Mapping and Spatial Characterisation of Major Urban Centres in Parts of South Eastern Nigeria with Nigeriasat-1 Imagery

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Key words: Urban Planning, Urban growth, Urban Infrastructure, Landuse, Satellite Mapping, Spatial Analysis

SUMMARY

Many Urban centres in Nigeria are experiencing population explosion as many people continue to migrate from the rural areas into the Urban cities. This uncontrolled population growth is confronting urban planners and developers with numerous problems. These problems include over-stretched urban infrastructures, massive urban environmental degradation, urban flooding, deforestation as more settlements are constructed. As a result urban renewal projects suffer, essential amenities are not provided adequately, urban landuse are not properly planned and essential spatial data are lacking.

To tackle some of the above problems there has been an increase in demand for spatial map data for many urban centres in the country. The use of satellite imagery provides wonderful opportunity to satisfy these demands. With many high-resolution satellite images now available, the essential spatial maps for urban centres can be produced with less difficulties. NigeriaSat-1 satellite system provides medium resolution (32m) images in three spectral bands – Green, Red and Near Infrared. In this study, NigeriaSat-1 image data was used to map the distribution of major urban centres in parts of South Eastern Nigeria. The study also includes spatial characterisation of essential growth features of these cities by comparing the generated maps with existing topographic and plannimetric maps of the areas.

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1. INTRODUCTION

Urban centers in Nigeria are facing the problems of over-stretched infrastructures, environmental degradation, seasonal flooding, destruction of natural vegetation, all resulting from increase in population. To tackle these problems there is need for availability of spatial data. Unfortunately many urban centers in Nigeria lack suitable spatial data. Urban thematic maps are not available. Where they are available, they are grossly outdated. To overcome these handicaps, urban planners are now exploring various new technologies available for quick production of much needed spatial maps. One of the areas being vigorously pursued is the use of satellite images to generate vital thematic maps of various urban centers. High resolution imageries like the Ikonos data is currently being used to create different thematic maps of cities and settlements in Nigeria for the purpose of national population census scheduled to start in March, 2006.

Nigeria is also pursuing the creation of National Geo-spatial Data Infrastructure (NGDI). Obviously availability of different spatial datasets is one of the requirements of NGDI. Satellite remote sensing will be exploited to the fullest in satisfying this requirement, not only for the urban centers but also for the whole country. The advantages are numerous and include
- regional coverage of satellite images
- quick production of needed spatial data in digital and analogue form
- reduced financial involvement
- possibility for quick up-dating of the old maps
- etc.

As part of the action programme for the exploitation of space technology in solving the
Problem of lack of suitable spatial data, Nigeria on 27th September, 2003 launched the NigeriaSat-1 micro satellite system to provide medium resolution satellite images. In this study, NigeriaSat-1 image data was used to identify the locations of major urban centers in Anambra State, situated in the South Eastern part of Nigeria. Further more spatial characteristics of the urban centers which include landcover and landuse patterns, urban growth and expansion and other factors that affect urban planning and development were analyzed. The Urban centers studied are Onitsha, Awka and Nnewi, all located within the South East zone of the county, in Anambra State. The cities are of economic and political importance to the state as well as the zone.

2. DATA SOURCES

2.1 Satellite Imagery

For this project NigeriaSat-1 image data acquired in February, 2004 was used. NigeriaSat-1 produces 32m resolution images in three spectral bands as indicated in table 1. Four image windows were processed for the purpose of the study. The first window was to identify the locations and the distributions of the urban centers, while the other three were subsets to the three cities and their environs.
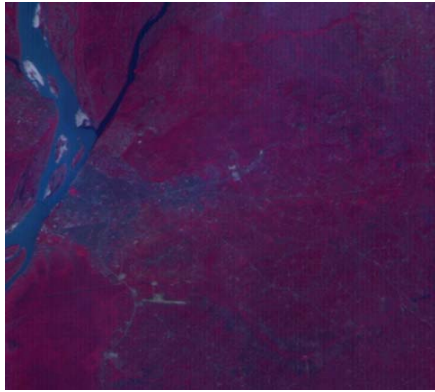
Table 1 NigeriaSat-1 Technical Data

