APPLYING REMOTE SENSING & GIS FOR THE MAPPING OF BASIC EDUCATION SCHOOLS IN ADAMAWA STATE, NIGERIA

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ABSTRACT
One of the major problems hindering the proper planning, monitoring and administering of the numerous basic education schools spread over Adamawa State is the lack of an accurate, up to date map, showing the location of the schools. While convention ground survey could produce such a map, the time, money and drudgery involved makes this option very unattractive. By mapping out the basic education schools in Adamawa State (Nigeria), this paper demonstrates how remote sensing and GIS could be employed to carry out the task with little stress. It also highlights some typical problems that should be anticipated. Satellite images were used to extract and create the base map, while the GPS was used to pick the coordinates of the schools. The map produced was more accurate and cartographically superior to the hand drawn maps. The manner in which local government boundaries are generated and stored, the attitude of stakeholders and the low computer literacy level of end-users are among the problems that should be addressed if digital mapping is to be fully embraced.

INTRODUCTION
The Adamawa State Universal Basic Education (UBE) is charged with the task of ensuring that basic education is brought to the door steps of all children of school-going age in Adamawa State, no matter how remote their abode may be. This task has been tackled with considerable success, but not without problems.

One of the problems is the lack of a comprehensive, updateable map of the basic education schools in the state. Most of the maps available were produced by local education officers. The maps are usually drawn off-hand, based on the local knowledge of the area. Produced without proper instruments and cartographic skill, the maps can best be described as sketches, lacking precision.

Though a comprehensive list of all the primary schools in the states is available the lack of a precise knowledge of how they are spatially distributed makes planning and management rather very difficult. This paper therefore demonstrates a typical method that can be adopted for creating the needed digital map and tries to highlight the anticipated problems that could be encountered.

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.

Anderson et al (1999) created maps of bush fires in Senegal by interpreting NOAA-AVHRR images. The NOAA reception station allowed the collection of both day and night passes; hence information is obtained in almost real time. The NOAA channel 3

night-time images were used to detect active fires. On the basis of these images, monthly and annual maps were generated by simply superimposing blank vector files on the images and digitizing the details on them.

Amuyunzu and Bijl (1999) successfully produced a digital map of elephant habitats in South Eastern Kenya. The procedure of mapping land cover involved three stages – (i) data collection and pre-processing. (ii) Defining land cover types for the elephant habitat suitability rating model and (iii) use of a decision rule to obtain the defined classes from satellite imagery.

Musa (2005) digitally produced a revised map of the Jimeta-Yola metropolis using a combination of SPOT XS images and hand held GPS units. The GPS unit was used to carve out the minor roads that ordinarily could not be seen on the satellite image. By applying relevant geospatial techniques, a revised map of the town was created.

In view of the fact that the GIS has never been used before to map the state also given the need for equitable project distribution and constant monitoring by various development agencies engaged in the running of basic education, a digital map of the state depicting all basic education is considered a necessity.

METHODOLOGY:

Data:
- Satellite images (soft copies)
- GPS coordinates of public primary and junior secondary schools.
- Political map of the state showing local government and ward boundaries.

Software:
- ERDAS Imagine 8.6
- Integrated Land & Water Information System (ILWIS) 3.1 GIS package.
- ArcView 3.2 GIS package.

Hardware:
- Laptop computer (specification 40 GB HDD, Pentium IV processor and 516MB RAM).
- Hewlett Packard Deskjet 9600 series.
- Garmin 12 handheld Global Positioning System (GPS).

Image Processing:
LANDSAT ETM satellite images of the state were acquired from the National Centre for Remote Sensing (NCRS) Jos. Given the shape and size of a state like Adamawa, about seven scenes of LANDSAT were required to cover the entire state. From the various scenes of LANDSAT ETM, a single mosaic was created covering the entire state. ERDAS Imagine 8.6 was chosen specifically for the purpose of creating the mosaic. This is because, from experience, this is one of the few GIS packages known to the writers that are capable of manipulating data of such magnitude. When ILWIS, for instance, was used for mosaicking, the software stopped functioning after adding the fourth LANDSAT scene, an indication that the data was too much for it to handle. Image enhancement techniques were done to improve the visual quality of the mosaic. It was hen projected onto a UTM coordinate system and then rectified into a

North/South orientation. The mosaic became the background layer from which many of the map features were extracted.

