International Journal of Scientific & Engineering Research, Volume 6, Issue 8, August-2015
ISSN 2229-5518

Baseline Data Preparation of Revenue Land Record

Rana Muhammad Sohail Aslam*, Sajid Rashid Ahmad, Kashif Aslam

Abstract— Importance of maps whether displaying spatial locations or geographical patterns remained significant in every age of mankind. Currently, different kind of maps are being prepared but human interest for land use mapping with focus on land ownership record and management is considerable at all times. In this regard, different land use mapping practices have had applied to observe, monitor and manage different man made activities at various scales. Cadastral mapping technique is one of these practices to maintain metes-and-bounds of a country at defined spatial units. Currently, traditional methods (i.e. paper maps) to update and maintain these maps are still in practice in most of the developing countries. In Pakistan, Board of Revenue (BOR), which is responsible to maintain the revenue land record at cadastral level (which locally called "Patwar System"), is mainly involved traditional revenue mapping methods. Each parcel of land in this Patwar system is called "Khasra" (i.e. a number assigned to a block of land). These khasra records are maintained through traditional cadastral mapping technique which needs to be switched with more efficient and convenient computer based methods such as geographical information systems (GIS). The purpose of this research is to propose a GIS based system that transform the traditional cadastral mapping method into a well-organized and handy mapping technique.

Index Terms— Cadastral Mapping, GIS, Land Information System (LIS), LRMIS, Mouza Boundary, Murabba Boundary, Latha Map.

INTRODUCTION

Maps are useful in different ways like to navigate locations, land resource planning, time management, town planning, etc. whereas machines are helpful in improving the navigation process by providing precise locations. Geomatics is playing a key role in computer based mapping [1]. Therefore the importance of GIS for base line data development, maintenance and updating of revenue land record cannot be denied. In Pakistan, use of GIS is not new as it has been utilized in different walk of life with focused on social sector planning and management. For example, [2] applied GIS for education and school mapping, [3] for health resource mapping. In this part of the world, GIS is also setting up an important role in revenue land record management and mapping ([4], see report).

There are two types of GIS: Raster GIS and Vector GIS. Raster GIS stores geographic features/data in the form of pixels, grid, tin, etc. whereas Vector GIS stores in the form of points (a set of xy coordinates), lines and polygons. In vector data preparation, few things like scale chosen for data development, use of suitable tool for data conversion from raster etc. are very important to maintain the accuracy of data being prepared. In modern societies, database systems (A database is collection of data in an organized manner) are essential component of daily life [5]. It provides the flexibility to retrieve, sort, analyze, summarize and reporting of the data. GIS and database both together has changed the whole concept of mapping.

- *Mr. Rana Muhammad Sohail Aslam has completed M.Phil degree program in Geomatics from University of The Punjab, Pakistan. E-mail: sohailaslam303@hotmail.com*
- *Mr. Sajid Rashid Ahmad is Proessor & Principal: College of Earth & Environmental Sciences, University of The Punjab, Pakistan. E-mail: sajidpu@yahoo.com*
- *Mr. Kashif Aslam has completed M.Phil degree program in Geomatics from University of The Punjab, Pakistan. E-mail: mkashifalam@yahoo.com*

In developing a revenue land record system, GIS in both forms (raster and vector) and attribute information stored in database are interconnected. High resolution satellite imagery (HRSI), a source of raster data, cannot be neglected in getting updated information. The importance of HRSI cannot be narrowed to any particular field as it has different applications in different fields (e.g., agriculture, meteorology, forestry, landscape, warfare, intelligence, surface temperature calculation, education etc.) and the race of spatial resolution has also given a new horizon to its importance[6]. In land revenue system use of HRSI becomes even more important when land conflicts occur. These conflicts can easily be identified and solved by using temporal archive of HRSI[7].

BACKGROUND

Land reform in sub-continent was first introduced by Sher Shah Soori (1534-1545). The major reforms were made by him in revenue land record management[8]. Further, the system was refined in *Mughal* regime by King Akbar (1556-1605). During the British Rule, a proper Patwar System was established in the region[9]. After the partition of Indian sub-continent, Pakistan introduced its first revenue land act in 1967. In this region, the existing revenue and land record system is comprised on centuries' old pre-partition British's settled structure therefore the cadastral paper maps containing geographic information i.e. "*Massavi map*" being used in India and Pakistan have similar standards as well as the land measurements (e.g. *Murabba, Killa/Acre* etc.).

International Journal of Scientific & Engineering Research Volume 6, Issue 8, August-2015
ISSN 2229-5518

In land revenue system, most commonly used units of land measurement are given in Table 1. The largest unit in revenue system is Murabba (Rectangle) which is approximately 25 acres in imperial unit system while the smallest unit is Karam which is equal to 5.5 feet (see, Tabel 1).

