Analogue Maps' Relevance in GIS Development in Developing Countries: Case of Nigeria.

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ABSTRACT

Geographic information was first represented in the form of maps. Nigeria has been producing maps for decades, though has not achieved total map coverage of her territory. With the advancement in technology in developed countries, it was soon apparent that computer systems could help to automate Nigeria's map production and for geographical analysis.

Against the background of the capabilities of the new technologies to be used by a wide variety of users to analyze geographical information, this paper examines the role of existing hard copy paper maps produced by traditional analogue method in organizing geographical data for these users in Nigeria. National Geo-spatial Data Infrastructure would have met these needs but they are yet very scanty and far in between in the country.

The six main map sources are outlined. The sources are evaluated, pointing out their current extent of coverage and their usefulness. The paper then recommended five (5) levels of spatial information based on t he availability of data potential sources and t he mapping work already carried out in Nigeria. The levels are: l, - 1: 1,000,000; 2, - 1:250, 000; 3, - 1:50,000; 4, - 1:10, 000, and 5 - 1:2,000. These levels, if adopted, would be a c omprehensive approach to the management of the nation's natural resources.

(Keywords: geospatial data, GIS, geographic information systems, mapping)

INTRODUCTION

Many human activities involve the use of "geographic information" which can be defined as "any information which can be related to a specific location on the Earth" (Choreley, 1987). According to Didon (1992), spatial information covers a large range which include the distribution of natural resources (soils, water, vegetation), the location of infrastructures (roads, buildings, utilities), political, administrative and ownership boundaries. Included in this definition is statistical data about population, employment and criminality in as much as they are related to a space.

Geographic information was first represented in the form of maps. The first maps were designed to describe places; hence, the term "topographic" derived from two Greek words: Topos = place, Graphie = to write. Topographical maps present the main features that can be s een in the landscape which are rivers, roads, settlements, forest, and r elief represented by isolated points and contours. These maps are referred to as 'general purpose maps'. But, there are other types of maps that provide information about particular themes which are known as 'thematic maps'. They describe natural features (e.g. a geological map or geomorphologic map) as well as human activities and they can be a tool for management (e.g. in land use planning).

However, the printed maps present significant disadvantages:

a) Map making is costly in terms of money, and effort.

b) There is a limit to the amount of information a map can contain; if it is congested, it will not be easy to understand.

c) Once a map is published, it remains a s tatic document that cannot be updated within a short time. Updating implies repeating the tasks of map making from the scratch. This is all the more a critical issue since the world we live in is changing very fast. Users of spatial data need up-to-date and reliable information,

and most of them are interested in spatial change that can occur in their field of application.

d) Retrieval of the exact information desired from a map may not be possible due to its complexity.

e) Analysis involving two or more spatial data sets from different maps (such as soils, slopes and vegetal cover to assess erosivity) is not simple and may be impossible. Today, many organizations require immediately usable documents which are able to provide them with the right and up-to-date information for a particular purpose. For such organizations traditional maps are becoming obsolete.

GIS proffers solution to these problems. However, the diversified nature of the disciplines involved caused a lot of disagreement on what a GIS is and what it should do. Each discipline seemed to have its own name for this new technology - computer graphics, computer aided mapping, computer assisted cartography, automated mapping, and facilities management, and others.

Many tags have been attached to this new technology for processing digital map information and the data associated with locations on that map. To some, the technology has provided a better way to produce maps; to others, it has allowed for the overlaying of different maps on top of each other; and to yet others, the new technology has been a new method for combining data from many different sources (maps as well as tabular data) for the purpose of analyzing spatial relationships among data related to locations on the earth. According to Huxhold (1991) GIS does it all; it improves the way we use maps, and it improves the way we analyze data about features located on the earth.

While GIS technology was developing, a new source of spatial data appeared, with the launching in 1972 of the first civil satellite for the observation of the Earth, LANDSAT I. Since then, satellite images have become a valuable source of up-to-date information on the surface of the earth. They are very effective for environmental monitoring of changes such as desertification, erosion, forest fires, floods, etc. Although they handle spatial information, image processing software's were developed completely separately from GIS and it has been long since an interest in linking both tools has arisen. A trend has emerged that integrates these complementary techniques. In recent time, GIS can and is used extensively as a tool for final map design and production e.g. ESRI Arc GIS 9 has introduced a new suite of design tools called Representations.

