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# Geospatial Data Development for Rural Roads Planning, Construction and Management: Case Study of ADRAMP-2 Project

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***Abstract* - Geospatial data describe objects and things with relation to geographic space often with location coordinate in a spatial referenced system. Rural roads are geospatial entities which can be captured and stored using geographic information system techniques. Therefore, a geographic information system is an essential tool to be placed on comprehending the information of spatial and non-spatial data over space and time. Data required for this paper include high resolution satellite imageries (QuickBird, SPOTS, IKONOS), Landsat (EOI Hyperion, DEM); local, state, and international boundaries; all Edges of transport routes connecting all settlements in the state, settlement data, stream network data, and terrain data. Roads associated attributes include location of potholes, bumps, drainages, drainage direction, and last date of road repaired, highest point, lowest point, mean elevation, maximum slope, average slope, road tears and wears which is expressed as roads condition. Road geometry data involve length of each road edge, width, and referential measurement. Data on nature of surfacing such as tar, asphalt, concrete, and laterite. Other data on roads are name, type, classification, and Geotagged pictures and video of all roads in Adamawa state. The field survey involves trailing the whole length of the roads from a referenced baseline at a vehicle speed using GPS Waypoint Navigators, handheld GPSs, and RoadLab application in iPad. These devices were used in collecting data on roads roughness index expressed as good, bad, excellent; visual assessment of road conditions and drainages were carried out during the field survey. When navigating the roads records taking of roads data, geotagged pictures, videos, and coordinates of event areas were captured. However, the use of RoadLab in assessing road conditions was only limited to Trunk a, b, and c roads across the state since they are the most tarred roads in regional road classification. Therefore, rigorous physical/visual surveys and assessment on all other rural roads were conducted. The result of the research indicate that trunk b, c and feeder roads are in bad shape and geospatial database of all road network in Adamawa State was developed.**

***Keywords:*** Geospatial Database, Geographic Information Systems, Data, Rural Roads, Road lap.

## I. INTRODUCTION

Geospatial data describe objects and things with relation to geographic space often with location coordinates in a spatial referenced system (Li, & Coleman, 2005). Literatures have confirmed that 80% of the data we use is geographic (Chen et al, 2010). Most of the data we use in this word can be geo-referenced, which indicate the importance of geospatial data. Geospatial data reduces processing time and facilitate access to future data processes in roads constructions. Geospatial data provides accurate road data, support decision making, ensures efficient roads planning, construction, maintenance and enhanced effective roads management.

Rural roads are geospatial entities which can be captured and stored using Geographic Information System techniques. Therefore, a Geographic Information System is an essential tool to be placed on comprehending the information of spatial and non-spatial data over space and time (Chen et al 2013). Geographic Information System (GIS) is a computer-based system which can be use for handling the entire geospatial data and it help in planning and management of rural roads (Li& Yan, 2010). GIS can effectively be use to prepare geospatial data of rural roads which can be use for planning, development, and management of rural roads network.

Rural areas play very significant role in a country development. In Nigeria, most especially in Adamawa state rural roads comprises of 87% of the total road network. Therefore, keeping these roads in good condition is very important for the rural people because they will get access to health facilities, education, markets and agricultural facilities.

For the past 60 years government at all levels have been trying to improve rural roads accessibility in Nigeria and in Adamawa State in particular using different intervention and programs, but up till now most of these interventions and programs did not yield much positive result due to lack of

 

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accurate and comprehensive geospatial database of roads facilities and rural roads in the State.

A geospatial database of roads comprises of; roads location, width, length, name, age (year of construction). Other information that forms roads data are culverts, bridges, river crossing. Some physical and climatic information needed for effective planning, construction and managements of roads also include soil type, water bodies such as rivers, streams, lakes, waterlog areas, amount of rainfall, temperature, slope, and geological formations.

But all these data are not available to relevant authorities in a comprehensive and digital form that can easily be manipulated, updated, and use for decision making, therefore the need for this paper.

The development of geospatial data on rural roads network in Adamawa State will assist Adamawa rural access and mobility project (ADRAMP-2) in planning, construction, and management of rural roads in the state therefore, this paper aim at using Geographic Information System in collecting, manipulating, storing, and analyzing geospatial data for better decision making and planning for ADRAMP-2.

This can be achieved through the following objectives: 1) to carry out a survey of all roads in Adamawa State, 2) to collect rural roads data using digital survey equipment, 3) to develop and analyze these data for ADRAMP-2 for better decision making in the organization.

The paper, therefore, seek to answer the following questions Q1) What are the geospatial data needed for rural roads planning, construction, and management? Q2) How can the geospatial data be collected, stored, manipulated, and analyzed using Geographic Information System?

## II. LITERATURE REVIEW

Various literatures have discussed on the use of geospatial big data and Geographic Information System for planning, construction, managements of rural roads for the economic development of rural areas in different countries of the world for example; big data for geospatial application for rural roads in China by Chen et al, (2009), developing big data analysis architecture for spatial data on rural roads in India, Chen et al, (2013), rural roads network planning using GIS methodology also in India by Chenet al, (2009). They also added that Geographic Information System can be used as an effective tool to prepare a geospatial rural roads information system which will be useful for planning and development of rural roads network. Liu et al (2022) also confirms that geographic information system is a computer-based tool which can handle the entire database and help in the management of the entire rural roads development program. The potential for the use of GIS and geospatial data in rural roads for both development and management are tremendous (Xu et al, 2022). Satter et al, (2018) further stress that GIS has been used for planning of rural roads connectivity for community development and the information system was developed for villages and rural roads. Satter et al, (2021) also support the use of Geographic Information System for maintenance and management of rural roads network. Li & Coleman (2003) advised that in order to avoid the problems associated with rural roads development, it is better to prepare a rural road plan by building strong data base which consist of village level information and roads inventory. Therefore, by this advice, this paper is geared towards developing a comprehensive and robust geospatial rural roads database for ADRAMP-2.

