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Achieving Integration of Nigerian Cadastral and Topographic Information Systems Based on the German Aaa Model

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Abstract- Now more than ever before data integration has become a very important issue because of the problems associated with heterogeneous geospatial data. It is almost impossible to handle heterogeneous data in a coherent manner because different data sets have different methods of acquisition, different representations, different resolutions and quality, and are based on different data models. Analysis of different data sets becomes difficult and data sharing almost impossible. Germany successfully integrated their topographic, cadastral, and geodetic data sets into a single application schema called the AAA data model. This ensured standardization and the elimination of redundancies leading to coherent analyses and data sharing. In Nigeria, the national mapping agency is the custodian of topographic and geodetic data sets while cadastral data sets are the responsibilities of the various state governments as stipulated in the Nigeria Land Use Act. There is no harmonized system of spatial data management, leading to difficulties in data sharing and other related problems. The goal for Nigeria is to achieve integration which will allow for the exchange of data stemming from different sources, different representations and structures, and thus establish the base for performing combined, integrated analyses, leading to the development of a national spatial data infrastructure which is a sine qua non for sustainable national development and good governance. This paper examines the possibility or viability of the integration of Nigerian cadastral and topographic data sets based on the German AAA data model. The paper also highlights the immense contribution such integration can make to the management of geospatial information in Nigeria. It concludes by challenging the Office of the Surveyor-General of the Federation (OSGOF) to be the catalyst for achieving integration of these fundamental data sets.

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I. Introduction

Although in geo-scientific applications the topography of the Earth surface and thus topographic data sets constitute a common base for most related data sets, discrepancies and even disagreements often arise when inspecting one and the same object in different data sets. This is visible when superimposing different data sets of identical objects in reality. The reason is that the different data sets are typically based on different data models and have been collected for different purposes (Butenuth *et al.*, 2006). Thus, different aspects of reality are important and have consequently been mapped. Also, different sensors are being used, data acquisition takes place at different dates, data representation differs (for example, in terms of vector and raster data), and so does the resolution and the quality of data.

Data integration is a big issue today when more and more digital data sets are being collected and made available. Due to the heterogeneity of the data sets, it is complicated and sometimes even impossible to handle them in a coherent manner. The integration of inhomogeneous data is therefore becoming more and more important. The benefits of such integration include:

i. To use the stored data for various purposes and applications. For example, the information which is not contained in one data base may be available in another.
ii. To complete and enhance the data bases thematically. For instance, from the integration of a data set with another one, new thematic information can be derived.
iii. To automatically verify the stored data regarding their quality, to correct them and improve their accuracy.
iv. When integrated data sets are standardized, they ensure sharing in a framework such as the Geospatial Data Infrastructure.

Basically, this means that new data acquisition – typically the most expensive part of spatial analysis tasks – can be largely reduced and is only required if no data are available or changes in the reality have occurred. Consequently, a considerable saving of cost and labour is achieved by adding significant value to the existing data. The challenge for Nigeria is to establish appropriate institutional and organizational infrastructures to manage the integration of topographic mapping and cadastral information into a coherent land administration system for sustainable development.

II. Motivation

Cadastral and topographic data sets have been identified as parts of the fundamental data sets of any country. Fundamental data sets are sometimes referred

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to as core or foundational data sets. The National Geo-information (NGI) Policy document (2003) defines fundamental data sets as data sets with national coverage needed consistently by more than one government agency in order to achieve their objectives; or a data set that cannot be derived from another data set and other agencies derive significant benefit from using it. This implies that fundamental data sets are required for national development. The NGI Policy (2003) lists the core data sets to include geodetic control database, topographic database/DEM, digital imagery and image maps, administrative boundaries data, cadastral databases, transportation data, hydrographic data, land use/land cover data, geological database, and demographic database.

