REMAPPING NIGERIA FOR NATIONAL CENSUS: THE CADASTRAL INFORMATION SYSTEM OPTION

By

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The conduct of any national population head count must necessarily begin and should be based on functional maps.

\- Alhaji Shehu Musa
(Former Chairman, National Population Commission)

INTRODUCTION

Population census is a space-related activity. Hence for successful census enumeration to be achieved the spatial dimension of this all-important exercise must be appropriately recognized, understood and taken into full consideration. Historically speaking, the first census in 'Nigeria' was conducted in Lagos in 1871 while the census for the entire country was undertaken in 1911 (Ogunkoya, 1992). Not until the 1973 national census count the role of maps and indeed geographically located data in census surveys was hardly recognized and appreciated. It was only in 1973 that somewhat adequate and elaborate plans were made, and hence adequate cartographic work done, to delimit the whole country into enumeration areas (EAs), though the EAs were not flawless (Adegbola, 1992a).

Many past censuses in this country turned out to be a colossal failure largely due to the inability of the organizers to fully integrate spatial or locational data into the entire process. Owing to the inadequate use of maps showing all legal geographic units in the country such as enumeration areas, districts, divisions, towns, cities, states and zones, many settlements are known to have been omitted during one head count or the other. For instance, as reported by Adegbola (1983), about 539 settlements were omitted in the 1952/53 census, 47 settlements were not counted in the 1963 exercise while 95 settlements were left out in the 1973 census exercise. On the other hand, residents of some settlements that were counted at all had cried foul alleging under-counting of their settlements or over-counting of some other settlements. Hence given such controversial circumstances, some past censuses in the country, notably the 1962 and 1973 censuses, have had to be largely discredited or the results cancelled outright. But the controversies that have often trailed census surveys in the country and the attendant gargantuan economic losses suffered would have been averted if the right things were put in place or done *ab initio*. In particular, the provision and use of enough map-based geographical information would have obviated most of the ugly incidents and failures that characterized past censuses.

Adeniyi (1992) has tried to capture the essence of locational information in census enumeration. In his words:

> In most cases, and in Nigeria in particular, major controversies often arise on the issue of the number of people within different administrative units. While such controversies are dictated by the desire of the people to control, share and utilize the other available resources, the fundamental influence of "location" and the spatial distribution of the people have received very little attention. Notwithstanding the relevance and the significance of the population characteristics, their manipulation for planning purposes depends largely on the ability to relate them to specific location. The topological and spatial aspects of population data processing make the application of the graphicacy concept more central to the planning and conduct of population census.

In most developed and developing countries of the world, the pivotal role maps play in national census survey has been clearly recognized. In Nigeria there is the growing awareness of the importance of maps in conducting a successful census. In fact each subsequent census exercise has often witnessed an improvement of some sort over the previous one in the use of maps. Whatever success that was recorded in the last national population census which took place in 1991 was largely due to the use of functional maps (Ugokwe, 1992). However, it must be pointed out that the maps used in the 1991 exercise, especially the EA maps, had some notable shortcomings. For instance, in some cases certain houses were not shown at all or were shown at the wrong location or on the wrong side of the road. Also on some of the maps linear (graphical) scales were not indicated or were inaccurately drawn, thus making it difficult for the enumerators to correctly estimate distances between buildings or settlements, as the case may be. This was particularly a problematic issue in the rural areas. Some of the maps lacked evidence of professional cartographic touch; hence they looked no better than mere sketches.

In as much as it is imperative to use maps in census surveys, such maps should be functional. To achieve this quality the maps should be made to accurately store and communicate locational, geometric and other ancillary information such as place name, necessary for intelligent and well-guided census exercise. Moreover, the mapped data/information should be complete, clear and simple as well as being easily readable and understandable. This is very crucial, especially given that most of the potential census enumeration map users are likely to have little or no formal training in map reading and interpretation.

Going by the decadal trend of national census surveys the country should have her next census in the year 2001, having had the last one in 1991. However, for now one cannot say with any degree of certainty that the 2001 exercise will be a reality. Nevertheless, for the success of the next census and indeed subsequent ones, there is every need to build a very formidable and robust cartographic database structure. Such a geo-referenced framework will not only facilitate the planning and actual execution of the census but also the accurate presentation and dissemination of the census results. Adeniyi (1992) has identified the lack or inadequacy of spatial database as the source of major errors and high cost of census surveys as well as the difficulty of applying contemporary demographic techniques for inter-censal population estimation.

