

**MASTERS PROGRAM IN**



# **GEOSPATIAL TECHNOLOGIES**

***SPATIAL DATA INFRASTRUCTURES MODEL FOR  
DEVELOPING COUNTRIES***

***A case study of Nigeria***

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Dissertation submitted in partial fulfilment of the requirements  
for the Degree of *Master of Science in Geospatial Technologies*



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# **SPATIAL DATA INFRASTRUCTURES MODEL FOR DEVELOPING COUNTRIES**

## **A case study of Nigeria**

### **ABSTRACT**

This research explores the basics of SDI, and investigates the National SDI of different countries. Further, the research analyses SDI implementation in developing country with specific reference to the National Geospatial Data Infrastructure (NGDI) of Nigeria. The research assesses the status and the milestones of NGDI implementation using key SDI components as assessment variables. These components were grouped into four classes: Policy and Legal Issues, Technical, Funding and People. A questionnaire survey via email was conducted on the stakeholders and users of geoinformation in Nigeria. From the analysis, the NGDI has an advantage of having a national policy backing its implementation and the establishment of the coordinating body. However, the lack of SDI directive and funding are major hurdles in the implementation of the NGDI making it lack behind most of the selected case study countries in other key components. Nigeria is also found to be applying a *Mixed Model* of NSDI implementation as both product model and process model are evident in the NGDI. In the real sense of access network and data sharing, NGDI is yet to be operational, though the project is going on.

## **KEYWORDS**

Clearinghouse

Metadata

National Geospatial Data Infrastructure (NGDI)

Spatial Data Infrastructures (SDI)

Standards

## **ACRONYMS**

**ASDI** - Australian Spatial Data Infrastructures

**ANZLIC** - Australian and New Zealand Land Information Council

**EUROGI** - European Umbrella Organization for Geographic Information in Europe

**GIS** - Geographical Information Systems

**ICDE** - Infraestructura Colombiana de Datos Espaciales

**NASRDA** - National Space Research and Development Agency

**NGDI** - National Geospatial Data Infrastructures

**NGII** - National Geographic Information Infrastructure

**NSIF** - National Spatial Information Framework

**NSDI** - National Spatial Data Infrastructures

**SDI** - Spatial Data Infrastructures

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# 1. Introduction

## 1.1 Background

The term Spatial Data Infrastructures (SDI) is often used to denote the relevant base collection of technologies, policies and institutional arrangements that facilitate the availability of and access to spatial data. The SDI provides a basis for spatial data discovery, evaluation, and application for users and providers within all levels of government, the commercial sector, the non-profit sector, academia and by citizens in general, (SDI Cookbook, 2001). SDI is now playing a much broader role in a modern society. The concept involves a complex digital environment including a wide range of spatial databases and is concerned with standards, institutional structures and technologies including the World Wide Web (WWW). SDI is now moving to underpin an information society and enable a society to be spatially enabled, (Rabajifard, 2006a).

Many countries worldwide are engaged in SDI development, which involves the development of geospatial services that support public service delivery. This development ranges from local to state/provincial, national and regional levels, to a global level. However, this research will focus on the development of National SDI (NSDI) as it applies to developing nations using National Geospatial Data Infrastructures of Nigeria as a case study.

## 1.2 Statement of Problem

The SDI concept continues to evolve as it becomes a core infrastructure supporting economic development, environmental management and social stability in developed and developing countries. Due to its dynamic and complex nature, it is still a fuzzy concept to many, with practitioners, researchers and governments adopting different perspectives depending on their needs and circumstances, (Williamson, *et al*, 2003a). Building SDI is a complex task, not just because of the evolving nature of the SDI concept, but as much because of the social, political, cultural and technological

context to which such development must respond. (Williamson *et al*, 2003b). The reality is that every country is at a different point in ‘SDI development continuum’, with the developed world at the front end of the pole, and the developing countries lagging far behind. In addition, many developing countries still have fragmented institutional arrangements in the spatial data and land information area. It is not uncommon to find a range of different government departments, often in different ministries, responsible for different aspects of the management of the spatial data. It is not surprising that moves to establish SDI under these circumstances are problematic at best or non-existent at worst, (Williamson *et al*, 2003b).

Current understanding of SDI has seen the development of SDI models that have not met user needs as expected, currently providing mainly an ability to access and retrieve spatial data. Hence the concept of an SDI needs to progress so that it allows more than just the ability to access spatial information. It needs to become an entity that is enhanced so that it is possible to share data, business goals, strategies, processes, operations and value-added products and services in order to support a spatially enabled government (Rajabifard *et al*. 2005b). Some studies have been carried out on the initiatives and models of SDI in different parts of the world such as documented in Nebert, (2006) for USA, Rajabifard *et al* (2006b) for Australia, GSDI Cookbook, Version 2, (2004) Columbia, Cromptvoets *et al* 2004 Worldwide development of national SDI clearing house.

However, a systematic study of the development of national SDI in developing countries with a view to assessing the success, challenges and problem which in turn will help in developing a model for SDI development is lacking.

### **1.3 Research Objectives**

The steps to develop an SDI model vary among countries, depending on a country’s background and needs. However, it is important that countries develop and follow a roadmap for SDI implementation.

Such aspects include the development of an SDI vision, the required improvements in capacity of the country, the integration of different spatial datasets, the establishment of partnerships, and the financial support for an SDI. The National

Geospatial Data Infrastructure Project in Nigeria under the National Space Research and Development Agency (NASRDA) has as its main objectives, the discovery, harmonization and standardization of geospatial data production and management, and the provision of a platform for data sharing thereby eliminating data duplication and conserving cost and time spent in producing already available data, (Agbaje and Akinyede, 2005).

The major objective of this thesis is to assess the status and milestones of the implementation of the Nigerian Geospatial Data Infrastructures and compare it with selected NSDI. In order to achieve this objective, the following specific objectives have to be achieved:

1. To examine the institutional arrangements in place to facilitate GI sharing;
2. To examine the issue of data access, data security, and partnerships among producers and users;
3. To examine progress made so far in the implementation of NGDI;
4. To examine the NGDI implementation in the light of some selected NSDI from other parts of the world.

#### **1.4 Research Questions**

The research will be guided by the following questions:

1. Who are the major stakeholders in NGDI?
2. What institutional arrangement is in place for the development of NGDI?
3. What are the problems and challenges facing the development of NGDI?
4. What lessons can be learnt from NGDI experience?
5. Is NGDI development in line with the selected NSDI trends?

#### **1.5 Research Hypotheses**

The research will test the following hypotheses.

- H<sub>1</sub>:** The current NGDI is effective and developing according to the National Geoinformation Policy.

**H<sub>2</sub>:** The NGDI experience is not different from the NSDI of the selected countries.

## **1.6 Research Methodology**

A questionnaire survey was carried out to assess systematically the development and status of National Geospatial Data Infrastructure of Nigeria with reference to the SDI components. The survey covered most aspect of NGDI components including policy, organizational and legal issues, data access mechanism, technical standards (metadata and clearinghouse) prices for data, people (including partnership). Considering the complex, dynamic and constantly evolving nature of NGDI, a multi-view assessment framework is used, (Grus, Cromptvoets and Bregt, 2007; Makanga and Smit, 2008). These NGDI components are grouped into four headings: Policy and Legal Issues, Technical, Funding and People. The data collected from the questionnaire was analyzed. Further, a comparative analysis of selected NSDI across the world was made vis-à-vis NGDI. Finally, recommendations will be made on the future of NGDI. The workflow of the methodology is shown in Figure 1.

## **1.7 Organization of the Thesis**

The thesis is organized in the following chapters:

*Chapter One* covers general introduction, statement of problem, objectives of the study, research questions, research methodology, hypothesis, and structure of the thesis.

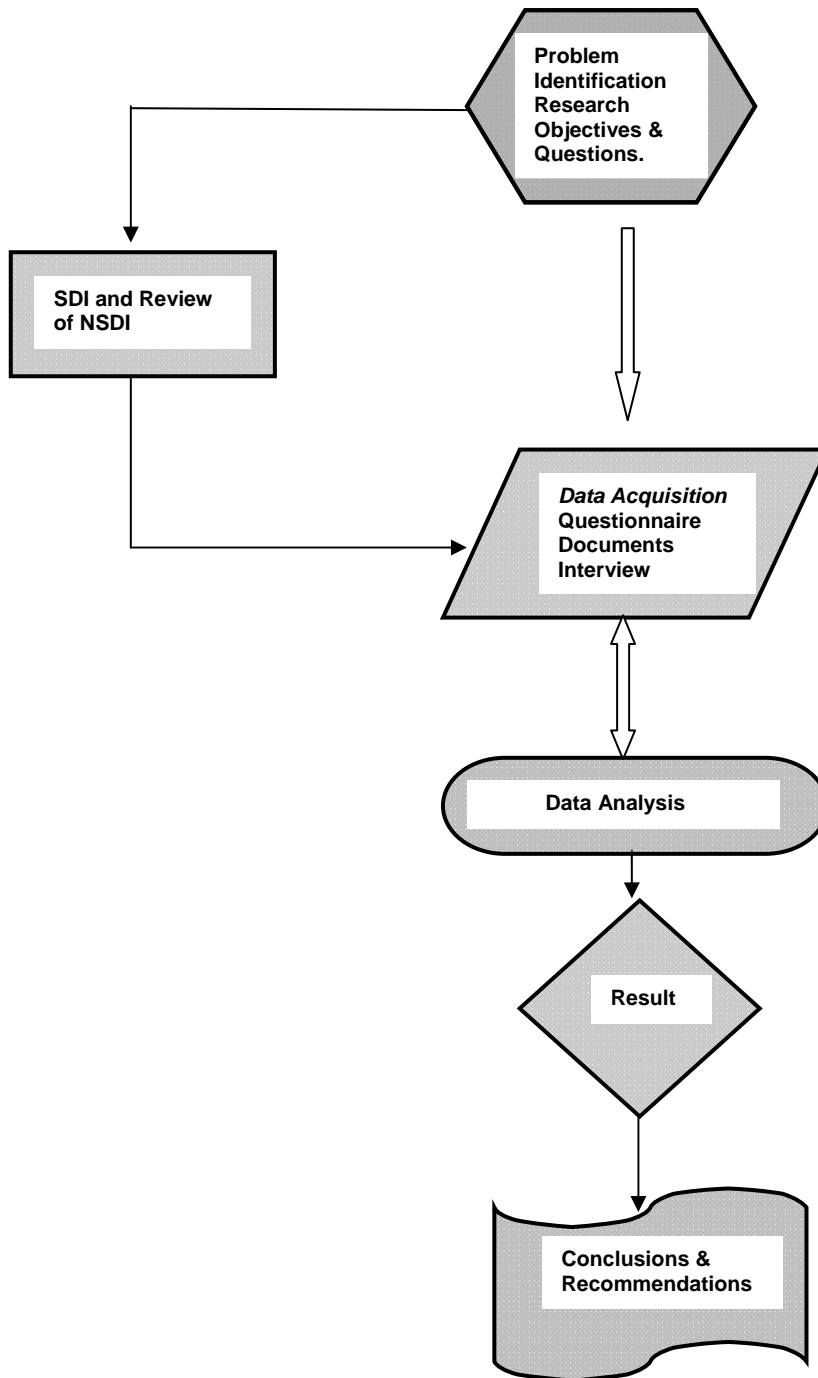
*Chapter Two* reviews the relevant literature. A general introduction of SDI is presented, definitions, components, hierarchy and history. National SDI initiatives are explored; Australia, USA, Colombia, The Netherlands, South Africa, and Indonesia.

*Chapter Three* focuses on the National Spatial Data Infrastructure of Nigeria. Further, chapter describes the methodologies that were used for data collection in the field study. A comparative study is made among the case study countries.



*Chapter Four* presents the data. Data Analysis is carried out with respect to data collected from the field.

*Chapter Five:* summarizes the thesis with conclusions, limitations of the study and recommendations for future work.



*Figure 1: Organization of the research*

## **2. Spatial Data Infrastructures and National SDI Case Studies**

### **2.1 Introduction**

This chapter explores the background of SDI, definitions, components, history and trends. Different levels of SDI: corporate, local, state, national, regional are identified. The chapter goes further to investigate a number of National SDI from both developed and developing world. Australia, Netherlands and United States were selected from the developed world, while Colombia, Indonesia and South Africa are selected from the developing countries. A summary of their respective NSDI is given at the end of the chapter. The NGDI of Nigeria, which is the primary case study area, is however treated in *Chapter 3*.

### **2.2 Definition of SDI**

SDI is playing a much broader role in today's information society as it evolves from just a concept to become a core infrastructure supporting economic development and environmental management across nations. A few definitions of SDI will highlight the nature of the infrastructure. The term "Spatial Data Infrastructure" (SDI) is often used to denote the relevant base collection of technologies, policies and institutional arrangements that facilitate the availability of and access to spatial data. The SDI provides a basis for spatial data discovery, evaluation, and application for users and providers within all levels of government, the commercial sector, the non-profit sector, academia and by citizens in general, (SDI Cookbook, 2001).

The Federal Geographic Data Committee (1997) defines the United States' national SDI as an umbrella of policies, standards, and procedures under which organizations and technologies interact to foster more efficient use, management, and production of geospatial data. It further explains that SDI consists of organizations and individuals

that generate or use geospatial data and the technologies that facilitate use and transfer of geospatial data, (Nebert, 2006).

Coleman and McLaughlin (1998) defines the Global SDI as encompassing ‘the policies, technologies, standards and human resources necessary for the effective collection, management, access, delivery and utilization of geospatial data in a global community’. Dutch Council for Real Estate Information (RAVI) defines the Dutch National Geographic Information Infrastructure as a collection of policy, datasets, standards, technology (hardware, software and electronic communications) and knowledge providing a user with the geographic information needed to carry out a task (Masser, 1998).

In summary, SDI is about the facilitation and coordination of the exchange and sharing of spatial data between stakeholders in the spatial data community. The principal objective of developing an SDI is to provide a proper environment in which all stakeholders, both users and producers of spatial information can cooperate with each other in a cost-efficient and cost-effective way to better achieve their targets at different political/administrative levels.

### **2.3 Components of SDI**

The definitions of SDI in 2.1 reveal some core components of SDI. The Australia New Zealand Land Information Council (ANZLIC, 1998) identifies institutional framework, technical standards, fundamental datasets, and clearing house networks as the core components. The institutional framework defines the policy and administrative arrangements for building, maintaining, accessing and applying the standards and datasets. The technical standards define the technical characteristics of the fundamental datasets. The fundamental datasets are produced within the institutional framework and fully comply with the technical standards. The clearinghouse network is the means by which the fundamental datasets are made accessible to the community, in accordance with policy determined within the institutional framework, and to agreed technical standards.

In addition to these basic components, there is the people component which includes the spatial data users, suppliers and any value-adding agents in between, who interact to drive the development of SDI, (Williamson *et al*, 2003b).

### **2.3.1 Data**

Data sets, which may be used for many different purposes and in many different applications, are often referred to as *base data*, *core data*, *fundamental data* or *reference data*. These datasets are widely needed for a variety of purposes and by many agencies. The other types of datasets are known as *thematic* datasets which are derived from the fundamental datasets, (SDI Africa, 2004).

### **2.3.2 Metadata**

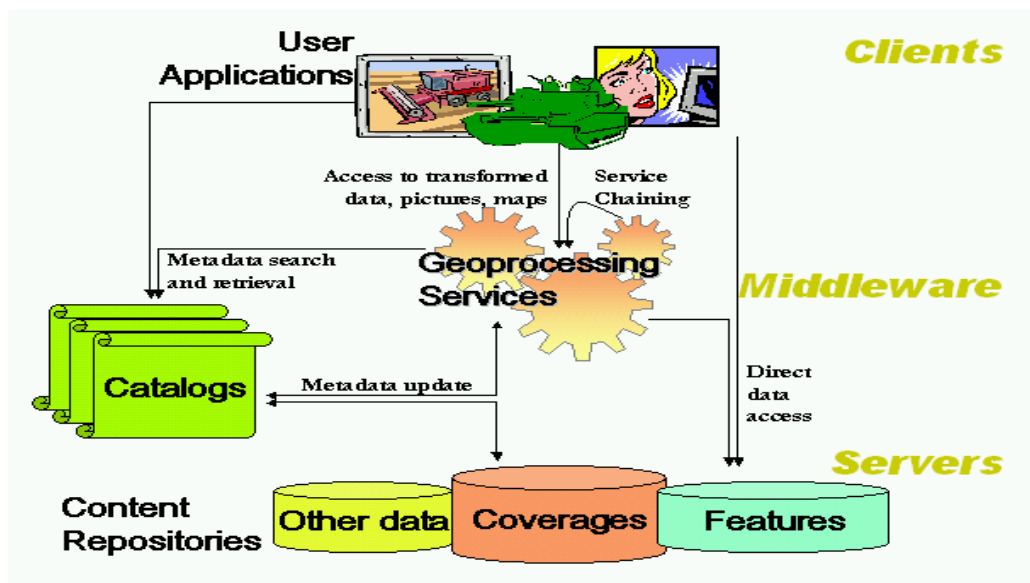
Metadata is a summary document about the dataset, including the geographic area that the dataset covers, the custodian, who to contact to obtain a copy of the dataset and other useful information that helps people decide whether or not the dataset is useful for their particular purpose. A geospatial metadata record includes core library catalog elements such as Title, Abstract, and Publication Data; geographic elements such as Geographic Extent and Projection Information; and database elements such as Attribute Label Definitions and Attribute Domain Values.

### **2.3.3 Standards**

Effective use and sharing of spatial information requires that it adheres to known and accepted standards. Standards facilitate the use of a wider range of data. Development of formal standards is a consultative process through national standard bodies through international standard organizations. Spatial data are standardized in terms of geographic referencing, the data content, the resolution, and metadata (SDI Africa, 2004). Some international standard organization for geographic information are ISO TC211 (*de-jure*) standards, and *de facto* specifications from organizations such as OGC (Open Geospatial Consortium), Organization for the Advancement of Structured Information Standards (OASIS) and W3C (Gould, *et al*, 2008). There is close relationship between OGC and ISO TC211, resulting in an effective joint development of certain standards.

