The steps of the coordinate's transformation from image coordinates system to ground coordinates system can be summarized in the following steps:

1. Selection of a number of well defined and distributed ground control points. In the study area used five well defined ground controls points and distributed these points GCPs over all the area of study as shown in figure (2).
2. Determinate the ground coordinates of ground control points, through the use of GPS type (Trimble-GeoXt), after applying the data preprocessing ; the accuracies coordinates with a precision of ∓30 cm as shown in the following table (1).

**Figure (2): The GCPs distribution in study area.**

**Table (1): The coordinates of Ground Control Points**

| GCP no. | Longitude | Latitude | Ellipsoidal height (m) | Easting (m) | Northing (m) |
|---|---|---|---|---|---|
| 1 | 44 °26 '37.73 " | 33 °18 '41.71 " | 31.114 | 448226.35 | 3685968.22 |
| 2 | 44 °26 '57.94 " | 33 °18 '19.02 " | 31.822 | 448745.35 | 3685266.60 |
| 3 | 44 °26 '18.49 " | 33 °18 '52.07 " | 31.563 | 447730.68 | 3686290.07 |
| 4 | 44 °26 "12.15 " | 33 °18 '41.49 " | 31.687 | 447564.98 | 3685964.89 |
| 5 | 44 °27 '08.44 " | 33 °18 '26.75" | 31.821 | 449018.03 | 3685503.37 |

3. The application of ERDAS software for the affine transformation (first order polynomial). The total RMSE obtained is less than (0.4056) pixel. The results of this method and the transformation coefficients can be illustrated in table (2):

**Table (2): Affine transformation 1st Order Polynomial Coefficients**

| | | | |
|---|---|---|---|
| $a_0$ | -4434970.826 | $b_0$ | -36882532.76 |
| $a_1$ | 9.996679716 | $b_1$ | -0.000855515 |
| $a_2$ | -o.oo9542856 | $b_2$ | 10.00421759 |

**TRMSE=0.4056 pixel**

## RESAMPLING

The next step in the rectification/registration process is to create the output file. Since the grid of pixels in the source image rarely matches the grid for the reference image, the pixels are resample so that new data file values for the output file can be calculated **[3]**. Resampling is used to determine the pixel values to be filled in the (output) image from the uncorrected (input) image.

## DATABASE DESIGNING

The study area including the administer boundary ( blocks, houses, and streets) were drawn using the ARC GIS software (ARC catalog, ARC map) programmers, the ARC catalog programme was used to create and constructive the data base which will be filled out letter on by the data received from Amana Baghdad which includes, table (3) show the database design.

**Table (3): GIS database**

| Hay | Main street | Quarter | Secondary street | Zukak no. | Municipality | House No. | Official cadastral no. |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

The digitizing of the map features can be classified in to the following category:

- Border as polygon
- Houses as polygon
- Streets as line
-

## UPDATING THE EXISTING BASE MAP

The updating of the urban cadastral maps developed by Amana Baghdad were done through the use of the aerial photos. The principles of manual georeferencing have been used for Amana Baghdad Base Maps and the aerial photos, four points had been selected for each block. Therefore; the number of the points which are used in Georeference processes to be minimum twenty (20) points not less of well defined features in the base maps as well as the aerial photos. Using this approach with consider ignore the coordinate system had been used for the production of the existing Amana Baghdad base maps simply.

## GEOREFERENCING METHODOLOGY

To start the georeferencing we have to determined the map number with which we will be start the georeference taking into consideration that the resulted final updating map would have the optimum precision .This can be done through the application of weighting system to the maps through which we start with the higher weight map and then gradually done to the lowest weight map. The weighting system used in this approach depends on the number of the surrounding maps. In our case study we have three types of different weight (4, 3, and 2) taking into consideration that those points must be well distributed on the map which must include a minimum of **two** points on each side closest to the edge boundaries of the map which have a continuity on the surrounding map to avoid the rotation and translation that might happened in the georeference of the surrounding maps. Generally the georeferencing can be done through the use of a variety of 2D or 3D transformation models starting from 2D affine transformation ($1^{st}$ order polynomial) and ending with the 3D (central projection model DLT).However; in the case study the terrain was almost flat for this reason the first order polynomial were used in this research for the georeferencing .