MAIN UNIT	SUB UNIT
1 Murabba	25 Acre/Killa
1 Acre	8 Kanal
1 Kanal	20 Marla
1 Marla	9 Square Karam
1 Karam	5.5 Feet

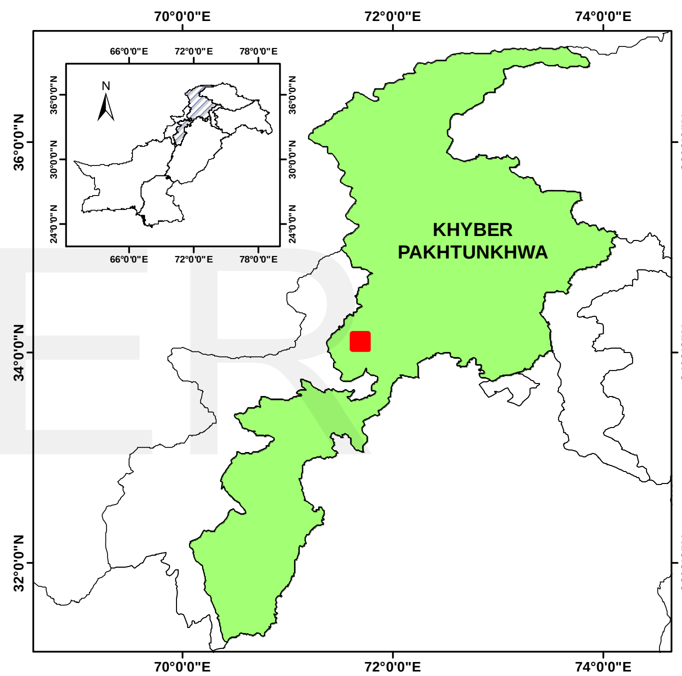
Table 1: List of Revenue Land Measurement Units

The "Patwar System" relies on two basic type of information (i.e. spatial & tabular). The spatial information is stored in the form of Massavi maps at the time of settlement. A copy of the Massavi map is traced on cloth, called "Lattha/Shajra/Aks Massavi". The other tabular information of the system is stored in different registers like "Field Book" (contains detailed information about Khasra #, Farmer ID, land type etc.), "Misel-e-Haqiat" (holds detailed information of land ownership, Owner ID, Parcel ID, Tax record etc.), "Register Intiqal" (shows the detailed Mutation record), "Khasra Girdawari" (includes inseminated crops detail and it is prepared twice per year), "Roznamcha" (illustrated the daily events occurred e.g. crop disease, death record etc)[10] etc.

In "Patwar System", "Patwari" is the official accountant to maintain the land's spatial as well as crop record for certain land area. In revenue land record system spatial component of data is maintained at cadastral level to show the extent of each khasra. In the system, these cadastral maps are useful in many ways like splitting of land ownership, calculation of exact area, crop diversity analysis etc. Cadastral mapping is also found helpful many times to resolve the land issues as well[11].

The cadastral mapping system of Pakistan is about two hundred years old and but currently there are several concerns due to change in societal needs by time[12]. To preserve this dense data manually at larger scale is not only a fatigue task but also challenging therefore the importance of GIS becomes even more imperative in the running scenario. Also, this manual work (both cadastral maps and text documents) is a massive task and the land administration does not have the required capacity to manage demand for cadastral services[13]. Today, remote sensing and global position system (GPS) technologies have changed the traditional mapping methods[14]. Using the modern technique, we can not only reduce the burden but can also make the system fast, efficient and transparent as well.

Objective of the study is to define the methodology for a GIS based land revenue system so that the traditional paper method for cadastral mapping can be replaced with modern technique of running era. More over the data developed by using the GIS formats is easy to use and sharing as well[15].



CASE STUDY

The study area geographically is between 34.113° to 34.124° North latitude and 71.680° to 71.695° East longitude and administratively, in Pakistan this area lies under Tehsil Charsadda of Khyber Pakhtunkhwa Province.

