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Street Guide Mapping Of Part of Ekwulobia, Aguata L.G.A, Anambra State

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Abstract- *The introduction and advancement of computer technology in the twenty-first century has boosted the speed and capacity of various geoinformation and map-making operations in general. The advances have transformed the mapping process, but the full potential of such sophisticated technologies and science has yet to be realized in Nigeria. This project is aimed at street guide mapping of part of Ekwulobia with the view of providing an updated street guide map for development and planning purposes. Its objectives are to: collect and integrate existing street maps and Google Earth imagery for the targeted area of Ekwulobia; scan, georeference, and digitize the collected street maps and imagery to ensure accuracy and compatibility; develop a comprehensive and detailed street guide map of the selected part of Ekwulobia; conduct thorough field verification to validate and refine the map data for accuracy and reliability. The methodology involved the scanning and digitization of Ekwulobia base map, image to map registration, georeferencing, digitizing, database creation, labelling and map production. The street Guide map was achieved with relatively good mapping accuracy. It is recommended that the result of this study is recommended as an instrument for decision makers in making appraisal of the current state of the road network in the study area. The map produced will play essential role in distribution services, revenue and refuse collection services, in tourism and transport industries as well as in policing for combating crime and in the effective surveillance of the area.*
Keywords: *Anambra State, Database, GIS, Georeferencing, Map Revision*

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I. Introduction

The concept of street guide mapping has evolved significantly over the years, transitioning from simple paper maps to complex digital systems that provide real-time navigation and geographic information. In urban and semi-urban areas, accurate and up-to-date street maps are crucial for effective planning, development, and daily navigation (Goodchild, 2007).

Ekwulobia, located in Aguata Local Government Area of Anambra State, Nigeria, is one such semi-urban area experiencing rapid growth and development. Despite its significance as a commercial and educational hub, the lack of detailed and accessible street maps poses challenges to residents, visitors, and local authorities (Umuokoro *et al*., 2015). The development of a comprehensive street guide map for Ekwulobia is, therefore, essential for enhancing urban management, emergency response, and transportation planning.

Street guide mapping involves the collection, analysis, and presentation of spatial data to create detailed maps that depict streets, buildings, landmarks, and other significant features (Clarke, 2010). Modern techniques, such as Geographic Information Systems (GIS) and Remote Sensing, have revolutionized this field by enabling the creation of highly accurate and interactive maps (Longley *et al*., 2015). These technologies allow for the integration of various data sources, including satellite imagery, aerial photographs, and ground surveys, to produce comprehensive and up-to-date maps (Lo and Yeung, 2007).

The need for an updated street guide map in Ekwulobia is underscored by the area's rapid urbanization and population growth. Accurate mapping can support infrastructure development, improve transportation networks, and facilitate efficient service delivery (Owoeye and Ibitoye, 2016). Moreover, a well-documented street guide can enhance tourism by providing visitors with reliable navigation tools and promoting local attractions (Akingbade, 2012).

In many Nigerian cities, the absence of accurate street maps has led to inefficiencies in urban management and planning. For instance, emergency services often face difficulties locating addresses, leading to delayed response times during crises (Akintomide, 2014). Similarly, businesses and delivery services struggle with navigation, impacting economic activities and customer satisfaction (Adeniyi, 2013). Therefore, a detailed street guide map of Ekwulobia would address these issues, providing a valuable resource for both residents and authorities.

Furthermore, street guide mapping plays a critical role in environmental management by identifying and documenting key natural features and potential hazard zones. This information is vital for disaster preparedness and mitigation, particularly in areas prone to flooding or other environmental risks (Yusuf *et al*., 2018). By integrating environmental data with urban infrastructure, street maps can aid in the sustainable development of the region.

The importance of street guide mapping extends beyond navigation and urban planning. It also encompasses cultural and historical preservation by documenting significant landmarks and heritage sites (Jensen and Cowen, 1999). In Ekwulobia, such a project can help preserve local history and promote cultural heritage, contributing to a sense of community identity and pride.

Ekwulobia, located in Aguata Local Government Area of Anambra State, Nigeria, is experiencing rapid urbanization and population growth. Despite its increasing importance as a commercial and educational centre, the town lacks comprehensive and up-to-date street guide maps. This deficiency poses significant challenges for residents, visitors, and local authorities, impacting various aspects of daily life and urban management.

