X-RAYING NIGERIA NATIONAL GEO-SPATIAL DATA INFRASTRUCTURE (NGDI)-THE JOURNEY SO FAR.

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KEY WORDS: ***Capacity Building, Geo-informatics, Survey co-ordination and implementation strategy***

SUMMARY

The development of NGDI in Nigeria has generated a lot of debates in the recent times. This stems particularly with the appointment of NASRDA, the country's space Research and Development Agency as the National clearing house by the National GI policy document. However, some schools of thought are of the view that the Office of the Surveyor General of the Federation (OSGOF), who by law are empowered to coordinate the practice of surveying and mapping (Survey Co-ordination Act No.28 of 1962 as amended in 1968 and 1973) should be responsible for all data custodianship in Nigeria including the implementation of the NGDI policy.

The short-comings of the Nigerian GI Draft Policy and Government selective inertia in funding the NGDI project are considered in this work. It is advocated that sincere implementation of NGDI in Nigeria by all stakeholders and necessary corrective measures should be taken for the observed gaps. However, when NGDI is properly implemented in Nigeria, the overall gains of the NGDI will sky rocket Nigeria into a stronger and virile economy by 2020 or 2030.

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1.0 INTRODUCTION

Spatial information technology has emerged as an essential tool in global efforts to improve food security, agriculture, environmental sustainability efforts in developing and advanced economies. Some notable and significant efforts have been made by some International organizations like FIG, UN-HABITAT, WORLD BANK, etc., in terms of advocacy in the use of Geographic Information Systems (GIS) by Government of different countries in the improvement of the lives of their citizens and in the eradication of poverty during the last decade. The central role of information in sustainable development has been recognized throughout the world. In line with the above objective, the Committee on Development Information (CODI) was formed in 1997 at the 23rd meeting of the Conference of African Ministers responsible for Economic and Social Development and Planning. The formation of this committee was to ensure that African countries key in and embrace the benefits of geo-spatial information as an important driver in good governance and effective service delivery. Since its establishment, the committee held two conferences, CODI 1 and CODI 2. The third CODI conference was held in Ethiopia from the 12 - 15th May, 2003 under the theme "Information and Governance" (Kufoniyi et al., 2005).
Geographic information system therefore provides the Platform for handling spatially referenced information and allows for integration of datasets from different sources. When such spatial information is available in organized form, a suitable framework or technology is needed to facilitate data sharing among various users and producers. Thus, Igbokwe (2005) observed that virtually all the information required for planning and national development is spatial in nature. That is, they are referenced to a given geographic location on the earth surface. Thus, for easy accessibility, sharing, storage, retrieval and dissemination such information must be produced in a coordinated and consistent manner and distributed harmoniously to all stake-holders

Geospatial Information (GI) is very essential to economic planning and national development and is universally regarded as a critical national resource. Geospatial Information is very vital to the development of various sectors of the economy such as Petroleum, Solid Minerals, Forestry, Agriculture and Food Security, Land Administration, Transport and Aviation, Environment, Security and Defense, Tourism, Census, Health, and Water Resources. Hence, as reiterated by de ZEEUW (2012), society is changing permanently, due to economic and political changes, technological development and globalization of our challenges (environment, population, natural resources etc.). As a result we adapt our land administration systems continuously, anticipating

as good as possible to user requirements in the future. He further emphasized that information supply on land administration should be supportive in the balanced analysis, monitoring and planning of land use and ownership, accounting for all three elements (people-profit-planet).This information modeling approach applies both to developed and developing economies. Land administration services are considered to be an important component of a national geospatial data infrastructure (de ZEEUW, 2012).
Globally, information services are developing fast from plain national registering service towards a functional national center for geospatial information, required in all kind of activities regarding planning, monitoring and analysing.

