Application of GIS Based Re-Settlement of Land Record of Mouza Shahbat Khel, District Mardan (Pakistan)

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Abstract

A cadastral information system is a set of processes for parcel/property-based data collection, including land tenure, land use, and land value. The primary goal of the Massavi maps at the time was to depict the distribution, status, and yield of arable fields; other information (such as rivers) was relatively inaccurately drawn, leading to geometrical inaccuracies. It results in a significant loss for revenue collection and other objectives. Secondly, It is difficult to overemphasize how necessary knowledge is to the success of any planning, development, or management work. Having a reliable knowledge base is especially crucial for developing countries with limited resources. Another issue that many developing nations encounter is the lack of accurate land records in the real estate market. The cause can include ownership titles, unclear boundaries between private and collective rights, etc. Thus, there is an urgent need to focus on the creation and deployment of a national digital cadastral information system. Given the preceding context, this article outlines all the obstacles and limits that would arise when combining geometric and legal cadastral data to create a new digital cadastral system. A digital cadastral land information system comprises spatial data that represent legal boundaries of land parcels and provides a vital base layer for integration into other spatial Information systems or as a standalone solution that permits users to retrieve, create, update, store, view, analyze and publish land information.

Keywords: Cadastral Information System, Land Tenure, Digital Layout, GPS Points.

Introduction

Maps are helpful in different ways to navigate locations, land resource planning, time management, town planning, etc. In contrast, machines are helpful in improving the navigation process by providing precise locations. Therefore, the importance of GIS for baseline data development, maintenance and updating of revenue land records cannot be denied. GIS also play an important role in revenue land record management and mapping. In modern societies, database systems are an essential component of daily life. It provides the flexibility to retrieve, sort, analyze,

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summarize and reporting of the data. GIS and databases together have changed the whole concept of mapping (Aslam et al., 2015).

Land administration is "the regulatory framework, institutional arrangements, systems and processes that encompass the determination, allocation, administration and information concerning land. It includes the determination and conditions of approved uses of land, the adjudication of rights and their registration via titling, the recording of land transactions and the estimation of value and taxes based on land and property. There are three components of land administration, i.e., land rights registration and management, land use allocation and management, and land valuation and taxation (Lyons & Satish, 2001). A land administration system is comprised of textual records that define rights and information and spatial records that describe the extent to which these rights and information apply. In most jurisdictions land administration has evolved from separate systems to manage private rights in land and manage public land (Burns & Dalrymple, 2006). In this way, land administration is a system implemented by the State to record and manage rights in land for carrying out land-related activities (Ali & Nasir, 2010).

In this regard, GIS plays a vital role in digitizing the whole land records in the form of maps and attributes (Ahmed et al., 2016). Remote sensing satellite images and geographical information systems (GIS), including database management concepts, can improve quality, cost-effectiveness, performance and maintainability (Durovic et al., 2018). The adoption of these technologies provides enormous opportunities to share land-related information in an easier way than the old-fashioned technologies/methods in which the information is managed and shared through manual records and procedures and use GIS for mapping and maintaining geometrical cadastral details, which can really reduce the chance of duplication in data creation and updating for better performance of the organizations dealing with land information and management. The Current Cadastral maps can be compared with high-resolution satellite imagery to solve conflicts or to improve the accuracy of maps (Ahsan et al., 2017). The digital cadastral land information system is the basis used for the protection of the property by means of title registration and cadastral plans business (Ali et al., 2021)). Also, looking at the circumstances that this data is not available in public, in order to provide this data publicly, there is a need for a web portal. For that, in this study, an attempt is made to develop a web portal to provide all the data online on the internet accessible to everyone. Everyone can search their land records online according to their khasra number or parcel number, and everyone will be able to monitor and see their whole land records in a single click through this web portal developed in this study (Ahmed et al., 2016).

Land Records in Pakistan

The conventional land record system in Pakistan is being administered through the officials who can be categorized into two classes on the basis of their functions. This system has borrowed this hierarchy from the British. Still, the new millennium has heralded a new system based on the Devolution of power in tune with local governance in Pakistan. The new organizational hierarchy for the system of Devolution is also given; although the system of local governance has changed for better management, the mechanism of land records handling and revenue assessment remains the same as followed since the Mughal era. Before discussing various data constructs of the conventional land record system, it will be better to take a look at multiple terminologies that are frequently used. The land records data is maintained at Tehsil offices, whereby the following record sets are developed at the time of settlement.

