National Spatial Data Infrastructure for Nigeria – Issues to Be Considered

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Key words:

SUMMARY

Early in 2003, stakeholders held a workshop to discuss the draft policy on National Spatial Data Infrastructure (NSDI). The draft policy has been finalised and is now awaiting approval of government. During the workshop a number of issues were discussed including: standardisation, metadata, identification of stakeholders and membership of the implementation committee.

In order to have a successful implementation of the National Spatial Data infrastructure there is a need to have a well distributed and homogenous control network, a good geodetic reference datum, a well-developed geoid, identification of stakeholders, good telecommunication and well-trained manpower. Nigeria has a good geodetic reference datum and a well-distributed control network. Majority of the control network were established by traditional methods.

Nigeria however needs to take full advantage of GPS technology in the establishment and extension of control networks. But this is going to be hampered by non-availability of national geoid for Nigeria. Absence of national geoid will hamper realisation of the full potentials of the global positioning system especially conversion of geodetic heights to orthometric heights. Proposals have been sent to the Federal Government to address the issue of development of the geoid but lack of fund is creating a drawback.

Collaboration with International Organisation will assist the nation in achieving the goals of the NSDI. So far, the United Nation Economic Commission and United State Geological Surveys (USGS) have been of immense assistance in capacity building. Assistance from other organisations will be further help the nation.

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1. INTRODUCTION

The term "infrastructure" typically brings to mind public facilities such as roads, railway lines, electric lines, airports, telecommunications, geodetic control framework and similar physical structures or networks in which government has played a major role in their construction or ongoing support. "Information or Data infrastructure" also brings to mind the facilities, processes and standards which make information available to citizens, scientist, and other governmental agencies and bodies. Therefore, the concept of national infrastructure is not new to Federal Government. The rationale is that a legitimate role of government, on behalf of the nation, is to provide a common, consistent infrastructure upon which a variety of government, private sector and community activities can take place (ANZLIC, 1996), (Nwilo & Osanwuta, 2003).

One of the objects of this project is to emphasis the concept of a single, consistent, accessible, government funded infrastructure as a basis for developing competitive, private sector, value-adding services sustainable development (Nwilo and Osanwuta, 2000). In this regard, this paper views land and geographic information as an infrastructure, with the same rationale and characteristics as roads, communications and other infrastructure.

The data required for a NGDI development include topography, transportation and utility infrastructures, etc. In the past, this data has generally been stored, managed and analysed in analogue map form, but with the digital revolution which has improved efficiency and productivity, maps and drawings are being created from established database on-screen using computer-aided solutions (Osanwuta, 1999).

Spatial information infrastructure is therefore an institutional concept being advanced in order to respond to needs for a wide range of spatially referenced information in various problem solving domains. This is being facilitated by the rapid growth of geographic information system (GIS) concepts and technologies for good management of infrastructure development, sustainable economic planning, environmental conservation, and a variety of other challenges facing society. In terms of practical implementation, much effort and funding should be devoted to the development of NGDI.

On the other hand "Spatial Data Infrastructure" is a term often used to denote the matrix of technologies, policies and institutional arrangements that will facilitate the availability of and access to spatial data for all level of government, the commercial sector, the non-profit sector, academia and citizens in general.

2. IMPORTANCE OF NATIONAL GEOSPATIAL DATA INFRASTRUCTURE (NGDI)

Development of NGDI resources is heavily dependent upon land related activities. Typical examples of these land related activities include a networks of survey coordinates, waterways, road and railway networks, electricity supply, communication facilities, farming, fishing, forestry, transport, tourism, communities to be displaced or evolved, planning of services for the communities, and specialised human resources. Effective utilisation of these infrastructures for developmental purposes is dependent on the availability of spatial information. NGDI provides a base or structure of practices and relationships among data producers and users that facilitate data sharing and use. It is also a set of actions and new ways of accessing, sharing and using geographic data that enables far more comprehensive analysis of data to help decision-makers chose the best course of action. NGDI provides the necessary framework for adding values. Other roles of NGDI include:

i. Provision of necessary framework for mapping and environment monitoring.
ii. Reduces the risk of loss of life, cargo and other properties and environment 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. Functions as the basic building blocks upon which all other application is dependent.
vii. Are of critical importance in the design and delivery of essential public services and benefits.
viii. Are of critical importance in facilitating national innovation and economic opportunities.
ix. They are of universal relevance in society.
x. Their availability and access assist in avoiding duplication of efforts by different agencies and end users in producing the same datasets.
xi. Provide the necessary standards for integration of other similar networks (Nwilo, 2003).

