Developing a Cadastral Information System for Part of Fadaman-Mada Area of Bauchi Metropolis for Sustainable Development.

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Abstract

The study integrated and updated the entire Fadama-mada area with a comprehensive digital map and cadastral data. The raster image from the analogue maps was also fully utilised. Scanned images were sent to Auto CAD environment for proper geo-referencing. Positions of updated features were added using coordinate geometry (COGO). Drawings were properly edited using Arc view 3.2. Graphics were linked with non-spatial attributes data base. The result of this exercise was checked by some GIS operation and analysis; digital map of Fadaman-Mada was produced; and feature details shown in graphics and tables. Thus, for sustainable development, Cadastral Information System (CIS) has been made more effective for the monitoring, evaluation and management of cadastral records in government ministries, local government offices as well as other related government agencies.

Key words: Fadaman-Mada, Cadastral, GIS, Coordinate Geometry.

Introduction

The fuel driving the engine of growth and sustainable development of any nation is the nation's access to reliable and sufficient geo-information. In most developed countries, over 80 percent of rational and prospective allocation and environmental management decision is based on quality and accurate information. On the other hand, the roots of under development of third world countries, such as Nigeria emanated from a number of factors which include poor quality data collection, organisation, and management practices; and, lack of adequate knowledge to develop the area and manage the environment in a sustainable manner. The consequences of all these are obvious from air and water pollution, environmental degradation, diseases and death. These are the challenges of land information and data management in Fadaman-Mada area of Bauchi metropolis, against rapid socio-economic development. The study specifically examined the cadastral information system that is more feasible, and revolves around the cadastre that concentrates on the general systematic and up-to-date register containing information about land plots within the Fadama-Mada area. The cadastral information was properly collected, checked, integrated, analyzed and stored.

The Fadama-Mada layout had hitherto been properly executed, based on approved design. But its quality presently has been seriously affected by limitations associated with analogue maps system of storing, manipulating, assessing, and retrieval of cadastral information.

Since analogue cadastral maps are still being used for development, planning or, are accepted as valid documents in settling land dispute in the courts, issues such as retrieval of cadastral information, manipulating and assessing large volumes of information still remain a major problem. The case of Fadaman-Mada area is not different as its development plan has been seriously affected. For instance, there has been the expansion of the Muslim cemetery by the Bauchi State government thereby confiscating quite a number of residential plots that fall within the expanded area. Also, plot for the Nigeria Television Authority (NTA) transmitting station has been greatly reduced by half. The action of government has caused prospective developers, land speculators and even some government officials to engage in unlawful land activities, making control and planning of Fadama- Mada difficult for the government. If a comprehensive spatial data of the area were to be fully developed, it would be easier to check, stop the illegal dealings taking place in the area. This could be further used as a tool for developing the area, as well as, serve as model for controlling future developmental plans for the state and the nation at large.

One of the important components of any cadastral system is the cadastral maps. But the existing system in the study area consisting of paper maps and conventional land registers are becoming inefficient, for this reason a cadastral information system (CIS) based on digital cadastral map in which attributes and map data on cadastral unit stored in the same data base cannot be ignored. The role of this cadastral information system is to enhance the management and control of land resources, for sustainable development. The advent of computer technology has modernized the existing cadastral system. Some governments are forced to improve on the existing system due to the fact that the old system is becoming inefficient in areas such as:

i. Slowness of updating, retrieval and storage process in the conventional system.
ii. The disability for performing analysis and report in an easy way.

This study is aimed at developing a cadastral information system (CIS) of Fadaman-Mada area of Bauchi metropolis for sustainable development with the following objectives:

i. To digitize the original Fadaman-Mada layout plan, updating the digitized map of Fadaman-Mada area by incorporating co-ordinates of the new features obtained from the field using COGO.
ii. To develop a comprehensive cadastral data base of Fadaman-Mada area.
iii. To determine the efficiency of the GIS by issuing queries and observing how the CIS responds.

Overview of Geographical Information System

Improvements in the study of Cadastral Information System have been witnessed over time. In some countries some projects have been undertaken to extend the conventional system to cover new issues such as:

i. Automation of administrative tasks.
ii. Development of applications for managing the cadastral registers.
iii. Development of analytical tools for setting up digital cadastral maps and plans.
iv. Automation of land management for consolidation.
v. Implementation of land information system.

According to Elayachin and El-hassane (2001) the design and implementation of a digital cadastral system which require an approach that enables the integration of cadastral operations with GIS packages and

a tool that should be of use in a multipurpose system can be achieved through three levels.

(a) In the first level, the existing cadastral applications must be understood and all projects conducted for modernizing cadastral system should be analyzed;
(b) In the second level, it is necessary to outline different methods for linking cadastral data models to GIS software, where the existing methods, their strengths and weaknesses are discussed;
(c) The third level is concerned with the manner by which the conceived system is implemented.

Buragohain, et al (2002) developed a land information system using integrated remote sensing and GIS Technology for Guwahati city, India, in order to come up with an advanced database management system (DBMS) for the city. The methodology adopted in the study was the map of Guwahati city and its surrounding areas were digitized. The industrial data comprised of the characteristics of the draining network, road and railway network as well as infrastructure facilities in the city.

Also satellite data are processed and classified using supervised classification method to prepare the land use land cover map. The spatial and temporal changes in growth pattern are recognized from the digital data. At the end, plot- wise urban land use map was prepared and attributes were assigned for every plot with full ownership information. The result of the research was ended by developing a decision support system created to supply information regarding every plot and its attributes. A database was converted into a web supported format and, customized to provide query facilities for immediate and ready extraction of information through the web.

In 1925 Turkey's cadastral system was formed by the state with several legal and organizational modifications. These modifications have resulted in a lack of standardization and inconsistency in the geometric aspect of the cadastral data, such as the cadastral maps without a co-ordinate system or indifferent coordinate system.

The problem arising from data standardization, data quality, data inconsistency, digital archiving and the slowness in cadastral services forced Turkey to reform its cadastral system to a computer-based cadastral information system. In the study, the requirements of a cadastral database were analyzed and a spatiotemporal database was designed and developed to fulfill the requirement for spatial, temporal database and spatiotemporal queries for cadastral data. The Spatiotemporal uses Entity-Relationship (STEP) model in combination with the Enhanced Entity Relationship (EER) model. Oracle 8i spatial was chosen because it provides spatial data handling capability.

