

MAINSTREAMING GEOSPATIAL INFORMATION FOR SUSTAINABLE NATIONAL DEVELOPMENT IN NIGERIA

O. Kufoniyi^{a*}, J. O. Akinyede^b

^aRegional Centre for Training in Aerospace Surveys (RECTAS), Off Road 1, Obafemi Awolowo University Campus, PMB 5545, Ile-Ife, Nigeria

Website: www.rectas.org; www.uneca.org/rectas; Email: kufoniyi@skannet.com.ng

^bNational Space Research and Development Agency (NASRDA), Federal Ministry of Science and Technology, PMB 437, Abuja, Nigeria, Website: www.nasrda.gov.ng Email: jakinyede@yahoo.com

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ABSTRACT:

The fuel driving the engine of growth and sustainable development of any nation is the nation's access to reliable and adequate geospatial information (GI). Over 80% of socio-economic and environmental management decisions are based on quality and accurate information on natural resources and other geospatial data. On the other hand, the roots of under-development of the third world countries, such as Nigeria, emanated from a number of factors which include poor quality data collection, organization and management practices including lack of adequate infrastructure and skilled human capacity to develop the natural resources and manage the environment in a sustainable manner. The consequences of these are: food insecurity, air and water pollution, environmental degradation, etc. This paper therefore, examines in detail the above features in terms of the challenges facing the GI community in Nigeria if the nation must attain rapid sustainable socio-economic development. The significant role of space technology for comprehensive, reliable and real-time geospatial data acquisition and the need for the establishment of a national geospatial data infrastructure (NGDI) are discussed. The paper also presents highlights of the National Geoinformation Policy for Nigeria, focusing on the policy statements, objectives and strategies to enable implementation of the NGDI. The issues addressed in the policy include: geospatial datasets, standards, metadata, legal, data access and data security, organizational framework, commercial, capacity building, and related national policies and international cooperation. A focused implementation of the policy items is expected to facilitate efficient production, management, dissemination and use of geospatial information for national development.

* Corresponding author

1.0 INTRODUCTION

1.1 Sustainable Development and its Challenges

The term “sustainable development” has been popularised by the World Commission on Environment and Development (WCED), in its 1987 report entitled, “Our Common future”. The Commission defined sustainable development as “the development that meets the needs of the present without compromising the ability of future generation to meet their own needs”. Sustainable development stands on three pillars in terms of its definition for the 2002 World Summit on Sustainable Development (WSSD): Social development, economic development and environmental protection. In 1972, the first World United Nations’ (UN) Conference on Human Environment took place in Stockholm, Sweden, consequent upon the recognition of environmental problems as a global issue. Subsequent UN conferences and reports looked at issues of environment and socio-economic development and how to sustain them for the benefits of the present and future generations. It is against the foregoing principles that the 2002 WSSD focused on top ten strategies for the successful achievement of sustainable development. These are:

- Making globalization work for sustainable development
- Poverty eradication and sustainable livelihoods
- Changing unsustainable patterns of consumption and production.
- Promoting health through sustainable development
- Access to energy and energy efficiency
- Sustainable management of ecosystems and biodiversity
- Managing the World’s freshwater resources
- Finance and technology transfer
- Sustainable development initiatives for Africa
- Strengthening the system of international governance for sustainable development.

The achievement of the foregoing, with targets set by the UN through the Johannesburg political declaration to haul the World’s 2 billion poorest out of misery and restore/nurture the damaged environmental web that sustains all of its life, creates scenarios among Nigerian geo-information community for mass acquisition of reliable data about the nation’s natural resources and environment.

According to Abiodun (2003), the fundamental life support systems are air, water and food or agricultural resources; it may also include wholesome environment, shelter and access to health and education. The pre-occupation of visionary leaders of any nation and its people should be how to preserve these life support systems to the benefit of present and future generations. Accordingly, many societies around the globe, including Nigeria, are embarking on initiatives and developing agenda that could address/redress the problems of poverty, food security, protection from man-induced disasters and affordable health and housing.

1.2 Geospatial Information and Regional Initiatives

The recently launched New Partnership for Africa’s Development (NEPAD) by the African Union is, in part, a response to the repeated calls of Africa’s Scientists for the urgent need to develop and apply the most practical tools

possible to tackle the challenge of boosting sustainable food production, and of assessing, quantitatively, the extent and rates of desertification and deforestation and their impact on food and livestock production.

