

Improving Street Guide Mapping of Enugu South Urban Area through Computer Aided Cartography

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Keywords: Computer Aided Cartography (CAC), Street Guide Mapping in Nigeria, Computer Aided Drafting, Enugu South Urban Area, Enugu GIS.

Summary

The advent and advances made in computer technology in the twenty-first century has generally increased the speed and the capacity of various geoinformation and map-making processes. The improvements have revolutionised the map-making process, which has metamorphosed into the widely acknowledged Computer Aided cartography (CAC). CAC has tremendously transformed the traditional (analogue) method of map-making. Round the world, CAC is continuously being applied in achieving high precision street guide maps for a variety of purposes. However in some developing countries such as Nigeria, the full potentials of such modern technologies and science are yet to be realised. This paper discusses the revision of street guide map of Enugu South Urban Local Government area of Nigeria, through CAC, as a way to demonstrate and highlight the benefits of CAC, and increase awareness and participation in this field in the state. Various computer aided cartographic and GIS processes such as digitisation, georeferencing, vectorisation, ground-truthing, visualization and cartographic abstraction of the study area were employed in this study. A spatially referenced street guide map showing various essential information in the study area such as streets names, street index; important features and services such as schools, hotels, hospitals, water ways, and railways was produced in the process. It is expected that the result will among other things boost tourists' experience in the state, which are often hampered by the unavailability and often times outdated analogue street maps of the city. The results will also be of immense help to the general management and administration of the local government council through the provision of up-to-date information on the location of utilities and services in the state.

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1.0 Background

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). Maps, a spatial model of the Earth's surface (Heywood *et al.*, 2006), showing how physical features are positioned and related to each other, created through cartographic abstraction process are highly potent means of communicating spatial information to people. A street guide map is a type of map that focuses on the locations of streets in an urban area.

The map making process can be a daunting and challenging process, however advances made in computer hardware and software technology have tremendously improved both the speed and quality of map making. The computer has changed both the mapping process and the map as a concept. It has increased the value of the map as a source of environmental information for all types of planning and decision making. Furthermore, there has been an increase in the demands for high quality hardcopy and digital maps in recent times (ESRI, 2004). Thus the need for the capability or capacity of producing high precision and quality maps within a reasonable time frame and at a greatly reduced production cost. Unfortunately, traditional mapping processes cannot sustain such current demands. Among the advantages of CAC over traditional methods are the following:

- i. flexibility in the mapping process (Morrison,1988),
- ii. reduced vulnerability of maps to dimensional distortion (expansion or shrinkage),
- iii. capacity to respond to the increasingly complex and diverse requirements of planners and decision makers with respect to geo-information products (Morrison,1988),
- iv. Simplified and faster map revision process. (United Nations, 2000),

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v. quick and easy linkage to databases (geodatabase) and subsequently to Geographic Information System (GIS), (Burrough *et al*, 1998).

The use of maps in developing countries is relatively low compared to what is obtainable in developed countries. This is strongly linked to the dearth of accurate and up-to-date maps, which could be linked to the non adoption and application of recent advances in map making process. As far back as 1986, it was pointed out that Computer Aided Cartography would play a vital role in developing countries (Taylor, 1986). However, the earlier expectation that the new wave of advancements in computer technology will speed up the map making process in Nigeria has not necessary been met. In Enugu state as in most states of Nigeria, map production is still being based on traditional map making protocols. State and local governments agencies still rely on maps produced through traditional methods with obvious limitations (time consuming and expensive). This has thus led to obvious issues and deficiencies.

Although the advantages of CAC are well recognised, public administrators and managers in Nigeria are a bit reluctant in adopting and funding such CAC based projects. It is therefore expected that a pilot project such as the one carried out in this research will strongly demonstrate the merits and effectiveness of adopting such processes in the state, subsequently allowing for adequate provisions to be made in the budget to support this.

In this study, CAC is being advocated as a way forward in the map making processes in developing countries in order to quicken and improve map production process through increased precision, accuracy, quality, and productivity, among other things. The project aims at producing a revised map of Enugu Urban with detailed street information as a way to stimulate interest in the adoption of Computer Aided Cartography in the state, as well as boost the use of maps in the state, through the continuous updating and revision of the map.