Figure 1: Map Highlighting the Study Area

International Journal of Scientific & Engineering Research Volume 6, Issue 8, August-2015
ISSN 2229-5518

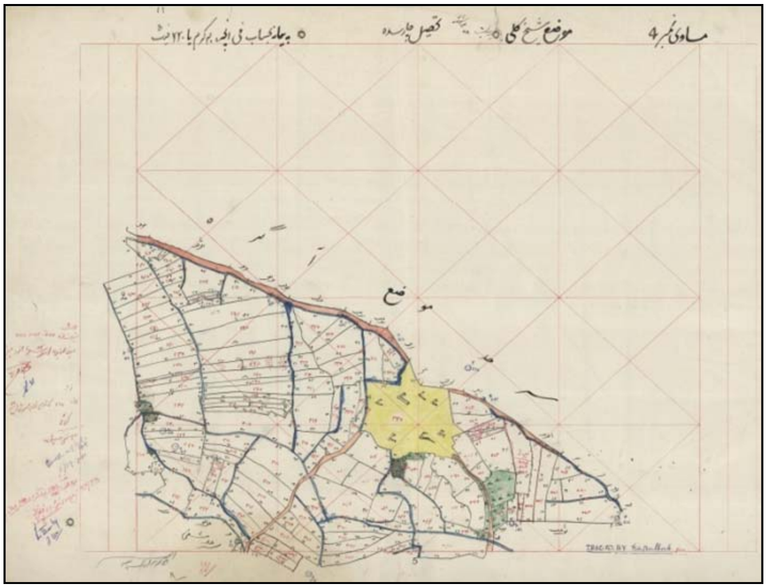


Figure 2: Original "Massavi Map" of the Study Area
Source: Pakistan Board of Revenue

Figure 3: Satellite Image of Study Area
Source: Google Earth (Acquiring Date: January 05, 2013)

In figure 2, the scale of map is clearly visible that 1 Inch = 220 Ft (40 Karam) and there is also 16 rectangles' grid shown with red color.

MATERIALS & METHODS

Datasets that mainly involved in preparation of baseline data are as follows:

- Raster data i.e. Scanned "*Massavi maps*"
- Vector data i.e. converted from raster data
- Database i.e. different field information
- Quick-bird's High Resolution Satellite imagery (HRSI)
- Software i.e. ArcGIS, MS Access

Figure 4 shows the flow chart of steps performed for preparation of required data from scratch to finished product.

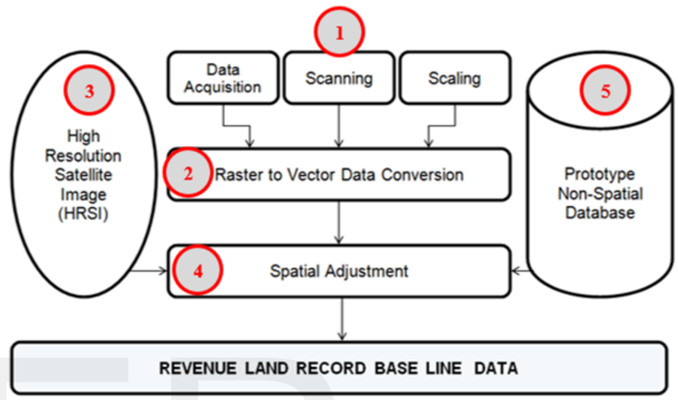


Figure 4: Flow Chart of Mapping Concept

The graphically shown 5-steps in figure 4, have been described in detail as follows:

1 ACQUISITION, SCANNING AND SCALING OF DATA

After receiving data of study area from BOR, it was scanned for making compatible to computer identifiable formats, vector conversion as well as pictorial representation.

1.1 Scanning

The dots per inch (DPI) equal to 200 was determined reasonable for clear scanning. On said DPI, the information available on "*Massavi*" would available for obvious readability.
The following two formats were chosen;

- Tagged Image File Format (TIFF)
- Joint Photographic Experts Group (JPEG)

Tagged Image File Format (TIFF) is although larger in size but it gives lossless information that is why TIFF is absolute in its quality and Joint Photographic Experts Group (JPEG) format is little lossy but lighter in size therefore easy to handle.

International Journal of Scientific & Engineering Research Volume 6, Issue 8, August-2015
ISSN 2229-5518

1.2 Creating Grid/Mesh

A "*Massavi map*" is consists of 4x4 rectangles with minor overlapped area from adjacent sides on right and left, having scale of "1 Inch = 220 Feet". During scanning process of any map, it loses the scale accuracy. Therefore to bring the scanned "*Massavi map*" back on actual ground scale, it was necessary to create a grid of exact measurements. To obtain the accurate results, we used the UTM zone for the creation of grid as shown in figure 5. Rest of the details are as follows:

I. UTM zone i.e. 42(66°E - 72°E Northern Hemisphere)
II. Datum i.e. WGS 84
III. Planer Units i.e. Meter
IV. Standard dimension of each rectangle in grid i.e. 1100 x 990 ft²