### 2.3.4 Access Network

Gould *et al* (2008) state that “Although SDI are primarily institutional collaboration frameworks, they also define and guide implementation of heterogeneous distributed information systems, consisting of four main software components linked via Internet. These components are: 1) metadata editors and associated catalogue services, 2) spatial data content repositories, 3) client applications for user search and access to spatial data, and 4) middleware or intermediate geoprocessing services which assist the user in finding and in transforming spatial data for use at the client side application.” This is illustrated in *Figure 2*



*Figure 2: High-level SDI architecture, taken from the FGDC-NASA Geospatial Interoperability Reference Model (GIRM), (FGDC, 2003).*

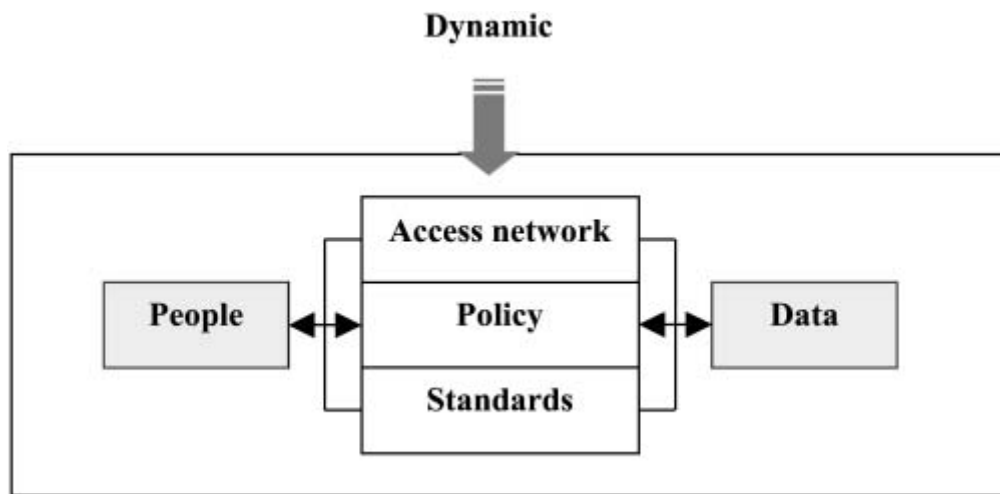
### 2.3.5 People and Partnership

This component includes the spatial data users and suppliers and any value-adding agents in between, who interact to drive the development of the SDI. For this reason the formation of cross jurisdictional partnerships has been the foundation of SDI initiatives supported to date. People are the key to transaction processing and decision-making. All decisions require data and as data becomes more volatile human issues of data sharing, security, accuracy and access forge the need for more defined relationships between people and data. The rights, restrictions and responsibilities influencing the relationship of people to data become increasingly

complex, through compelling and often competing issues of social, environmental and economic management. Facilitating the role of people and data in governance that appropriately supports decision-making and sustainable development objectives is central to the concept of SDI.

### 2.3.6 Policies and Institutional Arrangements.

The institutional framework defines the policy and administrative arrangements for building, maintaining, accessing and applying the standards and datasets, (ANZLIC, 1998). Policies and Institutional Arrangements define other components of SDI such as governance, data privacy and security, data sharing, and cost recovery, (Nebert, 2006). It is the policies and organizational components that make it possible for the realization of aims and objective of SDI. Even when data and other components are in place, without enabling policies, and institutional arrangements, coordination, cooperation and sharing will not be achieved. *Figure 3* illustrates the dynamic nature and relationships of this SDI Components.



*Figure 3: Nature and Relations between SDI Components.*  
( Rajabifard et al 2003a).

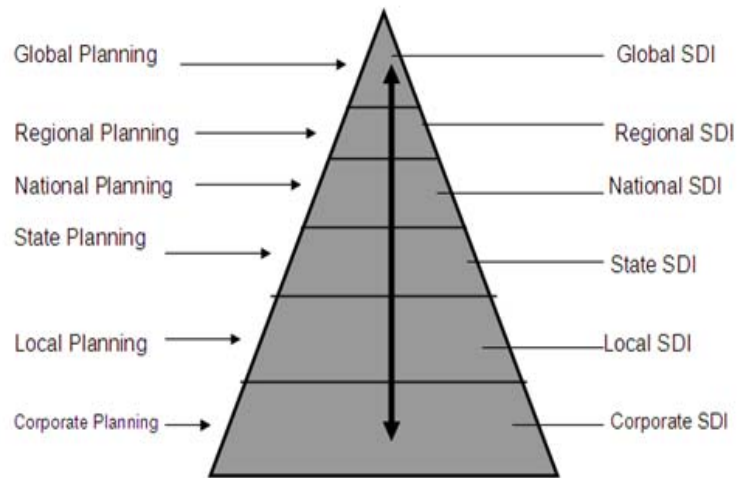
## 2.4 History of SDI

Like other forms of infrastructures SDI has development history, ‘with every country at different development continuum’, (Masser, 2003). The first generation of SDI

development emerged in the mid-1980s when the USA and Australia, for example, started to develop the data access relationships, which became the precursor to the development of NSDI initiatives. At this time, countries developing SDI on any jurisdictional level had only very limited ideas and knowledge about different dimensions and issues of the SDI concept, and rather less experience of such development. Within this generation, each country designed and developed SDI based on their specific requirements and priorities and nationally specific characteristics. The ultimate objectives of the SDI initiatives in this generation as summarized by Masser (1999) were to promote economic development, to stimulate better government and to foster environmental sustainability. A significant milestone overcome by the first generation, for whom there were few experiences and existing SDI developments from which to learn, was the documentation of researchers' and practitioners' experiences and status reports on their SDI initiatives and as part of that report on their clearinghouse activities which facilitated their SDI initiatives.

## **2.5 Levels of SDI**

SDI can be developed at corporate level, local level, state level, national level (NSDI), regional level and global level. Many countries are developing SDI at different levels ranging from local to state/provincial, national and regional levels, to a global level. The objectives of these initiatives are to promote economic development, to stimulate better government and to foster environmental sustainability, (Masser, 1998). Rajabifard *et al* (2000) developed a model of SDI hierarchy that includes SDI developed at different political-administrative levels. Based on this model, the SDI hierarchy creates an environment, in which decision-makers working at any level can draw on data from other levels, depending on the themes, scales, currency and coverage of the data needed, (*Figure 4*). The double-ended arrow in this figure represents the continuum of the relationship between different levels of detail for the data to be used at the different levels of planning corresponding to the hierarchy of SDI.

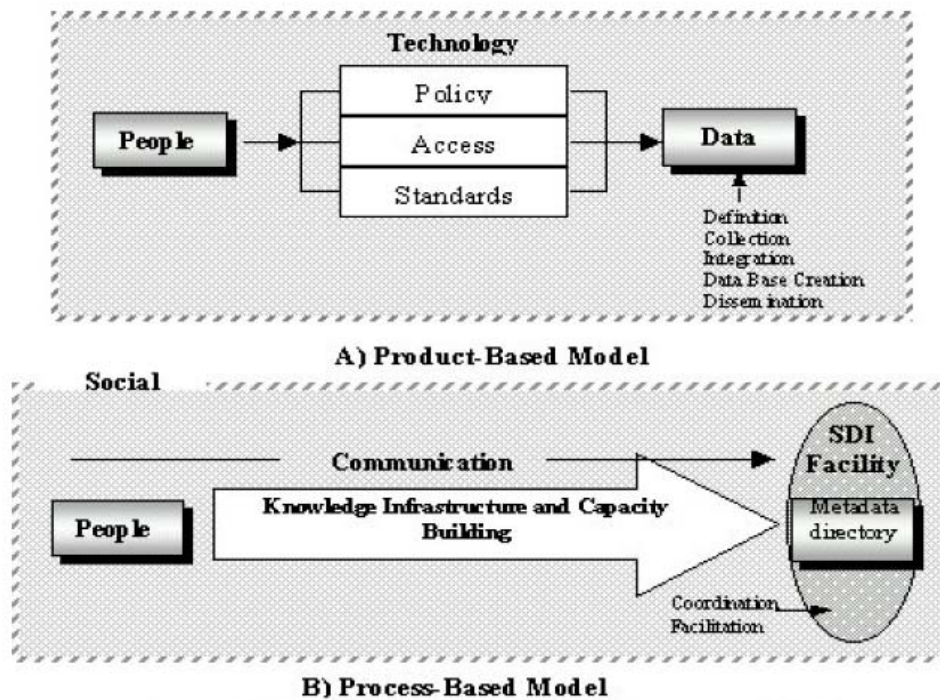


*Fig 4: SDI Hierarchy, Relationships among different levels of SDI and levels of Planning (Adapted from Rajabifard et al, 2000).*

## 2.6 SDI Development Models

Rajabifard, and Williamson, (2003b), identified two models namely product-based and process-based that can be identified in contemporary SDI development, as illustrated in *Figure 5*. The product-based model (*Figure 5A*), represents the main aim of an SDI initiative being to link existing and upcoming databases of the respective political/administrative levels of the community. The process-based model, (*Figure 5B*) presents the main aim of an SDI initiative as defining a framework to facilitate the management of information assets. In other words, the objectives behind the design of an SDI, by any coordinating agency, are to provide better communication channels for the community for sharing and using data assets, instead of aiming toward the linkage of available databases.





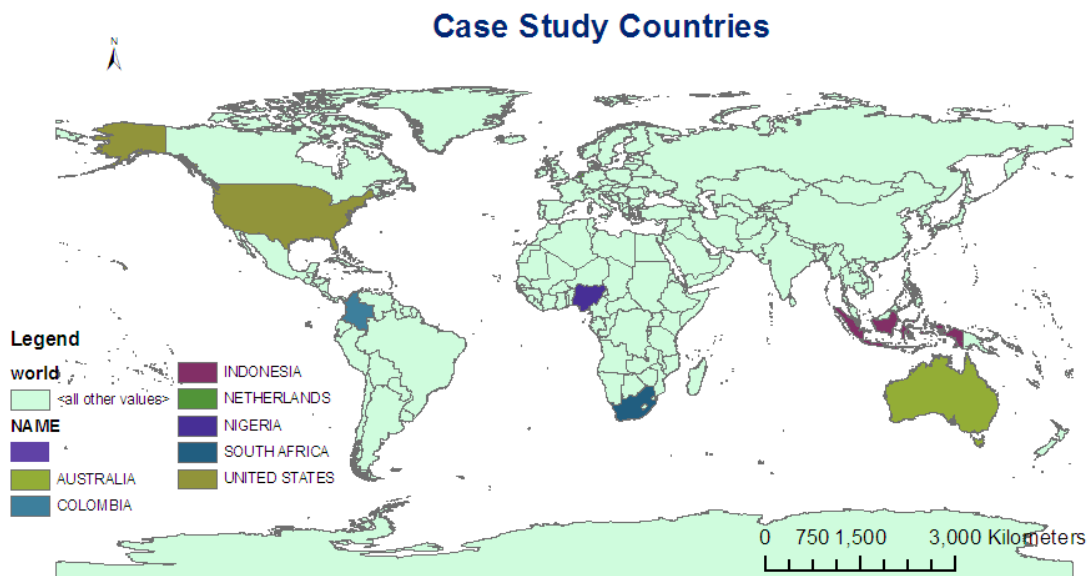
*Figure 5: Product and Process based models for SDI development (Rajabifard and Williamson, 2003b).*

## 2.7 National SDI Initiatives

Since the publication of the Executive Order 12906 on ‘Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure’ (President Clinton, USA, 1994), many countries throughout the have initiated NSDI. The goal of these infrastructures is to reduce duplication of effort among agencies, improve quality and reduce costs related to geographic information, to make geographic data more accessible to the public, to increase the benefits of using available data, and to establish key partnerships with states, counties, cities, tribal nations, academia and the private sector to increase data availability, (FGDC, 2006). According to Rajabifard *et al*, (2003c), ‘the national SDI is an initiative intended to create an enabling environment for a wide variety of users to access and retrieve complete and consistent datasets with national coverage in an easy and secure way-the national

SDI forms a fundamental framework to exchange data across many agencies and disciplines.’

NGDI of Nigeria is the primary case study NSDI. However, in order to have a comprehensive and comparative analysis of NGDI, other NSDI of other countries have to be reviewed. Six countries were selected, using the United Nation indices for human development of 2007 that divided the world into highly developed and developing nations. From the highly developed world, Australia (ASDI), The Netherlands (NGII), and United States (NSDI) were selected. From the developing nations, Colombia (ICDE), Indonesia (INSDI) and Republic of South Africa (NSIF) were selected. In addition to this development based criteria, the selection reflected geographical distribution, in that one country was selected from each continent, (Figure 6).



*Figure 6: Map showing case study countries.*

### **2.7.1 Australian Spatial Data Infrastructures (ASDI) - Australia**

The Australian Spatial Data Infrastructure (ASDI) is a national framework for linking users with providers of spatial information. The ASDI comprises the people, policies and technologies necessary to enable the use of spatially referenced data

through all levels of government, the private sector, non-profit organizations and academia.

Busby and Kelly (2004) stated that the Australian Spatial Data Infrastructures is designed to empower users by facilitating ready access to spatially referenced information, no matter where it is held. Initiated by the Australian Commonwealth and State and Territory governments in 1986, under the auspices of ANZLIC–The Spatial Information Council, the ASDI links SDI that are being established within each of the nine government jurisdictions throughout Australia. The ASDI is also reaching out to the private and education sectors and the wider community

## **Components**

### ***Fundamental Datasets***

Clarke, *et al* (2003) stated that one important early initiative was the fundamental datasets scoreboard project, which was designed to focus attention on the availability of key reference ASDI datasets. Ten themes were selected for audit –administrative boundaries, cadastre, elevation, land use, place names, roads, street addresses, vegetation and water. These datasets are used by multiple GIS applications, and underpin many spatial products and services.

### ***Access Network***

In 1995, ANZLIC established a Metadata Working Group to design and develop a national spatial data directory system. The Australian Spatial Data Directory (ASDD) is an online directory that enables people to discover what spatial data is available throughout Australia. The information contained in the directory is called metadata.

Clarke (2001) states that the clearinghouse component of the ASDI is not well defined beyond the central role of the ASDD. Busby and Kelly (2004) maintains that ‘Like other national clearinghouse initiatives based on client-server architecture and largely driven by data providers, the ASDI are proving difficult to sustain in its present form.

### ***Standards***

In response to changing user expectations, SDI in Australia are moving towards a web services model based on new international standards (ISO19115 and OGC Catalog Service specification). This will better meet the needs of a more aware and growing user base and make it easier to sustain the commitment to enhanced data discovery and access.'

### ***Policies***

ANZLIC has prepared a set of guiding principles to assist the preparation of a model spatial data access and pricing policy. The policy is aimed at providing easy, efficient and equitable access to fundamental spatial data', (Guiding Principles for Spatial Data Access and Pricing Policy, 2001). These principles emphasize easy, efficient and equitable community access and the maximizing of net benefits, and there is much less variation between jurisdiction pricing policies today, (Clarke, *et al* 2003). However, each jurisdiction is responsible for determining its own access conditions and arrangements. All jurisdictions have worked towards developing data pricing and access policies. Two recent national developments which underline the trend towards a more open pro-user spatial data pricing policy within Australian governments are documented in Clarke, *et al*, (2003).

### ***Institutional Arrangements***

ANZLIC comprises one representative from each of the eight Australian state and territory governments, one from the Australian Commonwealth Government, and one from the New Zealand Government. Each of these representatives is the head of the spatial information coordinating body in their respective jurisdictions, ensuring that ANZLIC represents all the public sector spatial data agencies.

## **2.7.2 National Spatial Data Infrastructure - USA**

Executive Order 12906 (Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure) calls for the establishment of the National Spatial Data Infrastructure defined as the technologies, policies, and people

necessary to promote sharing of geospatial data throughout all levels of government, the private and non-profit sectors, and the academic community. The goal of this Infrastructure is to reduce duplication of effort among agencies, improve quality and reduce costs related to geographic information, to make geographic data more accessible to the public, to increase the benefits of using available data, and to establish key partnerships with states, counties, cities, tribal nations, academia and the private sector to increase data availability, (FGDC, 2008). The Federal Geographic Data Committee (FGDC), established by the President's Office of Management and Budget to coordinate geospatial data activities, is charged with coordinating the development of the NSDI through three major activities: establishment of a National Geospatial Data Clearinghouse; development of standards for data documentation, collection, and exchange, and development of policies, procedures and partnerships to create a national digital geospatial data, (FGDC, 2005).

## **Components**

Since its inception, FGDC has worked to implement the six basic building blocks, or common elements, of the NSDI: metadata, clearinghouse, standards, framework, geospatial data, and partnerships. Each of these components serves as a cornerstone in establishing consistency and structure when it comes to documenting spatial data for everyday applications, as well as in building a distributed network of producers and users that facilitate data sharing. Nebert (2006) captures in *Figure 7*.

### ***Fundamental Datasets***

Geospatial data themes providing the core, most commonly used set of base data are known as framework data. They are *geodetic control, orthoimagery, elevation and bathymetry, transportation, hydrography, cadastral, and governmental units*, (NSDI Framework Factsheet, 2004). The framework is a collaborative community based effort in which these commonly needed data themes are developed, maintained, and integrated by public and private organizations within a geographic area. The framework is one of the key building blocks and forms the data backbone of the

NSDI. The framework concept was developed by representatives of county, regional, State, Federal, and other organizations under the auspices of the FGDC.

### ***Access Network***

The FGDC is tasked by Executive Order 12906 to develop procedures and assist in the implementation of a distributed discovery mechanism for national digital geospatial data. Geospatial metadata are critical to data discovery and serves as the fuel for the *Geospatial One-Stop* data portal and the *NSDI Clearinghouse*, (FGDC, 2008). The FGDC coordinates the sharing of geographic data, maps, and online services through an online portal, *geodata.gov* that searches metadata held within the NSDI Clearinghouse Network. *The geodata.gov portal* is operated in support of the Geospatial One-Stop Initiative to provide “one-stop” access to all registered geographic information and related online access services within the United States. *The NSDI Clearinghouse Network* is a community of distributed data providers who publish collections of metadata that describe their map and data resources within their areas of responsibility, documenting data quality, characteristics, and accessibility. Each metadata collection, known as a Clearinghouse Node, is hosted by an organization to publicize the availability of data within the NSDI. The metadata in these nodes is searched by the *geodata.gov* portal to provide quick assessment of the extent and properties of available geographic resources, (FGDC, 2008).