The cadaster as a land information system is very important for social and economic development. Enemark (2004) lists some of the benefits of a cadastral system to include identification of land parcels and securing land rights, facilitating land registration, land valuation, and land use control, and a foundation for sound land management. It is therefore crucial that governments invest in appropriate cadastral system development as the traditional systems are no longer adequate to support the sustainable development and to stimulate land markets (Tuladhar, 2003).

Germany has successfully developed a common AAA-application schema for AFIS (the official geodetic points information system), ALKIS (the official cadastral information system), and ATKIS (the official topographic-cartographic information system) based on the AFIS-ALKIS-ATKIS Reference Model for the basic geo-data sets of all public surveying and mapping authorities in Germany (Muller and Siebold, 2007). ALKIS combines the digital cadastral information system ALK (Automated Cadastral Map) which mainly represents geometric features like parcels, buildings, etc. and the Automated Land Register (ALB) where all the titles of the land records exist. ALKIS was launched in order to harmonize the cadastral information and the topographic data base ATKIS. ALKIS and ATKIS formed the new data model. But by integration of the geodetic reference points as well, AFIS becomes another part of the data model. Thus it is called the AFIS-ALKIS-ATKIS data model or the AAA data model.

The advantages of the AAA model are the integration of the spatial reference system, the real estate cadaster, and topography in one AAA-application schema, the harmonization of cadastral and topographic data, and the facilitation of the data exchange process. AAA contains descriptive and illustrative data in several product groups and will enable the surveying authorities to provide their customers in business and administration with data of high quality.

In Nigeria, such a harmonized system of spatial data management does not exist. The Office of the Surveyor-General of the Federation (OSGOF) have the constitutional mandate to produce topographic data sets and to act as custodians (NGI Policy, 2003), while cadastral data sets are the responsibility of individual state governments. These data sets are therefore fragmented and scattered. There is limited or no computerization of records, weak links between the two components of 'land registration' and 'cadastral mapping', and deficiencies in financial, administrative, and organizational issues. Some of these deficiencies include the use of paper records which are often incomplete and poorly organized, lack of a system to detect multiple registration of land, lands not properly surveyed and demarcated (plans mostly descriptive), susceptible to fire/destruction, difficult to manipulate data, etc. These deficiencies/weaknesses create a lack of security for land owners and authorities, resulting into:

i. Poor conditions for land credit (mortgaging)
ii. Problems for a transparent land market
iii. Arbitrariness, corruption, and political disturbances.

Set against these considerations, this paper will highlight the crucial role of an integrated spatial information system to sustainable development, examine the German AAA data model and its successful implementation, examine the viability of integration of cadastral and topographic data sets in Nigeria based on the German AAA model, and highlight the requirements for such an integration, its advantages and the possible challenges that may hinder a successful integration.

III. The Role of the Cadaster in National Development

a) Definitions of the Cadaster

Land is one of the most important financial assets in a country. Every investment in one way or the other is dependent on land. Land entails such concepts as ownership, use, and value (figure 1). Land administration refers to the processes of recording and disseminating information about the ownership, value, and use of land and its associated resources. Such processes include the determination of (sometimes known as the "adjudication") of rights and other attributes of the land, the survey and description of these, their detailed documentation and provision of relevant information in support of land markets (Dale and McLaughlin, 1999).

