

# **National Geospatial Data Infrastructure Development in Nigeria: The Journey So Far**

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**Key words:** Spatial Infrastructures, Metadata, Standards, Policy, Geospatial Information

## **SUMMARY**

Geospatial Information (GI) are essential to socio-economic planning and development, and are much a part of the nation's infrastructure as its other elements (e.g., the transportation network, the health care system, telecommunication) and should be accorded the same level of support and priority because they provide information on the geography of the country in terms of her assets and potentials. Thus there is a strong economic justification for investment by government in the collection and management of fundamental GI as component of National Information Infrastructure in order to ensure that GI permeate every aspect of society and are readily available as and when needed.

The successful launch of Nigeria's Earth Observation Satellite (NigeriaSat-1) and its immediate impact on development activities in the country has also served as catalyst to the development of the country's national geospatial data infrastructure (NGDI). The paper presents the achievements made so far in the development of NGDI in Nigeria including the generation of fundamental datasets from NigeriaSat-1. The National Committee has been inaugurated with necessary sub-committees. The task of these various committee and sub-committees and laid down strategies are discussed in the paper. A summary of the policy on which the development of SDI is based is also presented. When analyzed against the developments at regional level in Africa, the Nigerian approach may serve as one of the best practices for the development of SDI at national levels.

# **National Geospatial Data Infrastructure Development in Nigeria: The Journey So Far**

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## **1. INTRODUCTION**

As noted by Akinyede and Boroffice (2004), under-development in the third-world countries, such as Nigeria, is rooted in a number of factors which include poor quality data collection, organization and management practices and lack of adequate infrastructure and skilled human capacity to develop the natural resources and manage the environment in a sustainable manner. Policy-makers in these countries do not have adequate access to accurate information needed to make rational and prospective allocation and management decisions. This has led to food insecurity and hunger, air and water pollution, environmental degradation, poverty, diseases and death.

Thus there is a strong economic justification for national investment in the collection and management of fundamental GI as component of National Information Infrastructure. This view has been corroborated by the World Bank's African privatisation expert (Meyerman 2004) who blamed the inability of the African countries to compete in the international market to the lack of infrastructure in spite of the huge resources at their disposal. He noted that infrastructure is one of the biggest challenges to meet the millennium development goals (MDGs) in Africa. According to him, "Africa would need \$15 billion a year in infrastructure financing to achieve seven percent economic growth in order to halve extreme poverty by 2015 and to reach the millennium development goals."

The vision therefore is to ensure that GI permeate every aspect of the society and that they should be available to people who need them, when they need them, and in a form that they can use them to make decisions with minimal pre-processing (UNECA 2001) by integrating GI into the centre-stage of national information and communication infrastructure (NICI). The most efficient and effective way to achieve the above is through the implementation of a national geospatial data infrastructure (NGDI).

## **2. GEOSPATIAL DATA INFRASTRUCTURE (GDI)**

The New Partnership for Africa's Development (NEPAD) initiative by the African Union will serve as a major platform for Africa's Scientist and governments to support and develop most practical tools possible to tackle the core challenges of socio-economic development in the continent such as food production, information communications, health, desertification, deforestation, industrial production etc. This requires the commitment of individual countries to the provision of relevant GI to facilitate national development and regional integration (Kufoniyi and Akinyede, 2004).

To this end UNECA's Committee on Development Information, Geoinformation Subcommittee (CODI-Geo) has called on members states of ECA to establish spatial data

infrastructures (SDI) in their respective countries. In support of this call, CODE-Geo published an SDI implementation guide (UNECA *et al.*, 2003) to assist stakeholders in the understanding of the institutional and technical issues involved in SDI implementation. In order to lay a solid foundation for a regional SDI initiative, CODI-Geo is actively supporting the implementation of the African Geodetic Reference Framework (AFREF) to which African countries are expected to tie their individual national geodetic reference framework. Review of SDI activities, including policy development in African countries can also be found in Lance (2004) and Kufoniyi (2004).

All these point to the fact that conscious efforts are being made to implement GDI (or SDI) in various African countries.

