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Updating Cadastral Maps using GIS Techniques

Abstract- *The Cadastral maps are very important since they have technical and materialist specification of the property borders. However, these maps despite their use as land registration in world in general but in Iraq; the old maps are unfit for use. Therefore, updating and digitizing the cadastral maps are very pivotal. In the present work, we have an old agricultural cadastral map since thirties as a hardcopy which was digitized then updated using control points and modern satellite image (QuickBird 2009) for the same area. In this research, we upgraded the methodology for updating of the agricultural cadastral maps of Iraq based on the use of Differential Global Position system (DGPS), Total Station, and Satellite Imagery, in addition to the cadastral editor extension in ArcGIS software to produce new agricultural maps. The tolerance of this approach was tested by root mean square errors in addition the parcel points were compared with land records and QuickBird image. The motivation of current work was due to there are no modern cadastral maps for the study area, which is located in province of Wassit South-East of Baghdad. The results can be used as a basis for the decision makers in addition; this methodology can be utilized to solve problems relating to land property in study area and can be extrapolated to other datasets.*

Keywords: *Cadastral Maps, GIS, DGPS, Satellite Imagery.*

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1. Introduction

Cadastral map illustrating the limits of an area, frequently with directions, lengths and extents, in order to determine and register of property. You may also make use of many facilities likewise an infrastructure, sanitation, and additionally other features associates to land-use. Uncertainty has been an appreciable problem in cadastral maps and geographic sciences for over a decade [1-4]. Uncertainty can be divided into ambiguity and vagueness. Ambiguity refers to the uncertainty related to crisp categories. For instance, land cover is frequently modeled utilizing hard classification. Each hard group is suffering from some ambiguity. This ambiguity is most usefully known as a probability. Vagueness is the groups that are not crisp, but they are fuzzy such as the land cover, which often diverges ceaselessly from one point to another. In these cases, the classes should be defined as fuzzy, not crisp. This fuzziness is equal to vagueness [5].

This paper aims to update cadastral maps based on logical phases. These logical phases take into consideration the huge progress in geomantic tools and map production. The need to find out the borders of property that based on the cadastral maps using the modern devices of survey namely GPS, is rising continuously.

This dilemma has directed researchers to encourage that the spatial results of GIS and cadastral maps should be (at least) dual: (1) a map of the different of interest and (2) some evaluation of uncertainty in that map. Uncertainty has also been the subject of a lot of research in remote sensing [6,7] with the main care of such work being the evaluation of prediction . However, uncertainty in remote sensing appears to have been a less focus of research than uncertainty in GIS.

In order to reach a good level of accuracy which is the sum of unbias and precision: Accuracy= Unbias+Precision.

This simple equation was used to define accuracy in terms of precision and unbiased data is algorithmically essential in solving problems into uncertainty. Where an independent data is utilized to evaluate uncertainty, accuracy may be found directly. Essentially, the root means square error (RMSE) which is sensitive to both systematic and random errors can be utilized to predict accuracy [5].

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. Users are capable of giving their ideas expeditiously, and share their knowledge of borders and surroundings. These permit decision makers, encompassing planners and investors, to benefit from information to make right decision [8]. Darbha [9] account of the geometrical accuracy is warlike by the devotion of an object in the image to compare its actual location on the ground. Geometrical accuracy admission for Ikonos imagery in 2000, 2001, 2002

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and Quick Bird imagery in 2002, 2003 affecting ground control points (GCPs) methodology was the main task for this project. 90 usable GCPs were palmed. These points were chosen to be well scattered always a (14.5 km x 14.5 km) region of case study and to use the standard of NSSDA to find the definite accuracy approval for Ikono's imagery in 2000, 2001, 2002 and Quick Bird imagery in 2002, 2003. Global Positioning System GPS) has been known formidable progress in reducing errors and increasing accuracy [10]. Subsequently, many geo-dynamic tasks are detectable by GPS techniques [11].

