EVALUATING THE ROLE OF CADASTRE MAPS IN PAKISTAN' LAND ADMINISTRATION: A GIS PERSPECTIVE

Muhammad Adeel, ADEEL, PAKISTAN

SUMMARY

Cadastre plays the central role for land administration and record management in Pakistan. There are approximately 190 million land records containing the details of approximately 50 million landowners in Pakistan. All the land record cadastres are prepared and maintained in manual form. Although this land administration system is quite scientific in theory, in practice the system is a mess of traditional approaches and practices which cannot meet the present day demands. The study evaluates the advantages and disadvantages of present mapping environment and map outputs. It identifies that modern technologies like Remote sensing and Geo spatial Information Systems can be used to increase the accuracy of the cadastral contents leading to improved tenure security of the general public. The study also recommends that the cadastre map data needs to be linked with the mapping output of the survey of Pakistan. The step will help achieving a multipurpose cadastre and will ensure spatial accuracy and efficient integration of cadastral maps with other datasets. The step is required in order to meet the present needs of time and for better land administration in Pakistan.

SUMMARY (German):
Kataster spielt die zentrale Rolle für Land-Verwaltungs-und Record-Management in Pakistan. Es gibt ungefähr 190 Millionen Land Datensätze mit den Angaben von rund 50 Mio. Grundbesitzer in Pakistan. Das ganze Land Rekord Kataster sind bereit und in der manuellen Form beibehalten. Obwohl dieses Land Verwaltungssystem ist ganz in der wissenschaftlichen Theorie, in der Praxis des Systems ist ein Durcheinander der traditionellen Ansätze und Praktiken, die nicht erfüllen können heute verlangt. Die Studie bewertet die Vor-und Nachteile der heutigen Umwelt-und Mapping-Karte Ausgänge. Sie zeigt, dass moderne Technologien wie zB Remote Sensing und räumlichen Geo Information Systems können verwendet werden, um die Richtigkeit der Inhalte Kataster der zu einer besseren Sicherheit der Amtszeit der breiten Öffentlichkeit zu erhöhen. Die Studie empfiehlt auch, dass die Kataster-Karte Daten mit der Mapping-Ausgabe der Erhebung von Pakistan verbunden werden muss. Der Schritt wird dazu beitragen, ein Mehrzweck-Kataster und räumlicher Genauigkeit und effiziente Integration der Katasterkarten mit anderen Datensätzen zu gewährleisten. Der Schritt ist erforderlich, um den gegenwärtigen Bedürfnissen der Zeit entsprechen und für eine bessere Verwaltung Land in Pakistan.

FS 1F - Cadastre: Developments and Case Studies   1/12
Muhammad Adeel
Evaluating the role of cadastre maps in Pakistan's Land Administration: A GIS Perspective

FIG Congress 2010
Facing the Challenges – Building the Capacity
Sydney, Australia, 11-16 April 2010

Evaluating the Role of Cadastre Maps in Pakistan's Land Administration: A GIS Perspective

Muhammad Adeel, Pakistan

1. LAND ADMINISTRATION IN PAKISTAN

With the passage of time, people interactions with land have expanded enormously. The concept of land rights by Wallace and Williams (Wallace and Williamson, 2006) shows that land rights have magnified from basic to complex form and further under construction advanced forms. Thus, the land administration and record management systems also need to be improved for proper functioning of the system (Dale and McLaughlin, 1988). If the land administration system is not successfully upgraded with time, it is not able to provide sufficient security to the land tenure.

Pakistan is Asia's fourth largest country by population with 164 million inhabitants (National Institute of Population Studies, 2010). Approximately sixty percent of its population resides in rural areas and depends on agriculture for subsistence. Being an agricultural country, its 0.7 million km^2 land is considered as the heart of its economic base. Land administration system of Pakistan has been inherited colonial period of British rule in the sub-continent which lasted till the middle of 20th century. This system was designed to maintain, transfer and access land revenue and other levies from the land holders (Government of Pakistan, 2005). There are approximately 190 million land records in Pakistan which contain the data of nearly 50 million landowners. These records are all in manual form. (Usman, 2006). Present land administration system is based on 500 years old methods of land record management. (World Bank, 2006). The system was not built to manage titles to land rather it aimed to collect revenue from, the land cadastre do not provide sufficient base for an efficient land record management. The system has never been adapted or reformed according to new needs and challenges (Fawad et.al. 2006). Cadastre is the basic unit of land management in pakistan.