## III. STUDY AREA

Adamawa State is located at the northeastern part of Nigeria, it lies between latitude $7^0$ and $11^0$ N of the equator and between longitude $11^0$ and $14^0$ E of the Greenwich meridian. It shares boundary with Taraba state in the south and west, Gombe State in its Northwest and Borno state to the north. Adamawa State has an international boundary with the Cameroon republic along its eastern border. The state covers a land area of about 38,741 $km^2$ with a population of 36,917 $km^2$ People according to the 2006 census and a population density 115.1 $km^2$. Adamawa State is divided into 21 local government areas.

The Adamawa State government through the federal government ministry of infrastructure and rural development applied for financing of the rehabilitation/ construction of rural roads in the state from the World Bank and French development agency (AFD) which is guided by the government's rural travel and transport policy (RTTP). The approval was therefore granted in 2012 and the ministry of rural infrastructure and community development through the state project implementation unit (SPIU) is implementing the program for the Adamawa State, while the federal project management unit (FPMU) and the donor agencies are monitoring the project to ensure total compliance with the World Bank procurement guidelines. The overall objectives of rural access and mobility project (RAMP)is to support participating state and local governments in providing improved all-weather access roads in selected and prioritized rural development areas, rehabilitate prioritized river crossings statewide, and support the institutional reforms in the transport sector leading to optimization and improvement of the sector management.

 

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## IV. METHODOLOGY

Research methodology is a philosophical stance of worldview that underlies and informs the style and type of research (Paulinus & David, 2013). Methodology refers to how the researcher goes about practically finding out whatever he or she believes can be known Paulinus & David (2013). It is a research strategy that translates ontological and epistemological principles into guidelines that shows how research is to be conducted and the principles, procedures that govern research (Paulinus & David, 2013).

This paper adopts the mixed method research methodology which combines the quantitative and qualitative research methods which is underpin by the pragmatic research philosophy. The mixed method approach employs both quantitative and qualitative approaches in a research work for the purpose of breadth and depth of understanding and partnership (Creswell, 2012).

All research is based on some underlying philosophical assumptions about what constitute a valid research and which research method(s) are appropriate for the development of knowledge in a given study (Paulinus & David, 2013). Understanding research philosophy and agreeing to adopt a particular perspective for a proper research paradigm is the step in setting other research parameters and choice to a study.

The philosophical paradigm for this paper is pragmatism. This philosophy concerns thinking that choosing between one position (epistemology, ontology, or axiology) and the others is somewhat unrealistic in practice and it is argued that the most important determinant of which position to adopt is the research question (Paulinus & David, 2013) Therefore, this philosophy encourages the use of both qualitative and quantitative methods to solve real- world challenge as in this paper. There are many research design alternatives that can be applied in research study such as experiments, survey, case study, action research, grounded theory, ethnography, and archival research. Therefore, this paper combines both survey and case study.

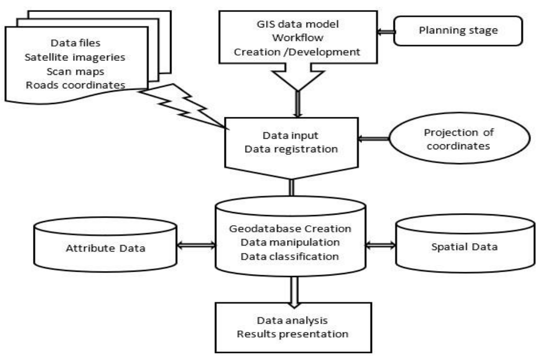


**Figure 1: GIS Geospatial Data Model**

## V. MATERIAL AND METHODS

Data required for this paper include high resolution satellite imageries (Quick Bird, SPOTS, IKONOS), Landsat (EOI Hyperion, DEM); local, state, and international boundaries; all Edges of transport routes connecting all settlements in the state, settlement data, stream network data, and terrain data. Roads associated attributes include location of potholes, bumps, drainages, drainage direction, and last date of road repaired, highest point, lowest point, mean elevation, maximum slope, average slope, road tears and wears which is expressed as roads condition. Road geometry data involve length of each road edge, width, and referential measurement. Data on nature of surfacing such as tar, asphalt, concrete, and laterite. Other data on roads are name, type, classification, and Geotagged pictures and video of all roads in Adamawa State.

*Quantitative approach* - Field survey formed the basis for primary data which represent relational attribute of the road segments; this was done through rigorous physical site visitation with the help of contemporary mapping devices. The field survey involves trailing the whole length of the roads from a referenced baseline at a vehicle speed using GPS Waypoint Navigators, handheld GPSs, and RoadLab application in iPad. These devices were used in collecting data on roads roughness index expressed as good, bad, excellent; visual assessment of road condition and drainages were carried out during the field survey. When navigating the roads records taking of roads data, geotagged pictures, videos, and coordinates of event areas were captured.

However, the use of RoadLab in assessing road condition was only limited to Trunk A, B and C roads across the state since they are the most tarred roads in regional road classification. Therefore, rigorous physical/visual surveys and assessment on all other rural roads were conducted. Policy statements concerning road provision and nomenclature were sourced from ministry of works Adamawa State.

RoadLab was used to capture data during the survey, such as speed of the vehicle used for survey, category of the road, start and end point latitude and longitude, IS fixed, international roughness index (IRI), distance covered and suspension of each road.

*Suspension* - Suspension indicate the smoothness or roughness of the road, RoadLab measured suspension in two categories of soft and medium. Survey data gotten from the used of RoadLab was converted into Geographic Information System shape files.

*Qualitative approach* - Data collected include information from various geoportals, Ministries, departments, and spatial

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data vendors vested with the responsibility of providing spatial data. Nigeria map and Adamawa State boundary map (shapefiles) was source from the Nigerian boundary commission in connection with the ministry of land and survey Yola.

