STANDARDS AND INTEROPERABILITY IN THE NIGERIAN LAND SECTOR

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GIS-Geographical Information System

SLTR-Systematic Land Title Registration

LIS-Land Information System

SDI-Spatial Data Infrastructure

NGDI-National Spatial Data Infrastructure

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ABSTRACT

In every economy, land represents a factor of production, without which production that will be able to facilitate entrepreneurship, poverty reduction and social cohesion is achieved. However, inefficiencies of the institutional and administrative components of the land sector which include the poor recordation of land information and transactions, lack of data and information about available land stock, lack of structures and non availability of fit-for-purpose systems to facilitate interoperability of the land data and poorly implemented or non implementation of standards to guide how data and information about land is used.

The nature of land suggests geography via the cadaster, which acts as a repository for land information. In order for the cadaster to be useful, it has to be shared and used by relevant stakeholders in the private and public sector. However, the legal and regulatory provisions that govern the use of the cadastral information, which will facilitate interoperability, are poorly implemented in Nigeria. The implementation of the standards to achieve interoperability has a dual purpose; it strengthens inter-ministerial collaboration and supports a functional platform for land information sharing and dissemination about land and its associated economic resources for end-users.

INTRODUCTION

To fully realize the capabilities and benefits of land information systems or efficient land administration systems, the data needs to be shared and systems across domains need to be interoperable. Information and data about land cuts across all domains in Nigeria and globally. Due to the nature of land as a factor of production, the economic resources that are within land and above it require the adoption of transparent land management practices by relevant government agencies. [1]Land management is the process by which the resources of land are put into good effect

[1] GSDI-9 Conference Proceedings, 6-10 November 2006, Santiago, Chile Spatially Enabled Land Administration – Bridging the Gap ,Stig Enemark, GSDI-9 Conference Proceedings, 6-10 November 2006, Santiago, Chile.

(UN-ECE 1996). Land management encompasses all activities associated with the management of land and natural resources that are required to achieve sustainable development. The concept of land includes properties and natural resources and thereby encompasses the total natural and built environment. These resources include agricultural resources, mining, water, and the built environment etc. To unlock the economic value of land and achieve poverty reduction, there is a need for an efficient land management and joint up effort amongst relevant regulatory agencies.

Sharing of land information require standardization to achieve interoperability amongst systems. Whilst the nature of land and its representation suggests geometry and space, land data and information including associated geometry and location are often collated and stored as cadaster layers within a land information system that allow for information about the resources on land and land itself to be stored and shared amongst stakeholders.

[2]Data transfer from one database to another, requires a spatial data standardization [Moellering 1991, Moellering and Hogan 1997] to allow data providers to store their data into a commonly defined standard way that can be interpreted by the data receiver to display the data meaningfully. With the growing number of users, nationally and internationally, the information about what data is available becomes important knowledge. In many countries, governments, providers and private organizations have been building digital infrastructural networks to enable development of the countrywide spatial data and information flow.

To achieve standardization on how land data is collected and used, there is a need to look into the process of land registration in Nigeria, which represents the primary and legitimate source of land data and information. The primary model of land registration in Nigeria is represented by the sporadic land title registration prescribed by the Land Use Act of 1978. This model of property registration has

[2] Henri J. G. L. Aalders , Spatial Data Infrastructure

severely limited the collection of land data suitable for use in driving the Nigerian economy.

Data on land can only be made available if the interpretation of the legal and regulatory structures support the implementation of standards and the standards are strictly adhered to by relevant agencies. In addition to these institutional requirements, are technological needs that provide the platform to disseminate and share the land data amongst agencies for decision-making.

However, Nigeria ranks 182 out of 189 surveyed countries in the 2017 World Bank Ease of Doing Business Rankings, for property registration, which is an indicator of the efficiency of the regulatory institutions to support land registration. If these systems are weak in delivering their functions, then collection of land data will be severely diminished. Hence data that is unavailable even in the public domain, cannot be shared and no incentive to develop open and efficient systems that will support the standardization and interoperability of land data. The use of Geographic Information Systems (GIS) in managing land has increasingly become the norm in Nigeria, with some of states having implemented enterprise GIS domiciled in the lands ministries. The GIS serves to manage both the spatial and non-spatial components of land by providing functions to store and visualize the land data.[3]Spatial as well as attribute data are key requirements for the development of infrastructure. Large-scale maps facilitate land administration but the level of cadastral mapping in Nigeria is very low and mostly prepared in analogue format. The focus now is tending towards technological reform leading to use of electronic/digital system.

However, this technological reform has been tardy so far with much land reform efforts in Nigeria focussing on improved governance rather than the development of structures to facilitate sustainability in the capture and usage of land data and information. Land information exists in a spectrum, from basic paper information to

[3] Reform in Cadastre and Land Administration in Nigeria-Coping with Challenges in Development Chuka Edward Oboli and Anne Omesiri Akpoyoware, Nigeria

sophisticated digital cadastral systems. While standards serve to describe elements of an administrative system, there is not a consistent use of geospatial description of neither land information nor adequate implementation of rules for defining and describing the quality of the records.[4]Sound public policy depends on high-quality information and informed public participation. There is a current explosion in the availability of geographic and spatial information, as well as the tools to use it for diverse public and private purposes. Measures are needed to reduce duplication of data collection and to promote the harmonization, dissemination, and use of spatial data. Standards support both the development of efficient data practices and the development of efficient land information systems that will foster the compilation of up-to-date, accurate and fit-for-purpose land data and its interoperability.[5]Interoperability in information systems is the ability of different types of computers, networks, operating system and applications to work together effectively, without prior communication, in order to exchange information in a useful and meaningful manner (Inproteo, 2005). Interoperability is the capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units (Rawat, 2003).

