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ACCURACY OF HORIZONTAL COORDINATES OF CADASTRAL MAPS AFTER GEOGRAPHIC REGRESSION AND THEIR MODERNIZATION USING GIS TECHNIQUES

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ABSTRACT

Cadastral maps are considered as a basic part of the land management infrastructure in the most of countries yet. However there is misunderstanding about their general characteristics and role. Due to the wide coverage of the urban expansion of different spatial systems and cadastral maps, it's so difficult to describe a "typical" map, which was range from1:500 to 1:10,000 scales.

Georefrencing is one of the first steps necessary to make any mapping work based on scanned maps or any aerial image that does not have coordinates, thus the map to be used should be returned to its geographically adjuster location based on their information attached to the map.

In this study, space image of the quick bird satellite 0.5m × 0.5m for the year 2015 Projection: UTM, Spheroid: WGS84and an old typical map for study area Projection: UTM, Spheroid: CLARCK 1880, for the year 1946 and scale 1: 2500, after converting it to UTM and WGS84 in ArcGIS were used. Some points of the study area were compared with coordinates monitored by DGPS.

Analysis of the mathematical results from cartesian coordinates showed that the standard deviation values of ΔE and ΔN were 0.262 m and 0.381 m, respectively.The horizontal coordinates of the new map were also compared with points in the study area monitored using the DGPS device. The difference rates and the standard division of ΔE &ΔN were -0.044 m and0.026 m and (0.344 m &0.292 m), respectively.

Keywords: Cadastral map, Geo-referencing, GIS, WGS84, CLARCK 1880.

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1. INTRODUCTION

Cadastral map is a map defining land ownership. The cadastral map can show all registered geospatial data. The cadastral map consists of cadastral units, each one represents a single registered plot of land. The cadastral map is not specified to defining possession boundaries, but includes geospatial references for other rights or burdens that affect the registered plots of land. It is ranged to include the seabed of Scotland out to the 12 mile [1].

For urban development plans the base maps are to be drown with a large scale and show all or part of the physical, topography and cultural features managerial and planning boundaries [2].

Maps are categorized according to their use or type but, in general, they become either a part of records of land division, a tool for engineering , planning and design, or a component of a GIS where they can used for many purpose[3].The cadastral maps must be overlapping with the base maps.

The maps provide a virtual framework upon of any part of the non-material information displayed, such as assessing comparisons, land appraisals and market or other statistical data. Vertical aerial image hasbeen an essential imagery product for development of the cadastral map. Imagery has high values when removing all distortions, it is connected to the main geodetic network, can serve as a base map, and meets the measurement tolerances with cadastral maps for the construction of the cadaster. Such images are called orthophotos, ortho rectified images, or “ethos”. Ortho photos are most commonly provided in a digital form either in black and white or color. Digital color ortho photos are the standard imagery product of most assessment agencies. At a minimum, new images of urban areas must be obtained every five years and of rural areas every ten years. Partnering with other institutions that also derive a benefit from aerial imagery such as fire rescue, emergency management, public works, engineering, utilities, planning, economic development, and aviation authorities may allow for acquisition on a shorter timetable (in some cases), reduced costs, and a higher image resolution [4].The web is supplying new techniques in this aspect. A ground control point for land-use maps represented the change is very significant task in modeling of an environment. Also, an urban planning could be built by remote sensing imagery with high resolution [5, 6].

Cadastral maps adopted formally and legally in the issues of land borders. In addition, it is used to warranty the rights of private and public feature. Therefore, the accuracy of cadastral maps is very important subject. Due to the accuracy of cadastral maps is extremely in continuous change, such subject must be further studied [7,8].The main objective of this study is to calculate the accuracy of horizontal coordinates after updating the old cadastral maps and then converted to UTM and WGS84 in ArcGIS.

2. THEORETICAL BACKGROUND

2.1. Cadastral Map

The cadasteris a document and up to date land information system comprising a record of reclaimed land (e.g. qualifications, rights, and responsibilities). It may include an engineering description of the land that linked with other records describing the nature reclaimed land, the possession, and its improvements.

Cadastral maps range from scales of 1:500 to 1:10,000. So that large-scale diagrams show more detail with dimensions and features are often intended aerial photography and land survey. Importantly, cadastral survey systems do not have ends in themselves. Their primary objective today is to support land tenure systems which protect land rights through public recognition. The successful system of a cadastral is a function of how successful they are in reaching the goals and economic objectives, and not the confusion of its legal framework the technical affectation of the cadastral surveys or cadastral map [8].

