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Street Guide Mapping of Auchi, Edo State, Nigeria

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Abstract. *This project is on the production of a Street Guide Map of Part of Auchi town in Etsako West Local Government Area of Edo State. The remote sensing method of map production was adopted for this project. Geo-referenced satellite imagery was downloaded in WGS84 datum and was saved in Geo-Tiff file format from Terra Incognita. The image was imported, and re-projected into Minna/UTM zone 32 and mosaicked in ArcGis 10.3 software environment, which was printed in A0 paper size and was used during ground-truthing. Garmin GPS60 was used to obtain the coordinates of well-located points which were identified on the printed satellite image and used to verify the accuracy of the georeferenced image. Layers were created and the features were digitized into their respective layers, some simple queries were carried out to test the database such as identification of hotels along the major road, the position of a particular school e.t.c. Map annotation and compilation were done, and at the end, a street guide map of part of Auchi Town was printed on A0 paper size at a scale of 1:10,000. In conclusion, the newly updated map can serve as a base map for other applications such as tourism navigation, urban planning, development traffic studies and control, crime monitoring, utility management, etc.*

Keywords: *GIS, Remote Sensing, Street Guide map, Satellite imagery, Auchi*

1. Introduction

A map is a model to scale part of the earth's surface showing the shape, political borders, natural features such as rivers and mountains, and artificial features such as roads and buildings (Abbas, Adama & Koje, 2010). Maps can perform several functions such as general inventories, planning of urban/rural development and administration, management of public properties and utilities, and execution of constructional works (Abbas et al., 2010). A map is produced to serve the purpose of giving direction, showing the extent covered by a certain feature, showing relief, and so on (Addai, Owusu, Poku-Gynanbibi, 2011). There are several types of maps

such as street guide, political, physical, topographical, climatic, economic, resource, thematic and population maps (Addai *et el.*, 2011). From the above types of maps mentioned, a street guide map can 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. According to (Idowu, Taofik Abayomi & Olayemi, 2016). A street guide map is a kind of map that focuses on the locations of streets and routes that links residential area in a civilized area such as towns, urban area, and city, etc. The following are the uses of a street guide map; it can be used as a guide for visitors and tourists for easy accessibility routing and information dissemination (Fasote, Haliu & Muibi, 2016). It provides tourists services information system. It provides information that will enhance map review. It provides an effective guide to rescuers in emergency situations e.g. Fire service, and police.

Also, the study area due to the settlement pattern, the majority of the social amenities such as health care facilities, financial institutions, educational institutions, hotels, recreational amenities, markets; petrol stations, and so on are located within the study area. Also, the presence of the institution within the periphery of the study area makes it one of the most visited places in the local government area by people who come to do business within the town. It is to note that majority of towns in Nigeria do not have street guide maps while others possess out-of-date of such maps despite their enormous importance.

Auchi is the administrative headquarters of Etasko West Local Government Area. Due to the settlement pattern of the local government area, the majority of the social amenities such as health care facilities, financial institutions, educational institutions, hotels, recreational amenities, markets; petrol stations, and so on are located within the headquarters. The presence of natural resources such as the vegetation, and rivers within the town makes Auchi one of the most visited towns in the local government area by people who came from different cities, towns, communities, and villages to do business within and outside the town. It is sad to note that majority of towns in Nigeria do not have street guide maps while others possess outdated maps, despite their enormous importance. Auchi, as it is with many towns in the country does not have an updated street guide map. For this reason, this project focuses on the production of a street guide map of the area using remote sensing and the GIS method.

2. Materials and Methods.

2.1. Study area

Auchi is the administrative headquarter of Etsako West Local Government Area of Edo state. Auchi community has a distance of 130km from Benin City t above sea level. The administrative headquarters of Etsako West Local Government Area,

Edo State. It is situated geographically between latitude 05° 40' 42″N and longitude 06° 23' 41″E to latitude 05° 43' 18″N and longitude 06° 26' 61″E of the Greenwich meridian. The map of the study area is shown in Fig.1. he state capital. The town itself is located on a terrain that is approximately 300m.