This paper therefore presents and also makes a case for the adoption and implementation of computer-based parcel level cartographic database as a viable and efficient option for successful census surveys and census mapping. The essential characteristics of the parcel (property) database are briefly discussed. Some of the potential applications of the system to census mapping are equally identified with some illustrations. Also considered are some of the prospects and challenges of creating an appropriate parcel level database for census mapping in Nigeria.

CENSUS MAPPING: Why?

Conducting a population head count without functional maps is akin to groping about in the dark. It is not that maps per se are the magic wands needed to perform extraordinary feats in census surveys. In fact, the mere availability of appropriate census maps does not automatically guarantee superb performance in any head count. However, the absence of or failure to use suitable census maps can effectively mar the smooth and successful conduct of any population census. The unsuccessful stories that have become the lot of most past censuses in the country as earlier pointed out, are cases in point.

The worth of maps in census taking is underscored by the fact that maps are inevitably needed at every stage of the entire census exercise. Looking at the 1991 national population in retrospect,

the National Population Commission (NPC) was entrusted with the onerous task of conducting a generally acceptable national census. However, in order to successfully accomplish this important mandate it became absolutely necessary for the Commission to first do six (6) vital things (Musa, 1992). These were to:

1. locate the population to be enumerated accurately and correctly;
2. identify problems such as terrain, accessibility, etc. that can hinder contact with the population to be enumerated since the method of data collection in Nigeria still relies on enumerators who individually visit every household to fill out a census questionnaire;
3. assess the total work-load;
4. distribute enumerator's workload;
5. ensure complete area and list coverage whereby each centimeter of land area of this country must be enumerated once by one enumerator only in order to eliminate over- and under-coverage;
6. plan for adequate monitoring and supervision of field activities.

Even a cursory look at the above six agenda will quickly unveil the fact that maps were obviously needed to actualize each of the tasks. The NPC equally saw such a need and hence went further to identify the particular type and scales of maps they would require for planning. The maps needed included (Musa, 1992):

- small scale maps showing the major administrative divisions, major physical features and location of cities and towns;
- relatively large scale maps such as topographic and planimetric maps which are required for the delineation of less densely populated areas into enumeration areas;
- cadastral maps for cities and towns;
- plans of towns and cities which are drawn to large scale and thus can be used for enumeration area delineation;
- special maps illustrating the distribution of physical features, transportation, etc.

Broadly speaking, three categories of functional maps are needed for census surveys. These are census planning maps, census execution maps (for the actual head count), and census publication maps (for presenting and disseminating census results) (Balogun, 1992).

Maps and allied products such as aerial photographs and satellite imagery play cardinal roles in the conduct of census and communication of population information. They provide the much needed geographical setting and reference of population figures. In other words, with cartographic and remote sensing products it is easy to display and disseminate vital information relating to the location, characteristics and spatial pattern of distribution of population. Population maps (post-census maps) will enable us to know vividly how many we are, where we are and how we are spread over space, at a given point in time. Such population thematic maps are veritable tools for development planning and resource allocation. They equally provide the vital information needed for making intelligent decisions in the siting of infrastructural facilities. By and large, mapping population data greatly enhances the utility and integrity of census data.

The current state of census mapping in Nigeria leaves much to be desired. Though the National Population Commission through its Cartographic Unit and other related Units, is poised to improve the face of national census mapping, yet there is a yawning gap between expectations and achievements so far made. One only hopes that the Commission would succeed in its bid to computerize census mapping in the country. Almost a decade after the last nation-wide head count the national census atlas is yet to be out, and it is doubtful if that atlas will be published before the next census – Census 2001?! This only goes to show the lamentable state of post-census mapping in the country. For the avoidance of doubt, it has been rightly observed at various times that post-census mapping is hardly undertaken in the country (Adegbola, 1992a; Wokoma, 1998).

It is not just enough to conduct a national population census. The results of such exercise should be promptly communicated to the public in an unambiguous and appealing manner. Census data is quite essential to effective development planning, sound administration and well-tailored people-oriented research work. Without any equivocation, it has to be said that post-census maps are the most effective means of disseminating population census data. The aim of post-census

mapping is to establish the geographic distribution of population and population characteristics so that population maps will be available for all area units (Adegbola, 1992a). This is very important because as Adegbola further reasons, "In this way, regional and local variations of population number and composition will be depicted and it will be easy to engage in demographic analysis of geographic variation in elements of population dynamics. The maps will also provide a factual basis for tackling the practical problems of regional development planning."