A cadastral map is used in resolving property disputes, takeovers or land gotten by individuals. It can be implicit that cadastral map is the combination of the technical side and man-made laws in addition to a regulatory side which added to the final symmetry of the map, where the production of maps related to legal technology which combines the concept technical legal and printing that is similar to the other maps [9].

- The types of spatial data that can support this process is as follows:
- Data description ground: as required by the legal meaning the type of the land is a natural description and land use, for example, agricultural land.
- Roads data: general throughway and rapid tourism sub and other local roads names.
- Churches and other houses of worship: refer to the documentation of the base information in terms of location and name.
- Data rail: The rail definition by width rail.
- Water sources: refer to the registration of water resources like rivers, rainwater and their tributaries, fork by marshes, lakes and reservoirs and water tides, canals, streams, and other water sources.

Other data: for example, when you talk about the length of the string display and height and steepness of the nature of the slope and about the hills to described hill length of display area [10].The spatial data representation and the method of installation bases represent the basic in GIS [6].

3. METHODOLOGY

3.1. Geo-referencing

Geo-referencing is one of the most important steps in GIS. The map to be used should be returned to its geographically correct location based on the information attached to the map.Geo-referencing can be defined as finding points that are known as coordinates, accurately defined on the map and the real ground based on the projection and reference map.These points are used as links between nature and the map and matching them in the right place and to make the map fit in the right place with nature.

ArcGIS now deals with this image without knowing the geographical area represented by these coordinates are the coordinates of the scanner.[15,16]

When the original map is scanned, the first step is to define ArcMap as the geographical area of the image with its real geographical coordinates. This is the so-called "Geo-referencing. As follows:

- Call (add) a scanned map image to ArcGIS.
- Make the *Geo-referencing* of this image through some of the old details in the cadastral map to determine its real geographical location.
- Evaluation of the original image and produce a new version of the reference geographically WGS84, UTM.
- Add a network of squares of the new map manually and very accurately.

- Comparison of some area points with coordinates monitored by DGPS.
- Comparison of some points of the region with the coordinates of a very accurate satellite image for the year 2015.
- Comparison of some points of the region with the coordinates of the network after conversion to the new projection.
- Analysis of mathematical results from horizontal coordinates.

3.2. GPS Observation Techniques

There are many observation techniques with GPS. The selection of the technique depends upon the purpose of the observations, the desired accuracy, the type and the number of the available receivers and the location of the points to be positioned. The main observing techniques used in GPS surveying are: Network. &. Kinematic [11]. The Global Position System (GPS) plays a vital role in matching features in the cadastral maps on the earth. Therefore, it is the foundation behind digital mapping navigation systems. The interest in the mapping of spatial information enhanced progress in the gathering experience and accessibility of digital details [7].

3.3. Network

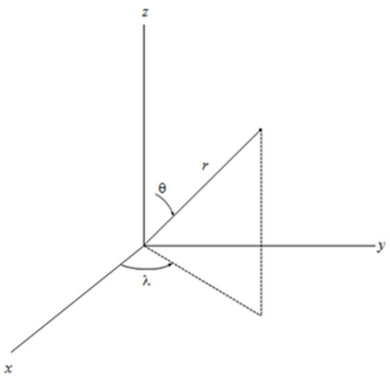
This method has almost similar monitoring to the static method but it uses a number of devices (more than two) to occupy a set of points simultaneously. Often, there are two points (from the observed grid points) of coordinates while other devices have points of unknown coordinates. Session time is increased by at least one hour (but depends on the lengths of the network lines) so that it can be accessed with appropriate accuracy [12].

3.4. Kinematic

In this way, the device is continuously in motion throughout the monitoring. As with a GPS device installed in an airplane or steamer etc. Therefore, this method is not used in geometrical geometry because its accuracy is equal to the accuracy of navigational or hand-held devices. The accuracy average is4-8 meters [13].

3.5. Ellipsoidal Coordinates

Ellipsoidal Coordinates are a three-dimensional orthogonal coordinate system that generalizes the two-dimensional elliptic coordinate system. Unlike most three-dimensional orthogonal coordinate systems that feature quadratic coordinate surfaces. In order to determine the coordinates of points in according to the ellipsoid, it was considered the ellipsoid with conventional (X, Y, Z) axes.