GIS are now widely used by environmental agencies, regional and urban planners, local authorities, governments, private companies, research institutes and universities. They cover a large range of size in terms of computer hardware, staff, spatial extent and data storage. From the experience of the developed world, there are four levels of applications that can be distinguished which are, in order of increasing complexity, (a) Mapping; (b) Management; (c) Analysis; and (d) Modeling. Nigeria has been in the race of map production for decades though not in any way nearing total map coverage of her territory.

With the advancement in technology in the developed countries, it was soon apparent that computer systems could help to automate Nigeria's map production and for geographical analysis. The University of Ibadan started training in GIS about a decade and a half ago. Apparently it was the first of its kind in Nigeria. Against the background of the capabilities of the new technologies to be used by a wide variety of users to analyze geographical information, this paper examines the issue of organizing geographical data for these users in Nigeria using the existing hard-copy maps produced by traditional analogue technology for management of the nation's resources.

Of recent there are evidences of increasing digitally produced maps and GIS datasets in Nigeria. Such new developments exist in the National Population Commission where a national RDBMS and GIS have been established for disseminating the 2006 census results. GIS datasets also exist for large scale cadastral mapping in States like Lagos, Imo, Niger and the Federal Capital Territory. At the National level, there are Environmental GIS (NEMA) and Election GIS (INEC). All these are still very scanty and not fully developed.

From early 2000, strong arguments have been put forward towards the establishing of Nigeria's National Geo-Spatial Data Infrastructure for development purposes (Igbokwe and Matthew, 2005; Nwilo and Osanwuta, 2004; Kufoniyi and

Agbaje, 2005) This objective has not been accomplished due to many reasons. Draft policy has been prepared, inventories of users and producers have been made but the draft policy has not been ratified by the Federal Executive Council and has not yet been presented to the National Assembly for the passage of the necessary laws and legislation that will govern data acquisition, management and sharing. So as it is now, there are no common policies and statement on the production, usage and sharing of geo-information. This is obviously delaying the NGDI project in the country.

In the light of this delay it is the view of this writer that existing analogue maps in the country which apparently contain all the fundamental Datasets and thematic datasets can be of value. In the interim when National Geo-spatial Data Infrastructure is being awaited, Geographical Information System could be dev eloped. This would be a n alternative to the option of starting from the scratch to build Geospatial Infrastructure with modern technique which apart from high cost would take a long time to materialize.

METHODOLOGY

Inventory of maps existing in the country was made. These included the various Topographic map series, Administrative maps and other special purpose maps. The sources of data for the maps were investigated; the nature of the data was examined and the authors were identified. The maps were evaluated from cartographers' point of view. Literature was searched on the historical backgrounds of the maps.

The remotely sensed imageries available in the country were also investigated; these included air photographs at different scales as well as other imageries like the Spot and Landsat TM.

ANALYSIS OF THE SOURCES OF GIS DATA

Balogun and Uluocha (1998) itemized five major Issues that are critical to the successful development and implementation of GIS in Nigeria. The issues are political, data, human resources, economic and socio-cultural. The data issues are in focus here. Data is a very important component of every GIS. According to Balogun and Uluocha (1998) more efforts and f und are needed for the acquisition of data than will be required for the acquisition of either hardware or software for GIS implementation. The data situation in Nigeria is not encouraging. The bulk of data needed for GIS operations is often spatial in nature, meaning that the data or information has to be mapped or geo-referenced. Unfortunately the country is grossly lacking in geo referenced information. Also a large proportion of the existing socio-economic data are not geo-coded thus rendering them unfit for any meaningful geographical analysis or for mapping purposes.

So, a major problem with the establishment of GIS in Nigeria is the lack of standardized geo-coding system. To organize data for a v ery big country like Nigeria is a great task. The territorial extent according to the Federal Surveys is 923,000 square kilometers comprising of 36 States and t he Federal Capital Territory. There are 774 Local Governments at the third level of Government.

It is noteworthy that the framework for most of the States has existed as far back as 1927 as Provinces. The same applies to the Local Governments which were regarded as Districts as at that time. However, these States and Loc al Governments do n ot have uniform base for data collection. Consequently, the geographical base and statistical contents vary considerably. At the Federal level, the Federal agencies for mapping and data collection have not operated systematic policies for their various activities all over the country. The Federal agencies in mind are: Federal Ministry of Works and Surveys for Topographical Mapping and Air Surveys; Federal Ministry of Mines and Power for Geological Mapping and Mineral Resources; and National Population Commission, to mention a f ew (see Table 1).