The National Geospatial Data Policy of Nigeria was drafted in 2003 aimed at ensuring proper implementation and strengthened synergy among stakeholders. Subsequently a 27 member National NGDI Committee was inaugurated and 6-Subcommittees on Geospatial Datasets, Standards, Clearinghouse and Metadata, Capacity Building and Awareness, Legal, and Sustainability and Funding formed. The detailed objectives of NGDI as stipulated in the draft policy as follows:

- To facilitate coordinated production and utilization of geospatial data in Nigeria.
- To facilitate rapid socio-economic growth of the nation based on exploring the gains on NGDI for planning and decision-making.
- To encourage data providers to use NGDI-endorsed standards this can improve value of the data in decision-making.
- To provide a legal framework for the production, management, distribution and use of geospatial datasets.
- To support the continuing development of the NGDI.
- To develop common solution that will enable discovery, evaluation, access and exploitation of geospatial data.
- To promote the awareness of Geo-spatial Information and its applications in Nigeria.
- To ensure adequate funding to maintain the momentum of change towards the NGDI vision and sustain the spirit of cooperation and collaboration.
- To ensure effective technology transfer in GIT in the country (Nwilo et al., 2005).

2.0 BENEFITS OF NATIONAL GEOSPATIAL DATA INFRASTRUCTURE

i. Provision of necessary framework for mapping and environment monitoring.
ii. Reduces the risk of loss of life, cargo and other properties and environmental damages in the ocean, seas and rivers.
iii. Provides the necessary framework for improved response to marine spills of oil and other hazardous wastes.
iv. Provides the necessary frame for the support of full use of space-based techniques.

v. Provides the foundation upon which more detailed and/or sophisticated datasets and related application are based.
vi. Serves as the basic building blocks upon which all other applications rely on.
vii. Assist in avoiding duplication of efforts by different agencies or stakeholders.
viii. Provide necessary standards for data integration (Nwilo et al., 2005).

3.0 FACTORS LIMITING THE NGDI PROGRAMME IMPLEMENTATION

- Absence of a homogenous horizontal and vertical geodetic datum for Nigeria (Africa).
- Lack of well-coordinated national geo-information policy in Nigeria. National data standards are not defined in line with regional and international standards. Inconsistent Geodetic Reference Systems usage in Surveying and Mapping activities in Nigeria. The adopted Minna-Datum is not consistent with the global datum (WGS84 and ITRS reference systems) with its inherent deficiencies especially in the basic assumptions used in the initial determination of the geodetic parameters including the determination of the geoid.
- Lack of collaborative effort by relevant regional and national agencies in establishing mechanisms and standards to harmonize GPS data collection, processing, archiving and exchange for in Nigeria and Africa generally.
- Selective inertia by some designated agencies in Nigeria on Geo-Information in participating in the Regional and Global Spatial initiatives.
- Poor coordination and control of the surveying and mapping operations of some multi-national companies in Nigeria by the apex surveying and mapping organization in Nigeria (OSGOF).

4.0 CHALLENGES IN NGDI PROGRAMME IMPLEMENTATION

Some of the observed challenges include:

- Creation of a common platform for the exchange of primary data and research results between stakeholders.
- Creation of common framework for standardizing spatial data and quality assurance (Quality control/assurance mechanisms).
- Establishing a uniform and consistent technical, legal and institutional mechanism to Share GIS related data, methodologies and solutions.
- Encouraging synergistic efforts in GIS-based development research at regional, national and local scales.
- Improve access to existing spatial and non-spatial data and information for the wider community (stakeholders).

- Capacity building and development of necessary expertise programs that will guarantee effective use of necessary platforms such as Web GIS, Web Map and Metadata concepts and applications .

5.0 COMPONENTS OF NGDI

The components of GDI according to Igbokwe (2002), include
- The spatial Datasets (Fundamental, Thematic and Framework Datasets)
- Data Distribution Network (Data Resources, Metadata System, equipment and Infrastructure – technologies)
- Policies and standards (policies, laws, standards that govern data acquisition, sharing and usage)
- Institutional Framework (needed for easy coordination among various producers and users of spatial data
- Providers (Producers) and users of spatial data.

The figure 1.0 illustrates the suggested initial implementation strategy for the Nigerian NGDI. According to the illustration, the Clearinghouse's primary purpose within the NGDI is to provide visibility into the overall NGDI network's holdings and access to its physical content. This would be accomplished using a centralized metadata database that takes full advantage of a variety of discovery and publishing mechanisms to index content throughout the NGDI network (Agbaje, 2010).