To fully understand the role and relevance of data standards and interoperability in the land sector, it is useful to examine the nature of land,which specifies geometry or cadastre. A cadastral system consists of the land registry (legal aspect) and the cadastre (geo-spatial aspect) (Zevenbergen and Bogaerts, 2000). A cadastre (in Continental Europe), is perceived as a systematic and official description of land parcels, which includes for each parcel a unique identifier. The description includes text records on attributes of each parcel which the prototypical means of parcel

[4] Spatial Data Infrastructure and INSPIRE, Europe and Central Asia Knowledge Brief September 2012, volume 55- The World Bank

[5] An Interoperability Toolkit For E-Land Administration Kalantari, M.[1], Rajabifard, A.[2], Wallace, J.[3] and Williamson, I.[4] Centre for Spatial Data Infrastructures and Land Administration, Department of Geomatics, The University of Melbourne

identification is a large-scale map that provides information on parcel boundaries (Silva and Stubkjaer, 2002). However, with a relatively new term , Land administration (cadastral system) represent the processes of determining, recording and disseminating information about the tenure, value and use of land when implementing land management policies (UNECE, 1996). It is considered to include a core parcel based cadastral and land registration component, multi-purposed cadastres and/or land information systems, and in many systems facilitates or includes information on land use planning and valuation/land taxation systems. However, land administration does not usually include the actual land use planning and land valuation processes (Enemark and Williamson, 2004).

The cadastre serves as the container for storing information about land. This information is put to proper use through the development of implementation of fit-for-purpose land administration or a land information system that takes into account the need for a participatory approach to the usage of land information to facilitate socio-economic development. Geographic Information Systems (GIS) has created opportunities that offer visual assessment of information on available land and when

implemented within the appropriate architecture and structure, there is much value delivered to the implementing organization in achieving their mandate.

The development of GIS for managing land information to achieve interoperability amongst end-users has to be governed by standards to ensure that a fit-for-purpose system that is aligned with the mandate of the implementing institution and capable of managing and sharing land information is achieved. Due to the geographic nature of land, a common standard that facilitates interoperability is the Spatial Data Infrastructure(SDI). A Spatial Data Infrastructure is fundamentally about facilitating and coordinating the exchange and sharing of spatial data between stakeholders in the spatial community (Rajabifard, A., Feeney, M. E., & Williamson, I., 2002) and an efficient and effective land administration system supporting sustainable development requires an effective SDI (Williamson, I., Enemark, S., Wallace, J., & Rajabifard, A., 2010).

Since the goal of the Spatial Data Infrastructure (SDI) is to facilitate the usage and sharing of spatial data including cadastral data, standardization is of paramount importance to enable interoperability of data and connectivity of information systems. Standards enable applications and technology to work together. Tools, applications and data affect each other and therefore, processes for developing standards must consider the interactions. The aspects of standardization that are of importance to SDI include data (production) standards, data presentation and transfer/exchange standards, and hardware and software standards.

It has been universally acknowledged that the value of wisely chosen standards for geographic information users is reflected in three primary themes, namely:

1. Portability, which implies an ability to use and move data, software, and custom applications among multiple computers and operating system environments without re-tooling or reformatting.
2. Interoperability and information access, which impact computers and networks, and users' ability to connect and retrieve information from multiple systems.
3. Maintainability, which addresses the use of standards to promote long-term and efficient updating, upgrading, and the effective use of computer systems and databases.

The two key requirements to achieve the efficient implementation of standards and achievement of interoperability include the following:

Institutional

1. Well articulated vision on the need for effective use of land information within a well formulated Spatial Data infrastructure Policy that takes into account the requirement of information from land to achieve sustainable socio-economic development.
2. Capacity of regulatory bodies to interpret the standards and ensure compliance.
3. Public sector ICT policy implementation and compliance.

4. Freedom of information policy and enforcement.
5. Availability of technical working group interfacing with economic planning committees and with supporting charter of operations.

Technical

1. Availability of service oriented enterprise GIS architecture.
2. Availability of Secure Internet infrastructure.
3. Constant power supply.
4. Availability of systematically collected and standardized land data.

[6]Land information is an essential commodity .The public sector keeps track of land – where it is, who has access to it, and its value – through land administration. This information, recorded in cadastres, land registers and tax rolls, is important for many land- related activities. One example is the collection of land, or real property, tax. Property tax is comparatively easy to collect and often forms the basis of local government income. A traditional, but inefficient method of collecting tax is literally knocking on doors. Utilizing land standardized land administration systems, local governments can instead bill registered landholders and monitor payments using computer systems.