2. The Purpose of the Study

Cadastral maps adopted formally and legally in the issues of land borders. In addition, it is used to guarantee the rights of private and public property. Therefore, the accuracy of cadastral maps is immensely important subject. Due to the accuracy of cadastral maps is frequently in continuous change, such subject must be further studied. The purpose of this research is to achieve cadastral maps for agriculture with good precision by correcting the hardcopy map (Figure 1). This can be done easily after converting it to a digital map. In order to reach this goal the control points in addition to QuickBird image were used by integrating them into a GIS system. This subject is primarily used to maintain the boundaries of the property and resolve legal disputes before the courts. Sometimes may use Cadastral maps as an alternative to the tourist maps to show a large amount of detail appointed in all state enterprises at all levels. It notes that the most important characteristic of cadastral maps is legal precision have no dispute over the validity and accuracy. So, they are used basically as a reference in the creation of maps of the regions and centers. In addition, it is essential to work with detailed maps of various kinds [12].

3. Theoretical Basics

The cadastal map can be described as the map of land possession, in a space, kept for the intent of taxing land. The procedure of subdivision originates new sections by legally subdividing old ones. Areas of land in a cadaster are usually unambiguously specified, by code, are also rationally continuous through time, and thus meet the needs of a registration system. However, few users recognize their identification code, and use of the cadastral map as a registration system is thus fixed hugely to government officials, with one main exclusion .

Its substantial, straightforwardness and harmony make it beneficial for many goals, and comprehendible by the community. The geometric harmony or regularity also permits it to meet the needs of a metric system of registration process, which will be defined by measured distances [13].

Cadastral maps are used in order to recreate the limits of ownership or description of the land, whether that land dedicated to the ownership of individuals or public ownership of the state. The importance of this type of maps could be listed as follows:

- In determining the properties of agricultural land.
- The subsequent paths in determining aqueous sewage agricultural irrigation.
- The determining the limits of roads properties of individual buildings and public and private property.

A Cadastral map is used in resolving property disputes, takeovers or land gotten by individuals. It can be implied that cadastral map is the combination of the technical side and man-made laws in addition to an organizational side which added to the final consistency of the map, characterized by map production which combines the connotation technical legal and printing that are similar to the other maps [14].

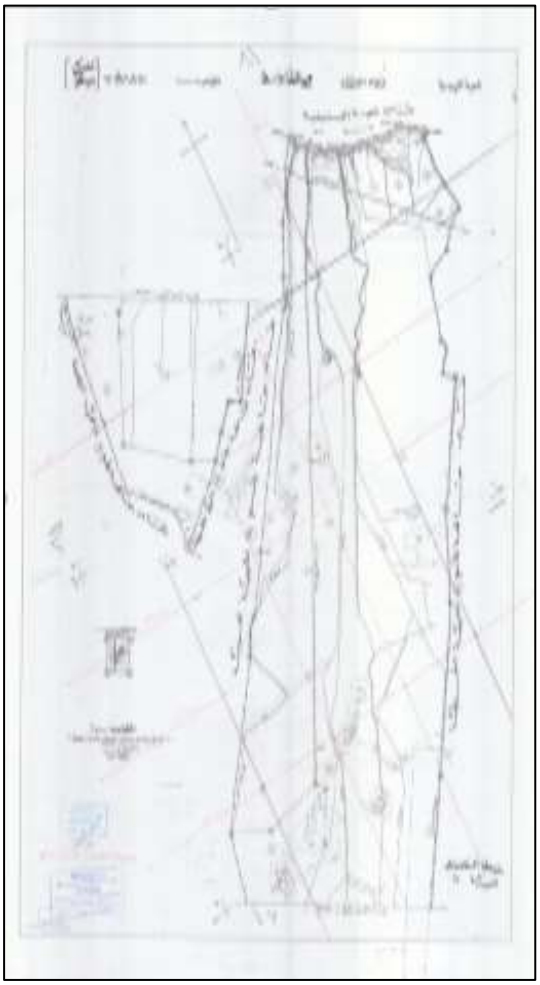

Figure1: Old cadastral map for Alshehaimeya province (Source: Ministry of Water Resources)

Utilizing constant features as mapping units rather than pixels admit the truth to us to compute for local spatial boundary and to modify the influence

of local pixel divergence on uncertainty of map production using classification. The cadastral maps depend on natural landmark or synthetic with features well- known in the region such as rivers, roads, wells, springs, and villages etc. Cadastral maps are source of information and data. Database is a vital structure of the Geographic Information System (GIS). The database is an important issue in GIS, which represent significant processes in the success and continuity of the work [15]. Digital mapping is the trajectory by which acquisition of data is combined and managed into a feasible imagery. The basic usage of this technology is to originate maps that give precise impressions of a definite area, documenting areas and points of interest. The technologies additionally endorse the appraisal of distances from one site to another. The core employment of these maps is with the Global Positioning System applied in standard automotive navigation systems. The concept is to use digital mapping to increase accuracy, which recently has amplified and has been linked to Global Positioning System (GPS) technology .