Aerial Surveys and Remote Sensing are embedded in the activities of the Federal Surveys. The Federal government contracted the flying of the country to various foreign firms and government agencies at one t ime or the other since 1948. As a result, there are photographs at various scales available at Survey offices all over the country. Therefore, geographic information of the country is available from quite a number of sources both native and foreign.

Table 1: Sources of Maps and Cartographic Products on Nigeria.

	Producer	Products
1.	The Federal Surveys of Nigeria	Admin. Maps of Nigeria and States, Topographic Maps, Township Maps, Aerial Photographs, National Atlas of Nigeria, Street Guides for Lagos, Road Maps for the Country, etc. Place name Gazetteer.
2.	State Survey Departments	Street Guides, State Admin. Maps, Road Maps, Thematic maps of State, Township Maps of Local Government Headquarters and other towns.
3.	Geological Surveys of Nigeria	Geological and Mineral Maps - Small Scale and Large Scale.
4.	Federal Department of Forestry	Vegetation Maps, Land use Maps
5.	Federal Department of Agriculture and Land Resources	Soils Maps, Land use Maps
6.	Town Planning Departments	
7.	Local Government	Local Government Maps, etc.
8.	National Electoral Commission	Maps showing towns, villages, constituencies and wards
9.	DFRRI (Defunct)	Maps showing all rural areas and the roads linking them.
10.	National Population Commission	Enumeration Area Maps. SA Maps - City Maps.
11.	U.S. Defense Mapping Agencies	City maps, photo mosaics, aerial photographs
12.	U.S. Bureau of Geographic Names	Place Name Gazetteer
13.	C.I.A.	Cartographic Data Bank Boundaries, outline maps, location of towns / villages
14.	NASA/USGS	Land sat Imageries covering all parts of Nigeria
15.	SPOT/IGN	Spot Imageries
16.	Directorate of Overseas Surveys	Topographical Land use Maps, Print Lay down, Photo mosaics
17.	Private mapping Companies, Nigeria mapping Co. John Bartholomew, Collins, Bartholomew Ltd., Cartografix Nig. Ltd., Macmillan Nig. Ltd Etc.	Street Guides, Road Maps, Political, Administrative Maps, Atlases, Business maps

(Adapted from Balogun, 1988)

From the wealth of data gathered it was clear that geographic information of the country is available from quite a number of sources which are:

a) **Political and Administrative Set Up:** The units are the Country, the State, the Local Government, and t he Towns and v illages. The country is divided into 36 States and the Federal Capital Territory, and 774 Local Government Areas.

b) **Survey Sheets**: Official maps covering the country at various scales ranging from 1:2,000.000; 1: 1,750,000; 1:1,500,000; 1: 1,000,000; 1:750,000; 1:500,000; 1:250,000; 1:50,000 to 1:25,000 showing the Topographical base elements of the landed area-relief features, drainage, settlements; transportation lines, etc. have been produced.

Administrative maps of the respective States are available at large scales - usually 1:500,000 and 1:750,000. Most of them were compiled from the Federal Surveys 1:500,000 map. Some States have, however, made their maps more detailed by adding more settlements, roads, rivers and Local Governments, etc. and thus provided base data for the production of the administrative maps published in 1988 by the Federal Surveys Department. According to Balogun (1988), the Federal Surveys Department started a project of producing old State maps at the following scales:

Table 2: Extent of Map Coverage in the Country.

Scale	No. of sheets for Full coverage	% Completed	Period of publication
1:500,000 (old Series)	16 (un-contoured)	100.00	1952 – 1960
1:500,000 (New Series)	33	24.24	1960 – 1975
1: 1,750,00	15	100.00	1938
1: 1,000,000	4	100.00	1944, 1988, 1992
1: 250,000	85	72.94	1957 – 1983
1:125,000	Only for selected areas of the country	30 (un-contoured)	Early Colonial time
1:100,000	357	85.00	Mostly before 1960
1: 50,000	1,348	95.00 (About 66%, contoured)	1949 1986
1:2,000,000	1	100.00	1924, 1944 1950, 1955 1956, 1972
1:1,500,000	1	100.00	1973, 1988
1:1,000,000	1	100.00	1993

1:750,000 - Sokoto, Kwara

1:500,000 - Bendel, Oyo, Kaduna, Kana, Borno, Ondo, Bauchi, Katsina, Gongola, Benue, Niger, Plateau.