In response to this requirement for effective land administration systems, it is essential to look into the experience from the GEMS3 programme on SLTR, which indicates the ease of collecting land information as against that of sporadic land registration. SLTR is able to leverage cadastre mapping data to achieve sustainable socioeconomic development. Within the provisions of SLTR, the following are

[6] Land administration – why Published by Sida 2008 Department for Infrastructure and Economic Cooperation Authors: Lantmäteriverket (Swedish National Land Survey). Printed by Edita Communication, 2008 Art. no.: SIDA44516en

achieved;

1. Supply driven model: The Ministry of land staff use claimant forms to collect data on land ownership and land use including socio-economic data from landowners on the field.
2. General boundaries instead of fixed boundaries: In contrast to sporadic land registration which is demand driven, surveyors have to physically ensure the demarcation of the land on the field, whereas general boundaries is done on the desk using satellite imagery and a GIS to extract the boundaries. This ensures data collected can be embedded in the boundaries and used in a land information system. It also ensures that large volumes of data covering an administrative division are collected for use.

In order to achieve the implementation of standards and interoperability in the land sector, there is a need to ensure that there is fit-for-purpose land administration system in place and also institutional structures or models that support the effective collection of land information that is inclusive and participatory.

This paper will examine the key constraints limiting the implementation of standards in the land sector, assess the readiness of the Government of Nigeria and the relevant agencies to implement SDI and achieve full data interoperability, role of land data in the Nigeria economy and, identify opportunities that will drive the sustainable implementation and institutionalization of SDI to facilitate data interoperability in the Nigeria land sector. The paper is divided into sections that cover, problem statement, Research objectives, Research assumptions, Research approach and findings, Key drivers for standards and interoperability in land, Stakeholders roles matrix, Existing standards and definitions, Recommendations, and Conclusion

PROBLEM STATEMENT

Land is central to all economic activity globally. [7]It is perhaps the single most important natural resource in the sense that it affects every aspect of a people's life; their food, clothing, and shelter. It is the base for producing raw material for the manufacturing industry.. No nation-city or rural area can survive as an entity without it. Thus, every person in a nation – the banker, the industrialist, the laborer, the educator, the student, the planner, the farmer- has a vital stake in the country's land problems and its proper utilization (Acquaye, 1976). However, over the years there has been a major focus in Nigeria on using land administration systems for granting secure title to land with a view to promote access to finance for small businesses and not the collection of data to aid socio-economic development.

With the high loan interest rates from Nigerian commercial banks of 23%, and other factors which include, unwillingness of the commercial banks to accept all available statutory titles as collateral for loans, lack of structures to monitor the performance of loans given out to businesses, tax cost of doing business and increasing inflation rates, land becomes a necessary but not sufficient condition for economic growth. In managing land to unlock its economic value, the geography and information about land use, ownership and value should be collected, recorded, shared and used in a coherent manner.

The geographic information and associated attribute information on land use, ownership and value should provide a common reference and language to establish linkages and balance among social, economic and environmental capital to improve on social response.

The following represent the pertinent issues facing the implementation of standards and interoperability in Nigeria land sector. These constraints have been divided into institutional and technical components.

[7] Making Land Administration Pro Poor Lasun Mykail Olayiwola and Olufemi Adeleye 18.2 Land Reform – Experience from Nigeria Promoting Land Administration and Good Governance 5th FIG Regional Conference Accra, Ghana, March 8-11, 2006

Institutional

1. **Policy integration and planning:** Although geography affects daily life and decision making in Nigeria, it has not been fully integrated into national and subnational policy development and implementation process. National and subnational economic planning should feature the use of geographic or land information as a basis for decision making.
2. **Land reform focus:** Much focus of the existing land reform efforts have been on achieving improved administrative structures to achieve access to secure title to land without reliance on the land information component. [8]According to the World Bank, land reform is "concerned with changing the institutional structure governing man's relationship with the land, involving intervention in the prevailing pattern of land ownership, control and usage in order to change the structure of holdings, improve land productivity and broaden the distribution of benefits" (World Bank, 1996).
3. **Transparency:** Lack of transparency in procurement processes for acquisition of technologies for land information or mapping.
4. **State Autonomy**: Constraints to harmonizing standards due to problems of control and ownership stemming from state autonomy on land, since each state is permitted to legislate individually on mapping issues and on the selection of the mapping systems.
5. **ICT policies**: Over decades, ICT implementation at both national and sub-national levels in Nigeria have constantly failed due to the lack of fit-for-purpose ICT policies that foster\ interoperability of systems within the public sector.
6. **Stakeholder coordination**: Lack of coordination amongst relevant government agencies.
7. **Participatory approach:** The private sector is not adequately represented in the planning procedure for the development of standards and achieving

[8] Land Management Chuka Edward OBOLI and Anne Omesiri AKPOYOWARE Reform in Cadastre and Land Administration in Nigeria-Coping With Challenges in Development .FIG Congress 2010 Facing the Challenges – Building the Capacity Sydney, Australia, 11-16 April 2010

interoperability in land. Guides or toolkits are not developed to support the implementation of standards.