2.1 The Goals of NGDI

The goals of NGDI as shared from the United State Federal Geographic Data Committee (FGDC, 2001) are:

- to improve quality and reduce cost related to geographic information;
- reduced duplication of effect among agencies;
- make geographic data more accessible to the public;
- increase the benefit of using available data;
- and establish key partnership with local governments, states, academia, and the private sector to increase data availability.

3. STATUS OF SPATIAL DATA INFRASTRUCTURE IN NIGERIA

In February, 2003, there was a national workshop on spatial data infrastructure where several of the stakeholders were invited to discuss the draft National Policy on Geospatial Data Infrastructure (NGDI). This workshop lasted for three days and attracted participants from Economic Commission for Africa, the United States Geological Surveys and Nigeria. The policy dwelt on among others standards, metadata, the National reference framework, the clearinghouse, the geoid, management and implementation. From the workshop, it was obvious that spatial data infrastructure is very essential for the development of any nation.

The status of spatial data infrastructure in Nigeria is rather poor. In terms of the geodetic coordinate systems coverage, the Federal Surveys Department has not covered the region effectively with primary controls. Most of the geodetic controls are through the traditional survey methods and in analogue format. Specifications for establishment of controls are still based on the traditional methods. The advent of satellite techniques have however assisted in provision of more geodetic controls and harmonisation of horizontal control datums but the absence of a national geoid for Nigeria has hampered the realisation of the full potentials of the benefits of the satellite methods. The absence of a national geoid is seen during the workshop as a major draw back to the realisation of the full potentials of the satellite methods of control establishment in Nigeria (Nwilo, 2002).

Other aspects of the NGDI such as communication, trained manpower, internet access and data sharing suffer similar fate. Even information on the waterways that are in abundance has not been managed in such a way that they are easily accessible to interested parties. Provision Information on the waterways is supposed to be the responsibility of the National Inland Waterways Authority but due to funding and inadequate manpower, the available data with the Authority is in analogue format and not up to date. The oil companies operating in the region have from time to time carried out bathymetric surveys of the waterways strictly for the operational purposes. There is no law currently in place, which compels the companies to submit such data/information to a Central Government Agency such as the National Inland Waterways Authority. The law establishing the National Inland Waterways Authority provides for all the companies including the oil companies that use the waterways to pay some fees to the Authority for such uses but is silent on the submission of survey data/information on the waterways.

In the case of communication, it can be said that the telephone density in Nigeria is poor but certainly one of the best in Africa. The recent introduction of digital mobile telephone services and the licensing of the private operators have seriously improved the teledensity in Nigeria.

4. COMPONENTS OF NGDI

The implementation of national geospatial data infrastructure requires a solid infrastructure based on policy and institutional arrangement, technical standards, fundamental datasets, and a means by which spatial data is made accessible to the end users. Spatial data also known as

geospatial data or geographic information refers to information that identifies the geographic location of resources. Managing this type of acquired information and maximising its use has become a focus for both developed and underdeveloped countries around the world.

The US NSDI began formally with a presidential Executive Order in 1994 for the coordination of geographic data acquisition and access through their National Spatial Data Infrastructure. Canadian has also developed the Canadian Geospatial Data Infrastructure (Bartlett *et al, 2004*). UK, Ireland and many other countries including Nigeria have held workshops and meetings towards the NSDI initiatives.

Respective spatial data infrastructure implementations geared towards national level will be managed under a program consisting of individual tasks as given by ANZLIC (1996). One of the components of the National Spatial Data Infrastructure (NSDI) are the establishment of Spatial Reference Framework and the specifications of Fundamental Data sets. We now go to discuss the components of a National Geospatial Data Infrastructure.

4.1 Establish an Institutional Framework

For a successful implementation of a National geospatial data infrastructure (NGDI), there is a need for a national policy that will provide the necessary guidelines, identify various committees to be responsible for the various aspects of the NGDI and provide issues that will hasten the take off of the NGDI. The policy must be discussed at a forum where all the stakeholders would meet to discuss on the various issues in the draft policy prior to the approval. There is also a need for an agency to be the lead agency in the development of a NGDI.

