

CADASTRAL MAPPING USING GIS TECHNIQUES IN URBAN DEVELOPMENT

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Abstract

The nature and pattern of growth of a town is a function of its complexity, which could be seen as the most complex of all human habitant because of its highly diversified, heterogeneous, dynamic, transient, fragile and chain-reactionary effects. This chain reactionary effect give rise to the problems of urban decay and rural dislocation which among others include the inefficient management of utilities, retardation in the movement of goods and services, and environmental deterioration has become a common place in most of the nation's urban centres. It is in light of these and other social problems that this paper tends to address using cadastre mapping, alongside the capability of capturing, storing, checking, manipulating, analyzing and displaying data which are spatially referenced to the earth.

Introduction

The nature of urbanization of a town is a function of its complexity and can be seen as the most complex of all human habitat in that it is highly diversified, heterogeneous, dynamic, translucent, fragile and chain reactionary. Urban centres are witnessing what Ayeni (1978), described as unprecedented growth rate that derives from socio-political and economic factors, rapid rate of population growth and rural urban migration. This high growth rate has reared various problems that were enumerated by Mabogunje (1974); include unemployment, lack of adequate social, medically, educational and recreational facilities (problem of serviceability), inability to manage urban facilities effectively (manageability), overutilisation of existing inadequate facilities retardation in the movement of goods and people and environmental deterioration.

Most of the above problems have been researched into with a view to ameliorate urban decadence at one time or the other. Scholars in this research include: Henderson (1978), Mabogunje (1962), Onokerhorayo (1980, 1984), whose works are on population growth and its antecedent problems on the environment. A critical review of the above literatures have shown that most of our urban centers are witnessing unprecedented population growth problems simply because they were not planned and where planned the plans are not strictly adhered to resulting to urban decay and dislocation.

Sequel to the unplanned nature of some of our towns and where planned, plans are not strictly adhered to, has led the author in this paper to revisit the development of urban centers using the process of cadastral mapping which is Geographic Information system(GIS) based.

Cadastre, which is a general systematic and up-to-date register containing information about land parcels including details of their area value and ownership dates back to about A.D800. There are three types of cadastres; fiscal, legal and multipurpose. Fiscal cadastres are essentially used as means of revenue generation, fiscal cadastral has been produced in France for the purpose of taxation (Osayimwese 1989). Legal cadastres are used to determine the legal right of an individual to a land. Originally, the fiscal cadastres were produced for the purpose of generating revenue through land taxation but many of them have become legal cadastres in that they also include records of property interest in the land. Multipurpose or utility cadastres are used as inventories of physical and human resources such as forest, water, pollution, pipeline and underground services and electricity services. This type of cadastre provides reliable information for planning the better use and administration of land (Dale, 1976).

A cadastre is made up of two parts; the first is the written record or register, while the second is a detailed description of the land in the form of a map or survey data. The first part contains information about land such as the name of the owner, location of the land and the area extent. The second part which is the cadastral survey is concerned with the location of the land and its extent. Thus, cadastre answers then question of whose, where, and how much. This paper tends to view cadastre mapping as performing functions of more than mere indications of property owners and

for the purpose of collecting taxes and tenement rates but to include its functionality in the organization, development and maintenance of urban centers to avoid urban decay and dislocation.

Functional Roles of Cadastre Maps in Urban Development

Maps in original provide the necessary information needed to plan, monitor and carry out intelligent logistic work in times of fire and criminal emergencies that may arise within and around an urban setting.

Monmonier (1982), opines that maps provides important information for significant decisions at many levels in line with his view, maps help in considering the course of the past, present, and future events and eventually support the evolvement of policies that could avoid effective urban management.