The result of the study was a creation of database tables defined in logical schema using Oracle 8i spatial, where the cadastral and land registry data of the study area were loaded into the database tables created. Oracle 8i does not provide graphic edit and display function for spatial data, map info 6.0 GIS software was used to retrieve, display, manipulate and analyze the cadastral data. Tella and Rably (2002) was a study that merged the old cadastral records with the new cadastral records, creating a robust cadastral database named VMDS. The VMDS contained both the georeferenced special data and the attribute data. Reghavendran (2002) described how an automated cadastral mapping and land information system could be created. He outlined two main issues of concern for setting up a cadastral information system, i.e, Spatial component/survey data

describing the spatial disposition of the parcels in the real world cadastral maps and Non-spatial component describing details such as ownership, tax value, e.tc. He uses spatial database (SDE) for the spatial components and micro station geographic for the non-spatial data. For customized query and reported generation, the database was put in Oracle format. At the end, analysis with the new CIS was unlimited, though it depended on the data that has been put as well as the user requirement.

In his work, "Cadastral Land Information System for Sustainable Land Conveyance in Bauchi state", Shuaibu (2008) used the existing analogue map which he converted to digital format using a digitizing tablet in ILWIS environment. An automated attribute database for the spatial database was created in an Arc view environment which was subjected to query and analysis. He was able to show land covered by certificate of occupancy, number of plots for residential, recreational and commercial purposes in the digital map he produced. In 1996 the government of New Zealand instructed the land information Zealand (LINZ) to develop a proposal to automate the nation's survey and tittles system; to integrate all survey and title processes; to digitize them and reduce the cost of both provision and compliance; to utilize technological development; and to meet the growing community demand for improved quality of cadastral works (Bevin1999).

The establishment of Abuja Geographic Information System (AGIS) in the Nigeria Capital city has changed the general approach to land administration in the city. The analogue cadastre was converted to digital format and accordingly, new certificate of occupancy were issued out to former holders of land titles within the capital territory. Prior to the creation of AGIS land transactions in the city was characterized by duplication of titles, delay in searches and land conveyance not properly registered.(www.abujagis.com).

Considering the various studies highlighted in this review especially, the problems that necessitated the various projects, the type of data used, the methodology adopted, the equipment and instruments used as well as the benefit derived at the end of each study, there are improvements made in Cadasral Information System, but, not work has been done in Fadaman-Mada.

Materials and method

The primary data was from the field survey, which involved field updating using electronic total station (sokia set 600) and hand-held GPS (German series); the secondary data consisted the cadastral layout blocks survey of Fadaman-Mada, as well as, the street-guide map of Bauchi town, from the Bauchi state Ministry of Land and Survey; Other secondary data used included text books, journals, conference papers and seminar proceedings.

The Non-spatial attribute data were also obtained from the Bauchi state Ministry of Land and Survey, which included Parcel information, Ownership, and Registration of titles. Purposes, Division, Location and other attribute information were obtained by physical inspection. An existing layout block survey of Fadaman-Mada was digitized using on-screen device. The coordinate of all the changes made on the original cadastral layout which was obtained through field survey using total station and the attribute information of individual parcels were obtained through Ministry of lands and survey, personal inspection and interviews. The existing cadastral map was converted into soft copy using an AutoCAD environment; the updating of digitized map was achieved by using COGO in the same AutoCAD environment while table-created queries and analyses were carried out in an arc view environment. Flowcharts of methodology are as below.