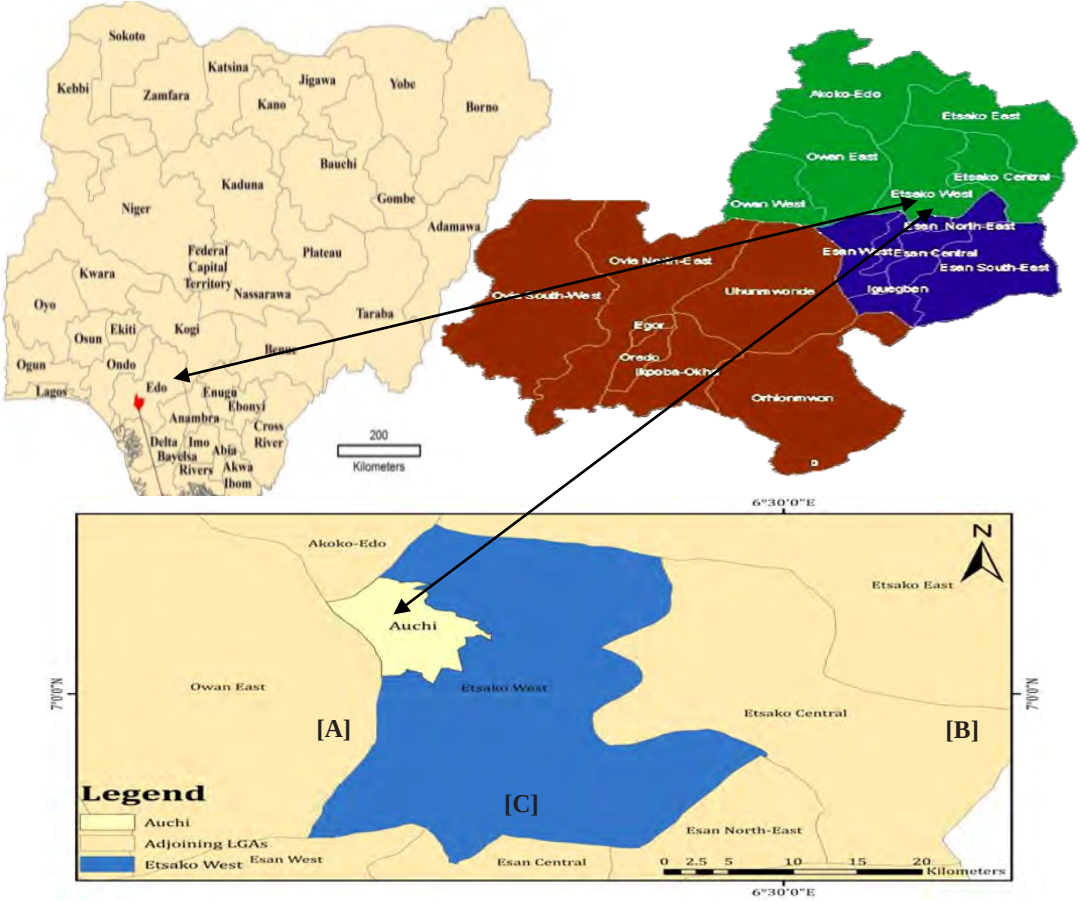

Figure 1. (a) Map of Nigeria showing Edo State; (b) Map of Edo North district; and (c) Map of Auchi indicating the experimental field at Auchi Polytechnic-Campus One. Source: Author's Arcmap 10.1 Production, 2022.

2.2. Study Design and Planning

The method entails planning, choosing the required instrument needed for the study, and seeking data necessary for the production of a digital street map. After due consideration of the cost of executing the project and knowing that the primary

data was readily available and cheaper to be acquired from Google Earth via Terra incognita. The remote sensing method was adopted for the street guide map production. The area coverage was extracted from Google Earth via Terra Incognita. The area of interest could not be extracted as one scene, because the street could not be viewed at such resolution (Hajara, Garba, Vincent, Ojeh & Ayeni, 2018). The geo-referenced imagery of part of Auchi was downloaded in two tiles with the use of the terra incognita software at which each scene required was saved in Geo-Tiff image format which was then matched together (i.e. mosaicked) with ArcGIS 10.3 software (Hajara *et al.,* 2018). The mapping of the street guide was basically done by digitizing the road/streets within the study area. Primary data and secondary data were used for this work these include:

i. Attribute data of marked features and street annotation of the study area;
ii. Aerial images were taken; and
iii. Land satellite is the longest method of a program in running an enterprise for the acquisition of satellite imagery of the earth.