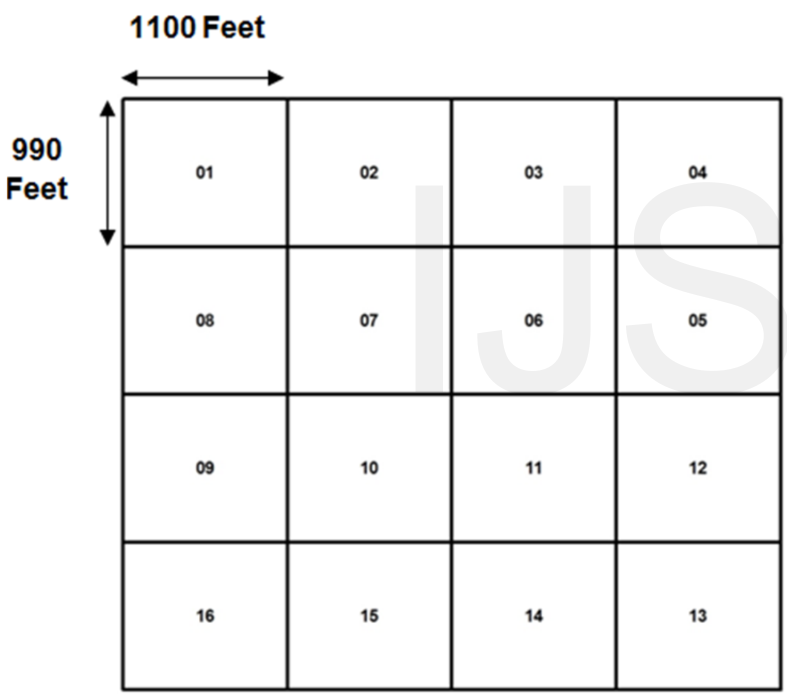


Figure 5: Grid of 4x4 Rectangles Showing Standard Dimensions of Each Rectangles

1.3 Scaling

To restore the actual scale, "*Massavi map*" (shown in figure 2) was registered on grid (shown in figure 5) by providing the four extreme corners of "*Massavi map*" to the respective rectangles on grid by using geo-referencing tool in ArcGIS Desktop 10. The result is shown in figure 6.

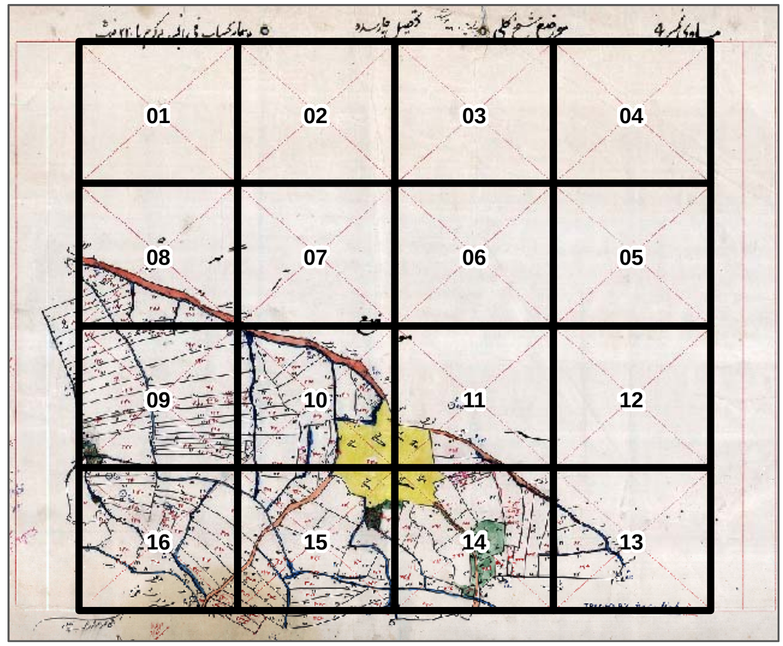


Figure 6: "Massavi Map" Registered on 4x4 rectangles grid

Figure 6 shows the "*Massavi map*" registered on grid of 4x4 rectangles (figure 5), rectangle numbers are also labeled. So after registration process, each of the rectangles from "*Massavi map*" (figure 6) contains the same width i.e. 1100 ft and height i.e. 990 ft. For further detail, rectangle number 14 of registered "*Massavi map*" is shown in figure 7.