The data are the specimens meanings that belong to an accurate phenomenon without originating its process so that the storage, collection and analysis of that data for the service of the community. The GIS depend on natural phenomena or spatial element in nature; other attractions. Various landmarks represent a key element in geographic information systems. Hence, adding importance to data whenever they are accurate and near to the truth and reality, and vice versa whether the supports were old and not up to date the interpretation of classes with aid of data becomes very difficult. The types of spatial data that can support this process is as follows:

Data description ground: as required by the legal meaning of the type of the land is a natural description or formative or exploitative of the land, for example, agricultural land.

Roads Data: General highway and rapid sub-tourism and local and other names of roads.

Churches and other houses of worship: refer to the documentation of the base information in terms of location and name and all other information.

Data rail: The rail definition by width rail.

Water Sources: refer to the documentation of water resources like rivers and their tributaries and fork by marshes, lakes and reservoirs and rainwater and water tides and wells and springs, canals and streams, subcommittees and other water sources.

Other data: For example, when you talk about the mountain chains can mention the following data and the length of the string display and height and steepness of the nature of the exploit. When you talk about the hills archaeological described to the hill length of display area [16]. The spatial data representation and the method of installation bases represent the foundation in GIS [16.[

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4. Methods and Datasetso

I.Data collection

Satellite imagery in addition to well-defined control points for the purpose of updating cadastral map of Alshehaimeya Province, study area , located in Governorate of Wassit Governorate (Figure 2).

To update any cadastral map we need to nutrition map data. In Iraq it has not been updated since the .cadastral maps produced have so far prevented that in our study, three sources:

1. The satellite image (Figure 2).

Figure 2: QuickBird (2009) for the study area
Source: Ministry of Water Resources

2. Cadastral old map install ownership limits.
3. Ministry of Water Resources / Public Space for the Authority in 1997and the Ministry of Planning Data, Central Bureau for Statistics for theconstruction Spatial data base of the new map.
Data collected through field work by using different devices as total station and GPS in addition to the Field visits to the study area which are often reached to more useful and accurate data since they were gathered using strict methods, can be repeated to other study areas, and, unlike collecting data using questionaire which may be suffer from bias. However,it can be analyzed using sophisticated statistical techniques. In other line with these stages of collecting data, in this paper we contact different govermentnal ministries, they courtesely provided us by maps and GIS data plus remote sensing data which was good source that is suitable for work evaluations, whereas these evaluations require hard measures to judge the ultimate value of the feature matching which were fullifelld using root mean squre errors tests.

II.Geo-reference and Least-Square Adjustmens Approaches

The least squares adjustment adjusts the cadastral features with respect to new
calculations and generate a new best-fit for all the features in map using Cadastral Editor Extension in ArcGIS software.
The least-squares adjustment corrects the lines measurments with the control points to extract new coordinates for the map points. The adjustment correspondingly repeats to produce a " best-fit" for the coordinates, depending on the land extent or land size, the accuracy of the used data.
Control points are assumed as unchanged points in the process. Due to the least-squares adjustment extracts new coordinates for the map points, map borders will adjust somewhat or hugely, based on how accurate the used data is.
This research also adopted the principles of manual geo-referencing of cadastral maps and the satellites image through the selection of a number of well-defined features in the map as well as the satellites image, the coordinates in cadastral maps (obtained through DGPS) are represent the source and the coordinates of satellites image are the reference. Six points had been selected for area study. Using this approaches we ignored the system used for the production of the (cadastral maps) simply because maps had unknown coordinate system and projection.

