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The strategy for incorporating Geographic Information System (GIS) into the mapping of the campus and planning of infrastructure at Nigerian Army College Environmental Science and Technology (NACEST) Makurdi, Benue State.

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ABSTRACT

The strategy for incorporating a Geographic Information System (GIS) into the mapping of the campus and planning of infrastructure at Nigerian Army College Environmental Science and Technology (NACEST) Makurdi, Benue State aims to advance spatial data technologies to enhance overall campus management and planning of infrastructure development, by integrating GIS, a powerful tool for capturing, analyzing, and visualizing spatial data into information. Nigerian Army College Environmental Science and Technology (NACEST) Makurdi, Benue State, can achieve improved decision-making processes, streamline resource allocation, and foster sustainable campus growth. The strategy for incorporating Geographic Information System (GIS) into the mapping of the campus and planning of infrastructure at Nigerian Army College Environmental Science and Technology (NACEST) Makurdi, Benue State, also aims to revolutionize spatial data management for enhanced decision-making and sustainable development. The polytechnic seeks to create a comprehensive and dynamic geospatial database, enabling precise mapping, efficient infrastructure planning, and data-driven insights. This strategic initiative focuses on optimizing campus layout, promoting safety through emergency preparedness, fostering collaboration among stakeholders, and integrating GIS seamlessly with existing technologies

Keywords: Strategy infrastructure, GPS, Geographical information system, database, mapping, campus, planning.

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1. INTRODUCTION

The decision to explore and implement a Geographic Information System (GIS) in the mapping of the campus and planning of infrastructure at Nigerian Army College Environmental Science and Technology (NACEST) Makurdi, Benue State, is driven by the recognition of the transformative power of spatial data technologies in contemporary campus management and infrastructure development. As campus infrastructure continues to evolve and expand, the need for a system to manage and plan these changes becomes crucial. GIS provides a comprehensive and efficient solution by integrating various layers of spatial data, enabling a holistic view of the campus layout, infrastructure, and resources. According to Actur and Zeiler (2004) a GIS design is built around a set of thematic layers of information that will deal with a set of requirements. The era of data-driven decision-making has become paramount in academic institutions. GIS, with its ability to analyze and visualize spatial data, empowers decision-makers at NACEST to make informed choices regarding infrastructure development, resource allocation, and emergency preparedness. This aligns with the broader trend in academia to base decisions on empirical evidence. The incorporation of GIS is motivated by a commitment to enhancing campus safety. GIS enables the mapping of emergency routes, identification of critical response resources, and the analysis of potential risks. This strategic approach aligns with the growing importance of ensuring the well-being of students, faculty, and staff.

The background to this study acknowledges the potential for NACEST to leverage these technological advancements to streamline processes, improve accuracy in mapping, and extract valuable insights from spatial data. Geographical data can range from a set of single Geo-referenced features or point observations to more complex collections of data in database structures (Goodchild et al., 2007). According to Zlatanova et al. (2002), GIS can play a pivotal role in assessing and enhancing eco-friendly practices on campus. The background to this study recognizes GIS as a tool to analyze energy consumption, plan green spaces, and support initiatives aimed at minimizing the polytechnic's environmental impact. The need for collaboration among different departments within the polytechnic is another driving force. GIS provides a common platform for various stakeholders to access and utilize spatial data, fostering interdisciplinary collaboration in areas such as urban planning, architecture, environmental science, and emergency management. The integration of GIS aligns with the global trends in higher education where institutions are increasingly adopting innovative technologies to improve efficiency, sustainability, and overall campus management and infrastructure management**.**

To clearly define the challenges and objectives, the following statement of problems is presented: The existing mapping infrastructure of NACEST Makurdi may be outdated or insufficient, leading to inaccuracies in spatial representation and hindering effective planning. There may be challenges in integrating spatial data sources relevant to campus planning, such as building layouts, utility networks, and environmental considerations, into a cohesive GIS platform. Insufficient expertise and knowledge among the staff and stakeholders regarding GIS technology may impede the successful implementation and utilization of GIS for campus mapping and planning. Challenges may exist in establishing a sustainable system for the maintenance and regular updates of the GIS infrastructure to ensure its relevance and effectiveness over time. Compatibility issues may emerge when integrating GIS technology with existing campus systems, such as administrative databases or academic management platforms.