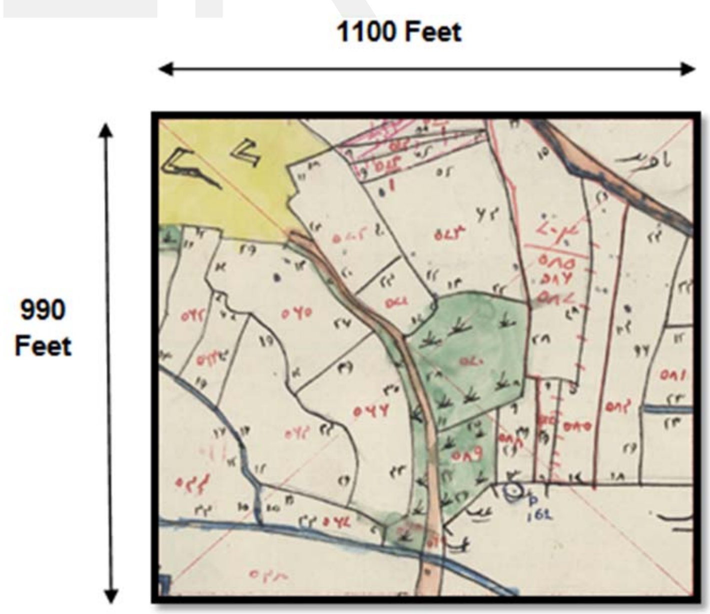


Figure 7: Rectangle # 14

International Journal of Scientific & Engineering Research Volume 6, Issue 8, August-2015
ISSN 2229-5518

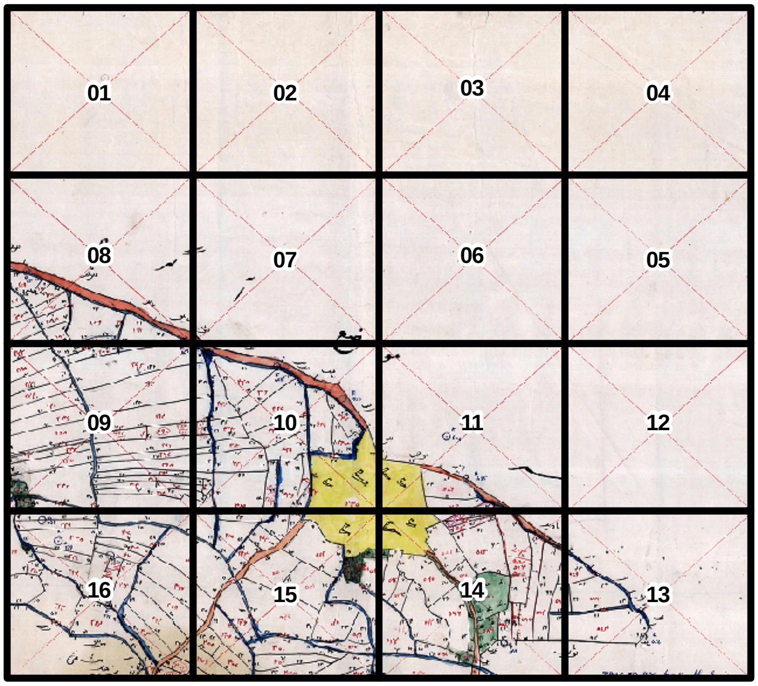


Figure 8: "Massavi Map" After Collar Clipping

Then the scaled "*Massavies map*" shown in figure 6, was collar clipped on outer boundary of 4x4 grid using clipping tool from ArcGIS Desktop 10. The output is shown in figure 8.
With the repetition of similar process the adjacent "*Massavi maps*" can be registered to the previously registered "*Massavi map*" using grid as source. In this way, it would prepare mosaic of all the "*Massavi maps*", the dummy representation is as shown in the figure 9.

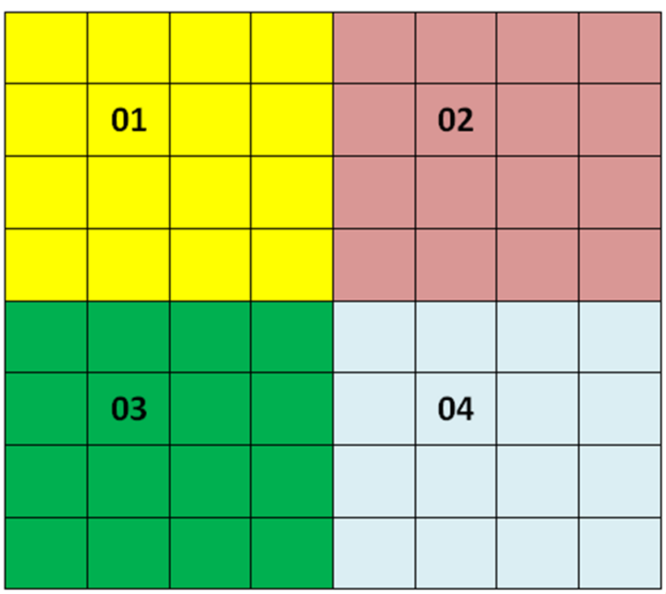


Figure 9: Four Adjacent "Massavi Maps" Registered on Grid

2 Raster To Vector Conversion

Esri's ArcGIS 10 software has been used for the preparation of vector data. Scale of 1:1500 is maintained for development of qualitative dense data. Polygon theme was used to digitize the "*Khasra*" boundaries in ArcGIS Desktop 10 and each polygon record assigned its respective "*Khasra Number*".