1:400,000 - Former Rivers

1:250,000 - Anambra, Akwa-Ibom, Imo, Lagos, Ogun, Abuja, Cross Rivers.

Cadastral maps were produced before Nigeria's independence according to Audifferen (1985). In that series, towns were graded as 1st, 2nd and 3rd Class Townships. Ground surveys were used, and the production of maps of these towns was at large scales. Lagos Maps 1:2,400 and 1:4,800 scales were compiled from the 1: 1,058 scale series in 1941.

The 1: 12,500 Township maps were also compiled and published. "A new set of township maps at scale 1: 1,000 and 1 : 2,000 were introduced in 1975 as a result of the adoption of the metric system of measurement" (Balogun, 1988). See Table 3. Unfortunately a number of these series were never produced.

c) **Remote Sensing**: Remote Sensing Images (SLAR) covering the country on a scale of 1:250,000 are available. There are other imageries like Spot, which is a brainchild of France, and Satellite Landsat imageries which is a brainchild of America. Information abounds at the RECTAS in Ile Ife.

d) **National Population Commission:** Enumerations Area and Supervisory Area Maps covering the entire country at various unspecified scales were available for the 1991 census. There is also population data for the entire country at their disposal. For the recently conducted census of 2006, some EAs & SAs were mapped. They were supposed to be an improvement on the 1991 maps.

e) **The Federal Department of Forestry**: This agency has published the Land Use and Vegetation Map of Nigeria in 69 Sheets at the Scale of 1:250,000. It has also produced 69 Sheets of Radar Mosaics which served as the photo base for the maps.

f) **The Geological Survey of Nigeria**: produces geological maps of Nigeria. Its products include small scale general geological maps of Nigeria and there are large and medium-scale geological maps as well. There are 1:10,000 series for localized study areas; while regularly it produces maps at scales 1: 100,000 and 1:250,000.

g) **Aerial Photograph**: has been produced at different scales. Full coverage has been achieved at the scale of 1:40,000 between 1956 and 1974 and were used for the production of 1:50,000 topographic maps. "The introduction of 1:25,000 topographic mapping led to the award of contracts for the production of 1:25,000 photographs for the whole country" (Balogun, 1985). For specific areas such as urban centers, large scale photographs are available. See Table 3

RESULTS OF ANALYSIS

Political and Administrative Maps

Most if not all the 36 States and the Federal Capital Territory, Abuja have produced an administrative map at scales of 1:500,000 and 1:750,000. The State's maps show the Local Government boundaries in each State. Attempts have also been made to show almost all the towns and villages where possible. In the majority of cases however, the maps are just dyeline prints, not the standardized conventional printed map. Nevertheless, they serve as the only base where the lowest level of administrative boundaries is shown. Since 1975, there has been one alteration or the other to the administrative set up; so much so that by today, Nigeria has 36 higher order administrative units (States & FCT) and 774 lower order (LGAs).

The available maps are meant for administration or revenue collection purposes. They were not properly compiled; at best, some State Survey Offices only extracted State's boundary from existing old State maps or Federal Maps and enlarged them. If these maps were adequately compiled, they could be used to show land use and general crop production; or items related to population and housing, or livestock census for any particular State. All other information related to planning, development and adm inistrative statistics can be mapped based on this framework.

The line and point data, e.g. meteorological data, distribution of industries, health facilities, educational institutions, markets, etc., can also appear within this framework and properly located. Line based data such as related to railways, roads network, waterways can be included in the GIS. The Directorate of Food Road and Rural Infrastructural States mapping project was an ef fort in the right direction. The compilation was not published. However, it can be said that it had l ittle or nothing to offer GIS because there were no basis for proper positioning on most of the maps. They were not properly surveyed and so they lacked proper co-ordinate values.

Survey Sheets

Survey sheets from 1:2,000,000 to 1:50,000 have been made; while 1:25,000 seems abandoned already.

The National Atlas Series for the entire country at medium and at small scales are available; among them are;

1:2 million medical facilities Maps
1:2 million Tribal Map of Nigeria (Census, 1931)
1:2 Million Outline Map of Nigeria, 1938
1:2 Million Map of Southern Provinces, Nigeria, 1939
1:2 Million Map of Northern Provinces, Nigeria, 1945
1:3 Million Map of Nigeria (Colored)
1:3 Million Map of Nigeria, 1940.