### ***Standards***

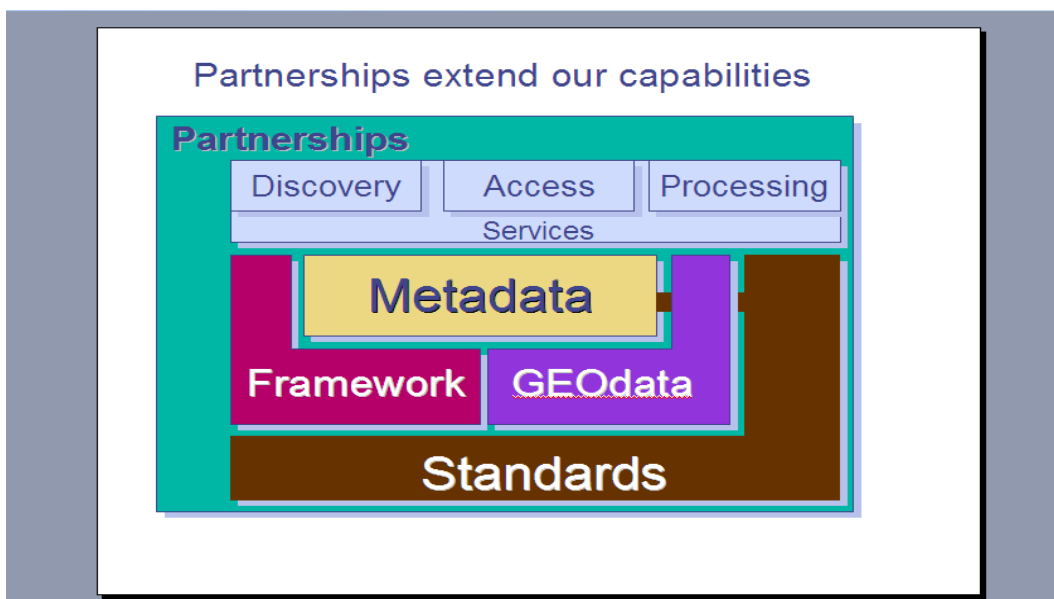
The FGDC develops geospatial data standards for implementing the NSDI, in consultation and cooperation with state, local, and tribal governments, the private sector and academic community, and, to the extent feasible, the international community. The FGDC develops geospatial data standards only when no equivalent voluntary consensus standards exist, in accordance with *OMB Circular A-119*. OMB Circular A-119 directs Federal agencies to participate in voluntary consensus standards bodies. Some key voluntary consensus standard bodies include ISO Technical Committee 211 (ISO TC 211), Open Geospatial Consortium (OGC) and World Wide Web Consortium (W3C).

### ***Policies***

The U.S. Office of Management and Budget and the U.S. Congress set policy for Federal agencies. The Federal Geographic Data Committee, a Federal interagency coordinating committee, is guided by those policies in the design of programs, activities and technologies. The FGDC sets geospatial information policy in harmony with overall information policy. Executive Order 12906 is the Presidential Directive establishing NSDI.

### ***Institutional Arrangements***

The FGDC, established by the President's Office of Management and Budget, is charged with coordinating the development of the NSDI. The FGDC Coordination Group is comprised of chairpersons of the thematic Subcommittees and 'cross-cut' Working Groups, and representatives from Federal agencies and FGDC recognized stakeholder groups.



***Figure 7: NSDI Components (Nebert, Douglas, 2006).***

### **2.7.3 The National Geographic Information Infrastructure - the Netherlands**

*“The Dutch NSDI can be described as the result of various initiatives taken in a bottom-up approach for more than 10 years. Different stakeholders take initiatives and eventually reach agreements for collaboration and elaboration. Different actors are actively involved and the NSDI is of a very dynamic nature but was, until recent, without legal steering”, (INSPIRE State of Play Report, 2007).*

The three main providers of geographic information are the Cadastre, the Topographic Agency, and the Statistical Bureau, (Bas C. Kok and Bastian van Loenen, 2000).

RAVI, the Dutch council for Real Estate Information, developed the national structure plan for geo information, approved by the Dutch Council of Ministers in 1992. The main target of this vision was to increase the compatibility and exchange between the main core data sets. In 1995, RAVI launched a discussion document for the National Geographic Information Infrastructure (NGII) which is defined in respect to policy, geographic data sets, technology, standards, knowledge and education. The case for developing a NGII was also strengthened by the emergency needs created by the severe flooding that took place in 1995, (SAI Publication, 1999).

#### **Components**

##### ***Fundamental Datasets***

Kok and Loenen states that “the NGII and e-government processes are based on the concept of core data – data that most people and organizations need in solving problems. This core data concept is similar to the FGDC’s Framework Data Concept.” In addition to the cadastral database and socio-economic data, the two foundation blocks are the 1:10,000 scale maps for the whole country which is being developed by the Topographic Agency, and the large scale 1:1,000 map being developed by a consortium including the Cadastre, Dutch Telecom, local government, and the utilities, (SAI, 1999)



### ***Access Network***

It is estimated that there are 36,000 data sets in the public sector of potential use to others. Documenting these datasets and making them visible to potential users is therefore a crucial task. For this purpose a National Clearing House Project was initiated by RAVI in 1995.

“Technically access to the data sets is being provided among others through the establishment of National Clearinghouse Geo-information (NCGI), an electronic metadata information desk. The clearinghouse provides a means for finding available data set, public and private, via the Internet. At the moment the NCGI provides only metadata, free of charge, contained in a central database. The data sets themselves are contained at the owning organization, being among others government agencies, provincial and local authorities”, (Onsrud, 1998). The NCGI promotes the access to (public) GI; the standardization of metadata; the use of geo-information; the use of OpenGIS technology.

### ***Institutional Arrangements***

Since its initiation, the NGII was coordinated by RAVI, through the foundation NCGI (in which RAVI has a leading role). RAVI had a scientific advisory board, a *Platform for Public Agencies* and *Platform for Companies* (INSPIRE 2007). RAVI has been playing a crucial role in developing a vision for an NGII, creating awareness, and developing political support. Much progress has been made over the last few years, but given that this organization has no formal powers to compel public agencies to participate in the plan, developing consensus and sense of purpose is difficult. In the future, Geonovum will take over the role of RAVI and NCGI.

### ***Policies***

The NSDI initiative is partially integrated in legal instruments. The Ministry of Spatial Planning and Environment, MinVROM has the formal responsibility for GI related matters in the Netherlands. A Ministerial Decree of 2 June 2006 installed the GI-Board. Its task is to make recommendations to the minister of housing, spatial planning and environment and to other ministers and public authorities on strategic topics regarding spatial information in the Dutch public sector. In addition, it should

propose frameworks for coordination, infrastructure and conditions for access, stimulating use, and standardization of spatial information. It should also advise the government on European and international affairs, and organize projects to improve the Dutch spatial data

### ***Standards***

SAI publication (1999) outlines linking of the core data sets, overcoming the barriers to data availability, issues of data pricing, data digitization and awareness creation as some of the burning issues. Netherlands response to the GSDI questionnaire (1998) highlighted that The RAVI seeks to achieve the status of a node in the European Geographic Information Infrastructure for the Netherlands and is a member of the European Umbrella Organization for Geographic Information (EUROGI), and that the NGII conforms to the EGII and ISO TC211 standards development.

### ***Institutional Arrangements***

Geonovum is the National Spatial Data Infrastructure (NSDI) executive committee in the Netherlands. The organization was founded in 2007 and devotes itself to providing better access to geo-information in the public sector. Geonovum develops and manages the geo-standards necessary to implement this goal. The tasks focus in particular on developing and controlling standards, making up-to-date geo-information accessible, developing knowledge and giving advice to the Council for Geo-information on technology and implementation aspects, (Geonovum, 2007).

#### ***European Umbrella Organization for Geographic Information (EUROGI)***

The emergence of regional spatial data infrastructure organizations began with the creation of the European Umbrella Organization for Geographic Information (EUROGI) in 1993 (Masser, 2003). EUROGI is an independently funded, non-governmental, and non-profit European organization that seeks to develop a European approach towards the use of geographic information technologies. “Its mission is to maximize the use of GI for the benefit of citizens, good governance and commerce. It promotes, stimulates, encourages and supports the development and use of geographic information and technology...” (EUROGI, 2008).

### *Infrastructure for Spatial Information in Europe (INSPIRE)*

INSPIRE is an initiative currently being prepared by the European Commission to support the availability of spatial information for the formulation, implementation and evaluation of the EU policies. It intends to set the legal framework for the gradual creation of a spatial information infrastructure. The INSPIRE policy vision is to make harmonized and high quality geographic information readily available for formulating, implementing, monitoring and evaluating Community policy and for the citizen to access spatial information, whether local, regional, national or international, (INSPIRE EU Directive, 2007).

INSPIRE State of Play (2007) reports that the Dutch Ministry of Spatial Planning and Environment (MinVRROM) assigned Geonovum to execute the INSPIRE programme in the Netherlands. Part of this programme is the development of the Dutch part of INSPIRE network, including national INSPIRE portal, connected to European INSPIRE portal, filled with geo-data and metadata and properly managed.

#### **2.7.4 National Spatial Information Framework (NSIF) - South Africa**

The National Spatial Information Framework (NSIF) is a national initiative to co-ordinate the development of infrastructure needed to support the utilization of spatial information in decision making. This building of a Spatial Data Infrastructure as it is termed in similar endeavors all over the world, includes policies, institutional arrangements, developing human resources and standards for geographic information, (NSIF,2008).

The South African Spatial Information Bill was passed on 13th May, 2003 “*To establish the South African Spatial Data Infrastructure, the Committee for Spatial Information, and an electronic metadata catalogue; to provide for the determination of standards and prescriptions with regard to the facilitation of the sharing of spatial information; to provide for the capture and publishing of metadata and the avoidance of the duplication of such capture;...*”, (Spatial Information Infrastructure Bill, May 2003 Revised) which established the South African Spatial Data Infrastructure (SASDI) as the national technical, institutional and policy framework

facilitating the capture, management, maintenance, integration, distribution and utilization

## **Components**

### ***Fundamental Data***

The NSIF Directorate, listed the following as Core data sets agreed upon by geographic information community: Cadastral Boundaries, Land cover, Hydrographic data, Services and Utilities, Elevation (DEMs), Administrative Boundaries, Digital Orthophotos.

### ***Access Network***

The Spatial Data Discovery Facility (SDDF) is a system for connecting spatial data users with spatial data sources, so that data can be exchanged. This will prevent costly duplication of effort in capturing and maintaining spatial datasets, (NSIF, 2008). According to the NSIF, the Spatial Data Discovery Facility (SDDF) is a “yellow pages” for accessing information about several hundred data sets. Danzfuss and Bishop (1999) state that the Spatial Data Discovery Facility (SDDF) is a web based application that allows users to discover the location and/or existence of spatial data. The design was based on three tier architecture: Database tier, Application tier and Presentation tier. There is a focus on developing mechanisms to improve access to existing information, avoid duplication in data collection and management and ensure that new data captured can be easily utilized together with existing geographic data, to enhance their collective values.

### ***Standards***

There is not much available data on standards component of South African NSDI.

### ***Policies***

In South Africa, the Directorate, NSIF is mandated to promote the development of the country’s SDI. This mandate is backed by the SDI Act which was signed into

operation on 28<sup>th</sup> of April, 2006. The SII Bill was published in Government Gazette No.25973, vol. 464 on 4<sup>th</sup> February 2004, and signed into operation by the President on 28<sup>th</sup> April, 2006.

### ***Institutional Arrangements***

The NSIF provides the parameters for a coherent national spatial data infrastructure and promote the utilization of spatial information in South Africa.

The NSIF is mandated to co-ordinate the development of infrastructure needed to support the utilization of spatial information in decision making. There are *NSIF membership* comprising surveyors, planners, geographers, IT technologist *and* three *Working Groups or Task Teams* on: policies, standards, and marketing and education.

### **2.7.5 Infraestructura Colombiana de Datos Espaciales (ICDE)-Colombia**

The Colombian Spatial Data Infrastructure, (*Infraestructura Colombiana de Datos Espaciales*, ICDE) is defined as the set of policies, standards, organizations and technology working together to produce, share, and use geographic information about Colombia in order to support national sustainable development. The ICDE is a young but promising initiative.

In the 1990's, an awareness of the benefits of geographic information started to grow in Colombia among municipalities, environmental agencies, oil companies, and the utilities sector, (GSDI Cookbook v.2, 2004). Colombian government agencies that have the mandate to produce geographic information are outlined in the GSDI Cookbook v.2, 2004. The development of NSDI in Colombia (ICDE) is a joint venture between various agencies and driven by the nation's programmes for governance to address national issues related to the environment, the economy, and social issues, (ICDE, 2008).

## **Components**

Main ICDE components may be defined as: administrative information policies and guidelines, geographic information standards including metadata, fundamental data, and a national geographic information network. (GSDI Cookbook v.2, 2004). Response to GSDI questionnaire (1998) indicated existence of metadata, clearinghouse, data standards, and core data.

### ***Fundamental Datasets***

Colombia Response to GSDI questionnaire (1998) identified the following basic datasets in building the national geographic database: Ground control points, transportation, hydrography, cadastre, relief, vegetation, land use, administrative, political areas, and geosciences.

### ***Access Network***

There is metadata availability in ICDE, and access mechanism is through the websites of the participating institutions. There is no clearinghouse yet.

### ***Standards***

A working group on standards and metadata is in place. A national geographic metadata standard was defined in March 1999 and standardization efforts are linked to ISO TC 211 and FGDC.

### ***Policies***

In Colombia, there is no formal mandate for the establishment and implementation of NSDI (Eelderink, 2006, GSDI Survey, 1998). According to Eelderink report, "IGAC guides the process but no official leader has been appointed. IGAC realizes that high-level support seems to be the major area requiring further efforts. No formal legal agreements exist to address issues such as privacy, access, use, pricing and liability".

### ***Institutional Arrangements***

There are well educated GIS/SDI experts in Colombia. The Centre of Research and Development on Geographic Information, CIAF, is in charge of carrying out training

courses. In the 1990s, NSDI awareness started to grow in Colombia, and presently most of the public institutions know about ICDE and understand its importance.

### **2.7.6 National Spatial Data Infrastructure in Indonesia**

The vision of Indonesian Spatial Data Infrastructure (ISDI) is “*to make the national fundamental datasets available, accessible and integrated in one national data standard*”, (Terima Kasih, 2005). Masser (2005) stated that in 1993, an interagency working group was established to identify the most important land data users and producers to establish a national geographic information system for planning purposes in Indonesia. Bakosurtanal, the National Coordinating Agency for Surveying and Mapping, coordinated the working group.

#### **Components**

##### ***Fundamental Datasets***

Under the Indonesian National Spatial Data Infrastructure (NSDI)'s concept, the fundamental datasets and the thematic data sets will be made available. The fundamental data sets comprises of geodetic framework; topographic databases, cadastral databases and bathymetric databases, (GSDI Survey, 1998). The geodetic control network includes the National Geodetic horizontal, vertical and gravity control networks spanning the whole Archipelagoes of Indonesia (more than 17.000 islands, large and small). Other than this, various thematic data bases cover International and National Boundaries, Land and Marine resources data bases, Indonesian Economic Exclusive and Continental shelf data bases, etc. Most of the fundamental data sets, as well as the thematic data sets, are available in digital format. Government institutions produce most data; the government requires that all producers deliver data to users. However, most data is produced for their own use, data is not well managed, and there is little awareness to disseminate data, (Matindas, *et al*, 2004).

### ***Access Network***

Matindas *et al* (2004) indicated that there is little awareness to disseminate data, and there is no data directory or metadata. The development of the clearinghouse is a long and complex process because it involves a large number of datasets, many data producing institutes and quite a number of professionals. The FGDC standard has been adopted for the collection of metadata. The access network can be accessed through the website of Bakosurtanal.

### ***Standards***

The FGDC standards have been adopted. However, the existence of standardized metadata in almost all data producing institutes is inappropriate, (Puntedewo and Nataprawira, 2004). In the second phase of the SDI initiative (2005-2009), Indonesia started with the development of a National Spatial Information System for the standardized data collection. However, regulations seem not to be available yet.

### ***Policies***

In July 2007, establishment of NSDI was institutionalized by a presidential decree. The NSDI will benefit the entire sector as it would provide spatial data not only of central. Government and provincial governments but also up local government level. The data will be available on the net for the government and private sectors. Recommendations for the establishment of legal aspects and policy within the Indonesian SDI are described in Abdulharis *et al*, (2005). A long term vision document (up to 2020) is also available.

### ***Institutional Arrangement***

One of the mission statements of *Badan Koordinasi Survei dan Pemetaan Nasional – BAKOSURTANAL* (National Coordinating Agency for Surveying and Mapping) is “to build National Spatial Data Infrastructure (NSDI), which covers elements of institution, regulation standard, spatial fundamental data, human resources, research and technology of surveys and environment for national development”,(BAKOSURTANAL,2008).



Bakosurtanal is the coordinator of the Indonesian SDI, and it carries out this function in collaboration with other agencies. Bakosurtanal has broken down the development of the infrastructure in phases. In 2001, the first phase started with the development of the SDI nodes, databases and metadata, a clearinghouse and standards. The following phase, which started in 2005, focuses on the improvement of coordination mechanisms; the completion of the spatial databases and national metadata developments, and the activities of the clearinghouse. Bakosurtanal have developed a long term NSDI vision, up to 2020. Issues such as the implementation of local clearinghouses and the maintenance of spatial fundamental data, and standards have been taken into considerations.

## **2.8 Summary and Conclusions**

In this chapter, the status of NSDI of Australia, USA, Netherlands (developed countries) and South Africa, Colombia and Indonesia (developing countries) were reviewed. Tables summarizing each of these respective NSDI are presented in *Appendix 1*.

This chapter has defined some fundamental concepts and terminologies within the field of Spatial Data Infrastructures. We have identified and selected six nations with their NSDI at different development continuum, and analyzed them with a view to finding the driving forces behind the initiatives, their present status and future direction.

The analysis of the definitions of SDI by respective NSDI is similar, and their fundamental (core) datasets are similar. On the driving forces behind the initiatives, there is however some variations between developed countries and developing countries. While the major driving force is to promote data sharing and reduce duplication in the developed world, it is to promote awareness in the use of geo-information to address national issues such as governance and environment in developing countries.

Access Network are better developed in countries of United States and The Netherlands with the presence of apex clearinghouse, while other countries in less developed countries show data/metadata through their respective websites. Some of

the NSDI have no formal mandate such as Colombia, and the Netherlands. One thing in common with all the reviewed NSDI is that their development is a continuous process as awareness and technology improves. Having reviewed the status and direction of the selected case study countries, an abridged version of comparative analysis of their summary is presented in *Table 1*, while more comprehensive comparative tables are presented in *Appendix 2*.

		CASE STUDY COUNTRIES						
		Developed World			Developing World			
SDI COMPONENT	SPECIFIC VARIABLES	<i>Australia</i>	<i>United States</i>	<i>Netherlands</i>	<i>South Africa</i>	<i>Colombia</i>	<i>Indonesia</i>	<i>Nigeria</i>
<b>Data</b>	<b>Core datasets Data Format Updating Resolution</b>	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
<b>Access Network</b>	<b>Metadata Access Mechanism Network Architecture Clearinghouse</b>	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
<b>Standards</b>	<b>Data Transfer Transfer Standard  Interoperability</b>	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
<b>Policy</b>	<b>Coordinating Body SDI Directive Data Access and Pricing</b>	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	No No No	Yes Yes Yes	Yes No Yes
<b>Institutional Arrangements</b>	<b>Coordinating Body Participating Agencies Working Groups</b>	Present Yes No	Present Yes Yes	Present Yes No	Present No Yes	Present Yes Yes	Present Yes Not Defined	Present Yes No

*Table 1: An abridged comparative analysis of case study countries.*

## **3. The NGDI and Research Methodology**

### **3.1 Introduction**

The National Geospatial Data Infrastructures of Nigeria (NGDI) is an NSDI initiative that among other objectives is to promote the production, dissemination and use of geospatial information for poverty alleviation, food security, job creation, improvement of quality of life, good governance, education and health care delivery, water resources management, environmental and disaster management, transportation, tourism, communications, gender mainstreaming, national defense and security, economic planning and natural resources management.