It is however essential to note that most of the initiatives usually commence without paying attention to the issue of policy to guide proper implementation. In many cases, problems are then encountered after the commencement of the initiative raising the need to then formulate a guiding policy. When possible, it is advised that the policy issue be put in the forefront of any GDI implementation. In the case of Nigeria, the on-going implementation of the country's NGDI started by first providing a GI policy.

In Nigeria at the moment, GI is acquired and stored in analogue form by various agencies of government and the private sector for their own use and applications with the attendant problems of unnecessary overlaps and duplication, lack of accessibility, and varying standards and formats. There is no coordinated production, management and dissemination of geospatial datasets that are commonly used by many agencies. Neither is there any policy for data quality, access, sharing and exchange. However due to 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 geospatial data production, management and dissemination by all sectoral institutions.

Towards the realization of a national SDI for the achievement of rapid sustainable socio-economic development, Nigeria has recently been making conscious efforts to mainstream GI in its national development strategies through the development of space programmes and the national geospatial data infrastructure (NGDI). Efforts have been made in the past and several position papers and memorandums submitted for the establishment of a national GIS Centre or NGDI in Nigeria. Major Associations/Parastatals of note in this respect are: Nigerian Institution of Surveyors (NIS), Nigeria Cartographic Association (NCA), and the National Planning Commission (NPC).

The paper presents the achievements made so far in the development of NGDI in Nigeria. It starts with a summary of the National Geoinformation Policy for Nigeria – the policy on which the development of the SDI is based. The National Committee has been inaugurated with necessary sub-committees. The task of these various committee and sub-committees and laid down strategies are discussed in the paper. The Users Requirement Survey and Analysis (UR&SA) is currently in progress and the production of fundamental datasets and application-specific NGDI projects are being undertaken by the lead Agency – National

Space Research and Development Agency (NASRDA) in collaboration with relevant agencies.

### **3. THE NATIONAL GEOSPATIAL INFORMATION POLICY**

In September 2002, the Hon. Minister of Science and Technology inaugurated A 10 – man Committee to draft a Geospatial Information (GI) Policy that will guide the implementation of the NGDI. The draft GI Policy was circulated to stakeholders for comments and was a subject of an international workshop of NGDI stakeholders/users held in Abuja, Nigeria in February 2003. The policy is expected to guide the realization of the NGDI in the country. Highlights of the policy objectives, policy items and implementation strategy are presented below (full document and further information can be found at [www.rectas.org](http://www.rectas.org); [www.nasrda.gov.ng](http://www.nasrda.gov.ng); and in Kufoniyi, 2004; NASRDA, 2003 and UNECA, *et al.* 2003).

#### **3.1 NGDI Workshop**

The NGDI Stakeholders Workshop can be considered as a watershed in the history of Nigeria in her collective aspiration to establish NGDI in Nigeria. The Workshop was well attended by Surveyors, Scientists, Engineers, students, journalists, Policy and Decision-makers and business executives from national and international organizations such as the UN Economic Commission for Africa (UNECA), United States Geological Surveys (USGS), Environmental Information System (EIS), South Africa, and International Institute for Earth Observation and Geo-Information Science, Enschede, The Netherlands.

The main goal of the Workshop was to provide a forum for the participants to take critical and inspiring look at the draft national GI Policy with the hope of providing a final road map for the geo-information community and the implementation of the NGDI project. In general, the Workshop was meant to achieve the following objectives:

- To create greater awareness of and promote public access to standard and coordinated geo-spatial data and the need for the establishment of a Geo-spatial Clearing House at various levels in the country.
- To identify and recognize major stakeholders and users in the production, management and utilization of geo-spatial data and information products in Nigeria.
- To appraise the participants of various on-going related projects and programmes in Nigeria.
- To articulate the roles of stakeholders in the development of NGDI, especially data rights roles and responsibilities.
- To map out immediate activities to be taken by all stakeholders towards the development of NGDI and propose the contents of a national GI Policy for Nigeria.