The use of GIS involves the handling of spatial data, which may raise concerns related to security, privacy, and ethical considerations that need to be addressed during the planning and implementation phases.

This study aims to develop and implement a strategic framework for incorporating a Geographic Information System (GIS) into the mapping of the campus and planning of infrastructure at Nigerian Army College Environmental Science and Technology (NACEST) Makurdi, Benue State. The study seeks to achieve the following objectives:

Develop an integrated GIS platform that consolidates diverse spatial data sources to create a comprehensive database. Utilize GIS tools to analyze existing campus infrastructure, identify areas for improvement, and develop a strategic plan for the optimization of infrastructure layout. Implement GIS-based spatial analysis techniques to provide actionable insights for data-driven decision-making. Integrate GIS into the polytechnic's emergency management system to enhance preparedness and response capabilities. Foster collaboration among different departments and stakeholders by implementing GIS as a shared platform. Ensure seamless integration of GIS with existing campus technologies, databases, and software applications. Establish a framework for ongoing monitoring and evaluation of GIS implementation, aiming to continuously improve the effectiveness of the system.

The research titled "The strategy for incorporating Geographic Information System (GIS) into the mapping of the campus and planning of infrastructure at Nigerian Army College Environmental Science and Technology (NACEST) Makurdi, Benue State."The incorporation of Geographic Information System (GIS) into the mapping of the campus and planning of infrastructure at NACEST holds significant importance in elevating the overall efficiency of campus planning and management. The study is significant in its potential to enhance operational efficiency by streamlining data management and providing tools for spatial analysis. The incorporation of GIS contributes significantly to campus safety and emergency preparedness. By mapping emergency routes, identifying potential hazards, and facilitating efficient emergency response planning, the study's significance extends to technological advancement and innovation within the polytechnic setting. Embracing GIS positions NACEST at the forefront of modern campus management practices. The integration of cutting-edge technology not only enhances the polytechnic's reputation but also fosters a culture of innovation that can positively impact various academic and administrative processes.

The scope of the topic is "**The strategy for incorporating Geographic Information System (GIS) into the mapping of the campus and planning of infrastructure at Nigerian Army College Environmental Science and Technology (NACEST) Makurdi, Benue State.**" The spatial extent of the research will cover Nigerian Army College Environmental Science and Technology (NACEST) Makurdi, Benue State.

Study area is located in North bank Makurdi Benue State along Yogbo road opposite NASME barracks Latitude 7.762◦ N and Long 8.540◦ E.



Fig 1 Map Showing the Study Area

2. LITERATURE REVIEW

INTRODUCTION

This chapter delves into key GIS concepts pertinent to this research, providing a theoretical framework for the data model used to distribute and map secondary education infrastructure in the Makurdi local government area of Benue state. It also outlines the essential steps for designing a data model for digitally representing geographic information within a geodatabase for analytical operations.

According to Goodchild (2000), a Geographical Information System (GIS) is a computing application that enables the creation, storage, manipulation, visualization, and analysis of geographic information. GIS is particularly beneficial in resource management, utilities management, telecommunications, urban and regional planning, vehicle routing, parcel delivery, and various earth sciences. A GIS framework organizes and displays spatial data and related information, facilitating analysis. Thus, GIS not only maintains a central database but also supports organizing, exploring, analyzing, editing, and viewing geographical data. This data ranges from single geo-referenced features or point observations to complex data collections in database structures (Goodchild et al., 2007). Zlatanova et al. (2002) identify five common GIS tasks: data capture, data structuring, data manipulation, data analysis, and data presentation.