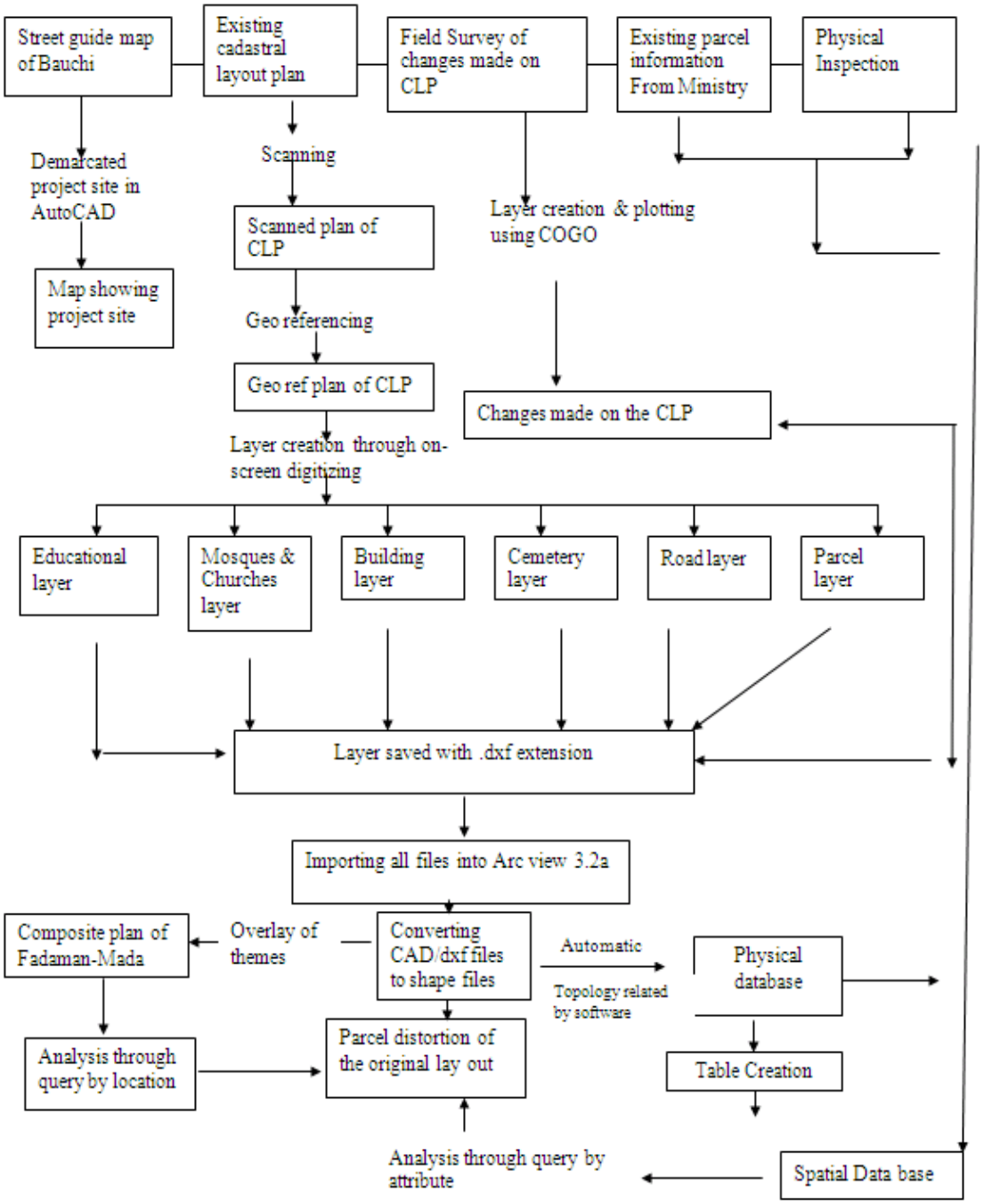


Fig 1: Diagram showing the Cartographic model of the project.

The Study Area

The study area of this project is Fadaman-Mada layout plan DP/8A in Bauchi Local Government of Bauchi State, located along Bauchi – Maiduguri road. The area is bounded by Babangida Square on the West and Sultan Abubakar Road on the North; and bounded by the following UTM coordinates:
(593302.542E, 1143077.321N) and (594402.711E, 1143077.321N)

(594402.455E, 1142327.628N) and (593302.542E,1142327.628N)

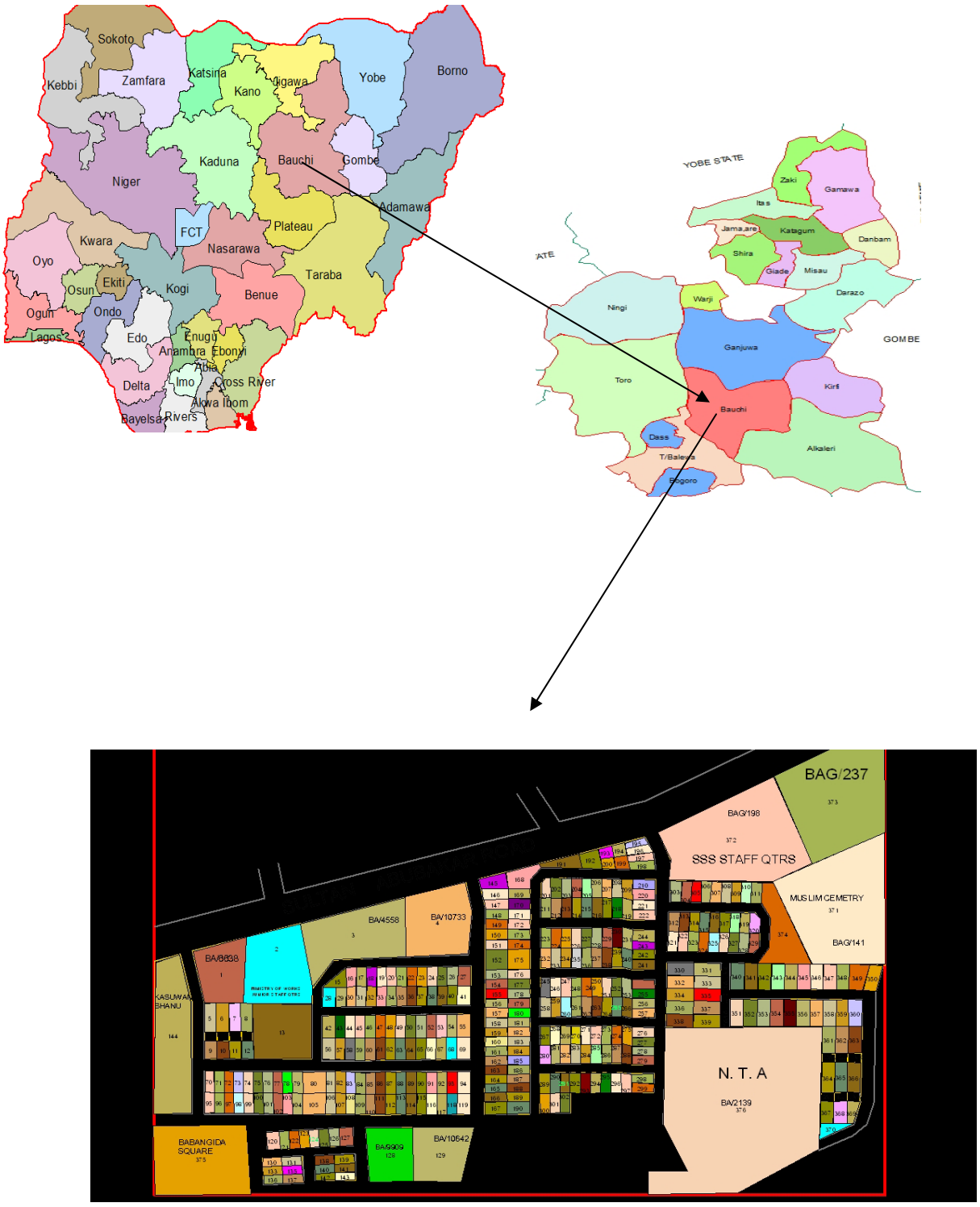


Fig 2: Maps showing the Location of the study area.

Source: Ministry of Lands and Survey, Bauchi.

Field Observation

Control Pillar BTR1048, was occupied, target was set up at control pillar BTR 1049, the coordinates and heights of the occupied station was keyed into the total station. Also the co-ordinates of the back station were keyed in. Initial azimuth of the references line was computed and logged in too.