2. CRITICAL EVALUATION PAKISTANI CADASTRE

As like traditional cadastre concept, Pakistan's cadastre data consists of two components cadastre map and the cadastre text documents. Their critical evaluation is given below.

2.1 Cadastral Map

Pakistan's cadastre map is paper based, graphical representation of land parcels which are drawn at large scale (1" = 200'). After the examination of a number of cadastre maps (As shown in Figure 1) it is observed that this component carries following positive and negative points.

2.1.1 <u>Positive points</u>
   1. Cadastres have been prepared in local language thus easier to understand

---

FS 1F - Cadastre: Developments and Case Studies   2/12
Muhammad Adeel
Evaluating the role of cadastre maps in Pakistan's Land Administration: A GIS Perspective

FIG Congress 2010
Facing the Challenges – Building the Capacity
Sydney, Australia, 11-16 April 2010

2. Cadstre maps are generated manually thus there are lesser technicalities involved in map making

3. Point Positioning is identified through permanent features like trees, water bodies thus the system do contain an initial level of scientific mapping.
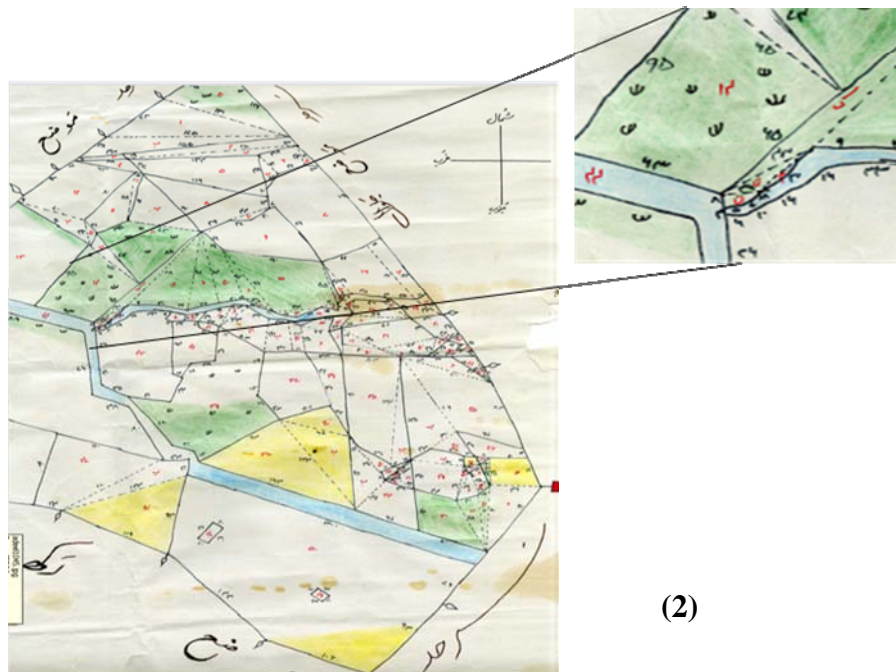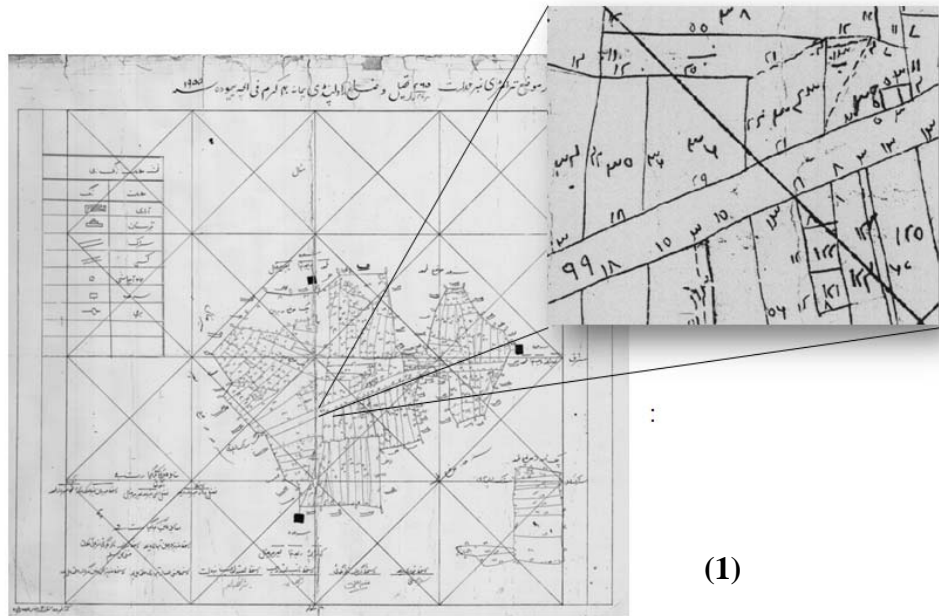