GIS allows users to view, understand, and query data in multiple ways, revealing relationships and patterns through maps, reports, or charts. Clients can use GIS to intuitively

examine existing data, aiding in problem-solving. GIS comprises three main components: the database, the map, and the model. GIS maps are intelligent illustrations depicting Earth's relationships. Data in GIS can be represented in raster or vector formats. Raster formats consist of digital images represented as pixel arrays, with resolution defined by pixel size in physical units (Dumitrescu & Smeureanu, 2010). Vector formats depict geographical features as geometric forms, classified by dimension (Zeiller, 1999):

- **Points**: Zero-dimensional shapes stored as single x,y coordinates with attributes, representing small geographic features.
- **Lines**: One-dimensional shapes stored as ordered x,y coordinates with attributes, representing narrow geographic features like roads or rivers.
- **Polygons**: Two-dimensional shapes stored as enclosed segments, representing broad geographic features.
- **Annotations**: Descriptive labels associated with features to display names and attributes.

This research will utilize both raster and vector data. Raster data, primarily satellite images of the study area, will serve as the base layer for schools, buildings, roads, and important places, aligning existing CAD data. Vector data will be derived from satellite images and CAD data through digitizing in Arc GIS 10, showing the locations of various secondary schools in aerial photographs.

Coordinate Systems

Geographic Coordinate Systems (GCS): According to Kennedy and Kopp (2000), a GCS uses a three-dimensional spherical surface to define locations on Earth, with angles measured from reference lines (Greenwich and Equator) to the center of mass to the surface point.

Projected Coordinate Systems: These systems are developed for flat, two-dimensional surfaces, maintaining even lengths, angles, and areas. Locations are identified by x,y coordinates on a grid, with each location having horizontal and vertical values (x-coordinate and y-coordinate).

CAD and GIS Integration

One significant challenge in managing GIS data is the bidirectional conversion between CAD drawings and the GIS environment, especially in urban infrastructure projects like roads, railways, bridges, and tunnels (Tzvika, 2009). CAD software is used for engineering and construction, while GIS software handles layout, planning, and analysis. Large projects often require integrating CAD and GIS for accurate feature positioning.

Geodatabase Design

Representation: Geographic representations are crucial in database design, with features represented as points, lines, or polygons, and other features depicted through continuous surfaces or imagery using raster or TINs. Text labels and symbols can also be applied to features (Actur and Zeiler, 2004).

Thematic Layers: A core GIS concept, thematic layers are collections of common geographic elements, such as road networks, parcel boundaries, soil types, elevation surfaces, satellite imagery, or wells (Actur and Zeiler, 2004).

GIS Datasets: These are collections of point, line, and polygon representations, which can be single or multiple datasets. Single datasets represent homogeneous features, while multiple datasets can represent complex networks like transportation systems. Gridded datasets represent continuous surfaces, organized as feature classes and raster-based data layers in a GIS database (Actur and Zeiler, 2004).

GIS Design Steps: According to Actur and Zeiler (2004), GIS design involves thematic layers to meet specific requirements. Initial conceptual design steps help identify each thematic layer. The logical design phase develops representation specifications, relationships, networks, subtypes, domains, and geodatabase elements. The physical design stage involves testing and refining the database. The final step is documenting the design. Buliung & Kanaroglou (2004) conducted an experiment on designing and implementing an object-relational database for complex urban activity and travel behavior.

3. METHODOLOGY

Creating a campus map for NACEST involves collecting spatial data, designing the map, and potentially implementing it for easy accessibility.

3.1 Data Collection:

Gather Existing Data: Spatial Data Campus maps, satellite imagery, and existing infrastructure, perimeter survey of NACEST

3.2 Field Surveys: Enrollment data, and conduct on-site surveys to gather accurate data on building locations, and other campus features.

DGPS receiver devices was use to carryout perimeter survey of the (NACEST)

Table 1 Downloaded coordinates of Differential Global Positioning System (DGPS).