Geo-referencing Ancillary Data:

The political map of Adamawa State was acquired from the state Ministry of Lands and Survey and scanned into the computer. Geo-referencing was done by tie-points. Three features were sought for, and used as tie-points, because of their ease of identification. The features include road junctions, river confluences and cross points of roads and rivers (i.e. bridges).

The political map of the state was geo-referenced to the reference frame i.e. the satellite image. This ensured that the political map aligned geographically with the satellite image. The ILWIS GIS package was chosen specifically for the purpose of geo-referencing. The Graphic User Interface (GUI) for geo-referencing by tie-points in ILWIS is considered by this writer to be easier and much more user-friendly. All the spatial data were later exported to ArcView 3.2a for feature extraction and data input.

Acquisition of GPS Coordinates:

Using the Garmin 12 GPS unit, coordinates of points that could not be seen on the satellite image such as minor settlements (with and without primary schools) were taken. As an error detecting measure (accuracy check) field officers were requested to take GPS coordinates in both LAT/LONG and UTM coordinate systems. For precision, locations were identified using both UTM and Lat/Long coordinate systems. An error was suspected if these two did not correspond and field officers were asked to repeat observations.

In mapping, Nigeria is covered by three UTM zones namely 31, 32 and 33. The bulk of Adamawa State falls in zones 33. This zone falls between long 12°E and 18°E, with its central meridian at long 15°E. Two coordinate systems exist for each zone, one system for the northern hemisphere and another for the southern hemisphere. For the northern hemisphere (where Adamawa State is located), the coordinate system is designed in such a way that the X-axis is 500,000m west of the central meridian, and Y axis lying along the equator. This ensures that no coordinate is negative.

When a mapped area spreads across more than one UTM zone, it is common practice to use the coordinate system of the zone in which the bulk of the mapped area falls. In the case of Adamawa state, the zone is 33. Unfortunately, it was noticed that the GPS does not operate that way. The GPS derived UTM coordinates of areas west of longitude 12°E, (Fig 1) were incorrect between this area falls in zone 32. This made it impossible to use the data for plotting since the reference axis was different from those their UTM value, using ILWIS vector operation module; before plotting could be done. For instance in Lawaru (Demsa LGA) instead of recoding a UTM coordinate of 16341E, 1040883N, the GPS was recording 822682mE, 1040883mN. The disadvantage of this is the lack of an independent check on coordinates derived from areas west of longitude 12°E. The UTM coordinates to the east of longitude 12 (i.e. zone 33) were however in agreement with their lat/long value.

Feature Extraction/Data Input:
In ArcView a variety of vector layers were created. Point, segment and polygon vector data were extracted (digitized) on point, segment and polygon layers. Also, different themes were digitized on different layer. Thus, even though roads and streams are both segment data, they were digitized on different layers.

Using the satellite image as background, features that could be identified on the image (i.e. streams, lakes, roads, etc) were digitized. Also, by making the political map boundaries and ward boundaries were digitized.

ArcView was chosen for this project mainly because of its ability to plot GPS data. This is done by creating an event table. Event tables always start with the fields 'X' and 'Y'. Different event tables were therefore created for different themes ensuring that in the final map different symbols could be allocated to the different point themes.

RESULTS AND DISCUSSION:

The Digital Map:
A total of 21 layouts were made, each layout depicting one of the 21 local governments. Te digital map (Fig 2) is neater and more accurate than the manually created one. The fact that the point data were plotted from a table of GPS coordinates facilitated quick speedy map update. This is because coordinates of additional points only need to be inserted in the table for it to be plotted automatically. Labelling is one aspect of map creation that gives the average cartographer nightmares. Not only because of the share number of towns that need to be labelled but also the difficulty of making the labels perfectly horizontal. As can be seen in Fig. 2, this cartographer's nightmare has become a delight to the digital mapmaker. However, the problem of overlapping labels still exists. Where towns are very close to each other the labels stand the chance of overlapping, thus making it difficult to read. The only solution to this is to remove some labels. Unfortunately it creates the impression that the town whose label is removed was omitted.