Technical

1. **Technological investment:** Fixation of the Nigerian public sector on physical information technology infrastructure and not the logical framework to catalyze its ability to pay for itself.
2. **ICT literacy:** Lack of institutional structures to support ICT literacy and continuous capacity building of relevant staff to sustain the procured information systems and poor knowledge transfer within relevant public sector organizations.
3. **Land registration processes:** The extant sporadic system of registering land is counter productive to the collection of land data and information, as it is voluntary to register land in Nigeria under the Land use Act.
4. **Funding:** Lack of capacity of the relevant regulatory institutions on mapping in Nigeria to attract funding to support the sustainability and implementation of standards and achieve interoperability in the land sector.
5. **Business critical infrastructure:** Standards that guide interoperability of data between public sector and private sector in Nigeria land sector need physical ICT infrastructure to interpret and implement the standards. For standardization in processes and data to be achieved, Information systems must be in place to ensure data and information is conveyed amongst stakeholders or end users seamlessly. One of the critical infrastructure to achieve this is power. [9]With electricity accessibility of about 33% (5 million connected customers), those connected to the grid self- generate about 66% of their needs from about 6,000 MW of high cost auto- generators. The preponderance of auto-generators creates another problem of recurrent

[9] Professor Epiphany Azinge SAN, PhD, LLD Director General, communiqué at the round table on power infrastructure, investment and transformation agenda

expenditure to power the generators. The government of Nigeria has not been successful in addressing this issue for decades neither has the government been successful at exploring alternatives to sustain information system infrastructure such as cloud computing.

6. **Spatial data collation and standardization:** Relevant institutions are not strengthened in their capacity to produce, store and share digital geospatial data.
7. **Monitoring structures:** There is a lack of structure to monitor the effective use and impact of standards in Nigeria.

RESEARCH OBJECTIVES

1. Establish the role of standards and interoperability in the Nigerian land sector.
2. Highlight key issues that limit the implementation standards and achievement of data interoperability in the Nigerian land sector.
3. Recommend incentives to sustainable implementation of standards and achieving interoperability in the land Nigerian land sector.
4. Distinguish between the role of National institutions and subnational institutions in developing and implementing standards in land sector.

RESEARCH ASSUMPTIONS

This research paper makes the following assumptions:

1. An effective land information system, which provides a platform that reinforces the role of data and process standardization in the Nigerian land sector, is a derivative of an efficient land administration system.
2. Adoption of Systematic Land Title Registration processes provides a platform for effective collection of data on land and standardization of land registration procedures.

3. There is an existing National Geodata Infrastructure domiciled with the Nigerian National Space Research and Development Agency (NASRDA).This paper focuses on implementing standards in achieving interoperability.
4. Lack of capacity of relevant agencies in Nigeria at both national and sub-national levels to achieve effective implementation of information systems to achieve interoperability.
5. The requirement for power to support high availability of information systems and the availability of internet or network resources to facilitate data sharing and interoperability amongst stakeholders.
6. Standards and interoperability in land is achieved through the implementation of best practices in land administration systems. Without effective data collection systems for land, implementation of standards and interoperability will not be achieved.
7. A measure of the readiness to implement standards and interoperability in land is represented by the availability of a national or sub-national geospatial or land information online portal.

RESEARCH APPROACH AND FINDINGS

The research methodology involves the evaluation of the readiness of the Nigerian national and subnational government to implement standards and achieve interoperability in land existing technical infrastructure to manage and share land (cadastral) data.

The following represent indicators used in assessing the readiness of the Nigerian national and sub-national levels based on the Spatial Data Infrastructure model. First is to describe the components of SDI namely;

TABLE 1.0 COMPONENTS OF SPATIAL DATA INFRASTRUCTURE

Component	**Description of component**	**Indicators to describe component**
User Base	Data suppliers, managers, end-users and others involved in SDI activities	Number of stakeholders, Number of end- users, Number of downloads, Number of visitors
Technology	Services, software and hardware facilitating the access to and use of data	Software and tools used, Availability of download – and mapping services
Policy	Financial and organizational framework and policies and guidelines for data and standards	Legal framework, Funding model, Type of SDI coordination, Registration policy, Type of data sharing arrangements
Standards	Standards for data models, data services, and metadata to ensure interoperability amongst the datasets and access mechanisms	Indicators for the application of: Standards for metadata, Data, and Services
Data	Content of an SDI e.g. the thematic content, the data types, the data formats	Number of metadata records, Number of available data sets, Thematic data content, Geographic extent

TABLE 2.0 ORGANIZATIONAL ISSUES

Organizational issue	Description	Examples of issues
Coordination	Coordination and organization of the relevant institutions or responsible authorities.	Responsible authority, Organization of coordination, Procedures, Policy or legal framework
Participation	Participation of stakeholders in the process.	Participation in: setting up system, Providing data, Reporting
Operationally	Application of the monitoring systems.	First application, Frequency of monitoring, Methods used for data collection

TABLE 3.0 FINDINGS

Component	Description of component	Results
People (Users Base)	Data suppliers, managers, end-users and others involved in SDI activities.	The institutions involved in SDI activities including land information management at the national level are: • Office of the Surveyor General of the Federation (OSGOF)-Data suppliers • Nigerian National Space Research and Development Agency (NASRDA)-Data suppliers • Federal Ministry of Science and Technology • Donor partners-End users • Private sector-End users and data suppliers