Station ID	Northing (m)	Easting (m)
NAC 001	857575.906	449389.758
NAC 002	857726.312	449209.167
NAC 003	857923.932	449053.002
NAC 004	858074.014	448974.397
NAC 005	858299.578	448862.122
NAC 006	858524.282	448753.479
NAC 007	858748.616	448646.112
NAC 008	858969.764	448528.032
NAC 009	859200.784	448428.436
NAC 010	859430.844	448332.553

*

NAC 011	859656.44	448217.025
NAC 012	859790.011	448138.31
NAC 013	859836.958	448182.053
NAC 014	859857.452	448377.113
'NAC 015	859919.561	448496.052
NAC 016	860075.21	448571.91
NA 724	860252.285	448586.264
NAC 017	860366.901	448591.786
NA 725	860544.154	448601.824
NA 726	860737.291	448600.656
NA 727	860872.821	448518.975
NAC 020	860997.112	448884.549
NAC 021	861005.041	449064.37
NAC 022	860506.422	449043.336
NAC 023	860270.391	449325.681
NAC 024	860250.611	449438.935
NAC 025	860201.184	449676.766
NAC 026	860136.028	449917.453
NAC 027	860063.754	450158.959
NAC 028	859978.746	450469.238
NAC 029	859769.717	450604.013
NAC 030	859554.115	450730.424
M811	859168.757	450715.979
NA 746	859063.141	450645.346
NA 747	858835.277	450433.525
NA 748	858493.587	450249.214
NA 749	858152.934	450004.635
NA 750	857885.702	449789.628
NA 751	857704.979	449568.332
NAC 001	857575.906	449389.758

*

TABLE 2 Back Computation of DGPS coordinate of NACEST site

Station From	Bearing	Distance (m)	ΔN	Δ E	Northings (m)	Eastings (m)	Station To
					858019.539	448973.430	NAC 005
NAC 001	*136° 49'07"*	*608.390*	-443.633	416.328	857575.906	449389.758	NAC 001
NAC 002	*309°47'21"*	*235.021*	150.406	-180.591	857726.312	449209.167	NAC 002
NAC 003	*321°40'59"*	*252.00*	197.62	-156.165	857923.932	449053.002	NAC 003
NAC 004	*332°21'24"*	*169.420*	150.082	-78.605	858074.014	448974.397	NAC 004
NAC 005	*333°32'17"*	*252.00*	225.564	-112.275	858299.578	448862.122	NAC 005
NAC 006	*334°11'47"*	*250.00*	224.704	-108.643	858524.282	448753.479	NAC 006
NAC 007	*334°25'27"*	*259.00*	224.334	-107.367	858748.616	448646.112	NAC 007
NAC 008	*331°54'14"*	*251.00*	221.148	-118.08	858969.764	448528.032	NAC 008
NAC 009	*336°40'42"*	*252.00*	231.02	-99.596	859200.784	448428.436	NAC 009
NAC 010	*337°22'29"*	*249.241*	230.06	-95.883	859430.844	448332.553	NAC 010
NAC 011	332°52'58"	*253.456*	225.596	-115.528	859656.44	448217.025	NAC 011
NAC 012	329°29'19"	*155.039*	133.571	-78.715	859790.011	448138.31	NAC 012
NAC 013	42°58'35"	*64.167*	46.947	43.743	859836.958	448182.053	NAC 013
NAC 014	84°00'07"	*196.133*	20.494	195.06	859857.452	448377.113	NAC 014
NAC 015	62°25'36"	*134.179*	62.109	118.939	859919.561	448496.052	NAC 015
NAC 016	25°58'58"	*173.150*	155.649	75.858	860075.21	448571.91	NAC 016
NA 724	04°38'03"	*178.00*	177.075	14.354	860252.285	448586.264	NA 724
NAC 017	02°45'29"	*115.00*	114.616	5.522	860366.901	448591.786	NAC017
NA 725	03°14'28"	*178.00*	177.253	10.038	860544.154	448601.824	NA 725
NA 726	359°39'12"	*193.140*	193.137	-1.168	860737.291	448600.656	NA 726
NA 727	328°55'24"	*158.240*	135.53	-81.681	860872.821	448518.975	NA 727
NAC 020	71°13'21"	*386.125*	124.291	365.574	860997.112	448884.549	NAC 020
NAC 021	87°28'30"	*180.00*	7.929	179.821	861005.041	449064.37	NAC 021
NAC 022	182°24'56'	499.062	-498.619	-21.034	860506.422	449043.336	NAC 022
NAC 023	129°53'40"	*368.007*	-236.031	282.345	860270.391	449325.681	NAC 023
NAC 024	99°54'24"	*115.00*	-19.78	113.254	860250.611	449438.935	NAC 024
NAC 025	101°44'25"	*243.00*	-49.427	237.831	860201.184	449676.766	NAC 025
NAC 026	105°08'50"	*249.350*	-65.156	240.687	860136.028	449917.453	NAC 026
NAC 027	106°39'37"	*252.00*	-72.274	241.506	860063.754	450158.959	NAC 027
NAC 028	105°19'17"	*322.00*	-85.008	310.279	859978.746	450469.238	NAC 028