Accuracy of Digital Map:
Since the satellite image used was a LANDSAT ETM (spatial resolution of 30m), the GPS has to be in error by 30m before the effect of its inaccuracy could become noticeable. However, for a GPS with an accuracy of 5m in single mode, and 1m in differential mode, such an error is very unlikely. Thus points picked by the GPS can be assumed correct. Though this could be seen as an advantage it should be noted that a lot of details had been compromised. For instance schools that were within 30m of each other usually merged intone point on the map. Such schools were very common in the major towns.

Local Government Boundaries:
Political boundaries, especially the LGA boundaries were probably the most difficult features to capture accurately. This is due to the nature of boundaries generally. Boundaries are not visible features that can be identified on satellite images. They are rather imaginary lines, which in this case, do not even have coordinates. They were carved out cartographically by interpreting the appropriate aerial photographs. The local government boundaries used for this project were digitized from such

cartographic work i.e. the political map of the state in the custody of the Ministry of Lands and Survey. The inherent inaccuracy of the boundaries is not usually obvious when dealing with maps of small scale, depicting major towns in the state. It becomes more obvious when the scale is larger and the details required are numerous. In order to obtain accurate boundaries there is no short cut to actual demarcation of the boundaries using the GPS. The boundaries should then be stored as series of coordinates. The boundaries should then be stored as series of coordinates.

Distribution of Schools into LGAs:

It was discovered that in certain places schools that geographically fall in one LGA, were being administered by another LGA. This could probably be due to inadequate knowledge of the precise locations of LGA boundaries. Ironically, no education secretary (ES) is willing to relinquish any of the schools under his custody. This is very obvious from the attitude of the ESs. While on one hand they agree that, based on their local knowledge of an area, schools have been located correctly on the map, on the other hand, where such schools fall outside their LGA boundaries, they will insist that the LGA boundary be adjusted in such a way as to enclose the school, irrespective of the degree of distortion it will cause on the shape of the LGA. The fallout of this inconsistency is obvious- disputed areas are created. Such disputed areas include, the boundaries between Mayo-Belwa and Fufore; Song and Shelleng etc.

CONCLUSION & RECOMMENDATION:

This paper described a study that created a digital layer (map) for basic education schools. Though the comprehensive map of UBE schools has been successfully created, the capability of the GIS has been under utilized. Three core areas must be looked into if an accurate, digitally driven, geographically based database of basic education schools should be created.

1. A more precise demarcation of LGA boundaries. For this the Nigerian Boundary Commission (NBC) can be invited. While NBC could provide funds and expertise, UBE could provide logistics. Most importantly however, the boundaries should be stored as set of coordinates. This way it can always be re-plotted by the computer without introducing any shift.

2. Inclusion of more data in the digital database. The only data presently in the database are the name of the schools and the local government area in which they fall. More data could however be included, e.g. the number of teachers in each school, the number of students, the name of the headmaster, condition of the buildings etc. While it might not be necessary to label the map based on other set of data, it might sometimes become necessary to create new maps by querying these set of data. For instance, it might be desired to have a map of all schools that have only one classroom block. If the necessary data is in the database creating the map requires simply querying the database for such information.