## PRECISION ASSESSMENTS

There are many measures of the quality of geospatial data, however the most commonly used measure is spatial or positional accuracy. Positional accuracy is a measurement of variance of the position of a map feature from the true of the entity, **[1].** Map accuracy is determined by checking the mapped position of a location, either horizontal or vertical, against its true ground position, [**5].** Moreover there are two

approaches used currently for the precision assessment which are termed as the (relative and absolute accuracy). There are two checked doing to assessment of update map accuracy; one through checking the length of well defined features (walls) of houses and through the computation of the coordinates of certain points by using GPS.

**Trial No. One:** in this trial different houses looked in Mahala 906 (study area) have been chosen randomly and measured the length of eleven wall defined side of houses in the photomap and through field survey using electronic distance measurement (EDM) type Leica Disto D3 ; as shown in Table (4).

**Table (4): Precision assessment, trail No. One**

| House number | Ground distance (m) | Map distance (m) | Error (m) |
|---|---|---|---|
| **1** | **11.333** | **11.211** | **-0.093** |
| **2** | **22.944** | **23.054** | **0.110** |
| **3** | **22.645** | **22.525** | **-0.120** |
| **4** | **6.452** | **6.552** | **0.100** |
| **5** | **11.537** | **11.640** | **0.100** |
| **6** | **7.730** | **7.601** | **-0.127** |
| **7** | **23.060** | **23.065** | **0.005** |
| **8** | **23.052** | **23.116** | **0.064** |
| **9** | **22.935** | **23.136** | **0.201** |
| **10** | **23.184** | **23.053** | **-0.131** |
| **11** | **22.944** | **23.052** | **0.108** |

Accordingly the RMSE for this trial is **RMSE = ∓0.115m**

**Trial No. Two** in this trial the three control points at the university district have been chosen and determined by the previous research **[6]** were the coordinates are measured by DGPS (TopCon –GR3) . The coordinates of those points as shown in the following Table (5):

**Table (5): Ellipse Height & Elevation above Geoid results of GCPs, [6]**

| Name | Latitude | Longitude | Ellipsoidal height(m) | Grid Easting(m) | Grid Northing(m) |
|---|---|---|---|---|---|
| **1** | 33°18'43.4"N | 44°27'02.1 "E | 31.246 | 448856.673 | 3686017.395 |
| **2** | 33°18'44.4"N | 44°26'50.2 "E | 39.958 | 448550.998 | 3686051.396 |
| **3** | 33°18'43.4"N | 44°26'38.9 "E | 43.966 | 448258.341 | 3686019.977 |

However; these points does not appear in photomap for that reason the closest well defined features had been chosen in the photomap and measured the distance to these features and control points through field survey works. When compare these

distances measurement with that computed using a photomap and the simple equation is, [3]

$$D = \sqrt{\Delta x^2 + \Delta y^2}$$

Where: $\Delta x = x\ map - x\ ground$ , $\Delta y = y\ map - y\ ground$

The results of the trail two are given in the table (6).

**Table (6): Precision assessment, trail two**

| From-To GCP | Map distance (m) | Ground distance (m) | error |
|---|---|---|---|
| 1 | 0.968 | 1.120 | 0.152 |
| 2 | 2.705 | 2.560 | 0.145 |
| 3 | 1.392 | 1.250 | 0.142 |

Accordingly the RMS for this trail is: **RMSE= ∓0.146m**

The international accuracy standards for large scale maps American Society of Photogrammetry and Remote Sensing (ASPRS) are defined in many references such as [8, 9, and10] as mentioned in the following Table (7):

**Table (7): The ASPRS Accuracy Standards for Large-Scale Maps**

| Planimetric(X or Y) Accuracy (limiting RMS error, meters) | Typical Map Scale |
|---|---|
| 0.0125 | 1:50 |
| 0.025 | 1:100 |
| 0.050 | 1:200 |
| 0.125 | 1:500 |
| 0.25 | 1:1000 |
| 0.50 | 1:2000 |
| 1.00 | 1:4000 |
| 1.25 | 1:5000 |
| 2.50 | 1:10000 |
| 5.00 | 1:20000 |

The standard accuracy (precision) for large scale map 1/500 specifically is RMSE = 0.125m.From that the field results the RMSE for trail one is smaller than the standard RMSE, and the RMSE for trail two is a little bit higher than the standards which is defiantly related to the precision of DGPS which is used in field survey works. Moreover; the updating of the urban cadastral map of our approach for fills the standard.

## MAP CONTENT

Maps are selective in content, consistently representing the features that are important for intended use of the map and omitting others. Through selection and the choice and placement of symbols and annotations, maps also emphasize some features and de-emphasize others, [5].The scale, grid line, title, legends are information should appear on any map with other additional information appear on the map, [11, 5]. Figure (3) shows the layout of map of study area (Mahala906).