The following are the functional roles of cadastre maps in an urban development; (1) Land use demarcation: Land use demarcation into different uses is an important cartographic product, which is crucial to a better understanding, development and management of urban environment .land has many attributes and there are many uses into which land is often put. This gives rise to a system of categorization which will make the maximum use of the urban land use to avoid the development of slums, indiscriminate dumping sites e.t.c. There should be no strict rule or pattern of demarcation, this could vary from town to town as topographic constraints such as the geometrical characteristic of individual land forms, relief, drainage, and the general irregularity of the landscape can inhibit the territorial growth of towns. (2.) Layout of streets: As landuse demarcation is in progress the networking of streets are equally laid out. The width of the road, the nature and types of the roads such as major roads, minor roads, walkways and foot paths should be spelt out. In the laying out of streets cadastrally, the names of streets and where closes are included should be spelt out and should be in such a way that the networking of the streets are in connectivity for easy vehicular routing and scheduling with the various landuses and subunits previously demarcated. (3.) Layout of utilities: Utilities as used in the paper are services provided to the public and include gas pipes, water pipes, electricity, waste disposal sites, telephone cables, sewage network and drainage network.. To be added to this category of landuse are security post, postal and fire services, health care centres, bus-stops etc. The layout of utilities come up after landuse and streets demarcation have been done. This is to avoid the destruction of some of these utilities especially those that involved the laying down of pipe after they have been laid down. The end product of cadastre mapping will give rise to "Town Scape Cartography" which can be seen as the aspect of cartography that deals with the design, drawing and production of maps (cadastral) in the development and maintenance of towns.

In cadastre mapping, land may be demarcated based on human activities into different categories such as residential, commercial, industrial, institutional, transportation, recreation and open spaces, vacant land and non urban land. These categories of landuse could further be subdivided into units' plots of different sizes as discussed below.

- (a) Residential Landuse: After earmarking the area or zone to be used for residential buildings, the area can be subdivided into units of plots of different categories such as large plots of 1-2 storey building with vegetated open space, medium plots, mainly of 2 storey building with small individual open spaces, medium plots with mixed 1-2 storey building having small individual open spaces and single storey row houses with common open spaces.
- (b) Commercial landuse: This category of landuse is demarcated to have correlative proximity with residential landuse. The following sub-divisions can be obtained for commercial landuse: Main commercial centre, mini shopping centres and shopping plaza. The mini-shopping centres and plaza should be at trekable distance from residential quarters while the main commercial centre which would further be subdivided into shops could be some few kilometers from residential quarters.
- (c) Industrial landuse: This category of landuse should be at the suburb of the town and can be divided into light and heavy industrial complex areas.
- (d) Institutional landuse: The demarcation pf institutional landuse into subdivisions would include the following: Education (schools, colleges etc) Health centres (hospitals, clinic), Force (Police, military, Navy, and Air force) Religion centre (Churches, Mosques etc) In

- the demarcation of institutional landuse, cognizance should be given to the group of people that would make use of such institution or such an institution would serve.
- (e) Transportational landuse: The demarcation of this landuse will take care of: Bus terminals, Marine terminals, Automobiles parking area and Highways right of way.
 - (f) Recreation and Open spaces: When this category of landuse is demarcated into subdivisions, should include sports ground, parks, beaches, gardens, greenery, hotels and clubs. These are areas meant for the purpose of relaxation and sportive activities.
 - (g) Vacant Land: This is the landuse category that would take care of unprecedented population growth and should be left intact without subdividing it into units because the population growth would definitely lead to the demand of other landuse types besides residential landuse. The aftermath of the data collated on the population that would determine the landuse types that would be allocated to the vacant land.
 - (h) Non-urban land: This category of landuse can not be done away with at the expense of producing food crops and raw materials for the growth of the economy. The demarcation of non-urban land should include: Croppable lands, plantations, forest (primary and secondary forests), sandy areas, and rock/stony areas.

The Place of GIS in Cadastre Mapping for Urban Management

The practical usefulness of geographical information system (GIS) has societal relevance in resource monitoring and management as well as a wide range of socio-economic and political activities.