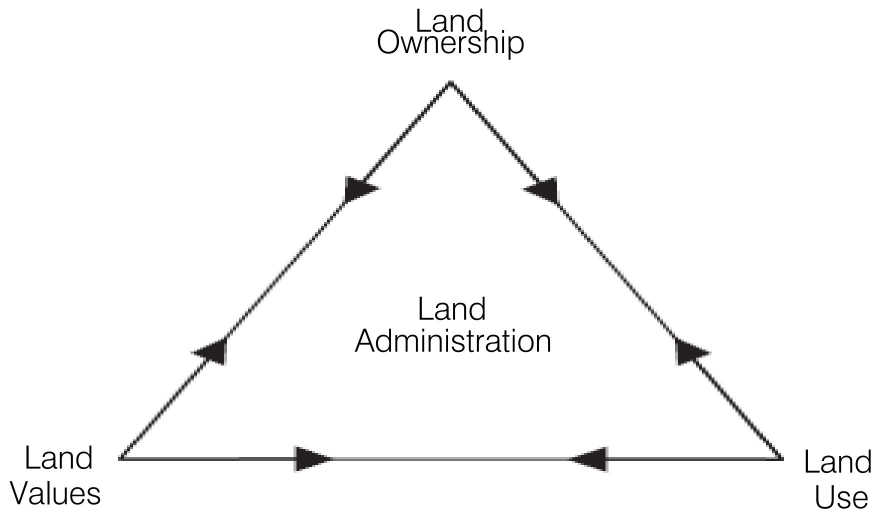

Figure 1: Land – ownership, values, and use (Dale and McLaughlin, 1999)

The cadaster is at the core of land administration. The cadaster has been variously defined by different authors. Dale and McLaughlin (1989) defined the cadaster as a parcel-based land information system where data are organized around the cadastral parcel. The cadaster therefore provides data concerning such matters as land ownership, value, and use, with the cadastral records consisting of maps and text.

The International Federation of Surveyors (FIG, 1995) defines a cadaster as a "parcel-based and up-to-date land information system containing a record of interests in land (e. g rights, restrictions, and responsibilities). It usually includes a geometric description of land parcels linked to other records describing the nature of the interests, ownership or control of these interests, and often the value of the parcel and its improvements. It may be established for fiscal purposes (valuation and taxation), legal purposes (conveyancing), to assist in the management of land and land use control (planning and administration), and enables sustainable development and environmental protection".

Enemark (2004) adopts the FIG definition but argues, however, that it makes sense to talk about cadastral systems or cadastral infrastructure rather than just cadaster. These systems or infrastructure include the interaction between the identification of land parcels, the registration of land rights, the valuation and taxation of land and property, and the control of present and possible future use of land. The cadaster provides the spatial integrity and unique identification of every land parcel usually through a cadastral map updated by cadastral surveys. The parcel identification provides the link for securing rights in land, controlling the use of land, and connecting the ways people use their land with their understanding of land (Enemark, 2009).

IV. Types of Cadaster

Dale and McLaughlin (1989) classified cadasters according to the information they contain or the primary purpose for which they have been developed. Based on these, 3 types of cadasters were recognized:

i. *Juridical cadaster*– which serves as a legally recognized record of land tenure. This is made up of two parts: written record or register (text), and the geometric records in form of maps or survey measurements.
ii. *Fiscal cadaster*– which is developed primarily for property valuation
iii. *Multi-purpose cadaster*– which encompasses both the fiscal and the juridical with the addition of other parcel-related information.

The International Federation of Surveyors (1995) classified cadasters in many ways, e. g by:

i. Primary function (e. g supporting taxation, conveyancing, land distribution, or multi-purpose land management activities).
ii. The types of rights recorded (e. g. private ownership, use rights, mineral leases).
iii. The degree of state responsibility in ensuring the accuracy and availability of the data (e. g. complete state mandate, shared public and private responsibility).
iv. Location and jurisdiction (e. g. urban and rural cadasters, centralized and decentralized cadasters).
v. The many ways in which information about the parcels is collected (e. g. ground surveys tied to geodetic control, uncoordinated ground surveys and measurements, aerial photography, digitizing existing historical records, e. t. c.)

Enemark (2004) recognized that the cadastral system is changing over time as a response to general trends in societal development. In line with this, he identified four phases of the evolution of the cadastral system:

i. *Feudalism:* 1800 (land as wealth)– fiscal cadaster (land valuation and taxation paradigm)
ii. *Industrial revolution:* 1800– 1950 (land as a commodity)– legal or juridical cadaster (land market paradigm).
iii. *Post-war reconstruction:* 1950– 1980 (land as a scarce resource)–managerial cadaster (land management paradigm).
iv. *Information revolution:* 1980 – to date (land as a community scarce resource)–multi-purpose cadaster (sustainable development paradigm).