In Nigeria, the lead Agency is the National Space Research, Development Agency (NASRDA) an agency of the Federal Ministry of Science and Technology. It was this agency that set up a Committee to prepare a draft policy, which was discussed at a national workshop attended by several stakeholders. The draft policy provides for National Council on NGDI which is made of ministers from 8 relevant ministries with the Vice President of the Federation as Chairman. Below the Council is the NGDI Committee and followed by Sub-Committees with responsibilities of the various components of the NGDI. All the important agencies that have stakes in SDI will be nodes of the NGDI. Such agencies include but not limited to the Federal Surveys under the Federal Ministry of Works, the Federal Ministry of Environment, NARSDA under the Federal Ministry of Science and Technology and several parastatals under the Federal Ministry of Transport.

4.2 The Spatial Reference Framework

The US National Geodetic Survey defines the National Spatial Reference Framework as the framework for latitude, longitude, height, scale, gravity, orientation and shoreline. It is the foundation for the NSDI. Traditionally, the Reference Framework consists of two components, the horizontal frame and the vertical frame. They consists of several positions horizontal positions that are referenced to a horizontal datum and several stations with height values that are referenced to the nations vertical datum. This positional framework is difficult

to maintain, control points are often inaccessible and their coordinates insufficiently accurate for today's needs.

The Spatial reference system needed today must support the use of GPS for navigation and positioning. The National Spatial Reference System should consist of the following components:

(i) a network of monumented points having four dimensional positions
(ii) a set of GPS continuously operating reference stations
(iii) high accuracy orbits of GPS satellites
(iv) a highly accurate geoid. This is not currently practicable in developing countries such as Nigeria.

From a developing country's point of view, the Spatial Reference Framework consists of a National geodetic datum and a network of geodetic coordinate system. The datum and the network of coordinate system are prerequisites for the mapping of a Nation.

Nigeria has a well defined national spatial reference framework consisting of the reference datum, the vertical height datum and a well distributed geodetic network of control points. These control points were mainly established by the classical surveying methods of traversing, triangulation, trilateration, triglevelling and geodetic levelling. The advent of satellite methods have reduced the rigours associated with the classical methods. It is also made establishment of control points much faster and cheaper. The Federal Survey departments and the oil companies have adopted the satellite and digital methods as methods for establishing controls.

4.3 Fundamental Datasets

Fundamental data sets are those datasets, which are produced within the institutional framework and are collected as primary data sources, from which, other data and information are derived by integration or value adding. Parker (2000) defines fundamental datasets in the context of spatial data infrastructure, as a dataset for which there is a demand for consistent regional coverage. This demands for a consistent coverage implies that:

(i) There is a need for coordination between custodians to ensure that components of the region datasets are collected to consistent standards:
(ii) That the community of users must be adequately consulted to determine specifications and problems;
(iii) Access to the data is provided in accordance with the policies determined for the countries spatial data infrastructure; and
(iv) The country's data set conforms to a set of standards that ensure that it can be combined with other components of the country's spatial data infrastructure to create value added products.

Parker (2000) added that there are three principal issues associated with the provision of fundamental datasets:

(i) Identification and prioritisation;
(ii) Production and integration; and

(iii) Data maintenance.

The Commonwealth Spatial Data Committee (CSDC) has identified more than 80 separate fundamental datasets produced by 11 Commonwealth agencies. The datasets include digital topographic, hydrographic, resource and environment data, and the boundaries used for statistical mapping. It does NOT include datasets which:

- are part of existing commissioned service arrangements and commercial contractual agreements, such as satellite remote sensing data licensed for overseas space agencies;
- 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.

From the above, it is obvious that in the context of Nigeria, the fundamental datasets country are scattered in several locations. Fundamental datasets, includes topographic maps, boundary surveys, control network data, geological maps, ecological maps of water bodies, bathymetric data, shoreline, forestry maps, soil maps place names, atlas maps, health maps, socio-economic information, road maps, rail lines and drainage system. Although, the private sector plays an important role, most of the datasets are provided by government agencies as part of their responsibilities to the society. The private sector merely compliments the efforts of the public sector. Interaction between the users and producers of the datasets ensures that there is standardization. The issue of what constitutes a fundamental dataset of the Nigerian NGDI is not yet fully agreed upon by the stakeholders in Nigeria but it is certain that control points and their coordinates, bathymetry, waterbodies, major roads, rail lines and major airports are part of it. In addition, thematic data such as soil and vegetation maps are part of it,

In generating information on fundamental datasets, it is important to map information on the following broad classification namely.