2.0 Study Area

Enugu South Urban (Figure 1) is situated within the heart of Enugu metropolis, in Enugu South Local Government Area of the State. It lies within longitudes $7^{\circ} 29' 13.5''E$ and $7^{\circ} 30' 30.1''E$,

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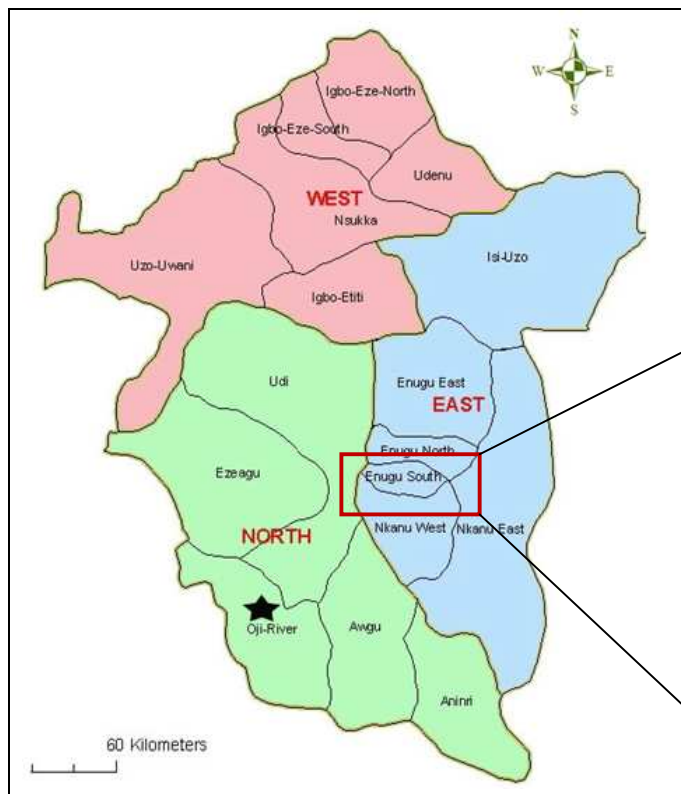
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and latitudes $6^{\circ} 24' 07.5''N$ and $6^{\circ} 25' 29''N$, and encompasses major high density residential and commercial areas in the urban part of Enugu State. It has an area of about 10km^2 and a population of up to 80,000 residents.



Figure 1: Map of Enugu State showing the locations of the 17 local government areas (Oji River Peoples Forum, 2011) and an Ikonos image showing the study area

3.0 Methodology

3.1 Data

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The main data used in this study were analogue street guide map of Enugu Urban (Figure 2) obtained from the Department of Surveying and Geoinformatics, Enugu State University of Science and Technology, and an Ikonos Satellite Imagery covering the study area.



Figure 2: Analogue tourist guide map of Enugu Urban

3.2 Methods

The methods (Figure 3) adopted in this study involved field survey, which was carried out at the commencement of the project to select and acquire reliable control points for georeferencing, as well as to acquire up-to-date street information (current names, status etc), and locations of public facilities such as schools, markets, hotels, churches, mosques, and hospitals.

This was followed by the digitisation of existing analogue greater Enugu Urban street guide map (published by the Department of Geoinformatics and surveying, University of Nigeria Nsukka in 1987) , which was subsequently georeferenced, alongside the 2011 Ikonos imagery with the coordinates of the control points acquired through field survey. Features in the digitised map were subsequently vectorised into various layers of streets, utilities and services (streets, markets, hospitals, hotels, railway, schools etc). New features captured by the Ikonos imagery were used