Other objectives include the discovery, harmonization and standardization of geospatial data production and management, and the provision of a platform for data sharing thereby eliminating data duplication and conserving cost and time spent in producing already available data, (Agbaje and Akinyede, 2005). An efficient functioning NGDI and the associated GI Policy is regarded as vital requirements for sustainable national development.

This chapter focuses on the National Geospatial Data Infrastructure (NGDI) of Nigeria: the development of the NGDI from policy formulation, stakeholders, organization, problems, challenges and prospects as documented in the literature will be presented. The chapter will also present research methodology adopted in this study.

### **3.2 Nigeria at a Glance**

Nigeria, officially named the Federal Republic of Nigeria is a federal constitutional republic comprising thirty six states and one Federal Capital Territory. There are 774 local government areas in the country. The country is located in West Africa and shares land borders with the Republic of Benin in the West, Chad and Cameroon in the East, and Niger in the North. Its coast lies on the Gulf of Guinea, part of the Atlantic Ocean, in the south. The capital city is Abuja (9°10'0"N, 7°10'0"E). It has a

surface area of 923,768km<sup>2</sup> (Figure 8). It has a population estimate of 148 million people comprising about 250 ethnic groups.



*Fig 8: Location map of Nigeria, (©Oxford Cartographers, 2008)*

Nigeria has a varied landscape. From the Obudu Hills in the southeast through the beaches in the south, the rainforest, the Lagos estuary and savanna in the middle and southwest of the country and the Sahel and the encroaching Sahara Desert in the extreme north. Nigeria is also an important center for bio- diversity. Nigeria’s main rivers are the Niger, the Benue which converge and empty out in the Niger Delta, one of the world’s largest river deltas. As a federal state, it has three-tier government: the federal, the state, and the local government, all coordinated by the ministries, agencies and parastatals.

### **3.3 NGDI & National Geoinformation Policy**

#### **3.3.1 The Driving forces**

Due to the increasing awareness of the use of GI for decision-making over the past years, coupled with the expected availability of primary dataset from the Nigerian Satellite, the country has realized the need to adopt policies for promoting greater awareness and public access to standard and coordinated geo-spatial data production, management and dissemination by all sectoral institutions and the need for the establishment of a Geospatial Data Clearinghouse at various levels in the country (local, state and federal) and linkages with the private sectors. Other driving forces include: New Partnership for Africa's Development (NEPAD)-provision of relevant GI to facilitate national development and regional integration; call of the United Nations Economic Commission for Africa (UNECA) to establish SDI, and Information and Communication Technology as it permits GI sharing and growth.

In September, 2003, the final draft of Nigerian Geoinformation Policy was formulated by the Federal Ministry of Science and Technology, Abuja. The vision of the GI Policy is to enhance optimal use of Geospatial Information as a critical resource in all phases of sustainable national development for the alleviation of poverty and improvement of quality of life of the people of Nigeria by establishing and maintaining an NGDI, (National Geoinformation Policy). The references to this section unless otherwise stated refer to National Geoinformation Policy.

#### **3.3.2 The NGDI Organization**

The mission of the NGDI, among others is to generate and disseminate geospatial databases, which are vital for development at the National, State and Local levels in Nigeria by facilitating cooperation and collaboration among GI stakeholders. To achieve these objectives, the National GI Policy has provided for the establishment of NGDI Council, the NGDI Committee and the NGDI Sub-Committee.

### ***The NGDI Council***

According to the National GI Policy, government shall establish a National Geospatial Data Infrastructures (NGDI) Council whose function shall be to develop all policy guidelines on NGDI with the Vice President of the Federal Republic of Nigeria as the Chairman and the Federal Ministry of Science and Technology as its Secretariat. However, at the time of this research, the NGDI Council is yet to be inaugurated.

### ***The NGDI Committee***

A 27- member committee was inaugurated by the Honorable Minister of Science and Technology. The Committee members are drawn from the academia, public organizations, and GI related NGOs, and private sectors. The Committee members are well spread in terms of stakeholders and geographical distribution across the country in order to enforce partnership and create an enabling environment for data access and dissemination. The National Space Research and Development Agency (NASRDA), is the lead Agency while other GI Producers shall be NGDI node agencies. The composition of the committee is shown in *Table 2*. The functions of the NGDI Committee are well documented in Agbaje and Akinyede, 2005.

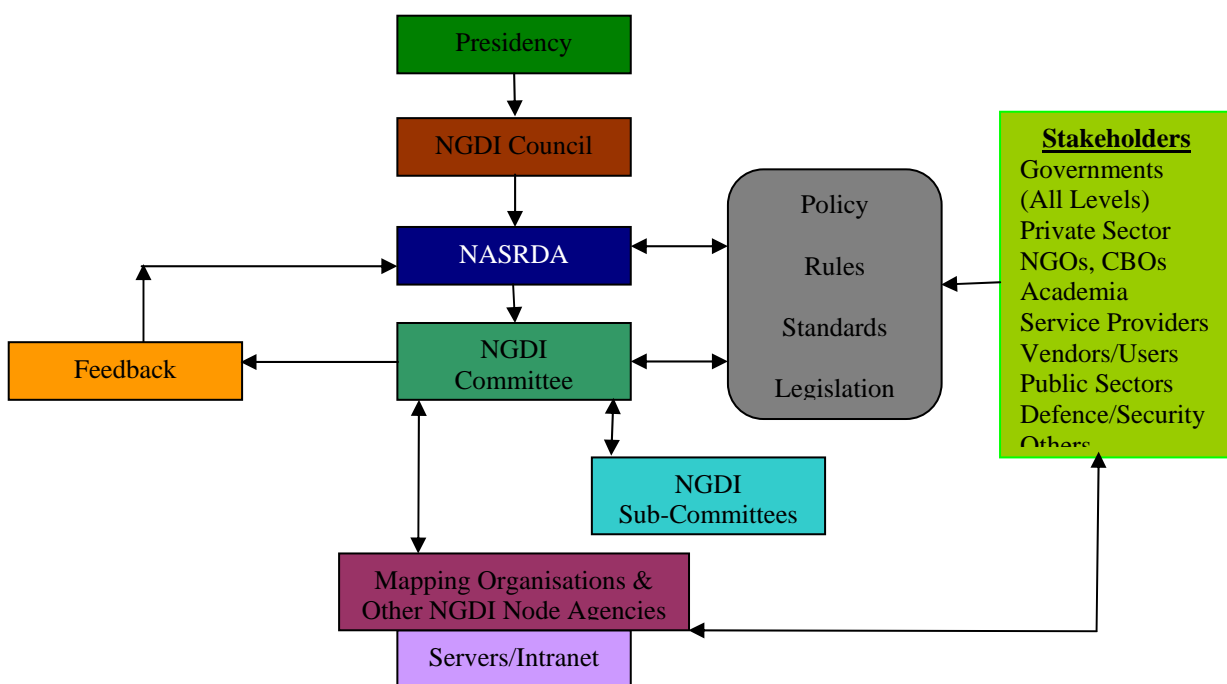
<b>No</b>	<b>Representation</b>	<b>Remark</b>
2	NASRDA	Lead Agency
2	Universities	Universities selected in rotation
2	Poly/Monotechnics	Poly/Monotechnics selected in rotation
6	Six Geopolitical zones-States nodal agencies	States within each geopolitical zone selected in rotation
4	Private Sector, Inter-governmental & Non-governmental organizations	GI related sectors
11	Federal Ministries/Agencies	See Annex...

***Table 2: Composition of NGDI Committee ( Agbaje and Akinyede, 2005)***

### *NGDI Sub-Committee*

At the inaugural meeting of the NGDI Committee, the following six sub-committees were created in line with the recommendations of the Stakeholders/Users meeting of February 2003. They include: Geospatial Datasets Sub-Committee, Standards Sub-Committee, Clearinghouse and Metadata, Capacity Building and Awareness, Legal Sub-Committee, and Sustainability and Funding Sub-Committee.

The activities and functions of each sub-committee are well documented in Agbaje and Akinyede 2005, and Kufoniyi 2004.



*Figure 9: NGDI Organizational Framework (National Geoinformation Policy, September, 2003).*

### **3.3.3 NGDI Components**

#### *The Fundamental Datasets*

The following datasets shall constitute the fundamental datasets for the NGDI: Geodetic control database, topographic database/DEM, digital imagery and image maps, administrative boundaries' data, cadastral databases, transportation data,



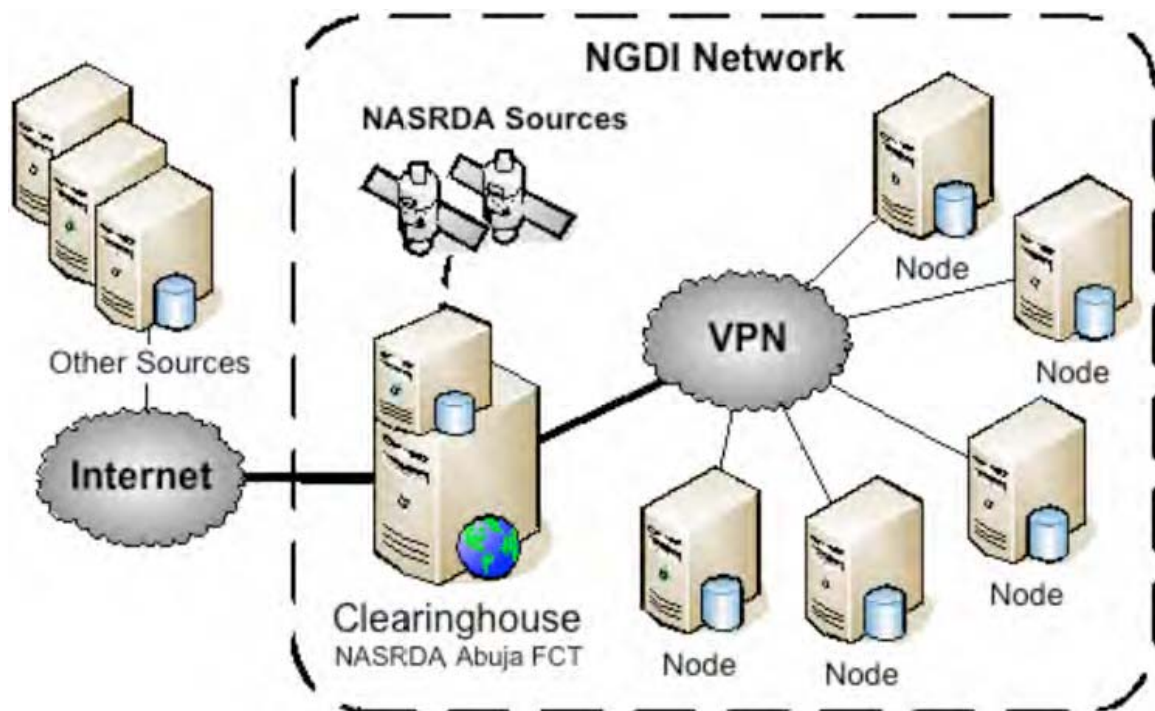
hydrographic data, land use/land cover data, geological database, and demographic database. Thematic Datasets on the other hand are derivative datasets from fundamental datasets.

### ***Access Network***

National GI Policy has a comprehensive statement on metadata of which the main ideas can be summarized as the following, “Every geospatial data producer shall provide metadata for each of its data holdings; the metadata of any dataset shall be updated whenever the dataset is updated; the metadata produced shall conform to the national standard; the metadata structure shall strive to conform to the ISO metadata standard (ISO TC211); metadata shall accompany the dissemination of all geospatial data. The importance of metadata cannot be overemphasized, as it gives descriptive information about the available data.

The apex Clearinghouse shall be at NASRDA as coordinating agency with Clearinghouse nodes at other geospatial data producing agencies (*Fig.10*); there shall be free access under a legal framework (protection of copyright) to other community and private datasets, and each geospatial data-producing agency shall establish a metadata database server as a NGDI node, linked to the apex Clearinghouse.

The availability of clearinghouse catalogue is paramount in any NSDI, and can be used as a yardstick in measuring the extent to which the NSDI is advanced.



*Fig 10: A Proposed Model of NGDI Network with a common Clearinghouse (Agbaje et al, 2008).*

### **Standards**

Standardization is of paramount importance to NGDI in information sharing, interoperability of data and connectivity of information systems. Some of the Policy Statements pertaining to standards include: the NGDI-endorsed standards shall cover data structure, data quality, data format, classifications, feature coding and metadata content, and shall strive at conformity with their counterpart ISO standards (e.g. ISO 15046) after endorsement by the Standard Organization of Nigeria (SON), the NGDI Committee through the lead agency shall prescribe a set of common standard file formats (e.g. DXF, DLG, TIFF and JPEG) as the National Standard Exchange Format to facilitate easy transfer/exchange of data.

### **Policy**

The NGDI has an advantage of having a national policy establishing it. The policy addressed all the components of the NGDI including funding issues. According to the policy NGDI lead agency and the NGDI Committee shall actively promote funding of all NGDI node agencies and work out further mechanism of obtaining

fund for NGDI. The NGDI funding model is highly skewed towards government patronage. In the policy the budgetary provision for NGDI implementation is outstanding; it addresses means of funding of all NGDI components. The fund shall accrue from: minimum 2.5% of annual budget; 10% of national ecological fund; 0.5% profit after tax of private organization; and all income generated from access charges and data sales; and international fund and grants.

### ***Institutional Arrangements***

The NGDI Project in Nigeria has administrative/organizational framework that is multidisciplinary, interagency and inter-sectoral network of institutions coordinated by the lead Agency, National Space Research and Development Agency, (*Figure 9*). .NASRDA shall work in close collaboration with the relevant National, State and Local Government Legislative Committees and Geospatial data producing organizations. (*NGDI Council, Committee and Sub-committee have been highlighted in section 3.3.2*). This arrangement will remove the institutional barriers that have in the past inhibited GI sharing among the producers and users. The coordinating Agency shall have powers to enforce rules and standards. Because the GI Policy is yet to be signed into law, this power of NASRDA to enforce rules and standards is not yet achieved. Government at different levels and organization are still creating spatial data for their own use and according to their own need. The stakeholders that would collectively ensure the successful realization of the NGDI vision shall include but not limited to: Government at all levels, Private Sector Agencies, Non Governmental Organizations (NGOs), Academic and Research Community; Service Providers/Vendors and End users, Public Sector Agencies, Defence/Security Agencies.

### ***Capacity Building***

There are strategies for capacity building such as ensuring that all GI related projects are locally implemented to a minimum of 75%. There has been significant progress in this direction as geographical information systems is now introduced into geography curriculum in the secondary schools. However, much work is still needed

as professionals presently with relevant GI skills are very few. This can be improved by in-service training, and sending some GI staff for advanced degree programmes.

### **3.4 Research Methodology**

#### **3.4.1 Introduction**

Since the late 1970's, many National Survey and Mapping organizations began to recognize the need to justify the large public investments they had received by improving access to and encouraging wider use of the spatial information in their custody (Groot, 1997). NSDI are mainly established by government bodies and resourced by public funds hence the need to assess their progress (Grus *et al*, 2007). NGDI has an impressive blueprint as outlined in the GI Policy. However, implementation of the policy is a different ball game. Sometimes, what is obtainable in reality is quit different from what is prescribed in the policy and professed in the literature, hence this questionnaire survey.

#### **3.4.2 A Review of SDI Assessment**

Due to their complex, dynamic and evolutionary nature SDI assessments are difficult, (Grus *et al*, 2007).

SDI have similar characteristics with Complex Adaptive Systems (CAS) in that they are open systems in which different elements interact dynamically to exchange information and where the system as a whole has emergent properties that cannot be understood by reference to the component parts, (Marion *et al*,2003).

“As SDI can be treated as a Complex Adaptive System, the assessment should include strategies for evaluating those kinds of systems. One strategy is to use multiple assessment approaches and methods”, (Grus *et al*, 2007). Some of the SDI assessments that have been done using the multi-view approach include:

- Assessing an SDI Readiness Index, (Delgado *et al*, 2005);
- World Status of NSDI Clearinghouses, (Cromptvoets *et al*, 2003);
- INSPIRE State of play: Generic approach to assess the status of NSDI, (Vandenbroucke & Jansse, 2008);

- A Review of the Status of Spatial Data Infrastructures Implementation in Africa, (Makanga and Smith, 2008).

### **3.4.3 Adopted Methodology**

For this study, a multi-view SDI assessment framework as proposed by Grus *et al* (2007) was adopted. The main idea of multi-view SDI Assessment Framework is that it acknowledges the multi-faceted character of SDI, and assesses the SDI from different viewpoints. Four view points were established and these are:

- Policy and Legal issues
- Technical issues
- Funding
- People.

A set of seventeen (17) more specific indicators were formulated which are based on the four viewpoints.

### **3.4.4 Questionnaire Survey**

A questionnaire is a commonly used method of collecting information from respondents. It is convenient for collecting data over large geographical distances and can be very useful in exposing the reality of the situation and identifying current problems.

The respondents were chosen from the various stakeholders of NGDI: the coordinating institution, the nodal agencies, committee members, users, government, private organizations, academia and NGOs.

The purpose of the questionnaire is

- To examine the different components and sub-components of NGDI;
- To assess the level of implementation of the NGDI Project;
- To identify some problems encountered in the implementation project.

The main points of reference for the questionnaire are the view points identified in 3.4.3 and broken down into a set of seventeen indicators (see *Appendix 3* for the sample of the questionnaire). The Information was compiled to establish scores against the indicators, (*Table 2*).

For all possible indicators, there were six possible responses namely:

- Absolutely True
- Fairly True
- Slightly True
- Slightly False
- Absolutely False
- Not Sure

In addition to these close ended questions, a provision was made for open ended comment at the end of the questionnaire.

For purpose of Ranking:

- Absolutely False = 1
- Slightly False = 2
- Slightly True = 3
- Fairly True = 4
- Absolutely True = 5

A total of 20 questionnaires were sent out for this survey. The questionnaires were sent to the stakeholders and users of geoinformation in Nigeria, both in government and private sectors; producers and users; within the capital city and up-country; NGOs and academia. There were significant limitations observed during the data collection process between October, and November 2008. One of them was hesitance on the part of the government officials to respond on questions which involve government or which they perceive should be answered by their senior officers. Some higher officers meanwhile delegated their junior officers to respond to the questionnaire. Attempt to overcome this problem was made by removing personal information section from the questionnaire and resending them. Response increased by more than 30%. The other major problem was how to reach the potential respondents. Some of the potential respondents were not reached because their email addresses were no longer functioning.

### **3.5 Conclusions**

This chapter has given a very brief introduction of Nigeria, the location of the main case study organization. It has reviewed the NGDI mostly as documented in the

literature and National GI Policy; the organization, policy statements with regards to the major components, and milestones. The chapter goes further to highlight some realities of the NGDI that are not moving according to the NGDI Policy. These realities answer some of the research questions of this work.