Therefore, for the effective execution of the project, a workflow plan was designed for easy execution of each stage of the project, the study's flowchart is shown in Fig.2.

2.3. Reconnaissance Survey

This is a preliminary survey or the overview of a place to obtain information by visual observation or other detection methods. Reconnaissance for this study was done in two stages:

i. Office Reconnaissance;
ii. Field Reconnaissance.

2.3.1. Office and Field Reconnaissance

After due consideration of the cost of executing the project and knowing that the primary data was readily available and cheaper to be acquired from online Google Earth Imagery through Terra Incognita, it was decided that the remote sensing method will be adopted for the street guide map production. So, the area of coverage was extracted. The area of interest could not be extracted as one scene, due to the fact that the street could not be viewed at such resolution. So, it was downloaded in two tiles to a better viewing resolution at which each scene required was saved in Geo-Tiff image format which was then stitched together (i.e. mosaicked) saved in Geo-Tiff image format which was then stitched together (i.e. mosaicked) with ArcGis 10.3 software.

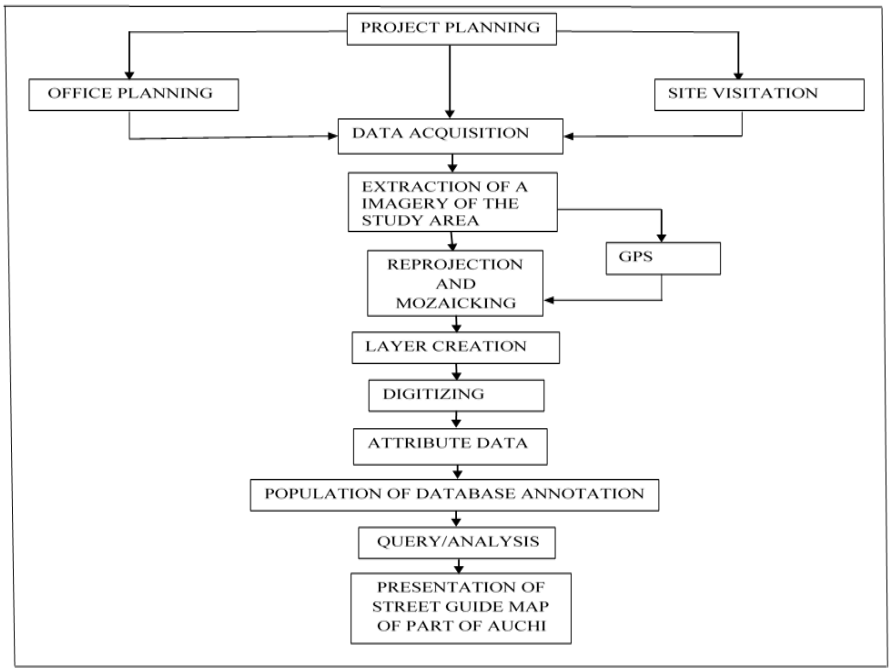

Figure 2. The work flow chart of street guild map of part of Auchi town.

2.4. Data search and Acquisition.

Data is a measure of quantity that when processed becomes information. In any project/research, the importance of data cannot be overlooked because it is the processed data that supply information upon which any research work depends. Satellite imagery of the area was obtained from Google Earth via Terra Incognita at a suitable resolution (12864 × 18064) and saved in Geo-TIF format, Spatial data (coordinates) of features were extracted from a satellite image of the area (Igbokwe, Itoro & Joel, 2008). The attribute data such as names of streets, roads, and so on were also obtained from field observation /social survey. The acquired satellite image was then imported into ArcGIS 10.3 software as a raster image as shown in Fig. 3.