Mussavies

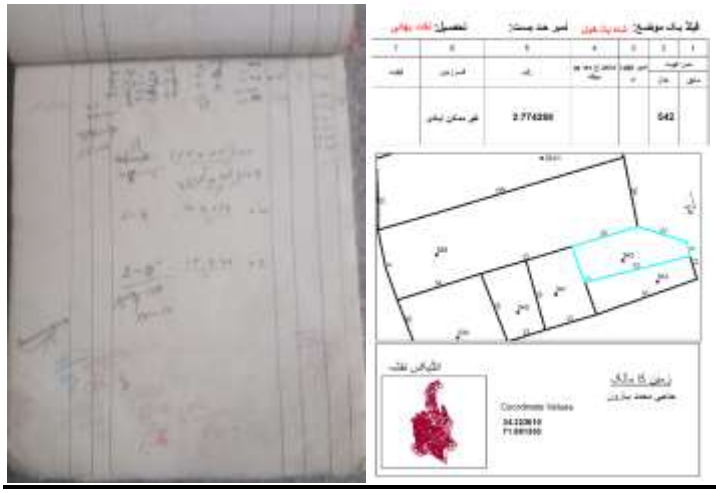
Massavies are "quantifiable measurements" in geographic space. The measuring unit on Massavies is "Karam," which is equal to 5.5 feet. These are basically surveyed paper maps at different scales depending upon village area, generally at a scale of 1" =40 Karam (that is about 1:2500 or so according to parcel sizes in the village). Land parcels are labeled with their Khasra number and dimension of each side. An owner owns each Khasra number. Mussavies are developed at the time of settlement. No changes can be made in this record set till the subsequent settlement. Subdivision lines break up an irregular land parcel into different regular geometrical shapes. The subdivision lines are generally represented with dotted lines and defined for the area calculation on the map.

A Mussavie also contains Index Mashkookiat (Errata List), which describes the errors on the map as compared to the ground. Every Mussavie has an index number, which helps in mosaicking all the mussavies of a particular village to get the map of the entire town at a given scale.

Records of Rights (Register Haqdaaraan-e-Zamin or Misl-e-Haqiat)

This register contains ownership records and is developed at the time of settlement along with the field book, Mussavie, and owner information. It indicates the ownership of each parcel. This book also contains pedigree sheets which give the details of the cultivating and landowner families of the village and their relationship. This record set includes several indexes like owner ID vs Parcel ID List (Khaivet number vs Khasra number), alphabetical index of owners (Index Radeef war Malkaan), etc., and other data like Owner ID, participants in the ownership, land parcels come under their ownership, share of each owner names of farmers who plough this field, land types and areas and information of levy and taxes are also written in this register.

Figure 1: Comparison between Digital and Manual Field book Layout



Mutation Register (Register Intaqaal)

This register dynamically changes as mutation in land records happen. This register contains all transitional land ownership record. At the time of new settlement, it replaces the name of old owner with new owner. This is a very important register that contains the sale purchase value of mutation.

Khasra Girdawari

It is the crop inspection register, wherein entry of every crop cultivated in every Khasra number (per acre) is made after spot visit by the Patwari in presence of Lambardar (Village headman) and

other interested persons. It also indicates ownership, person cultivating and the crop sown on the land. It is made twice in a year i.e. for crops of Kharif (October) and Rabi (March).

Roaznamchah (Diary)

It is a daily report register in which all important daily events are written like crop health, pesticide attack on crop, land transfer or mutation, village boundary benchmark (Seh Hadda) status and other similar activities.

Study Area

The study area Mouza Shahbat khel lies in Tehsil Takht-e-Bhai about 20 km away from Mardan District Khyber Pakhtunkhwa, Pakistan.The Total Area of Mouza Shahbat Khel is 793 acres having total of 1915 Parcels/Khasras. Geographically The Study area lies between 34° 19' 55" to 34° 20' 22" North Latitude and 71° 58' 9"to 71° 59' 4"East Longitude.

