Nigeria in Space – an Impetus for Rapid Mapping of the Country for Sustainable Development Planning

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Key words: Mapping, Sustainable Development, MDGs, Satellite imagery

SUMMARY

Nigeria being in Space is a deliberate attempt by the government to achieve rapid sustainable socio-economic development, including the development of new resources, understanding of our environment and the maintenance of national security. This resulted in the launch of her 1st Earth Observation satellite (NigeriaSat-1) in September 2003 and opened a window of opportunity to use real-time and easily accessible data from NigeriaSat-1 for socio-economic activities and sustainable national development planning including opportunity to map the country from satellite imageries.

The paper highlights some data utilisation applications of NigeriaSat-1 (a 32m spatial resolution imagery); and the enormous impetus the NigeriaSat-2 (2.5m (pan) and 5m (multispectral) to be launched in 2010 will create in large scale mapping for urban development planning. The impact of this is in the current Land Reform effort in the country vis-à-vis the challenges to surveyors for rapid mapping of the whole landmass of Nigeria (924,000 Sq. Km) is examined.

Mapping of the whole country is germane to achieving a sustainable national development planning to support the current effort in alleviating poverty and achieving the Millennium Development Goals (MDGs). Availability and easy access to satellite imagery at relevant spatial resolution serves as catalyst in this respect.

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1. INTRODUCTION

Sustainable development planning requires access to quality geospatial data, its collection, organisation and management practices, and skilled human capacity to develop the natural resources and manage the environment in a sustainable manner (Agbaje *et al*., 2008).

The growing population pressures on the land, especially in urban areas; increasing concentration of the poor in slums and squatters in the ever-expanding cities; gender inequalities in access to economic and social opportunities; fresh water availability approaching crisis level, etc. are some of the problems the Millennium Development Goals (MDGs) is addressing. The challenge is to meet the current world population needs for food, shelter and quality of life, without compromising the ability of future generation to meet their own needs.

Data from Earth Observation (EO) satellites has become vital in mapping the Earth's features and infrastructures; managing natural resources and studying environmental change. Satellite imagery is now crucial to the understanding of the influence of man's activities on his natural resource base over time. It provides extensive data coverage with the most recent and updated data; makes it possible to collect data on dangerous or inaccessible areas; replaces costly and slow data collection on the ground, and ensuring in the process that such areas or objects are not disturbed (Wilkie and Finn, 1996).

Satellite imagery has proved valuable and cost-effective for estimating some direct and indirect indicators of sustainable development. Direct indicators (e.g. land use change; loss of agricultural land due to urbanization) require validation using in-situ data while indirect indicators (e.g. urban population growth rate; floor area per person; arable area per capital) require integration with ancillary data (Borelli and Borzeli, 2005).

With a population of about 140 million people; land mass of about 924,000 Sq. Km, and abundant human and natural resources including arable land, natural gas, petroleum, tin, columbite, iron ore, coal, limestone, lead, zinc, gold, gemstones, marble, uranium, salt, soda and sulphur etc., Nigeria has all it takes to become the strongest economy in Africa – and one of the leading economies in the world in the long term – Vision 2020-20 (NPC, 2004).

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activities and sustainable national development planning including opportunity to map the country from satellite imageries.

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2.0 NIGERIAN SPACE PROGRAMME

The overall agenda of the Nigeria's space agenda is geared towards sustainable national development including the development of new resources, understanding of our environment and the maintenance of national security. In order to attain rapid sustainable socio-economic development, the Federal Government of Nigeria took a bold step by embarking on satellite system development which resulted in the launch of her first Earth Observation satellite (NigeriaSat-1) in September 2003.