High-Resolution satellite images were downloaded online through advanced use of Google Earth Pro, while Digital Elevation Model (DEM) and Landsat were source from the United States Geological Surveys (USGS) Archive (Earth Explorer). Google Pro was instrumental in online digitization of all road Edges at high resolution upon which road attributes that were collected during field survey using RoadLab and dual frequency GPS were aggregated and related with the road's geometry. Landsat was used for extraction of water bodies while digital elevation model (DEM) for building stream networks. These are all important data in the planning and management of road assets. Other qualitative data were information gotten from literatures that provide information on the extent to which similar projects have covered the subject of Geospatial data development for planning, construction, and management of rural roads.

## VI. DATA COLLECTION AND ENTRY

*Hardware* - these are physical devices that were used for data collection and entry. These include Laptop for inputting, processing, and displaying of spatial data. It was used for storage of roads data collected, and a medium for the installation of software packages which includes ArcGIS Desktop that was used for spatial data assembly, and Google Pro for online digitization of all roads. Dual frequency GPS for capturing coordinate locations of event data associated with road edges such as potholes, road tears, wears, drainages, culvert, water crossing and bridges. A smart phone for installation of survey and measurement apps and sensors such as RoadLab, Waypoint navigators, and cameras. The smart phone facilitates snapping geotagged images and videos of event sections of the roads and recording information on roads conditions such as good, poor, fair, and excellent.

*Software* - the software that were used include ArcGIS Desktop, Google Pro, RoadLab application, Waypoint navigators, PostgreSQL/PostGIS, Geo-sever, Microsoft office, and other related web applications. These applications were used for georeferencing, digitization, geo database creation, spatial data assembly, network development, linear referencing, road trailing, understanding road directions, road elevation, assessment of road condition, computation of roughness index of trailing paths in international roughness index scale, workflow development, report generation, establishment of geoportal, modeling, and analysis.

*Data Generation* - Geographic Information System database development is highly sensitive it requires thoroughness and should defy assumptions. The key element in this geospatial database is the absolute geometrical location of all rural roads in Adamawa State. Most open-source road data including the ones in most applications and geoportals were digitized at lower resolutions and should not be completely trusted as base data for a sensitive paper like this; hence, the need for a more practical, robust, accurate, and localized method of rural road data generation with high spatial integrity for the State.

For effective rural road inventory, a folder named Adamawa State roads was created at Google Pro table of content; subfolders were also created from the Adamawa State folder depicting different categories of roads. KML layers were created in each category, folders representing each road feature were created, each road feature was digitized online at the maximum resolution of the high resolution of satellite images (Quickbird and Ikonos) on the globe. The ability of the satellite image to reveal every rural road at a higher resolution within the boundary of the state was adequately spurred to capture 100% road networks within the territory necessary for conversion, aggregation, and relating with layers and tables that were generated from the field condition survey using RoadLab, GPSs and other devices.

The acquired data on road condition with RoadLab apps were directly linked with the Dropbox account where they were automatically saved. Both the digitized road network from Googlepro and road data from RoadLab were save in KML format and converted to shapefiles, transformed to UTM WGS 84 coordinate system using ArcGIS. This data are the rural road map and geometric attribute of Adamawa State that finally formed the geodatabase. Stream network of the entire state were generated from the DEM while the terrain was generated from LIDAR data. These data reveal areas on the roads where streams cross.

*Spatial Data Assembly (Creation of Geospatial database)* - The geospatial database for Adamawa State rural roads was created in a folder after which all features and attribute of the road were modeled and imported into it. The geospatial database storage model was based on a series of simple yet essential relational database concepts that leverage the strengths of the underlying database management system (DBMS). Topological operations were carried out on all road features within the geospatial database to ensure that all road features coincided to each other and that features maintained geometrical integrity. Simple tables and well-defined attribute types of all road assets were used to store the schema, rule, base, and spatial attribute data for each geographic dataset. This approach provides a formal model for storing and working with the road data. Through this approach, structured

 

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query language (SQL) a series of relational functions and operators was used to create, modify, and query tables and their data elements.

*Relational Database Creation* **-** The roads geospatial database was developed using the same multitier application architecture found in other advanced DBMS applications. The multitier architecture of the geospatial database is an object-relational model. The geodatabase objects persist as rows in DBMS tables that have identity, and the behavior is supplied through the geospatial database application logic. Road geometry tables, road condition tables, potholes tables, road category tables, geotagged image tables, and drainage tables were related to a primary key all within the geospatial database. At the core of the geospatial database is a standard relational database schema (a series of standard database tables, column types, indexes, and database object). The schema was used in the collection of geospatial database system tables in the DBMS that defines the integrity and behavior of the geographic information.

*Cartographic Finishing* **-** All the roads geospatial database features that were assembled within the Geo-database undergo professional cartographic finishing on the layout view where templates at varying scales were designed. The Maplex labeling engine was used for hi-tech labeling of all roads and their associated attributes; all map accessories such as scale bar, map grids, North arrow, legend, and neat lines were strategically decorated on the map layout.

## VII. RESULTS AND DISCUSSIONS

This section presents the result and findings of this study in summary form for easy understanding. The results are presented as road class rating, the distance covered using the RoadLab, International Roughness Index (IRI) of the roads surveyed using the RoadLab, summary of both roads surveyed and captured using satellite imageries and online digitization, others are maps of Adamawa State showing all the road network.