Table 1: The details of Mouza Shahbat khel

Total Massavis	Total Parcel No	Total Owners	Total Area
14	1915	2847	793 Acres

Figure 2:Location Map of the Study Area

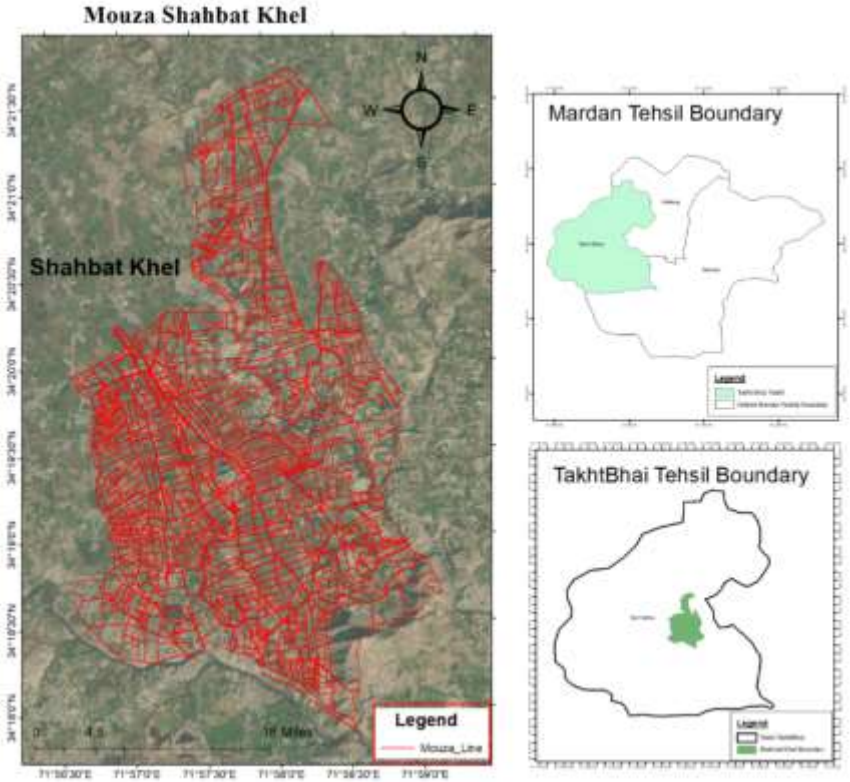
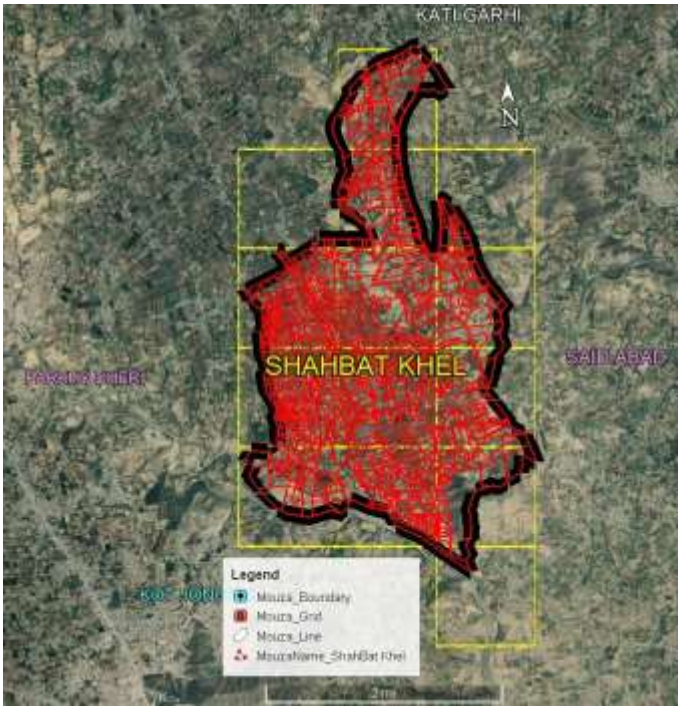


Figure 3: Study from High Resolution Satellite Imagery



Resettlement of Land Record

Resettlement of land records at the mouza involves the systematic organization, digitization, and management of land-related data within a specific administrative unit or locality known as a mouza. This process aims to modernize land administration systems, improve data accuracy, transparency, and accessibility, and facilitate effective land governance.

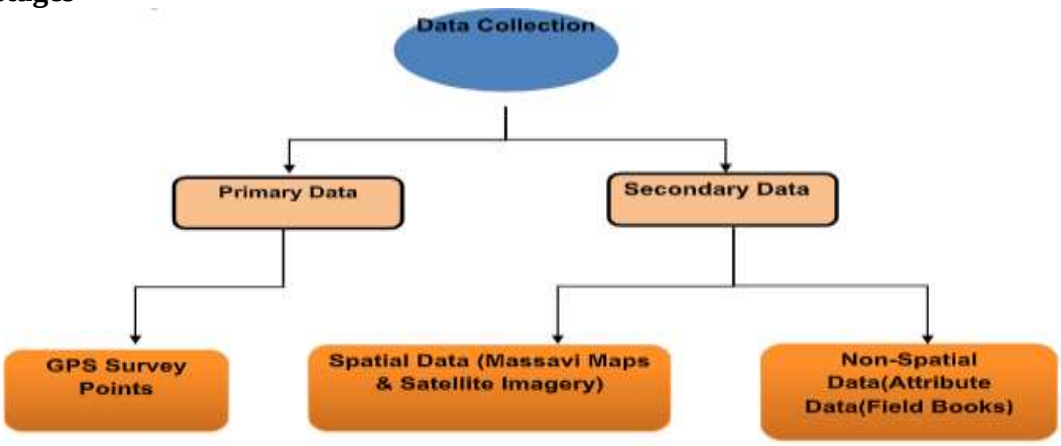
Methodology

The cadastral document of the village of Mouza Shahbat Khail is available in hard form in this study an attempt is made to digitize the whole cadastral system of the study area and to find the area of State land in the study area.