Other Atlas series on A griculture, Communication, Domestic Trades, Forests, Isogonic Charts, Isothermal, Geographical, Population, Rainfall, etc. are found in the National Atlas Published in 1978 and officially launched in 1981.

Most of the useful sheets that could serve as possible base- for land information system are not having full coverage of the country. Besides that, the maps are out of date. The 1:50,000 which is regarded as the basic scale for the country is relatively empty when compared to the 1: 1 mile series in Britain. To cap it all, the series have not been revised since they were published. To revise them now would amount to a re-survey and that would cost about N5, 000,000 for one square kilometer (crude estimate).

The unit of measurement on the topographic maps is the imperial system. Relief features are shown on the topographic map in a c ombination of benchmarks, boundary pillars, trigonometric stations, spot height and contour lines. All are in feet while the contours are at 50 feet interval. This means the topographic map expression is partly metric and partly imperial.

Table 3: Township Mapping by the Federal Survey.

	Towns	Area (Sq. km)	No. of Sheets	Year of Photography	Scale of Photography	Scale of Map
1.	Abeokuta	339	1,053	1976	1:6.000	1:1,000
2.	Greater Jos	48/96	330		1:10,0000	1:2,000
3.	Ogwashi-Uku	562	242	1977/78	1:10,0000	1:2,000
4.	Katsina	350	270	1976	1:10,0000	1:2,000
5.	Bunny	371	213	1977	1:10,0000	1:2,000
6.	Enugu	262	720	1977	1:6,000	1:1,000
7.	Makurdi	424	276	1977	1:12,000	1:2,000
8.	Warri	152	127	1977	1:10,0000	1:2,000
9.	Maiduguri	336	210	1976	1:10,0000	1:2,000
10.	Lafia	324	216	1977	1:10,0000	1:2,000
11.	Kafanchan	213	154	1977	1:10,0000	1:2,000
12.	Damaturu	64	40	1977	1:10,0000	1:2,000
13.	Ogbomoso	220	700	1978	1:6,000	1:1,000
14.	Biu	49	35	1977	1:6,000	1:2,000
15.	Ikorodu	63	185	1977	1:6,000	1:1,000
16.	Badagry	39	105	1977	1:6,000	1:2,000
17.	Epe	75	198	1977	1:6,000	1:1,000
18.	Atan Onoyom	71	190	1977	1:6,000	1:1,000
19.	Aba	115	270	1978	1:6,000	1:1,000
20.	Lagos Area	106	2,000		1:6,000	1:1,000
21.	Kano	944	594	1976/77	1:6,000	1:1,000
22.	Kaduna	842	2,200	1978	1:6,000	1:1,000
23.	Ibadan	520	720	1977/78/92	1:6,000, 1:4000	1:1,000
24.	Benin City	523	720	1979	1:6,000	1:1,000
25.	Calabar	408	270	1977	1:6,000	1:1,000
26.	Ilorin	1.219	2,251	1981	1:6,000	1:1,000
27.	Minna	270	720	1981	1:6,000	1:1,000
28.	Sokoto	603	1,608	1981	1:6,000	1:1,000
29.	Bauchi	622	1,659	1981	1:6,000	1:1,000
30.	Akure	561	1,496	1981	1:6,000	1:1,000
31.	Igarra			1978	1:10,0000	1:1,000
32.	Owerri	792	2,112	1977	1:6,000	
33.	Ubiaja				1:10,0000	
34.	Obudu				1:10,0000	
35.	Ikot-Epene			1977	1:10,0000	
36.	Oron			1978	1:6,000	
37.	Obubra			1977	1:6,000	
38.	Ugep			1977	1:6,000	
39.	Akampe (Uwet)			1977	1:6,000	
40.	Auyo			1977	1:4,000	1:2,000
41.	Opobo			1977	1:6,000	
42.	Etinam			1978	1:6,000	
43.	Abak			1978	1:6,000	
44.	Eket			1978	1:6,000	
45.	Fed. Capital Territory			1978 2003	1:10,000 1:	
46.	Lagos Metro Municipality			1977	1:2,700	
47.	Lagos Metropolitan			1977	1:6,000	
48.	Asaba/Onitsha			1978	1:6,000 1:10,000	1:1,000 1:2,000
49.	Uyo/Uuwaniba			1979	1:6,000	
50	Port-Harcourt			1977	1:6,000	1:2,000

Extracted From Balogun, 1988

Remote Sensing: Availability

The RADAR imagery which was used by Federal Department of Forestry to produce land use and vegetation map at 1:250,000 exists in form of (CCT) Computer Compatible Tapes in the Cartography Office of Federal Department of Forestry Jericho, Ibadan. The Imagery contains both North and South looks.