In addition to paper presentations, discussions and debates, and contributions from participants, the Workshop came up with a communiqué and made valuable recommendations for inclusion in the GI Policy to the 10-man drafting Committee. The NGDI Committee submitted the final GI Policy draft to the Hon Minister in September 2003

### 3.2 Policy Objectives

The objectives of the GI Policy are to:

- Facilitate coordinated production and utilisation of Geospatial Data (GD) which are common to multiple applications to eliminate duplication of efforts & wastage of resources.
- Facilitate rapid socio-economic growth of the nation through widely available, accessible, current, reliable and authoritative GI for planning and decision-making
- Encourage data providers to use NSDI-endorsed standards in order to create and maintain data at a high level of quality and consistency, which can improve value of the data in decision-making
- Provide a legal framework for the production, management, distribution and use of GD.
- Promote relationships among organizations to support the continuing development of the NSDI.
- Develop common solution that will enable discovery, evaluation, access and exploitation of GD.
- Promote the awareness of GI and its applications.
- Ensure adequate funding to maintain the momentum of change towards the NSDI vision and sustain the spirit of cooperation and collaboration.
- Ensure effective technology transfer in GIT in the country.
- Promote investments in the production of geospatial databases.
- Promote research, training, education and capacity building related to geospatial data production, management and usage.

### 2.3 Policy Implementation Strategies

The GI policy recommended the adoption of the following strategies for the implementation of the NGDI project in the country:

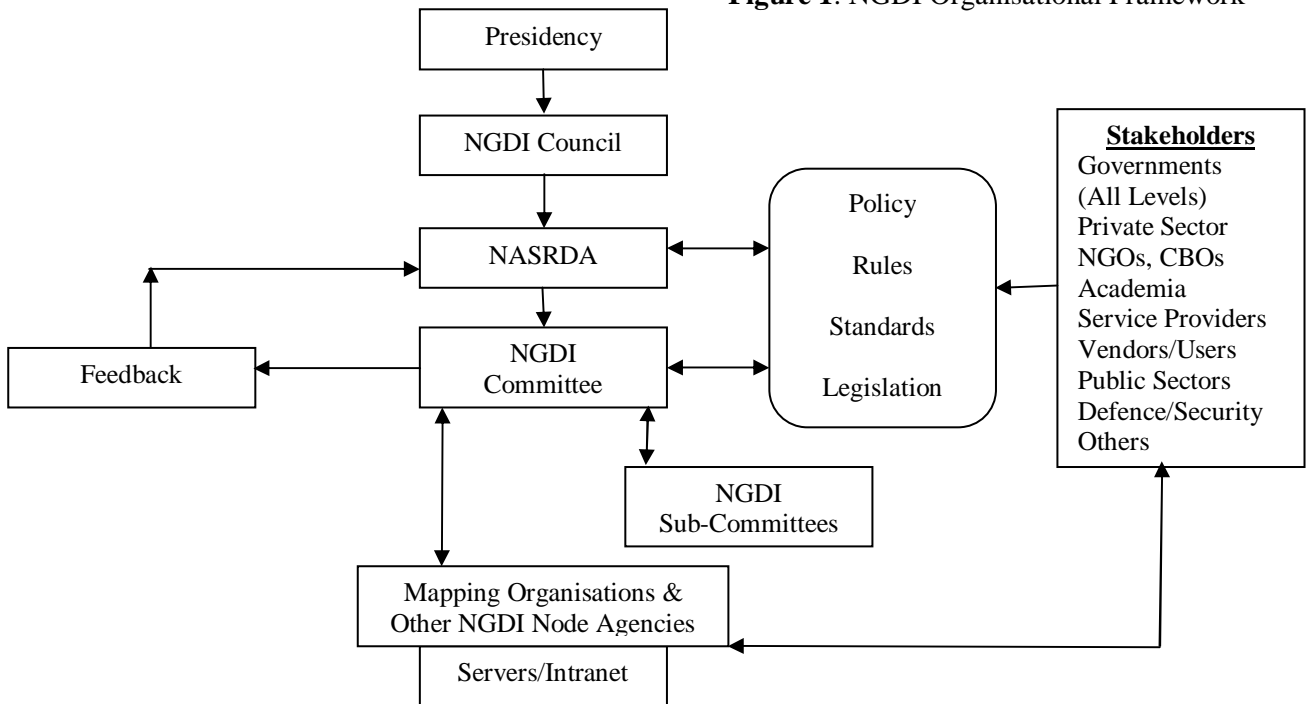
- Inaugurate the NGDI Council under the Chairmanship of the Vice President of the Federation.
- Set up a 27-member NGDI Committee, as well as necessary working groups, to work on the implementation of the NGDI in collaboration with NASRDA as lead agency and set up NGDI focal unit in each node agency.
- Carry out User Requirements Survey and Analysis including inventory of the existing datasets and resources, and their standards.
- Make provision for immediate production of non-existent but essential fundamental datasets by the agency legally mandated to produce the dataset, in accordance with the NGDI standards.
- The custodian shall keep the dataset(s) it produced while making the metadata available to the NGDI clearinghouse.
- Develop geospatial data standards for the NGDI, which shall strive to conform to the ISO standards.