(1)

(2)

Figure 1: Cadastre map of two different areas in pakistan (1) Islamabad rural area (2) Attock (Punjab province area) and their zoom in view

FS 1F - Cadastre: Developments and Case Studies
Muhammad Adeel
Evaluating the role of cadastre maps in Pakistan's Land Administration: A GIS Perspective

3/12

FIG Congress 2010
Facing the Challenges – Building the Capacity
Sydney, Australia, 11-16 April 2010

4. The system works with english measurement units. Lenght of lines is mesured in 'Karam'. One Karam unit is equal to 5 feet roughly. Similary, areas are measured in Acres. One Acre equals to 4046 m^2. The system of measurement is considered indegnous way of recording boundary measurements.

5. Some additional length measurements are also provided in the map for reference purpose which is conisdered as useful additional information.

6. In this mapping system, manual area calculation of polygons is easire and less complicated because the curved lines (for example of water channels) are generalized into straight lines.

2.1.2 <u>Negative points</u>
1. Since the system is not based on sophisticated survey technologies, the geometric representation of lines and objects is not found very precise.

2. Map objects may not be drawn on scale accurately so areas calculated through maps may not be reliable.

3. In cadastre map, object may be represented with sharp edges which appear un real and un reliable (e.g. boundary of wate channels)

4. Since the maps are prepared manually, map classification and symbology may not be very clear to map reader many measurements are not readable or missing on maps.

5. Map drawing and presentation errors appear frequently on the map (e.g. bold line instead of dashed line)

6. Position of corner points is not mentioned on map through coordinates which makes on ground vertex identification very difficult.

2.2 Cadastral record books

Cadastral text data is preserved in land record books in manual form. The record of one land parcel is written in 17 different registers each containing its own purpose and attributes (Usman, 2006, Fawad et al., 2006 and World Bank, 2006). A list of these registers and their purpose is given in table 1 below.

Table 1: The list of land record registers and their purpose of use in cadastre

Sr. No	Record Set Name	Purpose
1.	Shajra Paarcha	Village map
2.	Shajra Nasab	Genealogical history of land holder
3.	Khasra Numbers	land parcel Index Numbers
4.	Radeef Waar Malikaan	Alphabetical index of land holders
5.	Register Haqdaaraan e Zameen	Land tenure description of owners
6.	Haqooq-e-Chahaat –wa-Nul Chahaat	List of rights holders of water wells
7.	Wajib ul Arz	Statements of community customs
8.	Field book	Survey note book

FS 1F - Cadastre: Developments and Case Studies
Muhammad Adeel
Evaluating the role of cadastre maps in Pakistan's Land Administration: A GIS Perspective

FIG Congress 2010
Facing the Challenges – Building the Capacity
Sydney, Australia, 11-16 April 2010

4/12

9.	Register Girdawari	Harvest Inspection Register
10.	Register Tagrarut Kaasht	History of changes in crop cultivation
11.	Register of Dakhil Kharij	Land parcel mutation statement
12.	Dhal Baacha	Demand of Government Dues
13.	Roznamcha Waqeaati	Daily event registering register
14.	Roznamcha Hidayaati	List of Instructions for officials
15.	Roznamcha Partaal	Cross verification register
16.	Laal Kitaab	Book of statistics
17.	Roznamcha Kaarguzari	Work Book