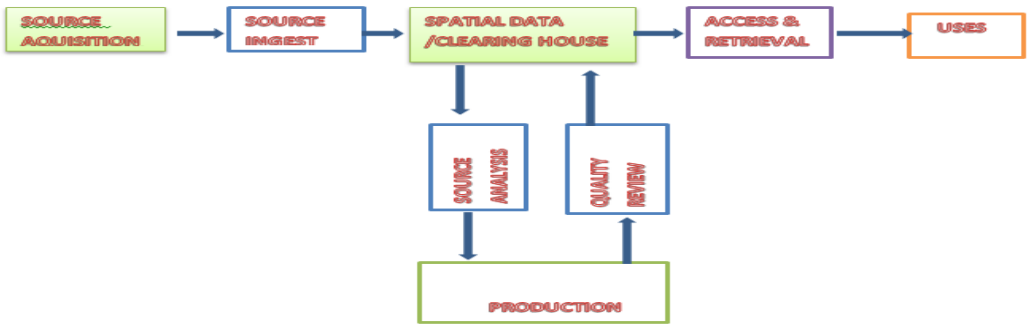


Figure 1: NGDI Incorporates a Spatial Data Clearinghouse Approach (Source: Modified after Agbaje, 2010).

The Clearinghouse according to Agbaje, 2010, will be hosted at NASRDA's Digital Databank and Library to be located at NASRDA's Headquarters, Abuja, Nigeria, along with image processing capabilities, which would be implemented during the first phase.

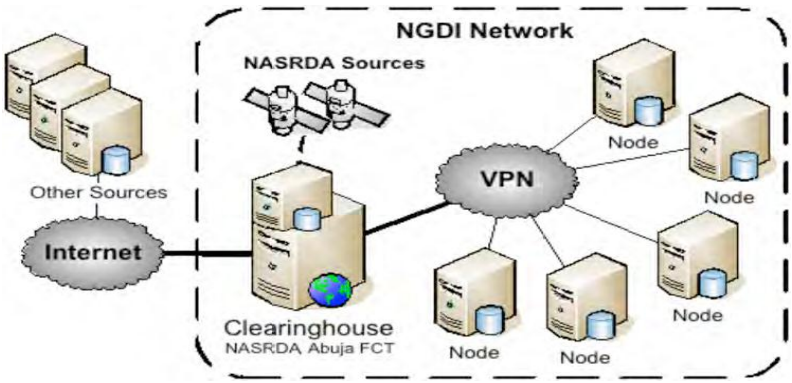


Figure 2.0: The NGDI Network Supports Distributed Holdings.
(Source: Agbaje et al., 2008)

Co-located with the NGDI Clearinghouse will be data nodes for data that is sourced and produced locally to NASRDA as illustrated in Figures 2 above. This source data will also include geospatial reference data sets such as a nationwide ortho-mosaic, terrain, control points and other data for use by NGDI's stakeholders. However, a lot still need to be done in this regard by NASRDA.

6.0 NGDI POLICY FRAMEWORK

To ensure optimal use of geospatial information, Nigeria has prepared a draft policy document for the development and implementation of NGDI. The policy document has as its vision statement as enunciated below:

i. To facilitate cooperation and collaboration among stakeholders in generating geospatial databases which are vital for development at the national state and local levels in Nigeria?
ii. To eliminate duplication in the acquisition and maintenance of geospatial data
iii. To establish institutional legal, technical and administrative frameworks for
- A consistent and harmonized mechanism for geospatial data distribution
- Easy access to vital geospatial datasets and their efficient sharing and exchange
- Integration of datasets through the application of common standards
iv. To promote investments in the production of geospatial database
v. To promote research, training, education and capacity building related to geospatial data production, management and usage.

6.1 NGDI ADMINISTRATIVE /ORGANISATIONAL FRAMEWORK

The organizational framework of NGDI is shown in figure 3.0 below. NASRDA as the lead agency will have powers to enforce rules and regulations on geospatial data information on other agencies and ensure that standards are maintained. Other datasets needed are primarily non-spatial, such as statistical collections (although the spatial boundaries are included); or which incorporate confidential information, such as the addresses of welfare recipients