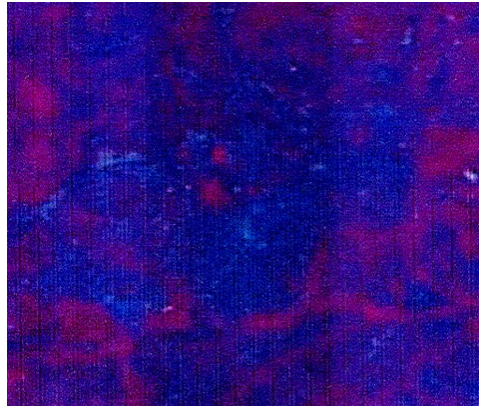| Swath	Typical Revisit	Ground Resolution	Number of Pixels	Orbit Height	Spectral Bands
600 km	3 – 5 days	32m	19,000	686 km	Green 0.52 – 0.62 Red 0.63 – 0.69 NIR 0.76 - 0.90

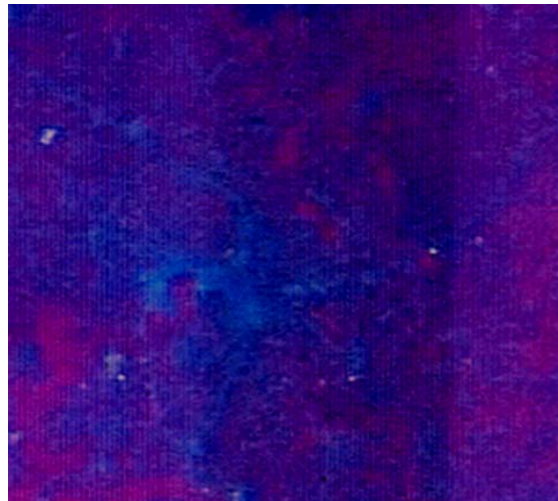The four image windows are shown in figure 1 (a),(b),(c),(d).
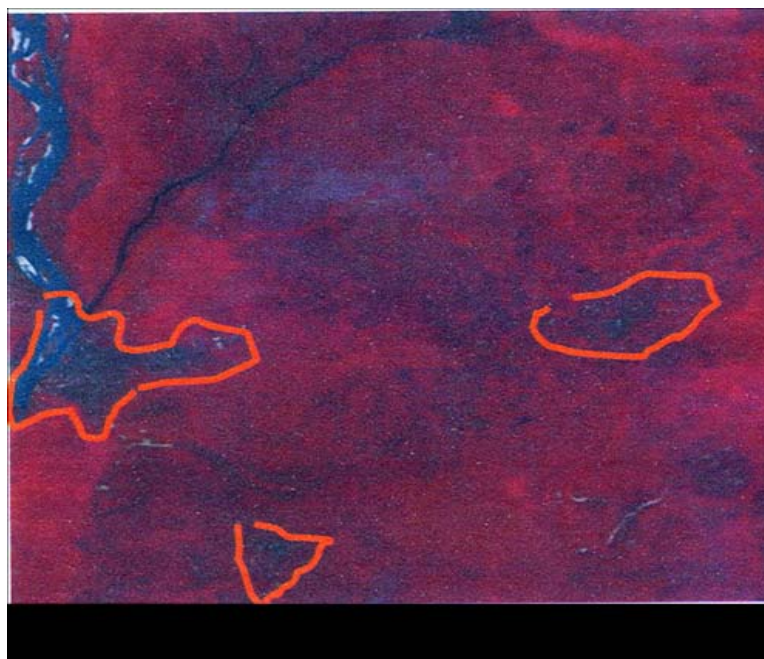
Fig 1 (a). Location of the Three Urban Centers

Fig. 1 (b). Urban Center 1: Onitsha and Environs

Fig. 1 (c). Urban Center 2 : Awka and Environs

Fig. 1 (d). Nnewi and Environs

2.2 Field Data

Field data comprises information gathered on the ground on landcover and landuse patterns in the three Urban Centers and their environs. The landcover include the water bodies, vegetation mostly shrubs and bush thickets, while landuse consists of mainly urban built- up-areas and settlements. Field photographs of these were taken. The internal urban infrastructures such as transportation networks were also closely observed.