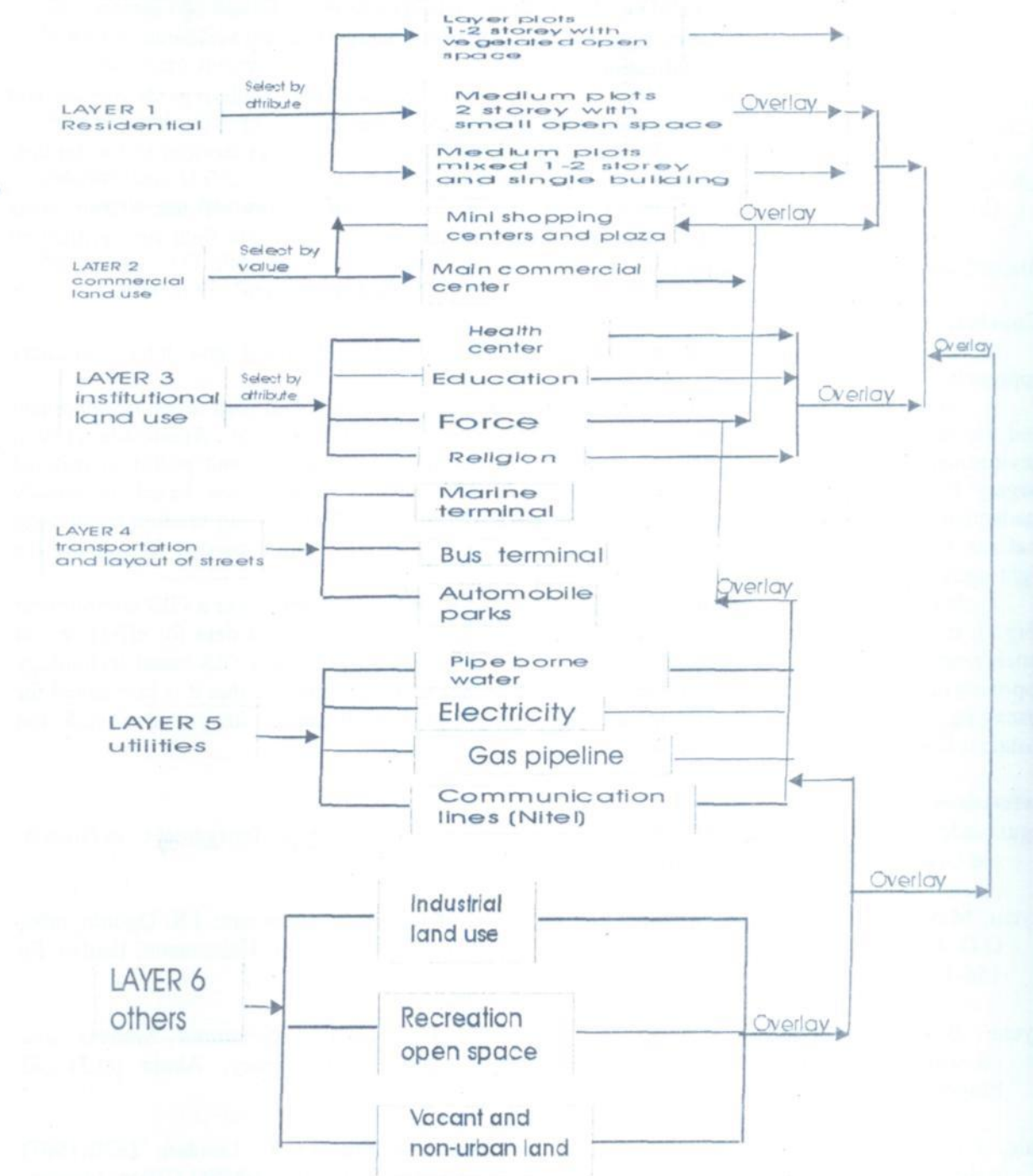
The concept of GIS is a de-mystification of space-based technology, a holistic approach to the knowledge of the total environment with options as to which sector or sub-sector of that environment one desires to lay analytical emphasis. Several definitions of GIS has been offered adopting that of DOE (1987), he sees GIS, as a system for capturing, storing, checking, manipulating, analyzing and displaying data which are spatially referenced to the earth. GIS in itself would be more academic and intellectual exercise if it lacked applicability to the human environment. From this stand point, this paper tends to explore the pragmatic principles of GIS in Cadastre mapping for urban development. A combination of approaches have been favoured i.e. integrated methods that tend to increase gains in overall performances of classifications, thereby enhancing applicability to the human environment (Wilkinson 1995).