3. Training in the use of the software. This will become valuable when updating the database.

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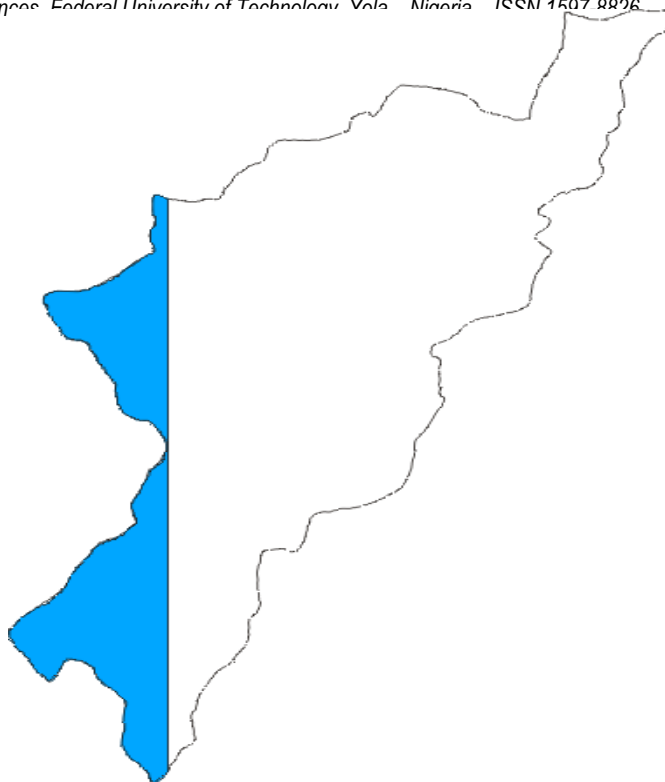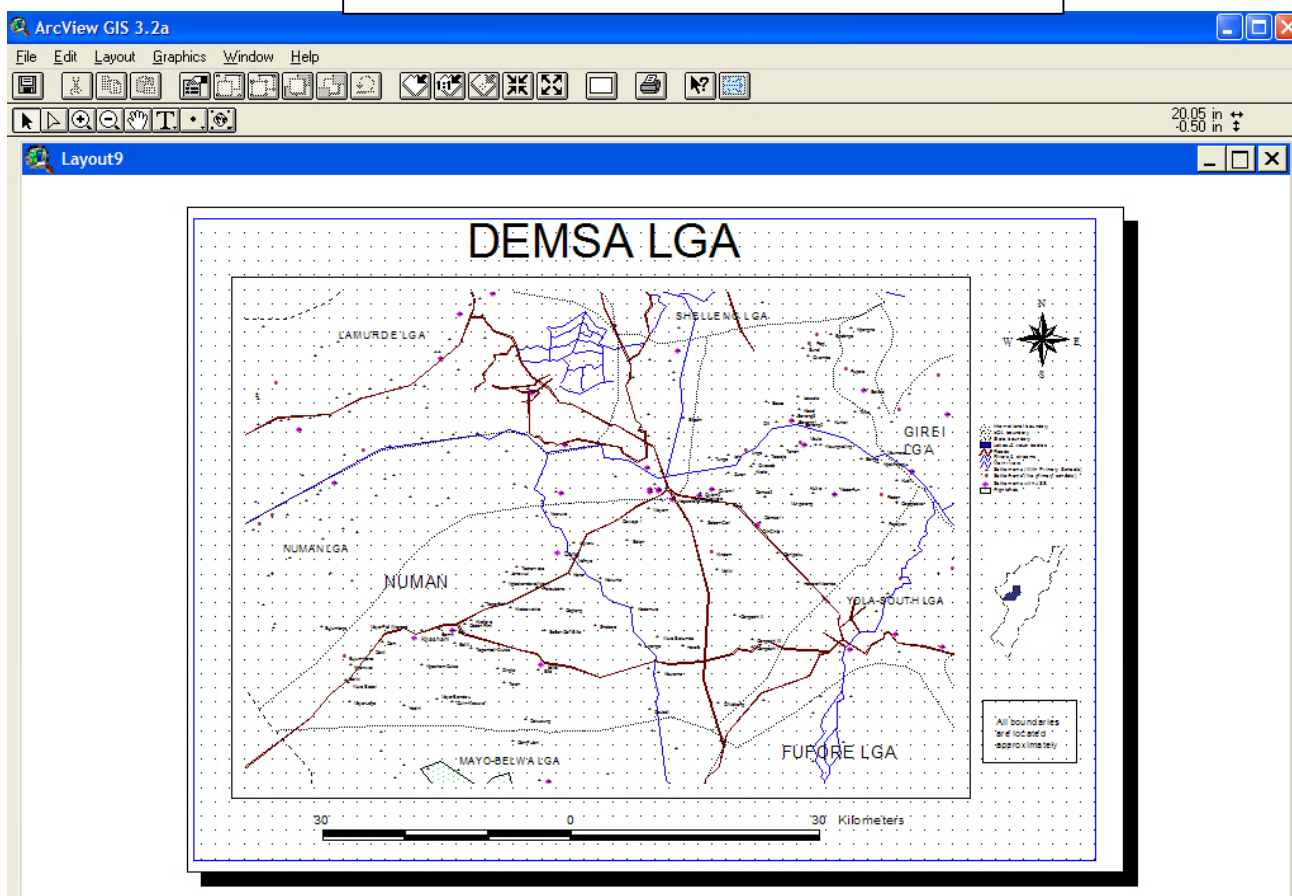
Fig 1: Areas west of longitude 12° (i.e. Areas in zone 32)

Fig 2: Map of Demsa LGA