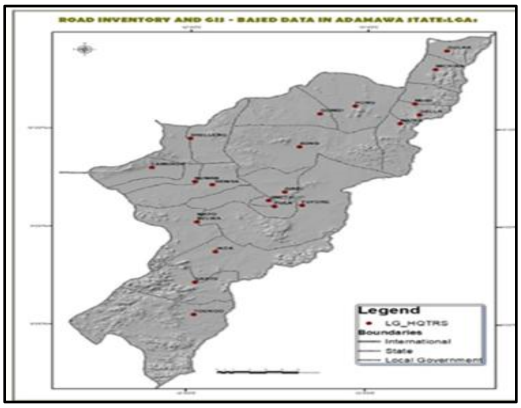


**Figure 2: Local Government Areas of Adamawa State**

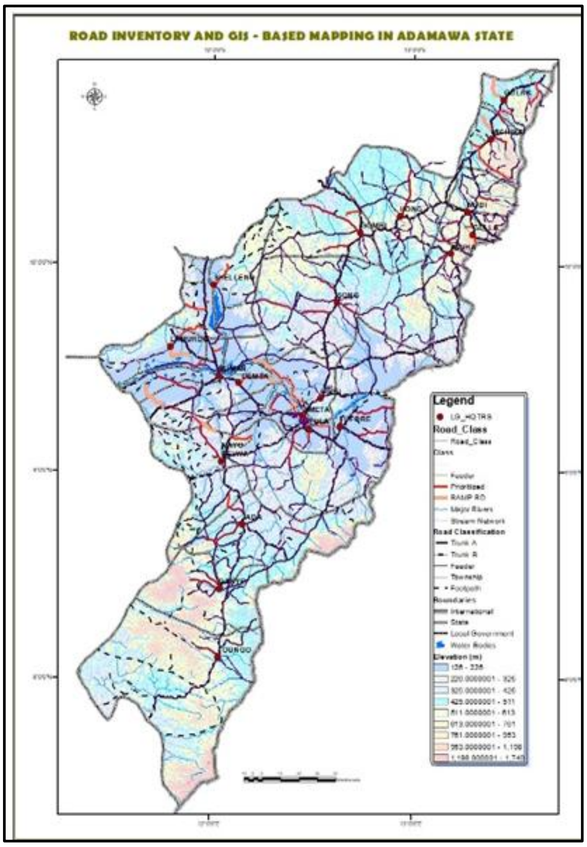


**Figure 3: All Road Network in the State**

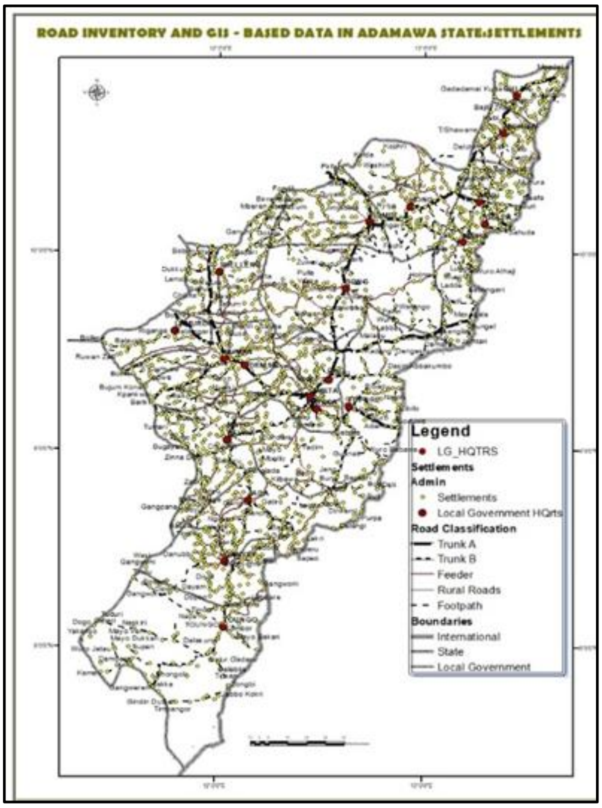


**Figure 4: Settlements in the Adamawa state**

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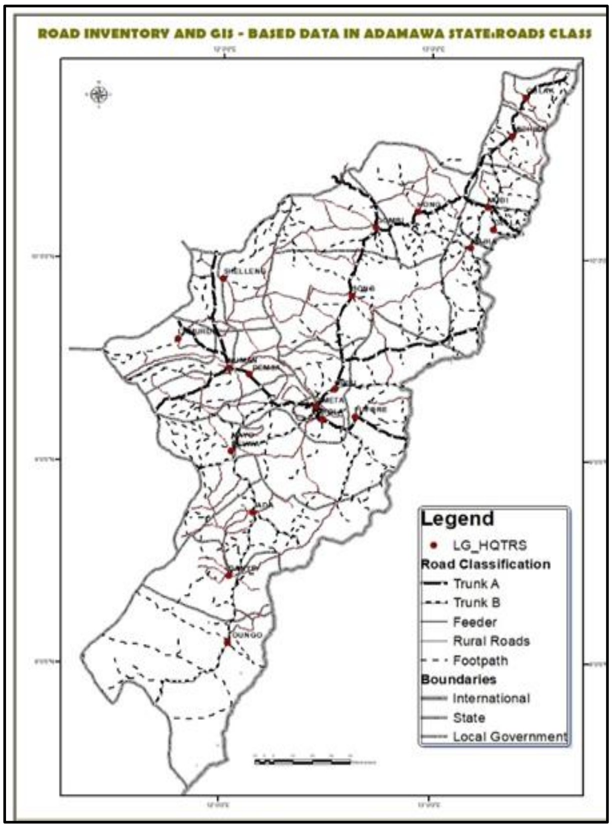


