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Street Mapping Using Remotely Sensed Data and Gis Technique

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Abstract: The pivot of this study was to demonstrate how street guide maps can be produced from remotely sensed data using GIS techniques. Quick bird imagery of 2008 with resolution of 0.6 meter was the major source of data while the street guide of Kaduna metropolis produced in 1977 by analogue method of map making was used as base data. During ground truthing identified street names were collated and placed on the map with additional information gotten from the existing street guide. The research work was based on computer interpretation of imageries using AutoCAD 2000i and Survcadd.xml software. On close interpretation of the imageries it was discovered that streets in Kaduna metropolis have metamorphorsised in quantity from 104 in 1977 to 409 in 2008. The use of high resolution imageries for digital production and updating of street guide information is therefore highly recommended.

Key words: GIS, remotely sensed data, imagery, software

INTRODUCTION

From the earliest civilization, maps have been used to portray information about the earth's surface. Navigators, land surveyors, town planners, military architects, e.t.c used maps to show spatial distribution of important geographic features. Once produced, this graphic image (Map) becomes static, therefore, it should be expected that a map may be partly out-of-date by the time of its publication and it may have to continue in this state for a period of time (Keates, 1973).

There is constant search for ways of providing the static map with information about changes. Thus, the true aim of map revision is to keep all maps up to-date with changes as may be witnessed over time. If the accuracy and quality of the map is to be maintained, then the revision information must be compiled exactly and carefully located.

Reconnaissance technologies such as aerial photography and satellite based remote sensing have come to man's aid in his quest to understand and preserve his environment. These advancements have given the map maker new tools for creating and updating maps as well as allowing mapping in details the multitude of new environmental phenomena, hence, the need for the use of remotely sensed data for updating the street guide of Kaduna metropolis (North east) using GIS techniques cannot be over emphasized.

The last street guide map of Kaduna metropolis was produced in 1977. The rate of development that has taken place since then is enormous and cannot be ignored. New roads have cropped up and some old roads have been upgraded. These changes must be documented if the maps are to carry accurate information about the earth surface.

Kaduna, the capital of Kaduna State and the melting point for the nineteen (19) northern states, is rapidly undergoing physical development and expansion, with remarkable changes in its landuse and urban landscape, especially the road networks. These changes may be largely adduced to its proximity to the federal Capital Territory, Abuja and the relative peace the city enjoys. The traditional method of data collection for map making is laborious and it takes longer time to produce which renders the map obsolete in real sense by the time the map is published.

Street guides are produced to show road information that is current especially to visitors and researchers. There is need therefore to produce street guides from data that can portray reality as faithfully as possible, so that the rapid nature of changes is accommodated in the guides. Remote sensing and GIS, an acceptable method of keeping inventory of the earth's resources offer such powerful data gathering tool.

Street guides where available in Kaduna are out-of-date and misleading. The last street map was produced in 1977. Based on this, this study is designed to map the streets in part of Kaduna metropolis (North-east) from remotely sensed data using GIS techniques.

When remotely sensed data is used to produce the guide, it will take a new form, encourage new uses and new users, and cartographic visualization can be possible, with adequate software image manipulation and analysis can be achieved. The result of the research would reveal the impact of using remotely sensed data in map making;

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it would also assist other researchers in their work and serve as reference material.

Using remote sensing and GIS in map making: A critical factor in the whole mapping process is its data acquisition methods, it's accuracy and quality is vital to the essence of graphic representation as geographic data as a whole. Just as Olaore (2004) observed while using SPOT (XS) and GPS data for updating the topographic map of Kaduna metropolis. He also noted that remotely sensed data provides repetitive, synoptic view and accurate information that can be used to obtain up-to-date maps.

In a similar vein Ndukwe (2001) advocated for the use of spot panchromatic and multispectral images as well as Landsat TM and MSS for mapping landuse and updating of urban land use. He adduced this to the fact that the method is fast and inexpensive and tests have proved that accuracies of ±9m in planmetric and ±4m in altimetric features have been recorded, which was derived from geometrically corrected imageries.