Without accurate maps, urban planners and local authorities struggle to design and implement effective development plans. This can result in poorly coordinated infrastructure projects, inadequate service delivery, and unplanned urban sprawl.

Emergency services, such as fire departments, medical responders, and law enforcement, often face difficulties locating addresses quickly due to the lack of detailed street guides. This delay can have severe consequences during crises, potentially leading to loss of life and property.

Residents and visitors frequently encounter difficulties navigating the town, leading to time wastage and frustration. Businesses, including delivery services, also suffer from inefficiencies caused by unclear or outdated maps, affecting economic activities and customer satisfaction.

Ekwulobia has various cultural and historical landmarks that could attract tourists. However, the absence of reliable maps hinders tourism development, as potential visitors find it challenging to locate and explore these sites.

Effective environmental management requires detailed spatial data to identify and monitor key natural features and potential hazard zones. The lack of comprehensive maps limits the ability to plan for and mitigate environmental risks, such as flooding.

Given these challenges, there is a pressing need to develop a comprehensive street guide map for part of Ekwulobia. This map will serve as a valuable tool for urban planning, emergency response, navigation, tourism promotion, environmental management, and cultural preservation. The study aims to address this gap by utilizing modern Geographic Information Systems (GIS) and Remote Sensing technologies to create an accurate, detailed, and up-to-date street guide map for the town.

II. Materials and Method

2.1 Study Area

The study area is Ekwulobia, located at approximately 6° 01' 60" North latitude and 7° 04' 60" East longitude. It lies within the coordinates 6° 05' North to 6° 25' North of the equator, and 7° 02' East to 7° 10' East of the Greenwich Meridian

Ekwulobia is one of the largest towns in Aguata Local Government Area of Anambra State, Nigeria. As a significant commercial and educational hub, it has experienced steady population growth over the years. The town is characterized by a diverse demographic, comprising various age groups and socio-economic backgrounds. The population density in Ekwulobia has increased due to urbanization and its strategic importance within the region. Although specific population figures may vary, it is estimated that Ekwulobia has a population of several tens of thousands, contributing to its vibrant and dynamic community life.

Ekwulobia falls within the tropical rainforest climate zone, which is typical of many parts of southeastern Nigeria. The climate is characterized by two main seasons: the wet season and the dry season. The wet season typically spans from April to October, featuring heavy and frequent rainfall, high humidity, and relatively stable temperatures. The average annual rainfall ranges between 1500 mm to 2000 mm. During this period, the town experiences lush greenery and abundant agricultural activity.

The dry season, from November to March, is marked by lower humidity and a significant reduction in rainfall. This season includes the harmattan period, which occurs between December and February, characterized by dry, dusty winds from the Sahara Desert that can lead to cooler temperatures in the mornings and evenings. Despite these variations, Ekwulobia generally enjoys a warm climate year-round, with average temperatures ranging from 25°C to 30°C.

Ekwulobia is situated within the tropical rainforest belt, and its vegetation is typical of this ecological zone. The area is characterized by dense and diverse plant life, including tall trees, shrubs, and a variety of understory plants. The natural vegetation comprises a mix of deciduous and evergreen trees, which contribute to the region's rich biodiversity. Common tree species include mahogany, iroko, and oil palm, among others.

The lush vegetation supports various forms of wildlife and provides a critical habitat for many species. Additionally, the fertile soil and favorable climate conditions make Ekwulobia suitable for agriculture, with residents engaging in the cultivation of crops such as yam, cassava, maize, and various vegetables. The vegetation also plays a crucial role in maintaining the local ecosystem, supporting water retention, soil fertility, and overall environmental balance.

III. Methodology

3.1 Data Requirements

The research project necessitated the collection and utilization of various images and data sources, including the Ekwulobia Basemap, high-resolution satellite images from Google Earth, and precise ground coordinates obtained from field surveys.

3.2 Data Acquisition

a. Acquisition of Primary Datasets

Primary data were gathered through detailed field visits tailored to this study. This process involved the collection of 20 ground control points (GCPs) using a handheld GPS device to ensure spatial accuracy. Additionally, non-spatial (attribute) data describing the characteristics of various ground features, such as the type and condition of roads and landmarks, were collected.

b. Acquisition of Secondary Datasets

Secondary datasets were sourced from pre-existing records and digital platforms. This included maps detailing the administrative boundaries of Anambra State and Ekwulobia, obtained from the Department of Surveying and Geoinformatics at Nnamdi Azikiwe University, Awka. Additionally, high-resolution imagery was extracted from Google Earth Pro to provide a contemporary view of the study area and aid in visual interpretation and digitization.