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NAC 029	147°11'14"	*249.00*	-209.029	134.775	859769.717	450604.013	NAC 029
NAC 030	149°36'58"	*250.00*	-215.602	126.411	859554.115	450730.424	NAC 030
M811	182°08'48"	*386.00*	-385.358	-14.445	859168.757	450715.979	M811
NA 746	213°46'24"	*127.058*	-105.616	-70.633	859063.141	450645.346	NA 746
NA 747	222°54'37"	*311.111*	-227.864	-211.821	858835.277	450433.525	NA 747
NA 748	208°20'34"	*388.230*	-341.69	-184.311	858493.587	450249.214	NA 748
NA 749	215°40'38"	*419.360*	-340.653	-244.579	858152.934	450004.635	NA 749
NA 750	218°49'08"	*343.00*	-267.232	-215.007	857885.702	449789.628	NA 750
NA 751	230°45'46"	*286.00*	-180.723	-221.296	857704.979	449568.332	NA 751
NAC 001	234°08'26"	*220.337*	-129.073	-178.574	857575.906	449389.758	NAC 001
NAC 005	136°49'07"	*608.390*	-416.328	443.633	858019.539	448973.430	HND 021

3.3 Spatial Data Preparation:

3.3.1 Geo-referencing: Geo-referencing is the process of aligning data from various sources to a specific geographic location on the earth's surface. It involves assigning geographic coordinate such as easting, northing and the zone. Geo referencing was carryout using these coordinate and landmark. The procedure for geo-referencing is as follows:

- Open ArcMap: Start ArcMap, create a new map document if necessary, and add the data layers you'll be working with.
- Activate Geo-referencing Toolbar: Go to `Customize` > `Toolbars` > `Geo-referencing` to activate the Geo-referencing toolbar.
- Add Data to Reference: Use the `Add Data` button on the Geo-referencing toolbar to add your scanned map or image that needs to be georeferenced.
- . Identify Control Points: Zoom and pan to identify common features between your scanned map/image and the reference data layers. These features are control points and should be identifiable on both datasets (e.g., Gate house, etc).
- Add Control Points: On the Geo-referencing toolbar, click `Add Control Points`. Click on a point in your scanned map/image and then click the corresponding point in the reference dataset. The point on Table 3.1 Repeat this for multiple control points spread across the dataset.
- Check Residuals: After adding control points, click `View Link Table` to view the residuals (errors) between the control points on the scanned image and their corresponding locations in the reference data. Minimize these errors by adjusting control points or choosing a different transformation method.
- Rectify: Once satisfied with the residuals, click `Rectify` or `Update Geo-referencing` to apply the transformation to your scanned map/image.
- Save Geo-referencing Information: Save the geo-referencing information as a world file (.tfw) or within the raster dataset itself if supported (like GeoTIFF).
- View Georeferenced Data: Turn off or remove the original scanned map/image and observe how the georeferenced dataset aligns with other spatial data layers in your map document.

*

- Adjust as Necessary: Fine-tune the geo-referencing if needed by adding or adjusting control points, changing the transformation method, or refining the alignment.