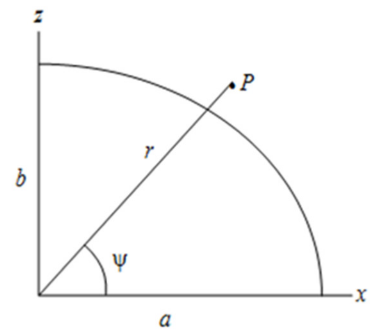


Figure 1 Spherical polar coordinates. **Figure 2** Geocentric latitude.

The first step was to define the meridian plane for a point as the plane that contains the point as well as the minor axis *(b)* of the ellipsoid. For any particular point *P,* in space, its longitude is given by the angle in the equatorial plane from the x -axis to the meridian plane. This is the same as in the case of the spherical coordinates (due to the rotational symmetry), see Figure (1). For the latitude, we have a choice. The geocentric latitude of P is the angle Ψ, at the origin and in the meridian plane from the equator to the radial line through P, Figure (2). Note that, however, the geocentric latitude is separate of any defined ellipsoid and is identical to the supplement of the polar angle defined earlier for the spherical coordinates [14].

ArcGIS deals with this image without knowing the geographical area represented by these coordinates, which are the coordinates of the scanner when scanning the original map. Thus, the first step required is to define ArcMap to the geographical area of the image with its real geographical coordinates.

4. STUDY AREA

The study area is located in the center of Iraq in the province of Babylonof the city of Hilla province number 12 between the coordinates of (N 3563550 m E 449500 m to N 3565050 m E 447500 m) surrounded from the east by Province No. 13 (North Bakrli), from the west by province of Jazri and Merna,from the north by Province No. 14. It is located at the south of District No. 6. Shatt al-Hillah is passed from the north-right side of the study area. The study area is characterized by simple terrain and high population density, Figure (3). The base maps provides the essential medium by which the locations of property portion can be related to the geodetic reference frame work to the natural and manmade features like water bodies, municipal, building, fences, roads, and political boundaries cadastral maps was provide for study are a Figure (4).

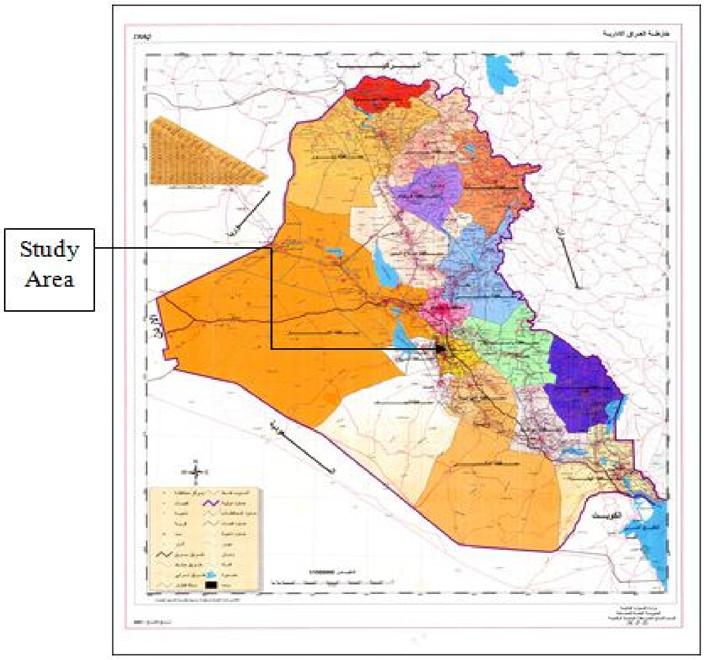


Figure 3 Location of the study area.

