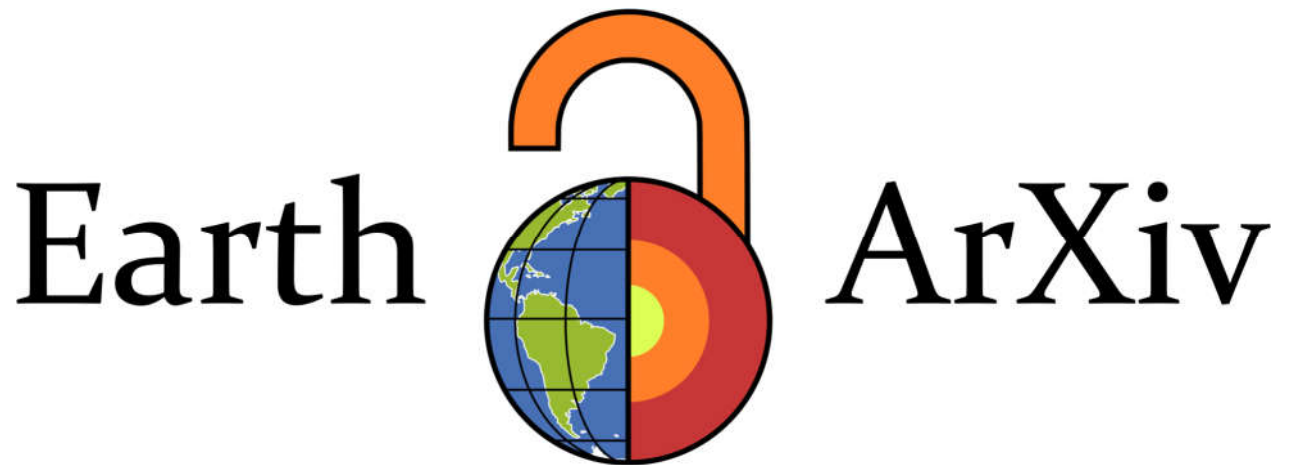




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TITLE: The Spatial Journey: A Visual Narrative of the Keffi to Makurdi Field Trip.

AUTHOR: Umar Yusuf

The Spatial Journey: A Visual Narrative of the Keffi to Makurdi Field Trip

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Abstract

Background: Field-based education is a critical academic component in geographical studies, designed to bridge theoretical knowledge with empirical observation. This paper reports on the development of a visual and interactive geospatial narrative based on a five-day geography educational field trip from Keffi to Makurdi, Nigeria, from the 26th to the 30th of August 2024.

Objective: The primary aim is to create an accessible web map utilizing collected field trip datasets. Specific objectives for this study include (i) geospatial capturing of significant features and points of interest along the route; (ii) documenting and structuring the resulting spatial, non-spatial, and multimedia datasets; and (iii) producing an animated web-based visualization and web mapping.

Methodology: The study used a GPS-enabled smartphone, a handwritten field book, and a digital camera to capture 102 geotagged waypoints (latitude, longitude, altitude, and timestamp) along the route. The waypoints, together with digitized local-government and ward boundaries produced in QGIS version 3.42.2-Münster, were published as a freely accessible, layer-controlled interactive web map. Leveraging the principles of Web Cartography and Visualization (WCV), these processed layers were then integrated into an interactive web-based map hosted on a web page at:

www.UmarYusuf.com/nsuk/fieldtripmap. The same field programme included structured site visits to the Benue Geographic Information Service (BENGIS), the Benue State Urban Development Board (BUDB) and the Oracle Business Limited (OBL), during which the institutional workflow for issuing a digital Certificate of Occupancy (C of O) and the use of a river-gauge station for flood early-warning were documented. **Result:** Results show that a low-cost smartphone-and-web-GIS pipeline can produce a citable, reproducible spatial dataset from routine fieldwork, and that the recorded geographical features were spatially distributed across nine Local Government Areas (seven in Nasarawa State and two in Benue State) and thirty-two political wards (twenty-six and six in Nasarawa and Benue states respectively).

Conclusion: This study successfully demonstrates the practical application of geospatial technology in creating a robust experiential learning tool, underscoring the vital educational significance of mandatory student field excursions for fostering academic learning and recommending their continued, essential integration into the curriculum.

Keywords: Academic Fieldwork, Geospatial Visualization, Field Trip, Web Map, Field-Based Learning, Keffi, Makurdi

1.0 INTRODUCTION

Fieldwork remains central to geographic training, yet student field reports are often produced as narrative accounts with limited geospatial academic rigor (Bruinsma, 2024; Lee, 2023). Fieldwork serves as the empirical foundation of geographical research by bridging abstract classroom theory with real-world observations (Bello et al., 2020; Firomumwe, 2022). Field-based geospatial education remains central to the training of professional geographers and GIS specialists in Africa, yet systematic documentation of how institutional GIS practices intersect with industrial landscapes is still limited (Olatoye and Fru, 2025). The field remains the primary laboratory of the geographer (Bello et al., 2020).

While geographic field trips offer powerful experiential learning opportunities, their impact is often constrained by a fundamental curricular disconnect. Devadoss and Merced (2026) observe that a significant gap persists between advanced critical geographic research and the introductory materials encountered by public audiences, ultimately limiting the reach of contemporary disciplinary debates. In the context of field education, this translates to site visits and excursions that frequently rely on traditional, descriptive frameworks rather than engaging students with dynamic spatial politics, power dynamics, and local inequalities. Bridging this divide requires reimagining field trips not merely as site-seeing exercises, but as active, pedagogical interventions where students can directly confront and apply critical geographic theories in real-world spaces. This disconnect is a well-recognized challenge in contemporary academia, often referred to as the "translation gap" between advanced academic theory and public geography (Devadoss and Merced, 2026). While university departments debate radical concepts like critical geopolitics, post-colonial spatialities, and emotional geographies, the public-facing materials such as high school textbooks, travel guides, and popular news maps frequently remain rooted in traditional, descriptive, and cartographically rigid frameworks. This gap limits the impact of the discipline because it causes the public to view geography merely as a static game of trivia (naming capitals and borders) rather than a dynamic tool for analysing power, inequality, and spatial justice.

This paper presents findings from a five-day geospatial field trip conducted by GIS students from Nasarawa State University, Keffi, to Makurdi, Benue State, Nigeria (26th–30th, August 2024). The field trip simultaneously served as an authentic learning environment, reinforcing the pedagogical value of structured fieldwork in postgraduate GIS curricula.

The paper further addresses two linked gaps. First, it demonstrates and documents a low-cost, replicable protocol for geotagged field-data capture and web-GIS publication, using a postgraduate academic field trip as the empirical setting. Second, it uses the same field programme to produce an empirical, site-based account of BENGIS's digital Certificate-of-Occupancy (C of O) workflow and of hydrological monitoring practice at the Benue State Urban Development Board (BUDB). The specific objectives are to; capture and structure a geotagged spatial dataset of an inter-state academic field route spanning nine local government areas (LGAs); develop and publish an openly accessible, layer-controlled interactive web map from this dataset; and document the resulting GIS-based datasets observed at BENGIS and BUDB.

2.0 Study Area and Dataset

2.1. Study Area

Makurdi, the Benue state capital, lies at approximately latitude 7°44'34"N, longitude 8°31'18"E along the Benue River and experiences a tropical monsoon climate with a distinct rainy season (Ohiaeri, 2020). Field activities within Makurdi were concentrated at three institutional sites: BENGIS and BUDB, both located near the historic Anguwan Jukun riverside settlement in the northwestern part of the town, and Oracle Business Limited (OBL), an agro-industrial complex approximately 6 km to the southwest (Figure 1). Recorded altitudes ranged from 64 m to 431 m above sea level, reflecting the transition from the low-lying Benue floodplain around Makurdi to higher terrain traversed near the Nasarawa Eggon hills and the Akwanga uplands earlier in the route. The field trip traversed approximately 225 km along the A234 highway from Keffi (Nasarawa state) to Makurdi (Benue state). The route crosses nine local government areas (LGAs), seven in Nasarawa state (Keffi, Kokona, Akwanga, Nasarawa Eggon, Lafia, Obi, Keana) and two in Benue State (Guma, Makurdi) (Table 1). It also encompasses 32 electoral wards (26 in Nasarawa, 6 in Benue). Average travel time under normal conditions is approximately three hours; the trip party departed Keffi at 13:00 on 26 August 2024 and arrived in Makurdi at approximately 18:30 the same day.