A review of this land register data shows that it is very difficult to clearly understand the information and share it with other departments and users due to manual hand writing and poor record management. Figure 2 shows some evidence regarding the condition of land record data in the cadastre books.
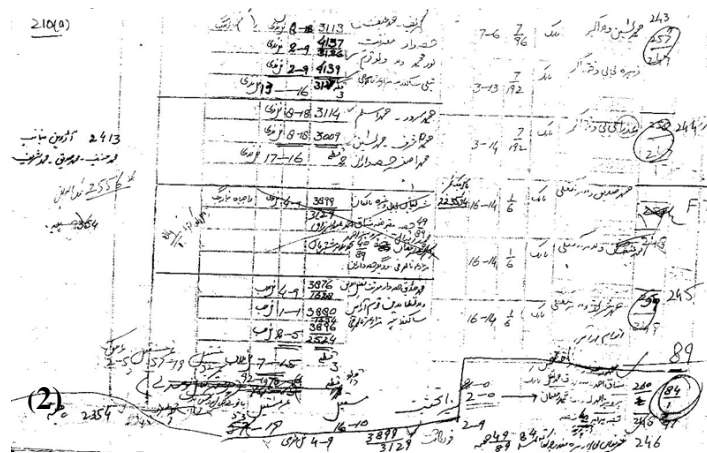

Figure 2. Cadastral text record document in Pakistan (1) record of document copies issued (2) land ownership document

As a result of this distributed land record keeping mechanism, the security of documents and their functionality is considerably reduced (). While talking about the communication and sharing of land parcel data, the situation is even worse. It is very difficult to clearly understand the information and share it with other departments and users efficiently. Studies have identified a number of flaws in the system such as:

1. The system has become obsolete and opaque with the ever increasing user - interactions and dimension of land rights

2. The land administration does not have sufficeint capacity to cope with the increased demand of cadastre. The system employees 14 000 Patwaris (land record managers) for 190 million land records.

3. The cadastre's inefficient record keeping is resulting in lack of public confidence and interest over the present land administration system

FS 1F - Cadastre: Developments and Case Studies   5/12
Muhammad Adeel
Evaluating the role of cadastre maps in Pakistan's Land Administration: A GIS Perspective

FIG Congress 2010
Facing the Challenges – Building the Capacity
Sydney, Australia, 11-16 April 2010

3. POTENTIAL ROLE OF GIS/RS FOR CADASTRAL REFORMS

Accurate and up to date land information is the essence of efficient land tenure management (United Nations, 1996). But in our case both are missing to meet the demands of present society. GIS and Remote Sensing can play a prime role for cadastral reforms in Pakistan. The use of modern technologies can enhance the efficiency of entire land administration (Peter W. and Martin P. Ralphs, 2003). It can also be beneficial for increasing the general public confidence on the traditional land administration.

An integration of both technologies can greatly help improve the land documentation and ensure tenure security (UNHABITAT, 2003). GIS technology can help in maintaining the cadastral record books digitally with an ease of data communication and verification (Von. N. M., 2004, ESRI, 2008 and ESRI 2009). The effort can be regarded as a basic step towards the creation of an efficient future cadastre anticipated in previous FIG events (FIG, 1995; Kaufmann & Steudler, 1998).

Free/Libre Open Source Software (FLOSS) can be efficiently used in preparing an initial level Spatial Database Management System (SDBMS) which can portray cadastre data as point, line and polygons graphically, as well (Espada. 2007, Lourini R., 2001).

FLOSS tools have the ability to operate in Command prompt as well as in GUIs. PGADMIN (via PostgreSQL) is FLOSS's most popular tool for this task. Capability of FLOSS products for digital cadastral database management has been thoroughly analyzed for different activities related to the creation and management of a Digital Cadastral Database (Steudler et al., 2010). A comparison of available FLOSS for this purpose is given below in Figure 3. After preparation of an initial digital cadastral database in FLOSS options, enhanced functionalities of the digital cadastre can be obtained through the use of enterprise level software like Spatial Data Engines as and when required (Wyatt and Ralphs, 2003).