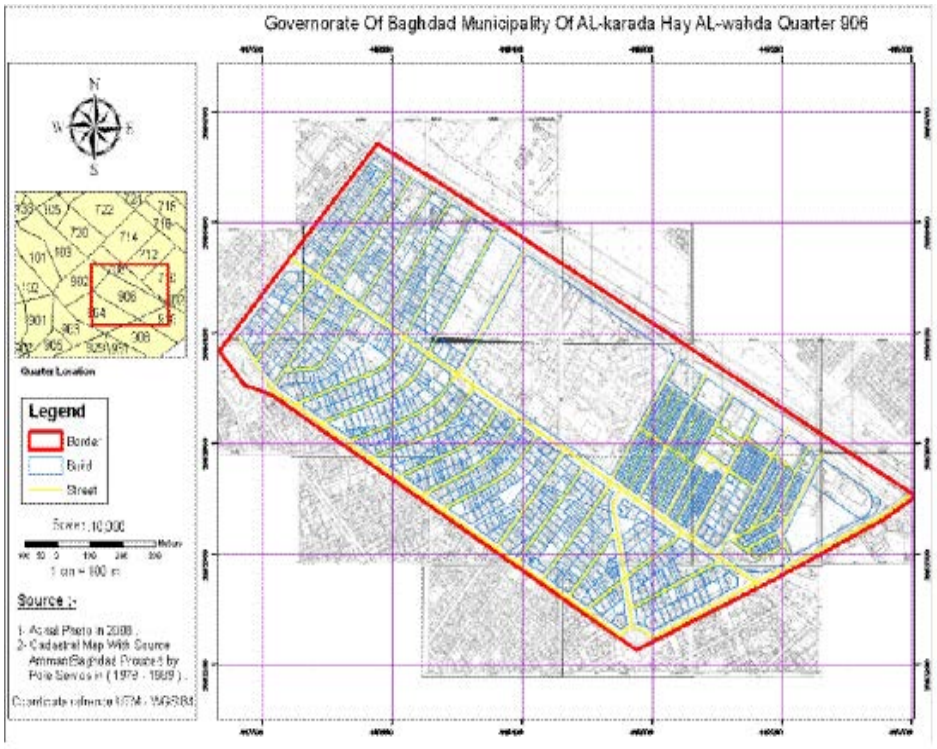


**Figure (3): Final updated map for case study area**

## CONCLUSIONS

The database for Urban Cadastral Map must be constructed in accordance with Land Information System (LIS). Large Scale aerial photos must be used for the production of the updating Urban Cadastral Map. The updating Cadastral Map produced from aerial photos simply consists of a photomap linked with the database. In this research georeferencing approach used for the updating of the maps with WGS84 system regardless their original coordinates system. In this approach a weighting system has been used for the production of the optimal updated maps with minimum errors equal ∓0.115 m (least square approach) starting from part to whole.

## REFERENCE

[1]www.nitc.gov/ base map, 14-9-2011.
[2]Town and Country Planning Organization Ministry of Urban Development and Poverty Alleviation Government of India, February, 2004 "Guide to preliminary planning surveys of urban areas including land use classification".
[3]Leica Geosystems, (2008),"ERDAS Field Guide™", Volume One, Leica Geosystems Geospatial Imaging, LLC, USA.
[4]Rocchini, D. and Rita, A. D., "Relief Effects on Aerial Photos Geometric Correction", Journal of Applied Geography (2005).
[5]Patricia M. Brown and D. Divid Moyer, "Multipurpose Land Information Systems, the Guidebook", the Federal Geodetic Control Committee, (1989).
[6] Mechman A. R. , (2004), "Accuracy Assessment of LiDAR Elevation Data Using Geomatic Technique" , M.Sc. Thesis, College of Engineering, Technology University
[7]http:// www.ferris.edu / faculty / burtchr /sare340 /notes / accuracy and standards.
[8]Geospatial Positioning Accuracy Standards, Part 3, (1998): "National Standard for Spatial Data Accuracy", Federal Geographic Data Committee.
[9] Burtchr, 14-4-2011, note book, http://www.ferris.edu.
[10]James M. Anderson and Edward M. Mikhail, (1998), "Surveying Theory and Practice", WCB McGraw-Hill, 7th Edition.
[11]Amana Baghdad Basemaps , produced by Pole Service Company 1979 -1989