It is imperative to point out here that census mapping is equally important for the planning and provision of necessary logistics during census surveys. For instance, Gana (1992) has noted that accessibility problems were encountered in some past censuses in the riverine areas owing partly to non-availability or obsolescence of maps and aerial photographs. Maps provide the base for delineating EAs, thus maps greatly assist in determining the number and allocation of enumerators. More so, maps supply topographic, terrain and accessibility information, which are vital in planning the movement of personnel and materials to enumeration areas.

Given the strategic role maps play in census surveys, various mapping methods have been suggested as means of easing the census exercise in the country. Of particular interest is the grid system (Ogunkoya, 1992). In a nutshell, the grid system involves overlaying an administrative or political map of the country with a mesh of equal sized grid squares. The grid squares could measure $100m^2$ each. Each square then forms a geographic unit (not administrative unit), of census data collection. It follows too that each grid square will form a cartographic unit for mapping the results of the survey.

The grid square system of conducting census sounds rather promising, especially given that, as its proponents claim, it will assist in obtaining accurate data, based on constant small area, devoid of political changes, invariable in time. However, Balogun (1992) has identified some major shortcomings of the grid square method that may make it practically difficult, if not impossible, to implement in Nigeria. One, the system is very expensive to practice. Two, it is difficult to locate the grid lines on the ground even if it is easy to cover the face of a map with grid squares.

This is the era of information technology (IT). Currently, information rules the world. There is every need therefore for Nigeria to develop a computerized geo-referenced database system for census mapping and census surveys. As noted by Wokoma (1998), establishing interrelationships between population, sustained economic growth and sustainable development requires multi-stage spatial data analysis, which is very difficult to achieve without adequate spatially referenced database. To achieve a high level of success in census mapping and census survey in the country the parcel level system option herein presented should be explored. It is a potentially robust, versatile and easy to implement system that will provide spatially referenced information on permanent, small area geographic units for census planning, execution and communication.

THE CADASTRAL INFORMATION SYSTEM FOR CENSUS

Basically, "A cadastre is a parcel based and up-to-date land information system (not necessarily computerized) containing a record of interests in land (i.e. rights, restrictions and responsibilities).... It includes a geometric description of land parcels (usually as a map, but not necessarily) linked to other records... Cadastral systems comprise a land registration system and a cadastral survey and/or mapping system as key components" (Williamson, 1997). Usually, a cadastre has multiple uses. Hence today it is more appropriate to talk about multipurpose cadastre, which Olaleye (1998) conceptually defines as "a framework of land records that supports continuous, readily available, and comprehensive supply of up-to-date information associated with individual parcels of land."

Usually, a multipurpose cadastre is made up of various components, hence different map layers, which are registered to a common coordinate system such as the geographic coordinates (latitude/longitude), UTM rectangular coordinates and State Plane coordinates. The various individual map layers may include those showing Utility lines, land use zoning, parcels, houses, roads, flood plains, addresses, base map, and so on. Our interest here is on the computerized cadastral (i.e. parcel or property) database system, which could be used for the purpose of planning, execution and dissemination of census and census results. The system is conceived to

have relevant and up-to-date spatially referenced information on important geographic entities and population parameters.

In other words, the census mapping cadastral system should have two important database components namely geographic (cartographic) database coupled with the associated attribute database and the population database (Figure 1). Each database component consists of various items that are individually held in separate thematic files. For the purpose of census survey and mapping the items in the geographic file may include separate map overlays of parcels, houses, transport network (roads, streets, railways, footpaths), addresses, significant physical landmarks, administrative (political) boundaries, and relief. These various map layers should share a common identification (ID) code that could be used to link them up as well as a common geodetic reference framework (coordinate system) that will allow two or more of the layers to be properly registered during any overlay operations.