FS 1F - Cadastre: Developments and Case Studies   6/12
Muhammad Adeel
Evaluating the role of cadastre maps in Pakistan's Land Administration: A GIS Perspective

FIG Congress 2010
Facing the Challenges – Building the Capacity
Sydney, Australia, 11-16 April 2010

PROPERTIES	GRASS 6.2.2	Quantum GIS 0.8.1	uDIG 1.1	gvSIG 1.0	OpenJUMP 1.01	ILWIS 3.4 Open	TerraView 3.1.4
Type of product	Open source Desktop GIS with raster, image processing and vector analysis functionality	Open source Desktop GIS with vector and raster support, to browse and create map data	Open source Desktop Internet GIS	Open source Desktop GIS with CAD, vector and raster support	Open source desktop GIS for manipulating spatial features with geometry and attributes	Open source Desktop GIS / image processing	Open source Desktop GIS viewer
License	GNU/GPL	GNU/GPL	LGPL	GNU/GPL	GNU/GPL	GNU/GPL	GNU/GPL
Size of download file	Multiple download files	54 Mb for Windows; 32.3 Mb for MacOSX; 23.3 Mb for Ubuntu	63.8 Mb for Windows; 74 Mb for Linux; 68 Mb for MacOSX	65 Mb for Windows, 66.8 Mb for Linux, 42.8 for MacOSX	6.7 Mb for binaries; 6.5 for source code	13.4 Mb	18.9 Mb for Linux 14.8 Mb for Windows
Operating system	Unix, Linux, MacOSX (runs on Windows only with CygWin tools)	Unix, Linux, MacOSX and Windows	Windows, Linux, MacOSX	Windows, Linux, MacOSX	Windows, Unix, Linux, MacOSX	Windows	Linux and Windows
Supported vector formats	GRASS vector (native format), read directly Shapefile, PostGIS; can import TIGER, DGN, MapInfo and GML2	OGR formats (Shapefile, MapInfo MIF/TAB, Spatial Data Transfer Standard catd.ddf, GML) PostGIS, GRASS)	Shapefile, PostGIS, OGR vector formats	Shapefile, dgn, dxf, dwg, PostGIS, WFS vector layers	JML (OpenJUMP GML) Shapefile, WKT Plugins for DXF, CSV, MIF, GeoConcept and PostGIS	ArcInfo (e00, .LIN, .PTS) Shapefile, AtlasGIS BNA, AutoCAD dxf, Infocam .SEQ	MapInfo MIF/MID, Shapefile, PostGIS, SPRING Tab/Geo, AtlasGIS BNA
Vector creation	Point, line, boundary, centroid (v.edit module)	Point, line, polygon	Polygon, line, point, rectangle, ellipse (Supports polygon with holes)	Point, multipoint, Line, arc, polyline, polygon, rectangle, circle, ellipse	Point, line, polygon (also polygon with holes, multiPoints, multiPolygon, multiLine)	Line segments, points. To create polygons, line segments must be created first which can then be converted to polygons	No vector creation
Editing functionality	Add/delete/move vertices; merge and break lines; copy/move/delete/ flip vector features; Dissolve polygons Trim/extend lines	Includes a GRASS toolbox for editing GRASS layers	Add/delete/move vertices	Add/delete/move vertices; move, rotate or flip features, Clip, dissolve	Inserting and delete vertices; cut polygon, merge polygons	The geometry of polygons cannot be edited; segments can be edited, split and merged	No editing possible
Buffer (around point, line or polygon)	Yes (v.buffer)	Only with PostGIS layers	No	Yes	Yes	No	Yes
Vector Overlays (Union, Intersect, Subtraction)	Yes	No	No	Yes	Yes	No	Yes
Spatial queries on vector layers	Yes (v.distance)	No	No	Yes (nearest neighbour / contained in)	Yes (intersects, contain, assign data by location)	No	Yes (assign data by location)
Convex hull	Yes	No	No	Yes	Yes	No	No

Figure 3: Abilities of FLOSS Desktop GIS products for different objectives of land administration
Source: Espada, G.P. (2007)

Muhammad Adeel
Evaluating the role of cadastre maps in Pakistan's Land Administration: A GIS Perspective

FIG Congress 2010
Facing the Challenges – Building the Capacity
Sydney, Australia, 11-16 April 2010

It is noticeable that, most FLOSS software support SDBMS and file formats equally as non FLOSS. The most important step towards creation of such digital cadastres would be the defining of goals and selection of suitable tool for it (Yeung. and Hall, 2007 and Zevenbergen, J. 2004).