Table 1. Local government areas and electoral wards traversed by the field trip route.

State	LGA	Ward(s)
Nasarawa	Keffi	Jigwada
Nasarawa	Kokona	Garaku, Kokona, Hadari, Dari
Nasarawa	Akwanga	Gwanje, Gudi, Akwanga East, Akwanga West
Nasarawa	Nasarawa Eggon	Alogani, Ende, Nassarawa-Eggon, Ubbe-Ogba
Nasarawa	Lafia	Agyaragu Tofa, Wakwa, Akurba, Gayam, Ciroma, Shabu Kwandare
Nasarawa	Obi	Gidan-Ausa I, Gidan-Ausa II, Kyakale, Gwadenye
Nasarawa	Keana	Galadima, Kadarko, Madaki
Benue	Guma	Nyiev, Mbawa
Benue	Makurdi	North Bank I, North Bank II, Wailomayo, Fiidi

2.2. Dataset

The datasets utilized in this study were collected through the field trip route and the specific institutional case study sites visited. In total, 102 geotagged waypoints were logged across the five days field trip. A representative sample of ten records is given in Table 2, the complete 102-point dataset underlies the interactive web map described in section 3.3 and is available as supplementary material.

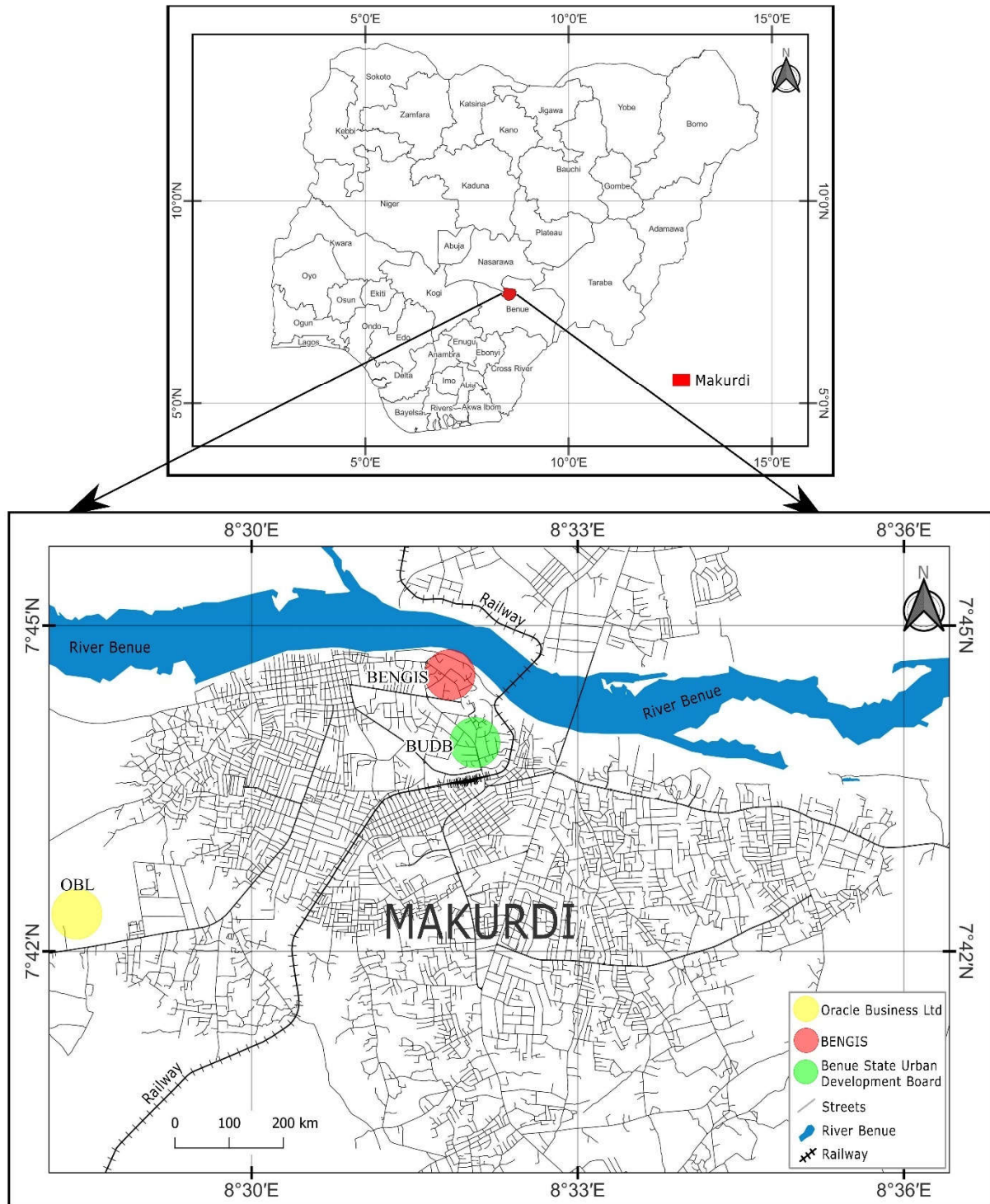


Figure 1. Location of Makurdi within Benue State and Nigeria, showing the Benue River and the town's street network (Source: Author's cartographic output).

Table 2: Extract of Geographical features encountered along the field trip route (Source: Author's fieldwork).

S/N	Latitude	Longitude	Altitude	Lat (DMS)	Long (DMS)	Lat (DD)	Long (DD)	Image
1	(8.0, 50.0, 6.28368)	(8.0, 27.0, 9.92916)	431	8.0° 50.0' 6.28368"	8.0° 27.0' 9.92916"	8.835	8.4525	30-08-2024_05-00-34_7579\26-08-2024_03-27-07_9894.jpg
2	(8.0, 44.0, 21.35544)	(8.0, 32.0, 24.66168)	277	8.0° 44.0' 21.35544"	8.0° 32.0' 24.66168"	8.739166667	8.54	30-08-2024_05-00-34_7579\26-08-2024_03-42-23_9417.jpg
3	(8.0, 42.0, 54.82368)	(8.0, 32.0, 28.41576)	269	8.0° 42.0' 54.82368"	8.0° 32.0' 28.41576"	8.715	8.541111111	30-08-2024_05-00-34_7579\26-08-2024_03-45-00_8984.jpg
4	(8.0, 42.0, 29.99952)	(8.0, 32.0, 21.79284)	263	8.0° 42.0' 29.99952"	8.0° 32.0' 21.79284"	8.708055556	8.539166667	30-08-2024_05-00-34_7579\26-08-2024_03-46-21_6849.jpg
5	(8.0, 34.0, 21.4734)	(8.0, 33.0, 23.34384)	159	8.0° 34.0' 21.4734"	8.0° 33.0' 23.34384"	8.5725	8.556388889	30-08-2024_05-00-34_7579\26-08-2024_03-57-38_2362.jpg
6	(8.0, 34.0, 12.33444)	(8.0, 33.0, 10.48644)	148	8.0° 34.0' 12.33444"	8.0° 33.0' 10.48644"	8.57	8.552777778	30-08-2024_05-00-34_7579\26-08-2024_03-58-05_8370.jpg
7	(8.0, 13.0, 56.4924)	(8.0, 34.0, 22.3554)	179	8.0° 13.0' 56.4924"	8.0° 34.0' 22.3554"	8.232222222	8.572777778	30-08-2024_05-00-34_7579\26-08-2024_04-44-09_6061.jpg
8	(7.0, 48.0, 40.38696)	(8.0, 34.0, 11.76636)	157	7.0° 48.0' 40.38696"	8.0° 34.0' 11.76636"	7.811111111	8.569722222	30-08-2024_05-00-34_7579\26-08-2024_05-23-01_9810.jpg
9	(7.0, 44.0, 26.3364)	(8.0, 33.0, 2.8332)	64	7.0° 44.0' 26.3364"	8.0° 33.0' 2.8332"	7.740555556	8.550555556	30-08-2024_05-00-34_7579\26-08-2024_05-31-40_8692.jpg
10	(7.0, 43.0, 37.73028)	(8.0, 32.0, 40.40916)	78	7.0° 43.0' 37.73028"	8.0° 32.0' 40.40916"	7.726944444	8.544444444	30-08-2024_05-00-34_7579\26-08-2024_05-43-07_1818.jpg
11	(7.0, 43.0, 38.35308)	(8.0, 32.0, 41.63208)	78	7.0° 43.0' 38.35308"	8.0° 32.0' 41.63208"	7.727222222	8.544722222	30-08-2024_05-00-34_7579\26-08-2024_05-43-41_3746.jpg
12	(7.0, 43.0, 22.25352)	(8.0, 31.0, 56.6778)	107	7.0° 43.0' 22.25352"	8.0° 31.0' 56.6778"	7.722777778	8.532222222	30-08-2024_05-00-34_7579\27-08-2024_08-45-15_7994.jpg
13	(7.0, 44.0, 42.14616)	(8.0, 31.0, 43.4982)	88	7.0° 44.0' 42.14616"	8.0° 31.0' 43.4982"	7.745	8.528611111	30-08-2024_05-00-34_7579\27-08-2024_09-37-54_9004.jpg