V. Importance of the Cadaster

Dale and McLaughlin (1989) highlighted some of the benefits of a cadastral system to include certainty of ownership, security of tenure, reduction in land disputes, improved conveyancing, stimulation of land markets, security for credits, monitoring of land markets, facilitating land reforms, support for land taxation, improvements in physical planning, recording of land resource infrastructure, e. t. c.

Cadasters provide the location or place for many activities in the built environment through the cadastral map (Williamson, 2008). Cadastral systems provide a basic land information infrastructure for running the inter-related systems within the areas of land tenure (land rights, legal means leading to social stability, economic growth, efficient land markets, and security of tenure and investment). The cadaster is the primary means of providing information about property rights (FIG, 1995). Specifically, the cadastre provides the private and public sectors with:

i. Information identifying those people who have interests in parcels of land
ii. Information about those interests (e. g. nature and duration of rights, restrictions, and responsibilities)
iii. Information about the parcels (e. g. their location, size, improvements, value).

The cadaster forms part of the base data required in any land information system. Since information about land parcels and land holdings is often needed by many different users, having a unified, standard cadaster for each jurisdiction helps to avoid duplication and assists in the efficient exchange of information. Hence a national cadaster has been identified as the engine room of the entire land administration system, underpinning a country's capacity to deliver sustainable development. Enemark (2009) argues that the cadastral map is a tool that represents the human scale of land use and how people are connected to their land. The digital cadaster is a representation of the human scale of the built environment, and the cognitive understanding of land use patterns in people's farms, businesses, homes, and other developments, then form the core information sets that enable a country to build an overall administrative framework to deliver sustainable development.

Williamson and Wallace (2007) identified the cadaster as being at the operational core of a land administration system (LAS). They argue that modern digital cadasters are much more central to governments because they are spatially enabled and allow computers to accurately identify where a feature, such as a street or house, is on the globe. They change computerized data into intelligible, people-friendly information and present it in visual (picture) formats. By adding geo-coded addresses, cadasters can show how parcels of land are arranged into properties and businesses.

All modern economies recognize the importance of the cadaster as being central to a successful Land Administration System (Williamson *et al.*, 2006). The cadaster provides a spatial integrity and unique identification for land parcels within a system. Critically, it provides the spatial component for LAS and more particularly the location and place dimension with the most useful output being a geo-coded street address of each property. Simply, the cadaster is the central component in spatially enabling government. It is destined for a much broader role as fundamental government infrastructure equivalent to a major highway or railway though it was created on behalf of tax payers merely for better internal administration of taxation, and, more recently, titling of land in support of more efficient and effective land markets (Williamson, 2008). Without these digital facilities, modern governments cannot understand the built environment of cities, manage land competently, and utilize computer capacity to assist policy-making, or retrieve significant value out of land.

Therefore, integration of such an essential component of a nation's spatial information with the topographic and geodetic components is necessary for sustainable national development. Germany have successfully integrated these three components in the AAA data model and they provide Nigeria with a platform on which we can explore the viability and possibility for such an integration,

VI. The German AAA Data Model and its Benefits

Germany recognized certain deficiencies and shortcomings in their cadastral and topographic information systems and their applications (Muller and Siebold, 2007). Some of the deficiencies or deficits identified included:

i. Model description and feature catalogues were only in text documents
ii. Lack of integration of graphical and attribute data
iii. No semantic harmonization of cadastral and topographic data
iv. Difficulties in realization of cartographic aspects, and lack of data modeling between cadaster and topography
v. No concept to integrate additional data (metadata, quality data), no versioning/historical data, and no standardized notation of the data models and the exchange structure
vi. Redundant data within the cadastral application (ALB and ALK), as well as between ATKIS and the cadaster
vii. Implemented with old-fashioned software and hardware