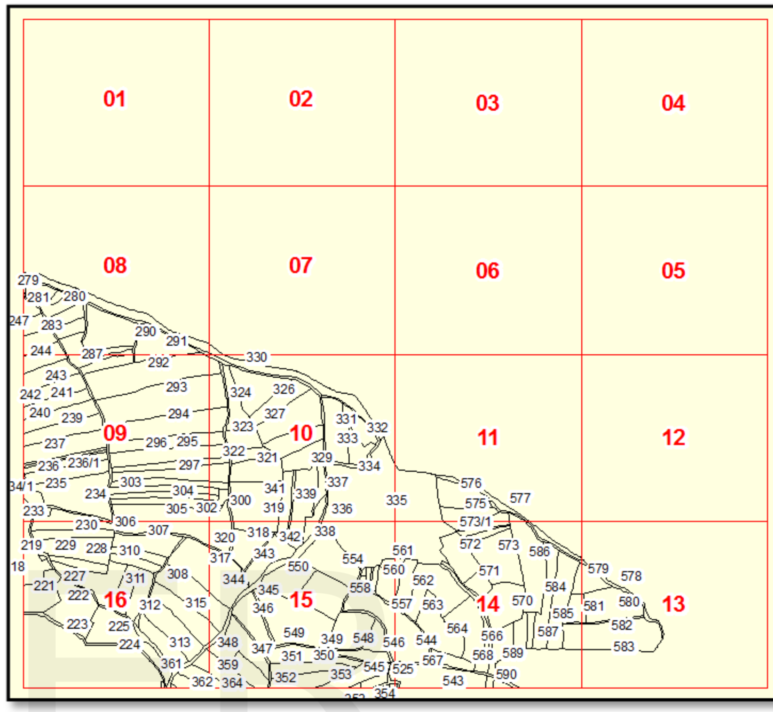


Figure 10: Vector Data Converted from Scaled "Massavi Map"

Figure 10 shows the vector data developed from scaled and collar clipped "*Massavi map*" which is shown in figure 8. Rectangle number is also available for fast comparative reading of features in both figures 8 and 10. The value shown in each polygon of figure 10 is "*Khasra Numbers*". The "*Khasra Number*" is unique and cannot be repeated within a "*Mouza*" (i.e. the smallest administrative unit in rural area).

3 High Resolution Satellite Imagery (HRSI)

The HRSI used was downloaded from Google Earth. It's of Quick-Bird satellite having panchromatic sensor's spatial resolution of 0.6 meter. The image acquired by satellite on January 05, 2013. Then it was rectified by using Google Earth as source. In revenue land record, high resolution imagery can play a vital role to distinguish time by time parcel level changes, land encroachments as well as updating of baseline data according to the running ground situation.

International Journal of Scientific & Engineering Research Volume 6, Issue 8, August-2015
ISSN 2229-5518

4 Spatial Adjustment

The vector data prepared (figure 10) was on actual ground scale (i.e. 1:1) and its spatial adjustment was made to bring the features on actual coordinates so the data can be compared with satellite image or datasets from other sources. The spatial adjustment was made by observing the common linear features e.g. road crossings or water channels etc.. The method is self-explanatory by concentrating figures 11 & 12 that show the process gradually and the data after complete spatial adjustment with this technique is shown in figure 14.

Figure 11: Spatial Data Being Adjusted Gradually

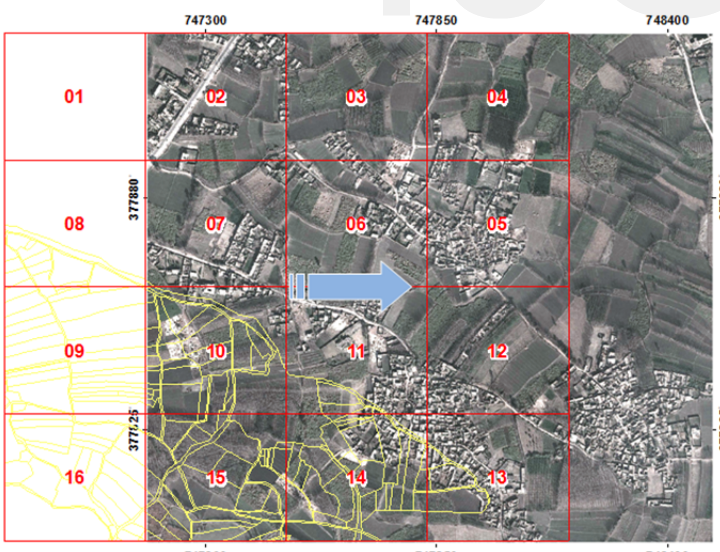


Figure 12: Spatial Data Being Adjusted Gradually

5 Non-Spatial Database

Revenue system of Pakistan is very complex which can only be well maintained by indulging it in latest data storage designs. For instance, there are various data registers containing particular information associated with land which are to be maintained by the "*Patwari*" in manual way. By developing a comprehensive system for revenue land, this is necessary to maintain such information digitally. The information stored in database, modeled on maps by interlinking it with spatial data under few easy clicks.