3.0 METHODOLOGY

3.1. Overview

The research adopted a multi-method field design combining mobile geospatial data collection, direct observation of institutional workflows, semi-structured interactions with agency staff, and photographic documentation. Primary instruments comprised consumer-grade smartphone GPS receivers, field notebooks, digital cameras, and personal protective equipment (safety boots and gloves). All coordinate data of conspicuous features encountered within the local government areas (LGAs) and electoral wards traversed (Table 1) were recorded in WGS 84 and subsequently converted to DMS format for archival purposes (Table 2).

3.2. Field Data Collection Instruments

Field observations were captured using a GPS-enabled android smartphone with a built-in GNSS receiver and its integrated camera. It was used for both waypoint logging and photographs geotagging. A handwritten field notebook along side a writing pen were used in taking extra notes of the captured features. Personal protective equipment (safety boots and hand gloves) was worn throughout site visits at the industrial facility. No dedicated survey-grade GNSS receiver was used, so positional accuracy therefore reflects consumer-grade smartphone GNSS signal performance that is typically between 3m to 10m under open sky, degrading near multi-storey structures or under building cover.

3.3. Field Data Collection Procedure

Over five consecutive field days, a location-logging function on the smartphone recorded a waypoint each time a notable geographic feature such as settlement, toll gate, or institutional site was encountered. Each waypoint embedded latitude, longitude, altitude (metres above sea level, as reported by the device), and a timestamp in the metadata of the associated photograph (Figure 2). Parallel handwritten notes were kept in the field notebook, recording place names, local clock time, and estimated distance to the next major settlement or to the final destination. These notes were used to cross-validate GPS-derived place names post-hoc.



Figure 2. Extract of Geo-tagged photographs of some activities and notable geographic features

3.4. Spatial Data Processing and Cartographic Production

The 102 waypoints data were processed in open-source GIS software namely QGIS version 3.42.2-Münster. Major roads were extracted from Open Street Maps (OSM), missing once are manually digitized using polylines. Publicly available administrative boundary layers for state, LGA and ward levels were compiled and overlaid in the QGIS environment to produce the static reference maps presented in this paper and in the accompanying field-trip report. The geographic coordinates of the institutional case studies visited during the fieldwork were digitized into a point vector layer using QGIS software (Figure 3).

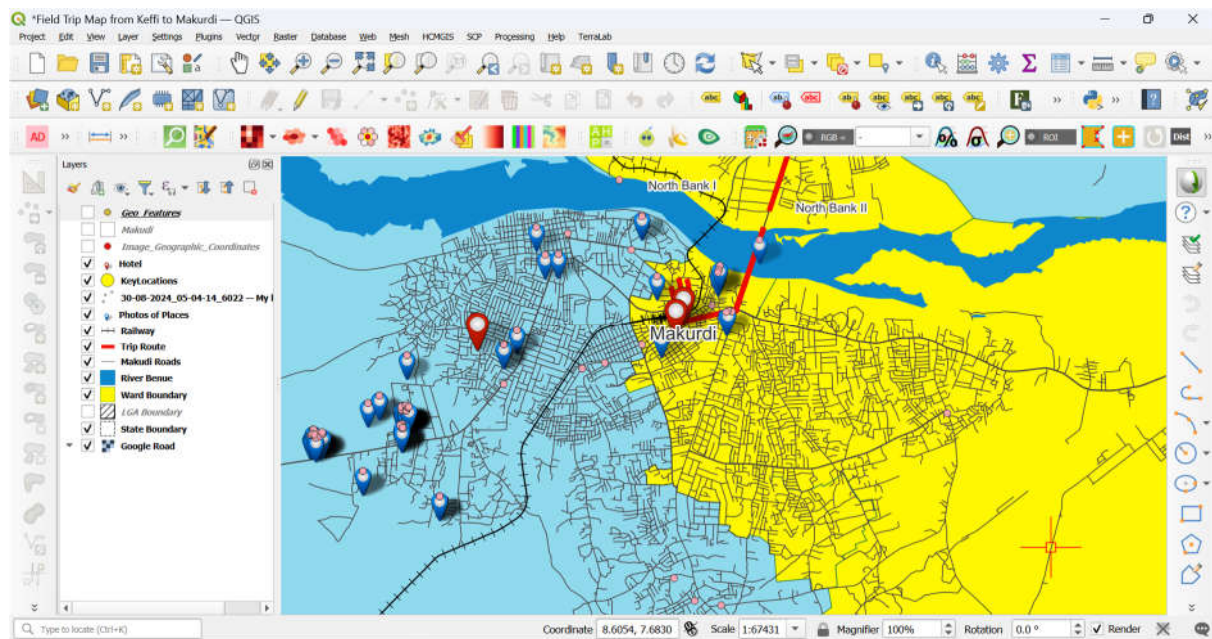


Figure 3: QGIS Software Interface Displaying the Various Map Layers for the Study (source: author's cartographic output)

3.5. Web-GIS Development

The plugin qgis2web was utilized to translate the desktop QGIS project into a standalone web application package. The configuration process involves setting specific parameters within the plugin interface. Each layer is configured to determine whether it is visible by default or toggleable by the end-user. Interactive pop-ups are enabled for the 102 waypoints and clicking on each displays the associated attribute including the geotagged photograph of the point.

A control panel is included to allow users to toggle layers on and off. An attribute search bar is enabled, mapping to a specific unique identifier field in the primary data layer. Basic navigation tools are deployed, including zoom buttons, a scale bar, a measure tool (for distances/areas), and a locate button to track user geolocation. The template is configured to match the current QGIS canvas extent, with maximum and minimum zoom levels restricted to prevent users from navigating outside the study area boundaries. Once the parameters are finalized, the project was exported into a local directory containing structured HTML, CSS, JavaScript, and data folders.

3.6. Institutional Case-Study Protocol

At BENGIS and BUDB, the field team undertook a structured facility tour led by a designated staff resource person, combined with direct observation of GIS workstations, the document-management system, and the organizational chart, together with informal question-and-answer exchanges with department heads including the Surveyor-General, the Director of Planning, and the GIS Project Manager. Observations were recorded contemporaneously in the field notebook and cross-checked against photographs of screens, signage and organograms taken on site (Figure 4 & 5). No individually identifying data on private landholders or members of the public were collected. OBL facility tour was led by an industrial staff engulfing the oracle farm, oracle plastic, and oracle feed mill (Figure 6 - 8).