III. Root Mean Square Error Test

Root Mean Square Error (RMSE) is one of the most exceedingly used to calculate errors in survey GIS, and remote sensing data . RMSE can be used for a assortment of applied geostatistical process . RMSE calculates the error between two data. RMSE often match a predicted data and an observed data. We use RMSE test to calculate the error .Root Mean Square Error (RMSE) is also known as to be the square root of the average of the squared gaps where these gaps are the variation in coordinate or elevation magnitude as assessed by an independent survey process. For example, the rms error in the Y coordinate direction can be computed as:

$$RMS_y = \sqrt{G^2/n} \quad (1)$$

Where:
$G^2 = g1^2 + g2^2 + \ldots + gn^2$.
g = difference actual values and the predicted values in the Y … coordinate direction = Ymap - Ycheck
n = total number of points checked on the map in the Y coordinate direction.
When correcting the cadastral old map and the application of georefrence approach was RMS = 0.32 which was shown in Figure 3.

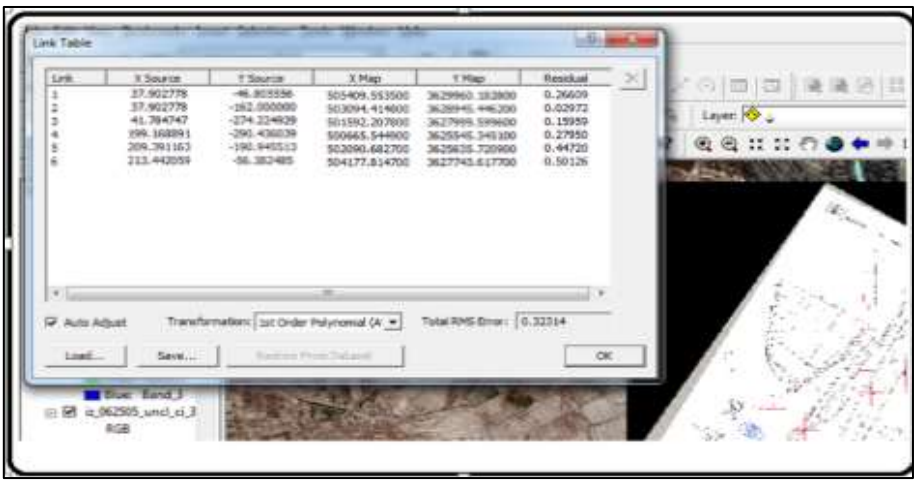

Figure 3: Calculation of root mean square error. Source: Author's own work

5. Results and Discussions

After updating map and matching features between cadastral old maps and features in satellites image it can be perceived that there is a difference between the old features and features in satellite image, the reasons for the difference are:

- The low accuracy of the old drawings.
- Changes that occur on the features during a period of time

Since that Iraq cadastral old maps production has not been updated so we find lack of conformity of all the features as shown in Figures 4–9. Table 1 illustrates ground control points for the study area which was obtained from DGPS and satellite image with high resolution.

The cartographic parameters for study area are:
Linear unit: Meters
Projection: UTM North-Zone_38E
Spheroid: WGS1984
Datum: WGS1984
Governorate : Wassit
Province : ALshehaimeya (study area).

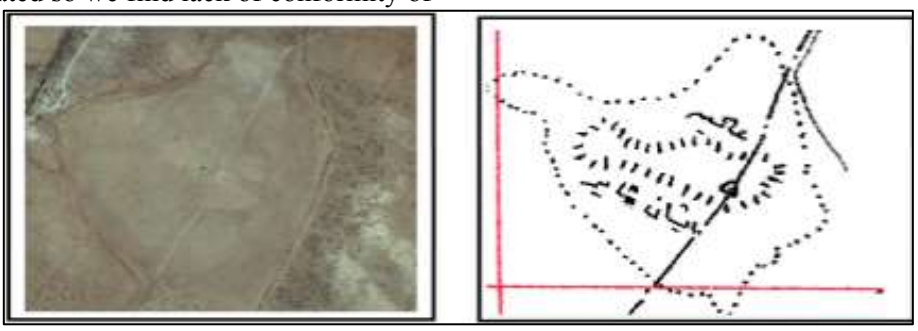

Figure 4: Point No.1 (Ishan Thayer)