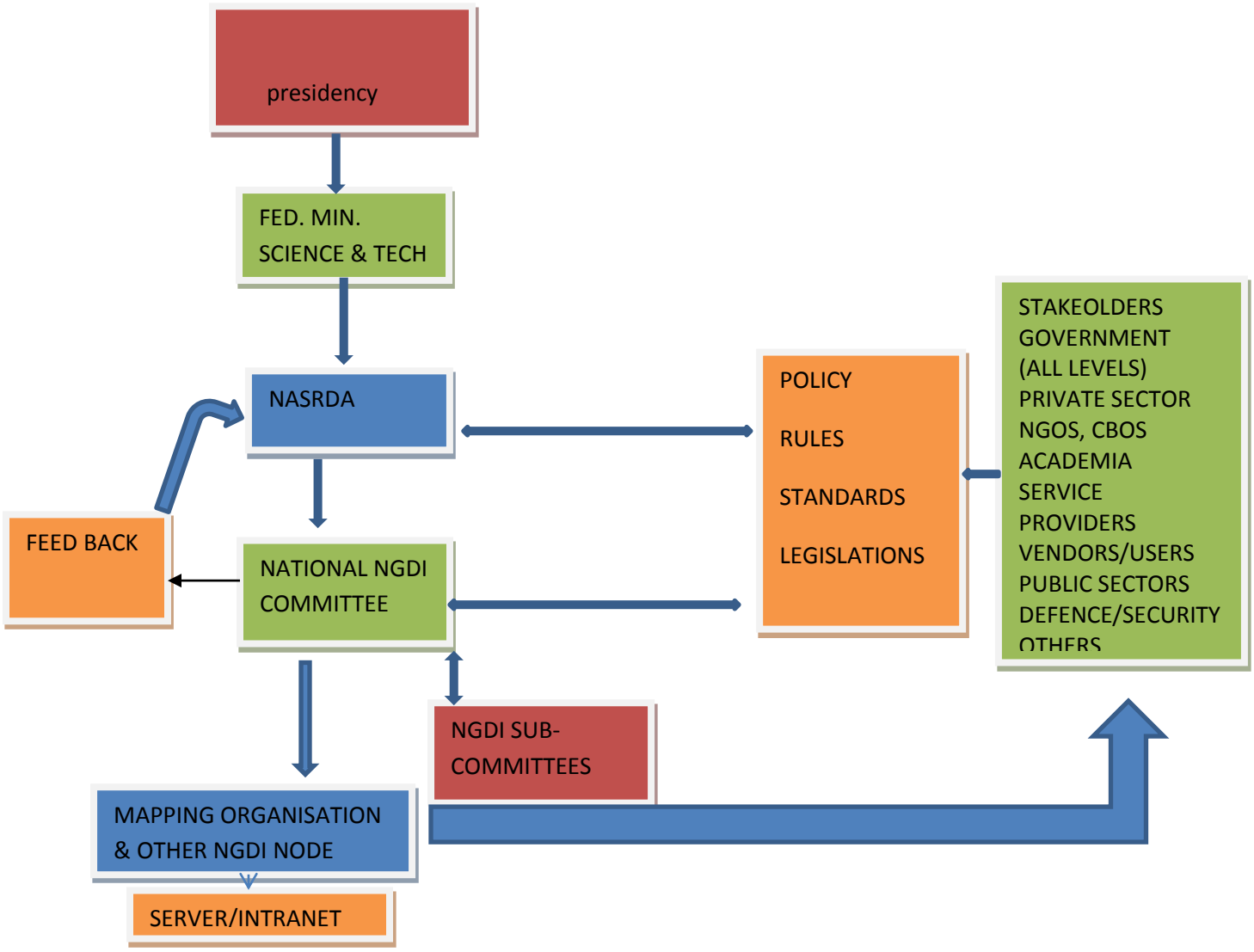


Figure 3.0 NGDI organizational Framework (Modified after Kufoniyi et al., 2005)

6.1.1 Standards

The aspects of standardization that are of importance to NGDI include data acquisition standards, data presentation and transfer / exchange standards and hardware and software standards.

6.1.2 Metadata

The Nigeria's NGDI policy statement states that every geospatial data producer shall provide Metadata for each of its data holdings which must contain at minimum
- Data scale and date of acquisition
- Data quality (positional accuracy, attribute accuracy, temporal accuracy, lineage, Completeness and logical consistency)
- Geospatial data organization and spatial referencing
- Identification information (names of data, custodian of data, geographic coverage, etc)
- Entity / attribute information
- Distribution information

The Metadata produced is expected to conform to national and international standards.

