APPLICATION OF GEOSPATIAL TECHNIQUES IN REVISING AND UPDATING STREET NAMES IN BUNKORO DISTRICT, CADASTRAL ZONE C18, F.C.T ABUJA, NIGERIA

A.M. Bello[1], A.B. Hassan[1]

[1]Department of Geography, Federal University of Technology, Minna, Nigeria

Corresponding Address: muhammadbello62@gmail.com , adamu.muhammad3@st.futminna.edu.ng ,+2348166607566

Abstract

Maps in Nigeria lacks revision and update thus, obsolete. Maps produced some years back lack details of recent development, this contributes to the relatively low use of streets maps in a developing country like Nigeria compared to what is obtainable in the developed countries. An adoption and application of recent advances in map making process would help solve the problem of lack of accurate and up-to-date maps therefore, the study carried out a revision and updating of google map and production of a guide map of Bunkoro, Gwarinpa district, F.C.T, Abuja. The study applied the science of remote sensing and Geographical Information System (GIS) in base map acquisition (using drone aerial photograph) and extraction of street survey-beacon points (using Arc GIS and AutoCAD) respectively for accuracy. A qualitative research was carried out on initial (past) and revised (present) street names. The result was a generation of location-based information as regards to current street names on the study area. The revised roads include; street, close, crescent, arterial and sub-arterial, with a number of 36 streets which constitutes 65% of the roads revised, 10 closes constituting 18%, 5 crescents constituting 9%, 2 sub-arterial constituting 4%, 1 arterial constituting 2% and 1 highway constituting 2%. 22 number of roads were renamed, 21 were unchanged, 10 had no street sign (name), and 2 were recently assigned. The study demonstrates a way in which remote sensing and GIS could be used in tackling the issue of obsolete maps in Nigeria. The study also recommends the adoption of regular revision of maps in Nigeria and implementation of the updates acquired.

Key Words: GIS, Remote Sensing, Street Guide, Transport, Map

Introduction

A map is a symbolic representation of selected characteristics of a place, usually drawn on a flat surface. Maps present information about the world in a simple, visual way. They teach about the world by showing sizes and shapes of countries, locations of features, and distances between places. Maps can show distributions of things over Earth, such as settlement patterns. They can show exact locations of houses and streets in a city neighborhood (National Geographic Society). Maps are specially designed to serve several purposes and answer specific questions such as street maps, utility maps etc. (Idowu et. al., 2016)

The process of mapping the Earth accurately was, until recently the preserve of highly skilled, well-equipped, and organized individuals and groups. For many years, it was usually the role of surveyors, cartographers, and geographers to map the world and transcribe it on paper or, since the 1960s, into the computer (Mordechai (Muki) Haklay and Patrick weber 2008).

Maps have played vital roles in the world through aiding decision making and policy formulation processes as well as aiding tourism and general navigation (Longley et al. 2007). Map, a spatial model of the earth's surface (Heywood et al., 2006) showing how physical features are position and related to each other, created through cartographic abstraction process are highly potent means of communicating spatial information to people.

Ezra and Kantiok (2007) argued 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 etc. 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, 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.

It can also be defined as a graphic portrayal of a town or city, showing the positions and names of all the streets; major/minor highways and roads, railroads, tracks and other points of interest and the general road network. It is a form of map that details roads and transport links. Also some of the usage of street map as: for locating houses and streets; car navigation; planning of transportation, trips and driving directions; and for planning of movement and provision of facilities, goods and services (Udoh, and Igbokwe, 2014).

The lack of proper addressing systems especially of functional street names in most Nigerian Cities has a deep-rooted problem in the absence of proper urban planning and design principles (Suleiman et al 2013). Street map stands as a basic datum that can also help researchers conduct good research such as emergency response studies, proximity and accessibility studies (Idowu et al 2016).

The importance of Remote sensing and Geographic Information System in map making cannot be overemphasized because of its ability to integrate spatial data with non-spatial data and also communicate the resulting information in a way that everyone would understand. Several works have taken advantage of the abilities of these technologies to produce street maps using High resolution images (Idowu, et.al 2016).