According to Mostert et al (2003), an initiative of this magnitude can only be fulfilled with African governments taking active roles to support and utilize the benefits of the relevant programmes. For instance NEPAD science and technology objectives must focus on the core challenges of food production, health, energy, information communications, mining and industrial production. NEPAD must provide a platform for scientific excellence in Africa in order to be globally competitive and contributing to the socio-economic development of the continent. To achieve this, the individual countries must pay adequate attention to providing the relevant GI to facilitate national development and regional integration.

These measures are also in line with the resolutions of the UN ECA’s Committee on Development Information, Geoinformation Sub-committee (CODI-Geo) calling on member states of ECA to establish spatial data infrastructures (SDI) in their respective countries in order to ensure that geospatial information (GI) are readily available for sustainable development activities. CODI-Geo has gone further by publishing an SDI implementation guide (UNECA et al, 2003) to assist stakeholders in African countries in understanding the institutional and technical issues involved in SDI implementation. Further more, 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. Again, the Global Mapping programme also entails the participation of each country within a category that is convenient for the country; in this case Nigeria has opted to participate under the category of countries that will not require external assistance. In the coastal and oceanography sector, the country is also expected to participate in the Global Ocean Observing Systems (GOOS)/Regional Ocean Observing and Forecasting Systems (ROOFS) for the African region.

Towards achieving the objectives stated above, Nigeria has recently been making conscious efforts to mainstream GI in its national development strategies through development of space programmes and the national geospatial data infrastructure (NGDI). This paper focuses on the country’s achievements in these two vital areas.

2.0 Space Application Support for Sustainable National Development

A prerequisite for the effective management of any development is essentially our ability to monitor the environmental status and its variations in both time and space. Earth observation, communication and navigation satellites play a vital role in the collection and dissemination of information, in a very timely manner providing crucial inputs required for carrying our operationally viable strategies.

2.1. Nigerian National Space Policy and Programmes

Within the framework of the foregoing objectives and to meet the sustainable development challenges and Nigeria's aspiration to utilize space assets for the improvement of the quality of life of its people, the Government of Nigeria approved a National Space Policy and Programmes and the establishment of a National Space Research and Development Agency (NASRDA). NASRDA was mandated to conduct appropriate research and development activities and also consolidate all space science and technology-related activities to make a greater impact on developmental efforts in Nigeria, particularly in sectors of the economy such as transports, agriculture, communication, education, cadastre and urban development, rural health care delivery, solid mineral development, water resources, defence and security, and protection of the environment.

The set objectives and targets of the policy were to be realized through the establishment and empowerment of six implementation centers, viz: Centre for Basic Space Science, National Centre for Remote Sensing, Centre for Satellite Technology Development, Centre for Geodesy and Geodynamics, Centre for Space Transport and Propulsion and African Regional Centre for Space Science and Technology Education. The mandates of these Centres and NASRDA's administrative structure have been highlighted in another publication (Akinyede, 2003).

2.2 Nigeria's Satellites Projects

2.2.1 NigeriaSat-1: The first Nigerian satellite, a micro-satellite called NigeriaSat-1, was successfully launched into low earth orbit on 27th September 2003. The choice of NigeriaSat-1 was influenced by its low cost, affordability and the advantage of comparable performance to the expensive large satellites and the possibility to support capacity building. Fifteen (15) Nigerian engineers/scientists were trained in all aspects of satellite technology including ground station management. To date, NigeriaSat-1 has captured high quality images, using the six cameras on board the satellite, 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. 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. Further benefits of the availability of real-time data from NigeriaSat-1 include:

- Opportunity for sharing knowledge and solving the problems of digital divide in Africa.
- Being configured in Disaster Monitoring Constellation (DMC) with other satellites that belong to Algeria, China, Turkey and U.K. gives it added advantage of global coverage and daily revisit with provision of real-time data.
- Ground sampling distance (GSD) or spatial resolution of 32m with an economic swath width of 600km; it has a minimum of five years life span.

- A camera-based system/technology with sensors in 3 spectral bands: green (0.52 -0.62m), red (0.63-0.69m) and near infrared (0.76-.9m) with strong potential for NDVI (Normalized Differential Vegetative Index), which can be used for a variety of application and inferences including desertification and famine early warning and appropriate decision-making
- Great potential for broad spectrum of data acquisition for the National Geospatial Data Infrastructure (NGDI), an initiative for GI-based economy that will improve the quality of life of Nigerians and alleviate poverty.
- Mutual benefits from the DMC satellites include daily imaging capability with reduction in cloud problems and increased commercial value, setting a new international EO standard, and stimulating partner-nations-value-added business and high public profile in terms of international disaster support and out of world's first coordinated EO satellite constellation.
- With the linkage of the other satellites in the DMC, through Internet facility to permit sharing of data, NigeriaSat-1 offers a great potential for disaster management and monitoring such as oil spillage and environmental degradation in the Nigerian Delta area and any other part of the world.
- Provides opportunity for an array of applications in many areas of socio-economic development and environmental management such as: oil pollution monitoring, land use/cover dynamics, environmental degradation in the Niger delta area, drought/desertification studies, influence of urbanization/urban sprawl on socio-economic activities, water resources development, coastal/beach erosion studies, etc.