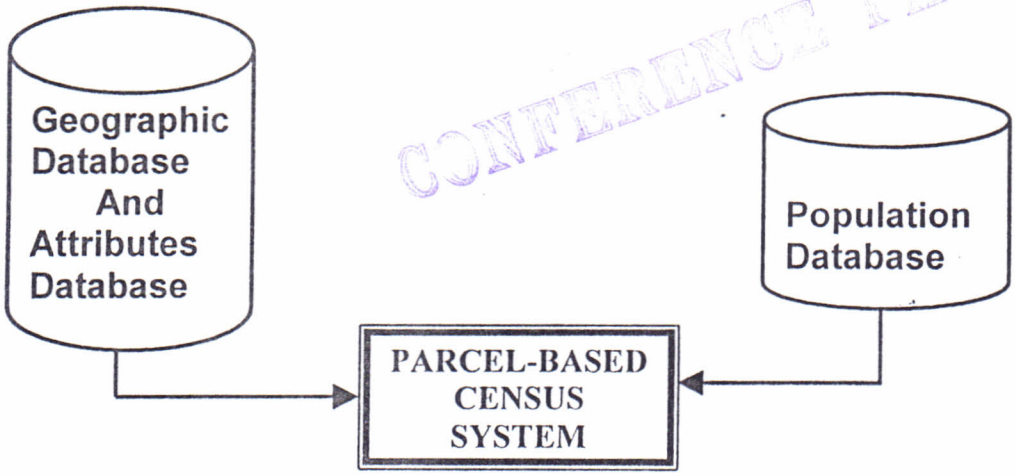

Fig. 1 Components of a cadastral system for census mapping

Furthermore, the attributes pertaining to each of the items in the geographic files should form part of the system. For instance, a feature such as a parcel will have attributes like size (area), shape, number of buildings on it, number of households, number of people, and so on. A building (house) will have such attributes as size, shape, number of floors, number of rooms, number of households, number of people, house number (street address), house code (NPC code), and so on. Each attribute will be linked with its geographic entity using a meaningful ID.

The population database component of the system will contain statistical data on such demographic parameters as age, sex, occupation, marital status, employment status, religion, ethnic/tribal affiliation, state of origin, nationality, literacy level, income, number of people in household, number of rooms occupied, and so on. For the purpose of geographical referencing, mapping and spatial analysis, each piece of data in the population database will be linked with the specific geographic area (parcel) unit in the geographic database to which it relates. This linkage could be achieved using a code (ID) shared in common by the population data and its associated geographic unit. The linkage mechanism makes it possible to simultaneously manipulate both the geographic database and the population database, for some desired results. It must be noted though that at will, each of the databases can be manipulated separately. However, if the population database is manipulated independent of the geographic database the outcome of such operation cannot be displayed in map form.

CENSUS APPLICATIONS OF THE CADASTRAL SYSTEM

The potential applications of the cadastral system to census surveys and mapping are quite numerous. With the system it is possible to present at a micro level (parcel level) useful information needed for population activities and other related issues. The system has much relevance to and indeed has the potentialities to enhance both pre- and post-census mapping. Some of the important pre-census activities that could be effectively undertaken using the geo-referenced data/information provided by the cadastral system include:

(i) conducting census of houses (housing survey);
(ii) identification of the precise location of the population to be enumerated;
(iii) making logistic arrangements;
(iv) evaluation of the over-all workload;
(v) objective delimitation of enumeration areas (EAs) and supervisory areas (SAs);
(vi) equitable sharing of workload among enumerators and supervisors;
(vii) estimation of the amount of resources (personnel and materials) needed;
(viii) identification of potential mobility (accessibility) problems.

The cadastral system can equally provide vital geographically located information for undertaking post-census activities such as:

(i) verification/validation of census returns;

(ii) data analysis;

(iii) inter-censal population estimation;

(iv) generating parcel level thematic maps showing important demographic components such as:

- total population per building/parcel;
- number of rooms per building/parcel;
- number of houses per parcel;
- number of households per parcel;
- number of adult males;
- number of adult females;
- number of children (males/females);
- age distribution;
- sex composition;
- room population density;
- house population density;
- type of housing structure;
- marital status;
- religion;
- ethnic composition;
- literacy;
- employment;
- occupation.

Figures 2 and 3 are demographic maps illustrating the utility of the cadastral database system in census mapping. The maps show the layout of a section of Alagomeji in Yaba, Lagos. The demographic figures used were hypothetically generated while credit is due to Uluocha (1999) for the base map.