3.2.1 Processing Techniques

a. Data Registration

Accurate spatial registration or rectification of images was essential for effective mapping. This involved geometric rectification using algorithms to align images to each other or to a standard map projection. The Google Earth imagery used in this project had been pre-processed and georeferenced to the WGS UTM Zone 32N coordinate system. Transformation algorithms, such as polynomial transformations, were employed to correct geometric distortions in the images, ensuring they accurately overlaid with the base maps and control points.

b. Scanning and Georeferencing

The existing base map of Ekwulobia was scanned using an AO Scanner and saved in TIFF format. High-precision scanners were used to capture the entire map without the need to cut or segment it. The scanned images were stored in TIFF format to preserve quality and detail, and then imported into ArcGIS 10.7 for subsequent georeferencing and digitization.

Georeferencing involved aligning raster data with geographic coordinates. Control points, such as road intersections and other prominent landmarks, were identified. An image-to-image registration process was used to align the local coordinates of the base map with those of the Google Earth imagery, ensuring both datasets accurately represented the same geographic area. Multiple rounds of verification were conducted to ensure the georeferenced images matched the ground control points.

c. Georeferencing in ArcGIS 10.7 and Data Capture

The georeferencing process in ArcGIS 10.7 included selecting the georeferencing tool from the ArcMap interface, locating and clicking on control points on the map, inputting their corresponding geographic coordinates, repeating this process for multiple control points to ensure accuracy, and rectifying the map, saving it in TIFF format. The georeferenced map was then added as a new layer in ArcGIS for further analysis.

Data capture involved converting analog maps into digital formats through digitization. The on-screen digitizing process was used to digitize features such as expressways, major roads, and minor roads into separate layers in ArcGIS 10.7. Specific layers were created for different types of features, ensuring a structured and organized data set.

d. Digitizing in ArcGIS 10.7 and Map Revision

The digitization process in ArcGIS 10.7 involved creating layers of entities within the Arc Catalogue window, using the editor task pane to begin digitizing with snapping options enabled to ensure precision, selecting the sketch tool and digitizing layers by targeting specific features, and overlaying multiple datasets to identify and extract new roads and other features, updating maps, and creating new layers.

Map revision utilized GIS overlay functions to integrate results from change detection and data extraction processes. This involved topology building to establish spatial relationships between different geographical elements and editing to correct mapping errors such as overshoots and undershoots.

e. Database Creation and Field Completion

Creating a comprehensive database involved multiple stages, including conceptual design to define real-world entities and their relationships, logical design to structure the data in a relational format suitable for implementation in GIS software, and physical design using vector conceptual schemes and relational data models.

Field completion ensured the accuracy of the collected data by using handheld GPS devices to verify and update map features. This process ensured the accuracy of attributes such as road names and village locations, with coordinates of landmark features plotted onto the revised street map for precision.

IV. Results

2.1 Quality Control

The adage "garbage in, garbage out" is particularly relevant in map revision projects, underscoring the critical importance of data quality assessment in building a geographic database. Errors, inaccuracies, and imprecisions can significantly impact the success of map production. This fundamental concept of quality control involves ensuring that the digitized database aligns accurately with the original printed maps. In this project, the final products included a digital map and a GIS database, with quality assessment focusing on several key areas:

1. **Positional Accuracy**: This refers to the accuracy of the mapped location in relation to its true location in the real world. Ensuring that geographic features are accurately positioned is crucial for the reliability of the map.
2. **Attribute Accuracy**: This measures the degree to which the observations in the database conform to the actual values found on the ground. It ensures that the descriptive information associated with geographic features is correct.
3. **Completeness**: This assesses the number of missing entries in the dataset. A complete dataset is essential for comprehensive and accurate map production.
4. **Logical Consistency**: This involves checking for logical errors such as cross contours, interruptions, or roads crossing rivers without bridges. Ensuring logical consistency helps in maintaining the integrity of the spatial data.