Table 3.1

Zone	Landmark	Easting	Northing
32N	Admin block	449110.552	858455.026
32N	Auditorium	449036.094	858585.006
32N	Gate house	448827.038	858355.477
32N	Unknown point	448846.696	859157.806

3.3.2. Data Digitization: Data digitization refers to the process of converting analog information into digital format, making it easier to store, process, and analyze using computers. Digitize the collected data to create a digital representation of the campus. ArcGIS 10.8 was used for digitization.

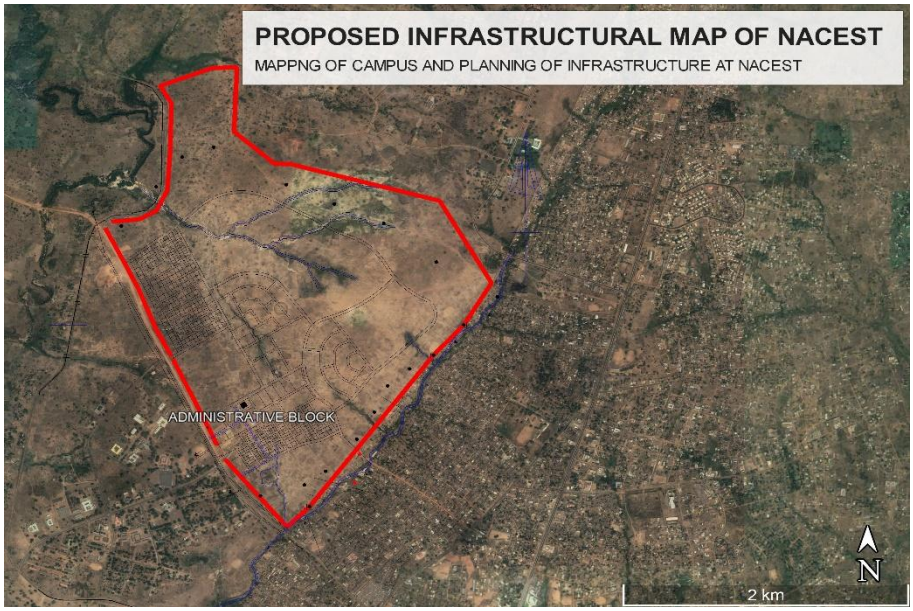


Fig 2 Digitization of Boundary Perimeter of the Site

3.3.3. Infrastructure Layers:

Organize GIS layers based on infrastructure components:

- ✓ Administrative Area
- ✓ Banks
- ✓ Class Rooms

*

- ✓ Fire Department
- ✓ Green Area
- ✓ Mini-Market
- ✓ Officer Quarters
- ✓ Parade Ground
- ✓ Post Office
- ✓ Roads
- ✓ School of Management
- ✓ Sport Complete
- ✓ Staff Quarters
- ✓ School of General Studies
- ✓ Water Department