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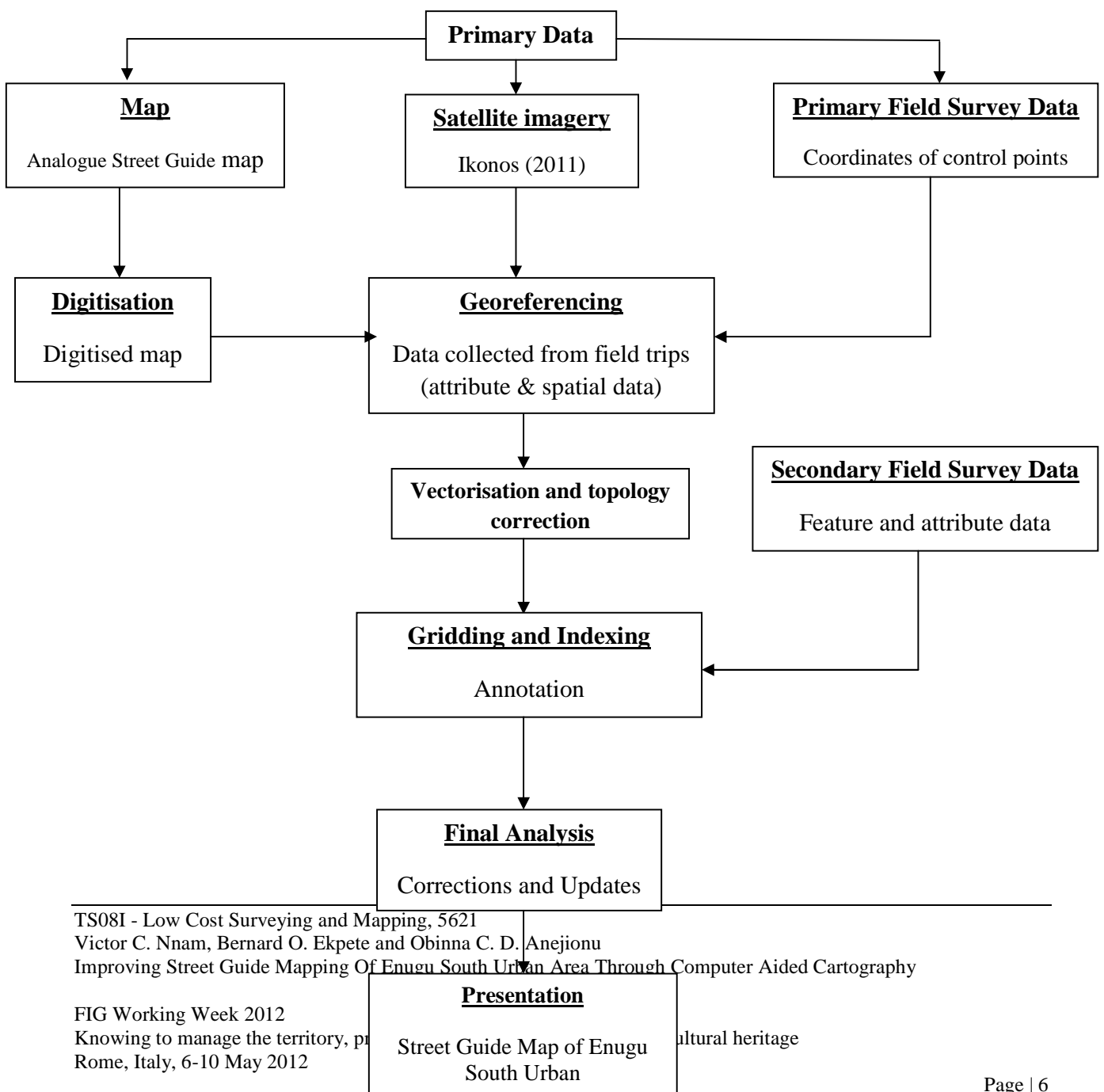
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to update the vector map. Observed topological errors were corrected and a 500m x 500m grid was applied to facilitate map indexing (Figure 4). Visual enhancement was performed on the map by the selection of appropriate symbology and colours, and annotations carefully added to improve the readability of the map.

Post map production field survey was carried out after the production of the preliminary map, to assess the accuracy of the produced map. After which the final map was produced.



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Figure 3: The project work flow