Finally, the research methodology adopted for the work was elaborated. Questionnaire survey was justified, structure of the questionnaire outlined, and the limitations of the survey highlighted.

## 4. Results

### 4.1 Introduction

In this chapter, the results of the questionnaire collected from the respondents are presented. The questionnaire was sent to 20 people in Nigeria by email. Out of these total, 9 questionnaires were returned which is 45 percent of the questionnaire sent out. Moreover, the respondents are from relevant people and are here considered as a true representative of the population.

The raw result is presented in *Table 2* after which the data are analyzed from different perspectives (multi-view SDI assessment framework), and presented in charts, (*Figures 11-14*).

In *Table 2*, the scores from the respondents are presented against the indicator classes. The respondents which are nine in number are represented by numbers 1-9. Each indicator class is divided into specific indicators represented by alphabets. Each of these alphabets represents and corresponds to a question in the questionnaire. The response from each respondent for each specific indicator is scored on a scale of 0 -5 (*section 3.4.4*).

Finally, the scores of each respondent for all the specific indicators in all the indicator classes are summed and converted to percentage. This percentage now represents the total score given to the NGDI by the respondent (*section 4.2.4*).



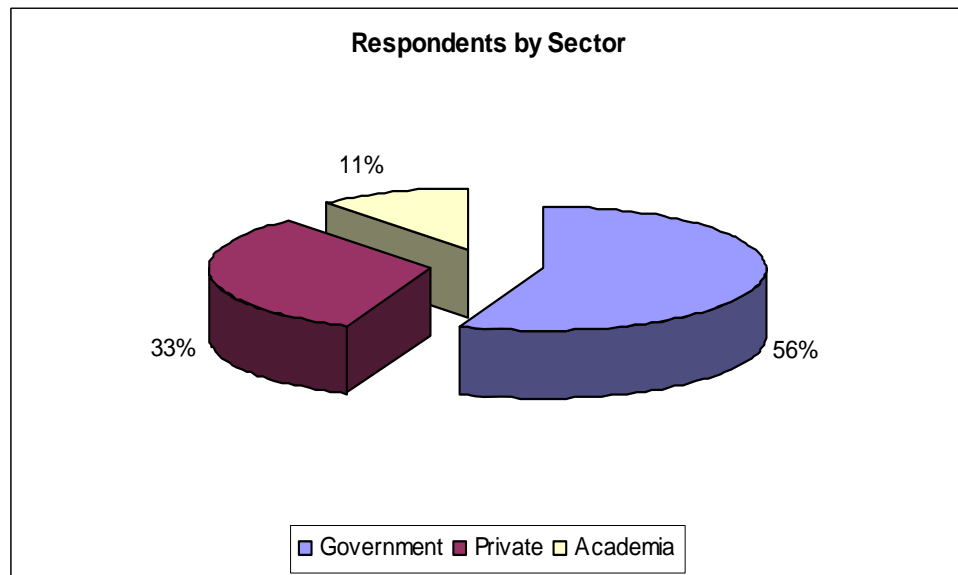
Indicators Class	Policy and Legal Issues					Technical						Funding			People			
	A	B	C	D	E	A	B	C	D	E	F	A	B	C	A	B	C	Score
<b>1</b>	5	5	5	3	2	5	1	5	4	2	1	3	1	1	4	3	4	<b>63.5</b>
<b>2</b>	5	5	5	4	4	3	5	5	4	3	2	4	3	4	0	5	5	<b>77.6</b>
<b>3</b>	5	3	3	0	1	1	1	3	3	2	1	4	1	1	2	1	4	<b>42.3</b>
<b>4</b>	5	5	3	3	1	1	1	3	0	1	2	3	4	2	0	3	4	<b>48.2</b>
<b>5</b>	5	5	1	3	1	0	3	3	3	0	1	3	3	1	0	3	5	<b>47.0</b>
<b>6</b>	4	4	1	4	4	1	2	2	1	1	1	4	3	4	1	2	4	<b>50.5</b>
<b>7</b>	5	5	4	5	4	4	4	4	5	4	5	3	3	4	1	4	5	<b>81.2</b>
<b>8</b>	5	5	5	0	0	1	1	5	1	0	1	5	4	0	0	5	5	<b>50.5</b>
<b>9</b>	0	0	0	0	0	5	1	1	1	0	0	1	0	1	1	1	0	<b>14.1</b>

*Table 3: Result of Questionnaire Survey converted to scores*

## 4.2 Analysis by Respondents

Based on the responses a detailed analysis has been performed.

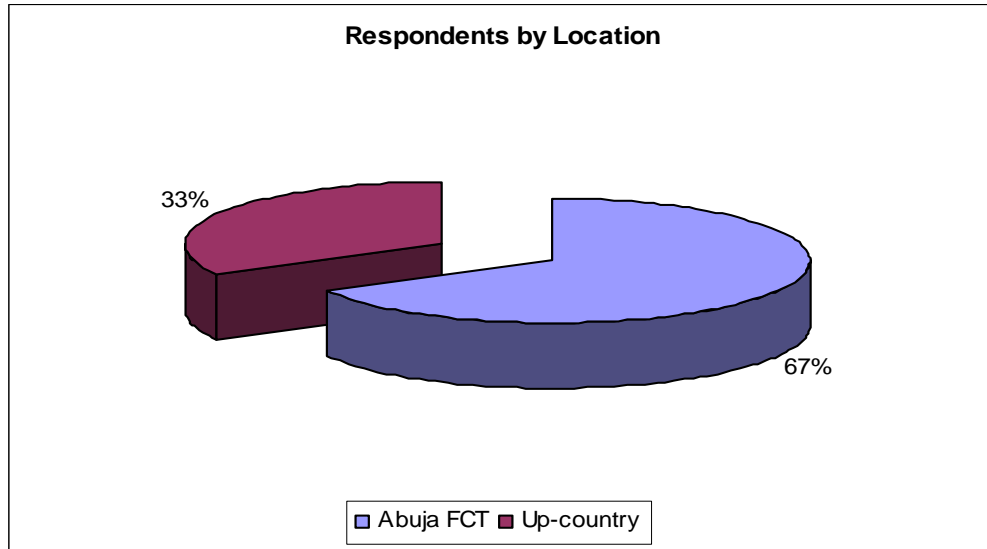
### 4.2.1 By Sector



*Figure 11: Analysis by Sector*

56% of the respondents are from the government sector, 33% from the private sector and 11% from the academia. NGDI is a government project; therefore the participants are mostly people working in public sector. The committee members are mostly drawn from government establishments. Even though the GI policy makes room for public-private participation, the reality is that people that constitute the geospatial data creators disseminators and users fall within government sector.

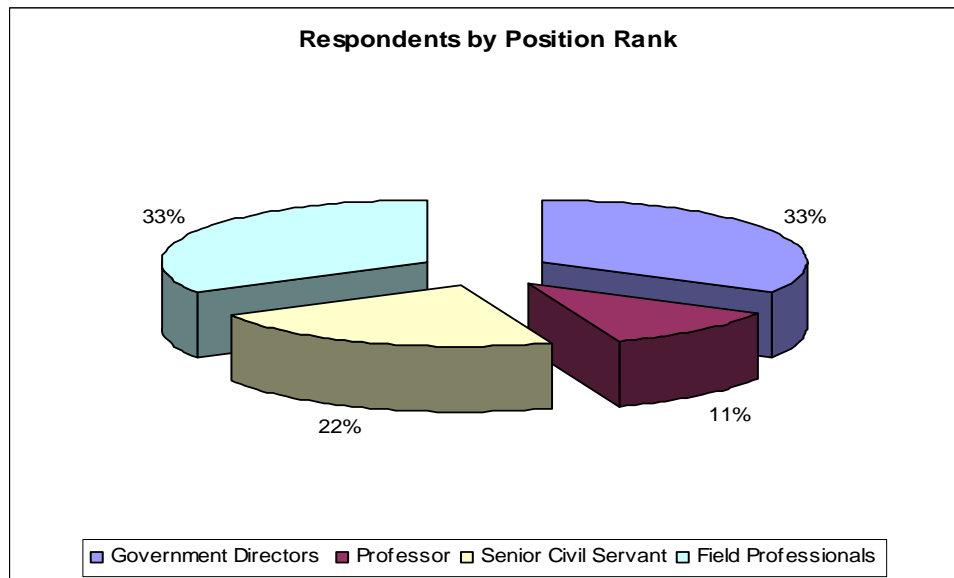
#### 4.2.2 By Location



**Figure 12: Analysis by Location**

67% of respondents are working in Abuja, the Federal Capital Territory of Nigeria, while 33% of the respondents are outside (up country) Abuja. Nigeria as a federal state has the headquarters, including NASRDA of all the ministries in the capital city, Abuja. Most government decisions are taken in the headquarters of the ministries. Though the questionnaire are sent nationwide, the subjects at Abuja seems to be more informed of NGDI, as most people from up-country did not respond .

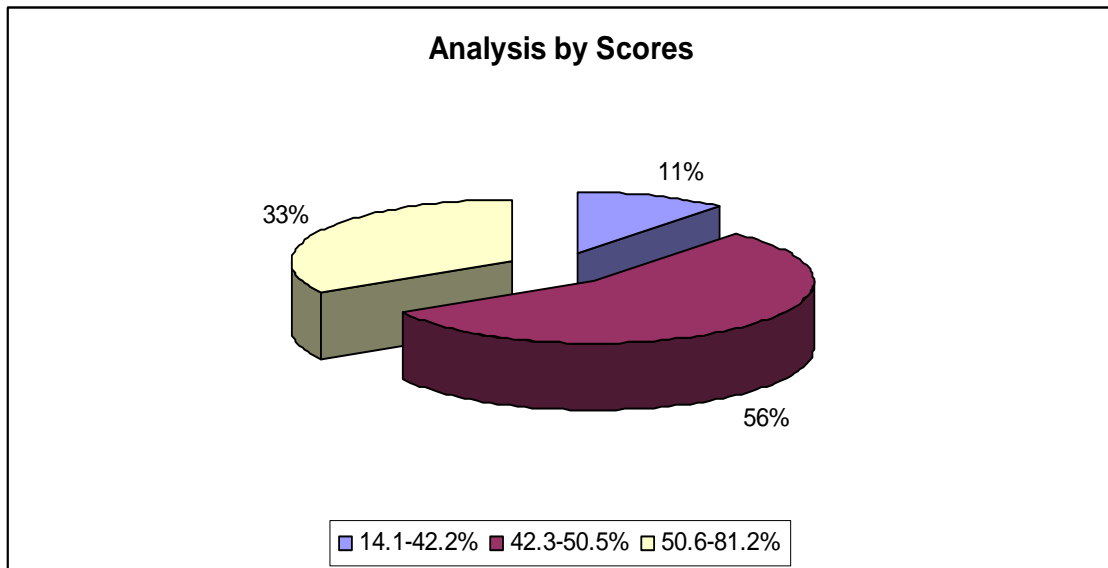
#### 4.2.3 By Position Rank



**Figure 13: Analysis by Position Rank**

The respondents consist of directors from government (33%), university professor (11%), senior civil servants (22%), and field professionals (33%). This is more or less an equitable distribution of respondents.

#### 4.2.4 By Scores



**Figure 14:** Analysis by Scores

The scores of each respondent are added up and normalized to 100% to give what we can call here *NGDI Score* of the respondent. The NGDI Score herein after known as the Score of the respondent represents the assessment value of the NGDI from the perspective of the respondent. In this study it is assumed that each specific indicator has equal weight and therefore the summation of the scores will give an indication of the status of NGDI from the point of view of the respondent.

The score ranges from 14.1% to 81.2%. and are divided into three classes: 14.1-42.1, 42.3-50.5, and 50.6-81.2.

14.1-42.2: There is only one respondent whose score is in this class, a government director by rank, from up country. This suggests that the NGDI awareness is very limited in some parts of Nigeria outside the capital city.

42.3-50.5: This is both the modal class and the class that contains the median. Five respondents are in this class. In qualitative terms, respondents in this class gave a medium score in the overall assessment of NGDI status. Respondents here are

distributed across government (geospatial dataset committee), private sector and academia.

50.6-81.2: The respondents in this class gave a high score to NGDI project. Three respondents are within this group. Two is from government (a representative of the project manager himself, and a committee member, geospatial datasets) and one from the private sector. It is obvious that these respondents are close to the project. The private sector here may be doing some contract in NGDI implementation.

### **4.3 Analysis by Indicators**

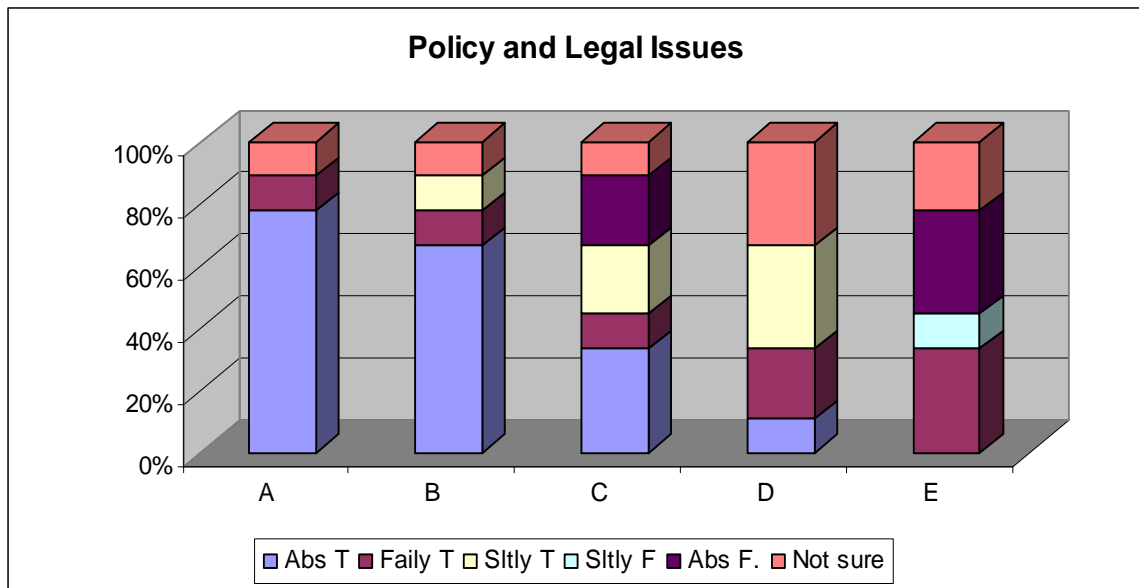
Here an analysis of the results based on responses to each specific indicator is made. *Table 4* summarizes how research subjects responded to each specific indicator. Each alphabet on the left column of the table represents a specific indicator (question in the questionnaire), while the figures inside the table represent the number of respondents that scored the NGDI a particular ranking. For instance, in specific indicator, **A** in *Policy and Legal Issues* component class, seven (7) respondents answered ‘Absolutely True’ in the questionnaire, while 1 (one) respondent each answered ‘Fairly True’ and ‘Not Sure’ respectively. This means that there is certainly the presence of the variable which specific indicator **A** is assessing.

<i>Ranking</i>	Abs T	Fairly True	Sltly True	Sltly False	Abs False	Not Sure
<i>Spec. Ind</i>						
<b>Policy and Legal Issues</b>						
<b>A</b>	7	1				1
<b>B</b>	6	1	1			1
<b>C</b>	3	1	2		2	1
<b>D</b>	1	2	3			3
<b>E</b>		3		1	3	2
<b>Technical</b>						
<b>A</b>	2	1	1		4	1
<b>B</b>	1	1	1	1	5	
<b>C</b>	3	1	3	1	1	
<b>D</b>	1	2	2		3	1
<b>E</b>		1	1	2	2	3
<b>F</b>	1			2	5	1
<b>Funding</b>						
<b>A</b>	1	3	4		1	
<b>B</b>		2	4		2	1
<b>C</b>		3	1		4	1
<b>People</b>						
<b>A</b>		1		1	3	4
<b>B</b>	2	1	3	1	2	
<b>C</b>	4	4				1

**Table 4:** A summary of respondents to each specific indicator.

The above table is represented and analyzed in the following charts and paragraphs respectively.

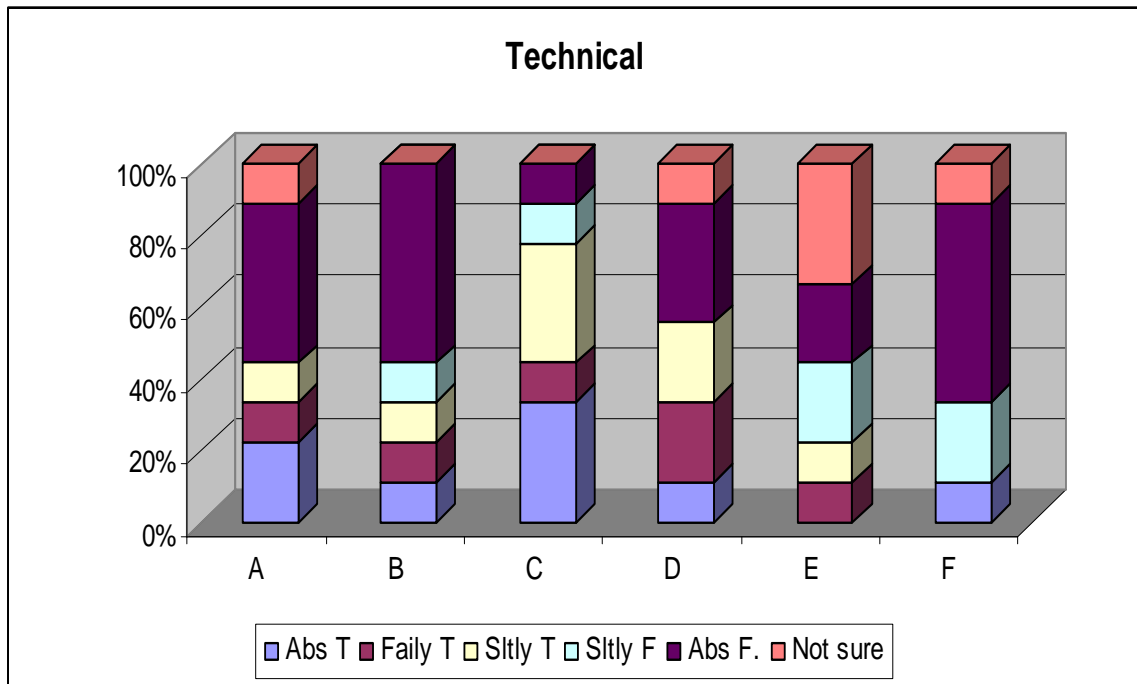
### 4.3.1 Policy and Legal Issues



**Figure 15: Policy and Legal Issues Indicator Class**

Analysis of the result of questionnaire on the Policy and Legal Issues component class indicate that NGDI started well on this component. There is almost unanimous agreement on the presence of national SDI coordinating body, and the presence of a policy establishing the coordinating agency. The response to the specific question on the NGDI Champion at highest political level was scored well. Here we mean a politician in the National Assembly pioneering and pushing for SDI awareness, funding and law. The civilian administration of 1999-2003 actually gave priority to Nigerian Space Mission which put NigeriaSat-1 into space and established NGDI coordinating agency. There is a new administration now, and hitherto emphasis on earth observation satellite is now shifted to telecommunication satellite NigComSat-1 that was launched in China in 2007. On the legal framework for spatial data creation and pricing, the respondents scored it poorly. Actually there is policy framework guiding these activities but they are not signed into law yet.