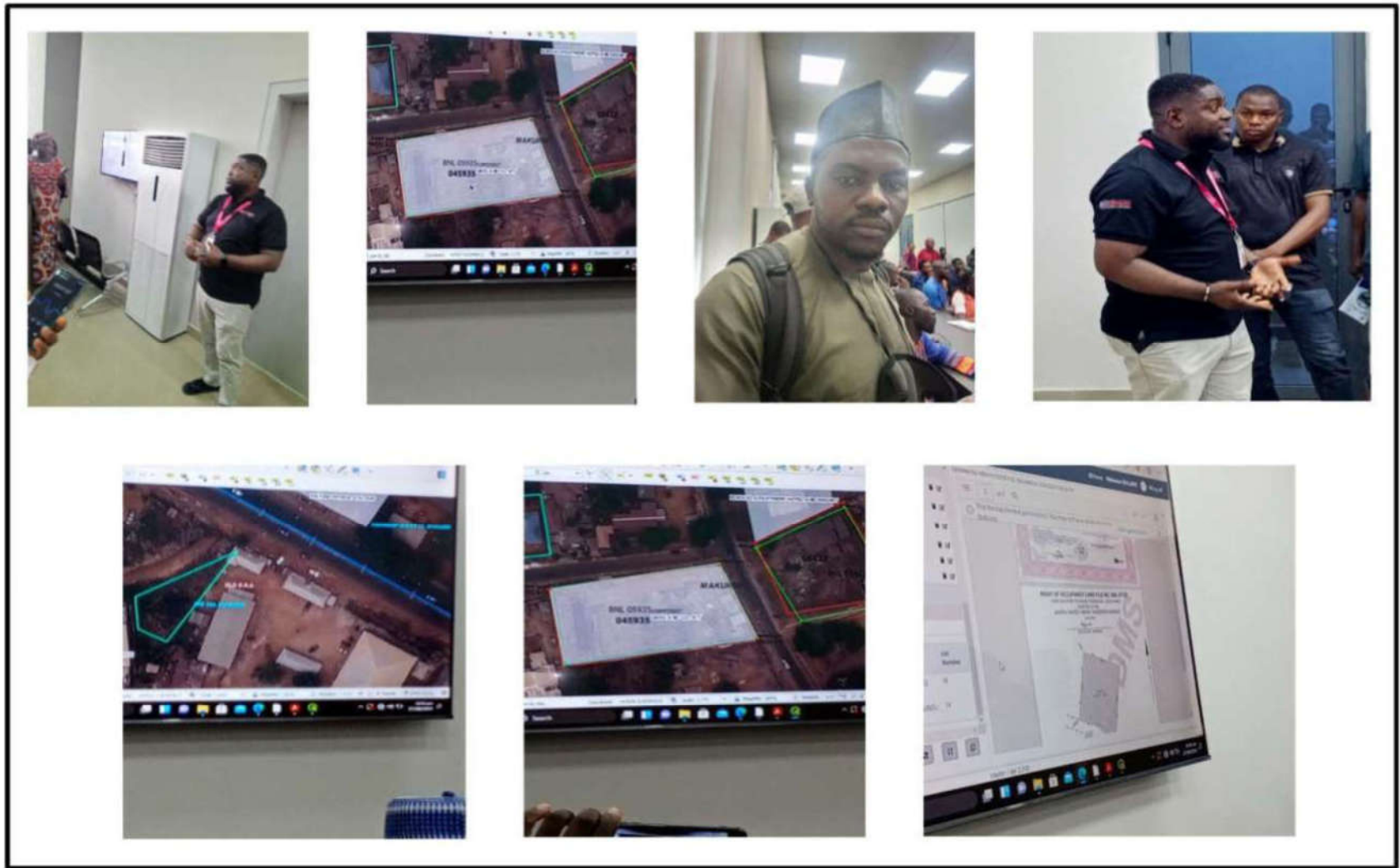


Figure 4. Pictures of some activities a BENGIS

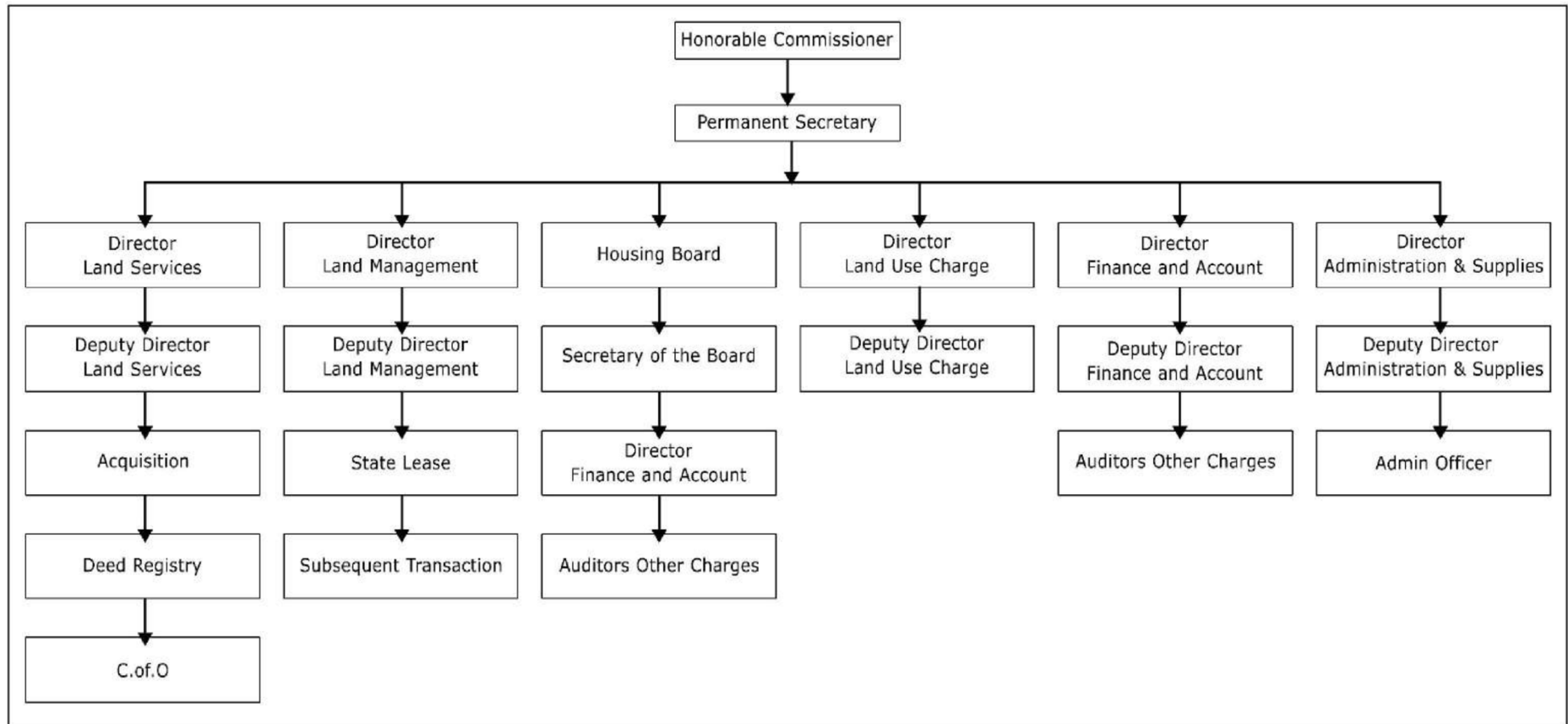


Figure 5. Organizational structure of the Benue State Ministry of Lands, Survey and Solid Minerals, showing the reporting lines through which BENGIS's GIS-based Certificate-of-Occupancy workflow is administered.