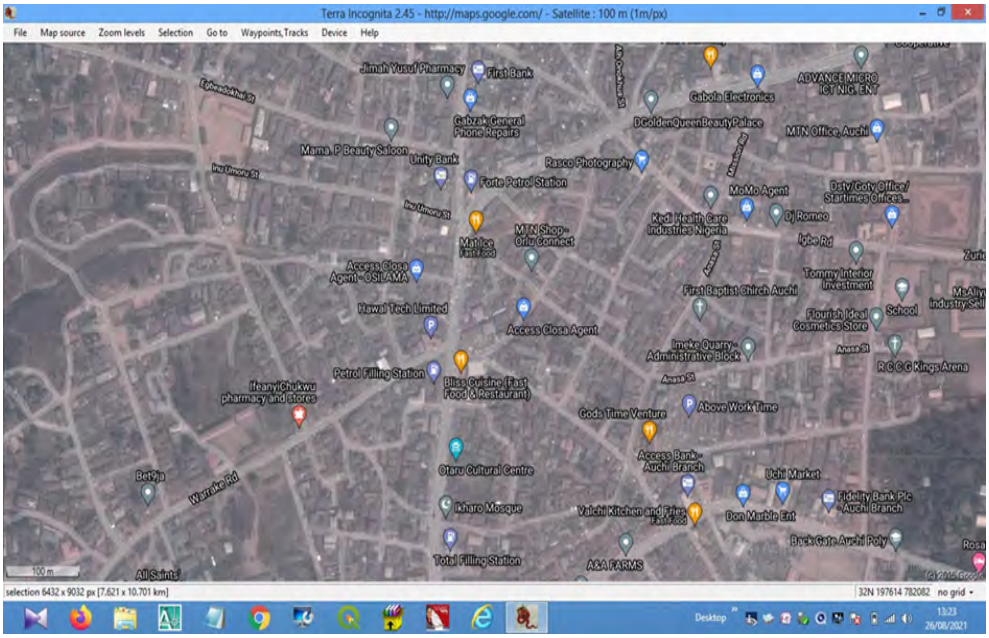

Figure 3. Google Earth Image via Terra Incognita of part of Auchi (Project Area), Etsako West LGA.

2.5. Field operation-ground truthing

This stage involved printing and taking the satellite image to the field for ground-truthing; many roads were captured within three classes of roads network namely, Major roads, Minor Road, and Street Road, prominent features such as Banks, Market, schools, and so on were obtained and written on the printed satellite imagery for verification. Table 2 presents extracted coordinates from the re-projected image whose coordinates were obtained from Google earth, coordinates of the same points were then taken to the field to confirm and verify the accuracy of the re-projected image, and points were obtained during ground-truthing. Table 2 shows the comparison of both coordinates, it is shown that the re-projected coordinates are of an acceptable standard. For capturing the geo-spatial data, we moved around all the roads in the town so as to be able to capture all the vital features (such as street names, schools, markets, banks, religious worship centres, palaces, and so on) with respect to their true ground position, this was made possible with the handheld GPS receiver and Satellite imagery. The data obtained were written on the printed satellite imagery for proper identification.

Table 2. Google Earth and GPS Field Coordinates for check

	Google Earth Coordinates		GPS Field Coordinate		Difference	
Point ID	Easting (m)	Northing (m)	Easting (m)	Northing (m)	Easting (m)	Northing (m)
FGP/ EDY073	199292.495	775546.359	199292.398	775546.305	0.097	0.054
2	193129.776	777082.225	193128.987	777081.999	0.789	0.226
3	192870.755	785199.117	192870.739	785199.114	0.016	0.003
4	199569.727	784157.626	199569.738	784157.627	0.011	0.001

3. Results and Discussion

3.1. Satellite Image Mosaicking

Due to the extent of the study location and the solution required to conveniently identify features on the ground, it was not possible to download a single scene satellite image covering the study area, so Google Earth satellite images were downloaded in tiles and saved in Geo-TIF file format as described by (Kolawole, Alaga & Oloko, 2016). The mosaicking of the image (or stitching) in the ArcGIS software environment as depicted in Fig 3a-e. Georeferencing could be understood as the process of conveying real coordinates to the spatial data. It assigns coordinates to the pixels of raster images. Common frames and coordinate systems are developed to define the positions within the information. It helps in determining how the areas in an image corresponding to the surface (Olatunde, Omoniyi & Olatunde, 2016).

The geo-referencing of spatial data can be done through two main methods. Firstly, by using 3D coordinates in which the center of the earth serves as the point of origin of all 3 axes.

