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ASSESSMENT OF FORMS AND EXTENT OF INFORMAL CHANGES TO THE GEOMETRY OF A LOW DENSITY GOVERNMENT LAYOUT IN BAUCHI TOWN, BAUCHI STATE, NIGERIA.

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ABSTRACT

In spite of being prohibited by the contemporary land policy (Land Use Act) in Nigeria, the mutation of the geometry of statutory land parcels without official approval is taking place. Such mutations create differences between the geometric attributes of the parcels concerned as recorded in land registries and what obtains on the ground. By comparing the sizes of parcels as officially allocated and as developed, this paper attempts to provide evidence of the mutations that have taken place in a low density residential layout in Bauchi metropolis, the administrative headquarters of Bauchi State, Nigeria. The designed layout plan was obtained from the Ministry of Works, Lands, and Housing, while the corresponding Google Earth satellite image of the layout was downloaded using Terra Incognita 2.4 software package. Geo-referencing, digitization, creation of layout plan – satellite image overlay and computation of areas of the parcels as designed and as built was done with ArcGIS 10.5 Software package. The results indicated that the layout was designed to have 307 plots with a mean area of 2680.56m^2. A rock outcrop, approximately at the centre of the layout, occupy 72,842 m^2. 164 of the designed plots (inclusive of the rock) have been subdivided into 1473 smaller plots, 35 have been extended in 99 instances, while 7 have been merged into 3. Together, the geometric changes have altered the configuration of the layout from its conceptual design. Employing GIS techniques to update the plans of all government layouts for systematic registration of associated non-spatial attributes of the plots and more effective development control is recommended. In addition, access to formal land by the people should be enhanced through the creation of layouts on a regular basis.

Keywords: Informal changes, Geometry, Government Layout

INTRODUCTION

The administration of land to achieve desired sustainable spatial and socio-economic development objectives is perhaps the primary responsibility of governance. To this end, governments establish legal institutional, and spatial frameworks that empower them to appropriate, deploy and regulate the access, use and development of land in their respective jurisdictions (Enemark, 2017). Together, these frameworks operationalize statutory Land Administration Systems (LAS) that superintend the basic jurisdictions of land administration, the creation of land parcels, the conceptualization and implementation of rights, restrictions and responsibilities related to the parcels, and managing information (spatial and non-spatial) about the parcels. Creation of land parcels entail land acquisition, survey, subdivision, demarcation and mapping according to approved procedures (Nuhu, 2008) The created parcels are then allocated to competing users and uses with clearly defined rights, restrictions and responsibilities. Land rights define allowed uses, restrictions specify allowed use rights, while responsibilities relate to obligations to be discharged by land right owners (Williamson *et al*, 2010). Information about all the created land parcels and their associated rights, restrictions and responsibilities are then kept in land registries (in form of cadastres) of the systems. To be useful, such information should be accurate, assured, authoritative and up to date (Williamson et al, 2012).

Operating within their circumstances, formal LAS in the cities of developing countries have created and allocated land parcels as dictated by their respective legal and institutional provisions (Provide reference(s)). In creating land parcels and their associated rights, physical and land use planning tools are used to plan for efficient and safe urban growth and development. While physical planning (in form of layout and master plans) is used to guide spatial growth, land use planning (through land use zonation) regulates and controls the utilization of land for various uses (Aribigbola, 2007; Madu and Innocent, 2013).

When formal LAS design and allocate the plots to beneficiary users and uses, the cadastral attributes of each parcel are recorded. These attributes are of two forms: spatial and non-spatial (Enemark, 2009). Spatial attributes are those related to location (coordinates of the beacons that define the boundaries) and geometry (size) of each plot. Non-spatial attributes identify the plots and describe the rights associated to them. These include, a unique plot identity number, the name of the rights owner, the purpose of the right, date of allocation, etc. Typically, these cadastral attributes are displayed on plans and text registers for the spatial and non-spatial attributes, respectively (Dale and McLaughlin, 1990). In the analogue systems that are typical in the land registries of developing countries, both the plans and texts are in manual paper forms.

To ensure that none of the cadastral attributes of government allocated land parcels are changed arbitrarily as to negate the achievement of government`s spatial objectives, prior statutory consent is required before the attributes are changed by beneficiaries of government allocation of the parcels (Provide reference(s)). Further, statutory development control mechanisms are mandated to ensure that all land developments are made in conformity with government approved physical and land use plans. Due to several incapacities, the formal LAS in most developing countries have been unable to enforce compliance with layout plans. As a result, the spatial and non-spatial attributes of government allocated land parcels are informally changed, implying gaps between formal regulations and what is practiced (Lugoe, 2007). Such informal land practices have been reported in several countries (Fekade, 2000; Rakodi, 2004; Barnes and Griffith, 2007; McGaffin and Kihato, 2014; FIG/UNECE, 2015).

