APPLICATION OF REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM (GIS) IN REVISING TOWNSHIP MAP: A CASE STUDY OF MUBI METROPOLIS, ADAMAWA STATE, NIGERIA

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ABSTRACT

The major phenomenon in our contemporary era is the high and accelerating rate of changes and extensions of urban centers. This calls for fast technique for updating the existing maps. This research demonstrated the application of Remote Sensing and Geographic Information System (GIS) in revising township map of Mubi metropolis. A conventional map of 1975 and Quick-Bird imagery of 2005 of Mubi metropolitan town were used for the map revision of the metropolis. GPS was used for picking the required coordinates; Ilwis 3.1 was used for geo-referencing the satellite imagery, Arcview 3.2a was used for digitizing roads and ward boundaries. This research revealed that a lot of changes have occurred on the road network which indicated increase in the number of roads from 15.205km in 1975 to 30.023km in 2010.The built-up areas expanded from 17.3158km^2 in 1975 to 23.8780km^2 in 2010. It was recommended that revisions of all categories of maps should be embarked upon. The use of remotely sensed data should also be adopted for mapping purpose by the relevant government authorities for example, Federal Ministry of Survey.

Keywords: *Map Updating, Remote Sensing, GIS, Mubi Metropolis.*

INTRODUCTION

Nowadays, several countries in the world face problems in relation to outdated maps. As a consequence according to Holland, Guilford and Murray (2004), there is the necessity to apply methodologies which allow map updating in a faster and more efficient fashion. Owing to this fact, satellite images (since orbital sensors were created) have been considered as an information source which presents several advantages: speed in the process of obtaining updated information, possibility to apply faster updating methodologies than the traditional photogrammetric process, high temporal resolution, spatial resolutions which are even thinner and fairly low costs. In support of this assertion, Musa (2006) reports that from every day activities of man the landscape changes rapidly. Based on this reason therefore, maps produced some years back soon lack details of recent development, hence, map revision- the process of updating earlier maps, is therefore necessary so as to incorporate recent changes in the landscape. This research examines the potential of high resolution satellite

sensor imagery for the updating of township map of Mubi metropolis. After a review of satellites capable of being used for this purpose, several examples of mapping projects are presented. Holland and Marshall (2006) concluded that high resolution satellite sensor imagery does have a role to play in the update of township mapping, especially in the detection of change.

Township mapping from satellite imagery is carried out all over the world, using data from an ever-growing number of sensors. Traditional film cameras are gradually being replaced by digital cameras and scanners, but most townships mapping still rely on sensors based on airborne platforms. According to Vaughan (2004) mapping the earth from space has been a topic of research for almost half a century. High resolution images from satellites such as GoogleEarth and QuickBird have proved their usefulness over the past few years, especially in the mapping and surveillance or otherwise inaccessible areas, for example in areas of military conflict, such as Afghanistan and Iraq (Kumar and Castro, 2001). Such images have also been used to update maps, or generate completely new mapping, in many areas of the world, including Saudi Arabia, Indonesia (Mandeville, 2001).

Keates (1973) made it clear that map revision is an important factor in virtually all types of map production. Therefore, once a map is produced, the graphic image is static and there is a constant need to provide the map with information on changes and at the same time reducing or avoiding this defect. This however, has to be set against the value of having a permanent graphic image for use and the fact that much of the information on the map will remain valid for relatively long periods, even though some items will have changed Olaore (2004). High and accelerating rate of the township changes and township area extensions, particular in developing countries, calls for an efficient and fast technique for mapping the urban changes with the required accuracy for updating the existing maps. The availability of the new generation satellite imageries have opened a new era and signaled promising futures for producing and updating digital maps.

The existing map of Mubi which was published since 1975 has not been revised till date. Attempt at map revision are crippled by the lack of recent aerial photos. This means that all the developments and changes that have taken place since 1975 still remained unmapped. Moreover, most of the existing maps are not registered onto any projection system which makes it difficult to ascertain the coordinate points on the map, hence calculation of area and distances of which is highly needed for georeferencing are difficult if not impossible.