Having achieved the orientation set up, the reflector target kept on roving recording coordinates of desired objects. The first point that was sighted was beacon number BA30230. When all the features within the occupied area have been picked, instrument position was changed.

At the new instrument position, the new values of the present occupied station were logged in for both the occupied and the back station before commencing fresh observations. The reflector target kept on roving around, and coordinates of desired points within the occupied area were recorded. In each plot, coordinate of four corners of the plots were obtained making the total number of coordinate obtained for sixty plots to be 240 points, these were used for plotting the whole plots. This was the method used throughout in picking changes of all features within the cadastral layout plan of DP/8A. The sample data is as follows:

BUILDING	EASTING	NORTHING	REMARKS
1	593471.056	1142736.802	POLICE
	593495.131	1142742.020	STATION
	593470.613	1142716.312	
	593495.171	1142716.310	
3	593467.777	1142487.151	ALISS
	593539.053	1142490.088	HOTEL
	593539.053	1142454.411	
	593467.107	1142454.411	
14	593973.009	1142868.321	BLOCK
	594037.419	1142885.301	INDUSTRY
	594049.368	1142863.386	
	593973.021	1142855.117	

Data Processing

Four referenced co-ordinate points that relatively appeared on the four corners of the scanned Fadaman-Mada plan were plotted in the AutoCAD environment. The layout plan was scanned using A0 scanner, which was later exported into an AutoCAD environment. Then through the "insert'" menu, raster image was clicked to bring in the scanned Fadaman-Mada image into the same environment of the plotted four co-ordinates using R14 overlay.

From the image menu, through the correlates sub menu, rubber sheet was clicked to start the geo-referencing. Subsequently, the source points on the scanned image were clicked followed by clicking their respective destination points on the plotted four co-ordinates.

After clicking the last points "enter" command was clicked which immediately rubber sheet (Geo-referenced) the scanned Fadaman-Mada image to the geo-referenced point. Digitizing was also done by 'freehand' using the on-screen digitizing capabilities of AutoCAD 200i

The individual layers created in the AutoCAD environment were saved as individual drawing files, bearing the name of the features they contained. This means that the number of features/ layers is equal to the number of files saved.

While in the Arc view environment, the AutoCAD files were brought into the Arc view window by highlighting the CAD reader extension. After displaying the different themes in the view, the individual themes were converted into Arc view shape files through the theme menu.

Notably, Arc view automatically creates a table that automatically links to the graphics immediately the themes are displayed. In a view, the tables so created by the Arc view were edited only when the theme was converted to shapefiles. In this study, the table of concerned was the table created for the individual parcels. Therefore, the parcel themes were brought into the Arc view environment as a polygon theme.

Table Creation

The table for the parcel was automatically created when the parcel file was imported into the Arc view environment. Consequently table creation here involved editing the table for the parcel so created. Editing involved deleting unwanted columns automatically created by the Arc view and creating columns of interest. The column of interest are those attribute information that were obtained through physical inspection and from the Ministry of Land & Survey, such as owner address, owner name, occupation, change of ownership, change of purpose, plot number, parcel address, file number, date of C of O, etc.

Queries Generated

Queries were generated for retrieval and displaying of parcel information. These queries proved the genuineness of the database both spatially and non-spatially. Arc view 3.2a was used in generating queries by attribute as well as by location from the database table with the use of query builder icon. These were achieved as followed:

- Display all distorted parcels.

Steps

- Query builder icon was clicked;
- A dialog box was opened;
- Distortion field was double clicked;
- Equal sign (=) was double clicked;
- "Yes" was double clicked;
- "New Set" was double clicked;

All distorted plots on the map and the records containing attributes of the plots were automatically displayed.

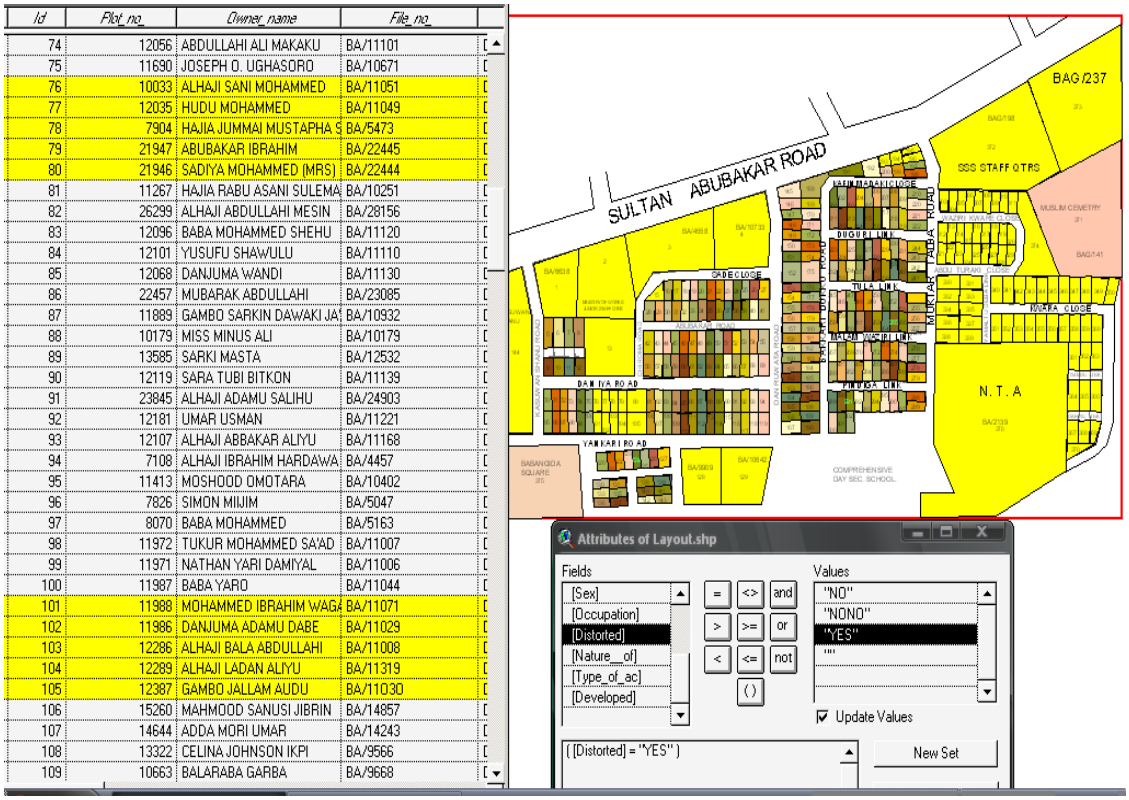


Fig 3: Part of Fadaman-Mada showing all queried parcels that are distorted (verged in yellow colour).