- Facilitate the creation of preliminary standard services to help users understand and apply standards, at the initial stage of NGDI development and promote the benefits of using the NGDI supported standards.
- Define the metadata content and structure for the NGDI and produce detailed metadata implementation guidelines, including practical advice on maintenance and use of metadata
  - Establish Clearinghouses in the NGDI node agencies and enter the certified metadata of data producers.
  - Facilitate adoption and legalisation of all agreements and protocols relating to NGDI operations.
  - Put in place high-speed and high-bandwidth backbone carrier in the apex clearinghouse as the main gateway and master server and implement a database server at each NGDI node agency.
  - Promote submission and early passage of the bill to establish NGDI, which shall include the policy items and funding.
  - Encourage indigenous personnel with relevant skills in acquisition and analysis of GI in the country by ensuring that all GI related projects are locally implemented to a minimum of 75%.
  - Put in place modalities to ensure that GI producers give evidence of local contents of their production activities.
  - Promote synergy among GI-related policies.
  - Liaise with Federal Ministry of Environment and the Department of Petroleum Resources to implement compulsory geo-referenced data requirements for EIA and ESI.
  - Ensure adequate fiscal provisions and funding of the NGDI.

### **2.3 NGDI Administrative/Organisational Framework**

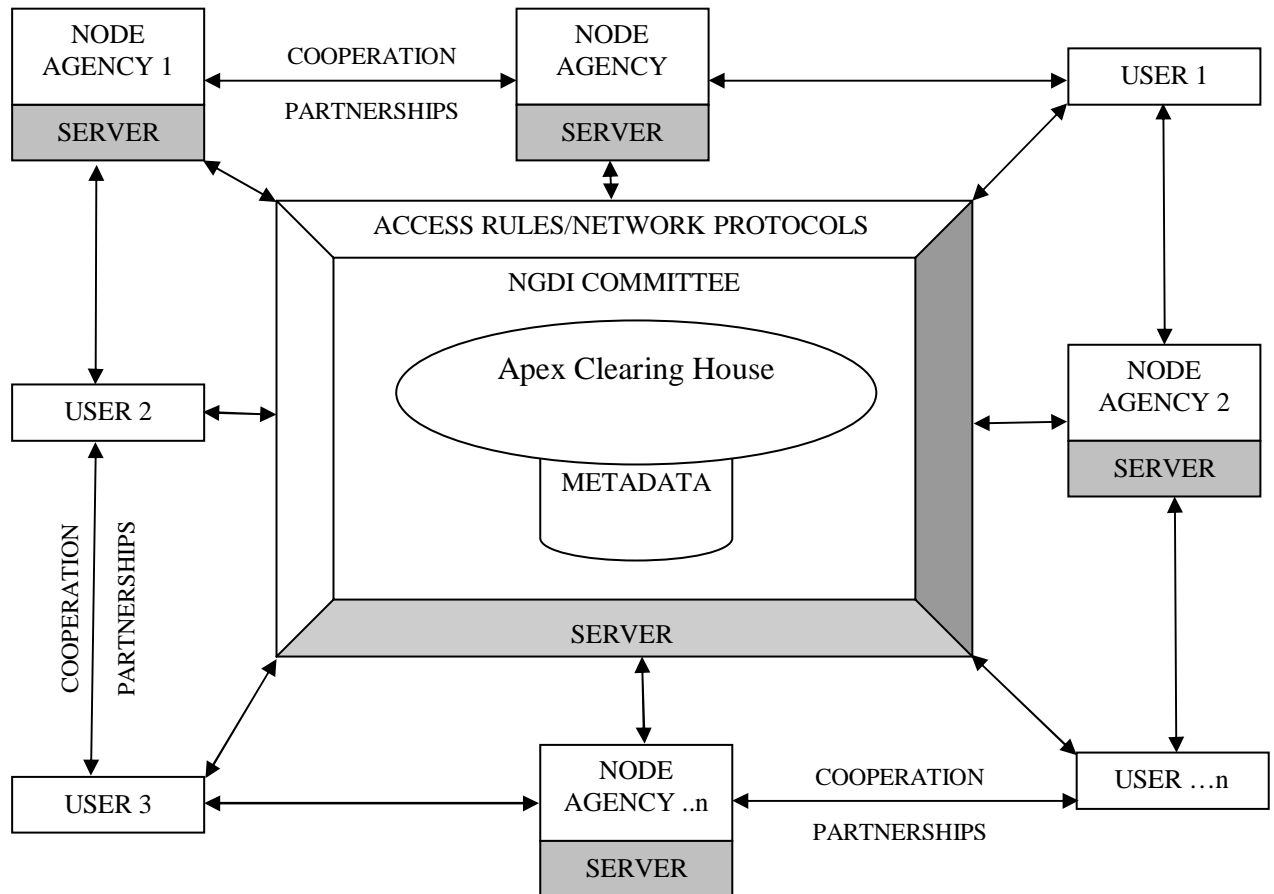
The NGDI administrative/organisational framework is multidisciplinary, inter-agency and inter-sectorial network of institutions coordinated by the lead Agency – NASRDA. The Coordinating /Lead Agency shall work in close collaboration with the relevant National, State and Local Government Legislative Committees and Geospatial data producing organisations and shall have powers to enforce rules and standards. Figures 1 & 2 shows the NGDI administrative/organizational framework and technical framework respectively.