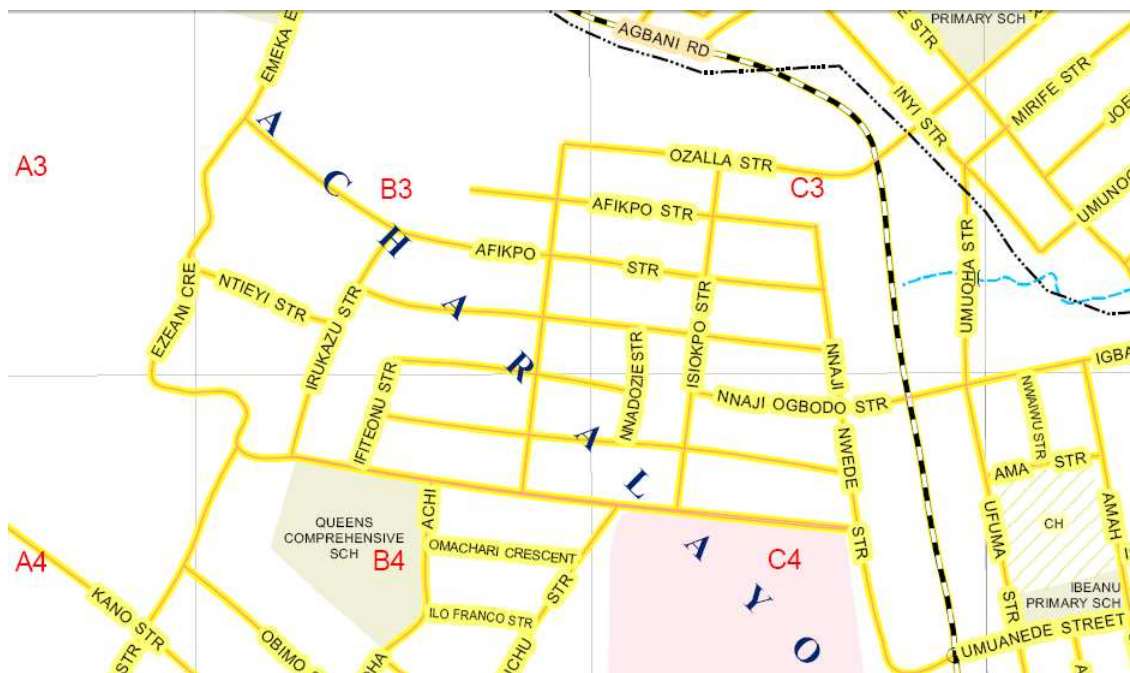


Figure 4: Indexing and annotation of the map.

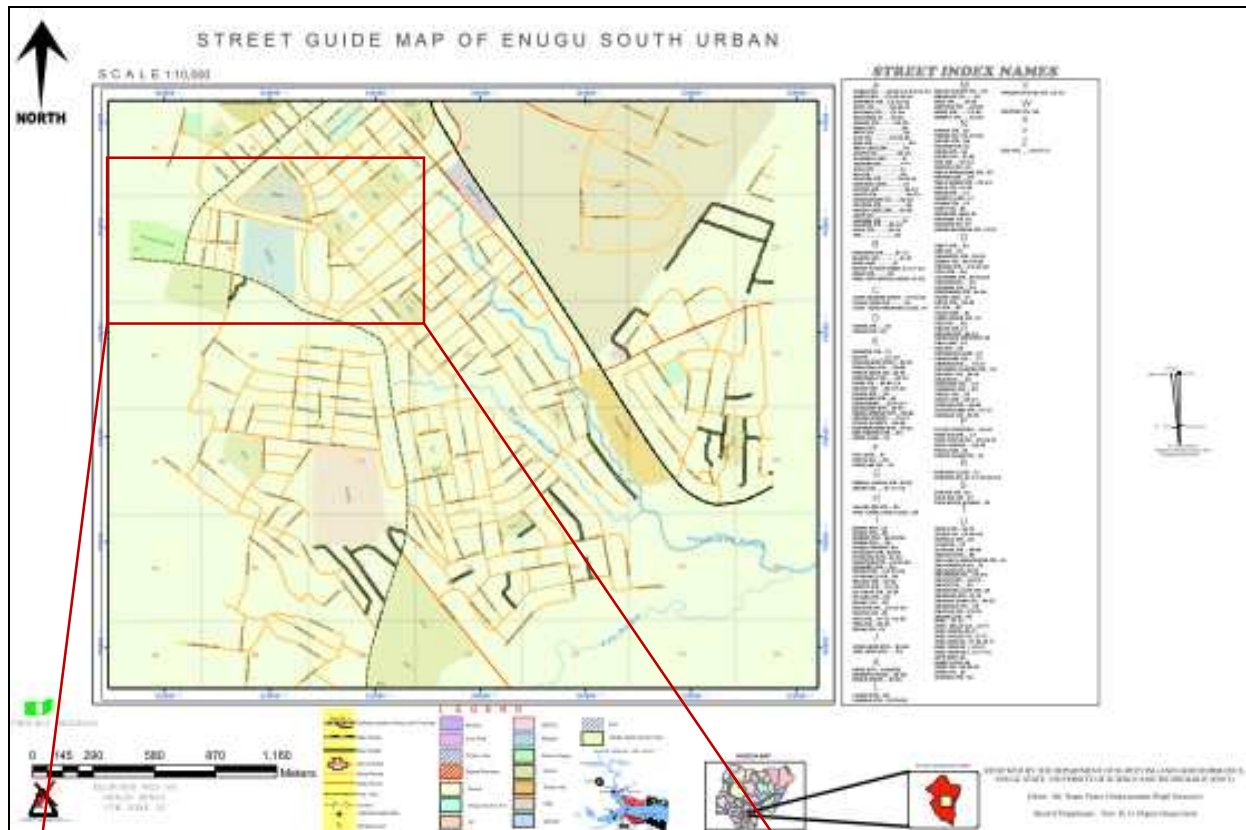
4.0 Results

An up-to-date digital street guide map of Enugu South Urban area was produced through CAC in this project (Figure 5). This map holds a comprehensive list of the locations and names of important features in the area. In addition, the georeferenced and orthorectified Ikonos imagery

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produced from this project could serve as an 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. This is expected to serve as an important database for future related projects in the state.