**Figure 5: Roads Classification in Adamawa state**

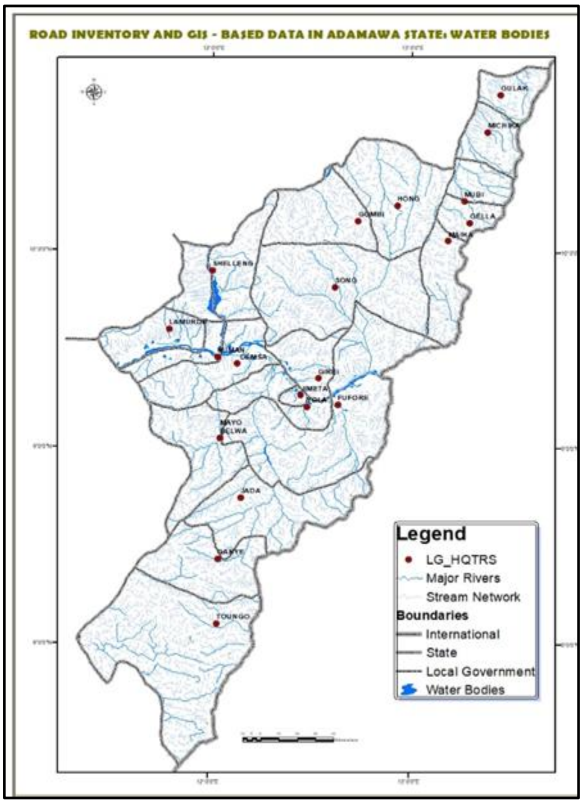


**Figure 7: Adamawa state Rivers, Lakes and Streams**

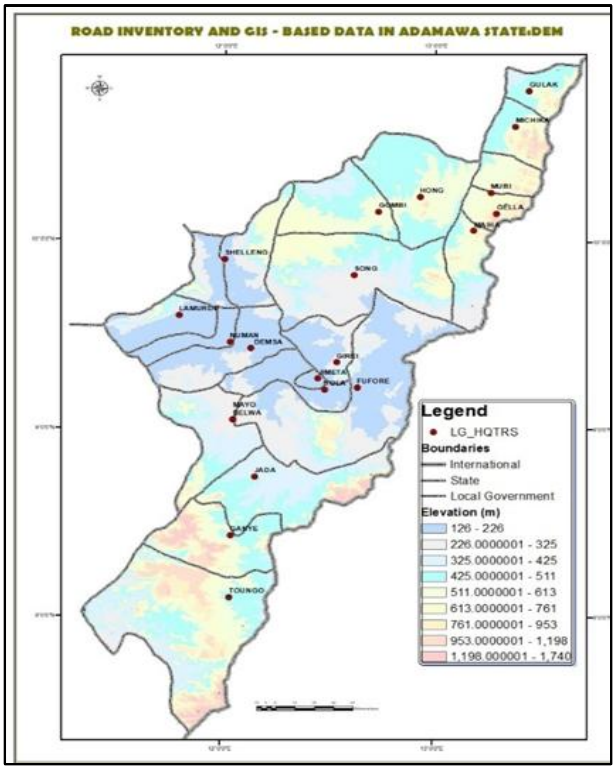


**Figure 6: Adamawa state digital elevation model (DEM)**

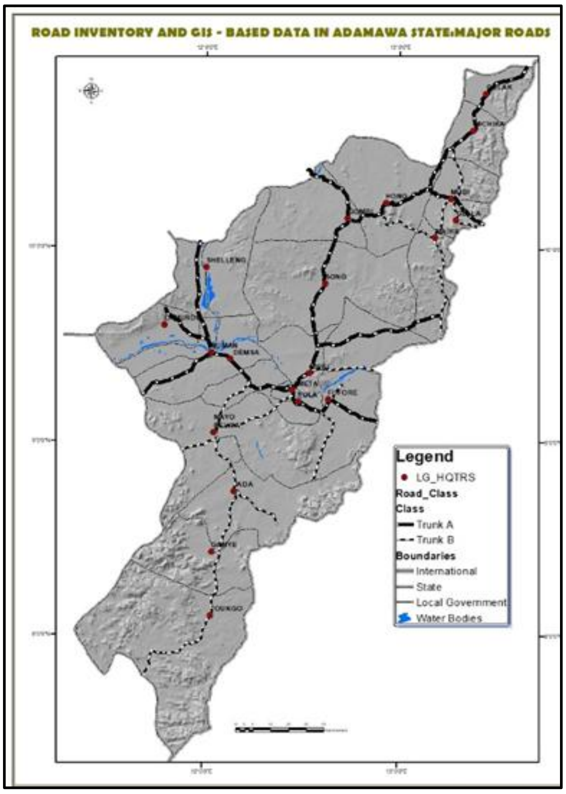


**Figure 8: Adamawa state major roads (trunk a and b roads)**

 

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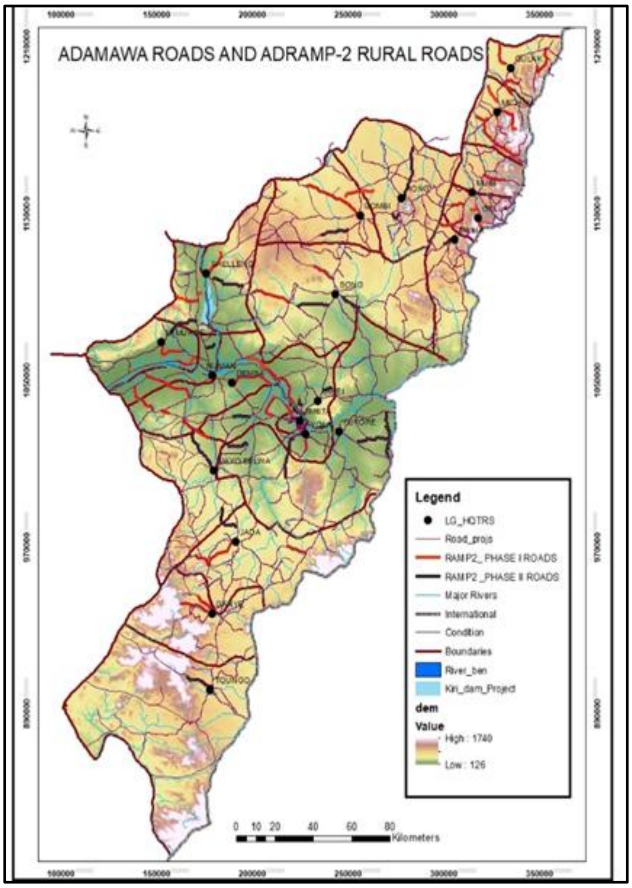