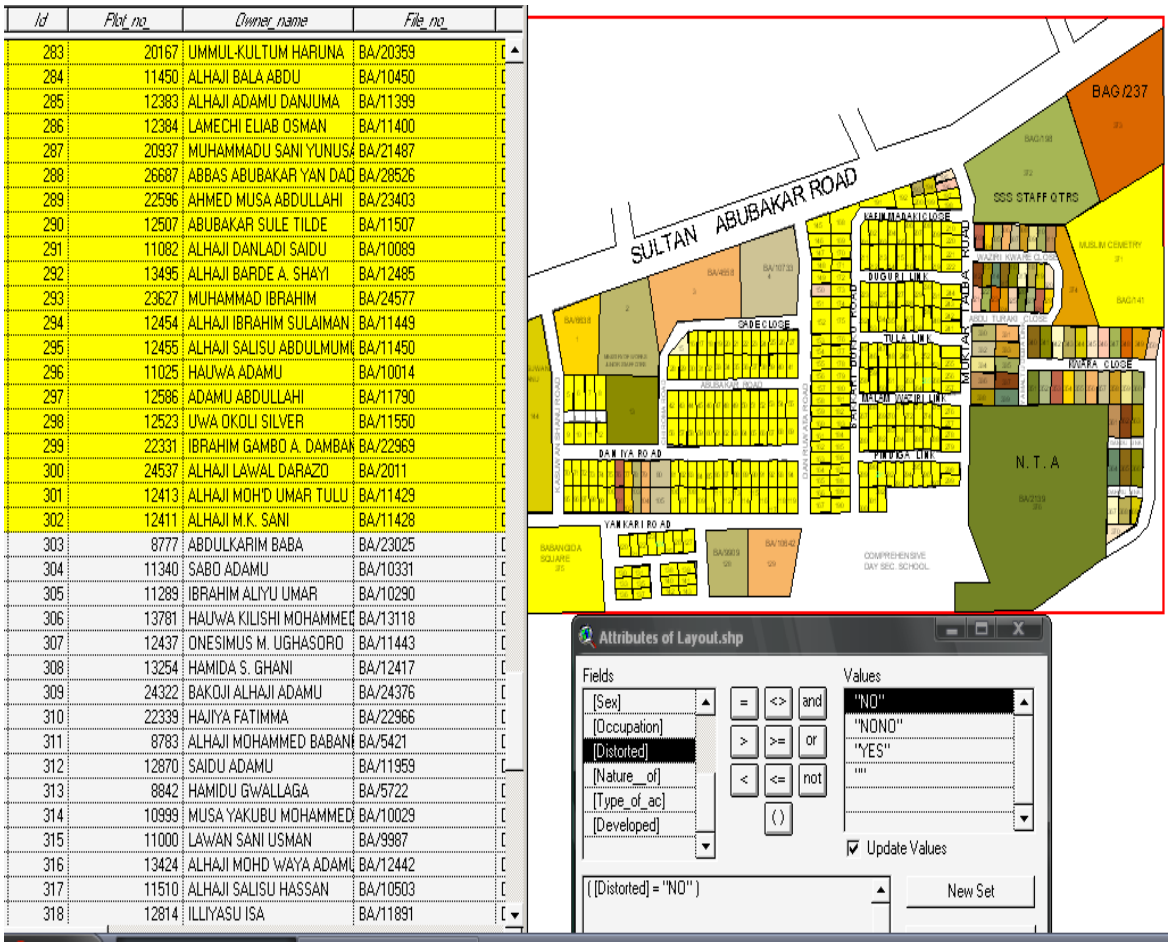


Fig 4: Part of Fadaman-Mada showing all queried parcels that are not distorted (verged in yellow colour)

Displayed Database

This study has a total of 16 fields and 376 records. The fields includes:-

- The identification number of the respective parcels.
- Parcels ownership address.
- Ownership occupation.
- Division of parcels.
- Parcels date of certificate.
- Parcels location.
- Parcels distorted.
- Parcels file number**.**
- Present parcel owner.
- Parcels land use.
- Nature of distortion among others.