2.1 NigeriaSat-1

NigeriaSat-1(Fig. 1) built by Surrey Satellite Technology Limited (SSTL) of UK was successfully launched into Low Earth Orbit (LEO) from Plesetsk, Moscow, on the 27th of September 2003 off the Kosmos Rocket along with two other Disaster Monitoring Constellation (DMC) micro-satellites - UK DMC, and BILSAT (Turkey satellite). It is a micro-satellite with a circular sun-synchronous orbit at an altitude of 686Km. It is a 100kg spacecraft with Push-broom scanning technology, and designed for 5 year minimum lifespan. It has a swath width of 600Km and the imaging payload is 3-band multi-spectral imager in the green, red and near-infrared bands (0.52-0.62(Green), 0.63-0.69(Red), 0.76-0.9(NIR) and has Ground Sampling Distance (GSD)/Spatial resolution of 32m (Akinyede, 2003; Chizea, 2005; NASRDA, 2004).

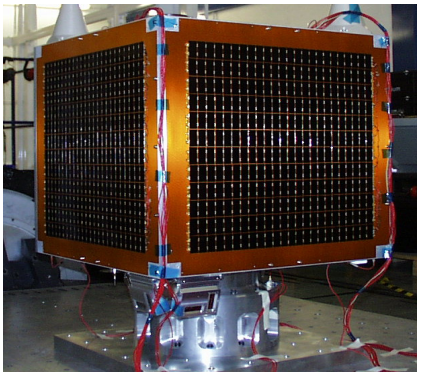

Figure 1: NigeriaSat-1 (SSTL, 2003)

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 to enhance sustainable development and support disaster

management in the country and other parts of the world. The data is currently being used to address key socio-economic problems in the country, for example revision of the Land Use/Land Cover, which was last revised in 1995 using SPOT imageries; Development of Predictive Models for Desertification Early Warning; Mapping and Monitoring of the Impact of Gully Erosion in South-Eastern part of Nigeria; Settlements and Major Roads Mapping (Fig.2); Satellite-based Environmental Change Research in the Niger-Delta area (Fig.3) ; Flood Mapping in the Kainji Lake Area; Deforestation in the South-Western part of Nigeria etc. Further discussion on Nigeriasat-1 satellite data utilization is available in Agbaje and Akinyede (2006).