Figure 9: Adamawa state ARAMP-2 Rural Roads

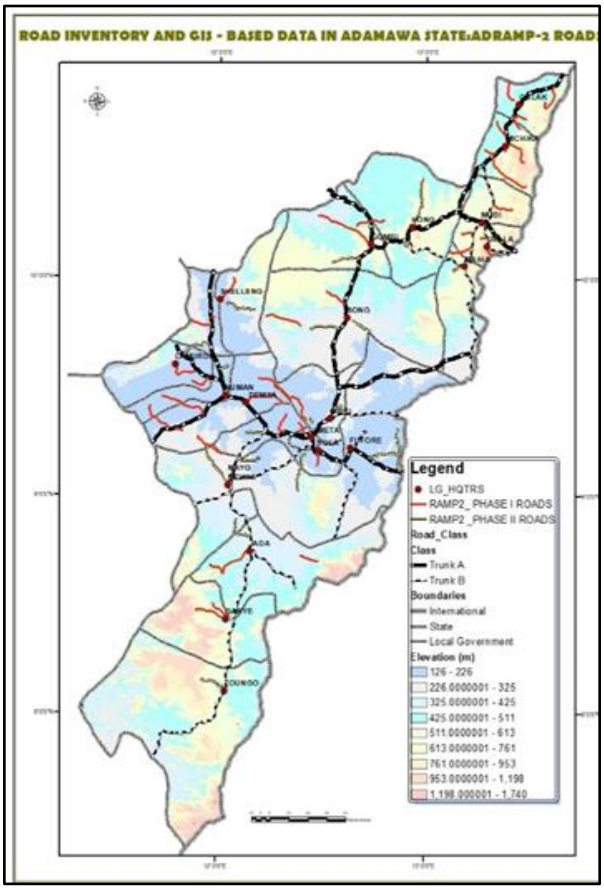


Figure 11: ARAMP-2 Phase I and II Rural Roads

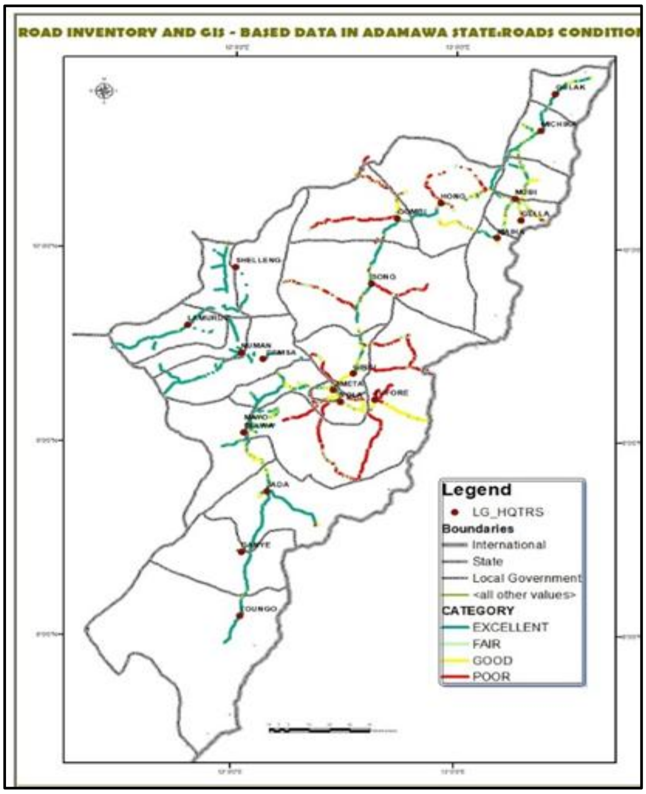


Figure 10: RoadLab Roads Condition Survey

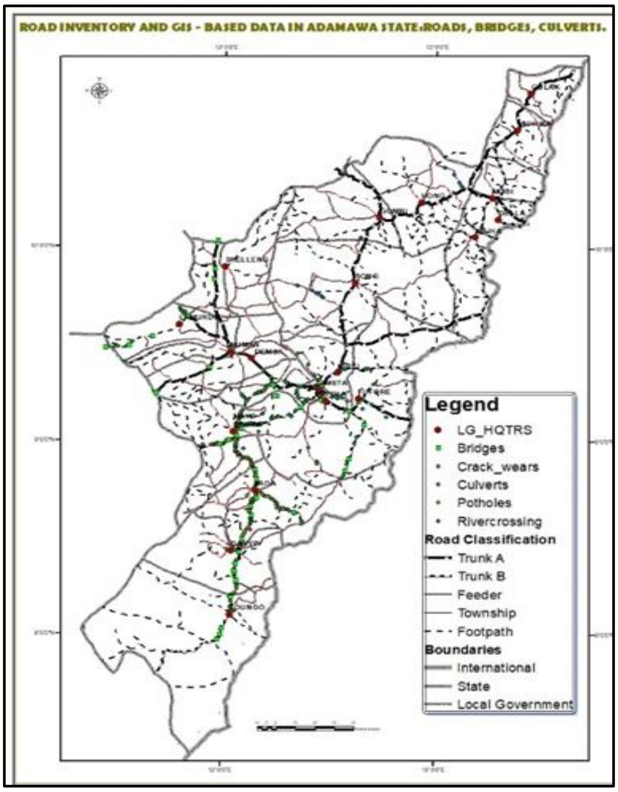


Figure 12: Culverts, Bridges, River Crossings and Potholes

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Fig. 1 represent the Geographic Information System geospatial database model developed to capture, stores, analyzed and present the results of the roads geodata developed for Adamawa State.

Fig. 2 represent the 21 Local Government of Adamawa State areas overlayed on the digital elevation models developed to show the lowest and highest elevation in each local government area for easy cut and filling analysis for roads construction.