		• Academic institutions. • Non-Governmental Organizations (NGOs)
Technology	Services, software and hardware facilitating the access to and use of data.	Availability of GIS and Land Information Systems technologies exist in silos amongst the user base with divergent software licenses and data output.
Policy	Financial and organizational framework and policies and guidelines for data and standards.	The policy provisions of the National Geodata Infrastructure include the following: 1. Production, ownership/custodianship, archiving and maintenance of fundamental and thematic geospatial datasets. 2. Standardization of data production, transfer and exchange, and of hardware and software. 3. Provision, standardization and maintenance of metadata for every geospatial data holding in the NGDI 4. Legal issues pertaining to ownership/custodianship of datasets, copyright/intellectual property, and confidentiality, privacy and liability. 5. Modalities for data access and data security. 6. Modalities for the organizational arrangement of NGDI, which takes cognizance of the fact that management of geospatial datasets should be done as close as possible to source and it is non-threatening to the mandate of stakeholders. With NASRDA as the NGDI lead agency, other GI producers shall be NGDI node agencies and a 27-member NGDI Committee shall be established under the lead agency for the operations of the NGDI. 7. Funding of the NGDI with a provision for a NGDI fund, which shall accrue from: minimum of 2.5% of annual budget; 10% of national ecological fund; 0.5% of profit-after-tax of private organizations; all income generated from access charge and

		data sales; and international funding and grants. 8. Commercial aspects with provision and guidelines for access and data fees, on differential basis, for research/educational, government to government, and commercial/private use of community, private and value-added datasets. 9. Capacity building in terms of manpower and technology transfer making it mandatory: to include training component in GI projects; to locally implement GI projects to a minimum level of 75%; that all GI producers shall provide evidence of the local contents of their production activities in compliance with Government policy on local content; etc. 10. Promotion of synergy, and amicable resolution of possible conflicts, among Geographic Information- related national policies and legislation while ensuring that geo-referenced data produced according to NGDI-endorsed standard shall be made a compulsory component of Environmental Impact Assessment (EIA) and Environmental Sensitivity Index mapping (ESI) for all development projects for which EIA is mandatory in Nigeria. Appropriate action shall also be taken to incorporate into national legislation, the international obligations which Nigeria has assumed under conventions and treaties for the purpose of NGDI implementation including continued participation in the progressive development of international procedures on cooperation in Regional and Global Spatial Data Infrastructures.
Standards	Standards for data models, data services, and metadata to ensure interoperability amongst the datasets and access mechanisms.	Standards for data models exist within the National Geodata Infrastructure policy but these standards are not being implemented. This has led to poorly collated data with no information on available datasets. An example can be viewed at http://www.ngdi.gov.ng/search.php.
Data	Content of an SDI e.g. the thematic content, the data	The metadata records available on the NGDI website have not been updated since 2010.In addition, a considerable volume of the data

	types, the data formats.	available and domiciled with the agencies are in analogue format, which due to improper storage, some have been damaged and cannot be recovered for conversion to digital format. There is no available public facing data portal in Nigeria. The following represent the datasets to be covered by the NGDI. 1. Geodetic control database 2. Topographic database/DEM (at the scale of 1:50000 pending availability of 1:25000 national coverage) 3. Digital imagery and image maps 4. Administrative boundaries' data 5. Cadastral databases 6. Transportation (roads, inland water ways, railways, etc.) data 7. Hydrographic (rivers, lakes, etc.) data 8. Land use/land cover data 9. Geological database 10. Demographic database

TABLE 4.0 ORGANIZATIONAL ISSUES FINDINGS

Organizational issue	**Description**	**Findings**
Coordination	Coordination and organization of the monitoring support.	National Space Research and Development Agency (NASRDA) coordinate the existing NGDI.
Participation	Participation of stakeholders in the process.	1. Ministry of Defense 2. Federal Surveys Department 3. Ministry of Agriculture and Rural Development 4. Ministry of Solid Minerals 5. National Planning Commission

		6. Federal Capital Development Authority 7. Nigerian National Petroleum Corporation 8. Ministry of Environment 9. Ministry of Water Resources 10. Ministry of Transport 11. National Population Commission
Operationally	Application of the monitoring systems.	There is no evidence of monitoring systems setup for the Spatial data infrastructure in the public domain or within the agencies involved in the SDI.

ANALYSIS

From table 3.0 and 4.0,it can be observed that although the necessary structures required to sustain the implementation of standards are in place, there is no clear evidence that these structures function within the context of land. Key gaps in the structures include the following.

1. Lack of private sector involvement in developing the standards.
2. Lack of clear monitoring structures to evaluate the impact of the SDI.
3. Lack of a strategic plan to implement the SDI within best practices, promote the SDI and attract funding from external sources.

In order to achieve full SDI implementation especially for land/cadastral data, there is a need to for the government of Nigeria to adopt the implementation of SLTR as the de facto process for registering land and acquiring land data, as such that, the availability of land data in itself will promote the implementation of standards and achievement of interoperability in the land sector to achieve economic development.

However, it is crucial to note that the current implementation model for the SDI in Nigeria is also a factor limiting the successful implementation of the SDI. Attempts at implementing SDI at national scale have not been successful so far.

A pilot implementation at the subnational level will be able to demonstrate how the SDI can catalyze investment opportunities and generate impacts, which can be replicated at the national level. Due to the Autonomy of the states on land, it is therefore beneficial for each state to implement both SLTR and SDI.