(i) Data types
(ii) Data sources
(iii) Nature of access
(iv) Orders of data.

4.4 Development of a Clearinghouse Network

This is a means by which the fundamental datasets are made accessible to the data users, in accordance with policy determined within the institutional framework and the technical standards agreed. The clearinghouse can be a separate establishment created essentially for fundamental datasets to be made available to data users as distinct from the providers of the information all conforming to consistent standards that provide for a virtually integrated clearinghouse functions. The clearinghouse when fully functional should be accessible through the NGDI website.

4.5 Development of Metadata

Metadata is an essential strategic link to an effective clearinghouse. It is the data about data. Metadata provides for labelling, cataloguing and descriptive information structured in such a way that allows data to be properly searched and processed in particular by computer. In other words, Metadata Activity is concerned with ways to model and encode metadata.

4.6 Standards

There is always a need to apply international standards to spatial data to simplify access and improve data quality and integration. Standards are required in reference systems, data model, data dictionaries, data quality, data transfer and metadata. There are different standards for different datasets. Standards are essential for interoperability of data and information.

4.7 Promotion and Outreach

It is necessary to undertake a variety of projects to publicise the spatial data infrastructure nationwide using such media as the Internet, brochures, trade show exhibitions, workshops and conferences. This is very important in sensitising the populace. Most people including the members of the National Assembly who will eventually debate and pass the necessary legislation do not at the moment seem to appreciate the importance of the NGDI. So, creation of awareness is a very important component of the implementation strategy.

4.8 Qualified Manpower

Qualified manpower is an essential component of a geospatial data infrastructure. There is no doubt that several Nigerians have been trained in fields relevant to spatial data infrastructure such as in the field of surveying, geoinformatics, geodesy, photogrammetry, remote sensing, geography, geographic information system, geoinformatics, waterways management, civil engineering, water resources management and hydrography. Unfortunately, however, most of this experienced and qualified manpower were trained in the period when the concept of spatial data infrastructure (SDI) was simply not there. At the time the concept was developed, Nigeria was more or less a pariah state under military governments. Existing manpower, therefore need retraining and exposure in these emerging fields to be relevant. New professional also need to be trained.

Nigeria has 24 Federal Government universities and about 20 state universities, 6 private universities and 16 other degree awarding institutions. These institutions offer training programmes relevant to SDI. So, with some form of capacity building particularly for the already trained manpower, Nigeria will have the right calibre of qualified hands for the effective management of SDI activities in Nigeria.

4.9 Other Important Issues

There are other important issues that are important in the implementation of an SDI policy for a nation. These are effective telecommunication, a vibrant press, good road and rail networks, well distributed and functional internet facilities. Although these may not be in their optimal situations, there are certainly available for the country to make a good start.

5. CONCLUSIONS

Spatial Data Infrastructure has become an important tool for economic development. Several countries such as the United States of America, countries of the European Community, China

and the Asian countries have embraced the concept of SDI. African countries are not left out as several of them have initiated policies towards the establishment of a National Spatial Data Infrastructure (NSDI). To further emphasise the importance of NGDI to Africa, the Economic Commission for Africa whose headquarters in Addis Ababa has a unit whose major responsibility is to assist the African countries implement SDI programmes in their respective countries.

It is for the importance attached to SDI that the Nigerian National Space Research and Development Agency (NASRDA) invited stakeholders to a 3 day workshop aimed at discussing and adding values to a draft policy on NGDI. In addition, it was an opportunity to sensitise the stakeholders and the populace at large on the importance of SDI to Nigeria's economic development and growth.

Issues that came up at the workshop and which are central to a successful implementation of a National Geospatial Data infrastructure are:
- National spatial reference framework;
- The geoid;
- Standardisation;
- Metadata;
- Identification and sensitisation of stakeholders;
- Clearinghouse and other portals;
- Telecommunication;
- Communication between government agencies and other stakeholders;
- Capacity building and manpower development; and
- Internet access.

The policy is now ready for presentation to the Federal executive Council before it is presented to the National assembly for legislation. A successful implementation of the SDI policy will create a conducive environment for geoinformation sharing, access and reduce duplication of efforts in acquisition and management of geodata.

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