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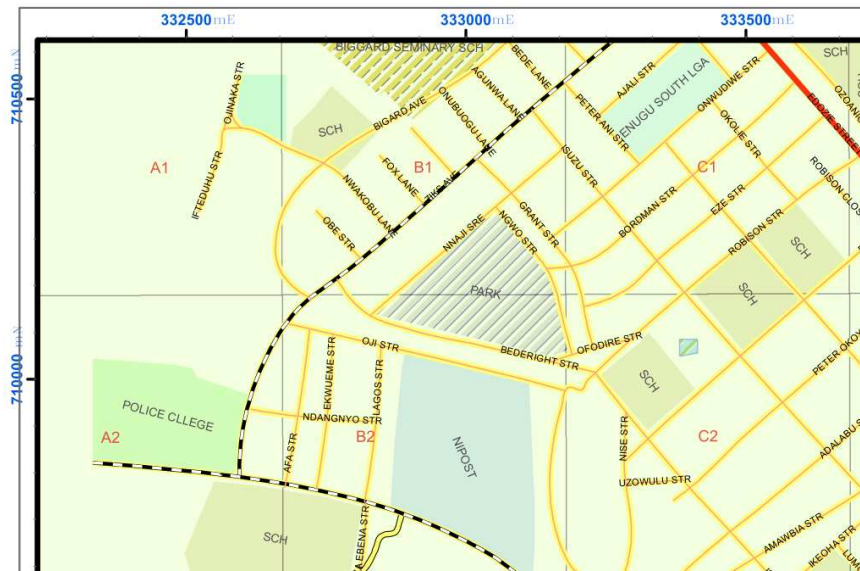


Figure 5: Produced street map

5.0 Discussions

The result obtained from this study satisfies the aim and objectives of the project. A high quality and updated street guide map of Enugu State was produced through Computer Aided Cartographic processes. The map compared with the existing analogue map of the area clearly demonstrates the merits of adopting CAC methods in the state. It is expected that the results obtained will play essential role in the following areas:

- i. **Tourism Industry:** Despite the fact that the state is inundated with several eye-catching tourists' locations and hospitality services, tourism in the state is continuously ebbing. Lack of up-to-date maps is believed to be one of the major factors contributing to this. The map produced from this study is thus expected to boost and improve tourists experience in the area and state in general as major centres of attractions were effectively captured.

- ii. **Transport Services:** This detailed street map will help to improve the transportation system in the area to a very large extent, as it would aid navigation within the area through easy identification of routes and services.
- iii. **Revenue Collection Services:** The information contained in the street map will immensely assist relevant state and local government agencies in planning and executing elaborate revenue mobilisation schemes which will tackle the challenges of the current system based on out-of-date and analogue models.
- iv. **Refuse Collection Services:** Waste recycling in the state is at its lowest due to inefficient refuse collection system. However, through the aid of street map and other information contained in the map produced from this research, relevant waste management agencies would be able to effectively plan regular, intensive and reliable refuse collection services.
- v. **Policing:** The revised street map will also assist police patrol teams and as well as other security agencies in the state in combating crime in the state.
- vi. **Mail Services:** The use of detailed street guide maps will go a long in improving mail delivery services around the area. Delivery of mails in the state has largely been restricted to post offices and big institutions and departments. But the improvement achieved in this research is expected to revitalize house-to-house mail delivery, as delivery routes could easily be planned from the offices.
- vii. **Engineering and construction:** The produced street map could be used by the Departments of Works in the local and state governments for planning road rehabilitation projects, urban drainage projects, culverts construction, and water pipe-laying projects.

6.0 Conclusion

This pilot study has highlighted the benefits of adopting Computer Aided Cartography in street mapping in Enugu State, through the production of an accurate, high quality, comprehensive and

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up-to-date street map of Enugu Urban area. The map is expected to boost tourism in the state, as well as play vital role in transportation, hospitality, policing, mail delivery, revenue collection, refuse collection and engineering works. The map was produced in a quick and cost effective way that underscores the advantages of CAC over the traditional methods currently being employed in the state. The digitally based map will also grant map makers the flexibility of quick updates and revisions, and could be used for the generation of application specific maps in a cost effective and quick way.

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