2.3 Map Data

The Map data consists of the existing topographic maps of scale 1:50,000 and some other old thematic maps from where the boundaries of the urban centers were digitized for the purpose of determining the extent of growth of these cities from the time the maps were made to the time the images were acquired.

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3. LOCATION OF THE STUDY AREA

The three urban centers studied are all situated in Anambra State in the South Eastern part of Nigeria. The towns have been witnessing unprecedented expansion both in population and infrastructural development in the last two decades (Fig. 2).
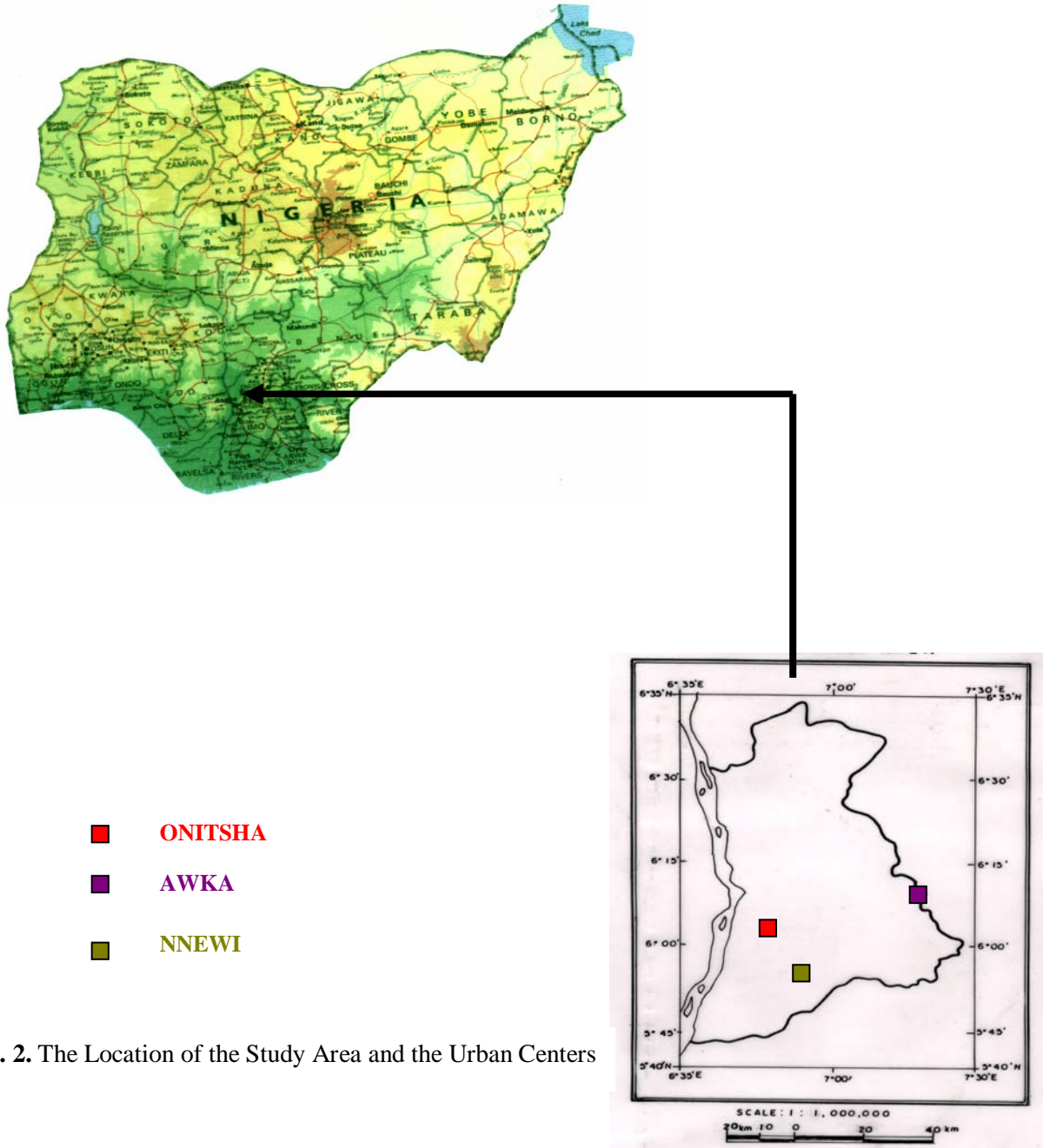