Back-up programmes are also being planned and they include a low-cost ground receiving station to capture data from satellites other than NigeriaSat-1. Similarly, NigeriaSat-1 ground station in Abuja will be up-graded to receive data from other relevant satellites including the proposed ARM satellite (see section 2.2.3). The ground stations will be equipped with the state-of-the-art-facilities for data reception, cataloguing, archiving and data pre-processing. Apart from the fact that the ground stations will facilitate speedy access to real-time data at affordable cost, it creates opportunity for international co-operation and capacity building with the training of Nigerian engineers and scientists. A more detailed analysis of NigeriaSat-1 application potentials has been well documented (see Akinyede, 2004).

2.2.2. Nigerian Communication Satellite – NigcomSat-1:

Experience in some developing countries has shown how satellite-based communication accelerated development. Ineffective communication systems are usually one of the greatest drawbacks to the socio-economic development of developing countries. Consequently and as a follow-up to the successful launch of NigeriaSat-1, 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, the implementation of a functional Information Communication Technology (ICT), as a driving force behind most development

activities, particularly in the capture, processing, storage, management and communication or sharing of geospatial dataset, has been considered as part of the comprehensive benefits of a communication satellite.

The outline of the proposed communication satellite, based on a survey conducted by NASRDA (NASRDA, 2003b), includes a 20 hybrid transponders with 15 years life spans and coverage of the African continent, Middle East and Europe. The project is expected to commence in 2004 and the satellite itself will be launched in 2006.

2.2.3 African Resource Management Satellite Project: A joint satellite programme of South Africa, Nigeria and Algeria and any other interested country in Africa 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. Such a programme would benefit Nigeria in advancing the realization of the objectives of its space policy.

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.

2.3 Monitoring of the Nigerian Environment

Observations of the Earth's atmospheric system are essential for a better understanding of the atmosphere, ozone depletion, global warming, sea-level rise, atmospheric and water pollution, floods, droughts, land degradation and desertification, deforestation and loss of biodiversity, mitigation of natural disasters, freshwater availability, agricultural services and hazardous wastes disposals. These observations constitute challenges that can be met by strengthening monitoring facilities for the observation of the earth-atmospheric system and collection of reliable data, as well as provision of frameworks for promoting synergy among relevant national and international programmes to ensure linkage with all counties.

The implications of the Earth's Observing System (EOS) to sustainable development, according to Obasi (2002), include the delivery of increasingly accurate and reliable data and warnings of severe events related to weather, water, climate and natural environment and ensuring that the warnings reach their target audience in a timely and useful manner, as well as the enhancement of the relationship between meteorological factors and the quality of agricultural production, water resources management, aviation and marine navigation services and environmental protection.

To actualize the implementation of the EOS-related programmes in Nigeria through the provision of awareness on the usefulness of the weather observations and environmental data services, the Nigerian Government established a National Meteorological Services Agency (NAMSA) to provide the appropriate metrological services for Nigeria. Furthermore, NAMSA is to facilitate efficient linkage and cooperation with the Integrated Global Observing Strategy Partnership (IGOSP) to enable Nigeria derive maximum benefits from its various programmes such as the Global Ocean Observing Systems (GOOS), Global Climate Observing System (GCOS), etc.

Taking advantage of sharp images of the changing weather from the recently launched meteosat second generation (MSG-1) satellite, for example, all countries in Africa, including Nigeria, have agreed under a unique partnership to transform the data to useful information in support of sustainable development. Accordingly, a task force on preparation for the Use of Meteorological Generation in Africa (PUMA) and African Monitoring of the Environment for Sustainable Development (AMESD) projects has been set up to provide better network of data and services for early warning of disasters, improved food security, better health management, more efficient water and energy use and safer transport.