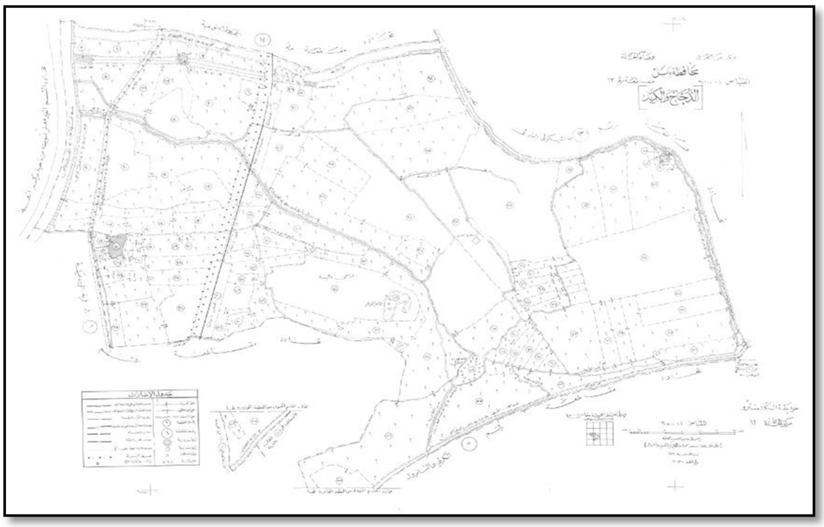
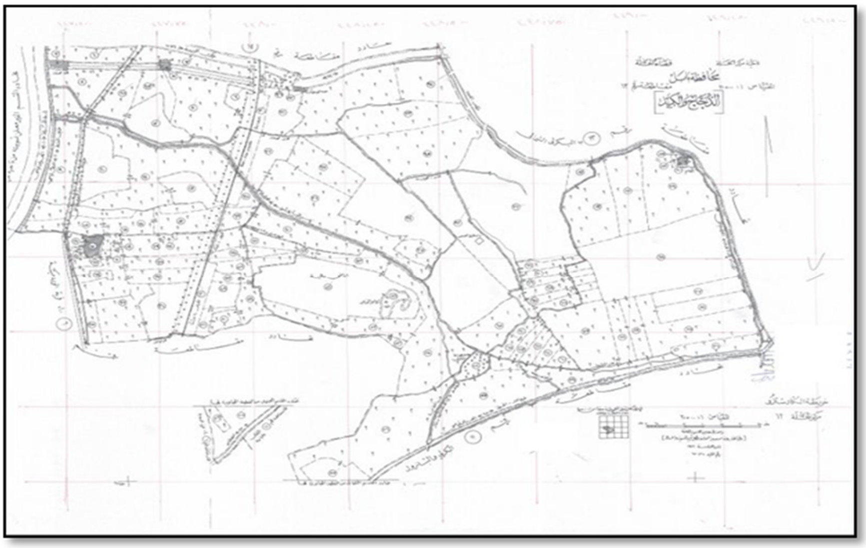


Figure 4 An old cadastral map of the study area Projection: UTM, Spheroid: CLARCK 1880, 1946, scale 1: 2500.

5. AVAILABLE DATA

Different sorts of data are available at the selected area of study, which are thought to enable the achievement of the mentioned proposed objective. The available data can be classified into three groups**:**

- DGPS data (high-resolution fixed mode and data processing through OPUS).
- Space image of the quick bird satellite 0.5m × 0.5m for the year 2015 Projection: UTM, Spheroid: WGS84.
- An old cadastral map of the study area Projection: UTM, Spheroid: CLARCK 1880, for the year 1946, scale 1: 2500**.**



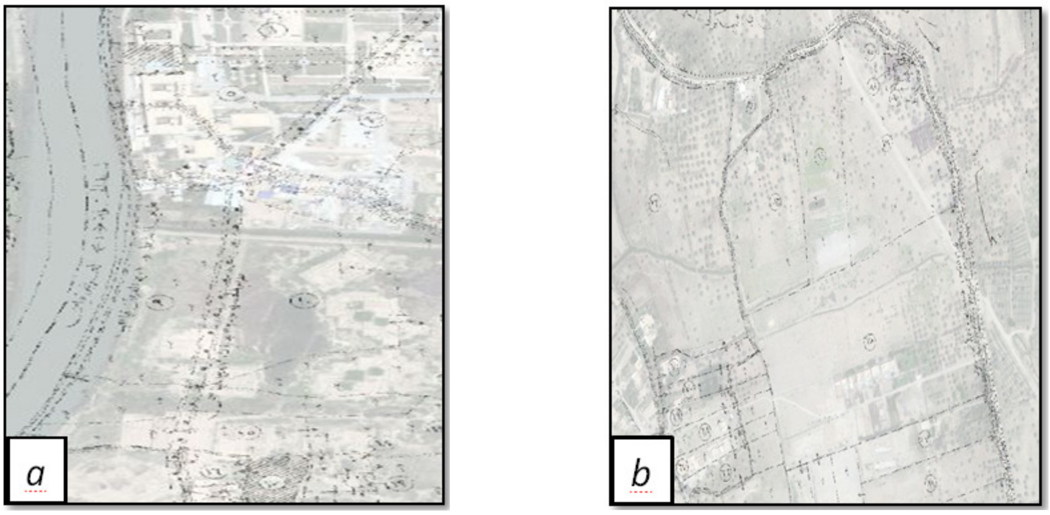


Figure 5 Study area after manual networking on Projection: UTM, Spheroid: WGS84

a) The study area shows that the map matches the image of the Hilla River.

b) The study area shows that the map matches the picture.