6.1.3 Legal issues

The National NGDI Committee is expected to provide advice to government on legal issues regarding the production, management and sharing of geospatial information to ensure that GI are produced, maintained and delivered in consistent way.
The legal issues cover
- Ownership / Custodianship of data
- Copyright / Intellectual property
- Confidentiality, Privacy and Liability

6.1.4 Data acess and security

The NGDI policy statement provides for two types of data access, namely
- Restricted Access (Data that relates to national security)
- Community Access (Data that can be accessed freely without restriction)

6.1.5 TECHNICAL REQUIREMENTS AND HUMAN CAPACITY BUILDING

Qualified manpower is an essential component of any geospatial data infrastructure. Nigeria has 24 Federal Government universities and about 20 state universities, 6 private universities and 16 other degree awarding institutions. These institutions offer training programs relevant to SDI. Various efforts have been made by Nigerian Institution of Surveyors (NIS) in collaboration with NASRDA and Office of Surveyor General of the Federation (OSGOF) to train the Surveyors in

Nigeria on the Applications and Use of GNSS/GPS CORS applications with emphasis on Hands-on Data Processing. On March 28-29th 2011 such workshop was organized in order to expose surveyors on the need for data integration through GNSS technology. The workshop helped the apex mapping agency to address the challenges of Nigerian national reference systems in favour of regional and global systems, whose framework has been provided by the GPS-based WGS-84 ellipsoid. Prior to this date the office of the Surveyor General of the Federation of Nigeria (OSGOF) had organised international Awareness conference on the continuously operating reference system (CORS) on GNSS technology on 1st-2nd September, 2010. Owing to the importance of these GNSS/COR Stations, the Federal Government of Nigeria through the Office of the Surveyor- General of the Federation (OSGOF), acquired and installed Ten (10No.) Continuously Operating Reference Stations (CORS), in line with *International GNSS Service and African Geodetic Reference Frame (*IGS/AFREF) guidelines/ standards, for the determination of Continental Reference System for Africa which will be consistent and homogeneous with the Global Reference Frame.

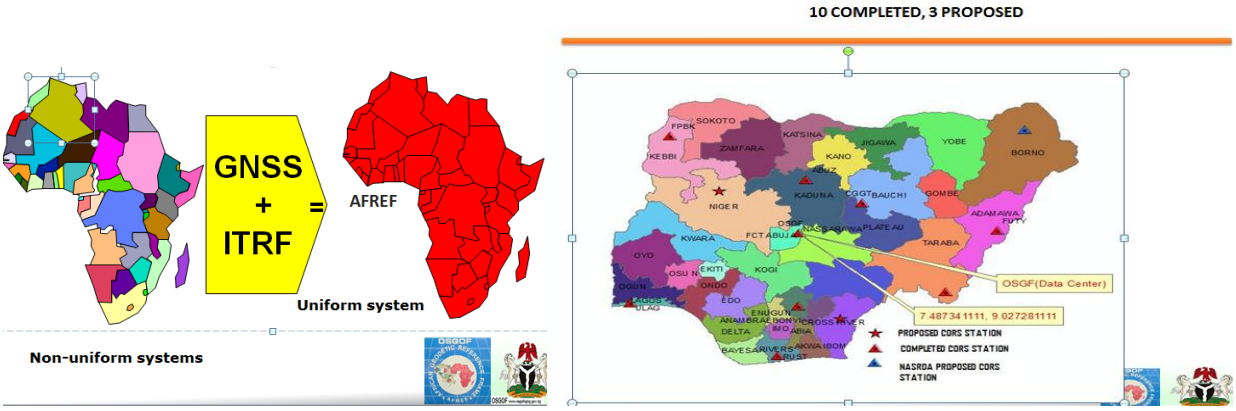


Fig. 4.0 Established GNSS/COR Stations in Nigeria (Source: OSGOF, 2010.)