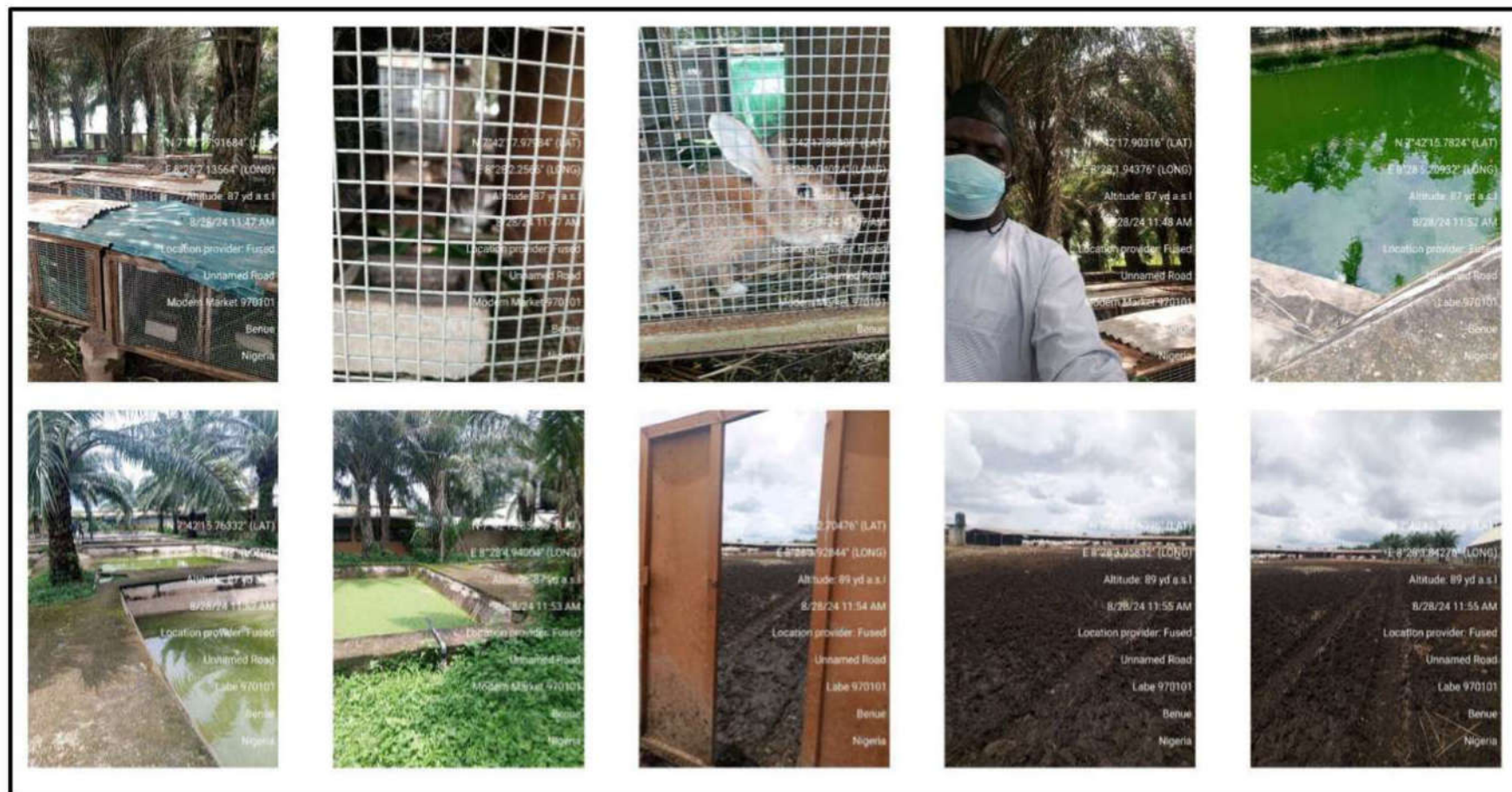


Figure 6. Pictures of Rabbit Hutches, Fish Pond and Cattle Paddock at Oracle Farm