Different people define GIS, according to its capability and purpose for which it is applied but summarily, it can be said to be a computerized system that deals with both spatial and non-spatial data. A very brief description of GIS is that it is a computerized system (tool) that deals with spatial and non-spatial data from different or multiple sources in various formats to produce desirable answers for different applications (Santosh, 2011). (Ndukwe 2001) defined remote sensing as "the science of detecting or monitoring the chemical or physical properties of an object without being in physical contact with the object (target)".

As a scientific tool, GIS is used to capture, store, create interactive queries, analyze and manage spatial information and edit spatial data and associated attributes. It provides a computer-implemented spatially oriented database for evaluating remote sensing data in conjunction with other spatially formatted data and information acquired from different sources (Udoh, and Igbokwe, 2014).

Digital mapping has now become an indispensable tool in solving many environment-based problems. The method used for producing digital maps are many, depending on the level of detail required, the use to which the map will be put and the source of data (Musa, and Tukur, 2006)

Study Area

The study area the study area is located between:

LONGITUDE: 7º 23' 30" E and 7º 25' 30" E;

LATITUDE: 9º 07' 00" N and 9º 05' 00" N.

It covers an approximate size of 241 hectares. It is also bounded to the North-East by Jahi district cadastral zone B08, to the South-East by Kado district cadastral zone B09, to the North-West by Wupa district cadastral zone C15. It is within the UTM National Grid of Zone 32N.

Bunkoro has a macro climatic variation i.e. the dry season last from November to March and wet season from April to October, the climate of Bunkoro is hot, humid and tropical type. Bunkoro has temperature ranging from 21^{o}C – 26.7^{o}C yearly and a total annual rainfall of approximately 1,650mm. About 60% of annual rainfall during the month of July, August and September, Nigeria Meteorological Agency (2010). Relative humidity values are high during the rainy season reaching 80%-95% between May and October as low as 32% in the dry season and hamarttan months of January and February. A crucial climate characteristic of this area is the frequent occurrence of squall lines heralded by thunder storms, lightening, strong winds and rainfall of high intensity.

Vegetation is within the Guinea savannah zone. Guinea savanna is characterized by grasses with scattered trees and shrubs; trees are shorter and thorny. The Guinea savannah has been affected by human activities in the form of cultivation and grazing. The districts have the features of park savannah with stunted tree cover, man-made vegetation and riparian vegetation.

Figure 1 depicts a vector representation of the study area map.

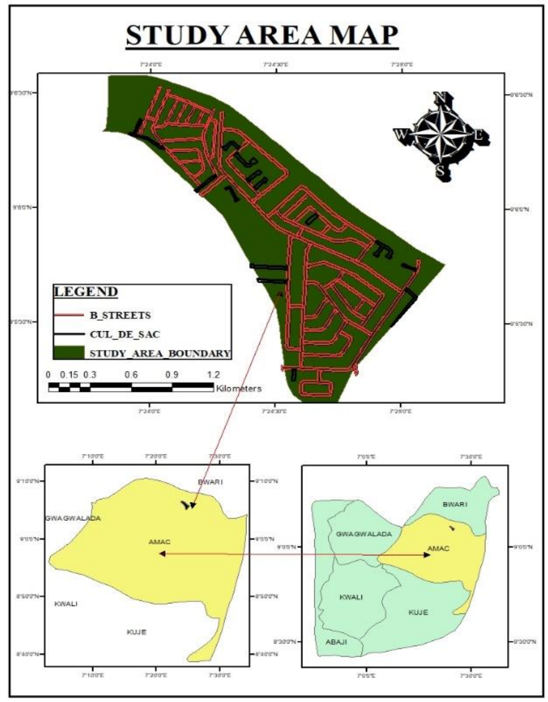


Figure 1: Map of Study Area

Materials and Methodology

Data

The data used consisted of:

- Abuja Geographical Information Systems (AGIS) acquired Aerial Imagery with less than 0.5m resolution of the study area.
- Survey data layout of the study area from the Department of survey and mapping, Federal Capital Development Authority (FCDA).
- Old Street names from Abuja Geographical Information Systems (AGIS) database.