There was therefore the need to combine these applications into one common application schema in order to reduce or avoid the noted or existing deficiencies. The new data model was designed to ensure:

i. Standardized and to a large extent redundancy-free object view
ii. Standardized notation and encoding
iii. Integration of additional data (metadata, quality data)
iv. Management of different temporal versions of the same object
v. Inclusion of cartographic information

In Germany, geo-base data were available in 3 data sets: Authoritative Topographic-Cartographic Information System (ATKIS); the Official Cadastral Information System (ALKIS); and the Official Geodetic Points Information System (AFIS). The three geo-data sets were integrated into one data model called the ATKIS-ALKIS-AFIS (AAA) data model. The AAA model now serves as a standardized basin for specialized information systems.

a) Authoritative Topographic-Cartographic Information System (ATKIS)

ATKIS was developed to establish and maintain uniform topographic geo-data bases at the federal level and aims at the provision of digital models of the Earth's surface suited for data processing (Gundelsweiler and Bartoschek, 2007). It is used as a base for spatial reference and for the linkage to and combination with thematic geo-data. The ATKIS describes the surface of the Earth with digital landscape and terrain models. The topography (landscape) includes settlements, transport networks, vegetation, water, terrain, boundaries of political and administrative units with names, etc. There are four main data sets (Hintze and Lakes, 2009):

i. Digital landscape models (DLM)
ii. Digital elevation models (DEM)
iii. Digital topographic maps (DTM)
iv. Digital orthophotos (DOP)

b) Official Cadastral Information System (ALKIS)

The ALKIS provides the official list and proof of land property and ownership where parcels of land and buildings are listed and described (Hintze and Lakes, 2009). It also provides basic functions for legal services, administrative and economic. It handles identification of land values, environmental and nature conservation considerations, and integrates official house coordinates data sets. It also provides the basic data for Spatial Data Infrastructure (SDI). ALKIS is made up of:

i. The ALK (real estate maps or digital cadastral maps) – covers property and real estate in the form of maps, location and geometry of the real estate, and individual parcels of land and their borders, the buildings, type of land use and its borders, etc.
ii. The ALB (real estate cadaster book or digital cadastral register) – identification, area and position description; public law provision for areas such as nature protection areas; and for tax purposes and property ownership.
iii. The HK – official house coordinates

c) Official Geodetic Points Information System (AFIS)

AFIS contains information about the geodetic points and their spatial references. Reference points for location, height, gravity, and reference stations for Global Positioning Systems (GPS) are integrated (Hintze and Lakes, 2009).

d) Benefits of the AAA Model

The main goal of the AAA model is to integrate cadastral information (ALKIS), geodetic information (AFIS), and topographic information (ATKIS) into a new model, into one single application schema (Muller and Siebold, 2007). The AAA-Reference Model for the basic geo-data sets of all public surveying and mapping authorities in Germany has been developed by the Working Committee of the Surveying Authorities of the States of the Federal Republic of Germany. Some of the benefits derived from this include:

i. Integration of the spatial reference system, the real estate cadaster, and topography in one AAA application schema
ii. Harmonization of cadastral and topographic data as a base for the modeling of application-specific themes
iii. Integrates the data management of historical data (data versioning)
iv. Defines metadata and a standard-based Data Exchange Interface (DEI) based on Geography Mark-up Language (GML)

v. Lays the foundation for a broadly applicable geo-data base, which can be the impulse for the implementation of a beneficial and also economically successful National Spatial Data Infrastructure (NSDI).