In the decentralized model ,each state will develop and implement its own SDI based on the benefits of SLTR as a driver of economic growth. This means that due to state autonomy on land in Nigeria, the regional implementation model will permit the propagation of SDI implementation across the Nigeria states with a metadata portal at the national level that links to the state metadata. However, the Forum Of The State Surveyors-General Of Nigeria (FOSSGN), in their resolution on the draft Land Use Act Regulations, states that "References in the Draft Regulations to National Land Depository which provide for wholesale transfer of all land records from the State Registry to the National Land Depository should be amended to provide for transfer of abstracts of land records, which shall be limited to the total number of land titles without individual names of land owners. "This provision already limits the achievement of the implementation of standards and achievement of interoperability on the land sector at the national level.

KEY BUSINESS DRIVERS FOR IMPLEMENTATION OF STANDARDS AND INTEROPERABILITY IN LAND

The key business drivers describe incentives for achieving the implementation of standards and interoperability in Nigeria land sector. The question that invariably occurs is that, what will make the Nigeria states or Federal government implement standards and achieve interoperability in the land sector?

These key business drivers will catalyze the implementation of standards and achievement of interoperability in Nigerian land sector. The key business drivers are outline below in table 5.0.

TABLE 5.0 KEY BUSINESS DRIVERS

Component	Driver	Value
Investment and job creation	**SLTR** **Has the potential to achieve value through computerized addressing systems for land information standardization information sharing through interoperability.**	Use of cadastral maps to disseminate information about land in conjunction with socio-economic data provides information about customer profiles and skill clusters for industry development.
Internal Security		Availability of information on property ownership can be used to monitor crime and distribute security resources according to the index of need.
Food security		Federal Government of Nigeria (FGN) has signed up to the New Alliance for Food Security and Nutrition, as have some of the renowned private sector companies. The concept note for Nigeria clearly states that the United Kingdom, under this land partnership, will partner with the Government of Nigeria at federal and state levels

		with focus on strengthening state capacity for land titling through systematic land titling and registration.
Sustainable Development Goals (SDG)		The data available through SLTR can support relevant government agencies in achieving their SDG objectives.
Ease of doing business		Property registration represents a key indicator identified by the World Bank on the ease of doing business rankings. Reduction in the cost and time taken to register land will improve the ease of doing business by reducing the tax cost of doing business.
Effective urban planning and renewal policies		SLTR data is able to display using maps and provide information on urban dynamics.

STAKEHOLDER ROLES MATRIX
TABLE 6.0

National and subnational Ministries, Departments and Agencies		
Office of the Surveyor General of the Federation (OSGOF) and states offices of survey general	Develop and legislate SDI	Responsible for providing maps and spatial data nationwide. The agency is making data and geospatial products available online at cost. Reliance on decentralized state governments for data collection creates challenges owing to lack of resources at the local level.
National Space Research and Development Agency (NASRDA)	Develop and legislate SDI	Houses the Nigerian NGDI and data clearinghouse – with which all government institutions are mandated by law to provide their metadata. Responsible for facilitating data sharing across government agencies – including an internal data portal that is slated to become public.
Regional Centre for Training in Aerospace Surveys (RECTAS)	Provide capacity building on SDI for both private sector and public sector users.	Responsible for delivering training in GIS and RS as well as providing consulting services. Reputedly one of the best agencies in Africa for photogrammetry, cartography and RS. Has immediate access to satellite data acquired by Nigeria's SAT 1 and 2, LANDSAT, SPOT, Quickbird and IKONOS.
Federal Ministry of Agriculture and Rural Development	SDI implementation	Responsible for acquiring crop, transportation, and socioeconomic data from hundreds of sites across the country. Funded by the World Bank, the program collects geospatial data to improve agricultural value chains. Geospatial information is shared with 658 local governments and helps build capacity at the national scale.
Private sector		
Financial institutions	Data end users and SDI beneficiaries	
Corporate bodies	Data end users and SDI beneficiaries	
Land professional bodies	Data end users and SDI beneficiaries	
Civil societies	Data end users and SDI beneficiaries	

STANDARDS AND INTEROPERABILITY

This section will examine the definition of standards and interoperability for geospatial data within the context of Spatial Data Infrastructure and Geographic Information System (GIS), with references taken from existing literature. In previous sections of this research paper, references have been made to land data as cadastral or geospatial data with more specific references made to the Nigerian land sector.

HISTORY OF SPATIAL DATA INFRASTRUCTURE

History development of SDI In many countries a spatial information infrastructure is developed to enable users to discover, explore and exploit datasets according to the needs in their applications. These can be seen as first generation information infrastructures; [Masser, 1998] gives an overview of the state of the art. These systems are mostly explicitly nationally organised, and deal with spatial information only. During the UN Conference on Environment and Development in Rio de Jeneiro in 1992 a major resolution was accepted to reverse the impact caused by environmental deterioration e.g.: deforestation, pollution, depletion of fish stocks, monitor and control of toxic waste, etc. Also, the GATT summit in 1999 in Vienna emphasised on the availability of information access over the Internet all over the world. The importance of spatial information to support decision making and management at local, national, regional and global level becomes apparent in many applications and mostly spatial information plays an important role. The capture of spatial data is expensive, forcing the reuse of the same data several times for different applications. And so serving the community through a spatial data network to discover, explore and exploit the available data is developed, firstly at the national level but after the Rio Summit also on a global level.