Fig. 3 shows all the road network in Adamawa State, the trunk ‘A’ roads are the federal government roads, trunk ‘B’ roads are the state government roads while trunk ‘C’ and feeder roads are the local government roads.

Fig. 4 is the map of all the settlements in Adamawa State showing how settlements in the state are either linked or not linked with the roads, this information is important for decision making and planning.

Fig. 5 shows the classification of roads in Adamawa State, this classification is important because the federal government roads are only maintained by the federal ministry of works and they are classified as trunk ‘A’ roads, while the other roads are classified as trunk ‘B’, ‘C’ and feeder roads which are maintained by the state government and local government respectively.

Fig. 6 the map of Adamawa State digital elevation model showcases the lowlands and high lands in a model form, this data is important for cut and fill operations in road construction. This shows that Adamawa State land is flat at the central zone and the elevation at the southern and northern zone are not flat due to the mountainous nature of the two zones.

Fig.7 Adamawa State rivers, lakes and stream map shows the two major rivers in the State, the River Benue and River Gongola. These two major rivers in the state produces the drainage system, this data is important to engineers and decision makers, the data helps them in road costing, road design and construction of bridges, river crossing and culverts.

Fig. 8 Adamawa state major roads map represent trunk ‘A’ and trunk ‘B’, this information means that the state capital Yola and the local government headquarters are the once linked with this category of roads. While the other settlements are linked with trunk ‘C’ roads and feeder roads.

Fig. 9 and Fig. 11 shows the ADRAMP-2 rural roads and ADRAMP-2 roads phase I and phase II. This data was developed to present the ADRAMP-2 roads that were constructed in the State for the period covered by the intervention.

Fig. 10 RoadLab Roads Condition Survey map provide information about the road condition survey indicating the tired roads as excellent (in good condition) while earth roads as poor in bad condition.

Fig. 12 shows the culvert, bridges, and river crossing constructed in the state and their locations, this information is good for maintenance and repairs of roads infrastructure.

*DEM* - (Digital Elevation Models) digital elevation models help engineers in design, planning and construction of roads. The digital elevation models (DEM) show engineers low land and uplands, flat areas and hill areas, this geospatial data helps in cut and fill operation, roads design and construction.

*Drainage* - (watercourses or stream data) this geospatial helps the engineers in hydrologic design and planning, engineers use this data in designing and constructions of culverts, bridges, water crossing and cut and fill operations, the drainage data also help in decision making for the type of roads construction materials to be use.

*Roads Classifications* - the geospatial data on roads classification usually help in decision on road that belong to the federal and state government, the data also helps in the management and maintenance of rural roads which are always classified as trunk C roads or feeder roads.

*Roads Condition Survey Data* - this geospatial data is the analyzed roads conditions which are categories into excellent, good, fair, and bad. This type of geospatial database helps in decision making, construction, maintenance, and management of roads by showing areas that needs attention.

*Geospatial data on roads infrastructures* - geospatial data on bridges, river crossings, culverts and potholeshelp in repairs and maintenance of roads, this data shows the locations and condition of these roads infrastructure for easy management and decision making.

## VIII. RoadLab SURVEY SUMMARY

Road Class Rating- this table provide a comprehensive data on the different types of roads surveyed using the RoadLap, the RoadLap classify the categories of the nature of the roads into excellent, good, fair, and poor.

 

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**Table 1: Road class rating using the RoadLab**

| S/No. | Rating | Count (Trunk A) | (Trunk B) | (Feeder) | Township | TOTAL |
|---|---|---|---|---|---|---|
| 1 | Excellent | 1187 | 4124 | 1093 | 129 | 6533 |
| 2 | Good | 1156 | 644 | 868 | 350 | 3018 |
| 3 | Fair | 419 | 107 | 1241 | 106 | 1873 |
| 4 | Poor | 547 | 33 | 2962 | 199 | 3741 |
| Total | | 3309 | 4908 | 6164 | 778 | |

*Distance Coverage* - this is the distance covered during the road lap survey for the whole roads network in Adamawa state.

**Table 2: Distance coverage using the RoadLab**

| S/No. | Rating | Count | Min. | Max. | Sum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|
| 1 | Excellent | 6533 | 100.01 | 192.39 | 709223.26 | 108.560119 | 6.700456 |
| 2 | Good | 3018 | 100 | 166.53 | 321271.1 | 106.451657 | 5.484436 |
| 3 | Fair | 1873 | 100.02 | 190.34 | 198171.74 | 105.804453 | 7.430516 |
| 4 | Poor | 3741 | 100 | 196.74 | 392324.08 | 104.871446 | 5.190105 |

*International Roughness Index (IRI)* - the surface roughness of the roads survey is presented in the table below.

**Table 3: International Roughness Index (IRI) using the RoadLab**

| S/No. | Rating | Count | Min. | Max. | Sum | Mean | Std. Deviation |
|---|---|---|---|---|---|---|---|
| 1 | Excellent | 6533 | 1 | 2 | 7942.58 | 1.215763 | 0.296614 |
| 2 | Good | 3018 | 2 | 4 | 8677.48 | 2.875242 | 0.557057 |
| 3 | Fair | 1873 | 4 | 6 | 9404.95 | 5.021329 | 0.585039 |
| 4 | Poor | 3741 | 6 | 49.34 | 35140.81 | 9.393427 | 3.643385 |

## IX. ROAD INVENTORY SUMMARY

The entire road network covered in this project is presented in this table, some roads are not accessible. Therefore, they were mapped using the online digitization, the table below gives the total number of the roads surveyed in the state.