In Nigeria, the Land Use Act of 1979 is the principal legal instrument for formal land administration. The Act prohibits any form of transaction on statutory land outside established formal regulations. In spite of this prohibition, informal land transactions on formal land are common occurrence (Rakodi and Leduka, 2003). These transactions result in officially unregistered and unrecognized geometric, ownership and land use changes to statutory plots (Ojigi, 2012).

Hence, this study presents the forms and extent of informal geometric changes that have taken place in a government low density residential layout in Bauchi metropolis, the headquarter of Bauchi State, north east Nigeria. Official cadastral records obtained from the Bauchi State Ministry of Works, Lands and Housing and field data were plotted and analysed using Geographic Information System tools. The objectives of the study were; Digitization of the analogue survey plan of the layout as officially designed Overlaying the digitized layout plan with its corresponding satellite image Digitizing the geometric changes to the plots revealed by the satellite image-layout plan overlay and verified in the field and Plotting an update of the layout plan as built.

The Study Layout

The study layout is Fadaman Mada West (DP 23) in Bauchi metropolis, the capital of Bauchi State, north east, Nigeria. The layout is located between 1.9 km and 3.2 km from the Awalah roundabout on the right side of the Bauchi- Maiduguri road. The cadastral records of the Bauchi State Ministry of Works, Lands, and Housing reveal that by design, the layout was approved in 1989 for low density residential use.

Types and Sources of Data

Three types of data sets were used to conduct this study. These were;

a) The survey plan of the layout that was designed by the government in line with its spatial development standards. The plan also reveal the boundaries and sizes of the plots as designed and hence, provide the benchmark for determining alterations to the sizes as built. This was obtained from the Bauchi State Ministry of Works, Lands, and Housing.

b) Remote Sensing imagery covering the extent of the layout plan was required to obtain current data about land developments in the layout. The imagery was downloaded from Google Earth using Terra Incognita 2.4 Software package.

c) Global Positioning System (GPS) coordinates of the perimeter and corner points of some of the plots in the layout were required for geo-referencing the layout plan and the remote sensing imagery. Geo-referencing allowed the layout plan and satellite imagery to be related to physical space through the GPS coordinates collected in the field using a hand held GPS instrument.

Data Processing

The ArcGIS 10.5 Software package was used for data processing. To digitize the layout plan, it was scanned using an A0 scanner and saved on a memory card which was then used to upload the scanned image to the computer. In the computer, the scanned layout image was geo-referenced by zooming to the respective locations of the beacons whose GPS coordinates were obtained in the field. The values of the coordinates were then entered and updated. The UTM (zone 32N) projection coordinate system was chosen for the geo referencing. The satellite image was similarly geo-referenced with the same GPS coordinates that were used for the layout plan. With this geo-referencing, locations on the ground and their equivalents on the plans and satellite images have been spatially integrated and coordinated with respect to a common geodetic reference system.

Two shape files or themes (parcels and roads) were created for digitizing the layout plan. This was achieved using the on-screen method (using computer cursor to trace the futures from the scanned and geo-referenced plan). Each of the two groups of features (parcels and roads) was as independent thematic layers. After digitizing, editing of the traced features followed immediately. The editing involved the trimming of lines, erasing of unwanted details, etc. The resulting digitized layout plan was saved. A column was created for area in the attribute table of the layout plan and the calculate geometry command was used to calculate the areas of all the digitized parcels.

The overlay of the digitized layout plan and its corresponding satellite image was achieved by adding them. The resulting overlay was saved and printed to produce a field map that served as a field guide to validate the identified geometric changes in the field. The validated geometric changes were digitized on the overlay in different shape files (subdivision, extension, merger) to produce the updated plan of the layout. A copy of the updated cadastral plan of the layout was taken to the field to ensure that it truly portrays reality. Observed misrepresentations were corrected on the updated plan in the field and subsequently on the computer to produce a final copy. The spatial extents of the geometric changes were computed using the compute geometry command of the ArcGIS Software.

RESULTS AND DISCUSSION

Table 1: The GPS Coordinates

X	Y
1143987	0593995
1143967	0596231
1143141	0596153
1142126	0594212

Source: Field Survey, 2018.