### 4.3.2 Technical



**Figure 16: Technical Indicator Class**

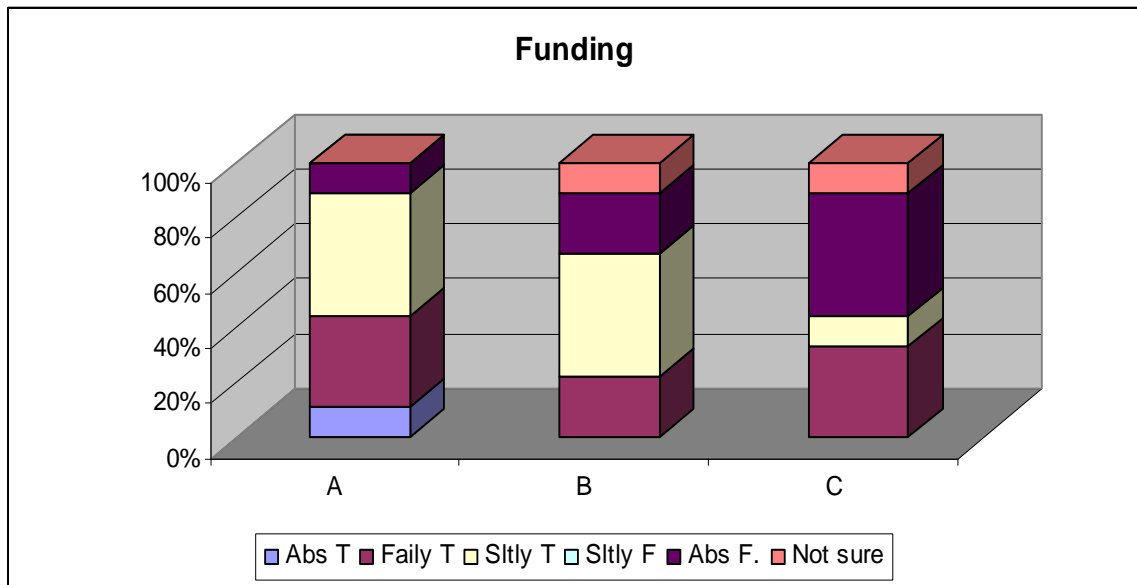
The technical aspect of any NSDI is the pivot on which its data sharing rotates. With respect the NGDI access network, the intention is to put in place a high-speed and high bandwidth backbone carrier as the main gateway and master server and implement a database server at each mode. This is not available in reality yet. In addition telecommunication facilities and electricity power supply are still problematic in Nigeria.

The bad shape of access network facilities notwithstanding, the analysis from the questionnaire responses indicates good accessibility to geospatial data through CDs. There is equally good effort towards interagency coordination of spatial data creation. Metadata capturing is also scored highly by the respondents.

The responses however show lack of standardization in spatial data creation and absence of apex clearinghouse. Data is acquired and stored for own use and applications, with the difficulties of unnecessary overlaps and duplication, lack of accessibility, and varying standards and formats



### 4.3.3 Funding

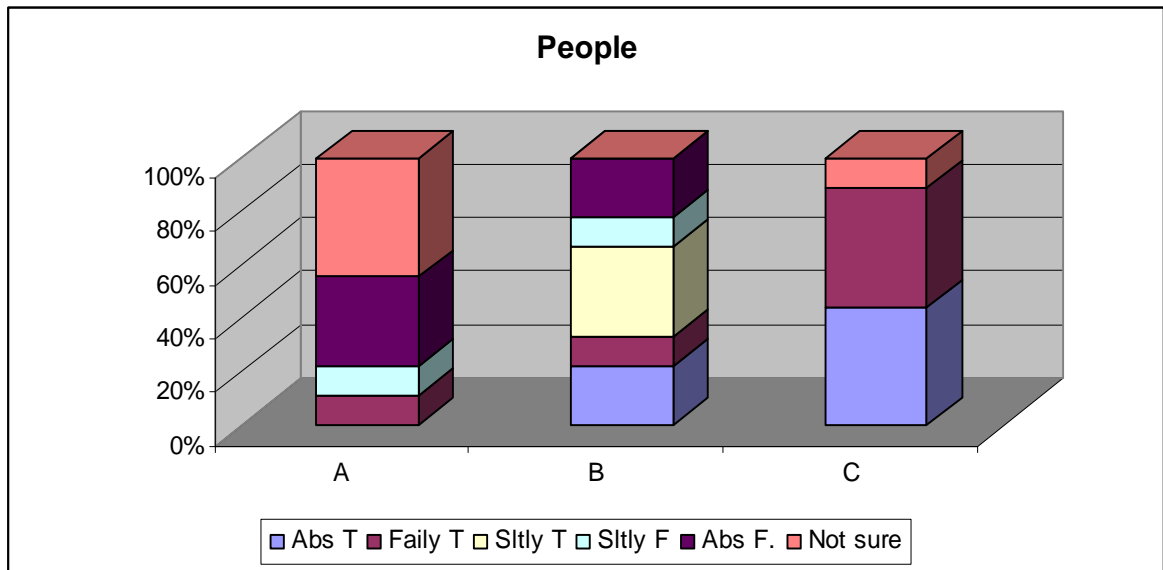


*Figure 17: Funding Indicator Class*

Section 3.38 highlighted the policy statements on NGDI funding. But that have not been fulfilled in full probably due to lack of SDI Directive. And funding is earmarked as major problem in the NGDI implementation.

The responses of the subjects to this component class are not very encouraging. The major source of income for NGDI implementation is from national budget. There is effort towards fund generation from access charges and data sales, but this is not viable yet. In addition Nigeria has not received international grant. Even there is no agreement on the existence of policy for spatial data pricing.

#### 4.3.4 People



*Figure 18: People Indicator Class.*

There is sound organizational framework for the NGDI implementation. There is the NGDI Committee, the Sub-committees and working groups as highlighted in section 3.3. Responses from the questionnaire however indicate there is not enough public-private participation. The major stakeholders, predominantly government however participate in the implementation. On the specific component of skilled personnel, there is capacity working group in place, and there is reasonable number of skilled personnel to man the NGDI implementation. Though availability of skilled personnel especially in technical areas is still a problem.

#### 4.4 Conclusions

In this chapter the result from the questionnaire has been presented and analysed. The responses to each specific indicator vary greatly across respondents, across position rank, across sectors of the economy and across geographical location.

This is expected as SDI is a complex and dynamic concept, with each respondent approaching it from where it matters to him most. However, the result of the analysis will yield some interpretations and conclusions which will answer the research questions of the thesis in the next chapter.

# 5 Conclusions and Recommendations

## 5.1 Introduction

This chapter gives the conclusion of the research by discussing the research questions, limitations of the study, and recommendations for future work and implementation of National Spatial Data Infrastructures especially in the developing countries.

## 5.2 Conclusions

This research has one major objective: to assess the status and milestones of the implementation of the Nigerian Geospatial Data Infrastructures., and six research questions (see sections 1.2 and 1.3) which are addressed in the previous chapters. Answers for the research questions are summarized below.

### **Research Question 1:** *Who are the major stakeholders in NGDI?*

From the discussions in Chapter 3, and analysis of questionnaire survey in *Chapter 4* we discovered that the major stakeholders of NGDI are Government (federal, state, local and their ministries and agencies), Academic and Research community, Service Providers/Vendors and End-Users, Non-Governmental Organizations, Private Organizations, Public Sector Agencies, Defense and Security.

**Research Question 2:** *What institutional arrangements are in place for the development of NGDI?* The NGDI has a singular advantage of starting off with a policy formulation (top-down approach) which placed the required institutional arrangement in place to implement it. At the apex of the NGDI organizational framework is the NGDI Council to be chaired by the Vice President. At the time of this research this is yet to be inaugurated. Below the NGDI Council is NASRDA, which is the lead agency and the secretariat of the NGDI Committee inaugurated in 2003 to oversee the implementation of the NGDI. NASRDA has commendable

institutional framework for NGDI implementation. There is in operation, an Earth Observation Satellite (NigeriaSat-1) in orbit which is in constellation with other four satellites from China, UK, Algeria, and Turkey. There is also state of the art ground receiving stations in Abuja that processes and manages images that are captured by Nigeria Sat-1. There is a Centre for Remote Sensing in Jos which is another agency under NASRDA that facilitates image processing from Nigeria Sat-1. This is a significant step towards mapping and geoinformation in general. Agreement for the design, building and launch of NigeriaSat-2 which will replace Nigeria Sat 1 has been signed. It is expected to go into orbit in 2009.

In addition, there are six NGDI Sub-Committee whose functions virtually cover every aspect (components) of NGDI. Each of this committee is empowered to establish Working Groups as it considers necessary.

There is a Policy establishing the lead agency (NASRDA), but what is lacking now is SDI Directive. In other words NGDI Policy is yet to be signed into law.

In concept, all the stakeholders mentioned in Research Question 1 are to partake in production, dissemination and utilization of geospatial data within a set of policy, rules, standards, and legislation from NASRDA.

**Research Question 3:** *What are the problems and challenges facing the development of NGDI?* The policy statement of the NGDI is impressive. However, the implementation of the NGDI is facing a lot of challenges: these challenges are outlined in the comments made by respondents. They include:

**Funding:** Since the inauguration in 2003, funding has been a problem for NGDI implementation. It is just of recent that a foreign company was engaged to partake in implementation of development of clearinghouse at NASRDA.

**Lack of SDI Directive:** The GI policy is yet to be passed into law. This makes it difficult for NASRDA to implement standards on data acquisition and sharing.

**Lack of data sharing:** Individual data acquisition is still going on among geospatial data creators, thus efforts are duplicated in data creation, and data sharing is still lacking. Nigeria is a land of contrast with diverse geographical, social, cultural features. And each section of the country has its own peculiar data requirement and often reluctant to share their data without anyone unless they have something to

benefit. SDI directive will minimize this individualistic attitude towards data collection and sharing.

Capacity building and Awareness: Though there is reasonable number of skilled personnel in the field of geoinformation, much effort is still needed in this area, as NSDI is dynamic creating the need for training and retraining of professionals. Awareness is another problem faced by NGDI implementation. Up till today, Nigerian populace is still asking the justification of Nigeria Space Mission and the launch of Nigeria Sat-1. Some awareness seminar has been done by NASRDA in Abuja, but it is not enough. Nigerian citizens still see NigComSat-1 which went into orbit in 2007 as more beneficial to their lives.

**Research Question 4:** *What lessons can be learnt from NGDI experience?*

NGDI can be regarded as a second generation NSDI. It started when some countries have gone far in the implementation of their NSDI. Nigeria had the advantage of professionals from USA, the Netherlands, and the UK to attend the first stakeholder and user's workshop in February 2003 which charted the way for NGDI implementation. Nigeria's experience is worthy especially to the developing countries that are yet to define their SDI structure and direction.

In section 2.6 we discussed the two SDI development models suggested by Abbas Rajabifard, (2002), the product model and process model. The study of NGDI revealed that it is following a *Mixed SDI development model* which combines elements of both the product model and the process model. NGDI is still battling with the harmonization of creation and linkage of fundamental datasets (product model). And at the same time working on distributed responsibilities and cooperation towards spatial data sharing (process model). This is principally because Nigeria is a Federated nation with three tier of government. In addition, one of the objectives of NGDI among others is to provide better communication channel for Nigerian geospatial community for sharing and using datasets.

Another outstanding lesson from NGDI is the *top down approach* adopted in its development: the GI Policy and the establishment of a recognized coordinating body backed by the policy. Having an operating environmental satellite in orbit or easy

access to satellite images is a requirement that will enhance smooth development of SDI of any nation.

**Research Question 5:** *Is NGDI development in line with the selected NSDI trends?*

NSDI initiative can proceed by following certain steps towards the creation of an infrastructure in which to facilitate all parties of the spatial data community in cooperation and exchange of their datasets (Rajabifard, 2003). Discussions in chapter 2 revealed some variations in the development of NSDI both spatial and temporal. NSDI of each country must respond to political and socio-economic peculiarities of that particular country. For instance, creation and dissemination of geospatial data to a specified standard is largely influenced by the presence or absence of SDI directive in the country. Attachment 2 compares the NGDI with other selected NSDI. From the table we can see that the NGDI shows more differences than similarities in the pattern of development compared to other NSDI.

NGDI compares favorably with other NSDI in terms of definition of core datasets, participating agencies, policy establishing the coordinating body and in adoption of ISO standard. These variables are very much present and running in NGDI.

However, NGDI is yet to establish metadata (though data created recently has), no access mechanism, no clearinghouse, no interoperability and no SDI directive. NGDI lacks behind most other NSDI in terms of these variables.

All said and done, NGDI implementation is still going on in the following areas: conversion of data from analogue format to digital format; data update; clearinghouse implementation; and signing GI policy into law.

### **5.3 Hypotheses Testing**

The Hypotheses stated in 1.5 are hereby tested based on the result of the research.

**H<sub>1</sub>:** *The current NGDI is effective and developing according to the National Geoinformation Policy.*

Results from the analyses show that while the NGDI project is going on, it is not yet effective especially in Access Network components. The GI Policy is yet to be

signed into law, coupled with funding problems. This hypothesis is therefore *rejected*.

**H<sub>2</sub>:** *The NGDI experience is not different from the NSDI of the selected countries.*

The comparative analysis of the NGDI with the other NSDI reveals significant differences in the level of development, funding models and policy framework.

While the major driving forces for NSDI in developed countries such as the United States and Australia is to avoid duplication of efforts and reduce cost in data creation, and facilitate sharing, the major driving forces for the NGDI is to promote public access to geospatial data, and provision of GI for sustainable national development and poverty alleviation. Another point of significant difference is in partnerships and working groups. Due to low level of consumption of geospatial data products in Nigeria, the predominant partaker in NGDI is the government. The Committee members are mostly from the public sector and the working groups are not yet functioning. The Mixed Model Approach is another point of departure from other NSDI.

However, it should be noted that no two NSDI will be exactly the same as each country implements their NSDI in accordance with her political and socio-economic needs. That notwithstanding, NGDI implementation has several peculiar features for us to conclude that the experience is unique. This hypothesis is therefore *rejected*.

#### **5.4 Limitations of the Study**

During this research, there was limited time frame. Assessment period was November and December, 2008 when the data was collected. Evaluation of NSDI programmes at different moments in time is necessary so as to capture the progress of development. This research rather took on-the spot evaluation due to time constraints.

NSDI is dynamic and equally operates in a dynamic environment. This makes it difficult to select the component classes and specific indicators. The component classes we used in this research together with the specific indicators are based on

their easily identifiable nature and their frequent use as indices in the previous works on SDI assessment. It is possible to use a different set of variables, and even more hidden specific variables.

Further, and in relation to the limitation mentioned above, weights were not assigned to the component classes and specific variables. On one hand, it is not very easy to assign weights to so many specific variables, and on the other, each country operates in different historical, social, political, economic and technological situation and one variable might have more weight in one country than the other.

Finally, the selected case study countries, though dichotomized based on the United Nations human development index of 2007, the individual countries were arbitrarily selected based on availability of data. There are more countries that fall into each of the categories which have NSDI at different levels of implementation.

## **5.5 Recommendations for Future Work**

Based on the above highlights of limitations of the study, the following recommendations for further research can be given:

- In the near future, similar research could be carried out on NGDI to better capture and understand the progress in its development especially as the implementation is ongoing;
- A more detailed set of indicators could be used in further research as specific indicators can assume high importance over time.
- A different set of case study countries especially among developing nations could be used.



## Bibliographic references

ABDULHARIS, R. *et al*, 2005 Assessment of Geoinformation utilization at the Tsunami affected areas in Aceh and Nias, Indonesia. In *Disaster and Risk Management, Part III, Chapter 6*.

[http://www.gdmc.nl/publications/2006/Assessment\\_Geo-information\\_utilisation\\_in\\_Indonesia.pdf](http://www.gdmc.nl/publications/2006/Assessment_Geo-information_utilisation_in_Indonesia.pdf), September 15, 2008.

AGBAJE, G.I. and AKINYEDE, J.O., 2005, NGDI Development in Nigeria: Policy Issues on Information Access and Information Dissemination. In *United Nations Economic Commission for Africa, CODI-IV*, April 23-28, 2005, ([www.uneca.org/codi/Documents/WORD/Agbaje\\_Akinyede\\_CODI4.doc](http://www.uneca.org/codi/Documents/WORD/Agbaje_Akinyede_CODI4.doc)) ,p 13, August 3, 2008

AGBAJE, G.I., *et al*, 2008, National Geospatial Data Infrastructure (NGDI): An Enabler for Socio-Economic Improvement in Nigeria. In *GSDI 10 International Conference for Spatial Data Infrastructure, University of West Indies, Trinidad, 25-29 February, 2008*. ([www.gsdi.org/gsdi10/papers/TS46.5paper.pdf](http://www.gsdi.org/gsdi10/papers/TS46.5paper.pdf)), p 8, August 20, 2008.

ANZLIC, 2009, *Homepage of the Spatial Information Council, Australia and New Zealand*, (<http://www.anzlic.org.au>), (October 7, 2008).

AUSTRALIAN SPATIAL DATA INFRASTRUCTURE (ASDI), 2005, *Homepage of Australian Spatial Data Infrastructures*, (<http://www.ga.gov.au/nmd/asdi/>) November 2, 2008

AYALANDE, A.ORIMOOGUNJE, O.and BORISADE, P.2008, Geospatial data infrastructure for sustainable development in sub-Saharan countries In *International Journal of Digital Earth, Vol.1 No.3, Sept. 2008, pp 247-258*.