The use of high resolution remote sensing data like of Quickbird and IKONOS can greatly enhance the on scale map generation and verification (Alexandrov, A et al. 2002). SOPT 2.5 meter panchromatic data also provide other useful options for updating cadastral maps at relatively lower costs.

If the system is considered expansive from image purchase point of view, freely available high resolution data from a variety of sources like Google Earth can help identifying and correct the cadastral boundaries issues. The system can be benefited from the use of Global Positioning Systems for cadastral mapping. It can help vertex identification and boundary demarcation.

It is proposed that the modernization of cadastral data be started in a cost effective manner. The pilot project may be initiated a sizable area where magnitude of problem is not very high. The creation of relational databases of the land records can help managing huge and complex land records.

4. METHODOLOGY FOR UPGRADING CADASTRE TO DIGITAL CADASTRAL DATABASE

Existing cadastre map can be updated by satellite image registration and overly operations. A methodology for converting paper maps into digital cadastral database is given in below.

1. Digitization of Moza map and its geo referencing using GPS

2. Acquisition of satellite image

3. Overlaying Moza map on satellite image

4. Adjustment of land parcel boundaries through the help of satellite image and ground surveys

5. Attaching the land records to the land parcel polygons

6. Area calculation for land parcels

7. Preparation of GIS based software for map and attribute data visualization and analysis

The proposed work flow of the project is shown below in Figure 4.

FS 1F - Cadastre: Developments and Case Studies   8/12
Muhammad Adeel
Evaluating the role of cadastre maps in Pakistan's Land Administration: A GIS Perspective

FIG Congress 2010
Facing the Challenges – Building the Capacity
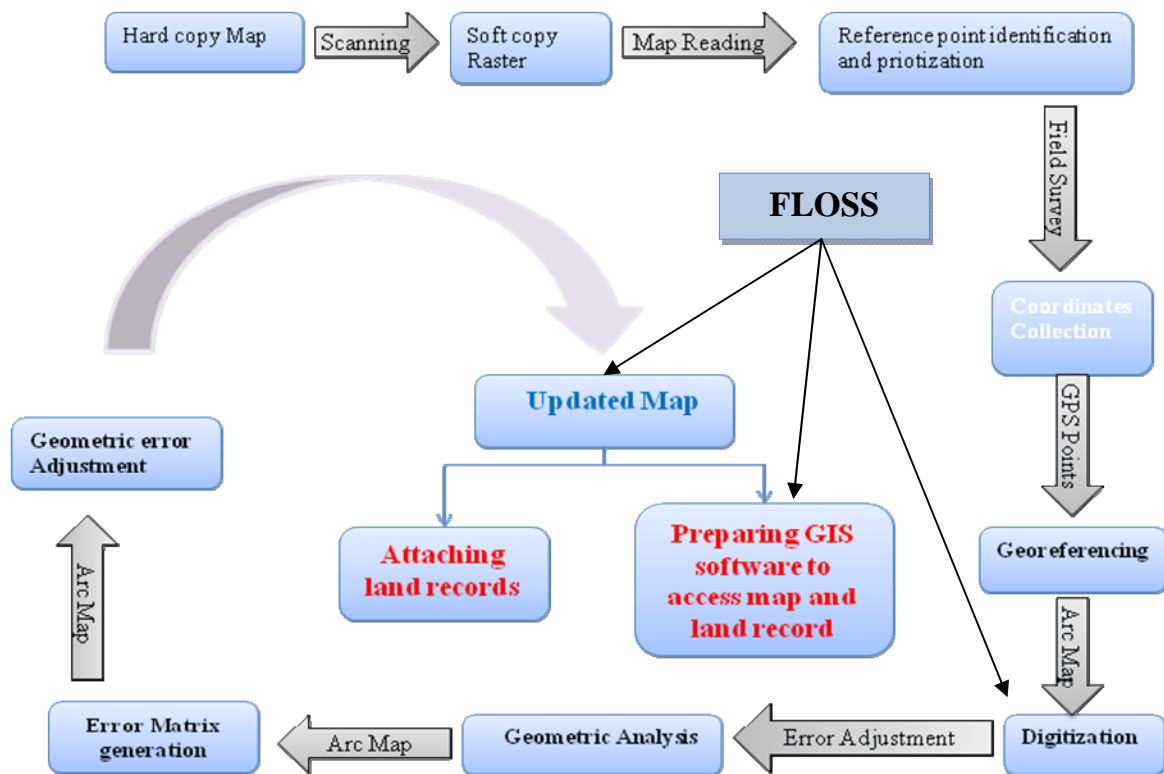Sydney, Australia, 11-16 April 2010