This study whose major aim is to revise Mubi metropolitan map produced since 1975, becomes imperative response to the aforementioned problem. The specific objectives of the study however include:

i To demonstrate the application and potential of GIS technique in map updating.

ii To use the integration of QuickBird imagery and existing conventional map to update the map of Mubi metropolis.

iii To produce up-to-date map of Mubi metropolis and to make the map appreciable to other users.

iv To register the map on to the universal transverse mercator system

METHODOLOGY

Mubi metropolis as a geo-political area comprises of two Local Government Areas; Mubi North and Mubi South. According to Adebayo, (2004) the area is located between latitudes 10°30' and 10°05'N of the equator and between longitude 13°10' and 13°30'E of the Greenwich meridian. It occupies a land area of 192,307Km and support a total population 260,009 people (National Population Census 2006). Mubi and it environs exhibits a tropical wet and dry type climate. The wet season runs from the months of April to October, while the dry season commences in November and end in March. The annual average rainfall input at about 86.775mm with the highest occurrence in July and August. The temperature regime in Mubi is warm to hot throughout the year because of the radiation income which is usually relatively evenly distributed throughout the year.

However, there is usually a slightly cool period between November and February with gradual increase from January and March relative humidity is low. Adebayo 2004 points out that it starts rising as from April and reaches the maximum in August following the cessation of raining season in the area. The soils of Mubi fall under the category of ferruginous tropical soils of Nigeria base on genetic classification made by the Food and Agricultural Organization of the United Nations (1998). Based on this classification three soil types were identified which are *Lithosols, Luvisol* and *Cambisols*. The vegetation of Mubi and its environs fall within the Sudan savanna belt of Nigeria. The vegetation zone referred to as cambretaceous woodland savanna (Areola 1983). About 70% of the vegetation is made of grasses and weeds with few scattered woody plans which makeup part of the natural vegetation and exotic which were brought from other areas into the region. Figures 1 and 2 are maps showing the study area.

An HP Laptop Computer HP 530 an HP colour printer, hand held GPS (Garmin 72) and Genx A4 Scanner were the main hardware used for this study. The software packages used were of two categories: the GIS and non-GIS packages. The GIS software packages were ILWIS 3.1 Academics for geo-referencing and Arcview 3.2a for digital mapping while Idrisi was used for overlay, calculation of area and map analysis. Other non-GIS Software packages includes CorelDraw 12 for map scanning and map export to ILWIS, Microsoft word 2003 for typing and other text formatting processes.

Two data types were sourced by the researchers in order to achieve the desired aims and objectives of the study. The sources area summarized on Table 1.

Table 1: Baseline Data

Data Type	Data Source	Date	Other characteristics
Mubi Metropolitan Map	Federal Ministry of Survey, Lagos	1975	
Satellite image of Mubi Metropolitant	QuickBird	2005	Multispectral Resolution (2.4m), Band: Multispectral Panchromatic, Format: Geo TIFF

Data Capture

The Global Position System (GPS) reading of two round-about (police round-about and Lokuwa round- about) and two road junctions (Maiha road junction and Gella road junction) for the purpose of geo-referencing the 2005 satellite imagery. In order to geo-reference the satellite image, four points on the ground which were identifiable on the image were visited. Two out of the four points that were visited were round-about (police round-about and Lokuwa round- about) while the other two points were road junctions (Maiha road junction and Gella road junction). In each of these points, the GPS was turned on and coordinates were observed and recorded.