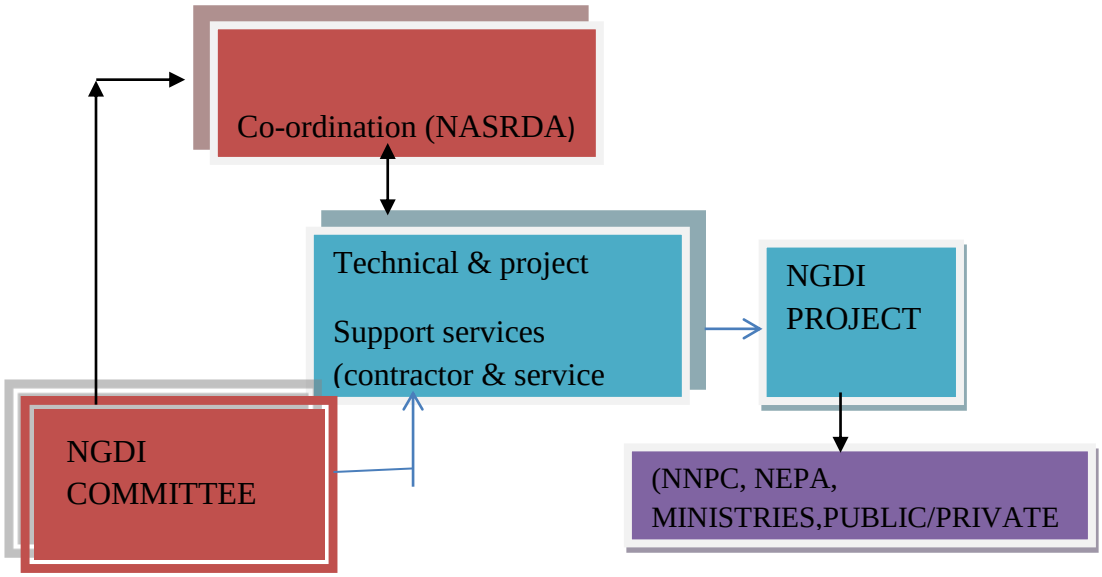
Windhoek declaration on an African Geodetic Reference Frame (AFREF) is predicated on the - fact a uniform coordinate reference system is fundamental to any development project, application, service or product that requires some form of geo-referencing. The concept of a unified reference frame has been recognized since the 1980s and the African Doppler Survey (ADOS) project was intended to provide it. Thus, the establishment of GNSS/CORS stations in Nigeria is in line with the objectives set out by African Heads of Government in the New partnership for Africa's development (NEPAD) which is centered on effective use of geo-information in governance. The concept is, therefore, to establish a network of permanent GPS/GNSS stations such that a user anywhere in Africa would have free access to, and would be at most 1000km from, such stations.

The African Geodetic Reference Frame (AFREF) is conceived as a unified geodetic reference frame for Africa. The AFREF, which will be part of ITRF SYSTEM, will facilitate development planning and enable Africa countries to tap into global spatial data resources for use by planners and decision makers. It is note- worthy that the plan for implementation of the World Summit on Sustainable Development (WSSD) recommended amongst three other key issues, the development of information systems that make the sharing of valuable data possible, including the active exchange of Earth observation data. Thus, the deployment of CORS (NIGNET) by the office of the Surveyor General of the Federation (OSGOF) is in line with the NEPAD objective.

7.0 THE JOURNEY SO FAR IN IMPLEMENTATION OF NGDI PROGRAMME

A national space development agency (NASRDA) was established in ABUJA in Abuja in 1999. The establishment of this space agency and subsequent launching of Nigersat-1 satellite into orbit kicked started the march for the establishment of NGDI. As part of the implementation strategy for NGDI in Nigeria, the NGDI is being coordinated by the National Space Research and Development Agency (NASRDA), a parastatal of the Federal Ministry of science and Technology. The NGDI stakeholders consist of the public sector and Non-Governmental Organizations. Some of the observed activities of NASRDA since inception include:

i. Successful launch of the Nigerian sat-1 environmental monitoring satellite on 27th September, 2007.In 2011, the agency also launched the Nigeria Sat-2 which is expected to have improved spatial resolution for resource inventory and mapping,
ii. The inauguration of the NGDI committee. On the 9th September, 2004, a 27-member NGDI committee was inaugurated.
iii. Creation of NGDI six sub committees in February 2003.They are: Geospatial Datasets, Standards, Clearinghouse and Metadata, Capacity Building and Awareness, Legal, and Sustainability and Funding
iv. Appointment of NGDI Project Consultant and Project Manager. Regional Center for Training in Aerospace Surveys (RECTAS) was appointed as the project consultants.
v. Development of User Requirements Survey and Analysis (URSA) & Project Document .This will capture the current use of data within the data producers, co-producers, users and other stakeholders.
vi. Provision of fundamental datasets in line with the GI policy. The establishment of some CORS stations aimed at integrating the Nigerian Geodetic System to the African Reference Frame work (AFREF) and International Terrestrial Reference Frame (ITRF) will definitely guarantee high quality fundamental data sets (Windhoek Declaration).
vii. Development of Application Specific projects with agencies like NEPA, NPC, NEMA, etc.The updating of 1995 Land use /land cover map of Nigeria using the NigeriaSat-1 image datasets (Kufoniyi & Agbaje, 2005).