Equipment and Software

1. Equipment

The equipment consists of:

- HP Laptop
- GPS (handheld Garmin Etrex10)
- Hewlet Packard Jet 130 colored printer, scanner and photocopier
- Camera

2. Software

The software consists of:

- AutoCAD 2007
- ArcGIS 10.2
- Microsoft office 2010 packages

Georeferencing and resampling

Having acquired the aerial imagery of the study area and pyramids been created on ArcGIS 10.2, the imagery was brought into harmony with the true ground coordinates by using four control points on ArcGIS.

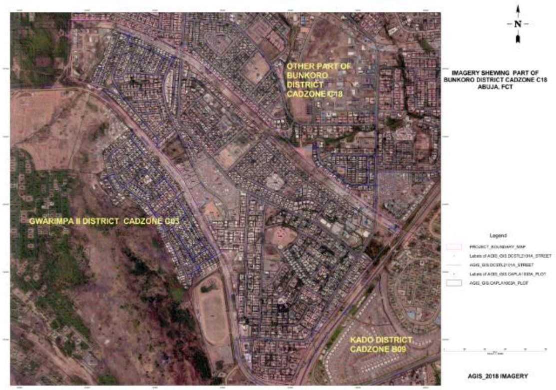
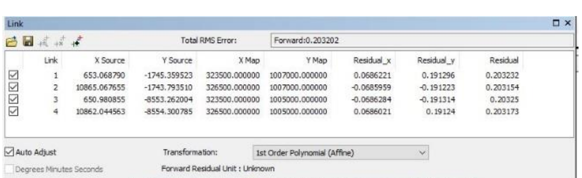


Figure 2: Registration of study area aerial view

Root Mean Square Error (RMSE) Of The Geo-Referencing

The residual of Root Mean Square error (RMSE) during geo-referencing of the acquired aerial imagery is **"0.2"**

"0.2" indicates a very minimal Root Mean Square Error (RMSE) and is within the acceptable range value of Root Mean Square Error (RMSE) as values greater than 0.5 reflects a relatively poor accuracy of data or model (Hanan, 2019).


Link

Total RMS Error: Forward:0.203202

Link	X Source	Y Source	X Map	Y Map	Residual_x	Residual_y	Residual
1	653.068790	-1745.359523	323500.000000	1007000.000000	0.0686221	0.191296	0.203232
2	10865.067655	-1743.793510	326500.000000	1007000.000000	-0.0685959	-0.191223	0.203154
3	650.980855	-8553.262004	323500.000000	1005000.000000	-0.0686284	-0.191314	0.20325
4	10862.044563	-8554.300785	326500.000000	1005000.000000	0.0686021	0.19124	0.203173

Auto Adjust Transformation: 1st Order Polynomial (Affine)

Degrees Minutes Seconds Forward Residual Unit : Unknown

Figure 3: RMSE result

Extracting the Street Beacon Coordinates from the Survey Data Layout

The on-screen digitizing process was used in vectorising 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 2007 software.

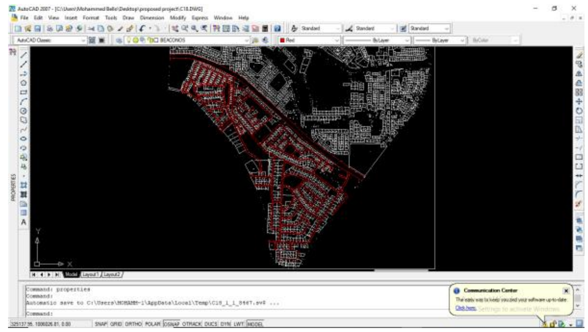


Figure 4: On-screen vectorization of beacon points

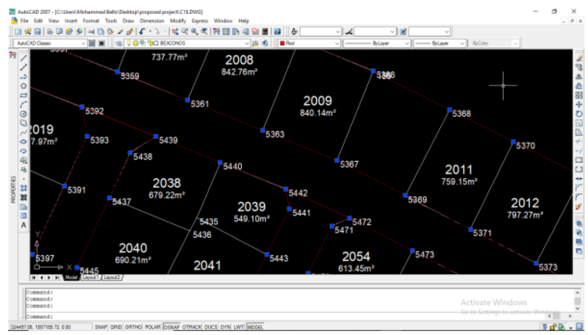


Figure 5: On-screen vectorization of beacon points showing vividly the beacon points in blue