Methodology and Discussion is Consist of the following 3 stages

Figure 4: First stages of Method

1st stages



2nd Stage

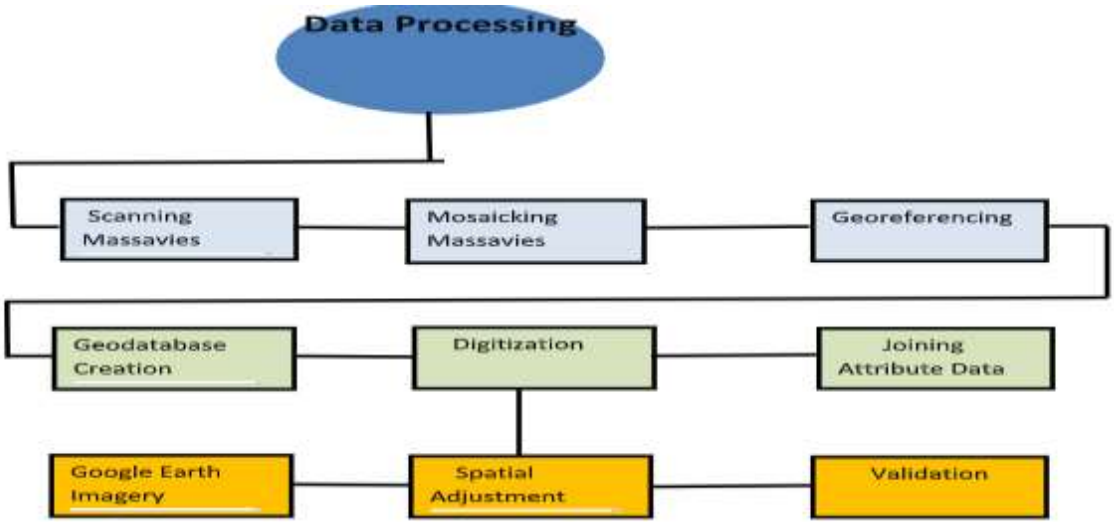


Figure 5: Second phase of Methodology

Georeferencing

Georeferencing is the process of assigning real world coordinate to the raster image, So for the process of Georeferencing we done field survey and collect GPS points of Known areas, which is easily identified in massavis and point of Sehaadas (The point on ground where three mauza or village boundary touched), After collecting coordinates with the help of GPS the cadastral map of the study area is georeferenced in ArcMap, using the Projection system WGS84 datum and UTM 42 Zone.

Figure 6: Grid based referencing of the massavi maps

Geodatabase Creation

Geodatabase is an alternate way to store GIS information in one large file, which was created to store geometry, a spatially reference system and all attributes of each feature of the Mauza.

Digitization

Digitization is the process of converting geographic data either from a hardcopy or a scanned image into vector data by tracing the features. During the digitizing process, features from the traced map or image are captured as coordinates in either point, line, or polygon format. So for the digitization of mauza we digitized it in line feature for this we create line feature class and digitized all the mauza features and validated according to the lengths and directions given in the field book.

Figure 7: Initializing line base digitization

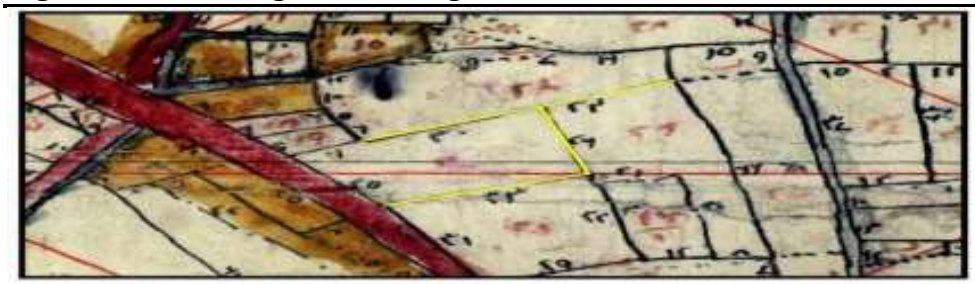
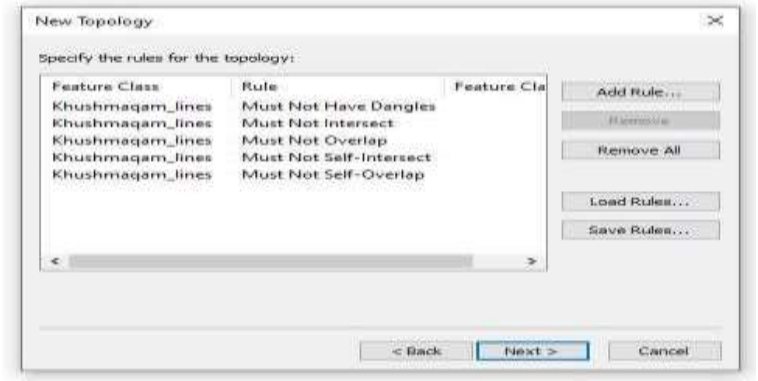