**Figure 1: NGDI Organisational Framework**



*Composition of the NGDI Council:*

- Vice President of the Federation – Chairman
- Minister of Agriculture & Rural Development
- Minister of Defence
- Minister of Environment
- Minister of Science and Technology
- Minister of Solid Minerals
- Minister of Water Resources
- Minister of Works



**Figure 2:** Nigerian NGDI Technical Framework

### 3. IMPLEMENTATION SO FAR

#### 3.1 Impact of Successful Launch of NigeriaSat-1 on NGDI Implementation

The NGDI implementation Agency in Nigeria is NASRDA- an agency under the Ministry of Science and Technology. So far NASRDA has taken bold steps in the implementation of the NGDI project. NASRDA’s effort in this direction is corroborated with her successful launch of Nigeria’s first satellite – NigeriaSat-1 on the 27<sup>th</sup> September 2003. NigeriaSat-1 has captured high quality images and demonstrated good commercial value. The launch has generated wide spread national attention and stimulated countrywide space and GI awareness, especially among stakeholders and users of satellite data for GI acquisition for socio-economic activities in Nigeria. Similarly, decision makers have shown a great interest and have been highly optimistic about its application potentials. With ground sampling distance (GSD) or spatial resolution of 32m and swath width of 600km, NigeriaSat-1 has spatial resolution similar to LANDSAT and spectral resolution similar to that of SPOT. it has a minimum of five years life span. The fact that data from NigeriaSat-1 is timely accessible and entirely owned by Nigeria has stimulated research and development by many relevant



institutions of government and the private sectors in Nigeria. The potential application areas of NigeriaSat-1 are well documented in Akinyede (2004). NigeriaSat-1 provides a great potential for broad spectrum of data acquisition for the NGDI.