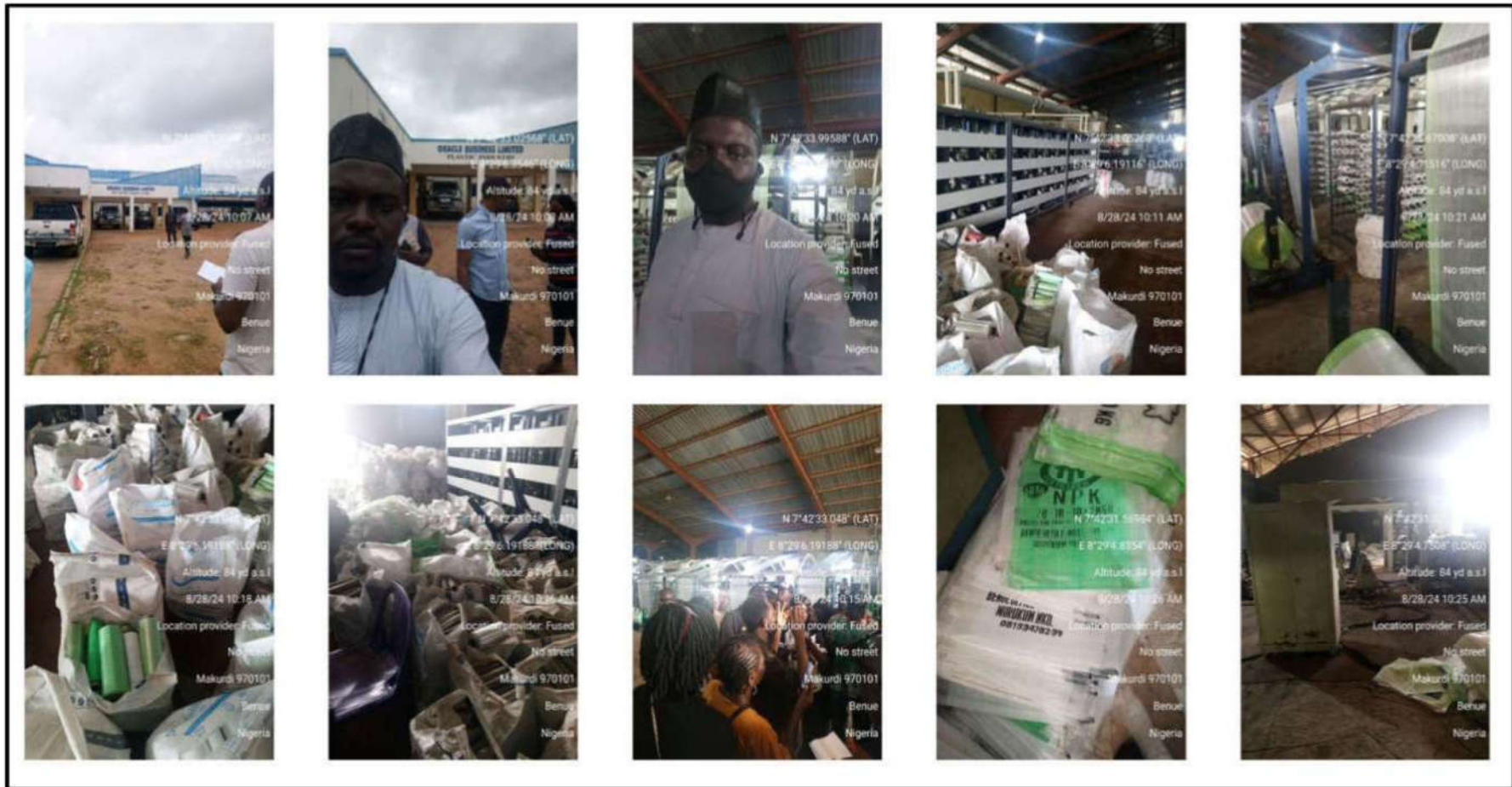


Figure 7. Pictures of some production activities at Oracle Plastic

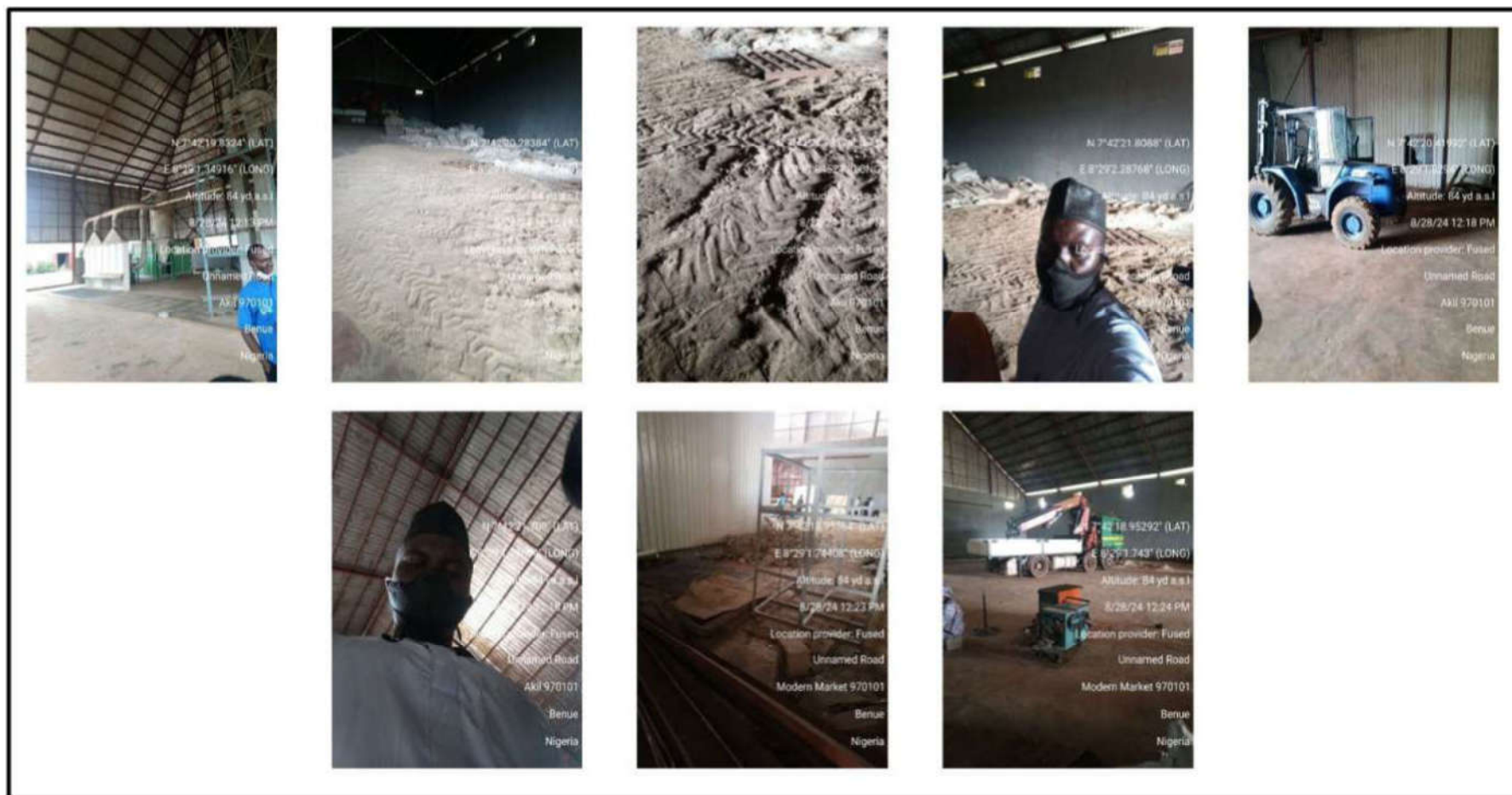


Figure 8. Pictures of some activities at Oracle Feed Mill

4.0 RESULTS

4.1. Static Cartographic Reference Maps

Map showing visited institutional case-studied locations (Figure 9) is one of the static cartographic maps produced to document the collected datasets in the study. Another static map is the one showing important sites along the route (Figure 10) was produced and documented in the study. The nine LGAs and thirty-two wards traversed by the field trip route are also mapped and documented (Figure 11 & 12).

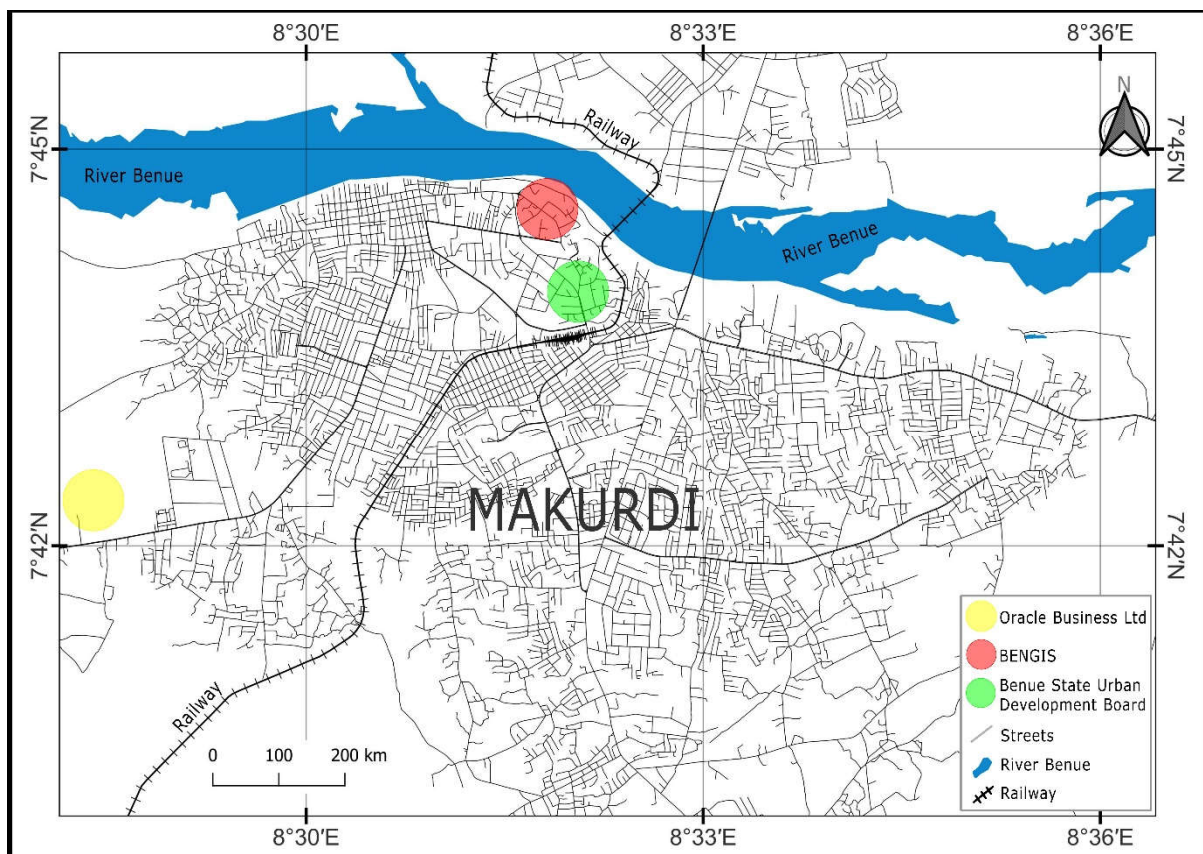


Figure 9: Map Showing Visited Institutional Case-Study. BENGIS in red circle, BUDB in green circle and OBL in yellow circle.

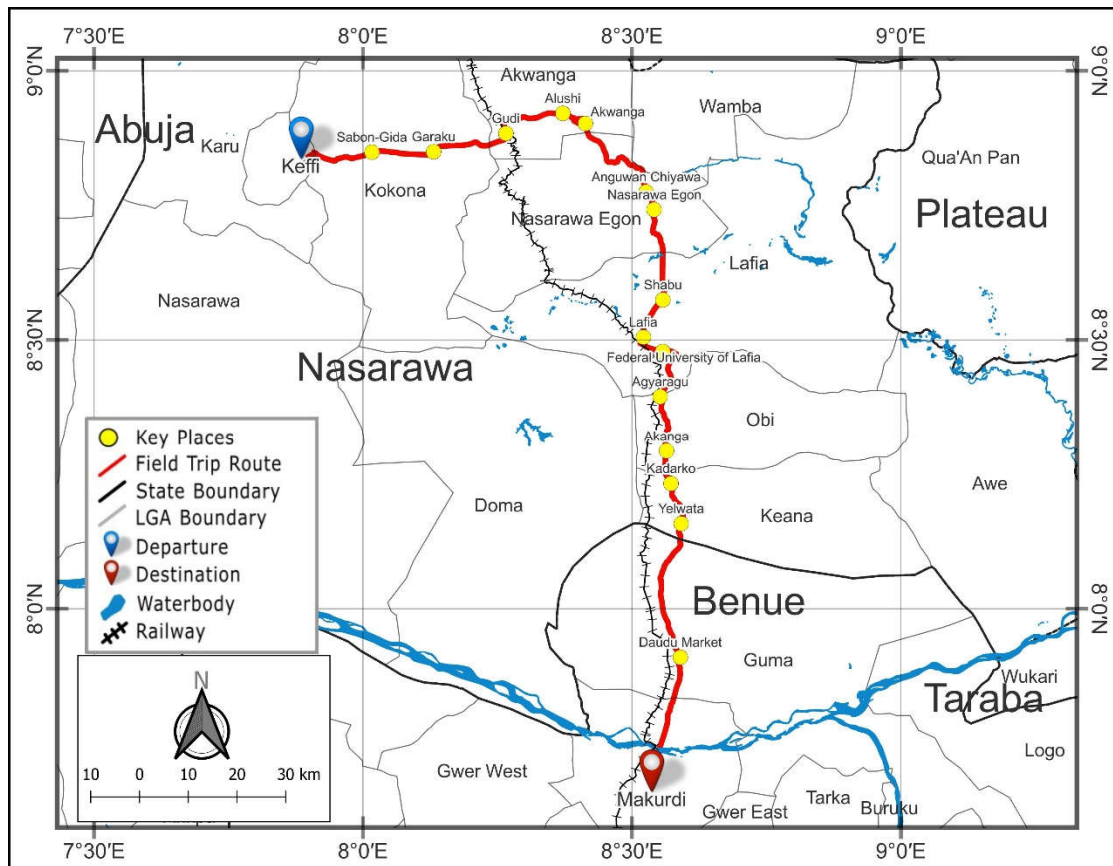


Figure 10: Map of the field trip route from Keffi to Makurdi (source: author's cartographic output).