Figure 4: a methodology for updating Pakistan cadastre to digital cadastral database using GIS/RS technologies and FLOSS tools

5. SPATIAL DATA INTEGRATION OPTIONS FOR PAKSITAN'S CADASTRAL DATA

At present valuable land record data in Pakistan is being utilized for revenue calculation and land management purposes only. First and foremost issue regarding these paper based cadastre maps is that these maps cannot be integrated with other dataset. Data integration issues arise when other organizations demarcate these land ownerships on their survey accurate datasets. As a result, this resource proves of limited use for other departments.

There is a need to create a harmony between the datasets of cadastral surveying and other physical surveying. Survey of Pakistan is responsible for conducting topographic surveys throughout the country and has nationwide coverage of buildings and physical infrastructure. These topographic surveys are undertaken at 1:25, 000 scale using digital technology and the geographic coordinates. There is a dire need for data coordination and data sharing between these two major organizations (United Nations, 1996; USDA and USDI BLM (2001). The action is supposed to enhance the spatial accuracy of land record maps as well as their interoperability with other national datasets (Von, 2004). The integration will also help achieving the goal of a useful multipurpose cadastre for Pakistan.

FS 1F - Cadastre: Developments and Case Studies   9/12
Muhammad Adeel
Evaluating the role of cadastre maps in Pakistan's Land Administration: A GIS Perspective

FIG Congress 2010
Facing the Challenges – Building the Capacity
Sydney, Australia, 11-16 April 2010

6. CONCLUSIONS

Good land management helps promoting economic and social development in the country. With the passage of time, people's interactions with land have increased a number of times. So the land administration needs to be updated in order to cater for the need of time. Presently, land record system is around 500 years old. A review of the existing system shows that it has a number of positive aspects. In order to meet the increased demands of land administration, this base system needs a lot of improvements. Mapping components of cadastres can be improved significantly through the use of Geographical Information System and remote sensing methods.

Freely available open source software (FLOSS) can help manage and share the Pakistani cadastre. Introduction of advanced technology is the need of time and it will help achieving tenure security and efficiency of the land administration system. After preparing initial spatial database of cadastres on FLOSS tools, the system can be enhanced through the introduction of enterprise solution for enhanced capabilities like web mapping and e-land administration. Since the cadastre maps are hand drawn outputs, they lack spatial accuracy and ability to be integrated with other survey accurate datasets. It is proposed that the Survey of Pakistan needs play its role for accuracy of cadastral maps.

REFERENCES

Alexandrov, A et al. (2002). Application of Quickbird Satellite Imagery for Updating Cadastral Information, Sofia, Bulgaria. [Online], Paper Retrieved from
Dale, P. F., & McLaughlin, J. D. (1988). Land information management—an introduction with special reference to cadastral problems in third World countries. Oxford: Oxford University Press.
ESRI (2008). GIS for National Mapping and Charting, ESRI® GIS Technology in Europe. A technical document by Environmental System Research Institute (ESRI), pp: 4-7. Redlands, USA.
ESRI (2009). Parcel Data Models Template, Environmental System Research Institute (ESRI), Redlands, USA.
Fawad, S. Raza, Almas, M. and Ahmed, K. (2006). Land Records Information Management System
http://www.proceedings.esri.com/library/userconf/proc05/abstracts/a1279.html Assessed on March 22, 2010
FIG (1995). Statement on the Cadastre, International Federation of Surveyors, FIG Bureau, Canberra, Australia. [Online] Report retrieved from http://www.sli.unimelb.edu.au/fig7/cadastre/statement_on_cadastre.html retrieved on 12 February. 2010.
Espada, G.P. (2007). The Use of FLOSS in Cadastre and Land Registration, conference presentation by FAO Land Tenure and Management Unit (NRLA), FIG Commission 7 and World Bank Thematic Group on Land Administration.