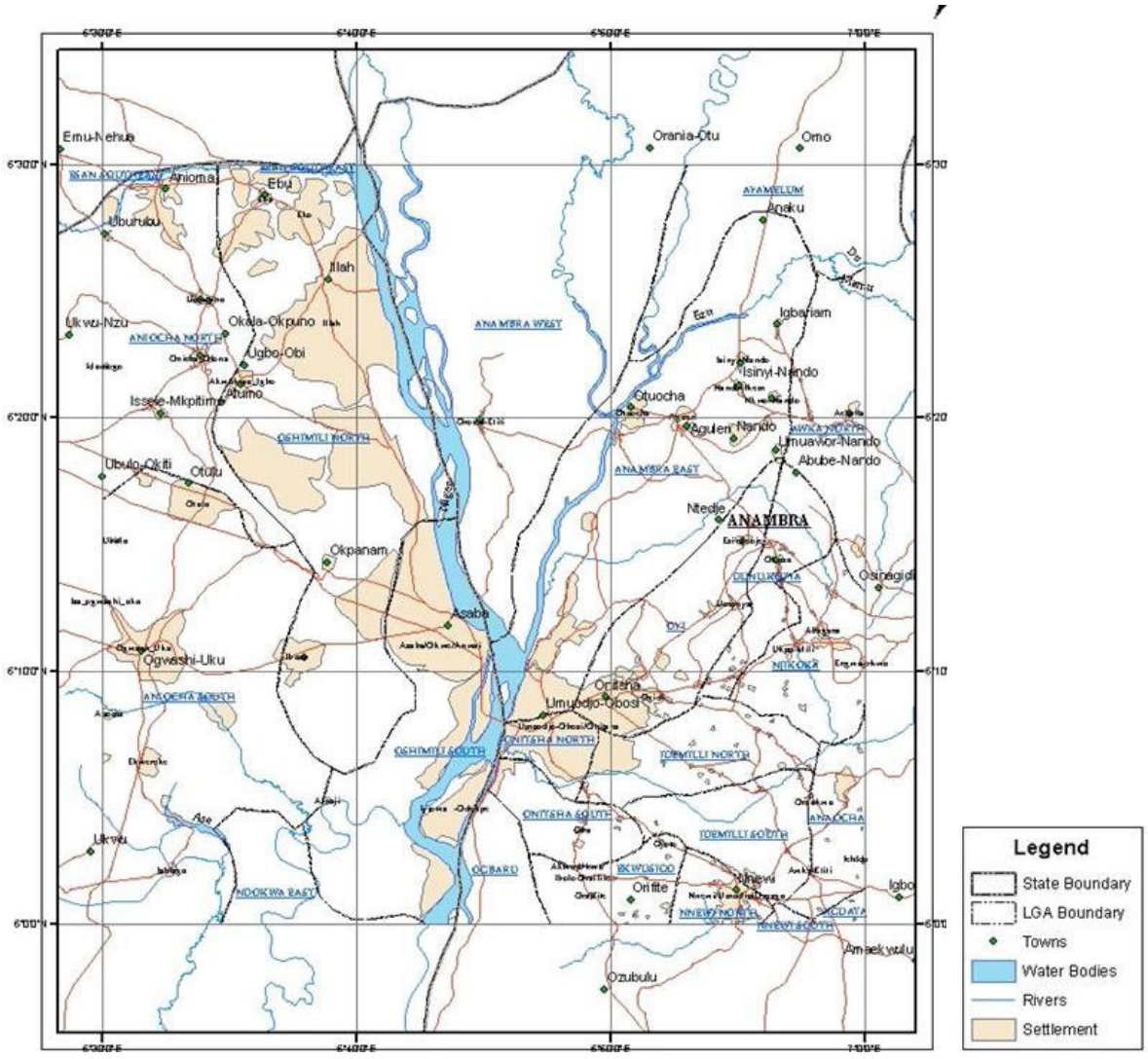

Figure 2: Settlement Map – Part of Anambra State, Nigeria

NigeriaSat-1 is one of the five (5) satellites of the Disaster Monitoring Constellation (DMC) built to address the need for daily revisit and global coverage to monitor natural disasters and

other dynamic phenomena. DMC images are made available free of charge for disaster management.

While Nigeriasat-1 is currently in its 7th year (two years over its designed lifespan), Nigeria has built her 2nd Earth Observation satellite – Nigeriasat-2.