Coverage overlays and queries are routine concepts that constantly reoccur in applications of GIS (Ayeni 1998). At this level of application, coverage may defined as a map-like collection that contains recognizable geographic definitions of a feature and its associated attributes and characteristics. An overlay is the process of combining two or more coverage to create new sets of information while querying is an operation that searches the database of a spatial entity with a view to depiction, the attributes of that entity. A query may also be given to search for a specific entity or to look for spatial relationships between one entity and the other. The three operations viz: Coverage, Overlays and Queries in GIS environment are features that enhance the capability of GIS as a tool for decision making and planning in geographic space and are hereby adopted in the conceptual model of cadastre mapping for urban development as shown in Figure 1

Below. Preceding the conceptual model is the attribute data for building the geospatial database of the conceptual model (Table 1). When such conceptual model has been developed for a particular town, it could be named after the town as: "Abuja Geographic Information System".

Table 1: Environmental Attributes for Building Geospatial Database for Urban Management Layer

Layer	Landuse category	Sub-category (attributes)
1.	Residential	i Large plots of 1-2 storey buildings with vegetated open space ii. Medium plots of 2 storey buildings with small open space iii. Medium plots with mixed 1-2 storey and single building.
2.		i. Mini-shopping centres and plaza ii. Main commercial centres
3.	Commercial	i. Health centres ii. Education iii. Forces (Military, Police, Navy, Air force)
4.	Institutional	iv. Religion i. Marine terminals ii. Bus terminal iii. Automobile parks
5.	Transportation & Street layouts	i. Pipe borne water ii. Electricity iii. Gas pipeline
6.	Utilities	iv. Communication line (NITEL) line i. Industrial ii. Recreation & open space iii. Vacant and urban land



From the conceptual data model for urban management, the different layers over each other, give the environmental setting of the settlement a holistic arrangement. When layer 1 is queried in the above conceptual model, residential land use will be displayed, as an entity with its associated attributes of large plots of 1-2 storey with vegetated open, medium plots, 2 storey with small open space and medium plots with mixed 1-2 storey and single storey. A further query of each of the attributes will reveal the number of buildings that is contained therein and in an instance where an attribute table is compiled alongside the conceptual model, the names and the complete information of each occupant can be queried.

In course of querying layer 1, the various layers (2,3,4 and 5) depicting commercial, institutional, transportation and layout of streets and utilities that it has been overlaid with will show the various attributes of those entities giving the environment a holistic view. For independent analysis each entity can also be queried in isolation. Spatial modeling of the environment using GIS

makes it easy to access places of incidents for effective management in the following regards:

- (1) Quick response in times of emergencies during fire out break, theft and accidents.
- (2) Effective refuse disposal collection.
- (3) Prompt detection of points where utilities have faults. Facilities in this regards include laid down pipes for water, NITEL lines, and PHCN installations.
- (4) Serves as an effective means for the distribution of PHCN bills, postal services and water bills to customers.
- (5) Importantly, it would ease census processes; by this the demarcation of enumeration areas could be carried out in the laboratory before if need be, going to the field for verification exercise to ascertain fuzzy boundaries.

Conclusion

Effective and efficient urban management requires an integrated and interdisciplinary approach.

Moreover, without an accurate, up-to-date, comprehensive cadastral map urban development and management would proceed in a haphazard manner. As observed by Agunbiade (1991), environmental problems in Nigeria, such as soil degradation, deforestation and pollution resulted largely from misguided or unguided decisions on environmental resource use based on grossly inadequate environmental data. GIS is a robust, dynamic, versatile, flexible and reliable technology that can be conveniently used to manage and provide the right information needed for making the right decision in tracking, environmental problems.

With the complete mapping of an urban landscape and its modeling into a GIS environment (Fig. 1), it becomes very easy and cheap to up-date retrieve and manipulates data for effective and quick responses in time of emergence. The cardinal reason for advocating a GIS-based technology approach to handling environmental problem with reference to urban setting is that it is best suited for managing environmental information and moreso; it greatly enhances integrated sound and sustainable environmental management.

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