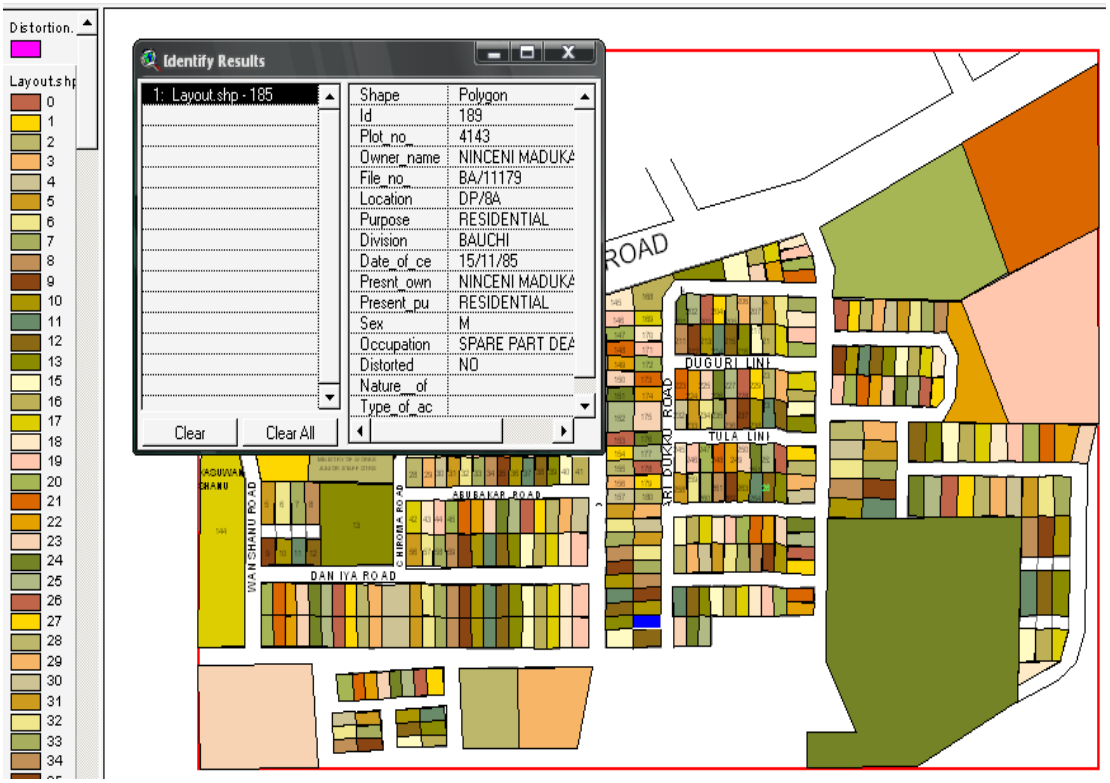


Fig 5: Part of Fadaman-Mada showing queried by location.

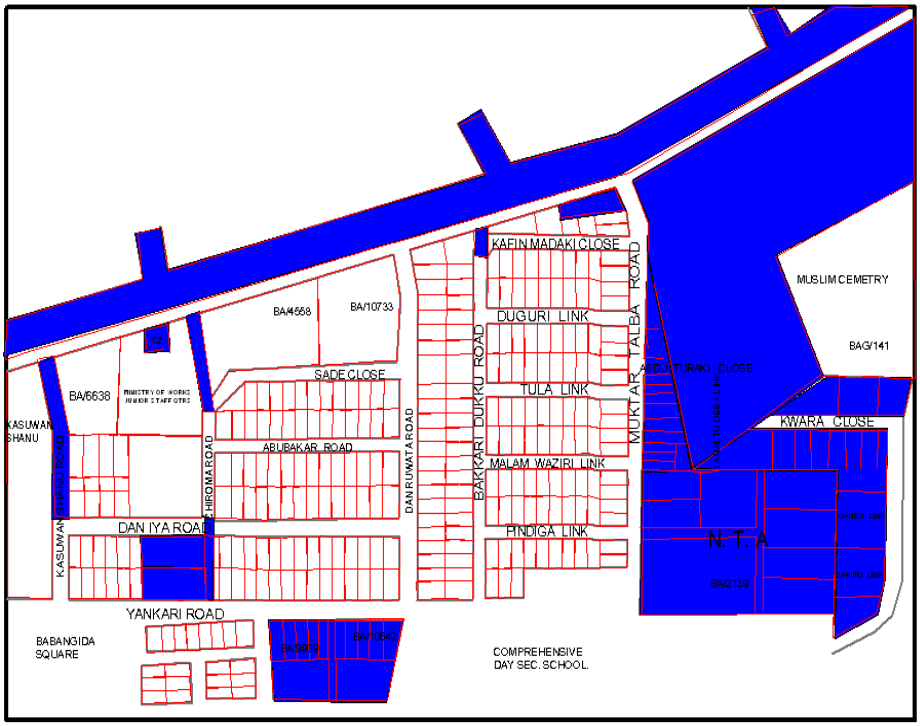
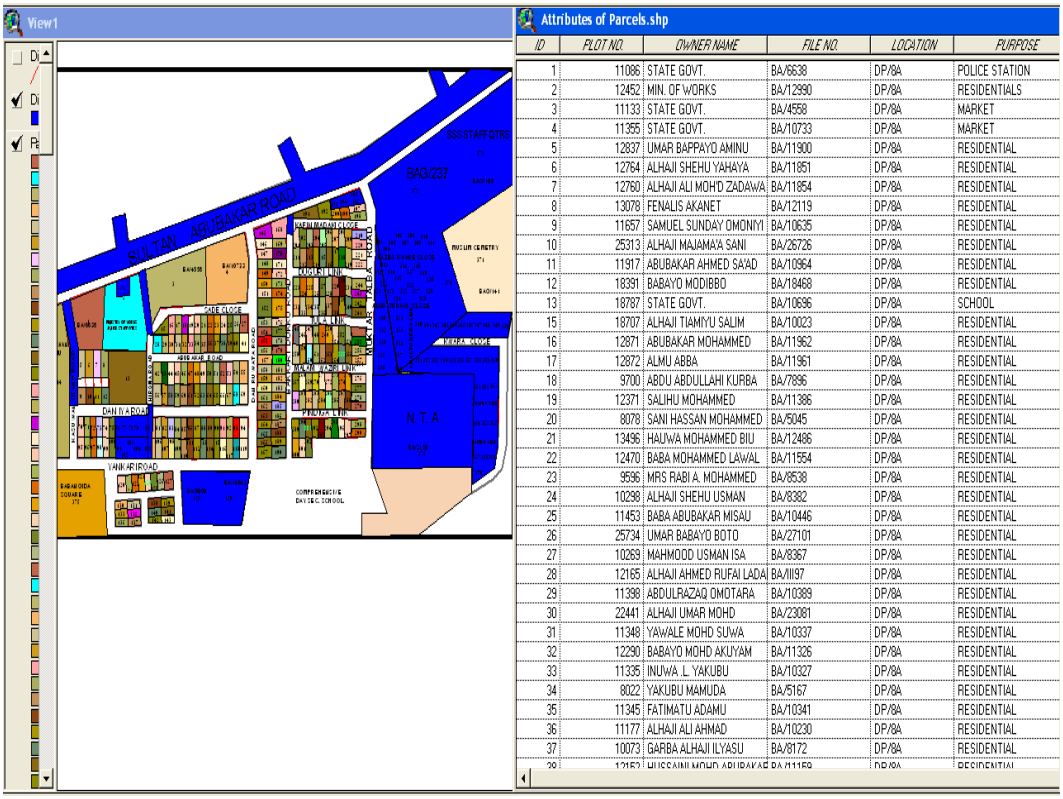


Fig 6: Plan of part of Fadaman-Mada showing changes made on the original plan in blue.