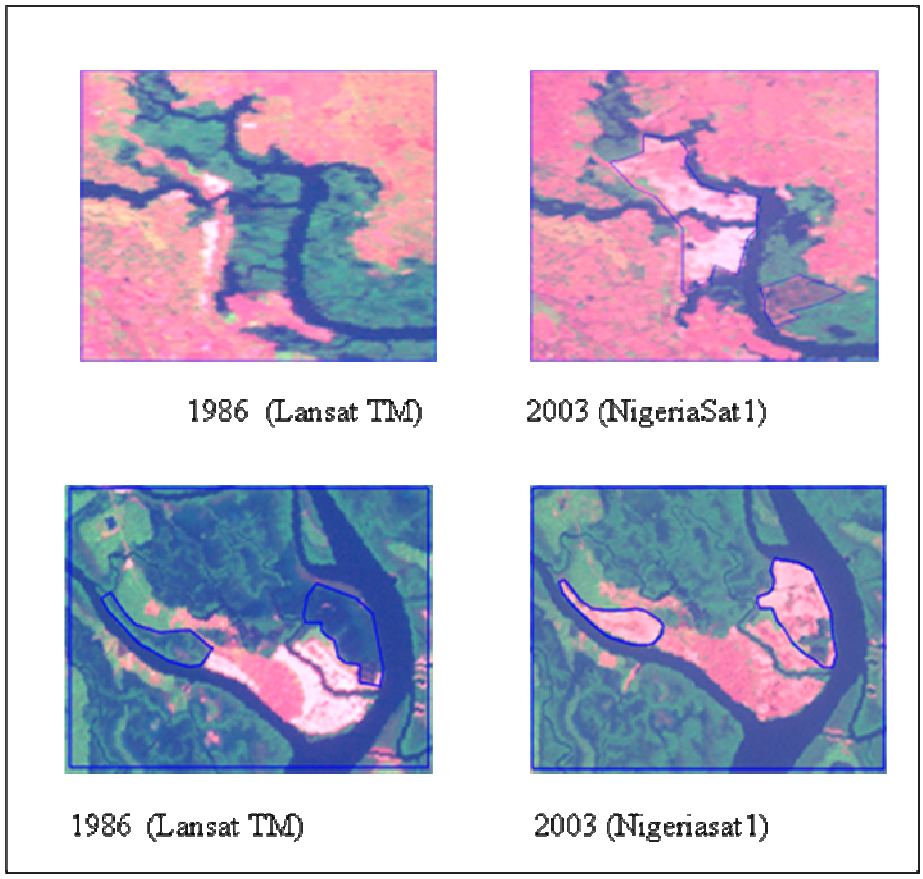

Figure 3: Niger-Delta Mangrove Lost: Mangrove lost between 1986 and 2003 estimated at 153 ha and 165 ha respectively

2.2 Nigeriasat-2

There is still a dearth of appropriate and adequate large-scale mapping coverage in Nigeria to facilitate more effective land-related planning, development and management. However, availability of high resolution satellite imagery, database technologies for storage of large datasets and GIS technologies for data management, analysis and manipulation has opened the window of opportunity for the production of large-scale maps at the scales required to support planning and sustainable land development and management (Okpala, 1996; Enemark, 2007).

Nigeria is consolidating on her achievements with Nigeriasat-1 by developing a high resolution Earth Observation satellite – Nigeriasat-2. The satellite is designed to have 2.5m and 5m spatial resolution in panchromatic and multi-spectral respectively, with four spectral bands in the RED, GREEN, BLUE, Near Infra-red (NIR). To ensure data continuity, NigeriaSat-2 will carry the 32m multispectral payload of NigeriaSat-1 to meet the requirements of a variety of applications which include large-scale mapping and precision agriculture.

The new 300kg satellite (Figure 4), with the design life of 7years is billed for launch in 2010. It will provide Nigeria with valuable geographically referenced high-resolution satellite imaging for applications in large-scale mapping, water resources management, precision agricultural, population estimation, health hazard monitoring and disaster mitigation and management etc. To be launched with NigeriaSat-2 is its training model (TM) named – NigeriaSat-X. Nigeriasat-X was built by Nigerian Engineers using Surrey Satellite Ltd, UK facilities. The Nigeriasat-X sensor will provide 22m multi-spectral (RGB, NIR) imagery.

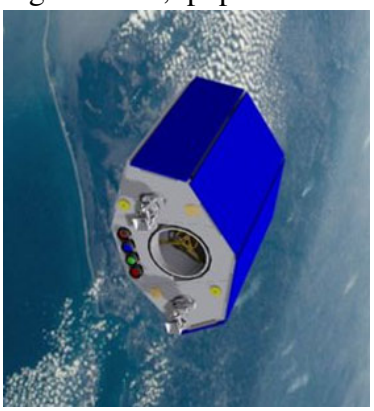

Figure 4: NigeriaSat-2 Model/Impression
(SSTL, 2007)

Using the appropriate technologies and the expected Nigeriasat-2 imagery, a major role is now being carve out for the Nigerian surveyors for the production of large-scale maps of cities, towns, and villages to facilitate more appropriate settlements and other related land development planning.

3.0 LAND REFORM

To tackle the problem of poverty headlong and open new economic opportunities to all Nigerians, the government is set to overhaul the over three-decade old Land Use Act (1978), which gives possessory right to land in the Governor of a State. Inaugurating the Presidential Technical Committee on Land Reform on the 2nd April 2009, the Nigerian President, Umaru Musa Yar'Adua described the land reform as key to poverty alleviation in the country.