An attempt was made by Ogunleye and Obiniyi (2007) to study the utilization of remote sensing products in Kaduna State. The result points to the fact that patronage by people was poor and that only aerial photographs of all the remotely sensed products was more popular with 27.92% of respondents they sampled being familiar with it. They further observed that the utilization of remote sensing products was mostly used for map production and researches. This point to the fact that remotely sensed data can be used to map the streets in the study area.

While writing on the relevance of maps in the control of urban slums in Nigeria, Ezra and Kantiok (2007) stated that street guide are not only important for aiding navigation within the city, but are also useful in planning enumeration areas by demographers, and are equally useful to tourists, salesman, firemen, police, security agents, tax collectors, postal services e.t.c and that they serve as base for land use classification mapping and town planning, which points to the fact that the use of street guides are diverse more so when they are produced in a GIS environment as observed by Musa and Yusuf (2007), where they noted that with query analysis in a GIS, questions like where a road is, where it leads to, the distance and type, the best route between points A and B or the shortest route between points can be easily provided in a GIS spatial search because it is able to combine spatial and non-spatial data from different sets in a spatial analysis operation.

Bashir (2001) pointed out that the worldwide remote sensing application in mapping and related phenomena is modernizing, simplifying and easing the exercises which would otherwise be executed through conventional methods, thus the need for improved mapping becoming inevitable. Just as Lillesand and Kieffer (2000) share the same view with Bashir that the field of mapmaking is not being subsumed within the filed of GIS, but rather it is impacting positively to the growth of the field of cartography.

The need for map revision: Map revision is an important factor in virtually all types of map production. Its true aim is to keep all maps up-to-date with changes and this task is only theoretically possible even with many times the resources normally devoted to it, Keates (1973). This is because once 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). Ndukwe (1997) stated that revision can be

- Cyclic – where there is an internal
- Selective – this means certain geographical areas, or certain groups of sheets are given priority within the revision frame and
- Continuous revision – where collection of information is always on going and such information are accumulated and incorporated at a chosen time.

MATERIALS AND METHODS

Study area: The study area is located between latitude 10º 23′ 30ºN and 10º 38′ 00″ N and longitudes 7º 21′ 30″E and 7º 30′ 30″E. It covers the Kaduna north local government, which comprises of settlements like Kawo, Ungwar Sarki, Badarawa, Ungwar Rimi, Malali, Ungwar Muchi, Kabala Doki and Costain. It is bounded to the east by river Kaduna.

Materials and equipment: The following hardware and software were used to carry out the project hardware

- Acer laptop
- GPS (hand held Garmin 20)
- Hewlet Packard jet 130 colored printer
- CD – ROM
- A3 Scanner
- Mouse

Software:

- AutoCAD map 2000i
- Survcadd xml, CAD overlay with Geocal
- Other materials used are:-
- Quick bird satellite imagery 2008 with 0.6meter resolution of the study area

Plate 1: Quick bird statellite imagery of the study area, Source: Koduna polytechnic

Table 1: Coverage description of the Quickbird imagery

Scene	Identification and coverage	Year
Scene 1	313 – 166	2008
Scene 2	313 – 165	"
Scene 3	313 – 164	"

Source: Quick Bird Satellite Imagery (2008)

- Township map of Kaduna metropolis 2008
- Street guide of Kaduna metropolis 1977 and 2008

Data acquisition and data source: To produce a street guide that does not exist or that needs updating, primary data acquisition method is preferable, whereby new data are obtained by ground surveying or remote sensing surveying. This therefore necessitated the acquisition of Quick bird satellite imagery 2008 (Plate 1) with resolution of 0.6m from Department of Topographic Science, Kaduna Polytechnic, to serve as the primary source of data. Other data for the project was derived from fieldwork and the existing street guide of Kaduna metropolis (Fig. 1) produced in 1977 for Festac festival of Arts sourced from the library of the Department of Topographic Science, Kaduna Polytechnic.