SPATIAL DATA INFRASTRUCTURE

A spatial data infrastructure (SDI) is a data infrastructure implementing a framework of geographic data, metadata, users and tools that are interactively connected in order to use spatial data in an efficient and flexible way. Another definition is "the

technology, policies, standards, human resources, and related activities necessary to acquire, process, distribute, use, maintain, and preserve spatial data".

A further definition is given in Kuhn (2005):"An SDI is a coordinated series of agreements on technology standards, institutional arrangements, and policies that enable the discovery and use of geospatial information by users and for purposes other than those it was created for." Source:Wikipedia.

Geographic information system (GIS) technology is evolving beyond the traditional GIS community and becoming an integral part of the information infrastructure in many organizations. The unique integration capabilities of a GIS allow disparate data sets to be brought together to create a complete picture of a situation. GIS technology illustrates relationships, connections, and patterns that are not necessarily obvious in any one data set, enabling organizations to make better decisions based on all relevant factors. Organizations are able to share, coordinate, and communicate key concepts between departments within an organization or between separate organizations using GIS as the central spatial data infrastructure. GIS technology is also being used to share crucial information across organizational boundaries via the Internet and the emergence of Web Services.

To fully realize the capability and benefits of geographic information and GIS technology, spatial data needs to be shared and systems need to be interoperable. GIS technology provides the framework for a shared spatial data infrastructure and a distributed architecture.

COMPONENTS OF SPATIAL DATA INFRASTRUCTURE

A SDI should enable the discovery and delivery of spatial data from a data repository, via a spatial service provider, to a user. As mentioned earlier it is often wished that the data provider is able to update spatial data stored in a repository. Hence, the basic software components of an SDI are:

- Software client - to display, query, and analyse spatial data (this could be a browser or a desktop GIS)
- Catalogue service - for the discovery, browsing, and querying of metadata or spatial services, spatial datasets and other resources
- Spatial data service - allowing the delivery of the data via the Internet
- Processing services - such as datum and projection transformations
- (Spatial) data repository - to store data, e.g., a spatial database
- GIS software (client or desktop) - to create and update spatial data

Besides these software components, a range of (international) technical standards is necessary that allow interaction between the different software components. Among those are geospatial standards defined by the Open Geospatial Consortium (e.g., OGC WMS, WFS, GML etc.) and ISO (e.g., ISO 19115) for the delivery of maps, vector and raster data, but also data format and internet transfer standards by W3C consortium.

Specific components include:

1. Policies & Institutional Arrangements (governance, data privacy & security, data sharing, cost recovery)
2. People (training, professional development, cooperation, outreach)
3. Data (digital base map, thematic, statistical, place names)
4. Technology (hardware, software, networks, databases, technical implementation plans)

INTEROPERABILITY

[10]In the domain of spatial information interoperability is the cooperation, the

[10] An Interoperability Toolkit For E-Land Administration Kalantari, M.[1], Rajabifard, A.[2], Wallace, J.[3] and Williamson, I.[4] Centre for Spatial Data Infrastructures and Land Administration, Department of Geomatics, The University of Melbourne

compatibility of an information system to run, manipulate, exchange and share the data of different organizations related to spatial information on, above, and below the Earth's surface; for any kind of application to serve the society over networks (Rawat, 2003). The idea was then developed for businesses and organizations as well as public administrations to improve collaboration and productivity in general, increase flexibility, enhance services efficiency and add to productivity while simultaneously reducing the costs.

The complexity of land administration systems raises issues not only related to technical aspects of the subsystems but also related to the semantics, legal and inter-community aspects which need to be addressed to achieve interoperable e-Land Administration system. Interoperability in e-Land Administration facilitates the ability to link land administration subsystems cost effectively to share the resources, find the data, functions and processing to serve the public.

[11]It is important to understand that during the past 20 years, the concepts, standards, and technology for implementing GIS interoperability have evolved through six stages.

1. Data converters (DLG, MOSS, GIRAS)
2. Standard interchange formats (SDTS, DXF™, GML)
3. Open file formats (VPF, shapefiles)
4. Direct read application programming interfaces (APIs) (ArcSDE® API, CAD Reader, ArcSDE CAD Client)
5. Common features in a database management system (DBMS) (OGC Simple Feature Specification for SQL™)
6. Integration of standardized GIS Web services (WMS, WFS, ArcIMS)

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[11] Spatial Data Standards and GIS Interoperability An ESRI® White Paper • January 2003

All six of these approaches and related technologies are important and continue to play a significant role in GIS interoperability today. In early years, the constraints of computational speed and cost limited our ability and caused us to focus on practical solutions such as direct file conversion. Data sharing between organizations with different GIS vendor systems was limited to data converters, transfer standards, and later open file formats. Sharing spatial data with other core business applications was rarely achieved. Today, most GIS products directly read and sometimes dynamically transform data with minimal time delay. The point here is that the GIS community has been pursuing open interoperability for many years, and the solutions to achieving this goal have changed with the development of new technologies.

THE VALUE OF BEING OPEN

An open GIS system allows for the sharing of geographic data, integration among different GIS technologies, and integration with other non-GIS applications. It is capable of operating on different platforms and databases and can scale to support a wide range of implementation scenarios, from the Federal Ministry of Agriculture in Nigeria, facilitating large scale agricultural investment through data sharing with the Federal Ministry of Environment, National Bureau of statistic, Office of the Surveyor General of the Federation and Federal Ministry of water resources to disseminate information on available land suitable for specific agricultural investment, using an open GIS or land information portal. An open GIS also exposes objects that allow for the customization and extension of functional capabilities using industry- standard development tools.