For joining of the non-spatial data with spatial data, it is necessary to have a unique key (table field) within the tables but common on both sides. In our case, "*Khasra number*" was used for unification of tables or data, it does not repeat within a "*Mouza*". At broader level, "*Mouza Code*" merges with "*Khasra number*" to give unique code for higher level administration of database.

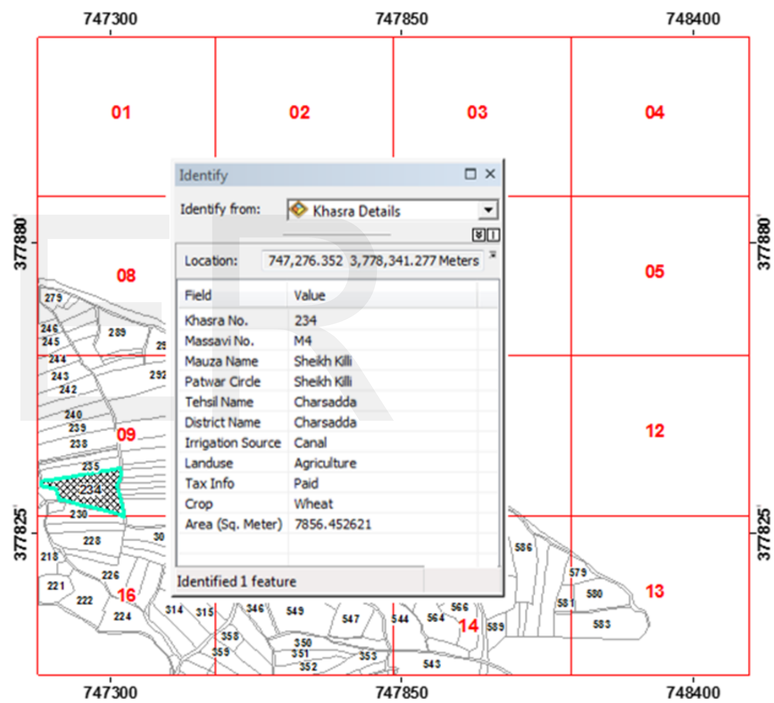


Figure 13: Information Contained by Non-Spatial Database

International Journal of Scientific & Engineering Research Volume 6, Issue 8, August-2015
ISSN 2229-5518

Results & Discussion

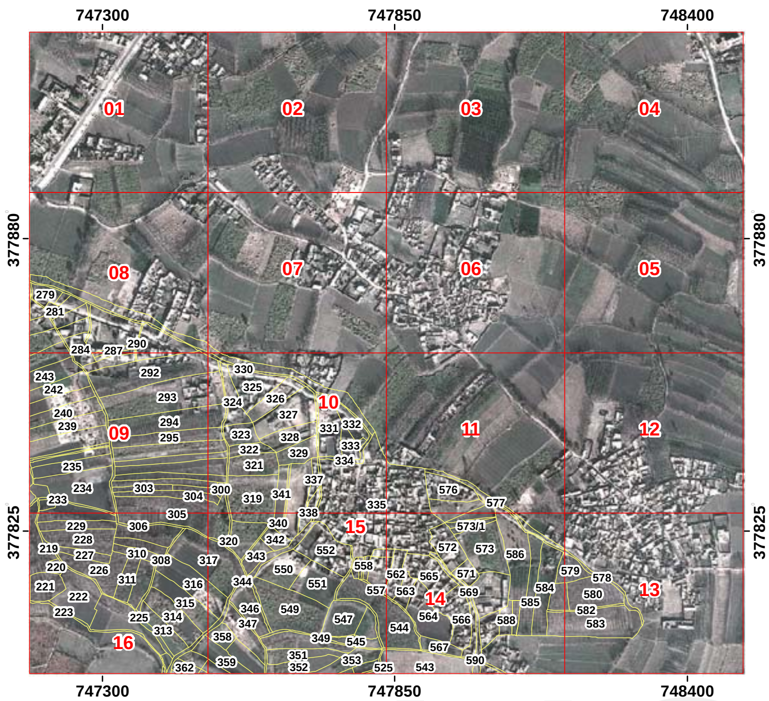


Figure 14: Spatially Adjusted Data on High Resolution Satellite Image

The figure 14 shows the spatial vector data adjusted on HRSI of the study area and the grid values labeled at right, left, top & bottom of the frame are in meters. The data prepared with discussed methodology attained up to 90% or even above precision, depending upon the personal skills and accuracy of handmade cadastral "*Massavi map*". Minor changes in digitized data and HRSI may be due to any of the following reasons:

I. Non regular updation of *"Massavi maps"*.
II. Day by day man made changes which can easily depict through HRSI at regular interval due to frequent revisit time of satellites of modern era.