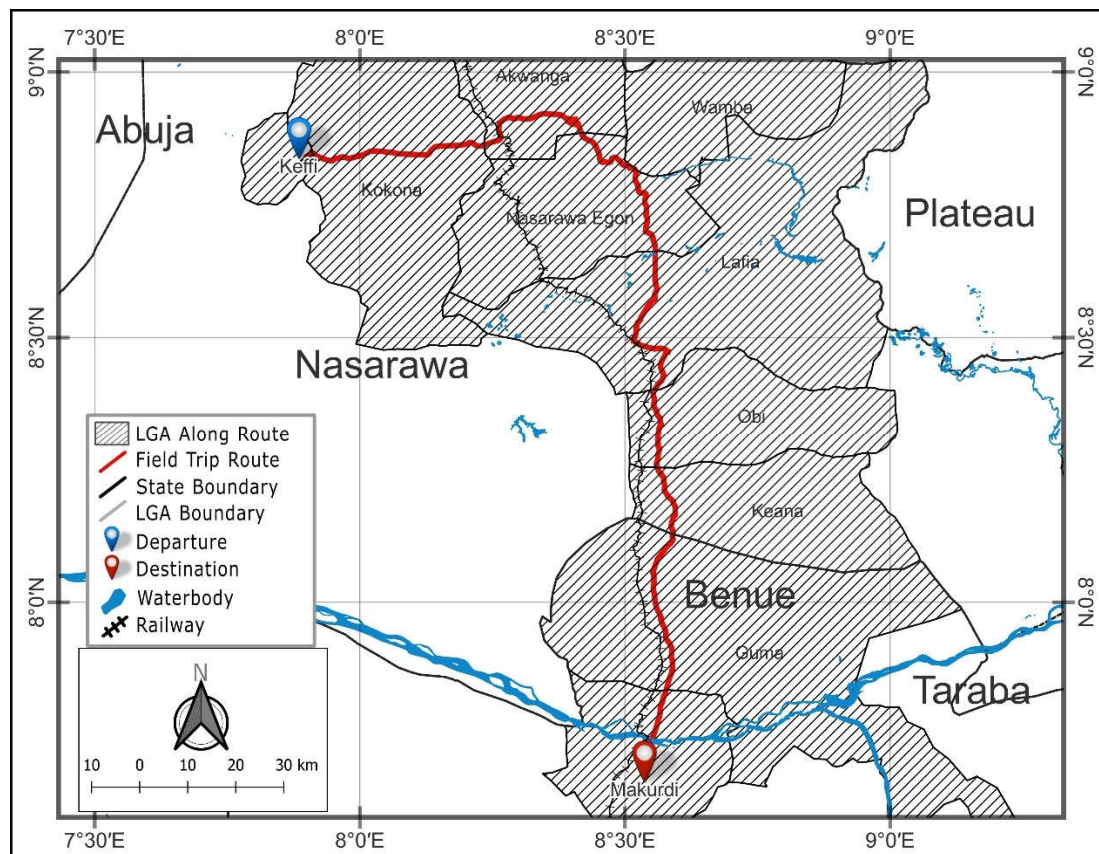


Figure 11: Map of the LGAs traversed by the field trip route (source: author's cartographic output).

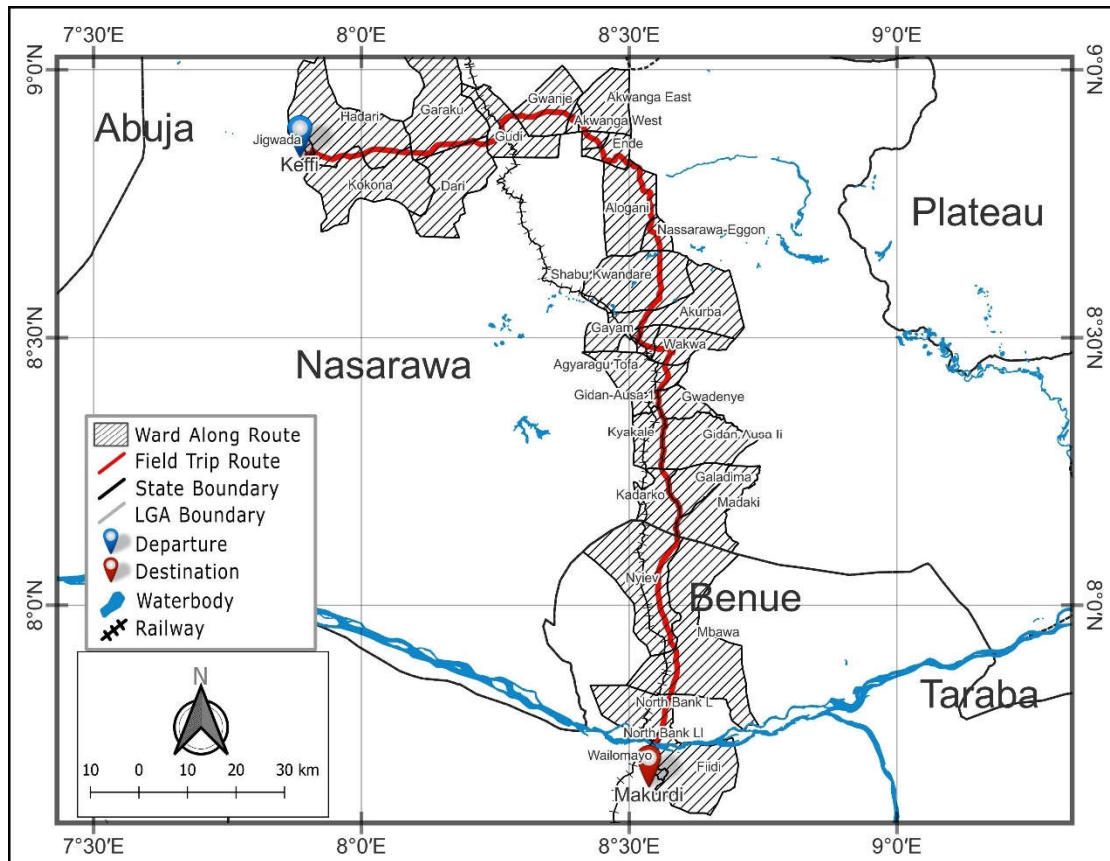


Figure 12: Map of the wards traversed by the field trip route (source: author's cartographic output).

4.2. The Web map Interface

The compiled spatial layers were published as a freely accessible, interactive web map (<https://umaryusuf.com/nsuk/fieldtripmap>, accessed on 6 September 2026), allowing hotel locations, geotagged photograph markers, the trip route, Makurdi's road and railway networks, the Benue River, and ward, LGA and state administrative boundaries to be toggled independently through a layer-control panel (Figure 9). Clicking a photograph marker displays the corresponding geotagged image together with its coordinates and capture time.