Figure 8: Digitized lines on the Massive



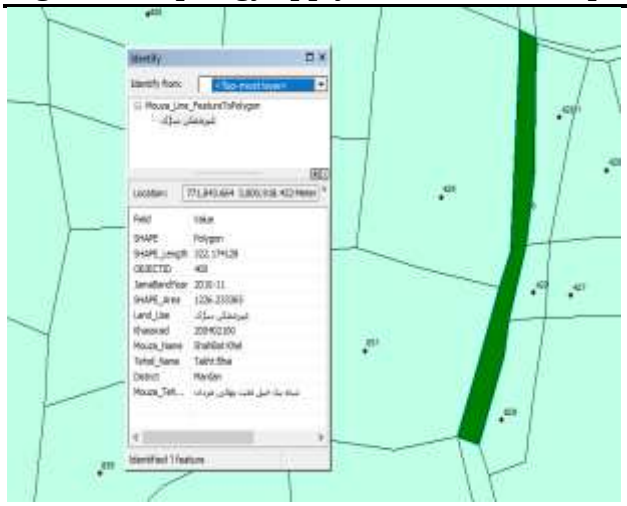
Topology

A Topology is a set of rules that defines how point, line, and polygon features share coincident geometry. Topology describes the means whereby lines, borders, and points meet up, intersect, and cross.

Before converting line to polygon so we first apply topology on line and given the following rules:

- Must not overlap
- Must not intersect
- Must not have dangles
- Must not self-overlap
- Must not self-intersect

Figure 9: Topology apply on line in ArcMap



After applying the topology see all the errors are remove through editing, then convert that line to polygon to make parcels from it. When polygons created from the lines then added Khasra (Parcels) numbers to every polygon through massavis.

Joining Attribute Data

The attribute table are in the form of excel sheet as each parcel has a unique ID called Parcel ID

(Khasra Number) and this field is also common in massavis, the excel sheet joined through Parcel ID with joined and related in ArcGIS. The data in the excel sheet contain the information of the ownership etc of the study area.