Fig. 2. The Location of the Study Area and the Urban Centers

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4. IMAGE PROCESSING

The image processing was done according to the flowchart shown in figure 2. Each of the four image windows were radiometrically corrected, by modification of their histograms and applying limited contrast stretching. They were then enhanced through filtering. The locations of the Urban centers were then identified in the first window and marked as shown in fig. 3. A detailed landcover and landuse classification using maximum likelihood method was performed for each of the urban centers and their environs. Each classified image was checked against corresponding field data for assessment of accuracy. Where applicable modifications were made. The final classified images for the urban centers are shown in fig. 3 (a), (b), and (c).
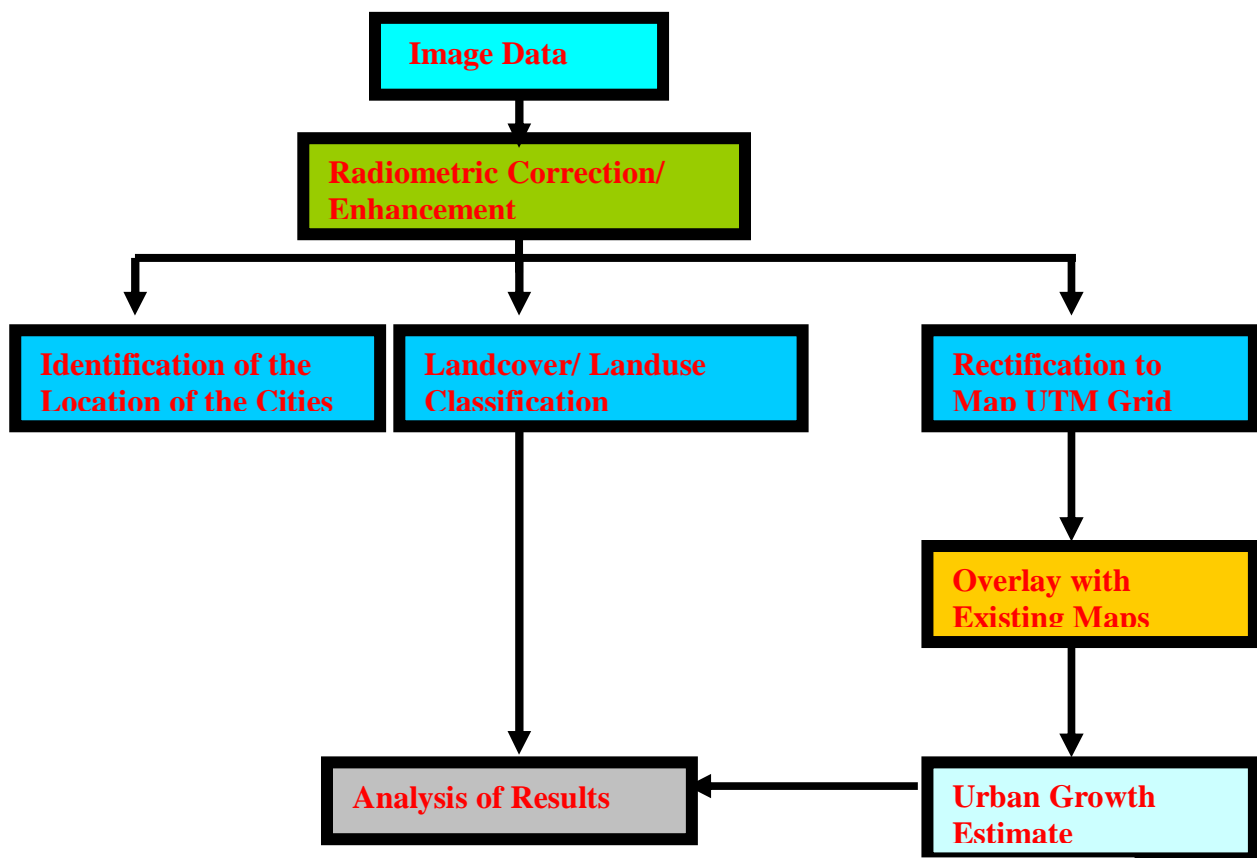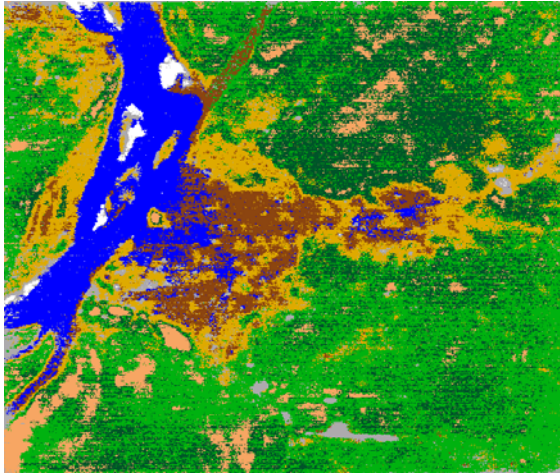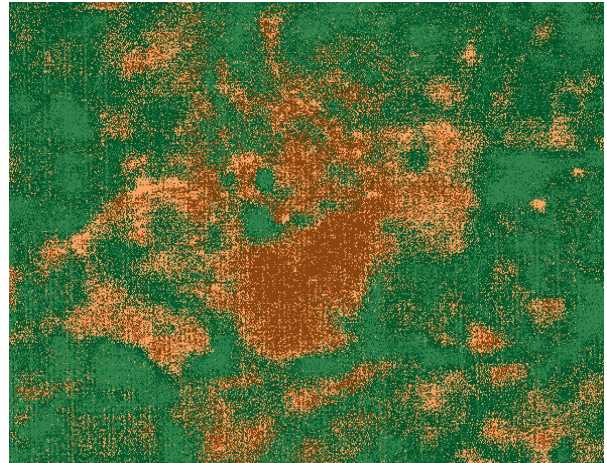
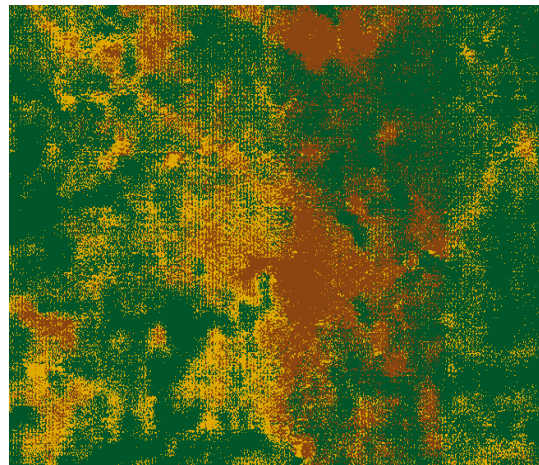

Fig. 3: Image Processing Scheme

(a) Onitsha and Environs

(b) Awka and Environs

(c) Nnewi and Environs

Fig. 3: The Classified Images of the Urban Centers

The classified results show that the urban centers has been witnessing massive urbanization. The natural vegetation has been destroyed to give way to the expanding residential and commercial houses in the areas. These developments are uncoordinated leading numerous urban problems that are existing in the areas now. Such problems include indiscriminate dumping of solid and harzadious wastes within the urban centers, blockage of drainage channels leading to urban flooding in rainy seasons and non functional urban infrastructures.