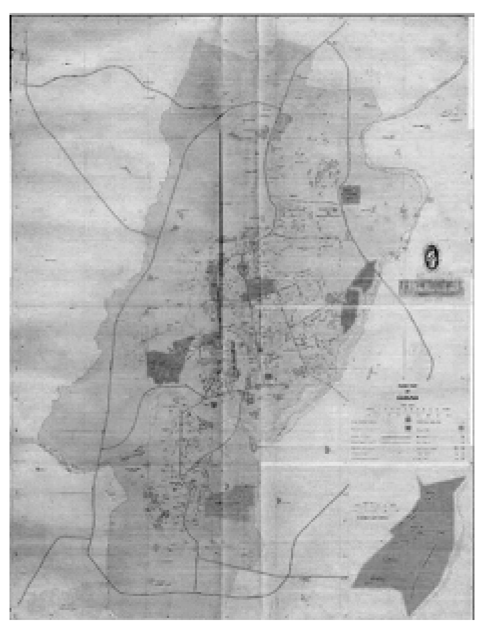


Fig. 1: Street Guide of Kaduna Metropolis (1977), Source: Department of Topographic Science, Kaduna Polytechnic

Table 2: Identification keys of the planimetric details on the quickbird imagery

Feature	Feature variation	Tone/colour	Texture	Size	Shape	Pattern	Proximity context
Roads							Buildings
	Dual -	Dark grey					Junctions
	carriages	with white	Coarse	0.10mm	Linear	Regular	Motorable
	Main Minor	Dark grey	Medium		"	"	"
	Other	Dark grey	Fine	0.005mm	"	"	"
		Brown	Fine	0.005mm	"	"	"
				0.002mm	"	"	"
Rail line	-	Medium grey	Fine	0.003mm	"	"	" and bridge
Water bodies		Grey	Fine	-	"	Irregular	Bridge tress
	Rivers						on the banks
	Streams	Right grey			"	"	"
Building		Light grey	Medium	-	Regular polygon	Regular	
Vegetation		Green	Coarse	-	Crown	"	Near water bodies

Source: Author

Data integration: The quick bird imagery of 2008 covering Kaduna metropolis was acquired on Compact Disk with software that is compatible with the AutoCAD software in the laptop. Three (3) single scenes as shown in Table 1 covered the study area (northeastern part of Kaduna metropolis).

Geo-referencing: Having merged the three scenes on the computer screen, the imagery was brought into harmony with the true ground co-ordinates using the Survcad xml. To do this, the following steps were also followed. Using the Survcad xml and the AutoCAD 2000i the three (3) scenes were imported from the Compact Disk one at a time unto the laptop. The following steps were then used to merge the three (3) scenes to form a mosaic that covers the study area.

Steps taken: Save image in my document – launch AutoCAD and Survcadd – click on insert on the menu bar – scroll down to raster image click on it – another dialogue box appears then go to my documents (with a recognized name) highlight the 1st scene then go to open – then click – (another dialogue box appears) – specify scale is un marked then specify 0.1. Then click open.

Repeat for scene 2 and scene 3 respectively then press F3 (on snap). Pick 2 points on the edge of the scene then drop where desired.
Repeat for other scenes then save with another name.

- Pick four known points with a G.P.S that is located on each scene.
- Use Geocal to convert the geographic coordinates to rectangular coordinates, to confirm.
- Go to map on the standard tools then click on the map scroll to tools then branch to rubber sheeting – on command pick the point on the scene – supply base point 1 coordinates eastings before nothings.
- Press enter supply for base point 2 – then – select object – type x and enter z enter then the image re-appears supply base points in a clockwise direction then save.

Image classification: The overall objective of image classification is to categorize all pixels in an image into classes or themes. The spatial pattern recognition approach was adopted. It is based on the categorization of image pixels according to their relationship with pixels surrounding them. Aspects like image texture, proximity, feature size; shape orientation, repetition and context were taken into consideration, which coincidentally was also used during visual interpretation process. The categories were then characterized across the entire image to create an interpretation key for each informational class.

The Table 2 shows the keys that were used to identify all planimetric details that relates to road information on the imagery.

Data capture: Data capture refers to the digitization process through which new data required to produce a map is transformed into digital format for storage, comparison with data attributes and further processing where necessary in a computer.

The on-screen digitizing process was used to vectorize the data to bring out details from the image that will form part of the new map information. It was carried out using the AutoCAD 2000i and Survcadd xml software. Based on the interpretation key that was developed for identification of information themes, layers were created as shown in Table 3.

Ground truthing: Ground truthing other wise known as field check is used as the basis for making decisions on training areas and evaluating classification results.