Figure 10: Attribute data after joined to parcel in ArcGIS Environment

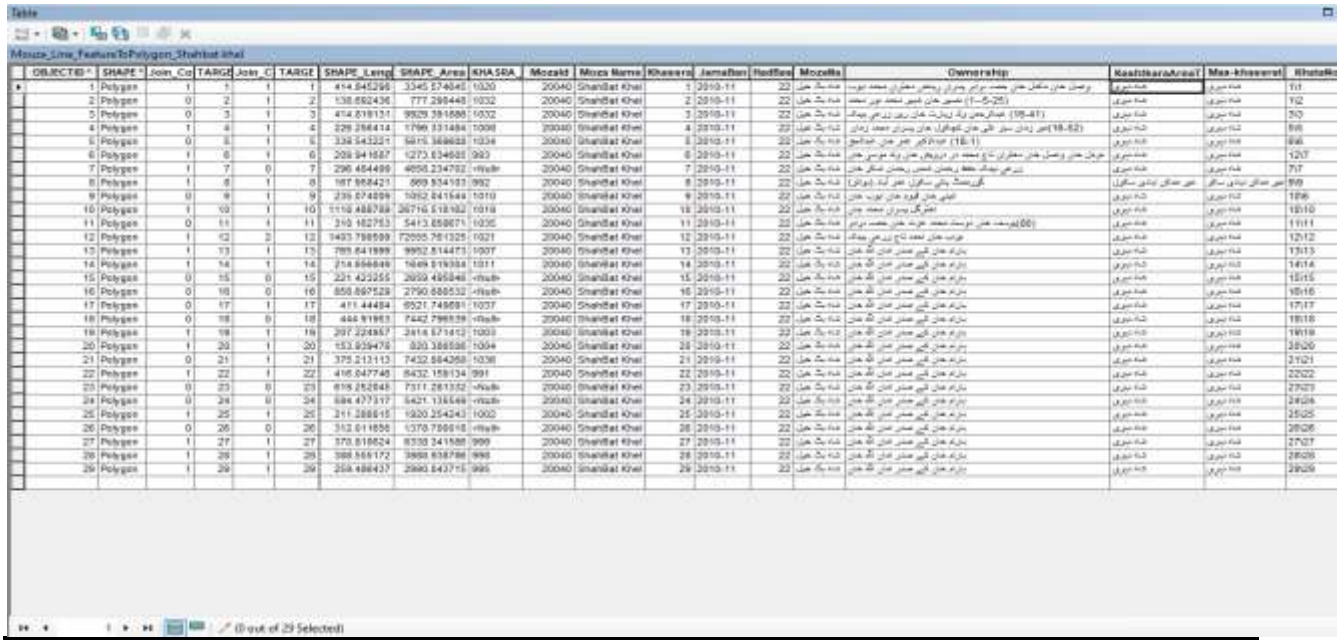
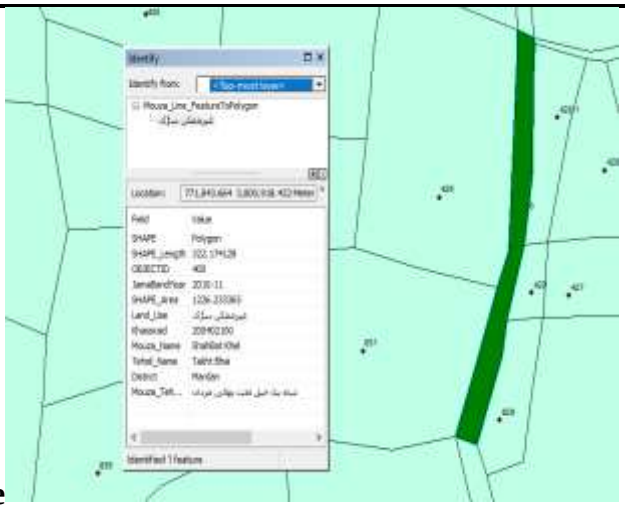
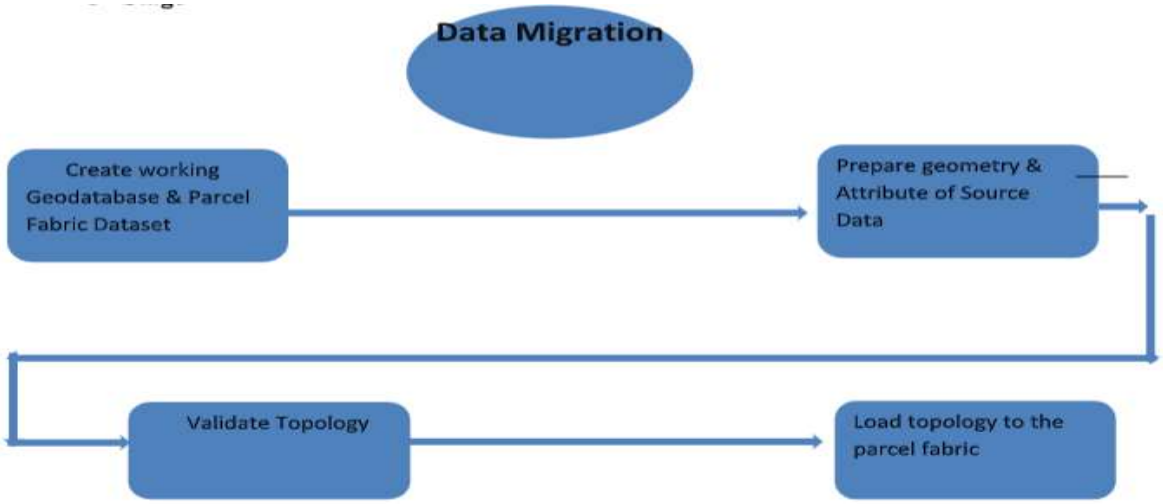


Figure 11: An overview of information show on one click in cadastral database



3rd Stage



Spatial Adjustment

The spatial adjustment tools provide interactive methods to align and integrate your data. Spatial adjustment supports a variety of adjustment methods and will adjust all editable data sources.

Spatial adjustment of vector data (Digitized data) is carried out in the High Resolution Satellite Imagery (HRSI). The vector data prepared 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 made by observing the common linear features e.g. road crossings or water channels etc. and the vector data again cross checked and validated in accordance with field book.

In short, the digitized data is first spatially adjusted with the High Resolution Satellite Imagery and second time validated with the field book hence, all the data is cross checked with each other and validated accordingly and through this process the image is spatially adjusted.

Create Working Geodatabase and Parcel Fabric Dataset

The first step is to shift data to parcel fabric dataset is to create geodatabase and parcel fabric dataset. So for this Geodatabase created first and then create feature dataset inside feature dataset created a parcel fabric dataset. The next step is to prepare geometry and attributes of the source data, so for preparing geometry for each Parcel Type.

- Check and repair any polygon Geometries
- Polygon to lines
- Curves and lines add-in
- Rebuild polygon from lines
- Check Polygon inventories

For preparing attributes field if there is similar attribute like Parcel ID (Khasra No), so in parcel fabric dataset this attribute has specific field that is “Name” Field and its 30 type is “text”, so change all the field that is same in both source data and parcel fabric dataset according to parcel fabric dataset.