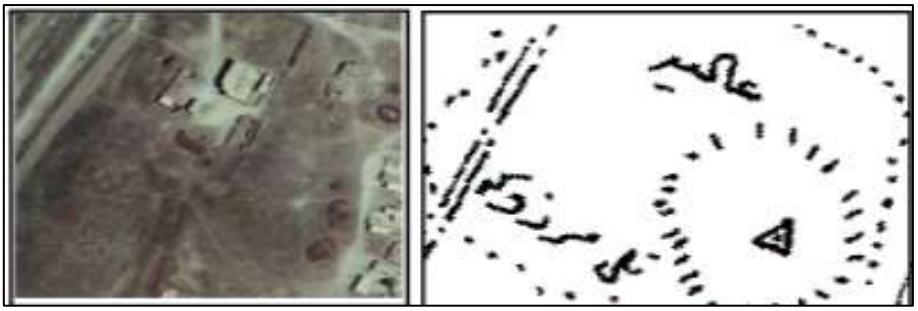

Figure 5: Point No.2 (Tel Merzouga)
Source: Author's own work

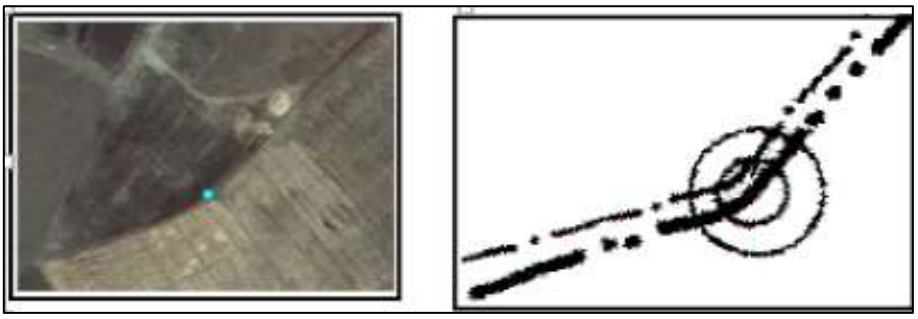

Figure 6: Point No.3 Well-Defined Pointst (WDP) 1

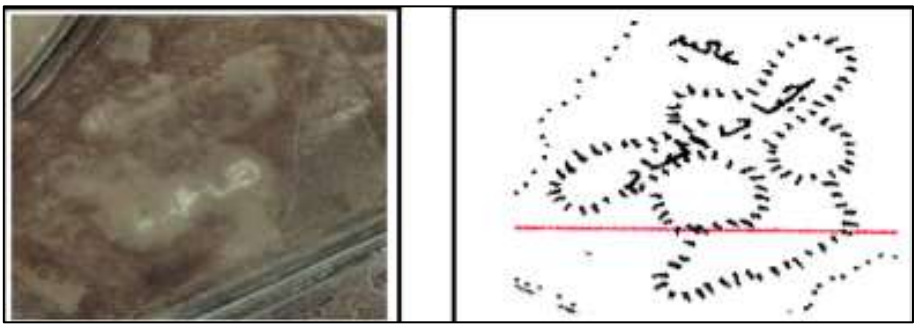

Figure 7: Point No.4 Jabab Al-Nar

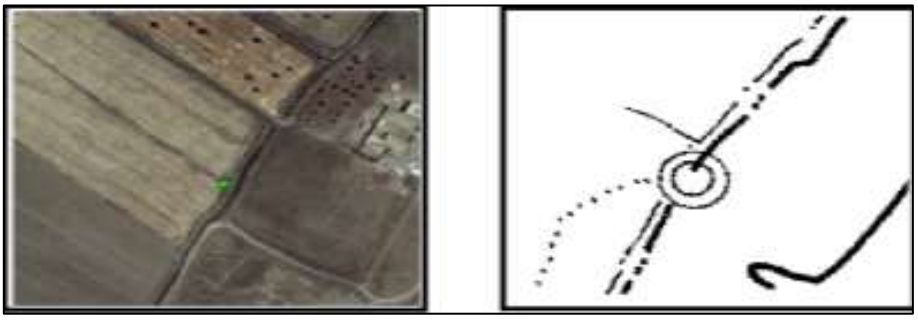

Figure8: Point No.5 Well-Defined Pointst (WDP) 2

Figure 9: Point No.6 Well-Defined Pointst (WDP) 3. Source: Author's own work

Table 1: Ground control points obtained from DGPS and satellite image with high resolution for study area