The coordinates of the four points picked were 10° 15 52.89"N, 13° 16' 10.51"E (police round-about) 10° 16' 23.86"N, 13° 16' 40.48"E (Lokuwa round-about) 10° 16' 08.53"N, 13° 15' 10.71"E (Maiha road junction) and 10° 15' 48.78"N, 13° 16' 30.22"E (Gella road junction) these coordinates were transformed to Universal Transverse Mercator (UTM) through the transform module of Ilwis 3.1 to create the geo-reference points. Geo-referencing ensures that coordinates of pixels in the image correspond to the true coordinates of the points they depict on the ground. The transformation gave the minimum "X" and "Y" values 306150.24, 1139028.81 respectively and also 314191.88, 1139332.43 as maximum "X" and "Y" respectively. The four points picked with GPS were identified on the satellite image and were used as tie points. The referenced satellite image was then resampled and some points were again picked on the ground and were compared with the same points on the referenced map and found out that the coordinates on the ground corresponds to the coordinates on the map, which is called ground truthing. The image was then exported to Arcview for digitizing.

The conventional map of Mubi was scanned using the Genx scanner through CorelDraw 12 and imported to Ilwis environment via Tagged Image File-TIFF and the map was geo-referenced using the four point corners of the map as tie points. The referenced map was then resampled using the minimum and maximum coordinates of the resampled satellite imagery that the two maps (conventional map and satellite imagery) can have the same rows and columns for two maps to overlay; they were then exported to Arcview environment for digitizing.

The major roads, minor roads and access roads on the satellite imagery were digitized as line through the digitizing modules of Arcview by creating independent thematic layer for each of the digitized features on the satellite imagery. The ward boundaries were also digitized as polygon through the same digitizing modules of Arcview. Some of the boundaries were identified by field survey and information

from the wards heads of some of the wards. Each thematic layer was then edited to eliminate digitization error.

RESULTS AND DISCUSSION

The Road Network: Most of the roads in the metropolis were untarred as at 1975 except Ahmadu Bello way, Kashim Ibrahim road, Zaria road, Bauchi road and Aliyu Makama road. The total distance of the roads network as at 1975 was 15.205km. Roads such as Kabang road, Gaya road, Sabon Pegi road, Digil road, Wuro-Gude road, Shagari road and Lowcost road were identified as unpaved as at 1975 but in 2010 are paved. The total distance of road network in the Metropolis is 30.023km. However, the road names were stored in attribute file.

Development: Quite a number of developments have taken place since 1975 when the last map of Mubi was published. Some wards such as Sabon-Gari, Unguwan-rami, Saminaka, Unguwan-Kara, Arahan-Kunu, Gi'ima, Matakam, Dazala, Wuro-Harde, Wuro-Barka, Va'atita, Gi'ipalma, Gerewol, Shagari-Lowcost, Sabon-Pegi and Barama were not in existence as at 1975. By 2010 the wards have experienced rapid growth and development.

Map Registration: Map Registration is the process of putting the map on to a known projection. The observed values of the grid lines are the outcome of registering the map onto a Universal Transverse Mercator (UTM) system. With grids properly in place it is possible to measure distances and bearing between any points on the map with points outside the map provided that these points are in UTM coordinates. The outcome of this research at glance shows that the updated map depicts the different wards and the road network (major, minor, access and footpath) in Mubi metropolis (Fig. 3). The research shows that the built-up area in 1975 has the total area coverage of 17.3157km^2. As a result of subsequent spatial growth of the town, in 2010 the total area coverage expanded to 23.8780km^2. The built-up area has 42.03% in 1975 and 57.97% in 2010.

CONCLUSION AND RECOMMENDATIONS

This research produced a revised map of Mubi metropolis. The simplicity, accuracy, versatility and most importantly the convenience associated with digital mapping, especially when addressing problems associated with map revisions, will beckon all those associated with maps and map making. This research also concludes that map makers should gradually embrace the integration of satellite remote sensing, Global Positioning System and Geographic Information System in map revision project. Remotely sensed data and GIS provide a reliable base for map revision especially when high resolution satellite imagery (QuickBird imagery) is used, updating of maps becomes easier and less costly.