The Layout as Designed

From the digitized cadastral plan of the designed layout Figure 1, indicated three hundred and seven (307) plots meant for various uses with a rock outcrop located roughly at the centre of the layout. The pattern of the design of the layout was made in a manner that arranged the plots with their backs on each other in successive blocks that are separated by access roads.

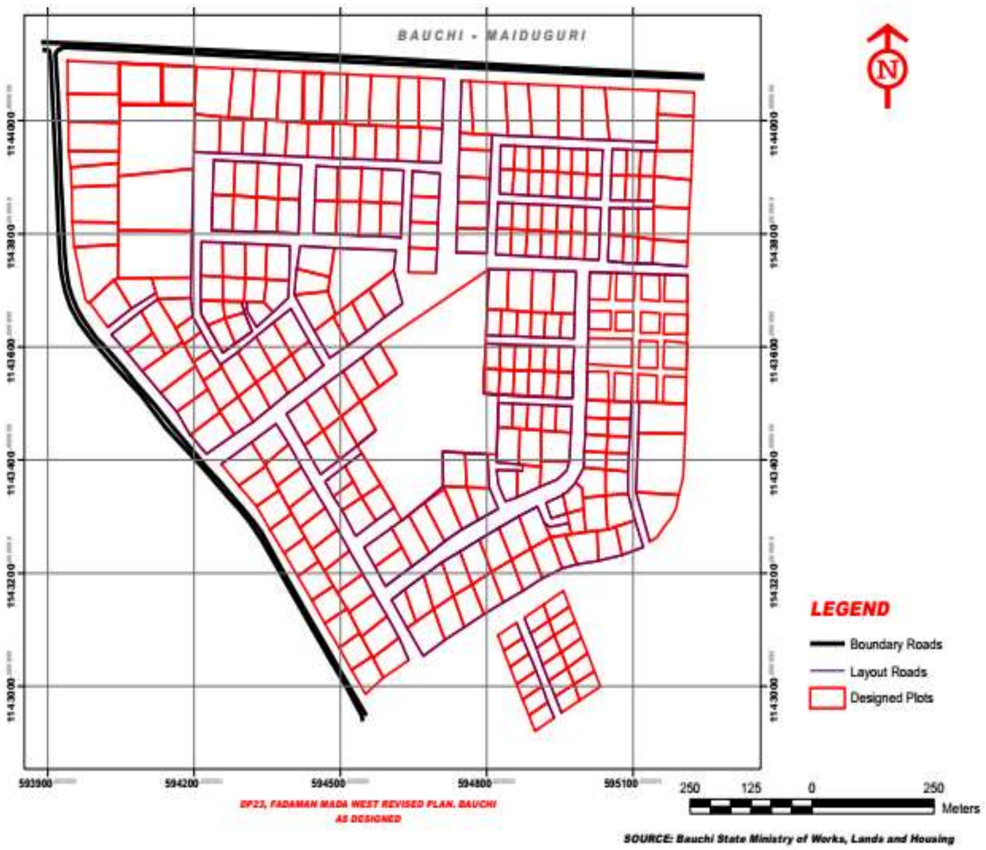

Fig. 1: Fadaman Mada West (DP 23) Residential Layout as Designed

Source: Digitized from analogue plan obtained from Bauchi State Ministry of Works, Lands, and Housing, 2018

The computed spatial extents of the plots are summarized in Table 2.

Table 2: Spatial Profile of Plots in the Study Layout as Designed

Variable	Frequency
No. of Plots	307
Total Area of Plots (m^2)	822932
Range of Area (m^2)	922-10200
Mean Area of Plots (m^2)	2680.56
Area covered by Rock (m^2)	72842
Total Area of Layout (m^2)	895774

Source: Computed from the Designed Layout Plan, 2018.

The computed extents of the layout (Table 2) suggested that the layout covered a total area of 895,774 m^2. Out of this, the designed plots covered an area of 822932 m^2 while the rock covered 72842 m^2. The average area of the plots was 2680.56 m^2 with the smallest and biggest plots being 922 m^2 and 10200 m^2, respectively. The wide range in the sizes of the plots in the layout suggested that these were not designed to have equal sizes that may have been intended for allocation to different categories of uses and beneficiaries with different capacities to develop them.

The Layout -Satellite Image Overlay

The overlay of the layout plan (as designed) and the corresponding satellite image of the area it covers on the ground are presented in Figure 2.

Fig. 2: Fadaman Mada West (DP 23) Residential Layout – Image Overlay

The Updated Layout Plan

The update of the layout plan (as built) is depicted in Figure 3.