- BAKOSURTANAL, 2008, *Homepage of National Coordinating Agency for Surveying and Mapping of Indonesia* (<http://www.bakosurtanal.go.id>), October 2, 2008.
- BAS C.KOK, and BASTIAAN van LOENEN, 2000, *Policy Issues Affecting Spatial Data Infrastructure Development in the Netherlands*. Delft, University of Technology. (<http://www.geo.tudelft.nl/gigb>) November 4, 2008
- BUSBY, J.R. and KELLY, P., 2004, Australian Spatial Data Infrastructures, In *7<sup>th</sup> Conference of Global Spatial Data Infrastructures, February 2-6, 2004. Bangalore India*.
- CLARKE, D., 2001 Development of the Australian Spatial Data Infrastructures. In *International Symposium on Spatial Data Infrastructures, 19-20 November, 2001 University of Melbourne, Australia*.
- CLARKE, D. *et al.*, 2003 Development of the Australian Spatial Data Infrastructure. In *Developing Spatial Data Infrastructures: from Concept to Reality*, edited by I. Williamson, A, *et al* (London: Taylor & Francis), pp. 131–145.
- CLINTON, W., 1994, Coordinating Geographic Data Acquisition and Access to the National Spatial Data Infrastructure. *Executive Order 12096*, Federal Register 59, 17671-4, Washington, DC.
- COLOMBIAN SPATIAL DATA INFRASTRUCTURES, 2008, *Homepage of Infraestructura Colombiana de Datos Espaciales*, (<http://www.icde.org.co/>) October 8, 2008.
- CROMPVOETS, J. *et al*, 2004, Assessing the worldwide developments of

National Spatial Data Clearing House, In *International Journal of Geoinformation Science*, Vol 18, no. 7, pp 665-669 London, Taylor & Francis (<http://www.informaworld.com/smpp/content>), August 23, 2008.

CROMPVOETS, J., and BREGT, A., 2003, World status of National Spatial Data Clearinghouses. In *URISA Journal (Special Issue on Public Participation GIS)*, 15, APA I, 43–50.

DANZFUSS, F. and BISHOP, J. 1999, Lessons learned from building a Web-based Spatial Data Directory facility. In *Proceedings 7<sup>th</sup> IEEE Workshop on Future Trends of Distributed Computing Systems*, 20-22 December, 1999. Cape Town, South Africa.

DELEGADO, et al, 2005, Assessing an SDI Readiness Index. In *FIG Working Week, 2005, and GSDI-8, From Pharaohs' to Geoinformatics*, Cairo, Egypt. April 16-21 2005 (<http://www.gsdi.org/gsdiconfproceedings/gsdi-8/gsdi-8.asp>) August 5, 2008.

EELDERINK, L., 2006, Towards key variables to assess National Spatial Data Infrastructures (NSDI) in developing countries. *Geographic Information Management and Applications*, MSc thesis, ITC, Enschede, the Netherlands May, 2006. ([http://www.itc.nl/library/Academic\\_output/AcademicOutput](http://www.itc.nl/library/Academic_output/AcademicOutput)) September 5, 2008.

EUROGI, 2008, *Homepage of European Umbrella Organization for Geographic information*. ([http://www.eurogi.org/SITE/UPLOAD/DOCUMENT/News\\_2008/EUROGI\\_Members.pdf](http://www.eurogi.org/SITE/UPLOAD/DOCUMENT/News_2008/EUROGI_Members.pdf)), November 13, 2008.

EZIGBALIKE, C. et al, 2000 Spatial Data Infrastructures: Is Africa Ready?

In *Fourth Spatial Data Infrastructure Conference, Cape Town, South Africa, March 13-15, 2000* ([www.gsdi.org/gsdiconfproceedings/gsdi-4/gsdi-4.asp](http://www.gsdi.org/gsdiconfproceedings/gsdi-4/gsdi-4.asp))  
August 30, 2008.

FEDERAL GEOGRAPHIC DATA COMMITTEE, 2008 *Homepage of Federal Geographic Data Committee*. (<http://www.fgdc.gov/nsdi/nsdi.html>).  
October 1, 2008.

FGDC, 2002, *Geospatial One-Stop; Office of Management and Budget Capital Asset Plan* (Exhibit 300). Version 3 (Washington, DC: Federal Geographic Data Committee).

GEONOVUM, 2008, *Geonovum Homepage*  
(<http://www.geonovum.nl/english.html>) October 1, 2008.

GOULD, M.*et al* (2008), *Spatial Data Infrastructures*.  
In Karimi, H. (ed), *Handbook of Research on Geoinformatics*, pp 36-41  
Information Science Reference (Hershey, 2008).  
(<http://www.geoinfo.uji.es/publications.html#p2007>) February 2, 2009.

GRANGER, KEN 1998, *ASDI from the ground up: a public safety perspective*.  
*Australian and New Zealand Land Information Council and Australian Geological Survey Organization*  
([http://www.ga.gov.au/oracle/library/catalogue\\_details.php](http://www.ga.gov.au/oracle/library/catalogue_details.php)), January 5, 2009.

GROOT, R. and MCLAUGHLIN, J. (eds), 2000, *Geospatial Data Infrastructure: Concepts, Cases and Good Practice*. Oxford, Oxford University Press.

GRUS, L., CROMPVOETS, J., and BREGT, A. 2007, *Multi-view SDI Assessment*

Framework. In *International Journal of Spatial Data Infrastructures Research*, Vol.2, pp 33-53. (<http://ijsdir.jrc.ec.europa.eu/index.php/ijsdir>). December 12, 2008.

GSDI SURVEY ON NATIONAL SPATIAL DATA INFRASTRUCTURES, 1998  
1998, *Homepage of Global Geospatial Data Infrastructures*,  
(<http://www.spatial.maine.edu/~onsrud/GSDI.htm>) October 23, 2008.

IGBOKWE, J.I and ONO, M.N 2005, Nigeria's National Geospatial  
Data Infrastructure: Problems and Prospects. In *FIG Working Week, 2005,  
and GSDI-8, From Pharaohs' to Geoinformatics*, Cairo, Egypt. April 16-21  
2005 (<http://www.gsdi.org/gsdiconfproceedings/gsdi-8/gsdi-8.asp> ) August  
19, 2008.

INSPIRE STATE OF PLAY REPORT, 2007, *Homepage of Infrastructure for  
Spatial Information in Europe*, ([http://inspire.jrc.ec.europa.eu/state\\_of\\_play](http://inspire.jrc.ec.europa.eu/state_of_play))  
November 4, 2008.

INSPIRE EU Directive, 2007, In *EUR-Lex: Official Journal of the  
European Union*, L 108 vol.50, 25<sup>th</sup> April, 2007,  
([http://ec.europa.eu/gmes/pdf/Dir\\_INSPIRE\\_L108.pdf](http://ec.europa.eu/gmes/pdf/Dir_INSPIRE_L108.pdf)). February 2, 2009.

KUFONIYI, O., 2003, Development of Geospatial Data Infrastructures of Nigeria,  
In *National Workshop on Nigeria –Sat -1, June 15-17<sup>th</sup> 2004*.  
(<http://www.nasrda.org>) August 3, 2008.

KUFONIYI, O. and AGBAJE, G.2005, National Geospatial Data Infrastructure  
Development in Nigeria: The Journey so far. In *FIG Working Week, 2005,  
and GSDI-8, From Pharaohs' to Geoinformatics*, Cairo, Egypt. April 16-21  
2005 (<http://www.gsdi.org/gsdiconfproceedings/gsdi-8/gsdi-8.asp>) August  
19, 2008.

- LONGLEY, P.A. *et al*, 2005 *Geographical Information Systems and Science*, 2<sup>nd</sup> Edition, Chichester, John Wiley & Sons Ltd.
- MAKANGA, P. and SMIT, J., 2008, A Review of the Status of Spatial Data Infrastructure Implementation in Africa. In *GSDI News*, (<http://www.gsdi.org/newsletters.asp>), December 4, 2008.
- MARION, R. *et al* 2003, Complexity theory and al Qaeda: Examining Complex Leadership. In *Emergence: A Journal of Complexity Issues in Organization and Management* 5, pp 56-78.
- MASSER, I., CAMPBELL, B., and CRAGLIA, M. (ed) 1996 GIS Diffusion: The Adoption and Use of Geographical Information Systems in Local Government in Europe, *GISDATA* 3. London, Taylor & Francis.
- MASSER, I., 1999, All shapes and sizes: the first generation of National Spatial Data Infrastructures. In *International Journal of Geographical Information Science*, 13, 67–84.
- MASSER, I, WILLIAMSON, I, RAJABIFARD, A and BINNS, A. 2008, Spatially enabling governments through SDI Implementation. In *International Journal of Geoinformation Science*, Vol. 22, Issue 1, pp 5-20 (<http://www.informaworld.com/smpp/content~content=a780499598>) September 18, 2008.
- MATINDAS, R.W., *et al*, 2004 Development of National Spatial Data Infrastructure in Indonesia. *Proceedings from FIG Working Week 2004, Athens, Greece, May 22-27, 2004*, [www.fig.net/pub/athens/programme.htm](http://www.fig.net/pub/athens/programme.htm) November 2, 2008.
- NASRDA, 2004, *National Geoinformation Policy*, Federal Ministry of Science and Technology, Abuja. ( <http://www.nasrda.org>) May 15, 2008.

- NATIONAL SPATIAL INFORMATION FRAMEWORK OF SOUTH AFRICA, 2008, *Homepage of National Spatial Information Framework of South Africa* (<http://www.nsif.org.za/>) October 25, 2008.
- NEBERT, D., 2001 (ed), *Developing Spatial Data Infrastructure: The SDI Cookbook, version 2.0, 25<sup>th</sup> January 2004.* (<http://www.gsdi.org/>) October 12, 2008.
- NEBERT, D. (ed.), 2004, *Developing Spatial Data Infrastructures: The SDI Cookbook, Version 2.0 (GSDI-Technical Working Group Chair, GSDI)* (<http://www.gsdi.org/>) October 21, 2008.
- NEBERT, D., 2006, *Development and Status of the U.S. National Spatial Data Infrastructure: Concepts and Components US Federal Geographic Data Committee Secretariat.* (<http://www.fgdc.gov/>) August 15, 2008.
- NASRDA, 2004, *Nigeria Inaugurates National Geospatial Data Infrastructures (NGDI) Committee, In NGDI Press Release, 2004, Abuja.* (<http://www.nasrda.org> ) May 20, 2008.
- NSIF, 2006, *Draft Report on Workshop on GIS Skills Development held in Durban on 9<sup>th</sup> May, 2006. Homepage of National Spatial Information Framework,* (<http://www.nsif.org.za/Documents/>). Nov. 18, 2008.
- ONSRUD, H. J., 1998, *Compiled Responses by Question for Selected Questions. Survey of national and regional spatial data infrastructure activities around the globe. Global Spatial Data Infrastructure Survey* (<http://www.spatial.maine.edu/yonsrud/gsdi/Selected.html>) November 30, 2008.
- PUNTODEWO, S.S.O., 2004, *The Progress of SDI Development in Indonesia.*

In *FIG Working Week, 2005, and GSDI-8, From Pharaohs' to Geoinformatics*, Cairo, Egypt. April 16-21 2005  
(<http://www.gsdi.org/gsdiconfproceedings/gsdi-8/gsdi-8.asp>) August 6, 2008.

RAJABIFARD, A., FEENEY, M. E., and WILLIAMSON, I. P., 2002,  
Future directions for SDI Development. In *International Journal of Applied Earth Observation and Geoinformation*, 4, pp 11–22.

RAJABIFARD, A. and WILLIAMSON Ian P., 2001, Spatial Data Infrastructures: Concept, SDI Hierarchy and Future Directions. In *Proceedings of GEOMATICS'80 Conference, Tehran, Iran*.  
(<http://repository.unimelb.edu.au/10187/1247>) January 4, 2009.

RAJABIFARD, A. *et al*, 2003a Spatial Data Infrastructures: Concept, Nature and SDI Hierarchy. In *Developing Spatial Data Infrastructures: from Concept to Reality*, edited by I. Williamson, A, Rajabifard and M. E. Feeney London: Taylor & Francis, pp. 17-40.

RAJABIFARD, A. *et al*, 2003b SDI Diffusion. In *Developing Spatial Data Infrastructures: from Concept to Reality*, edited by I. Williamson, A, Rajabifard and M. E. Feeney London, Taylor & Francis, pp. 79–94.

RAJABIFARD, A. *et al*, 2003c, National SDI-initiatives. In *Developing Spatial Data Infrastructures: from Concept to Reality*, edited by I. Williamson, A, Rajabifard and M. E. Feeney London, Taylor & Francis, pp. 95–109.

RAJABIFARD, A. *et al*, 2000, From Local to Global SDI initiatives: A pyramid of building blocks. In *4th GSDI Conference, Cape Town, South Africa, 13 - 15<sup>th</sup> March, 2000*. ([www.gsdi.org/gsdiconfproceedings/gsdi-4/gsdi-4.asp](http://www.gsdi.org/gsdiconfproceedings/gsdi-4/gsdi-4.asp) ) September 2, 2008.



- SDI-Africa: An Implementation Guide, 2004, Geoinformation Team,  
*Economic Commission for Africa*  
<http://geoinfo.uneca.org/sdiafrica/default1.htm> ) June 30, 2008.
- SPACE APPLICATION INSTITUTE (SAI) PUBLICATION, 1999, Proceedings  
of Geographic Information Policies in Europe: National and Regional  
Perspectives, In *EUROGI-EC Data Policy Workshop, Amersfoort, 15th  
November, 1999.*
- TERIMA KASIH (2005), Indonesian Spatial Data Infrastructure, In  
*11th PCGIAP Meeting, May 18-21 2005, Inna Kuta Beach Hotel, Bali.*  
([http://219.238.166.217/pcgiap/bali/bali\\_rep.htm](http://219.238.166.217/pcgiap/bali/bali_rep.htm) ) October 19, 2008.
- VANDENBROUCKE, D., and JANSSEN, K, Is there a future for Spatial  
Data Infrastructure. In *INSPIRE State of Play, Development of the NSDI in 32  
European Countries between 2002 and 2007.*  
(<http://www.gsdi.org/gsdi10/papers>). October 30, 2008.
- WILLIAMSON, I., RAJABIFARD, A., and FEENEY, M. E., 2003,  
*Developing Spatial Data Infrastructures: From Concept to Reality* London,  
Taylor & Francis.
- WILLIAMSON, I., RAJABIFARD, A. and BINNS, 2006a, Challenges and Issues  
for SDI Development. In *International Journal of Spatial Data  
Infrastructures Research, 2006 vol. 1, pp 24-35.*
- WILLIAMSON, I., WALLACE, J. and RAJABIFARD, A., 2006b, Spatially  
Enabling Governments: A new vision for spatial information. In *17<sup>th</sup>  
UNRCC-AP Conference and 12<sup>th</sup> Meeting of the PCGIAP, Bangkok, Thailand  
18-22 September, 2006.* ([http://219.238.166.217/pcgiap/17thUNRCC-  
AP&12thPCGIAP/17thUNRCC-AP&12thPCGIAP\\_Report.htm](http://219.238.166.217/pcgiap/17thUNRCC-AP&12thPCGIAP/17thUNRCC-AP&12thPCGIAP_Report.htm) )  
October 19, 2008.

# Appendices

# 1. Descriptive Summary of Case Study Countries

## 1.1: Description of Australian SDI

<i>Summary of Australian ASDI</i>	
<i>Data Component</i>	
<b>Core data sets</b>	Administrative Boundaries,Cadastre,Elevation, Land Use, Place Names,Roads,Street Addresses,Vegetation,Water
<i>Access Network</i>	
<b>Metadata</b>	ANZLIC established a metadata working group in 1995 that developed the Australian Spatial Data Directory (ASDD).
<b>Access Mechanism</b>	Metadata is accessible online to people in industry, government, education and general community.
<b>Network Architecture</b>	ASDD provides a central access point to 25 distributed nodes around Australia.
<b>Gateway</b>	Geoscience Australia maintains the gateway to ASDD on behalf of ANZLIC
<b>Clearinghouse</b>	The clearinghouse component of the ASDI is not well defined
<b>Maintenance</b>	Maintenance of individual nodes lies with the relevant organization
<i>Standard Component</i>	
<b>Interoperability</b>	ASDI is moving towards a web-services model( WFS,WMS,WCS)
<b>Type of Metadata Standard</b>	The web services model is based on ISO 19115 and OGC Catalog Service Specification.
<i>Policy Component</i>	
<b>Policy on Data Access and Pricing</b>	Yes. <ul style="list-style-type: none"> <li>▪ <i>Guiding Principles for Spatial Data Access and Pricing Policy, 2001.</i></li> <li>▪ <i>Data Access and Management Agreement with the National Land and Water Resources Audit,</i></li> <li>▪ <i>Commonwealth Policy</i></li> </ul>
<i>Institutional Arrangements</i>	
<b>Coordinating Body</b>	Yes,ANZLIC-comprising one representative each from Australian state,territory,commonwealth governments, and New Zealand government
<b>Other stakeholders</b>	Private sector, education sector, and wider (public)community

## 1.2: Description of United States NSDI

<b>Summary of United States NSDI</b>	
<b>Data Component</b>	
<b>Framework data sets</b>	Geodetic control, orthoimagery, elevation and bathymetry, transportation, hydrography, cadastral, and governmental units.
<b>Data Format</b>	FGDC
<b>Maintenance</b>	
<b>Digital Data Sets</b>	Data available in digital formats: FGDC
<b>Data Suppliers</b>	
<b>Access Network</b>	
<b>Delivery Mechanism</b>	FGDC coordinates the sharing of data and services through an online portal, <i>geodata.gov</i> . The <i>geodata.gov</i> supports <i>Geospatial One-Stop Initiative</i> .
<b>Network Architecture</b>	<i>The NSDI Clearinghouse Network</i> (community of distributed data providers)
<b>Metadata</b>	FGDC tasked to develop procedure and assist in data sharing; The Metadata is held in Clearinghouse Node; Searched by <i>geodata.gov</i> portal.
<b>Standard Component</b>	
	FGDC develops geospatial data standards. Other voluntary consensus standard organizations include: ISO TC 211, OGC, and W3C.
<b>Policy Component</b>	
	FGDC established by the President's Office of Management and Budget to coordinate geospatial data activities.
<b>Institutional Arrangements</b>	
<b>Coordinating Agency</b>	FGDC comprising chairperson of the thematic sub-committees.
<b>Other Agencies</b>	Working Groups, Federal Agencies, Stakeholder Groups

### 1.3: Description of Netherlands NGII

<i>Summary of Netherlands NGII</i>	
<b>Data Component</b>	
<b>Core data sets</b>	Land cover, Waterways, Geology, Archeology, Cadastre, Altitude, Population
<b>Resolution</b>	Two foundation blocks: 1:10,000 and 1:1000 scale maps
<b>Data Suppliers</b>	Topographic Agency and a Consortium of Cadastre, Dutch Telecom, Local Governments, and Utilities.
<b>Data Custodian</b>	Data are kept at the database of the organizations that created (owns) them.
<b>Data Volume</b>	36,000 data sets in the public sector.
<b>Access Network</b>	
<b>Metadata</b>	Yes, provided through National Clearinghouse Geo-Information (NCGI)
<b>Clearinghouse</b>	Yes. The NCGI, the electronic metadata information desk initiated in 1995 by RAVI.
<b>Network Architecture</b>	NCGI is web-based. At the moment provides only metadata, free of charge, contained in a central database.
<b>Standard Component</b>	
<b>Transfer Standard</b>	NGII conforms to the EGII and ISO TC211 standards development.
<b>Policies</b>	
<b>Ministerial Decree</b>	Decree of 2 <sup>nd</sup> June 2006 installed the GI Board.
<b>Formal Responsibility</b>	This lies with MinVROM
<b>SDI Directive</b>	No. RAVI has no formal powers to compel public agencies too participate in the NSDI plan.
<b>Institutional Framework</b>	
<b>Coordination</b>	RAVI is playing the leadership role. It develops the vision for NGII, creates awareness and develops political support.
<b>Formal Responsibility</b>	MinVROM-Ministry of Spatial Planning and Environment has formal responsibility for GI related matters.
<b>Other Institutions</b>	Geonovum-NSDI executive committee and NCGI-National Clearinghouse Geo-Information.
<b>Funding Component</b>	
<b>Budgeted Funding</b>	Yes. Coordination funding of 1m Euros per year to RAVI, for standardization, raising political awareness and further development of knowledge infrastructure.
<b>Pricing Model</b>	Cost recovery for data supplied to third parties.
<b>Affiliation to Regional SDI Initiatives</b>	
<b>EGII</b>	RAVI seeks to achieve the status of a node in the European Geographic Infrastructure (EGII) for the Netherlands.
<b>EUROGI</b>	RAVI is a member of the European Umbrella Organization for Geographic Information (EUROGI)
<b>INSPIRE</b>	The MinVROM assigned Geonovum to execute INSPIRE programme in the Netherlands, part of which is the development of the Dutch part of INSPIRE network.