This ensures that land data can be used and value added to the land data by other agencies. For example, the Ministry of mines and steel developing a mining cadastral published in the public domain for investor access.

COMPARATIVE ANALYSIS OF SPATIAL DATA INFRASTRUCTURE

Figure 1.0 Spatial Data infrastructure comparative analysis

		CASE STUDY COUNTRIES						
		Developed World			Developing World			
SDI COMPONENT	SPECIFIC VARIABLES	Australia	United States	Netherlands	South Africa	Colombia	Indonesia	Nigeria
Data	Core datasets Data Format Updating Resolution	Defined Digital Yes Different	Defined Digital Yes Different	Defined Digital Yes Different	Defined Digital Yes Different	Defined Digital Yes Different	Defined Digital Yes Different	Defined Analogue Yes Two Scales
Access Network	Metadata Access Mechanism Network Architecture Clearinghouse	Yes Yes 25 distributed nodes Not well defined	Yes Yes Distributed data providers Yes	Yes Yes Web based architecture Yes	Yes Yes Web based with several nodes Yes	Yes Yes LAN/Internet in institutions Yes	Yes Yes Network Gateway	No No Central Server
Standards	Data Transfer Transfer Standard Interoperability	Arranged ISO 19115,OGC Yes	Arranged FGDC,ISO TC211,OGC Yes	Arranged EGII,ISO TC211 Yes	No Data FGDC,ISO, SDI ACT No	Arranged ISO TC 211 FGDC No	Arranged FGDC No	Not Arranged SON,ISO Standards No
Policy	Coordinating Body SDI Directive Data Access and Pricing	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	No No No	Yes Yes Yes	Yes No Yes
Institutional Arrangements	Coordinating Body Participating Agencies Working Groups	Present Yes No	Present Yes Yes	Present Yes No	Present No Yes	Present Yes Yes	Present Yes Not Defined	Present Yes No

Source: Spatial Data Infrastructures Model For Developing Countries a case study of Nigeria Chinonye Cletus Onah.

CONCLUSION AND RECOMMENDATIONS

This research paper examines the implementation of standards and interoperability in the Nigerian land sector. A major assumption is that Nigerian institutions are able to coordinate the production of policy documents that prescribe how land data and information should be adapted to economic plans at both the national and subnational levels. However, the major constraint is the implementation phase of the policies. Data standards and interoperability in Nigerian land sector is a relatively new concept in Nigeria and the structures required to support such implementation are not available. Such structures include e-government. This paper has illuminated

the benefits of standards, which can be applied to the Nigerian land sector. A key requirement for standards and interoperability in Nigerian land sector is the source of the data. The standards could be applied to the Nigerian land sector because of its geographical nature. Although efforts have been made by the government of Nigeria and donor partners to reform the land sector and the focus has been driven by the need for efficient land governance and not the application of land data. The DFID GEMS3 programme has implemented pilot SLTR programmes in Kano, Kaduna, Kogi, Jigawa and Cross-River State, with a scale up in Tarauni Local Government Area in Kano State. This has demonstrated the need for joint up efforts amongst government agencies in using land data and associated socio-economic data to raise the profile of investment opportunities in the designated areas.

In order to sustainably implement standards and achieve interoperability in Nigeria land sector, the following should be considered;

1. As a prior action, SLTR and the availability of structures to implement standards should be considered as a condition for loan requests made by both the Nigeria federal and state governments to donor partners. The Lagos State World Bank DPOII, which investment climate is a pillar, is a recent example of how land systems could be used as a condition to evaluate the readiness of the state to acquire loans and derive measurable impact. An output under the investment climate pillar of the World Bank DPOII is the production of the Lagos State GIS strategic development plan.
2. The future development of standards in Nigeria should be accompanied by strategic implementation plans. These will serve as guides to achieving sustainability in implementation. Strategic implementation plans usually include funding strategies and options and facilitate inter-ministerial collaboration.
3. Implementation of GIS or Land Information Systems in Nigeria should gravitate toward private sector participation under a Public private Partnership arrangement, with specific terms of reference that will include the achievement of interoperability through the implementation of standards.

4. Develop State specific ICT strategic development plan to enable the sustainable use of ICT at the MDAs.This will ensure that the physical and logical components required to facilitate inter-ministerial collaboration and interoperability is achieved within industry standards and best practices. The ICT strategy will guide the activities of contractors operating within the public, private partnership model and ensure the element of interoperability is captured in the implementation process. The ICT strategic plan will provide indicators that measure the performance of the investment in ICT and its impact on productivity and delivery of public service.
5. Adopt state specific implementation of Spatial Data Infrastructure, driven by data derived from Systematic Land Title Registration. This ensures that the state is able to benefit from both the implementation of Spatial Data Infrastructure and data from effective land administration systems.
6. Setup a technical economic planning committee under the office of the state governor to oversee the implementation of Systematic Land Title registration and Spatial Data Infrastructure. The committee will support the development of the vision for the application of Spatial Data Infrastructure and Systematic Land Title Registration to achieve sustainable economic growth in a transparent manner in the state.

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Tables and figures