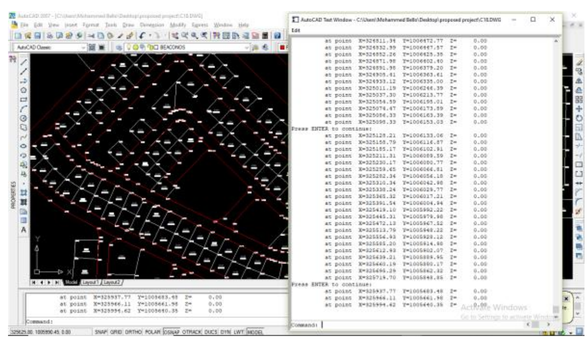


Figure 6: Listing of beacon coordinates

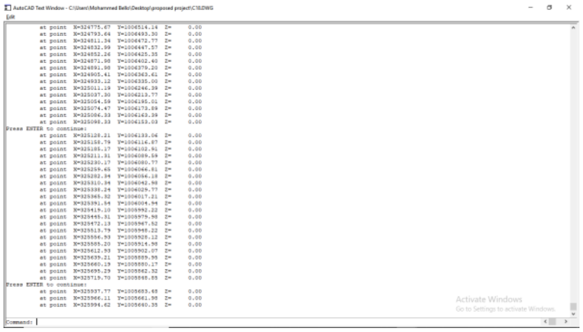


Figure 7: Listing of beacon coordinates

Overlay of the Extracted Street Beacon Coordinates

The extracted point coordinates of street beacons were imported into ArcGIS 10.2 and overlaid on the aerial imagery.

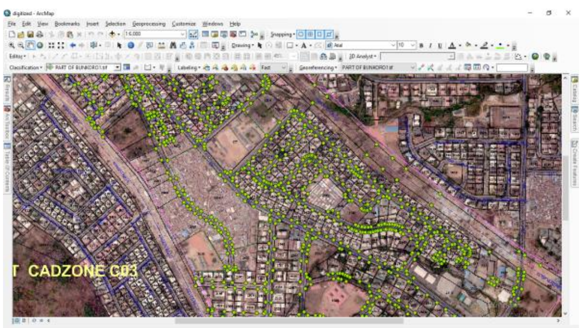


Figure 8: Overlay of imported points

Revising and Naming the streets

The names of the streets were obtained by field work. The names of the streets were written on the streets with the aid of a field reconnaissance sketch made and images of street sign posts taken during the field work which made it possible to place appropriate names on appropriate streets.

Figure 9: Field reconnaissance sketch

Digitizing and Compilation of the Street's Name

The road network of the study area consists of different categories of road such as the highway, arterial road, sub-arterial road, street, close (cul_de_sac) and crescent.