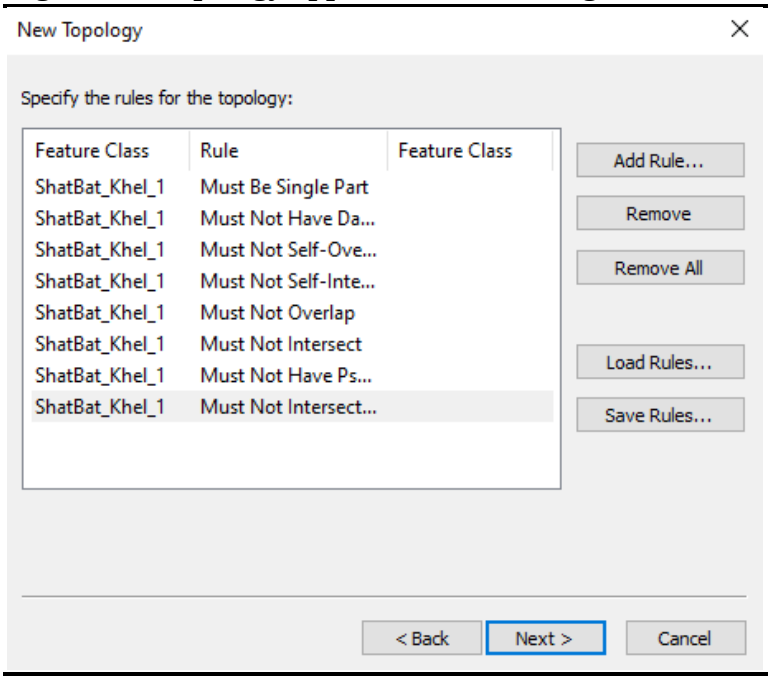
Validate Topology

The parcel fabric relies on topological correctness when representing and storing parcel data. Parcel datasets being loaded into the parcel fabric need to reflect a similar level of topological

correctness. Parcel polygons and lines are added to a topology and validated against a required set of rules to ensure that the data being loaded matches the topological integrity of the parcel fabric. After creation of Parcel Fabric Dataset, Prepared
Geometry and Attributes. Created a topology in the source datasets. Topology contain the following required rules:

i. [Line feature class] Must Be Covered By Boundary Of [Polygon feature class]
ii. [Line feature class] Must Not Self-Overlap
iii. [Line feature class] Must Not Self-Intersect
iv. [Line feature class] Must Be Single Part
v. [Line feature class] Must Not Intersect Or Touch Interior
vi. [Polygon feature class] Boundary Must Be Covered By [Line feature class]

Figure 12: Topology applied before loading to Parcel Fabric in ArcMap



Once a topology is validated, any violations of the topology rules or errors are symbolized and displayed in the topology layer in ArcMap. Topology errors are symbolized by points, lines, and polygons. So, we removed all that errors.

Load Topology to Parcel Fabric

The load topology to a Parcel Fabric geoprocessing tool can use either the parcel line or parcel polygon feature class as the Input (Topology) Feature Class; however, a topology of both a polygon and line feature class is required for loading to complete successfully. In this we input a source polygon to load into parcel fabric after this our data is converted to parcel fabric data model.