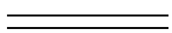
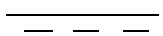
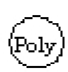
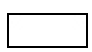
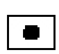
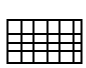
Ground truthing was then embarked upon twice, first to verify some of the information interpreted during data capture and give substance to the interpretation key that was used for the project and secondly, for the purpose of

Table 3: Layers created from the Quickbird imagery

Feature	Color	Line type	Line weight
Dual carriage	Black line with red infill	Double	3.0mm infill
Major	Red line	Single	Default
Minor	Black	Single	“
Other	Solid black lines	Solid	“
University		Polygon	“
Polytechnic		Single	“
Secondary		“	“
Hospital	Red	“	“
Buildings	Black with grey hatching	“	“
Filling station		Polygon	
River	Cyan	“	“
Streams	Blue	Linear	“
Legend	Black	Polygon	“
Guideline	Black	Linear	“
Text	Black	Text	“
River text	Black	Text	“

Source: Author

Table 4: Specifications adopted for use in map production

Feature	Symbol
Dual carriage road	
Main roads	
Minor roads	
Other roads	
Rail line	
Rivers	
Stream	
Building	
University	
Polytechnic	
Secondary	
Hospitals	
Police stations	
Market	
Legend	
Grid lines	

Source: Author

annotation (the collation of the names of streets and other important map details).

Map design: All decisions on the basic elements of a map are reached at this stage; such decisions are on the symbolization, colour concept, visual perception, sizes, legend and scale. They are important because they are the components of the map, which it must bear, and the map is viewed as whole composed of these components.
Based on the layers created the specification in Table 4 was adopted for use.

Editing: Editing was carried out in order to check for overlaps, intersections, overshooting and undershooting in the digitized image. This was carried out layer by layer.

Identifying new roads: The overlay module was used to super impose the vector image from the 2008 imagery on the raster image of 1977 to identify the new roads.

RESULTS AND DISCUSSION

Identified roads: The study was based on the digitizing of quick bird satellite imagery of 2008 of Kaduna metropolis (North East) coupled with data gotten from ground truthing which resulted in the production of the guide of the metropolis for 2008 (Fig. 2). From the guide, road types and coverage were identified and the result shown in Table 6. Other related features identified in 2008 were 2 bridges and 6 roundabouts. The 2008 guide was then compared with the already existing guide of the same area produced for festival of arts in 1977.

From the existing guide of 1977 (Fig. 1), the different road types and coverage were extracted and the result is shown in Table 5. Other features identified from the guide in 1977 were 3 roundabouts but no bridge was identified.

From Table 5, dual carriage way accounted for 0.96%, major roads 6.73%, named minor roads 17.3% while unnamed minor roads accounted for the majority of the roads in the study area. All the roads in the study area were 104.

The result of the GIS analysis of the quick bird imagery of 2008 is shown in Table 6.

From Table 6, dual carriage way had increased to 1.94%, major roads were 45.3% and minor roads (all

Fig. 2: Street guide of Kaduna Metropolis-North East, 2008. Source: GIS analysis

Table 5: Identified roads in 1977

Roads	Quantity	Coverage (%)
Dual carriage ways	1	0.96
Major roads	7	6.73
minor roads:		
named	18	17.3
Unnamed	78	75
Total	104	100

Source: GIS analysis

Table 6: Identified roads in 2008

Important roads	Quantity	Coverage (%)
Dual carriage ways	6	1.94
Major roads	140	45.3
Minor roads	69	22.33
Smaller roads:		
Named	33	10.67
Unnamed	161	52.10
Total	409	100

Source: GIS analysis

Table 7: Percentage comparism of road types in 1977 and 2008

Road type	1977 (%)	2008 (%)
Dual carriage ways	1	6
Major roads	7	140
Minor named	18	69
Minor unnamed	78	-
Others named	-	33
Others unnamed	-	161
Total	104	409