### 3.2 Inauguration of the NGDI Committee

Having submitted the GI Policy to the Federal Executive Council through the Minister of Science and Technology in order to effect the necessary legal procedure in passing it into law, NASRDA has already started implementing some of the recommendations in the GI Policy. One of such is the inauguration of the NGDI Committee.

On the 9<sup>th</sup> September 2004 a 27-member NGDI Committee that will guide the establishment and implementation of the NGDI in line with the GI Policy was inaugurated by the Hon. Minister of Science and Technology. The Committee members are drawn from the academia, public organizations, and GI related NGOs, IGOs and private sectors. The NGDI Committee composition is as depicted in Table 1.

No	Representation	Remarks
2	NASRDA	
2	Universities	Universities selected in rotation
2	Poly/Monotechnics	Poly/Monotechnics selected in rotation
6	Six Geopolitical zones – States nodal agencies	States selected in rotation
4	Private Sector, Inter-governmental & Non-governmental organisations	GI related sectors
11	Federal Ministries/Agencies	(See GI Policy for full list)

**Table 1:** Composition of the NGDI Committee

The NGDI Chairman is elected in rotation among members for a maximum of 2 consecutive terms of one year each. Each member can serve for a maximum of 2 terms of 2 years each.

#### 3.2.1 Functions of the Committee

The functions of the Committee can be summarized as follows:

- Develop the phases of implementation of the NGDI project
- Coordinate the GI –related activities of all NGDI node agencies
- Develop, streamline and enforce standards and policies for the infrastructure
- Appraise the manpower potentials of the nation in all sectors for a successful realization of the NGDI
- Mobilize local funding as well as foreign assistance whether technical or financial
- Create Sub-Committees within it for specific tasks as necessary

- Co-opt any person (s) it considers relevant in its function
- Sustain at all times, the tempo or momentum of change that will remain a necessary tonic for the realisation of the NGDI project

### **3.3 NGDI Sub-Committees**

At the inaugural meeting of the NGDI Committee, the following six sub committees were created based on the recommendations of the NGDI Stakeholders meeting of February 2003 (with minor amendments introduced where necessary):

- Geospatial Datasets
- Standards
- Clearinghouse and Metadata
- Capacity Building and Awareness
- Legal, and
- Sustainability and Funding.

Each sub committee was given approval to have a number of working groups as may be deemed necessary after obtaining the Committee's clearance.

At the next meeting slated for February 2005, the Sub-committees terms of reference will be ratified. The Sub-committees are expected to have at most 3 Working Groups, members of which may be drawn from outside the Committee. Sub-committee chairmen are also required to submit the list of their Working Groups (WGs) at the February 2005 meeting for approval by the NGDI Committee.

### **3.4 Appointment of NGDI Project Consultant and Project Manager**

For a successful implementation of the NGDI project, NASRDA appointed the Regional Centre for Training in Aerospace Surveys (RECTAS), Nigeria as the project consultant. RECTAS has since made very useful contribution that is shaping the project implementation direction. In addition, NASRDA has designated a Surveyor as the Project Manager.

### **3.5 Users Requirement Survey and Analysis (URSA) & Project Document**

An understanding of users' needs, operational priorities, related data and database requirements, and stakeholders participation at each stage of the development are absolutely fundamental to a successful and cost effective NGDI implementation.

The URSA is currently being carried out alongside an awareness campaign to increase the stakeholders buy-in to the NGDI initiative. The URSA is expected to logically review existing NGDI stakeholders and their data and databases that will impact the development and implementation of the project. The URSA will also capture the current use of data within the data producers, co-producers, users and other stakeholders. An assessment of the level of synchronization between existing data and desired data will be carried out.