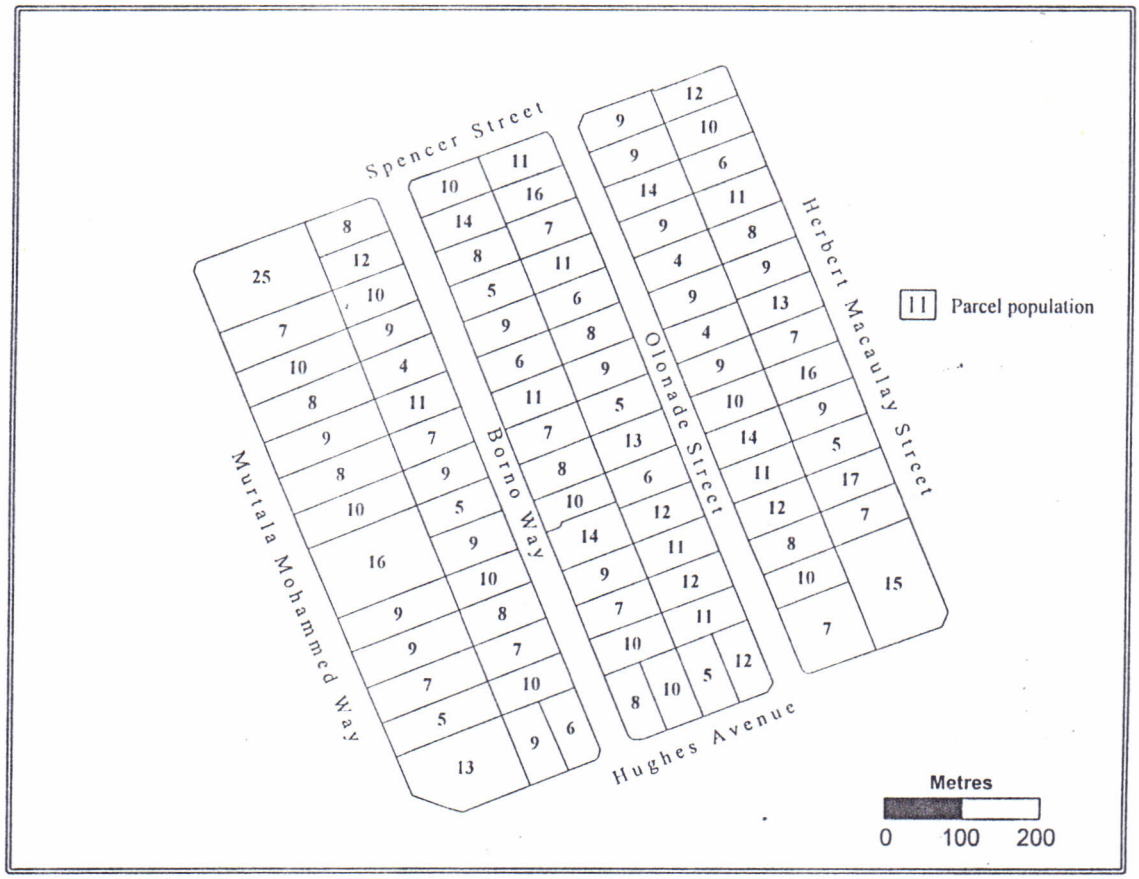

Fig. 2 Total number of people per parcel

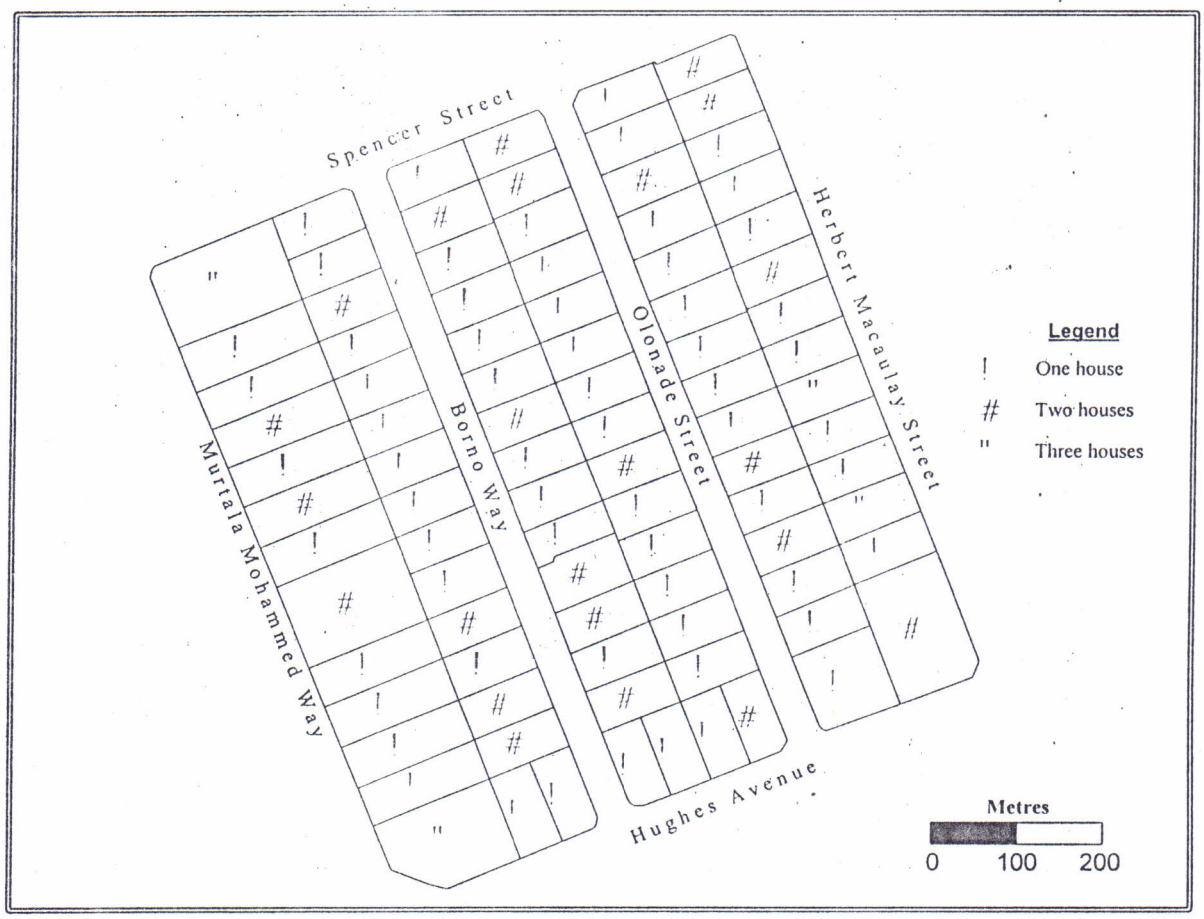

Fig. 3 Number of houses per parcel

BENEFITS OF THE CADASTRAL SYSTEM

Owing to space constraint it will not be possible to fully highlight and discuss in this paper the whole gamut of benefits accruable from using the parcel level system for population census. What follows therefore is a brief attempt to pinpoint some of the salient potential benefits of using the system.

- Parcel-based census mapping will serve to provide population information at the level of a small, specific geographic unit. This will make for more detailed and accurate

development planning and resource allocation. Moreover, as Ogunkoya (1992) has pointed out, for the guidance of planners and for the advancement of knowledge in general, population statistics should relate to small units, constant in area, invariable in time, and having, as far as possible, a small range in population totals.

- The cadastral system will greatly facilitate housing survey. Information on housing, if available for small areas such as parcels, provide measures of housing quality, rooms per household/measures of overcrowding, type of housing structure, energy sources and characteristics of each locality (Adegbola, 1992*b*). Equally, the information on housing units provided by the system could be used for inter-censal population estimation. More so, since the system can provide information on virtually every person in the country, the workload of the NPC will be significantly reduced. As observed by Onyeka (2000), by having all required information on persons living in any area, the job of census officials would be reduced to a matter of compiling these already available details.

- With the parcel level system it is possible to show every dwelling unit within each EA, thus guiding the enumerator to count everybody in each house within his or her own area. In this way, the problems of over-counting and under-counting (possible owing to omission of some dwelling units) will be drastically reduced if not totally eliminated. Similarly, since the system will make it possible to indicate the street name and number of individual houses, this will help eliminate the difficulty in locating some buildings as a result of improper house numbering. All these will make for adequate geographical coverage by ensuring that all individuals, dwelling units and settlements are enumerated. Adequate geographical coverage is one of the most important factors that determine the quality of census returns generally (Adegbola, 1992*b*).

- Conducting census on parcel or property basis will make it possible to obtain population data that is geo-coded. Such spatially referenced data can thus be easily integrated into geographic information systems (GIS) for spatial and statistical analyses as well as thematic mapping. Besides, since the system is computer-based, it becomes easier to update, query, retrieve, sort and analyse population data.