From a comparison of the layout plan as designed (Figure 2), and as built (Figure 3), four types of geometric changes are discernible: subdivision, extension, merger, and addition. In subdivision, the designed plots are further parcelled into smaller sizes. The incidence of subdivision in the layout is summarised in Table 2.

Fig. 3: Fadaman Mada West (DP 23) Residential Layout as built

From Table 3, the sizes of 164 out of the 308 designed plots in the layout (including the rock), representing 53.24% (more than half), have been subdivided. In all, 1473 smaller plots that cover a total area of 352633 m^2 and average 239 m^2 in size were created. The average size of the subdivisions is 11 times smaller than the average size of the plots as designed (2680.56m^2). On the average, 9 smaller plots were created from each of the designed plots that were subdivided and, the range of the subdivisions (30 m^2 to 3503 m^2), reveal a wide disparity in the sizes of the subdivisions. Subdivision has significantly increased the number of plots in the layout, the consequence of which is its densification and the multiplication of land rights. Imam and Rostam (2011) reported the subdivision of high density plots (15m× 15m) into two or three plots in Gadon kaya in Kano; a practice that resulted in the subdivision of 214 high density plots into 438 plots.

Table 3: Informal Geometric Changes in Sample Layout

Variable	Geometric Change			
	Subdivision	Extension	Merger	Addition
No. of Designed Plots affected	164	35	7	
% Total No. of Designed Plots	53.24	11.36	2.27	
No. of Subdivisions	1473	99	3	98
Total Area of Subdivisions (m^2)	352633	10803	17811	26952
Mean Area of Subdivisions (m^2)	239	109	5947	275
Range of Subdivisions	30-3503	7-455		24-1928

Source: Field Work, 2018.

Extension

Extension involves the expansion of a plot of land beyond its defined boundaries that results in the encroachment of defined building lines. There are 99 extensions from 35 low density plots. The extended plots took advantage of their proximity to the roads of the layouts to convert portions of the roads to become part of them. The effect of this is the narrowing of the layout roads.

Merger

Merger refers to the fusion of the ownership of distinct adjoining land parcels (or parts of them) changes from multiple to single ownership. The merger of plots in the low density layout affected 7 designed plots whose area is 17811 m^2 (1.98% of the total area of the layout). The average area of the plots after merger was found to be 5947 m^2, more than twice the average size of the designed plots. Two forms of merger were observed: the merger of complete plots (2 instances), and the merger of subdivisions from adjoining distinct plots (1 instance).

Additions

These refer to plots that were not among those in the designed layout plan but which are now evident on the ground. The layout has 98 additions (98) that cover 26952 m^2, average 275 m^2 and range from 24 m^2 to 1928 m^2. The additional plots were created by either reducing the widths of the designed roads or by completely blocking them. Some others were sited within the right of ways of the roads.

Effects of the Geometric Changes

The updated layout plan showed that its configuration has been altered from its designed form through an amalgam of the subdivision, extension, and merger of the plots in the layouts. The need to provide access to the subdivisions has also led to the creation of narrow (usually 6m wide) roads in the middle of subdivided plots. Among the plot mutations, the merger of plots has the least incidence. Its effect is in increasing the sizes of plots beyond their design sizes. The informal change to the sizes of the plots has created a dichotomy between official cadastral records and what obtains in reality. The implication is that the functionality of the cadastral records has been compromised. Besides, the changes revealed the weakness of concerned land agencies in superintending land developments in Bauchi metropolis.

CONCLUSION

In tune with the operative provisions of the contemporary policy framework for land administration in Nigeria, the Bauchi State government has, through its relevant agencies, appropriated, parcelled, and allocated land to different users and uses in form of layouts. In doing this, the layouts were designed to conform to desired spatial objectives as enunciated in land subdivision, use and development guides. It is required that the attributes of the plots as allocated to beneficiaries and recorded in the land registry should not be altered without approval by the government. However, this study found the incidence of unapproved geometric changes which took the forms of subdivision, merger, extension, and addition of plots in a low density residential layout. These changes have altered the configuration of the layout, led to its densification beyond what it was designed to be and created a dichotomy with the records held by the land registry.

RECOMMENDATIONS

To deal with these changes and update the cadastral records, it is recommended that;

i) All the layout plans of the town should be updated using GIS techniques to update the plans which should be used to guide systematic registration of the non-spatial attributes of the plots whose geometries have been informally changed.

ii) The agency responsible for development control should employ GIS techniques to monitor all the developments in all government layouts on a daily basis and appropriate action taken.

iii) The government should enable the land agencies with the required capacities to create and avail appropriately sized plots to the people so as reduce the demand pressure for land in the town.

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