Figure 13: Load Topology to Parcel Fabric

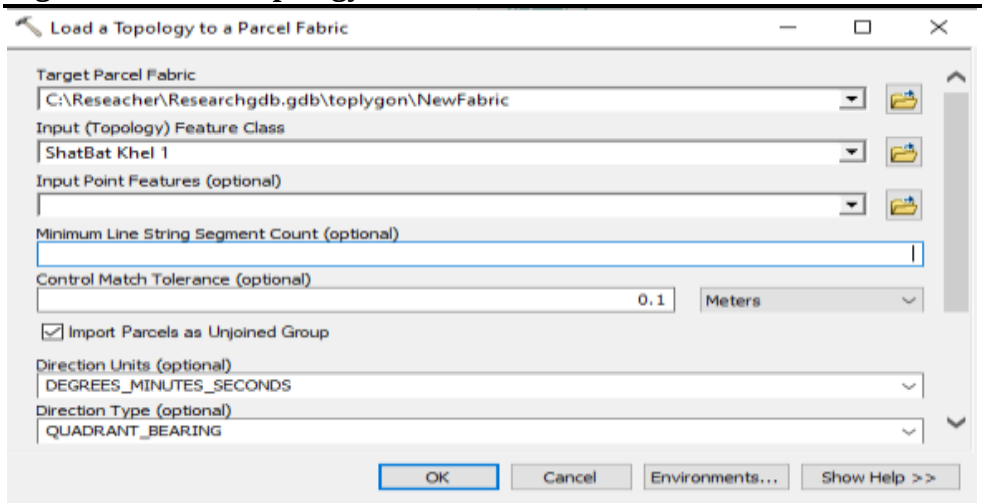
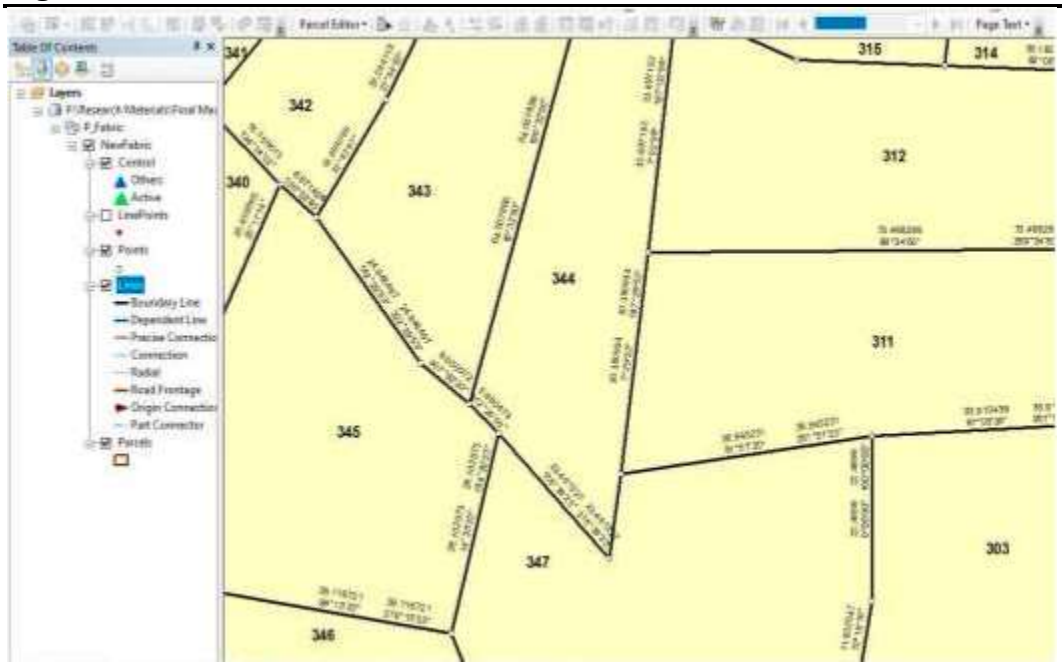


Figure 14: Data shows in Parcel Fabric Data Model of ArcGIS



Conclusion

This study brings out the importance of land records management system in Pakistan. GIS tools for land records management would be highly effective in Pakistan where land issues are predominant. In the present study it is find out that there are some points which are being neglected because of which it is been important to study deeply the land records management system. The hurdles for the infrastructure development can be solved. The land acquisition problem will be solved. The duplication of land will not come as people will have a proper record of it. Computerization process integrate registration of land titles. Land law process should be simplified for easy and fast implement. The cadastral survey should be done using the latest technology. The deep study of the land records management system is to be done so that a proper system is being

developed which will reduce the work load as well as help in every process. The aim of this research is to digitize the paper based cadastral land information system and to represent it in a web portal to the world so the government can take a look and start digitizing the land projects in the country accordingly to move the society further towards Digital age. The gaol of this research is to explore the new emerging technologies, such as GIS and the internet.

The paper-based land information system of Shahbat Khel has been replaced by digital cadastral land information system which meet the current needs of both public and government organizations. Digital cadastral land information system for cadastral and land use mapping, typically consisting of an accurate, current and reliable land record cadastre and associated attributes. This study integrated the GIS interface and web interface to give a digital cadastral land information system. This study contains spatially grid based referenced land data that represent the boundaries of land parcels or khasra numbers which are then digitized and converted from raster data to vector data by the validation of field books of Patwari and then this digitized imagery is spatially adjusted with Google earth imagery and GPS points and then this spatially adjusted imagery is joined with the attribute table we have in the form of excel sheet of each parcel ID (Khasra number). At last all that data is integrated with both the user interfaces online and offline through mango map server and carry map tool respectively and the data is available publicly and everyone can check their land records on these user interfaces. This digital cadastral land information system has persistent spatial aspects which a natural database cannot present its high quality spatial aspects.

GIS technology can effectively integrate non-spatial and spatial datasets for query and analysis, enabling efficient land record management. The use of GIS in land records can help identify suitable settlement areas that are environmentally sustainable, A GIS-based land information system can be developed to manage land records, including Mussavie (Index Map) and Khatuni records, at the Tehsil office level. The optimization of spatial allocation of rural settlements requires an evaluation of rural land suitability and location optimization, which can be achieved through GIS-based land records management. Overall, a GIS-based re-settlement of land record system can improve the efficiency and accuracy of land record management, leading to better decision-making in various administrative domains, including residential systems, environmental advancement, and agriculture.

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