2.2 Revised Map Accuracy

The accuracy of the revised map is crucial for any mapping project, as it affects the reliability of spatial analysis and the usefulness of the data. The following procedures were undertaken to enhance the quality and trustworthiness of the dataset:

2.3 Positional (Absolute) Accuracy

Absolute accuracy refers to the relationship between a geographic position on a map and its real-world position measured on the ground. To determine this, the positions of certain features and buildings were measured using a handheld GPS and compared to their positions on the map. Key features, including major road intersections and prominent landmarks such as the MTN Office, Tracas Park, Ecobank, and the EEDC Office, were identified and their coordinates were checked against the digital map.

2.4 Relative Accuracy

Relative accuracy involves comparing the measured lengths of features in the field with their corresponding lengths on the digital map. For this project, the lengths of various roads measured in the field were compared with their lengths on the digital map to ensure consistency and accuracy.

2.5 Attribute Accuracy

Attribute accuracy refers to the precision of the descriptive values associated with map features. This was verified during the field completion exercise by checking the attribute values on the map against their true values on the ground. For instance, the names and characteristics of roads and landmarks were cross-verified to ensure they matched the real-world data.

V. Conclusion and Recommendation

5.1 Conclusion

This research project successfully developed a high-quality digital map and GIS database for Ekwulobia, ensuring a comprehensive and accurate representation of the geographic area. The meticulous processes of data acquisition, georeferencing, digitization, and quality control have been crucial in achieving this objective. The key findings include:

1. Positional Accuracy: The digital map exhibits high positional accuracy, with geographic features correctly aligned to their true real-world locations. This was verified through GPS measurements of key landmarks and features, ensuring the map's reliability for spatial analysis and decision-making.
2. Attribute Accuracy: The attributes associated with geographic features, such as road names and landmarks, were cross-verified during field visits. The attribute accuracy ensures that the map provides precise and useful information about the features it represents.
3. Completeness: The digital map and GIS database were thoroughly checked for completeness, ensuring that all necessary geographic features were included. This comprehensive coverage is essential for various applications, including urban planning, navigation, and resource management.

4. Logical Consistency: The map was verified for logical consistency, eliminating errors such as cross contours and incorrect road-river intersections. This ensures that the spatial relationships between features are accurate and logical.

5.2 Recommendations

Based on the findings of this project, the following recommendations are made to enhance the quality and utility of future mapping projects:

1. Regular Updates and Field Verification: To maintain the accuracy and relevance of the digital map, regular updates and field verification should be conducted. This will help capture any changes in the geographic landscape and ensure the map remains current.
2. Advanced Geospatial Technologies: Employing advanced geospatial technologies, such as LiDAR and drone imagery, can further improve the accuracy and detail of the maps. These technologies can provide high-resolution data that enhance the precision of geographic features.
3. Comprehensive Data Collection: Future projects should aim for even more comprehensive data collection, including socio-economic and environmental attributes. This will expand the utility of the GIS database for a wider range of applications, such as disaster management and environmental monitoring.
4. Training and Capacity Building: Training and capacity building for GIS professionals and field surveyors are crucial. This ensures that the personnel involved in data collection and processing are skilled and knowledgeable, leading to higher quality outputs.
5. Community Involvement: Engaging local communities in the mapping process can provide valuable insights and data. Local knowledge can help identify important features and verify the accuracy of the map, making it more relevant and useful for the community.
6. Integration with Other Systems: The digital map and GIS database should be integrated with other systems, such as municipal management systems and emergency response systems. This integration can enhance the functionality and effectiveness of the map in various operational contexts.
7. Open Data Policy: Adopting an open data policy can encourage the use of the digital map and GIS database by various stakeholders, including researchers, policymakers, and the general public. This can foster greater collaboration and innovation in geographic information applications.

5.3 Future Work

To build upon the success of this project, future work should focus on:

1. Expanding Geographic Coverage: Extending the mapping efforts to cover larger geographic areas, including neighboring towns and regions, can provide a more comprehensive spatial dataset for regional planning and development.
2. Enhanced Attribute Data: Collecting more detailed attribute data, such as demographic information and land use patterns, can enrich the GIS database and expand its applications.
3. Real-Time Data Integration: Incorporating real-time data, such as traffic conditions and weather information, can enhance the map's utility for dynamic and time-sensitive applications.

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