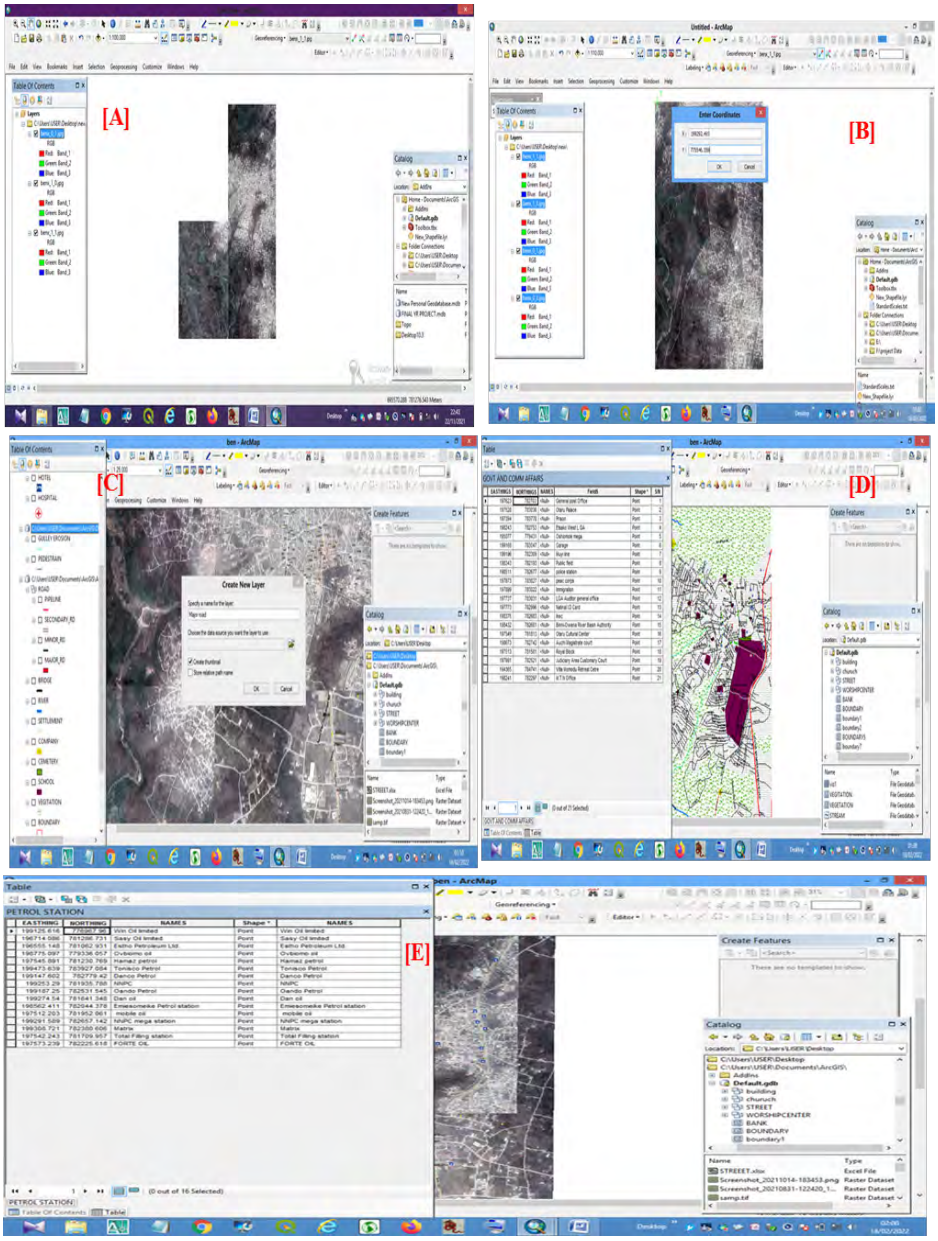

Figure 3. Mosaicking image of the study area (a), Geo-referencing of the imagery of the study area (b), Layers creation of the study area (c), Attribute table of government and community affair (d), and Attribute table of petrol station (e).

It is a popular method for scientific applications, but it is not considered feasible for applying to the points on the earth's surface. The second method is the projection of the points. In this method, 3D coordinates are expressed as a plane with some height above them. This technique helps in flattening the curved area of a small region into a flat surface for referencing purposes. The plane coordinates point towards a particular point within the projection. It is measured in terms of distances, north, and east from the origin (Raymon, Balogun & Clement, 2012).