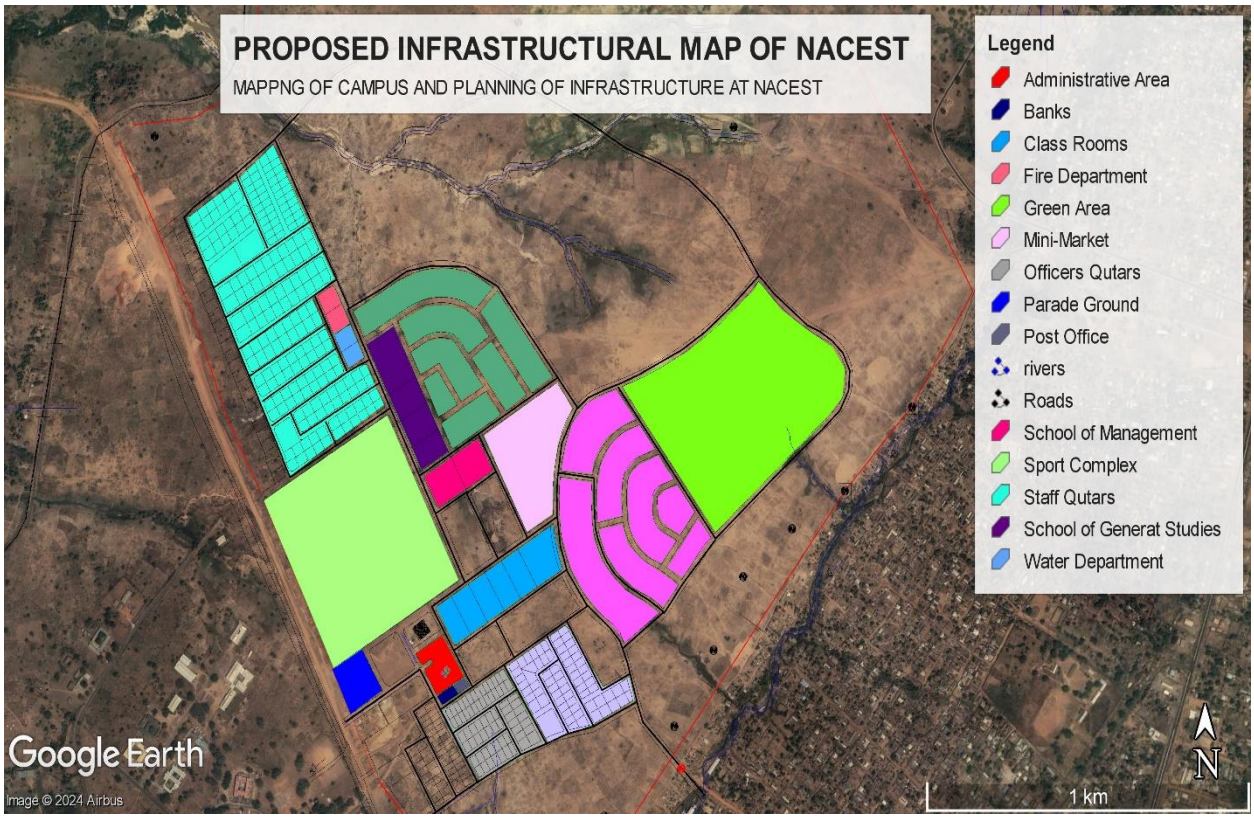


Fig 3 Map showed the various infrastructure components:

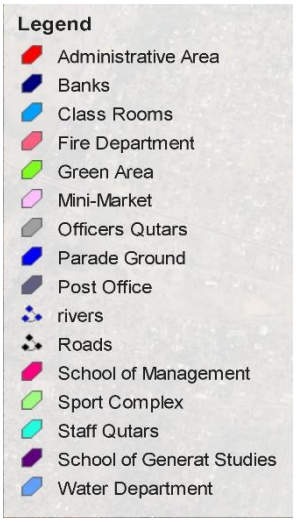
3.3.4 Mapping Elements: Mapping elements can refer to various concepts depending on the context. Symbols and colour were used to represent Administrative Area, Banks, Class Rooms, Fire Department, Green Area, Mini-Market, Officer Quarters, Parade Ground, Post Office, Roads, School of Management, Sport Complete, Staff Quarters, School of General Studies, Water Department.

3.3.5. Color Coding: Use a consistent color scheme for different types of features (Administrative Area, Banks, Class Rooms, Fire Department, Green Area, Mini-Market, Officer Quarters, Parade Ground, Post Office, Roads, School of Management, Sport Complete, Staff Quarters, School of General Studies, Water Department etc).

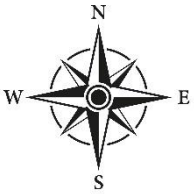
*

features	Colour coding
Administrative Area	
Banks	
Class Rooms	
Fire Department	
Green Area	
Mini-Market	
Officer Quarters	
Parade Ground	
Post Office	
Roads	
School of Management	
Sport Complete	
Staff Quarters,	
School of General Studies	
Water Department	

3.3.6. Legend: Include a legend to explain the symbols and colors used in the map. Scale Bar: Add a scale bar to indicate distances accurately.



3.3.7. North Arrow: Include a north arrow for orientation.





3.3.8 Printing and Distribution: A physical map was required, ensure that it was designed for easy printing and distribution. And place printed maps at key locations around the campus.