NGDI IMPLEMENTATION STRATEGY (source: NASRDA, 2010)

7.1 SOME OBSERVED IMPLEMENTATIONAL GAP –AN X-RAY:

The following gaps have been identified in the overall implementation of the NGDI programme in Nigeria:

i THE DRAFT POLICY

One of the strategies for the realization of the NGDI was to Set-up a 27-member NGDI Committee to work on the implementation of the NGDI with NASRDA as apex agency. The appointment of NASRDA as the apex organization for NGDI programme in Nigeria instead of the office of the Office of the Surveyor General (OSGOF) has generated a lot of debates in the country. The office of Surveyor General of the Federation (OSGOF) is empowered (by law) to control and co-ordinate all surveying and mapping operations in Nigeria (see Survey Co-ordination Act No.28 of 1962 and subsequent amendments of 1968 & 1973). Hence, the powers vested on NASRDA to be the clearing house or apex agency for NATIONAL GEOSPATIAL DATA INFRASTRUCTURE in Nigeria is to a large extent conflicting with the traditional functions of OSGOF, who are empowered by law to control and co-ordinate all surveying and mapping operations in Nigeria. This has led to a serious bottleneck in the overall implementation and realization of the objectives of NGDI.

ii **POOR FUNDING**

Effective implementation of the NGDI requires huge capital investment for human capacity development, establishment of the severs at the clearing house and other node agencies, maintenance and control. The Government of the day has not really lived up to their responsibilities of faithfully and sincerely providing necessary funding for NGDI.

iii. **INSUFFICIENT PLANIMETRIC AND VERTICAL CONTROL NETWORKS**

The planimetric and vertical control networks in Nigeria are still very inadequate and unreliable for a coordinated survey operation and data sharing. This has been a major setback to data integration and interoperability of data. The effort of OSGOF at establishing CORS stations is commendable as it will place Nigeria on the part of data recovery and reliability.

iv. **INADEQUATE DIGITAL DATASETS IN NIGERIA**

Most of the fundamental and thematic datasets in the country are still in analogue form. Few of them are current but most are grossly outdated. The Federal Survey Department commenced the conversion of existing analogue maps to digital a few years ago and the building of national topographic database, which will eventually be integrated into the NGDI spatial datasets. However the exercise is not progressing at the expected speed and generally the impact is not being felt.

v. POOR POLICIES AND STANDARDS

As it is now there are no common policies and standards on the production, usage and sharing of Geo-information. This is obviously delaying the NGDI project in the country.

vi. Erratic Power Supply and low Technological Development

vii. **LAME INSTITUTIONAL ARRANGEMENTS**

The Institutional arrangement adopted for now has not clearly defined the roles of many public and private agencies producing and using the infrastructure conflicts.

viii. **HUMAN CAPACITY NEEDS**

Availability of properly trained personnel is still a problem in the implementation of the NGDI project. There is an advocacy for capacity building and training of experts in Geo-informatics and related environmental disciplines.

8.0 CONCLUSIONS

The development of NGDI in Nigeria is in the right step towards sustainable development and good governance because information management is a recipe for strong and virile economic development. The world is in information age and this provides ample opportunity for developing countries like Nigeria that missed out of agricultural and industrial revolution to catch up with the rest of the world.

Geographic information products provide the link between all activities and the places or locations where they happen. Every event is location based. Information is the key driver to sustainable development and eradication of poverty.

Looking back at the implementation strategies of the NGDI in Nigeria, viz-a-viz the establishment of NARSDA as the apex clearing house, the conflicting roles of the apex Surveying and Mapping organization in Nigeria as defined by the extant laws and enactments with NARSDA, the near- inertia in the take-off of the NGDI initiative, the overall human capacity requirement and capacity built so far, the near in-adequate funding by Federal Government stemmed from a number of factors, the lack of or inadequate power and supply, very low technological development(consumer driving economy), political and administrative bottlenecks, tribalism and corruption, lack of virile policy on Surveying and Mapping in Nigeria have been some of the militating and identified factors to the full take-off and realization of NGDI in Nigeria since a decade ago.