Conclusion

The discussed method is the cheapest & fastest way to produce computerize spatial data from traditional maps, sitting in the lab with minimal field visits. As the information available on "*Massavi maps*" is outdated so further we can make baseline data up to date by using HRSI as well.
The data prepared may have various advantages within department during peace time as well as disaster e.g.

- Baseline for further spatial data updating
- Online availability of data everywhere so easy access to data & less paper consumption for printing purpose
- Instantaneous availability of maps with multiple required indicators collected by field officers i.e. "*Patwari*" etc.
- Easy crop yield analysis
- Helpful for quick tax recovery information
- After flood disaster, easy and quick retracing/recovery of land parcels
- Identification of land encroachments
- Identification of land along the banks of river which comes under water due to the change in river mender

Acknowledgement

We are thankful to the officials from UN-Habitat, Pakistan (Mr. Syed Subtain Hussain Bacha (IT Manager GIS/MIS) and Mr. Javaid Iqbal (Sr. GIS Officer)) who arranged our meetings with BOR officials to understand the revenue land system. Special thanks to Mr. Tayyab Ikram Shah for his valuable suggestions and support.

International Journal of Scientific & Engineering Research Volume 6, Issue 8, August-2015
ISSN 2229-5518

REFRENCES

[1] M.A. Gomarasca, "Basics of Geomatics," Applied Geomatics, vol. 2, no. 3, pp. 137-146, Jul. 2010.

[2] T.I. Shah, S. Bell and M. Ellahi, "School mapping in education micro-planning: a case study of Union Council Chak 84/15L, District Khanewal, Pakistan," Prairie Perspectives: Geographical Essays, pp. 01-09, 2011.

[3] S. Mujeeb, S. Shahab and A. Hyder, "Geographical display of health information: study of hepatitis C infection in Karachi, Pakistan," Public health, vol. 114, no. 5, pp. 413-415, Sep. 2000.

[4] Space Applications Center Haryana, India, "Modernization of Land Records," http://www.harsac.org/nlrmp/sdd.pdf. 2011.

[5] R. Elmasri. *Fundamentals of database systems*. India: Pearson Education, pp. 03, 2008.

[6] A. Zahir and M. SHAKIR, "Implementing GIS-Based Cadastral and Land Information System in Pakistan," Journal of Settlements and Spatial Planning, vol. 3, no. 1, pp. 43-49, Jan. 2012.

[7] P.F. Dale and J.D. McLaughlin. *Land administration*. United States: Oxford University Press, pp. 54, 1999.

[8] S. Gauhar, "Mapping Pakistan -Taking a Leaf Out of Sher Shah's Book," Blue Chip Magazine, vol. 3, no. 1, pp. 55-56, Apr. 2004.

[9] F. Raza, M. Almas and K. Ahmed, "Land Records Information Management System," 25th Annual ESRI International User Conference, pp. 01-20, 2005.

[10] Z. Ali, A. Tuladhar and J. Zevenbergen, "Developing a Framework for Improving the Quality of a Deteriorated Land Administration System Based on an Exploratory Case Study in Pakistan," Nordic journal of surveying and real estate research, vol. 7, no. 1, pp. 30-57, Jun. 2010.

[11] S. Manzoor, T.A. Qureshi, M.D. Liaqat, M.K. Farooq and S. Shamail, "A comparison between Cadastre 2014 and cadastral systems of different countries," Proceedings of the 3rd international conference on Theory and practice of electronic governance, pp. 293-297, 2009.

[12] M.U. Qazi, "Computerisation of Land Records in Pakistan," LEAD International, Islamabad, http://danida.vnu.edu.vn/cpis/files/References/PIS/1.pdf. 2006.

[13] M. Adeel, "Evaluating the Role of Cadastre Maps in Pakistan's Land Administration: a GIS Perspective," FIG Congress, pp. 11-16, 2010.

[14] A. Tuladhar, "Innovative land tools, surveying and geo-information technologies," Global Network for Pro-poor Land Tool Developers, pp. 01-05, 2005.

[15] F.M. Qureshi, A. Rajabifard and H. Olfat, "Facilitating urban planning and management at local level through the development of SDI (case study of Lahore-Pakistan)," http://hdl.handle.net/11343/26088. 2009.