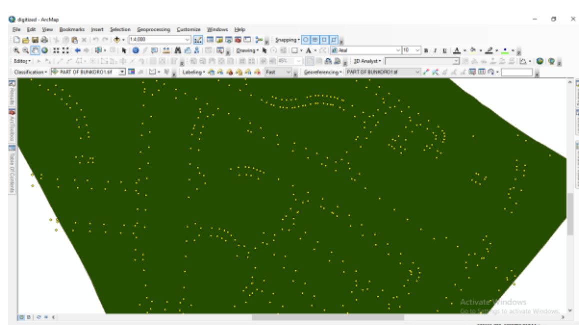


Figure 10: Imported Overlay points

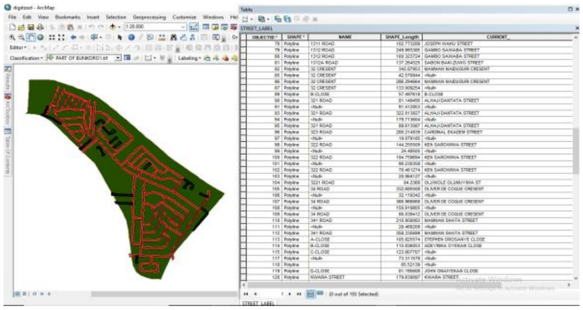


Figure 11: Integrating spatial and attribute data

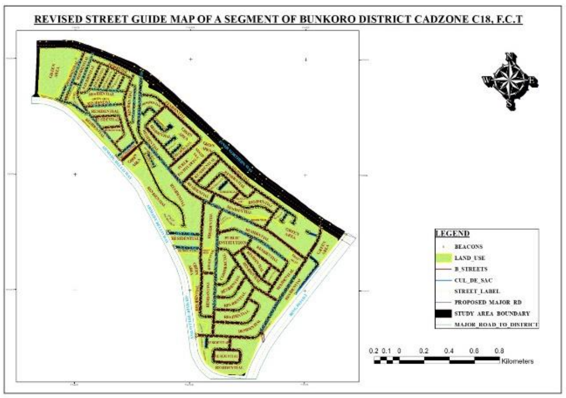


Figure 12: Street guide map

Figure 13: Grid A

Figure 14: Grid B

Figure 15: Grid C

Figure 16: Grid D

Figure 17: Grid E

Ground-Truthing

Final ground-truthing and identification of features on the map was carried out using hand held Garmin Etrex 10 GPS receiver to navigate to the positions on ground of the identified ground control points (GCP’s) on the map.

Table 1: Ground-truth points

GROUND-TRUTH POINTS AND THEIR X,Y COORDINATES					
		GEOGRAPHICAL COORDINATES (degree)		UNIVERSAL TRANVERSE MERCATOR (meter)	
S/N	NAME	LAT	LONG	E	N
1	DOMINO’S PIZZA	9º 06’5”N	7º 24’22”E	324855	1006450
2	THE LINGERIE CITY	9º 06’11”N	7º 24’17”E	324696	1006643
3	FOWLCHASE EATERY	9º 05’57”N	7º 24’39”E	325379	1006224
4	POLARIS BANK	9º 05’51”N	7º 24’36”E	325288	1006022
5	ZENITH BANK	9º 05’34”N	7º 24’37”E	325307	1005495
6	CHRISTIANA AJAYI OKUNUGA STREET	9º 05’34”N	7º 24’36”E	325285	1005503
7	E.C. AKINWUMI STREET	9º 05’33”N	7º 24’48”E	325651	1005468
8	PA IMODU MICHEAL AVENUE	9º 06’17”N	7º 24’16”E	324676	1006819
9	JOSEPH WAKU STREET	9º 05’32”N	7º 24’48”E	325653	1005454
10	RESIDENTIAL BUILDING	9º 06’22”N	7º 24’14”E	324604	1006998

Updating Google Map

The current street names were however uploaded on google map for review and update.