Source: Author

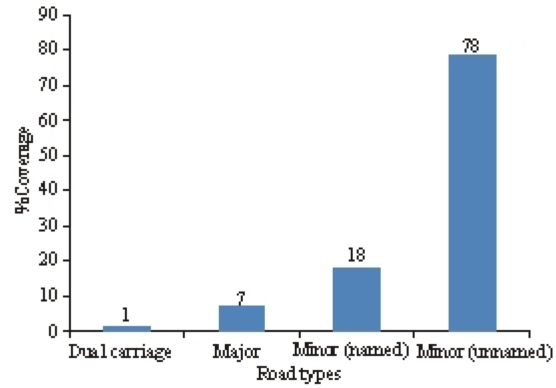


Fig. 3: Bar chart showing percentage coverage of road types in 1977, Source: Street Guide Kaduna Metropolis 1977

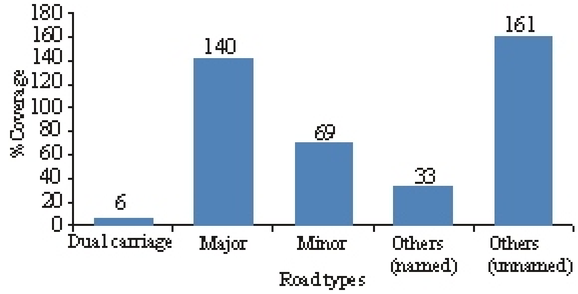


Fig. 4: Bar chart showing percentage coverage of road types in 2008, Source: Street Guide Kaduna Metropolis 2008

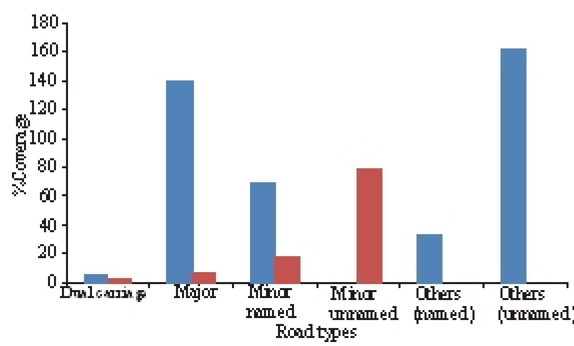


Fig. 5: Bar chart showing comparism of road types in 1977 and 2008, Source: Street Guide Kaduna Metropolis 1977 and 2008

named) were 22.33%. Other smaller roads named were 10.67% while those unnamed were 52.10%. The whole roads in the study area had increased to 409.

From the ground Truthing it was discovered that the dual carriage roads were characterized by two (2) lanes of tarred roads with partitioning running through the centre.

The main roads were single lane tarred roads that linked the main part of the city and usually linked up with roundabouts. The major roads were tarred roads that were offshoots of the dual carriageways; the other roads were un-tarred roads in the metropolis with some of them named and others unnamed.

It can be observed from Table 7, the roads had increased tremendously from what it used to be in 1977 (104) to 409 in 2008

Figure 3 and 4 are graphical representations of the road situation in 1977 and 2008 respectively while Fig. 5 is the comparism of both.

CONCLUSION

From the findings, there were many changes in the sizes, types of roads and road names in the study area for 2008 (Fig. 2) when compared with what existed on the street guide of 1977 (Fig. 1). It is worthwhile to state from this study, that street mapping using remotely sensed data and GIS technique is very important and less tasking compared to the traditional manual map making. It is also cost effective and time saving in view of the size of the study area.

From this study therefore, it can be concluded that:

- Remotely sensed data and GIS provide a reliable base for mapping streets especially when high quality-high resolution satellite imageries are used.
- Updating of maps is easier and less costly by using remote sensing data in a GIS environment because it only entails updating the digital mapping system data base.
- Integrated approach should be employed in any map production because it provides versatility in acquiring data from various sources and thus provides support and alternatives for data quality, processing and presentation.

RECOMMENDATIONS

The full potential of remote sensing and GIS can be realized by integrating remotely sensed data in a geographic information system environment. The following recommendations are therefore made;

- The use of remotely sensed data should be adopted for mapping purpose.
- High quality – high resolution satellite imageries should be made available at relatively low – cost.
- Ground truthing is highly recommended in order to confirm feature that are interpreted on the imageries.
- Revision of all categories of maps should be embarked upon as often as possible.
- Relevant government agencies should endeavour to keep database of street information and names approved by them in order to arrest ambiguity in the choice of which name a road bears.

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