ID	PLOT NO.	OWNER NAME	FILE NO.	LOCATION	PURPOSE
1	11086	STATE GOVT.	BA/6638	DP/8A	POLICE STATION
2	12452	MIN. OF WORKS	BA/12990	DP/8A	RESIDENTIALS
3	11133	STATE GOVT.	BA/4558	DP/8A	MARKET
4	11355	STATE GOVT.	BA/10733	DP/8A	MARKET
5	12837	UMAR BAPPAYO AMINU	BA/11900	DP/8A	RESIDENTIAL
6	12764	ALHAJI SHEHU YAHAYA	BA/11851	DP/8A	RESIDENTIAL
7	12760	ALHAJI ALI MOH'D ZADAWA	BA/11854	DP/8A	RESIDENTIAL
8	13078	FENALIS AKANET	BA/12119	DP/8A	RESIDENTIAL
9	11657	SAMUEL SUNDAY OMONIYI	BA/10635	DP/8A	RESIDENTIAL
10	25313	ALHAJI MAJAMA'A SANI	BA/26726	DP/8A	RESIDENTIAL
11	11917	ABUBAKAR AHMED SA'AD	BA/10964	DP/8A	RESIDENTIAL
12	18391	BABAYO MODIBBO	BA/18468	DP/8A	RESIDENTIAL
13	18787	STATE GOVT.	BA/10696	DP/8A	SCHOOL
15	18707	ALHAJI TIAMIYU SALIM	BA/10023	DP/8A	RESIDENTIAL
16	12871	ABUBAKAR MOHAMMED	BA/11962	DP/8A	RESIDENTIAL
17	12872	ALMU ABBA	BA/11961	DP/8A	RESIDENTIAL
18	9700	ABDU ABDULLAHI KURBA	BA/7896	DP/8A	RESIDENTIAL
19	12371	SALIHU MOHAMMED	BA/11386	DP/8A	RESIDENTIAL
20	8078	SANI HASSAN MOHAMMED	BA/5045	DP/8A	RESIDENTIAL
21	13496	HAUWA MOHAMMED BIU	BA/12486	DP/8A	RESIDENTIAL
22	12470	BABA MOHAMMED LAWAL	BA/11554	DP/8A	RESIDENTIAL
23	9596	MRS RABI A. MOHAMMED	BA/8538	DP/8A	RESIDENTIAL
24	10298	ALHAJI SHEHU USMAN	BA/8382	DP/8A	RESIDENTIAL
25	11453	BABA ABUBAKAR MISAU	BA/10446	DP/8A	RESIDENTIAL
26	25734	UMAR BABAYO BOTO	BA/27101	DP/8A	RESIDENTIAL
27	10269	MAHMOOD USMAN ISA	BA/8367	DP/8A	RESIDENTIAL
28	12165	ALHAJI AHMED RUFAI LADA	BA/III97	DP/8A	RESIDENTIAL
29	11398	ABDULRAZAQ OMOTARA	BA/10389	DP/8A	RESIDENTIAL
30	22441	ALHAJI UMAR MOHD	BA/23081	DP/8A	RESIDENTIAL
31	11348	YAWALE MOHD SUWA	BA/10337	DP/8A	RESIDENTIAL
32	12290	BABAYO MOHD AKUYAM	BA/11326	DP/8A	RESIDENTIAL
33	11335	INUWA L. YAKUBU	BA/10327	DP/8A	RESIDENTIAL
34	8022	YAKUBU MAMUDA	BA/5167	DP/8A	RESIDENTIAL
35	11345	FATIMATU ADAMU	BA/10341	DP/8A	RESIDENTIAL
36	11177	ALHAJI ALI AHMAD	BA/10230	DP/8A	RESIDENTIAL
37	10073	GARBA ALHAJI ILYASU	BA/8172	DP/8A	RESIDENTIAL

Fig 7: Plan of part of Fadaman-Mada showing both the spatial and attributes database.

Results and Discussion

The study has demonstrated that cadastral information system is capable of producing an accurate computer-aided cadastral map. It has also demonstrated that CIS can cope with large volume of spatial and non-spatial data. Prompt and accurate decision taking on land matters which are some of the vital ingredients necessary for any economic development of any organization was fully enhanced.

Implementation of an automated cadastral information system will go a long way in helping the relevant authorities charged with the responsibility of handling land records more efficiently. This CIS has also given the authority an opportunity to make some typical analysis in the assessment of land use, as well as building code violations; the sale transaction of a particular parcel or for the whole block; and the assessment of property for issues of planning permission. Finally it can also serve as an interactive means of land information for immediate and ready extraction of plot-wise details through the multi-query facility that was provided in the database which allow any individual user to gather information regarding land holding. The first objective of the study which was to digitize the existing Layout of the study area in order to convert it to soft copy for further analysis has thus been achieved.

The advantage of this digitized map is that:-

- It can be readily edited.
- Each feature in the digitized plan can be saved in an individual layer for a specific user need.
- Each particular feature in the digitized plan can be queried for a specific analysis.
- Better and new symbols or features can be added to introduce more value to the plan in terms of beautification of the plan.