The CCT can however only be interpreted by a special equipment which has been out of use; this might mean that the data is out of reach. There is however satellite Imagery of Nigeria dated 1993/1995 possessed by Federal Ministry of Agriculture and National Resources Federal Department of Forestry Coordinated by FORMECU Abuja. The scale is 1:250,000, it is Spot XS with UTM grid superimposed on it. Also some townships have very large scale imageries like Quick bird and Ikonos used for township mapping.

The 2006 Enumeration Area Demarcation (EAD) exercise were meant to use these types of imageries. If the satellite imageries can be geo-referenced in any of the software packages available e.g. Arc GIS, digital image analysis can be done on the imageries to build up data for this country. The problem is getting an appropriate remote sensing imagery at reasonable cost and also of good resolution.

National Population Commission (EA and SA Maps)

These maps have varying degrees of accuracy and scale. In quite a number of cases, they are best regarded as sketch maps because they were compiled by people who are not cartographically or geographically trained. These maps are not properly geo-referenced. However, a GIS expert could possibly make good use of some of them if a kind of grid or graticule is superimposed on the maps. Balogun (1988) also affirmed this concept of grid superimposition on map. The problem with this system is however very apparent, that is, the location of the grid lines on the ground, even though, it is easy to cover the face of a map with grid squares. The land survey system in Nigeria is not like in the USA Public Land System in which a grid cell may be equivalent to a block or a couple of blocks which can be identified on the ground.

Forestry and Land Use Maps

There are 69 sheets at Scale 1:250,000 for the entire country from SLAR imageries. The radar mosaics have been laid to the Joint Operations Graphics (JOG) Map sheet Series 1501 at 1:250,000 produced by the Defense Mapping Agency, Washington. The Vegetation Maps have been produced over the same base and conform to the same sheet layout.

The JOG series are the only continuous series at 1:250,000 for the whole country, Nigeria, but they have been compiled from wide variety of data sources with variable reliability. Certain details particularly the planimetric details and drainage are not correct.

Geological Sheets

Geological survey Department of Nigeria has produced geological maps at small, medium and large scales for the country. Scale 1: 10,000 has been used for localized study areas.

At present, over 80% of the country is covered by 1: 100,000 series, while the 1:2million map scale has been produced under the title: Economic Geology. For areas that are not covered by 1: 100,000, the alternative is to derive the information by extrapolations or rely on photo geology interpretation method. This would be a long process for the GIS envisaged for Nigeria.

Aerial Photographs

The 1:25,000 photographs ranked second to 1:40,000 in coverage of the country. It was procured for 1:25,000 topographical mapping with more than 65 percent of the photographs produced before 1984.

Most of the available photographs are outdated. Secondly, they are incoherently produced in the sense that several foreign bodies were invited to participate in this exercise over the years. Canada, Russia and Britain all participated in flying for coverage.

The large scale production by some states and by some agencies does not cover the entire country. These large scale photographs are used for township mapping only and they are as old as forty (40) years. A lot of field work would be

needed to bring the information up to date. To cap it all, red-tape will kill the initiative to use this source for GIS in Nigeria.

Recommended Base for a GIS in Nigeria

From the foregoing, it is obvious that Nigeria is endowed with different types of data sets within its Federal Structure, while the States and Local Governments are relatively poorer in data. This is so because the political structure has been evolving gradually over a number of years until it is what now exists. There are only five centers capable of map production and reproduction in a standardized way, these are located in the former regional capitals and former Federal Surveys in Lagos/Abuja. The result is that none of the new States are adequately prepared and equipped to produce any map in the standardized way. Therefore, it is suggested that it would be better to work on the Federal structure basis in building of GIS data for Nigeria. Five levels of spatial information are recommended based on the availability of data potential sources, and the mapping work already carried out in Nigeria.
The levels are as follows:

a) Level 1- 1: 1,000,000: In the present day Nigeria, a lot of information is available at this scale. Nigeria is covered by 4 sheets by the 1:1 million map. There was an administrative map produced on this scale as far back as 1944 and it is being updated. This scale shows the States and the Local Governments in the Federation. Regarding Information on population, physical features, transport and land use, this scale is adequately endowed with data. The 1:500,000 could be reduced to add more information to this scale. Soil information has been made available at the scale 1:1,000,000 by Federal Department of Agricultural Land Resources, Kaduna. This scale can serve as a base on which to superimpose other information. It is a useful framework for a GIS in Nigeria.