VII. Achieving Integration in Nigeria

a) *The Need for Integration*

The geo-data infrastructure described above is a must for a modern state. In Nigeria at the moment, geo-information is acquired and stored mostly in analogue form by various agencies of government such as Ministries of works, environment, etc., and by the private sector for their own use and applications with attendant problems of unnecessary overlaps and duplication, lack of accountability, and varying standards and formats (NGI Policy, 2003). The Office of the Surveyor-General of the Federation (OSGOF) has the constitutional mandate as custodians of topographic and geodetic data while cadastral data are in the custody of the various state governments (NGI Policy, 2003). The aim is to achieve an object-related data integration which will allow for the exchange of data stemming from different sources, different representations and structures, and thus will establish a base for performing combined, integrated analyses. Secondly, the integration of topographic, cadastral, and geodetic data sets is a sine qua non for the development of a functional National Spatial Data Infrastructure (NSDI) for Nigeria since cadastral and topographic data sets are basic elements of an SDI. With the integration, a fundamental technical and practical contribution for the NSDI would become available. In this vein, Enemark (2004) argues that Land Information should be organized to combine the cadastral and topographic data, and hence as a spatial data infrastructure at national, regional/federal and local levels based on relevant policies for data sharing, cost recovery, access to data, standards, etc. Thirdly, integration of these data sets will contribute to the local and national strategic agendas of economic growth, social cohesion and well-being, environmental sustainability, and good governance. Wide availability of more accurate, timely, and accessible data will facilitate better planning, better governance by providing citizens with richer information, and will support economic growth through enhanced resource planning, and therefore improved decision-making.

b) *Requirements for Achieving Integration*

For Nigeria to achieve the integration required for sustainable national development, certain steps must be taken. Some of the key steps include:

i. Need for development of a consistent and transparent legal and policy framework leading to planning, development, and maintenance of a national geospatial data infrastructure as a statutory infrastructure. For example, development of a geo-portal for data access.

ii. Education and broader capacity building to ensure that both the skills required to make best use of spatial information are available, and key decision-makers are aware of the value of this infrastructure

iii. Staff of the national mapping agency (OSGOF) will need to be retrained to acquire multidisciplinary skills. For example, the use of standards which is important for implementation, such as following the rules of ISO and use of "standardized" modeling language (UML).

c) *Challenges of Integration*

The major challenge of integrating the Nigerian cadastral and topographic information systems involves the way the Nigerian Land Use Act is structured. At the beginning of the 20th century when Britain made a colony and protectorate of Nigeria, there was a multiplicity of land tenure systems in the country. Apart from the system in the Lagos colony where an English freehold system had been established following its annexation in 1861, these diverse systems can be grouped broadly into two (Olakanmi and Co., 2009).

The first obtained in northern Nigeria where the colonial administration had placed all lands under the control and subject to the disposition of the Governor. Without the consent of the Governor, no title to occupation and use of land was valid. The Governor was to hold and administer the land for the use and common benefit of the native peoples. Any native or native community lawfully using and occupying land in accordance with native law and custom enjoys a right of occupancy and no rent is paid in respect of such rights. By contrast, in southern Nigeria, the second system recognized that land was owned by lineages or extended families. Individuals have only right of use on such family land. The only land held at the Governor's disposal was that which had been expressly acquired for public purposes as Crown land. It was not surprising, therefore, that faced with these contrasting land tenure systems and the considerable hassle in getting land for public purposes especially in southern Nigeria, the Military government sought to unify the two systems through the Land Use Decree of 1978 (Olukanmi and Co., 2009; Kenneth, *et al*., 2010; Otubu, 2010; Nuhu, 2011).

The Land Use Act, the major land statute in Nigeria, confers the right to allocate land on individual state governors. As it stands, land use/allocation is subject to political interference. Governors use their powers as conferred on them by the land use act to settle political scores, compulsorily acquire land belonging to their opponents or at other times revoke their certificates of occupancy, or delay granting consent on the issuance of such rights (Kenneth *et al*., 2010). The shortcomings and weaknesses of the

Nigerian Land Use Act of 1978 have to do with corruption and abuse of power by the state governors or their representatives. There is a stringent call for the amendment of the Land Use Act to reflect a modern system that is geared towards the generation of land markets, digital cadastres and sustainable social, economic and environmental development. Bennett *et al*. (2013) argues that good governance, transparency, social inclusion, effective disaster management, and spatially enabled societies, amongst other things, are more difficult to achieve if static, inadequately funded land administration systems prevail.