The URSA will encompass data holdings, data needs, hardware and software capacity, data flow parameters, staffing requirements, and organizational dimensions. The Survey results will identify data needs, systems requirements and budgetary implications.

The results of the URSA will serve as an essential input in the development of the *NGDI Project Document* that will provide a description of the NGDI systems development approach including project architecture and master schedule.

The URSA is expected to be completed in the first quarter of 2005.

### **3.6 Provision of Fundamental Datasets**

NASRDA in line with the National GI Policy is currently collaborating with the Federal Surveys in the provision of a network of GPS geodetic controls all over the country. Apart from being a fundamental datasets for the NGDI, the establishment of these geodetic controls is essential for the processing of NigeraiSat-1 imageries to ortho-rectification level.

The successful completion of the GPS geodetic controls project will be an essential input into the ongoing plan by the Federal Surveys Department, the Surveyors Council of Nigeria (SURCON) and some Nigerian Universities to densify, harmonise and adjust the national geodetic control network as a pre-cursor of an effective NGDI.

Currently the existing analogue 1:50000 topographic map series of the country are being converted to digital format by the Federal Surveys Department. This will be an essential dataset for the NGDI.

### **3.7 Development of Application-Specific Projects**

In order to demonstrate the power of GIS and hence the need for NGDI for efficient planning and good decision making, NASRDA is currently collaborating with National Electric Power Authority (NEPA) and the Nigerian National Petroleum Corporation (NNPC) on NGDI application-specific projects.

The NEPA project is meant to demonstrate the usefulness of the System in the effective planning of energy generation and distribution. On the other hand the NNPC project is the oil/gas pipeline mapping/monitoring project. The updating of the 1995 Land Use/Land Cover map of Nigeria using the NigeraiSat-1 has been incorporated into the projects. Project implementation Committees are already setup for both projects and preliminary work is on-going.

NARSDA is also collaborating with the National Emergency Management Agency (NEMA) in the development of a flood early warning system. The project will make use of NigeraiSat-1 imagery along with other satellite imageries.

## 4. FUTURE PROJECTS THAT WILL HAVE BENEFICIAL IMPACT ON NGDI

### 4.1 African Resource Management Satellite Project

After the successful launch of the NigeriaSat-1, there has been a lot of pressure by stakeholders on NASRDA to embark on a higher spatial resolution satellite. Nigeria is now involved in the African Resource Management Satellite (ARMS) Project. This is a joint satellite programme of South Africa, Nigeria and Algeria and any other interested country in Africa that would form the cornerstone of the African Resource Management (ARM) Satellite Constellation, laying the foundation of sustainable technology development in Africa. The ARM initiative was proposed by South Africa and supported by Nigeria as documented in a joint space technology project proposal between South Africa and Nigeria (Mostert et al, 2003).

The project is one of the key flagship projects in the NEPAD Science and Technology Ministerial Programme areas. The countries involved would collaborate in building capacity to support space programmes in Africa (Kufoniyi and Akinyede, 2004). Such a programme would benefit Nigeria in advancing the realization of the objectives of its space policy and development on NGDI.

The space segment of the system will consist of identical satellites to be built together by participating African engineers. Each satellite will have a high-resolution payload with a 2.5 meters resolution in panchromatic mode and a 5m resolution in multi-spectral mode in 6 spectral bands. The satellites will be phased to operate in constellation and will be accessed through the integration of the individual ground stations.

A joint working paper on the ARM was presented to AARSE Conference in Kenya in October, 2004. The proposal will be presented to the African Union Science and Technology Ministerial Conference in 2005 as part of NEPAD Project.

### 4.2 Nigerian Communication Satellite – NigComSat-1

The present average Internet bandwidth in Nigeria cannot meet the needs of the NGDI beyond support for metadata search without map uploading. Moreover, development of a GIS Portal necessarily require not only fast computers but those with huge random access memory in gigabytes for online geo-processing of geospatial data before being delivered to the user in the required form and format. For example, it should be possible for NigeriaSat-1 Ground Station to fully process, **online**, images that are being downloaded and (to) transmit them in real-time to users in the format required by the user. This will require enormous RAM resources with fast processor beyond what is presently commonly used by majority of GI users.