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Continuous Monitoring and Updates**:** Implement a system for continuous monitoring of infrastructure changes and updates. Regularly update the GIS database to reflect changes on any developing campus facilities.

3.3.9 Spatial Analysis:

- The green area is situated in the northwest part of the map because the highland there is suitable for this purpose.
- The staff gate is positioned in the northeast for convenient staff exit.
- The main school gate is located in the southeast for easy access to the main road.
- The sports complex is positioned in the southeast section of the map.
- The classrooms should not be close to the residential area to avoid noise disturbances.
- The area in the northeast, behind the green space, is suitable for crop production and animal husbandry.
- The northern part of the map is ideal for adding important departments like forestry, agriculture, and more.

4.0 RESULTS

The implementation of a centralized and comprehensive GIS platform for NACEST, incorporating accurate and up-to-date spatial data of the entire campus, including Administrative Area, Banks, Class Rooms, Fire Department, Green Area, Mini-Market, Officer Quarters, Parade Ground, Post Office, Roads, School of Management, Sport Complete, Staff Quarters, School of General Studies, Water Department etc.

A strategic plan for optimized campus infrastructure layout, addressing current needs and providing a blueprint for future development. This includes recommendations for efficient resource allocation, identification of areas for expansion, and improvements to overall spatial efficiency.

Actionable insights derived from GIS-based spatial analysis, empowering decision-makers with a deeper understanding of spatial relationships, demographic trends, and other factors influencing campus planning and development. This leads to more informed and strategic decision-making processes.

Implementation of GIS within the polytechnic's emergency management system, resulting in mapped emergency routes, identified critical safety resources, and a comprehensive spatial analysis to minimize risks. This contributes to an enhanced emergency preparedness system, ensuring the safety of the campus community.

DISCUSSION

GIS allows for comprehensive mapping and visualization of campus and planning of infrastructure, Administrative Area, Banks, Class Rooms, Fire Department, Green Area, Mini-Market, Officer Quarters, Parade Ground, Post Office, Roads, School of Management, Sport Complete, Staff Quarters, School of General Studies, Water Department and natural features. This spatial understanding aids in better decision-making for infrastructure planning and management. GIS enables real-time monitoring and spatial analysis, crucial for emergency response planning. For an institution focused on environmental science and technology, GIS can be instrumental in environmental monitoring, assessing ecological impacts of campus development, and planning sustainable practices. Integrating GIS into the

curriculum can enhance students' understanding of spatial analysis, data management, and environmental planning, preparing them for careers in environmental science and technology. Integrating GIS into campus mapping and infrastructure planning at NACEST Makurdi offers immense potential for enhancing spatial understanding, resource management, and environmental stewardship. By leveraging GIS effectively, NACEST can position itself as a leader in sustainable campus development and environmental education in Nigeria.

CONCLUSION

In conclusion, the strategy for incorporating Geographic Information System (GIS) into the mapping of the campus and planning of infrastructure at Nigerian Army College of Environmental Science and Technology (NACEST) in Makurdi, Benue State, presents a transformative opportunity for enhancing operational efficiency, environmental stewardship, and educational advancement. NACEST's focus on environmental science and technology aligns well with GIS capabilities in environmental monitoring, ecological impact assessment, and sustainable development planning. GIS can aid in identifying environmentally sensitive areas, implementing conservation measures, and promoting sustainable practices across campus. This prepares them for careers in environmental science, urban planning, and GIS-related fields, contributing to their professional development and the institution's academic reputation. By leveraging GIS for infrastructure planning, NACEST can strategically plan for future campus expansions, facilities upgrades, and infrastructure investments. The spatial insights provided by GIS support evidence-based decision-making and help prioritize projects that align with the institution's long-term goals. Incorporating GIS into the mapping of the campus and planning of infrastructure at NACEST Makurdi represents a strategic initiative that not only enhances operational efficiency and environmental sustainability but also enriches educational opportunities for students. By embracing GIS technology, NACEST can position itself at the forefront of innovation in environmental science education and campus management in Nigeria.

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