3.2. Digitization and Vectorisation

The re-projected satellite image was digitized (vectorized) using the on-screen digitizing method. In achieving this task, layers were created for features on the image and appropriate properties were also created for them as in the studies of Raymon *et al.* (2012) and Sedi (2013). The features digitized for the purpose of this study include roads, prominent features such as schools, worship center market filling stations, government and community affairs, and financial institutions and hotels. The technique of layering is one very important facility. In this, particular features were placed in their own unique layer; for example, all major roads were placed in a major road layer. The software allows layers to be turned on or off as required by the users. This enabled to set up layers of details and allows only those of particular interest to be selected and digitized or plotted. This is easily achieved by turning off all unwanted layers and turning on all the required layers. The finding agrees with the studies of Udoh and Jude (2014) and Vicctor, Nnam, Bernard, Ekpete, Obinna & Anejionu (2012). In other to digitize the features on the satellite image, a manual method of on-screen digitizing was adopted. All the mentioned features on the image were manually vectorized as depicted in Fig. 4.

3.3. Map Compilation

Compilation of the map was done in ArcGIS 10.3 software where all necessary details were put together. Map elements such as frames, scale, legend, title, etc. were shown on the map at this stage of compilation. A printed copy of the street guide map was taken back to the field to ascertain and reconcile both features on the ground and that on paper which is commonly referred to as field completion.

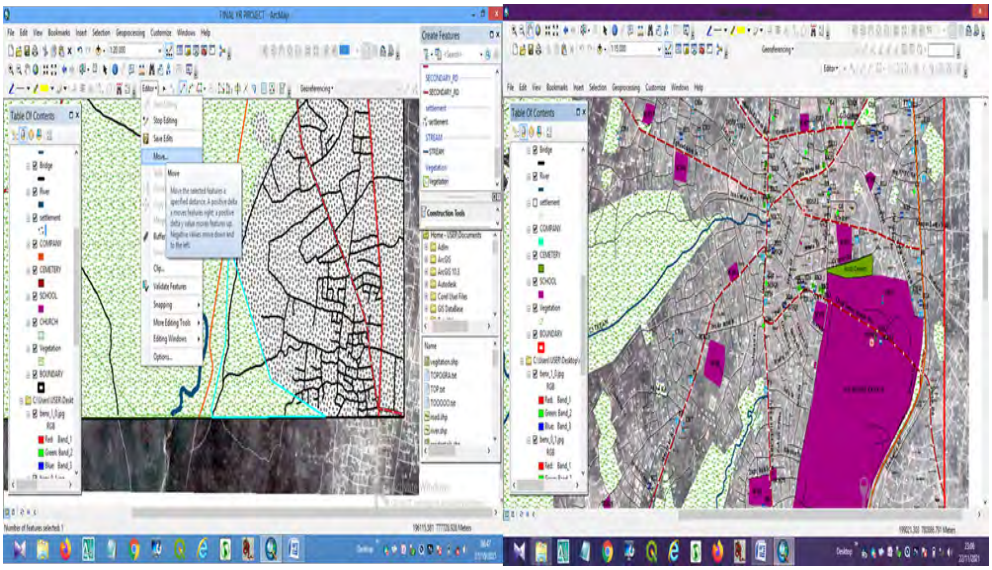

Figure 4. Vectorising and Vectorized Image of the Study Area

The information that was not found on the printed copy was updated and edited for the final finishing of the work. It is a query that has to do with how close an object is to another. In proximity query, the use of geometric distance to define the neighborhoods of one or more target locations. It has to do with the length between one object and another within an environment which in this case was 200m proximity between objects. This query is done or performed to determine the distance of petrol station located in this project area from the residential area, it was discovered that some of the petrol stations are located very close to a residential area. This query was performed to determine how many government and community facilities in the range of 50 meters from the major road from the Muyi line and Jattu garage as specified. With the simple query performed we discovered that Auchi is full of different denominations of church, a total of 15 different churches were captured with our project area, and most of the churches are within the range of 50 meters and below from the secondary and major roads respectively. Fig.5a-e shows the query outcomes over the study area.

The proximity query showed the hotels that are within a distance of 200 m to major roads. The result revealed that Hossana Resort and Suit, GNL Rental Hotel, Hotel De James, and Gabby Guest House are within the specified distance from the major road which was strategically and well located so as to serve the purpose of visitors that comes to the town, which gave easy access to a place for them to lodge if they need to pass the night.