The full potential of GIS can be realized by integrating remotely sensed data in a geographic information system environment. The following recommendations were therefore made that:

i The use of remotely sensed data should be adopted for mapping purpose by the relevant government authority for example, Federal Ministry of Survey.

ii High resolution satellite imageries should be made available at relatively low - cost to researchers to aid in global mapping.

iii Revision of township maps should be embarked upon as often as possible by mapping agencies such as ministry of survey so as to have current map of an area for further research and development.

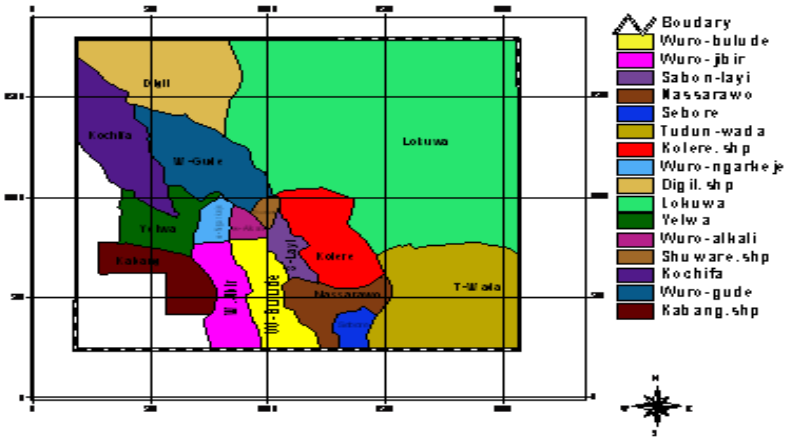

Fig. 1: Digitized Conventional Map of the Study Area 1975

Fig.2: Satellite Image of The Study Area.
Source: QUICKBIRD (2005)

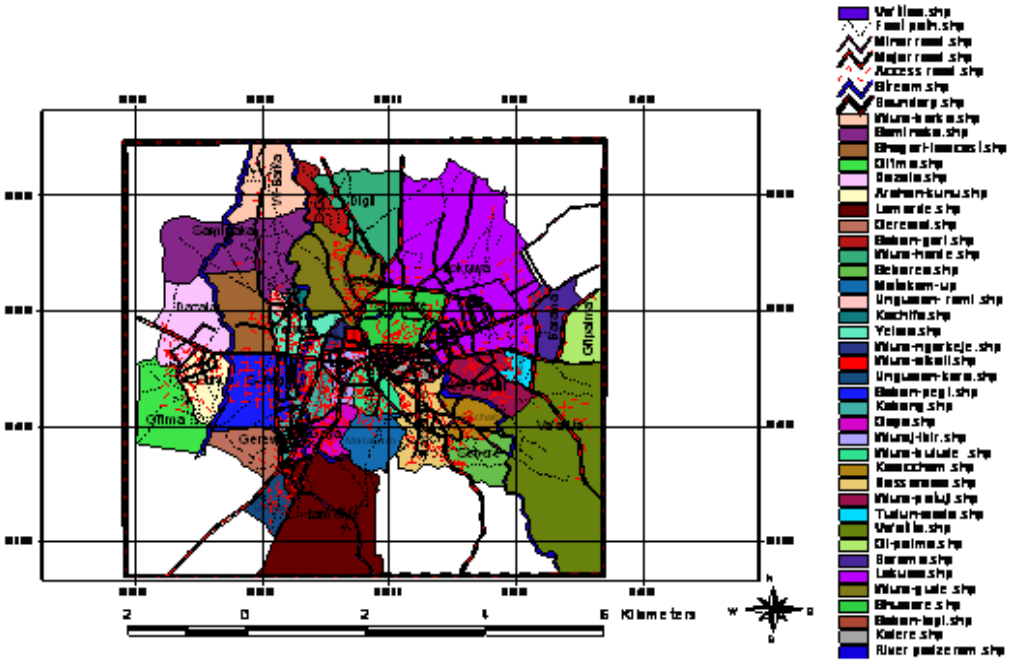

Fig. 3: The Updated Map of Mubi Metropolis

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