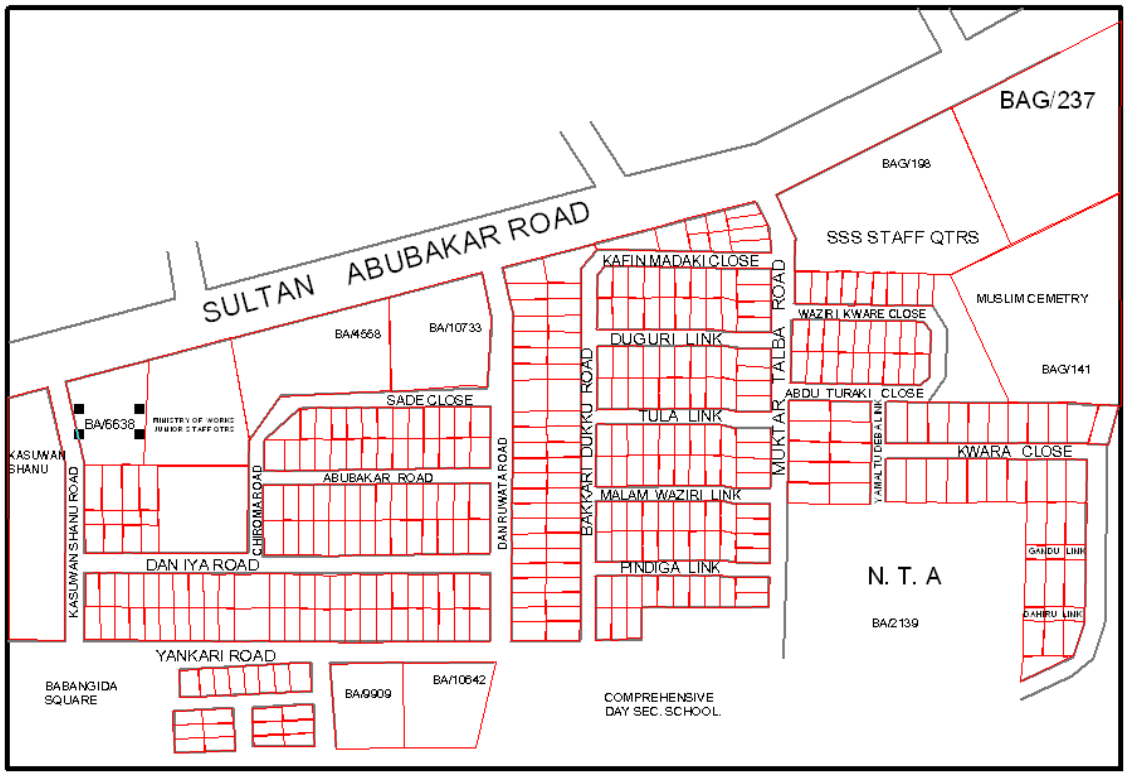


Fig 8: Plan of part of Fadaman-Mada showing the digitised details of layout.

The major changes were the expansion of the Muslims' cemetery yard officially carried out by the government. This expansion resulted in the revocation of some residential plots. However, the expansion has given way to the distortion of some left-out residential plots and some government plots like NTA Transmission Station by land speculators, land developers as well as some government officials who took advantage of the analogue nature of the layout plan.

Some residential plots have been converted to other uses such as commercial and religious activities.

Accordingly, roads initially designed for dual carriage were reduced to single lanes; others that were initially closed were extended to intersect the major ones. Furthermore, plots were further subdivided into smaller or bigger sizes than earlier designed. The major changes can be seen in figure 6, verged in blue.

The total storage space capacity of this study is 9.48MB. This implies that the entire database can be stored in a single CD or flash drive. Considering the storage capacity of a single CD which is about 700MB indicating that such storage device can contain 70 types of this database, talk less of comparing it with flash drive of 2G. Therefore one can conclude that there is high degree of portability, since 100 CD's can be carried along anywhere anytime. Consequently the quantity of information that can be stored in a single CD if converted to the analogue equivalent would have been too voluminous to carry about easily.

Similarly, another great advantage of this study is the flexibility of the database where both graphics and attribute data can be easily edited, unlike in the analogue method where such flexibility is very difficult. Also the speed at which information are retrieved in less than a minute cannot be compared with

the traditional method where it takes days before information are gotten.

Finally there is also provision for interconnectivity among the offices of the high ranking officers charged with land related matters within a ministry as well as other agencies that directly deal with land records. It can also be domiciled in a website making the device robust and easily accessible.

Table 1: Table of distortions

Serial no	Parcel description	Area before	Area distorted	Present area	Percentage Area distorted	Remarks
1.	NTA Transmission station	56033sqm	35636sqm	20397sqm	63.60%	Decreased
2.	Muslim cemetery	24142sqm	78090sqm	102232sqm	76.39%	Increased
3	Ministry of Works And Housing Junior Staff Qtrs	1085sqm	578sqm	10272sqm	5.33%	Decreased
4.	Plot BA/9909 & Plot BA/10642	12553sqm	6599sqm	5954sqm	52.57%	Parcel being partitioned to individual plots against initial purpose

Table 1 shows that about 63.60% of the total area earmarked as premises of the NTA Transmission Station have been distorted. About 76.39% increase of the cemetery yard was discovered following reported expansion by the Government. The table also presents some plots within the area that were either distorted officially or illegally.

Conclusion and Recommendations

The research focused on injecting the digital technology system into cadastral system of land administration in Bauchi State, to propagate the switching from analogue system of storing, assessing and retrieving cadastral data. The techniques and general procedures for digital cadastral map have been fully described in the study. The study also show how computer technology has come to play a vital role in keeping cadastral record by making it possible for information to be kept in different formats, allowing them to be assembled in any desired manner by individuals, ministry or parastatals that are directly involved with land related matters in satisfying their required needs.

Fadaman-Mada is only one out of the numerous developmental layouts that in the state capital and the Bauchi metropolis in particular that are yet to receive the new technology. It is therefore recommended that, relevant ministries, agencies and survey researchers in the state continue from where this research stopped if the state must attain sustainable development.

We crave the political willingness of those in power to fund the State Ministry of Land & Survey so that the latest satellite imageries of the state capital can be easily acquired, for

proper monitoring and detection of land use violation and changes within the metropolis.

The use of GIS should be embraced in developing digital cadastral maps. The need for seminars, workshops, training and re-training of personnel in the field of geo-informatics should be encouraged. The state will derive a lot of social and economic benefits from an efficient geospatial data infrastructure and cadastral database for efficient and proper co-ordination of geospatial information in the state. Therefore, quick transition from analogue cadastral system to digital system is strongly recommended to all agencies, ministries and parastatals dealing with land matters. Above all, an independent mapping agency needs to be established in all states of the federation for proper land use in order to maintain sustainable and protective environment.

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