d) Digital Cadasters Required for Integration

Digital cadasters ensure security of tenure and land rights of citizens. This is an important foundation for economic development. The traditional systems of land administration are no longer adequate to support sustainable development and to stimulate land market (Tuladhar, 2003). For many of these, land titles are the main sources of land collaterization for obtaining credit from informal and established institutions. Consequently, securing land rights and land titles is particularly relevant for all socio-economic classes in the nation's economy but especially to the farmers whose pervasive poverty to date derives from not having definitive property rights appropriate to a market economy. Furthermore, fees and taxes on such landed properties are very important sources of revenue for governments. However, a large share of land in the country is not formally registered while informal titles cannot be used in obtaining loans hence limiting financing opportunities for businesses, especially small and medium-size enterprises (Nuhu, 2011).

If Nigeria is to meet the challenges of competing effectively in an increasingly globalizing world, it is imperative that it gives urgent and sustained attention to promoting its land reform to facilitate property development. The use of traditional forms of tenure to provide security of tenure have proven to be a cumbersome approach that ultimately results in lengthy procedures which offer totally inadequate access to the poor (van der Molen, 2003). The Land Use Act has not and cannot guarantee an equitable distribution and administration of land in Nigeria. Unless the current legal regime is reviewed, the inequality and injustice in land administration engendered by the Act will continue unabated with dire consequences for the proper development of land market and land economy in the country (Olayiwola and Adeleye, 2006; Otubu, 2010). The land reform should seek to solve, among others, multiple allocations, unattended applications, forgeries, encroachments/conflicts, revenue generation, unplanned growth, misuse of land for non-compatible uses, and under-utilization of large expanse of land across states. This calls for a comprehensive digital cadaster survey to provide for a comprehensive digital cadaster and to capture the entire land holding in the country and establish coordinates therefrom (Nuhu, 2011).

To achieve digital cadasters as advocated above, there must be concerted and deliberate efforts towards:

i. Collection and maintenance of data digitally
ii. Improving internal processes, such as quality of management
iii. E-governance
iv. Improving services such as marketing, cooperation with partners and customers
v. Optimizing use of available resources, such as the training and re-training of staff
vi. Information Communication Technology (ICT), which is a major challenge in Nigeria in terms of computerization of records and internet availability and accessibility
vii. Standardization leading to interoperability
viii. Legal framework, organizations, and responsibilities to support policy implementation

e) Nigeria and the National Spatial Data Infrastructure Challenge

For Nigeria to achieve the required integration of its cadastral, topographic, and geodetic data sets, the country must overcome the National Spatial Data Infrastructure (NSDI) challenge. Nigeria has recognized that geo-information is critical to national development issues such as poverty alleviation, food security, improvement of quality of life, economic planning, and natural disaster management. Geo-information also plays a significant role in regional integration and international cooperation. It is therefore essential to the development of various sectors of the economy such as petroleum, solid minerals, forestry, agriculture, transport and aviation, environment, security and defense, tourism, population census, education, health, and water resources.

Several government agencies in Nigeria acquire and store geo-information for their own use and applications. There is no coordinated effort at production, management, and dissemination of geospatial data sets that are commonly used by many of these agencies. This creates problems such as unnecessary overlaps and duplication, lack of accessibility, varying standards and formats, and difficulty in sharing and exchange (NGI Policy, 2003). Some of the organizations involved in geo-information production and management in Nigeria include National Space Research and Development Agency (NASRDA), Office of the Surveyor-General of the Federation (OSGOF), Abuja Geographic Information System (AGIS), Regional Centre for Training in Aerospace Surveys (RECTAS), Nigerian Geological Survey Agency (NGSA), various relevant ministries, land and survey departments in all the states of the federation, etc.