FS 1F - Cadastre: Developments and Case Studies   10/12
Muhammad Adeel
Evaluating the role of cadastre maps in Pakistan's Land Administration: A GIS Perspective

FIG Congress 2010
Facing the Challenges – Building the Capacity
Sydney, Australia, 11-16 April 2010

Government of Pakistan (2005). Computerization of Land Revenue Records in Puniab, Proiect Concept - LRMIS Assessment Report, Project Management Unit and Board of Revenue, Lahore.

Kaufmann, J. and D. Steudler (with the Working Group 1 of FIG Commission 7) (1998). Cadastre 2014, A Vision for a Future Cadastral System, FIG, July 1998 (http: //www.swisstopo.ch/fi g-wg71/cad2014.htm).

Lourini R. (2001). Information Systems for Urban Planning, Taylor and Francis, London. ISBN: 0748409645

National Institute of Population Studies (2010). Population of Pakistan. http://www.nips.org.pk/Home.htm assessed on 22 March 2010

Peter W. and Ralphs, M. (2003), GIS in Land and Property Management' Spon Press, 416 pages, ISBN: 0415240654

Steudler, D., Törhönen, M. and Pieper, G. (2010). FLOSS in Cadastre and Land Registration, Opportunities and Risks, Food and Agriculture Organization FAO and the International Federation of Surveyors FIG, 100 pages, ISBN 978-92-5-106510-5, paper retrieved from http://www.fig.net/pub/fao/floss_cadastre.pdf assessed on March 12, 2010

UNHABITAT (2003). Surveying and land information management for secure land tenure. Regional Seminar on Secure Tenure Safari Park Hotel, Nairobi, 12 - 13 June 2003

United Nations (1996), "Land Administration Guidelines: with special reference to countries in transition". New york & Geneva.

USDA and USDI BLM (2001). Standards and Guidelines for Cadastral Surveys using Global positioning Methods,Version 1.0, 19 pages, Washington DC. USA.

Usman, M. Q. (2006). Computerization of land records in Pakistan: A comparative analysis of two projects from a human security perspective http://www.apdip.net/projects/e-government/capblg/casestudies/Pakistan-Qazi.pdf *assessed on 05 march 2010*

Von. N. M. (2004). GIS and Land Records, ESRI Press, 150 pages, ISBN: 1589480775

World Bank (2006). Punjab land records management & information systems Project, Project appraisal document, Report No: 36450-PK

Yeung, K. and Hall, G. (2007). Spatial Database Systems. The GeoJournal Library, Volume: 87, Springer.

Zevenbergen, J. (2004). A Systems Approach to Land Registration and Cadastre, Nordic Journal of Surveying and Real Estate Research, VOL 1, 2004

BIOGRAPHICAL NOTES

Author has obtained B.Sc. in city and regional planning (2004) and MS in GIS and Remote Sensing (2009) from Pakistan. Currently he is working as a Lecturer of Land Information Systems subject at the institute of Geographical Information Systems at the National University of Sciences and Technology, Islamabad Pakistan. He has five years of professional working experience as an urban planner with a number of government and private organizations in Pakistani. Land record management, spatial growth analysis, landscape ecology and remote sensing for environment are his areas of interest.

FS 1F - Cadastre: Developments and Case Studies
Muhammad Adeel
Evaluating the role of cadastre maps in Pakistan's Land Administration: A GIS Perspective

FIG Congress 2010
Facing the Challenges – Building the Capacity
Sydney, Australia, 11-16 April 2010

11/12

CONTACTS
Muhammad Adeel, Adeel
Institute of Geographic Information Systems (IGIS)
National university of Sciences and technology,
Islamabad
PAKISTAN
Tel. +925190854493
Fax +92519085 4402

Email: m.adeel@igis.nust.edu.pk
Web site: http://igis.nust.edu.pk/faculty.htm

FS 1F - Cadastre: Developments and Case Studies   12/12
Muhammad Adeel
Evaluating the role of cadastre maps in Pakistan's Land Administration: A GIS Perspective

FIG Congress 2010
Facing the Challenges – Building the Capacity
Sydney, Australia, 11-16 April 2010