5. GEO-RECTIFICATION AND OVERLAY WITH MAP DATA

The enhanced image window of each of the urban center was geo-rectified to the topographic map UTM grid. This was done to facilitate the overlay of the image windows with the map so as to compare the boundaries of the cities and thus determine the extent of growth. The resultant image subsets were then each overlaid with the corresponding map area, which already has the boundary of the respective urban center marked. The result of the overlay show that the urban areas have been expanding at a very fast rate. In 1965 when the topographic maps were compiled, Onitsha area occupied an area of about 10.756 sq. km and in 2004 occupied an area of 64.148 sq. km. This is about 1.37 sq. Km annual growth.. or 12.72 % annual rate of expansion. Awka occupied an area of 1.08 sq. km. in 1965 but in 2004 has expanded to 20.62 sq. km. That is about 46.39 % annual rate of expansion. Nnewi on the other hand expanded from 1.34 sq. km in 1965 to 23.49 sq. km. In 2004, i.e. 42 % annual growth rate. These expansion are phenomenal considering that there was a 30 Months civil war between the two periods. The expansions have completely overwhelmed the cities, urban infrastructures have not kept pace with the expansions leading to lack of vital services as water supply. In Onitsha, Awka and Nnewi, water supply have stopped completely for many years now. To compound the problems, production of suitable maps have been neglected in Nigeria since the end of the civil war. The result is that the urban planners and developers are handicapped in that without adequate spatial data, urban development and renewal projects cannot be monitored or controlled. The same situation is obtainable in almost all the urban centers in Nigeria with the exception of probably Abuja.

6. CONCLUSION AND RECOMMENDATIONS

It is obvious from the study that the uncoordinated expansion of the urban centers since the early seventies has created many and difficult urban problems in these centers. The growth of the centers has not over the years been matched with corresponding increase in the production of spatial data. The result is that in these urban centers, the scarcity of suitable spatial data has made it almost impossible to successfully tackle the problems on the ground. The same situation is obtainable in virtually all the cities in Nigeria, with the exception of probably Abuja. It means therefore that quick, accurate and massive production of different urban maps is now urgently needed to facilitate proper planning and development of our urban centers. In conclusion, the following recommendations are proffered.

– The Federal and State government authorities should immediately create Committees at national and state levels to work with relevant national and state agencies for the purpose of quick production of needed thematic maps of all major urban centers in Nigeria using the available high resolution satellite images.

– The Federal and State agencies charged with spatial planning and urban development should embark immediately on acquisition of knowledge and technical know how for the purpose of application of modern mapping techniques in their various areas of operation.

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- Production of thematic maps for urban planning and development will involve large sums of money. Only the Federal government and the state government will be able to provide the financial muscle needed to execute such project. Therefore they must be ready to provide all the funds that these agencies will need to prosecute such projects.

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BIOGRAPHICAL NOTES

Dr. **Igbokwe** obtained M.Sc. Degree in Surveying from Sofia, Bulgaria in 1983 and Ph.D. in Remote Sensing Applications from the University of Hanover, Germany in 1993. Currently, he is an Associate Professor of Surveying and Geoinformatics and Head of the Department of Surveying and Geoinformatics, Nnamdi Azikiwe University, Awka, Nigeria. He is a member of Nigerian Institution of Surveyors, Geoinformation Society of Nigeria and Nigerian Institute of Management. He is a Registered Surveyor. His research interest is in Remote Sensing and GIS applications

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