- The cadastral database system of census mapping makes it possible to present population data at a micro-level. Population data presented at the parcel level eliminates high degree of generalization, which could lead to bias or loss of vital details. Decisions based on over-generalised data could be misleading and less useful, for some activities. Post-census maps produced in the country are usually generalized maps, hence they do not allow for the identification of any household or association of it with any set of data (Balogun, 1992). But we need large scale maps that can display information relating to individual dwelling units for household analysis and so on. Post-census parcel level mapping will quickly reveal the spatial pattern of local variations of population characteristics. This no doubt will in turn greatly enhance micro planning for the provision of infrastructural facilities and other social amenities.

IMPLEMENTATION CONSIDERATIONS

It is instructive to note here that the implementation of the cadastral information system for census planning, enumeration and mapping could be confronted with some challenging issues. To all intents and purposes, the parcel level database system could be somewhat expensive to implement at the initial stage, especially given the enormous volume of cartographic work to be done. Implementing the system, just like any other computerized multipurpose cadastral system, will obviously involve incurring both direct and indirect costs in relation to the acquisition of equipment and other facilities, manpower training/retraining, enlightenment campaign, and so on (Macbeda, 2000). However, the exorbitant start-up capital notwithstanding, in the long run the method will surely prove to be cost-effective. The accuracy, completeness and reliability of the census results obtained through the method will more than compensate for the money expended. Through the system accurate and widely acceptable census results will be achieved. From the social, economic and even political perspectives it makes far more sense to acquire an accurate data through an expensive means than to acquire an error-ridden data through a cheap means. For decision-making and development planning purposes, an errant data set is even more dangerous to use than an expired drug or a medical quack.

One other notable issue that is most likely to challenge the successful implementation of the parcel level system of census activities in the country is the notorious dearth of reliable and accurate mapped cadastral data. Presently, only a few Nigerian urban centers have cadastral maps. Even at that, most of the existing cadastral maps are either outdated or not properly referenced (Uluocha, 1998 and 1999). Besides, there is yet a lack of appropriate reference framework on which the indispensable cadastral surveys will be anchored (Agajelu; 2000).

CONCLUSION

Obtaining accurate population figures of Nigeria has so far proved elusive. Most censuses conducted in the country were anything but successful. Admittedly, several political, economic and ethnic/tribal factors were contributory to the failure of most of the past attempts made to obtain widely acceptable figures for Nigeria. However, one outstanding yet surprisingly largely unrecognized or ignored factor that has made every other census exercise in the country to meet its waterloo is the crass neglect of geographically located information in the planning and execution of census. Today, at the very dawn of the 21st century, we cannot boast of knowing just how many we actually are and where exactly we are located within the confines of the geographical entity called Nigeria.

We have no option but to have accurate, comprehensive and up-to-date information about our population – the total amount, characteristics and spatial distribution. Population information is an essential resource without which it becomes extremely difficulty to effectively and efficiently plan for the equitable and sustainable allocation of other resources, for economic development and overall well-being of the people. But for population information to be utilized census data must first be acquired, processed, analysed and disseminated at a micro-level and in a spatial context. For this and many other reasons, the parcel level cadastral information system is considered a most viable alternative for census survey and mapping in Nigeria. A censal (census) cadastre will not only present a virile pedestal for improving both pre- and post-census activities, but will also make it possible to acquire and present accurate, complete and generally acceptable census data at the level of a small geographic area unit (i.e. the parcel). Mapping and presenting

demographic statistics at the level of a spatial unit as small as a parcel will definitely enhance the utility value of such data.

There is therefore every need to re-map Nigeria for national census and national development. Such re-mapping exercise, which expectedly will be a large-scale project, should lead to the creation of a computerized multipurpose cadastre for the entire country. Apart from population census activities, the national multipurpose cadastre could equally be applied in other areas such as public Utility management, tenement rate administration, land resources management, environmental management, and so on. The strength of a multipurpose cadastre basically lies in its ability to store and provide timely, geographically specific, accurate and useful information for management decision-making (Uluocha, 2000). A national interdisciplinary, multi-sectoral body should be inaugurated to develop a functional multipurpose cadastre for the country. The body should comprise of experts drawn from the Federal Surveys, the National Population Commission, cartographers, land surveyors, academics, remote sensing and GIS experts and allied disciplines and professions.

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