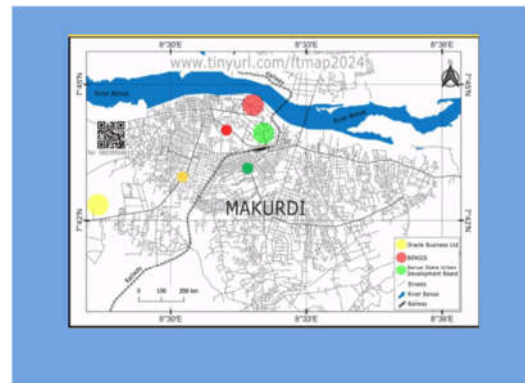
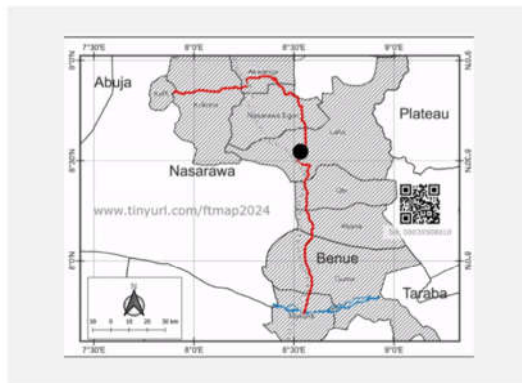
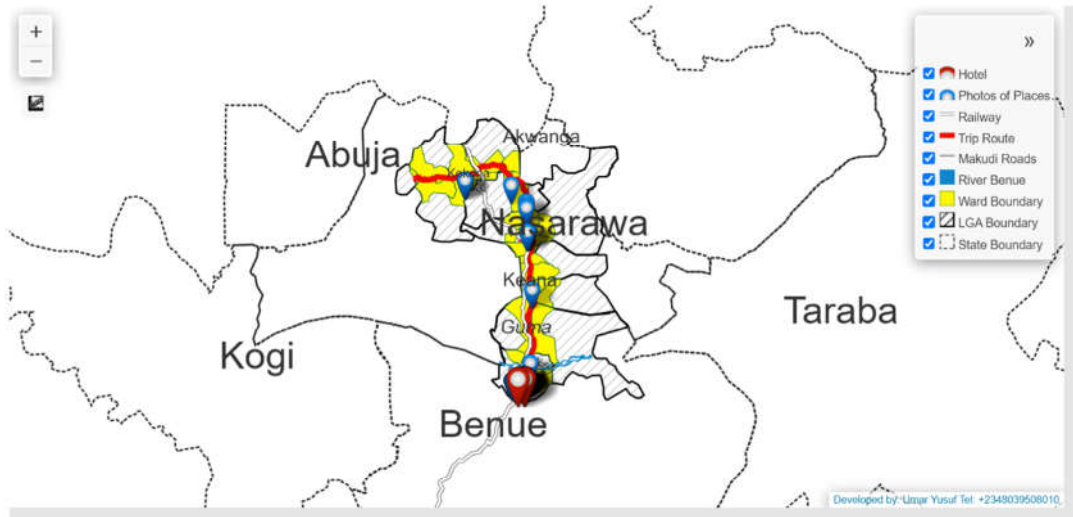
The web map interface allows nine layers including "hotel markers, photograph markers, railway, trip route, Makurdi's road network, the Benue River, and ward, LGA and state boundaries" that can be shown or hidden independently. This allows maximum interactivity between the spatial layers. Two linked thumbnail maps beneath the main map viewer connect to sub-pages for the animation along the departure route and for the daily movement from hotel accommodation to BENGIS, BUDB and OBL site clusters. This provided a single, citable entry point to all geospatial products generated during the field trip.

Field Trip Map from Keffi to Makurdi

Monday, August 26, 2024 to Friday, August 30, 2024

Report (PDF) | Poster | Departure | BENGIS | BUDB* | Oracle Business Ltd.

*Benue state Urban Development Board



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Umar Yusuf Tel: +2348039508010.

Figure 9. Main viewer of the published interactive web map, showing the layer-control panel and the digitized trip route across Nasarawa and Benue States (source: Umar, 2024).

4.3. BENGIS: A GIS-Based Workflow for Digital Land Titling

BENGIS, resides within the Ministry of Lands, Survey and Solid Minerals, follows a five-stage sequential workflow for processing a Certificate of Occupancy (C of O) application: (i) submission at the Application Submission Unit; (ii) registration at the File Tracking Management Office; (iii) boundary and ownership verification at the Surveyor-General's Office; (iv) compliance assessment against urban-planning regulations at the Planning Office; and (v) spatial capture and digitization at the GIS Unit, which finalizes the digital C of O. QGIS

was reported as the primary desktop GIS software in use, and a document-management platform (MerlinWeb Search) supports file tracking. The agency's reporting structure (Figure 5) places six directorates namely 'Land Services, Land Management, the Housing Board, Land Use Charge, Finance and Accounts, and Administration and Supplies' under a permanent secretary answerable to the honourable commissioner, with the C of O issued only at the terminal node of the Land Services branch (Acquisition → Deed Registry → C of O). This staged, GIS-anchored workflow parallels the desktop-GIS-based land information systems reported for Akure, Ondo State (Babalola and Uyi, 2019), and Enugu State (Azie et al., 2022), both of which similarly combine parcel digitization with a document/records-management layer.

4.4. BUDB: Urban Planning and Hydrological Monitoring

BUDB, established under the Urban Development Board Edict No. 8 of 1986, is responsible for building- and land-development permit approval, and reports through the same directorate structure shown in Figure 5. Field observation at the historic Anguwan Jukun riverside settlement identified a river-gauge station used informally by BUDB and the local community as a low-technology complement to formal planning activity: recorded gauge readings placed the Benue River's historical maximum stage at 74.97 m in 2012, with a second peak of 73.65 m in 2015, values used as an informal early-warning reference for flood-prone riverside development.

4.5. OBL: Industrial–Agricultural Integration

The third major site visit focused on Oracle Business Limited (OBL), a diversified enterprise comprising plastic manufacturing, agricultural production, a feed mill, a printing press, shea-butter processing, and ancillary services. Three operational units were examined in detail are:- (i) Oracle Plastic, production is organised into four specialised departments as follow; sack production, polyvinyl chloride (PVC) processing, extrusion, and injection moulding. Products range from packaging sacks and household items (chairs, spoons, toys) to plumbing pipes. The spatial organisation of the plant reflects a conventional linear production flow from raw-material intake through forming and finishing. (ii) Oracle Farm, the agricultural complex includes rice fields, poultry houses, a piggery, cattle paddocks, rabbit hutches, and fish ponds. The co-location of these units within a single peri-urban site facilitates material and labour synergies. (iii) Oracle Feed Mill, approximately 90% of the raw materials used in feed production are reported to originate from on-site farm by-products (notably rice husk for fish feed). This closed-loop arrangement constitutes a practical example of circular-economy principles applied at the scale of a single private enterprise.

5.0 DISCUSSION

The methodological contribution of this study is a simple, low-cost pipeline utilizing a GPS-enabled smartphone, a field notebook, QGIS, and a free web-mapping platform that converts routine academic fieldwork into a citable, reusable spatial dataset. This extends the established practice of geotagging individual field photographs into a fuller field-trip web-GIS that additionally overlays administrative boundaries and supports independent layer control, at negligible marginal cost to a teaching department.

Several limitations qualify these findings. First, the field itinerary was shortened by insecurity and logistical constraints, and two planned industrial sites (a rice mill and a cement factory in Gboko, Benue State) were not visited, limiting the range of institutions assessed. Second, intermittent telecommunications coverage produced occasional GPS gaps in the field record, as noted directly in the field notebook. Third, institutional data collection relied on a single field team and a single facility visit per agency, which limits generalizability and precludes formal inter-rater validation of the reported workflow. Fourth, consumer-grade smartphone GPS and barometric-altitude readings are less accurate than survey-grade GNSS, which should be considered when the published dataset is reused for applications requiring sub-metre precision.

These limitations point to concrete recommendations. For field-course pedagogy, a more flexible itinerary with pre-assessed telecommunications coverage along planned stopovers, clearer coordination with transport operators regarding stopping points, and, where practicable, a local-language-fluent guide to reduce toponym transcription error, would improve the completeness and consistency of student-generated geospatial data. For land-administration practice, BENGIS and comparable state agencies could increase transparency and public accessibility by extending their existing desktop-GIS capability with a public-facing web query layer similar to the Akure Ondo state model.

6.0 CONCLUSION AND RECOMMENDATIONS

This study demonstrates that a low-cost combination of smartphone GPS logging, a field notebook, open-source GIS, and free web-mapping software can convert an academic field trip into a structured, citable, and publicly accessible geospatial product. This study has documented the operational realities of GIS educational field trip through the lens of a structured postgraduate field expedition. BENGIS illustrates both the achievements and the residual challenges of digital transformation in Nigerian state land agencies. Makurdi's dual urban form and the circular practices observed at BUDB and OBL enrich understanding of the city's contemporary socio-spatial and economic geography. Simultaneously, the expedition itself functioned as an effective pedagogical instrument for GIS training.

The study therefore makes the follow recommendations for future field expeditions: (a) build greater itinerary flexibility to accommodate security and logistical contingencies; (b) conduct pre-trip assessments of telecommunication coverage along planned corridors; (c) brief transport providers on the scientific necessity of controlled stopovers; and (d) provide basic

cultural and linguistic orientation to minimise transcription errors. For land-administration policy, sustained investment in end-to-end digital workflows, staff capacity, and inter-agency data sharing will be essential if agencies such as BENGIS are to meet their stated service standards. Finally, Nigerian universities offering postgraduate GIS programmes should institutionalise structured partnerships with state GIS agencies and selected industrial enterprises, thereby converting episodic field trips into durable research and training platforms.

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