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These organizations require geo-information data in formats that are accessible to them, and that enable sharing and exchange.

Due to the increasing awareness of the use of geo-information for decision-making over the past years and coupled with the apparent availability of data from Nigerian satellites, the country has realized the need to adopt policies for promoting greater awareness and public access to standard and coordinated geospatial production, management, and dissemination by all sectorial institutions and therefore the need for the establishment of geospatial data clearinghouse at various levels in the country and linkages with the private sectors (NGI Policy, 2003). An efficient functioning NSDI is a vital requirement for sustainable development, but Nigeria should go beyond this. Nigeria should strive to develop a data model that integrates three of the key/critical fundamental data sets, i. e., topographic, geodetic, and cadastral, into one data model that is accessible to all the relevant agencies of government and the private sector.

f) Benefits to be derived in Achieving Integration

The advantages Nigeria stands to gain in integrating topographic, geodetic, and cadastral data sets are myriad. It will lead to sustainable local and national development (economic, environmental, social, and governance dimensions) since these are key fundamental data sets required by most agencies of government and the private sector. Some specific benefits include:

i. Standardization in Nigerian surveying to include standardized feature catalogue, data content, and standardized format for data exchange. It will also enable the standardization of project management and utilization of international standards (ISO/OGC).
ii. Use of metadata to describe, explain, or locate, makes it easier to retrieve, use, or manage an information resource. Metadata is often called data about data or information about information. It is commonly stored in a database system and linked to the objects described. It therefore facilitates discovery of relevant information. In addition to resource discovery, metadata can help organize electronic resources, facilitate interoperability and legacy resource integration, provide digital identification, and support archiving and preservation.
iii. Modeling base for specialized information, including eliminating difficulties in the realization of cartographic aspects and the lack of data modeling between cadaster and topography, and management of different temporal versions of the same object.
iv. Cadaster becomes part of e-government and thus more important for business and industry because the cadaster is the heart of land administration. The cadaster provides a spatial integrity and unique identification for land parcels within the land administration system. All land administration systems require some form of spatial data infrastructure. SDIs and cadasters support the vast majority of society in a transparent manner and are seen as enabling platforms in support of spatially enabled societies and governments.
v. More and quicker information becomes possible because redundancies have been eliminated, graphical and attribute data have been integrated and semantic harmonization of cadastral and topographic data has been achieved.

VIII. Conclusion

The Nigeria Land Use Act is the instrument employed for land administration in the country. Given the multitude of criticisms and adverse comments on the imports and effects of the Land Use Act on the individual property rights, the land economy and management, commercial activities and social harmony within the country, the time is ripe for a total and comprehensive review and amendment of the Act. One approach may be the integration of the cadastral, topographic, and geodetic data sets into one data model. Such an integrated data model will make for efficient use and application of geo-information for sustainable development. Germany has successfully integrated these three data sets into one data model called the AAA model. Nigeria has the potential to achieve a full integration of these three fundamental data sets. This paper advocates that Nigeria should study the processes involved and the system adopted by Germany and adapt these processes to suit any peculiarities in our system in order for us to have a single data model for easier access to, and sharing of geo-information, and for the country to establish appropriate institutional and organizational infrastructures to manage the integration of topographic mapping and cadastral information into a coherent land administration system for sustainable development. The Office of the Surveyor-General of the Federation (OSGOF) should be the catalyst and provide leadership in this direction, in collaboration with relevant agencies such as NASRDA, NGSA, AGIS, etc. Institutional, legal, technical, and administrative frameworks should be established to ensure that integration is achieved, while these agencies promote research, training, education, and capacity building. Our aim should, first and foremost, be the recognition of the importance of spatial data infrastructure by politicians and government. Local initiatives should be pre-requisites for a national spatial data infrastructure as we seek to encourage user-orientation as key to a successful and sustainable SDI leading to full integration of our topographic, geodetic, and cadastral data sets into a single data model.

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