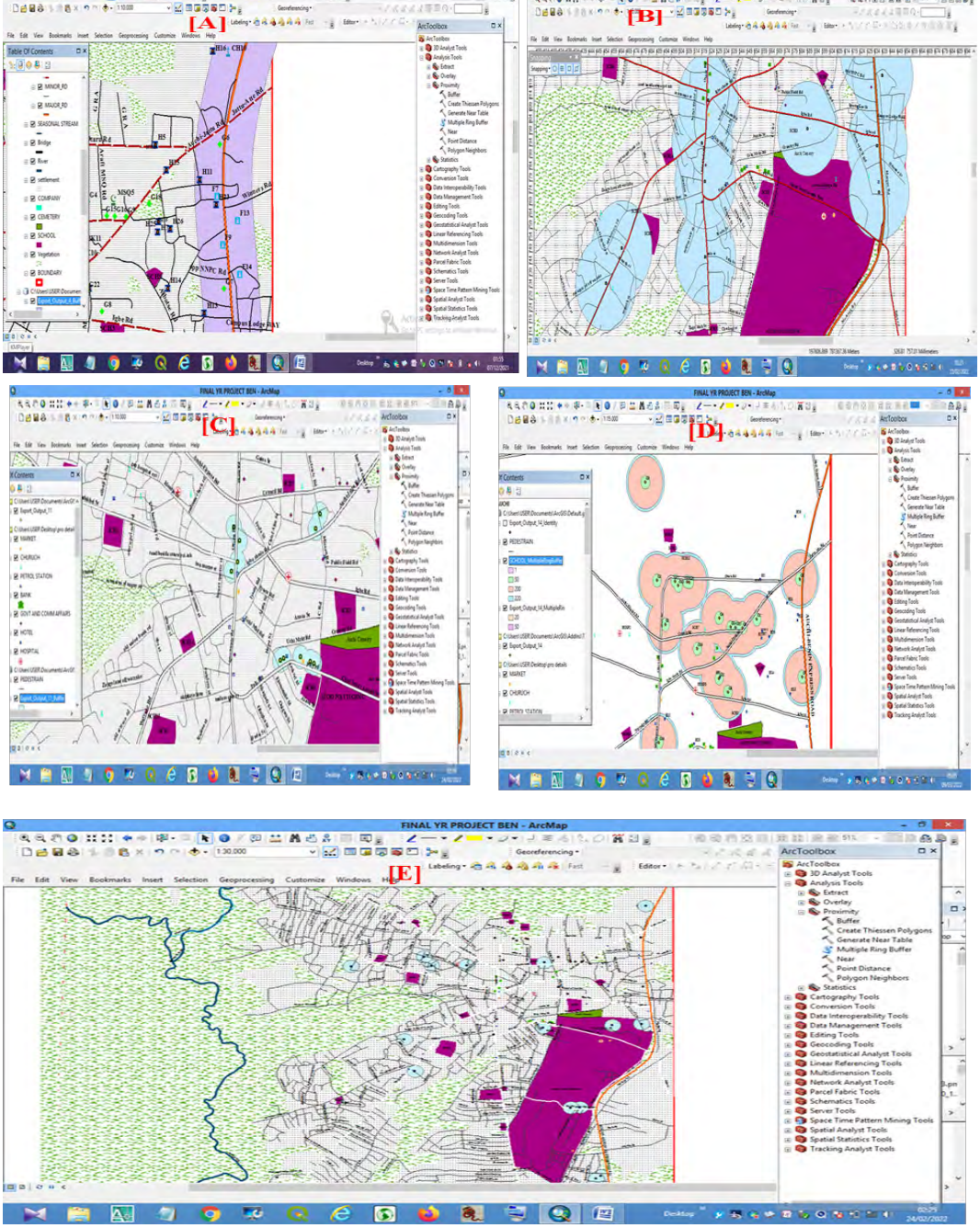

Figure 5. Proximity query of hotel within 200 metres away from major road (a), Query on petrol station in part of Auchi (b), Query of banks in Auchi (c), Query on government and community facility (d), and Query on church (e).

4. Conclusion

Concern with the idea of producing and up to date street guide map in Auchi and achieving it was indeed a huge success. This newly built map can serve as a base map for other applications such as navigation, urban planning, and development, traffic studies and control, crime monitoring, utility management, etc. With the simple query performed, the map can equally be used for business feasibility studies.

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