Satellite-based communication has been recognized in some developing countries as a vehicle for accelerated development. Based on this, the government of Nigeria has approved the implementation of a Nigerian Communication Satellite to be called NigcomSat-1. The

project is intended to provide the bandwidth requirement to address the telephony, broadcasting and broadband needs of the country. Similarly, a functional Information Communication Technology (ICT) is the driving force behind the capture, processing, storage, management and communication or sharing of geospatial dataset.

The outline of the proposed communication satellite includes a 20 hybrid transponders with 15 years life spans and coverage of the African continent, Middle East and Europe. The project commenced in November 2004 and the satellite will hopefully be launched in 2006.

A high speed and high bandwidth backbone carrier is expected to be installed at the NGDI apex clearing house as the main gateway and master server with the implementation of a database server at each NGDI node agency. The launching of the satellite will provide the much-needed broad Bandwidth, both down- and up-links, for information transfer. In addition, the management of the country code Top Level Domain (.ng ccTLD) has recently been handed over to the National Information Technology Agency (NITDA) to ensure that it is utilized for public interest (Ajayi 2004). It is therefore expected that the local hosting of .ng will increase the resolving speed of local addresses and give the nation a presence on the global network.

A functional NGDI with an effective ICT component will ensure a coordinated effort in the development and use of reliable/standardized geo-information.

## **5. NGDI PROJECT FUNDING**

The GI Policy addressed, in clear terms, means of funding all aspects of the NGDI including data production. This includes the provision of a National Geospatial Data Infrastructure Fund “which shall accrue from: minimum of 2.5% of annual budget; 10% of National Ecological Fund (or an equivalent Fund); 0.5% of profit-offer-tax of private organizations; all income generated from access charge and data sales; and international funding and grants”.

However, the main source of project implementation funding so far is through NASRDA’s budgetary allocation and joint funding of projects with other government agencies e.g. the NNPC. We are also exploring international funding and grants sources.

## **6. CONCLUSION**

A rundown of the factors mitigating against sustainable development in Nigeria has been identified as inadequate and poor geospatial data quality, lack of institutional GI data coordination, insufficient flow of information, overlapping and duplication of activities, lack of standardized metadata and poor documentation on who is doing what and the types of available information.

The efforts made so far towards the establishment of NGDI in Nigeria have been discussed. The Nigerian GI Policy was drafted with contributions from stakeholders including an

international Workshop in order to give it the necessary credence. The Policy is an essential backbone for the efficient realization of the NGDI.

In line with the GI Policy NASRDA has embarked on some of the implementation strategies in the Policy such as the inauguration of the NGDI Committee. The associated Sub-committees and Working Groups have also been set up and given set objectives and mandates to supervise the implementation of the GI policy. NASRDA has also embarked on the implementation of the Users Requirement Survey & Analysis, and the NEPA and Oil/Gas pipeline monitoring application-specific application projects.

The future launch of the Nigerian Communication Satellite (NigComSat-1) and the high resolution ARM satellite – NigeriaSat-2 will greatly facilitate the direct relevance of GI and impact on the national economy including an efficient management of the nation's natural resources and environment.

Without a coherent and consistent SDI in place, there will be lost opportunities and inefficiencies in the use of GI to solve problems. The development of NGDI for the country is seen as a major step towards poverty alleviation and hence sustainable development. However, the success of the NGDI depends on the adequacy of funding. It is therefore essential that the NGDI Fund provided for in the GI policy is fully implemented. Obviously, execution of the tasks enumerated in the foregoing sections will require a huge cost outlay in the beginning, but this is expected to decline while benefits (tangible and intangible) will increase. While NASRDA, the NGDI Committee and its sub committees continue with their work the approval of this policy should be pursued vigorously by leveraging on the current enthusiasm of Government for geospatial data arising from the success of NigeriaSat-1.

When analyzed against the developments at regional level in Africa, the Nigerian approach may serve as one of the best practices for the development of SDI at national levels.

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