### 1.4: Description of South African NSIF

<b>Summary of South African NSIF</b>	
<b>Data Component</b>	
<b>Core data sets</b>	Administrative Boundaries Cadastral Boundaries Elevation (DEMs) Land Cover Hydrographic data Services and Utilities Digital Orthophotos
<b>Access Network</b>	
<b>Metadata</b>	International metadata standards are currently being developed, NSIF (2008).
<b>Clearinghouse</b>	There is the Spatial Data Discovery Facility (SDDF) for connecting spatial data users with spatial data sources. Contains Metadata.
<b>Delivery Mechanism</b>	
<b>Design Architecture</b>	SDDF has three-tier architecture: Database, Application and Presentation tiers.
<b>Network Architecture</b>	Web-based. Available on NSIF website, and has several Nodes
<b>Standard Components</b>	
<b>Policy on Standards</b>	There is Sub-directorate on Policies and Standards was formed by NSIF in 1997.
<b>Type of Standard</b>	Conforms to FGDC, International Organization of Standards, and SDI Act.
<b>Policy Component</b>	
<b>SDI Directive</b>	Yes. SDI Act which was signed into operation on 28 <sup>th</sup> of April, 2006.
<b>Institutional Mandate</b>	Directorate, NSIF is mandated to promote the development of the country's SDI.
<b>Pricing and Copyright</b>	Committee on Spatial Information (CSI) Draft 2 of 12 <sup>th</sup> Sept., 2006.
<b>Custodianship</b>	CSI Draft Custodianship Policy version January, 2004.
<b>Capacity Building</b>	Draft Report on GIS Skills Development, 9th May, 2006.
<b>Institutional Arrangement</b>	
<b>Coordination</b>	NSIF is mandated to coordinate the development of spatial information infrastructure
<b>Working Groups</b>	There are working groups on Policies, Standards, and Marketing and Education

## 1.5: Description of Colombian ICDE

<i>Summary of Colombian ICDE</i>	
<i>Data Component</i>	
<b>Core data sets</b>	Topographic base maps of IGAC, Topographic maps of the 32 provinces Boundaries, Transportation, Geodetic Control, Ortho-images, Geographic Names, Land Coverage, Cadastre, Soils
<b>Data Format</b>	DXF
<b>Resolution</b>	Different Scales and levels of coverage
<b>Relevance</b>	ICDE is recognized as the reference information to decision making at geospatial level
<i>Access Network</i>	
<b>Apex Clearinghouse</b>	Not available.
<b>Delivery Mechanism</b>	Participating institutes show data via their respective webs sites.
<b>Status</b>	Project Level.
<b>Implementing body</b>	IGAC is the coordinating body.
<i>Standard Component</i>	
<b>Data Transfer</b>	A working group on standards including metadata is in place
<b>Type of Standard</b>	Standard efforts linked to ISO TC 211 and FGDC
<b>Metadata</b>	Available. ICDE institutions have created about 180,000 metadata units.
<i>Policy Component</i>	
<b>Executive coordinating body</b>	ICDE, guided by IGAC
<b>SDI Directive</b>	No formal mandate exists. IGAC is leading the formalization of the NSDI and promoting a high level declaration.
<b>Privacy</b>	No legal agreements to address the issue of privacy
<b>Pricing</b>	No legal agreements to address the issue of pricing
<b>Access</b>	No legal agreements to address the issue of access to data
<i>Other Component</i>	
<b>Human Capital</b>	Well trained people are available
<b>Awareness of SDI Concept</b>	Most of the public institutions know about ICDE
<b>Education</b>	CIAF, is in charge of carrying out training courses

## 1.6: Description of Indonesian SDI

<i>Summary of the Indonesian NSDI</i>	
<b>Data Component</b>	
<b>Core data sets</b>	Geodetic data, Topographic data, Cadastral data, Bathymetric data Thematic data in four classes: Land resources, Forest resources, Water resources, Geology and Mineral resources.
<b>Data Format</b>	ESRI
<b>Maintenance</b>	Databases are well maintained by the respective agencies that developed them.
<b>Digital Data Sets</b>	Most data are available in digital format.
<b>Data Suppliers</b>	Most data are produced by Government Institutions.
<b>Access Network</b>	
<b>Clearinghouse</b>	Implemented by BAKOSURTANAL
<b>Awareness</b>	. Most data are produced for own use. Little awareness to disseminate data
<b>Standard component</b>	
<b>Data Transfer</b>	Standards have been implemented for maps, databases and exchange format
<b>Type of standard</b>	FGDC
<b>Metadata (Availability)</b>	Yes, but inappropriate in almost all data producing institutes
<b>Interoperability</b>	Interoperability still difficult. WMS, WFS, WPS, WCS, not present
<b>Policy Component</b>	
<b>Policy establishing INSDI</b>	Policy establishing INSDI was backed by a Presidential Decree of July 2007
<b>SDI Directive</b>	Yes
<b>Legal Aspects</b>	Yes. Covering online issues, copyright issues, basic access to geoinformation, establishment of a permanent administrative body (Abdulharis 2005)
<b>Vision</b>	A long time Vision, 2005-2020 is present.
<b>Institutional Arrangements</b>	
<b>Coordinating Agency</b>	BAKOSURTANAL (National Coordinating Agency for Surveying and Mapping)
<b>Other Agencies</b>	Centre for Soil and Agro-climatic Research; Centre of Data and Information of the Department of Regional Settlement and Infrastructures.



### 1.7: Descriptive summary of Nigerian NGDI

<i>Summary of Nigerian NGDI</i>	
<i>Data Component</i>	
<b>Core data sets</b>	<p>Geodetic control database</p> <p>Digital Imagery and Image maps</p> <p>Administrative Boundaries</p> <p>Cadastral Databases</p> <p>Topographic database/DEM</p> <p>Land Use/Land Cover Data</p> <p>Demographic database</p> <p>Transportation data</p> <p>Hydrographic data</p> <p>Geological database</p>
<b>Data Format</b>	Analogue
<i>Access Network</i>	
<b>Metadata</b>	The NGDI Policy provides that every geospatial data producer shall provide metadata for each data holdings.
<b>Delivery Mechanism</b>	Project stage
<b>Network Architecture</b>	NASRDA shall be the apex clearinghouse with nodes at other data producing agencies.
<i>Standard Component</i>	
<b>Standard Coverage</b>	Shall cover data structure, data quality, data format, classifications, feature coding and metadata content
<b>Conformity</b>	Shall be at conformity with ISO standards after endorsement by the Standard Organization of Nigeria (SON).
<b>Standard Regulation</b>	NGDI Committee
<i>Policy Component</i>	
<b>Geoinformation Policy</b>	The Nigerian Geoinformation Policy was drafted in September, 2003
<b>Formal Responsibility</b>	This lies with NASRDA
<b>Enabling Laws</b>	Nigerian Geoinformation Policy yet to be signed into law
<i>Institutional Arrangements</i>	
<b>Coordination</b>	NASRDA
<b>Other institutions</b>	NGDI Council (yet to be inaugurated), NGDI Committee, NGDI Subcommittee, and Working groups

## 2. Comparison among case study countries

### 2.1 Comparison of *Data Component* among case study countries

	DATA COMPONENT						
	Developed World			Developing World			
Indicator	<i>Australia</i>	<i>United States</i>	<i>Netherlands</i>	<i>South Africa</i>	<i>Colombia</i>	<i>Indonesia</i>	<i>Nigeria</i>
<b>Core datasets</b>	Defined	Defined	Defined	Defined	Defined	Defined	Defined
<i>Defined/not defined</i>							
<b>Data Format</b>	Digital Format	Digital format: FGDC	Digital Format	Digital Format: FGDC	Digital: DXF	Digital: ESRI	Analogue format
<i>Digital format</i>							
<i>Analogue format</i>							
<b>Resolution</b>	Different	Different	Different	Different	Different	Different	Two Scales
<i>High/Low</i>							
<b>Updating</b>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Yes/No</i>							
<b>Language of Country</b>	English	English	Dutch	English	Spanish	Indonesian	English

## 2.2 Comparison of *Access Network Component* among case study countries

	ACCESS NETWORK COMPONENT						
	Developed World			Developing World			
Indicator	<i>Australia</i>	<i>United States</i>	<i>Netherlands</i>	<i>South Africa</i>	<i>Colombia</i>	<i>Indonesia</i>	<i>Nigeria</i>
<b>Metadata Availability</b>	Yes	Yes	Yes	Yes	Yes	Yes	No
<b>Access Mechanism (availability, search and procedure)</b>	Yes	Yes	Yes	Yes	Yes (via the websites of participating institutes)	Yes	No
<b>Network Architecture</b>	A central access points to 25 distributed nodes	A community of distributed data providers	A web-based architecture providing metadata from a central database	A web-based architecture with several nodes	LAN inside institutions and Internet	Interconnected Metadata Servers, and additional server as network gateway	Central Server at NASRDA with distributed nodes (under implementation)
<b>Clearinghouse</b>	Not well defined	Yes	Yes	Yes	No	Not well defined	No

### 2.3 Comparison of *Standard Component* among case study countries

	STANDARD COMPONENT						
	Developed World			Developing World			
Indicator	<i>Australia</i>	<i>United States</i>	<i>Netherlands</i>	<i>South Africa</i>	<i>Colombia</i>	<i>Indonesia</i>	<i>Nigeria</i>
<b>Data Transfer</b> <i>Arranged/Not Arranged</i>	Arranged	Arranged	Arranged	Data not available	Arranged	Arranged	Not Arranged
<b>Transfer Standard</b>	ISO 19115 ,OGC	FGDC,ISOTC211, OGC,W3C	EGII,ISO TC211	FGDC,ISO,SDI Act	ISO TC211,FGDC	FGDC	SON,ISO Standards
<b>Interoperability</b> <b>(WFS,WMS,WCS)</b>	Yes	Yes	Yes	No	No	No	No

2.4 Comparison of *Policy Component* among case study countries

	POLICY COMPONENT						
	Developed World			Developing World			
Indicator	<i>Australia</i>	<i>United States</i>	<i>Netherlands</i>	<i>South Africa</i>	<i>Colombia</i>	<i>Indonesia</i>	<i>Nigeria</i>
Policy establishing coordinating body (yes/no)	Yes	Yes	Yes	Yes	No	Yes	Yes
SDI Directive	Yes	Yes	No	Yes	No	Yes	No (in process)
Policy on data access and pricing (yes/no)	Yes	Yes	Yes	Yes	No	Yes	Yes

2.5 Comparison of *Institutional Arrangement Component* among case study countries

	INSTITUTIONAL COMPONENT						
	Developed World			Developing World			
Indicator	<i>Australia</i>	<i>United States</i>	<i>Netherlands</i>	<i>South Africa</i>	<i>Colombia</i>	<i>Indonesia</i>	<i>Nigeria</i>
<b>Executive Coordinating Body (present/not present)</b>	Present	Present	Present	Present	Present(no official appointment)	Present	Present
<b>Participating Agencies (yes/no)</b>	Yes	Yes	Yes	No	Yes	Yes	Yes
<b>Working Groups (yes/no)</b>	No	Yes	No	Yes	Yes	Not Defined	No (in process)

### **3. Questionnaire**

#### **Spatial Data Infrastructures Model for Developing Countries: A Case Study of Nigeria.**

*For: MSc Thesis-Geospatial Technologies*

#### **A Questionnaire Survey**

By

**Chinonye Onah**

#### **Introduction**

This survey aims at assessing the development, implementation and status of the National Geospatial Data Infrastructures (NGDI) of Nigerian with reference to the major SDI components. The major method of this survey is questionnaire survey. This questionnaire will be served to the staff of the coordinating agency of NGDI, National Space Research and Development Agency (NARSDA), members of the committee and stakeholders in NGDI implementation.

#### **Organization of the Questionnaire**

The SDI components to be assessed are grouped into four headings and questions are asked on different aspects of each heading. They include;

- i) Policy and Legal Issues**
  
- ii) Technical**
  - a. Data access mechanism
  - b. Technical standards
  - c. Metadata
  - d. Clearing house
  
- iii) Funding**
  - a. National Budget
  - b. Self sustenance
  - c. Pricing policy
  
- iv) People**
  - a. Partnership
  - b. Stakeholders
  - c. Skilled Personnel

The first part of the questionnaire is for personal details of the respondents. Then follows the closed end multi-choice questions prepared to address the objectives of the research. The respondents are required to tick (X) the appropriate answer to the question. At the end of the questions, a box is provided for free text comments on the status and development of NGDI.

**Section A: Personal Details:**

<b>Name of Organization</b>	
<b>Type of Organization</b>	
<b>Name of Person Completing Form</b>	
<b>Position</b>	
<b>Email Address</b>	
<b>Contact Address</b>	
<b>Phone Number</b>	
<b>Website</b>	



**Section B:**

**1. Policy and Legal Issues**

a. There is a National SDI coordinating body

<input type="checkbox"/>	Absolutely True
<input type="checkbox"/>	Fairly True
<input type="checkbox"/>	Slightly True
<input type="checkbox"/>	Slightly False
<input type="checkbox"/>	Absolutely False
<input type="checkbox"/>	Not Sure

B. There is a Policy establishing NGDI coordinating Agency

<input type="checkbox"/>	Absolutely True
<input type="checkbox"/>	Fairly True
<input type="checkbox"/>	Slightly True
<input type="checkbox"/>	Slightly False
<input type="checkbox"/>	Absolutely False
<input type="checkbox"/>	Not Sure

C. There is an NGDI Champion at the highest political level

<input type="checkbox"/>	Absolutely True
<input type="checkbox"/>	Fairly True
<input type="checkbox"/>	Slightly True
<input type="checkbox"/>	Slightly False
<input type="checkbox"/>	Absolutely False
<input type="checkbox"/>	Not Sure

D. There is a legal framework governing spatial data creation

<input type="checkbox"/>	Absolutely True
<input type="checkbox"/>	Fairly True
<input type="checkbox"/>	Slightly True
<input type="checkbox"/>	Slightly False
<input type="checkbox"/>	Absolutely False
<input type="checkbox"/>	Not Sure

E. There is a legal framework governing spatial data pricing

<input type="checkbox"/>	Absolutely True
<input type="checkbox"/>	Fairly True
<input type="checkbox"/>	Slightly True
<input type="checkbox"/>	Slightly False
<input type="checkbox"/>	Absolutely False
<input type="checkbox"/>	Not Sure

**2. Technical**

a. There is ready access to spatial data through a Geo-portal, CDs and other forms

<input type="checkbox"/>	Absolutely True
<input type="checkbox"/>	Fairly True
<input type="checkbox"/>	Slightly True
<input type="checkbox"/>	Slightly False
<input type="checkbox"/>	Absolutely False
<input type="checkbox"/>	Not Sure

B. The data creation process is formally standardized for all data creators

	Absolutely True
	Fairly True
	Slightly True
	Slightly False
	Absolutely False
	Not Sure

C. There is a reasonable level of interagency coordination of spatial data creation efforts

	Absolutely True
	Fairly True
	Slightly True
	Slightly False
	Absolutely False
	Not Sure

D. Metadata is captured for most of the data that is created

	Absolutely True
	Fairly True
	Slightly True
	Slightly False
	Absolutely False
	Not Sure

E. Data creators create metadata according to a prescribed standard

	Absolutely True
	Fairly True
	Slightly True

	Slightly False
	Absolutely False
	Not Sure

F. There is a clearinghouse(s) that communicates most of the available data resources

	Absolutely True
	Fairly True
	Slightly True
	Slightly False
	Absolutely False
	Not Sure

### 3. Funding

A. There is adequate national budget to fund the NGDI activities

	Absolutely True
	Fairly True
	Slightly True
	Slightly False
	Absolutely False
	Not Sure

B. The NGDI initiative is self-sustaining

	Absolutely True
	Fairly True
	Slightly True
	Slightly False
	Absolutely False
	Not Sure

C. There is a policy governing spatial data pricing

<input type="checkbox"/>	Absolutely True
<input type="checkbox"/>	Fairly True
<input type="checkbox"/>	Slightly True
<input type="checkbox"/>	Slightly False
<input type="checkbox"/>	Absolutely False
<input type="checkbox"/>	Not Sure

C. There is a reasonable number of skilled personnel to man the activities of NGDI

<input type="checkbox"/>	Absolutely True
<input type="checkbox"/>	Fairly True
<input type="checkbox"/>	Slightly True
<input type="checkbox"/>	Slightly False
<input type="checkbox"/>	Absolutely False
<input type="checkbox"/>	Not Sure

#### 4. People

A. There is a reasonable level of public-private participation in creation and dissemination of spatial data

<input type="checkbox"/>	Absolutely True
<input type="checkbox"/>	Fairly True
<input type="checkbox"/>	Slightly True
<input type="checkbox"/>	Slightly False
<input type="checkbox"/>	Absolutely False
<input type="checkbox"/>	Not Sure

B. There is a maximum stakeholder participation in NGDI (Government, Private Sector, NGOs)

<input type="checkbox"/>	Absolutely True
<input type="checkbox"/>	Fairly True
<input type="checkbox"/>	Slightly True
<input type="checkbox"/>	Slightly False
<input type="checkbox"/>	Absolutely False
<input type="checkbox"/>	Not Sure

*Please write any other comment(s) that you may have in the space provided below.*

**Please return the questionnaire as attachment to [chinonyecc@gmail.com](mailto:chinonyecc@gmail.com)**

**Thank you.**