However, an effort of the OSGOF and some agencies including NASRDA at establishing some CORS stations (NIGNET initiative) is commendable. Equally, the appointment of a scholar and a professor of Geo-informatics (Prof. Chigozie Nwilo) to head the apex Surveying and Mapping organization in Nigeria is a welcomed development. The efforts so far made to re-ignite and re-invent the Survey Co-ordination and Advisory Board on Survey training Conference (recently held at Port-Harcourt from 3rd-7th September, 2012, see www.osgofng.gov.ng for the nine point's resolutions/communique).Again, the recent launching of the second satellite environmental satellite (Nigeria Sat-2) and improvement to the low resolution DMC Nigeria Satellite,NigerSat1 which was launched into orbit in May 2007 in China (The launch is a good initiative towards provision of geo-spatial data which is an essential backbone to NGDI). However, a lot needs to be done to make the streamed data from the high resolution Nigeria second satellite (NigeiarSat-2) and Nigeria Sat-X Launched in 2011 in Russia to be available at the right time. It is expected that because of the high resolution of the satellites (2.5m resolution), NCRS is going to use it to map Nigeria into 1:25,000 scale (http:/entertainment4talks.blogspot.com/2011/08/Nigeria-launched-nigeria-2-and.html). Nigeria's investment in Satellite technology is expected to improve the NGDI initiatives. The campaign is expected to enhance Government's economic reforms, particularly in the areas of e-learning, e-commerce, tele-medicine, tele-education and rural telephony (see http:/www.thisdaylive.com/articles/history-as-nigeria-finally-launches-two-satellites/96588/)

Finally, there is urgent need to ensure that adequate man power needs are provide at all nodal points of the NGDI implementation. This will guarantee continuity and effective service delivery. The journey so far in implementing NGDI in Nigeria has been X-rayed. Without consistent effort and contribution from state holders the realization of the objectives of the NGDI may be a mirage, however, when properly harnessed this can sky rocket Nigeria to one of the emerging and virile economy by 2020 or 2030.

REFERENCES

Agbaje, G.I and Akinyede, J.O. (2005).NGDI Development in Nigeria: policy issues on information Access and Information Dissemination CO1-IV United Nations Economic Commission for Africa, Geo-Information Subcommittee, and Addis Ababa, Ethiopia.

Akinjemi, F. and Kagoyire, C. (2010).The Rwanda Metadata Portal: A Web Catalogue Service. International Journey of spatial Data Infrastructural Research, 2010, 382-401. San Francisco, California, USA. Meeting, March 13-15, 2002.

De Zeeuw, C.J. (2012). Land Administration for People, Profit and Planet. Article of the Month-October, 2012, International Federation of Surveyors.

Ezigbalike, C., Faiz Sami., Qhobela, C.S., Sam. Z.Z.,(2000).Fourth Spatial Data Infrastructure Conference, Cape Town, South Africa, March 13-15,2000.

Igbokwe J.I. and Ono, M.N. (2005).Nigeria's National Geo-spatial Data Infrastructure: Problems and Prospects Proceedings, from Pharaoh's to Geo-Informatics, FIG working week 2005,

Igbokwe, J.I. (2002). Geospatial Data Infrastructure and Nigeria Economic Development, Proceedings of the international Seminar of the Africa Association of Remote Sensing of Environment Abuja, 2002, Nigeria

Kufoniyi, O. and Ganiy I. Agbaje (2005).The National Geospatial Data Infrastructure Development in Nigeria: The journey so Far. Proceedings of FIG Working Week 2005 and GSDI-8, Cairo, Egypt April 16-21, 2005.

Kufoniyi, O., (2004). Geospatial Information Policy Development, an Essential Backbone for SDI implementation in Africa. Proceedings of 7th Conference on Global Spatial Data Infrastructure, Feb.2-6, 2004.

NASRDA, 2003 Draft Geoinformation Policy for Nigeria. National Space Research and Development Agency (NARSDA), Fed.Ministry of Science and Technology, Nigeria.

Nwilo, P.C and Qsanwuta, D.A. (2004).National Spatial Data Infrastructure for Nigeria: Issues to be considered, proceedings of FIG working week, 2004, Athens, Greece.

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