The Land reform is one of the policy initiatives of the Nigerian Government in the repositioning process of governance towards achieving Vision 20:2020. The need for reforming land administration system in Nigeria is mainly due to the identified deficiencies and inabilities of the subsisting laws governing land matters to adequately empower individuals and groups to use land for the upliftment of their standards of living (Mabogunje, 2009). It has long been recognized that insecure property rights inhibit use and investment in rural and urban land, and hinder good governance.

According to Mabogunje (2009), Land and its reform process are by nature social as well as economic. They reflect wide and divergent socio-economic interests of individuals, families, groups, associations and corporate bodies. Reforming the existing system would therefore required best professional and technical practice to guarantee sustainability of the structures and processes to be put in place. This will also ensure simplicity, accuracy and precision in the deployment of the necessary modern technology required.

The focus of the Committee's task is to provide technical assistance to government at all levels to undertake land cadastral nationwide; determine individuals' 'possessory' rights using best practices and most appropriate technology to determine the process of identification of locations and registration of title holdings; and ensure that Land cadastral boundaries and title holdings are demarcated in such a way that community, hamlet, village, town, etc are recognizable. Achieving the Land Reform objectives therefore rest squarely on the input from the professional surveyors into the process.

Nigeriasat-2 imagery will definitely serve as a major input into the planned process especially in the rapid generation of large scale maps to aid the cadastral process and features updating.

4.0 NATIONAL GEOSPATIAL DATA INFRASTRUCTURE (NGDI)

The National Geospatial Data Infrastructure [NGDI] coordinated by NASRDA, has as its main objectives, the discovery, harmonisation and standardisation of geospatial data production and management, and the provision of a platform for data sharing thereby eliminating data duplication and conserving cost and time spent in producing already available data. This will facilitate efficient use of geospatial data for sustainable development in Nigeria for the achievement of the Millennium Development Goals (MDGs), the 7-point Agenda, and Vision 20-2020 of the government. Facilitating improved information infrastructure, would no doubt allow for better resource management decisions.

An institutional arrangements is in place to facilitate geoinformation sharing among organizations in Nigeria; issues such as data access; the linkage between NGDI and each of the MDGs objectives; the National Geoinformation Policy, and the NGDI organisational and technical structures have been subjects of discussion by different authors in the past (Agbaje and Boroffice, 2006, Agbaje and Kufoniyi, 2005; Kufoniyi, 2004; NASRDA, 2003 and UNECA, *et al.* 2003).

The NGDI Clearinghouse will have service interfaces for accessing metadata and retrieval of the core data. Many of the access interfaces will be facilitated through the utilization of Open Geospatial Consortium (OGC) standards, primarily through the use of Catalogue Services – Web (CS-W). This catalogue interface will be the primary discovery mechanism for NGDI's metadata and services (Agbaje, *et. al.,* 2008).

To date, the NGDI Pilot project has been completed with 7 datasets from 4 Agencies in Nigeria (National Space Research Agency (NASRDA); Office of the Surveyor General of the Federation (OSGOF), Nigerian Geological Survey Agency (NGSA); National Population

Commission (NPopC) uploaded. The NGDI website can be accessed on www.ngdi-nigeria.org . It is expected that the metadata on cadastral survey that will results from the land reform process will in future be part of the NGDI holdings.

5.0 CONCLUSION

The Millennium Development Goals constitute a set of time-bound and measurable goals and target for combating poverty, disease, illiteracy, environmental degradation and discrimination against women. However, dearth of geospatial data, poor quality data collection, organization and management practices including lack of adequate infrastructure and skilled human capacity has been identified as major factors that may make the realization of the MDGs by most developing countries unachievable.

The quest for earth-related information has been on the increase in Nigeria. It is, therefore imperative that these and many other information be readily available in digital formats to facilitate the retrieval of such information to meet various research, development planning and decision-making needs in terms of time, scale, details, accuracy and update.

The launch of the NigeriaSat-1 in September 2003 generated widespread national attention and stimulated research and development by many institutions. Data from NigeriaSat-1, and NigeriaSat-2 and NigeriaSat-X expected for launch in 2010 provide opportunity for rapid mapping and updating at various scales can readily be carried out, on a timely and consistent basis. Furthermore, this will afford the availability of very accurate and reliable information, which hitherto, are scarce in Nigeria. Such accurate information is required by planners and decision-makers to formulate planning strategies and policies.