**Table 4: Road Inventory Summary**

| S/No. | Road Class | Length (Km) | Nature (km) | | General Condition | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Tarred | Untarred | Excellent | Good | Fair | Bad |
| 1 | Trunk A | 970km | 970km | Nil | 170km | 215km | 213km | 372km |
| 2 | Trunk B | 1,201km | 756km | 445km | Nil | 326km | 460km | 415km |
| 3 | Feeder | 1,902km | 452km | 1,450km | Nil | 156km | 307km | 1,438km |
| 4 | Major Footpath | 2,999km | Nil | 2,999km | Nil | Nil | Nil | 2999km |
| 5 | Total | 7,072km | 2178km | 4894km | 170km | 697km | 980km | 5,224km |

A road network is a valuable Government asset and failure to maintain the roads that form the network will lead to their rapid deterioration which in turn will lead to increases in road user costs and accidents and the need for expensive reconstruction works. Well-maintained roads make a valuable contribution towards the country's economy. This section presents the result of major finding of the project.

*Road Classification* - In Nigeria roads are classified in the following categories: federal roads, state roads, Feeder roads and footpaths.

*Federal Roads (TRUNK A)* - Federal roads are defined as Highways connecting state capitals with different divisional and old district headquarters, port cities and international highways. These roads have been categorized as federal roads considering their national importance and geographical positions. The federal roads in the state covered using the roadlap include the following:

Mubi Sahuda Road, Maraba Michika Road, Michika Madagali Road, Lafiya Gombe Road, Numan Jalingo Road, Numan Bui Road, Others are Ngurore Mayobelwa Road, Galadima Aminu Road, Jimeta Bye Pass, Mayobelwa Zing Road, Mayobelwa Jada Road, Yola Fufore Road, Fufore Gurin Road, Yola Numan Road, Yola Mubi Road, Jada Ganye Road, Dashen Ganye Road, Ganye Toungo Road, Gombi Bui Road,

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Gombi Song Road, Gombi Mubi Road and Numan Guyuk Road.

*State Roads (TRUNK B)*

The following are the state roads covered in this project using the roadlap: Mubi Vimtim Road, Vimtim Muva Road, Muva Mayobani Road, Maiha Gella Road, Mubi Maiha Road, Maiha Bellel Road, Maiha Pella Road, Michika Kurbususu Road, Mubi Digil Road, Kashim Ibrahim Way Others mohammed Mustapha Way, Justice Buba Ardo Road, Atiku Abubakar Road, Ahmadu Bello Way, Jada Kojoli Road, Mayo Inne Road and Maraban Jen Lafiya Road, Labondo-Borrong Road, Bazza-Zah Road, Kayo- Sabon Gari Road, Shuwa – Pallam, Koe-Koppa, New Densa-Kwaine, and Bille-Woro Bobbo Roads.

*Local Government Feeder Road (Trunk C)*

Feeder Roads are defined as Roads connecting state roads and other important rural centers (growth centers) within the existing Road network. These connecting roads are defined as Feeder Roads. There are two types of Feeder roads. Feeder road - Type A and Feeder road - Type B. This project was able to identify and cover the following trunk C roads in the state using the roadlap:

Muchalla Road, Prambe Road,Zumo Road, Mai Tulare Bilachi Road, Wuro Boki Malabu Road, Jabbi Lamba Farang Road, Vunoklang Road, Nepa Road, Gimba Road, Bishop Stree, Hospital Road, Jimeta Riverside Road, Garaha Mugwalar Road, Dzangwala Road, Bibiji Road, Dumne Road, Dirma Road, Bokki Tawa Road, Gaanda Road, Ngurore Mbilla Farm Road, Mayo Belwa Ndikong Road, Mayobelwa Wuro Jombe Road, Mayobelwa Mayo Inne Road, Mayobelwa Linringo Road, Rock Heaven Avenue, Grand View Terrance, Yolde Pate Yadem Rijiya Road, Rijiya Larlahi Road, Njoboliyo Rugange Road, Jada Gangwuso Tola Road, Jada Gidanmutuwa Road, Kojoli Shigari Road, Kojoli Ganye Road, Mayo Belwa Mapio Road, Fufore Dashin Road, Dashin Bwatiy Road, Fufore Ribadu Road, Kwanan Waya Namtari Road, Ring Road Malkohi Road, Forest Toungo Road, Bonghe Ganye Road, Sanga Somen Gurum Road, Police Station Road Ganye, Others Are , Bulo LCCN Road, Gyawana Lamurde Road, Kwah Maraban Waduku Road, Boshikiri Road, Bobini Road, Chikila Road, Numan Kikon Road, Maraban Dakanta Maliki Road, Ndwam Road, Old Demsa Road, Imburu Road, Kpasham Road, Mararaban Dong Dong Road, Guyuk Dukul Road, Mararaban Kiri Shelleng Road, Mugwalar Gashala Road, Kwamla Mubi Road, Gashala Mubi Road, Banshika Road And Garaha Road, Jambuto-Kofare road.

## X. SUMMARY AND CONCLUSION

In this study the RoadLab software was used, the results on road classification presented as excellent, good, fair, and poor. The results indicate that feeder roads in the state are in poor condition while trunk A roads are mostly in good condition. The distance covered in the survey and data collection of roads in Adamawa State are, excellent 6,533 km, good 3,018 km, fair 1,873 m and poor is 3,741 km, the reason is that RoadLab software are mostly used where the surface of the roads is flat. The areas where the RoadLab was used are trunk A roads and B roads which are mostly flat terrain. The international roughness index (IRI) of roads in Adamawa State indicates that, trunk A roads are in good condition, trunk B, C and feeder roads are in bad conditions.

The geospatial data was developed and presented in form of maps and relational-object based database system.

## XI. RECOMMENDATION AND FURTHER RESEARCH

This research was able to capture all the present road network in Adamawa State, it is recommended that attention should be given to construction, rehabilitation, management and maintenance of trunk C and feeder roads in the state. These roads are the once linking the local government areas, the villages and farm settlements. Further research is needed in carrying out an in-depth analysis of the settlement that is linked with these roads and how the roads impact their lives. It is also recommended that further studies should be carried out on the socio-economic importance and benefits of ADRAMP-2 roads to the benefiting communities in Adamawa State.

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