6. RESULTS AND DISCUSSION

The creation of digital maps is the basic step to start the construction of a database where it is useful to be used better of all the measurements and information matches of the place. In this study, a map of the Clark 1980 system (for one of the regions in Babylon) was linked to Projection: UTM, Spheroid WGS84, as shown in Figure (5), and matched them with real sites with the satellite image. Figure (5-a) showed a perfect match to the Hilla with the picture Figure (5-b).

After the final output of the map and making an intersection lines (grid map) of the map, the horizontal coordinates were extracted relying on the new plot as shown in Table (1). Using the ArcMap program, the difference between the X and Y coordinates of the selected points was obtained in the satellite image, where the maximum value of ΔE= (0.187 m)and the lowest ΔE= (-0.411 m), while the highest value of Δ N = (0.448 m) and the lowest ΔN= (-

0.394 m). As a result the standard deviation of the X and Y coordinates were 0.262 m and 0.381 m for E and N values, respectively.

The horizontal coordinates of the new map were also compared with points in the study area monitored using the DGPS device as shown in Table (3) and the difference rates of Δ E &Δ N were -0.044 m and 0.026 m, respectively. Thus, the Standard Division for ΔE &Δ**N** were 0.344 m and0.292 m, respectively.

The above results indicated that it is probable to update an old cadastral map of any region and any geographical reference and turn it into reference and reliable work of modern maps.

Table 1 Horizontal coordinates according to the new projection.

No.	**WGS84**		**CLARCK 1880**	
	Easting (m)	**Northing (m)**	**Easting (m)**	**Northing (m)**
1	448000	3564050	447999	3564093
2	447750	3564800	447749	3564843
3	449000	3564550	448999	3564593
4	449250	3563800	449249	3563843

Table 2 The value of the horizontal coordinate difference between the map on the new project and the spatial image through GIS program.

No.	**WGS84**		**Image**		**ΔE (m)**	**ΔN (m)**
	Easting (m)	**Northing (m)**	**Easting (m)**	**Northing (m)**		
1	448000	3564050	448000.411	3564049.552	-0.411	0.448
2	447750	3564800	447749.813	3564800.394	0.187	-0.394
3	449000	3564550	449000.386	3564550.299	-0.386	-0.299
4	449250	3563800	449249.957	3563799.626	0.043	0.374

Table 3 Identify horizontal coordinates between the map and the new projections with points within the region monitored by DGPS**.**

No.	**WGS84**		**DGPS**		**ΔE (m)**	**ΔN (m)**
	Easting (m)	**Northing (m)**	**Easting (m)**	**Northing (m)**		
1	448705.241	3564264.568	448704.961	3564264.373	0.280	0.195
2	448023.992	35648544.896	448024.421	35648544.690	-0.429	0.206
3	447934.234	3564799.848	447933.872	3564800.101	0.362	-0.253
4	447261.208	3564211.263	447260.962	3564210.880	0.246	0.383
5	449087.125	3564702.914	449087.516	3564702.497	-0.391	0.417
6	448772.087	35640811.530	448772.396	35640811.750	-0.309	-0.220
7	449260.119	35648024.659	449259.820	35648025.061	0.299	-0.402
8	447711.587	3564976.095	447712.001	3564976.214	-0.414	-0.119

7. CONCLUSIONS

Based on the results of this work, the following conclusions were derived:

1. Using the considered method to update old maps is very useful especially when the landmarks (objects) are homogeneously distributed (clockwise or counter clockwise) on the image.

2. Utilizing the ArcMap program gives high accurate results where the standard deviation of the X and Y coordinates were 0.262 m and 0.381 m for E and N values, respectively.
3. It is possible to update an old cadastral map of any region and any geographical reference and turn it into reference and reliable work of modern maps.

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