The land reform effort of the Nigerian government is a conscious effort to create wealth and generate employment in addition to freeing land as an economic instrument to massively ensure national development. Production of large scale maps from high resolution satellite imagery (NigeriaSat-2) by professional surveyors is an important ingredient in the land reform process.

The National Geospatial Data Infrastructure [NGDI] coordinated by NASRDA, will facilitate efficient use of geospatial data for sustainable development in Nigeria for the achievement of the Millennium Development Goals (MDGs), the 7-point Agenda, and Vision 20-2020 of the government.

REFERENCES

Agbaje, G. I. and Kufoniyi, O. (2005) National Geospatial Data Infrastructure Development in Nigeria: The Journey so far. In: Proceedings of the 8th International Conference on Global Spatial Data Infrastructure, Cairo, Egypt

Agbaje, G. I. and Akinyede. J. O. (2006) 'Nigeria's Satellite Data Utilisation for Sustainable Development', "Remote Sensing: From Pixels to Processes" - Proceedings of the ISPRS Mid-term Symposium 2006 Enschede, the Netherlands, 8-11 May 2006

Agbaje, G. I. and Boroffice, R. A. (2006) The Strategic Importance of the National Geospatial Data Infrastructure [NGDI] for the Achievement of the Millennium Development Goals [MDGs] and the National Economic Empowerment Development Strategies [NEEDS] Objectives in Nigeria. Paper Presented at the International Conference on Infrastructure Development and the Environment (INCIDEN), September, 2006 Abuja, Nigeria.

Agbaje, G. I.; Ingersoll M.; Mocharnuk, J. B.; (2008) 'National Geospatial Data Infrastructure (NGDI): An Enabler for Socio-Economic Improvement in Nigeria' Paper presented at the GSDI-10 Conference, Trinidad, Feb 25-29 2008

Akinyede, J. O., 2003. Nigeria and its Space Mission. GIM International, 17(2), pp. 13 – 15.

Borelli, T.; Borzeli G. L. E. (2005) Contribution of Remote Sensing to the Calculation of some Indicators of Sustainable Development – a presentation at the Joint Meeting of the Focal Points of BP/RAC, ERS/RAC and PAP/RAC Nice, 12 -15 May 2005

Chizea Francis D. (2005) The launch of Nigeriasat-1, African Skies, Volume 9, p.20

Enemark, S. (2007) Surveying and Mapping: Today and Tomorrow http://www.fig.net/council/enemark_papers/GIS-Development.Article.pdf assessed on 21 September, 2009.

Kufoniyi, O., 2004, Geospatial Information Policy Development, an essential backbone for SDI implementation in Africa. In: Proceedings of the 7th International Conference on Global Spatial Data Infrastructure, Bangalore, India. 14p

Mabogunje, A. L. (2009) Keynote Address on Land Reform on the Occasion of the Interaction with Selected Training Institutions on Land Reform, July 2009, Abuja

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

NASRDA, 2004, Nigeriasat-1: A Solution to Sustainable National Development Challenges, NASRDA NEWS, Vol.1, Issue 3

NPC (2004) Millennium Development Goals Report 2004, Nigeria, National Planning Commission, Abuja, Nigeria

Okpala, D. C. I. (1996) State of National Land Survey and Large-Scale Mapping - Land Use Policy, Volume 13, Issue 4, Pages 317-323

UNECA, EIS Africa, GSDI and ITC, 2003, SDI Africa – An Implementation Guide. United Nations Economic Commission for Africa, Development Information Services Division, Addis Ababa

Wilkie, D. S.; Finn, J. T. (1996) Remote Sensing Imagery for Natural Resources Monitoring: A Guide for First-Time Users. Methods and Cases in Conservation Science Series. New York, Chichester: Columbia University Press.

BIOGRAPHICAL NOTES

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