b. Level 2 - 1:250,000: Topographic Survey Sheets are available at this scale. From the table above, about 73% of the country has been covered on this scale. The Geological Department regularly produces maps at 1:250,000. Geophysical maps exist at this scale as well. To cap it all, the Federal Department of Forestry has published the land use and vegetation map of Nigeria at this scale. The Radar mosaics which served as the photo base for the land use and vegetation maps are an added advantage. Remote sensing technique using SLAR is useful at this scale

c. Level 3 - 1:50,000: The 1:50,000 topographic mapping started a long time ago (1948) but they were not contoured and were produced by Directorate of Overseas survey (D.O.S.) (Audifferen, 1985). Post-Independence topographic mapping at 1:50,000 was designed to replace the former un-contoured types (Balogun, 1985). The entire country is almost covered completely on this scale; according to Guilhe (1992) 95% of the country has been covered. The surveyed maps on this scale are uniform in the sense that they are all on UTM projection and if they are updated, they are fairly accurate.

According to Soneye (1998), it was accepted by users that the physical features are adequately represented on this topographic map series. However, interpretation of hydrographic features needs some caution because it is difficult to determine the seasonal characteristics of rivers and streams in some parts of the country. Also repeated point symbols have been used for the vegetation and plantation and without boundary, this gives no opportunity for area determination and monitoring of features. Cultural features are grossly outdated. These notwithstanding, this series are still going to be useful for starting GIS building in Nigeria.

d. Level 4 - 1:10,000: This scale was introduced for areas of close settlements. This could be a good scale for the towns other than the State and Local Government Headquarters. Already quite a number of towns have aerial photography at 1: 10,000 and 1:6,000. These scales of photography are very adequate for this level 4 information.

e. Level 5 - 1:2,000: Maps on this scale are not many. Admittedly, cadastral maps have been produced for some urban centers in which towns were graded as 1st, 2nd and 3rd class Townships (Audifferen, 1985). It is worthy of note that this scale was used for parts of the Federal Capital Territory Abuja mapped by Kaduna Polytechnic as far back as 1987 - 1988.

STEPS TO BUILD NIGERIA'S GIS

The way to build the country's GIS will be determined by the sort of decisions to be made by different users. Broadly, the users would have to

define their objectives, build both the spatial and attribute data bases and then do data base management for geographic analysis and present results in the form of maps. Building the databases involves data design. This essentially means identifying the study area boundaries which could be done on the map. The coordinates needed could be extracted from the map, the data layers could be analyzed from the map as well as the features in each layer. Attribute data for each feature can then be identified as well as how to code and organize them.

While building the databases, data is entered in vector or raster format depending on whether the map sources are conventional maps or remote sensing imageries. Digitizing will include entering spatial data and creating topology in the vector format, but for raster data, vectorization must precede building topologies. Attribute data is created in the form of data base files. Database management is one of the stages in building a GIS. This refers to translating the digitized map into real world coordinates, identifying coverage for analysis and maintaining the data base. The final stage is presentation of the maps for decision making.

CONCLUSIONS

Hitherto, Nigeria's efforts have been concentrated on topographic and administrative map production, mostly. The existing maps are outdated and not properly geo-referenced in some cases, but they are still useful to serve as the starting point for establishing a GIS for Nigeria.

Thematic mapping has been very slow or completely neglected. It is believed that with the development of GIS techniques, thematic cartographers will emerge. This group of experts will bridge the gap by supplying the geographical data needed to be incorporated into the base map elements to build some information systems for Nigeria.

Five levels of spatial information have been proposed according to the availability of maps produced by the various mapping agencies in the country. These levels, if adopted, would be a comprehensive approach to the management of the nation's natural resources and for planning. The GIS experts would be able to make accurate inventories of the resources such as land, water, and forests, mineral, offshore and ocean resources along the line of any of the mapping levels. This would be an alternative to the option of starting from the scratch to build Geospatial Infrastructure with modern techniques. That would be more costly and take a longer time to materialize.

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