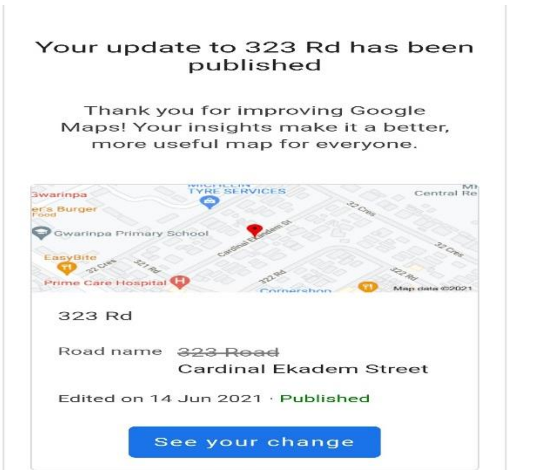


Figure 18: Formerly 323 road, now Cardinal Ekadem Street

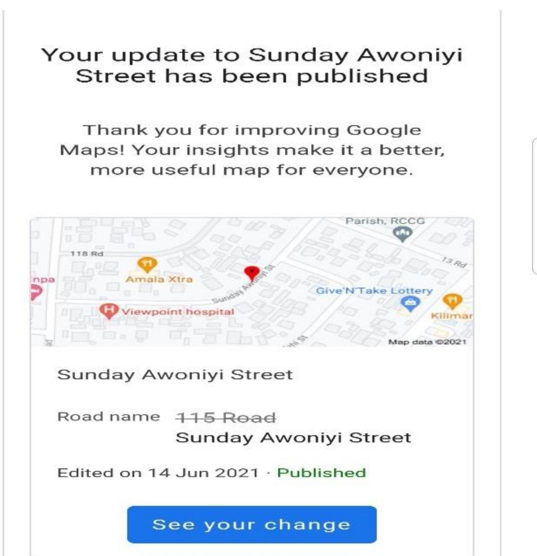


Figure 19: Formerly 115 road, now Sunday Awoniyi Street

Methodological flowchart

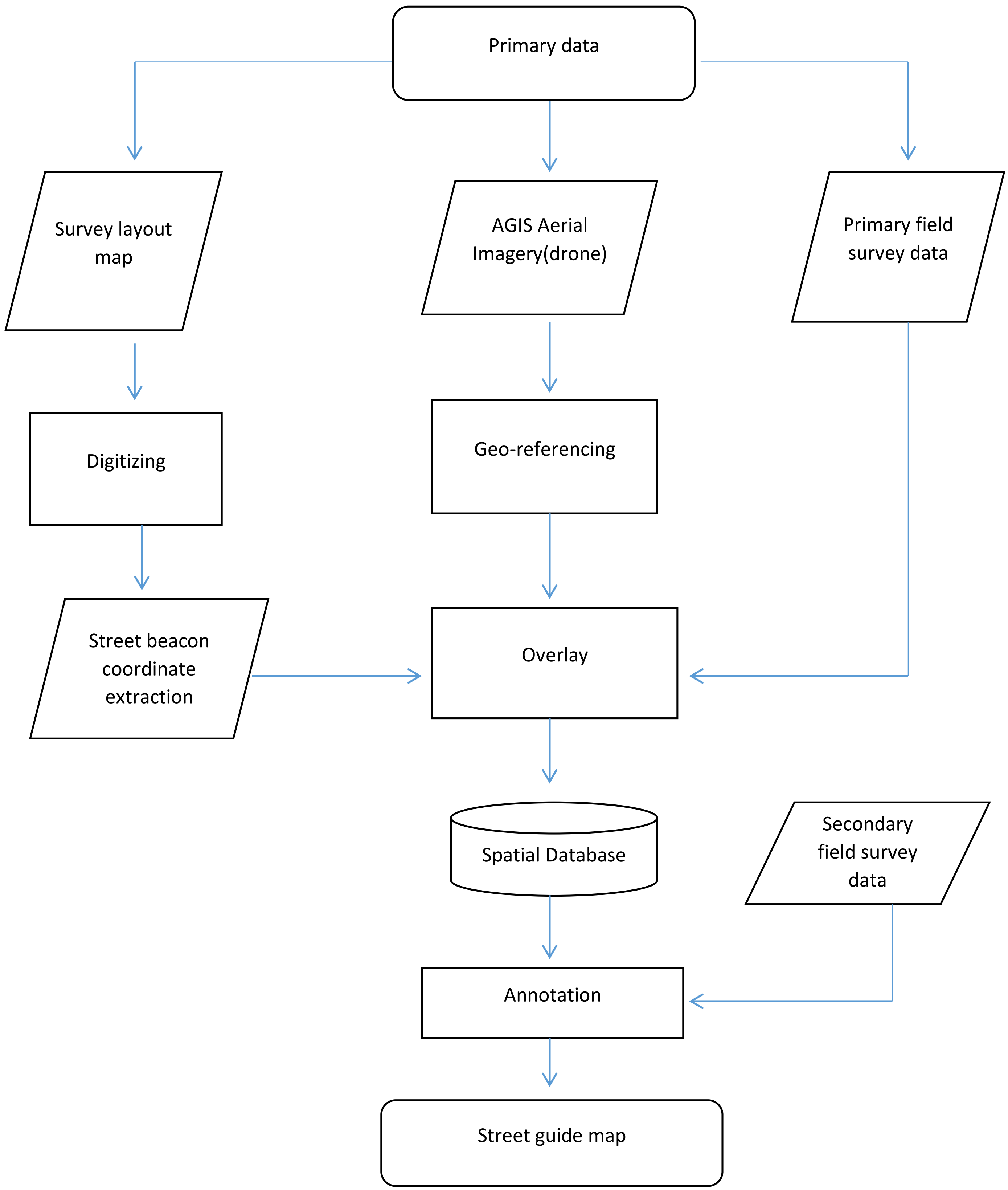


Table 2: Methodological Table

Methodological Table

DATASET	NATURE OF DATA	DATA SOURCE	USE
AERIAL IMAGERY	SECONDARY	ABUJA GEOGRAPHIC INFORMATION SYSTEM (AGIS)	For digitizing the boundary of the study location and other necessary features.
ATTRIBUTE DATABASE	PRIMARY / SECONDARY	PRIMARY FROM FIELD WORK AND SECONDARY FROM AGIS DATABASE	For aspatial information on the road network.
SURVEY LAYOUT DATA OF CADZONE C18	SECONDARY	DEPARTMENT OF SURVEY AND MAPPING, F.C.D.A	For extracting the street beacon coordinates.
GEOGRAPHIC COORDINATES	PRIMARY	FIELDWORK DATA, GENERATED USING THE HANDHELD GPS DEVICE	For ground-truthing, map registration and data evaluation.

Results and Discussion

A revised digital street guide map of Bunkoro, Gwarimpa District Cadastral Zone C18 was produced. The map contains a comprehensive list of the locations and names of important features in the area. Moreover, the geo-referenced map produced from this project could serve as a Street image map when the need arises. A comprehensive list of all the streets and relevant attributes of features were compiled and produced from this project and is expected to serve as an important database for future related projects within Bunkoro, Gwarimpa district in particular and Federal Capital Territory (FCT) in general.

Geo-spatial science and technology have given us the opportunity to present an up-to-date map of any place of interest in the world. It can also provide opportunity for updating of any map that interests us. With the help of this, map navigation would now be much more convenient in the southern axes of Bunkoro District that was revised and updated, which will in turn aid a lot of development in several areas such as Infrastructural Development and evenly distribution, tourism, marketing etc.