Point No	X-Coordinate (m)	Y- Coordinate (m)	Description
1	502090.682	3625635.720	Ishan Thayer
2	503094.414	3628945.446	Tel Merzouga
3	505409.553	3629960.182	Well-Defined Pointst (WDP) 1
4	500665.544	3625545.345	Jabab Al-Nar
5	504177.814	3627743.617	Well-Defined Pointst (WDP) 2
6	501592.207	3627999.599	Well-Defined Pointst (WDP) 3

6. Importing Control Points from a Feature Class into the Cadastral Fabric

Control points are utilised as a ground truth for ameliorating the spatial accuracy of all other land points in the network. Control points are making use of them as fixed points in adjustment and geo-reference the cadastral fabric. While fabric parcels may be accurately defined with respect to each other, control points were imported accurately coordinate parcels on the surface of the earth. Control points, also be entered manually, will be imported into the cadastral fabric from an existing feature class (Figure 10).You can perceive that using DGPS high accuracy surveying instead of GPS (GEO XT) application has improved the precision. We highlight using new tools, methods and programs of map productions to upgrade the agricultural cadastral old maps such as Geographic Information System was a great value for the work.

7. Map Production

It can be implied, that GIS works for alot time on installing 'error-aware' GIS, that also keep quality details about the data kept in the GIS information [17]. However,although a increasing need from the GIS users for suitable registration on spatial data assessment[5]. A good mapping, with uncertainty diminished to the least , will be lost if the outputs cannot be effeciently comprehended. This refer to cartographic skills with GIS data. It must also be mentioned that not any user can directly distiguish and understand the phenomena being represented [18]. Therefore, it must be carefully made use of communication and its efficiency considerations. It is usually a issue of having to provide maps with other representations, such as tables, graphs, and images. The Web is suppling new techniques in this aspect. A ground control point for land-use land-cover/LULC maps represented the change is very significant task in modelling of an environment. also in an urban planning could be built by remote sensing imagery with high resolution[19, 20]. Maps are classified 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 geographic information system where they can used for many purpose [21, 22]. Figure 11 shows the snapshot of corrected map for study area (Alshehaimeya).

8. Conclusion

In this paper, a procedure for updating cadastral maps for agricultural purposes has been introduced. Cadastral maps production in Iraq from different institutions so productivity is a multi-projections, but relied on the surround ellipse spheroid Clark 1880. This procedure was used to improve accuracy regarding measurement based on integration satellite imagery (with high resolution) with ground truth collected using DGPS. The tool of building model and integrating these spatial data was GIS. The designed procedure provides a convenient method to automatically upgrade cadastral maps. The results of the research have been validated by making several tests in the field and by using Root Mean Square Errors. This procedure can be applied to different datasets on condition that the model correlate variables professionally to conquer not only the asymmetrically between old maps and image map but also asymmetrically shape of features of property boundaries of old maps with shape in ground.

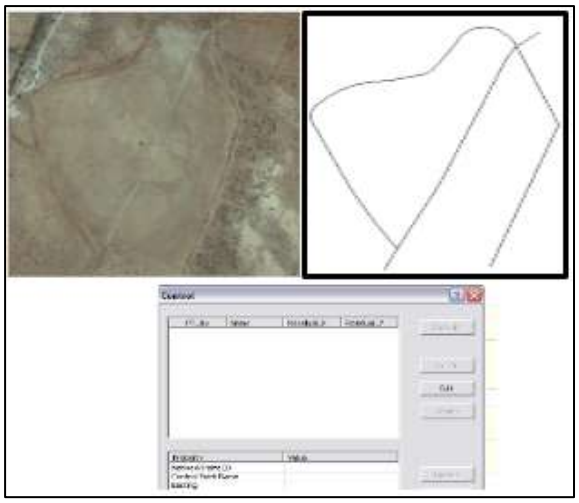

Figure 10: Updating Parcel based on control points and satellite image. Source: Author's own work

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Figure 11: Updating map for study area (Alshehaimeya) Source: Author's own work

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