3.0 DEVELOPMENT OF NGDI

In order to streamline interaction between space technology and the objectives set by the Federal Government of Nigeria for the improvement of the quality of life of its people, the Space Application Support for Sustainable Development (SASSD) programme was devised in addition to the earlier stated initiatives. Realisation of these objectives depends on availability and speedy access to real-time data and availability of relevant infrastructures for data acquisition, processing, standardisation and data sharing. This is only achievable through the development of a National Geospatial Data Infrastructure (NGDI).

Towards a final realisation of the objectives of the NGDI, the implementation of which has been attempted without success between 1996 and 1997, a National Committee was established and inaugurated by the Hon. Minister of Science and Technology in September 2002 to draft a GI policy for the country. The draft, which was circulated to stakeholders for comments including a stakeholders' workshop, was submitted to the Hon Minister in September 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, www.nasrda.gov.ng and in Kufoniya, 2004; NASRDA, 2003a and UNECA, et al 2003).

3.1 Policy Objectives

The objectives of the national 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.

3.2 Policy Items

The items/issues addressed in the GI policy are:

- *Geospatial datasets: Fundamental datasets and thematic datasets* focussing on the policy statements for the production, ownership/custodianship, archiving and maintenance of fundamental and thematic geospatial datasets. The datasets considered as “fundamental” in the policy are: geodetic controls, topographic data (at scale 1:50000 pending availability of national coverage at 1:25000), digital imagery/image maps, administrative boundaries, cadastral database (national and states), transportation (roads, inland water ways, railways, etc.), hydrography (rivers, lakes, etc.), land use/land cover, geological maps and demographic data.
- *Standards:* Standardisation of data production, transfer and exchange, and of hardware and software.
- *Metadata:* provision, standardisation and maintenance of metadata for every geospatial data holding in the GI community.
- *Legal Issues:* Policy issues pertaining to ownership/custodianship of datasets, intellectual property/copyright, and confidentiality, privacy and liability.
- *Data Access and Data Security:* Type of access, access protocol/mode of access, establishment of clearinghouse, data security measures, etc.
- *Organisational Aspects:* Modalities for the organisational arrangement of the NGDI, which took cognisance of the fact that management of geospatial datasets should be done as close as possible to source and it is non-threatening to the mandate of stakeholders. Provision was made for a high-level policy-making, eight-member NGDI Council under the Chairmanship of the Vice President of the Federation with seven other Ministers as members as well as a 27-member NGDI Committee, and the 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 (the membership and functions of the NGDI Committee are spelt out in the document).

- *Funding:* The 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-after-tax of private organizations; all income generated from access charge and data sales; and international funding and grants”.
- *Commercial Aspects:* The policy under this heading includes data pricing, with provision and guidelines for access and data fees, on differential basis, for research/educational, government to government, and commercial/private use of community, private and value-added datasets.
- *Capacity Building:* Dealing with human, institutional and technological capacity building. The policy makes it mandatory: to include training component in GI projects; to locally implement GI projects to a minimum level of 75%; that all GI producers shall provide evidence of the local contents of their production activities in compliance with Government policy on local content; etc.
- *Related National Policies and Legislation; International Treaties, Protocols and Cooperation: National Policies and Legislation; International Treaties, Protocols and Cooperation:* Promotion of synergy, and amicable resolution of possible conflicts, among GI-related national policies and legislation while taking appropriate action to incorporate into national legislation, the international obligations which the country has assumed under conventions and treaties for the purpose of NGDI implementation including continued participation in the progressive development of international procedures on cooperation in Regional and Global Spatial Data Infrastructures.

3.3 Policy Implementation Strategies

After adopting a national GI policy, implementation should immediately take-off to sustain the interest of Government and the tempo of activities. The following main strategies have been proposed for the implementation of the GI policy in Nigeria (not particularly arranged in any other of priority).

- 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. A notable effort in this direction is 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. Furthermore, the existing analogue 1:50000 topographic map series of the country are being converted to digital format.

- 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.

4.0 CONCLUSIONS

In the foregoing sections, the development of GI in Nigeria has been discussed with main focus on the national space programmes, geospatial information policy as well as the implementation of the National Geospatial Data Infrastructure. The new NigeriaSat-1 earth observation satellite has generated much interest at all levels and in all sectors in the country adding impetus to the decision of government to launch a communication satellite in 2006. The national GI policy as an essential backbone for efficient realisation of the NGDI has been prepared and submitted to government for approval; the policy is expected to facilitate respect and trust among all stakeholders, apart from its other benefits. With the medium resolution satellite already in place, when NGDI with the sustaining policy are properly implemented in the country, the essential GI will consequently become part of the national infrastructure that will facilitate a rapid improvement of the national economy including an efficient management of the nation's natural resources and environment.

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