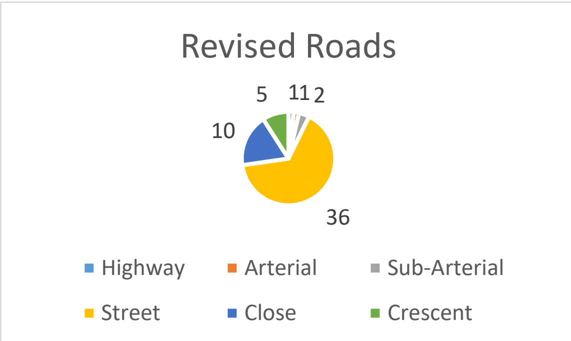


Figure 20

Conclusion and Recommendation

People in developing countries like Nigeria are been negatively affected from the effects of obsolete maps which is highly essential in a digital 21st century era.

While Geographic Information System (GIS) have been used to a great extent in mapping in Nigeria, its full potential has not been reached. GIS and remote sensing is an emerging technology which has the capability of integrating data from different sources. This enables users to overlay (another GIS capability) different layers into a single map.

The study was able to generate location-based information as regards to current street names on some parts of the F.C.T cadastral zone C18 which shows that our maps lack recent information as a result of lack of regular map review and revision after initial creation.

The employment of regular road mapping review results in better navigational details and more embracement of map usage by individuals as its tends to solve day to day navigational issues.

An important problem which needs to be addressed urgently is the need for policy makers in Nigeria to be highly aware, understand and recognize the relevance and impressiveness of using GIS and remote sensing technology in solving spatial related problems such as regular map review and implementation and other related spatial problems. Such awareness leads to an intensive increase in professional consultation on contents and relevance for high-technology adaptation in sustainable development in Nigeria.

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