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Design and Mapping Of Roads In The Ancient Parts Of YOLA Town, Adamawa State Nigeria For Emergency Response Using Geospatial Techniques.

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ABSTRACT:

The nature of houses and road patterns in some ancientparts of Yola town particularyMakama A, and Adarawoward do not represent any pattern for accessibility and convenience in social service and utility provisions resulting in lack of adequate access roads for accessibility, emergency response and basic amenities such as electricity lines, pipe born water, drainages, and garbage collection centers etc which made the area inhabitable. Therefore, this researchaimed at designing and mapping roads in the ancient parts of Yola that can be used to address the current situation. The procedures adopted involved the use of GPS, GIS, Satellite images and some Photographs in which GPS (Garmin-60) was used in obtaining the coordinates of the Study Area and that of some road junctions, while Processinginvolving the Satellite images downloaded and Analysiswas carried out using ArcGIS 10.4 software package. The attribute information was obtained from the field work and Govt records. The findings from the Study identified 16 existing roads with a total distance of 10.506km which are very poor, too narrowed, untarred and having dead ends with the exception of Damdu, Polo and Wuro-chekkeroads thereby depriving those areas from having access to any emergency response and basic amenities. A propose access road map was designed, a network analysis for emergency response was carried out and a comparison was made between the existing and the new propose access road from their overlay. The findings also revealed that, the services provided by the existing access roads in the study Area is very minimal, where many Areas are found to be inaccessible while that of the propose access roads solves the problem of inaccessibility and emergency response. A systematic, gradual and participatory upgrade Programmed through access road approach using the Access Road Map produced is recommended for transforming Makama A and Adarawo ward into a good neighborhood with roads and Streets liking the affected Areas with the rest of the city.

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I. INTRODUCTION

The haphazard nature of houses and the depressing conditions under which many households live in ancient parts of cities technically refer to as informal settlement or slum in urban areas in developing countries have been a major concern of many international development agencies over the past decades as reported by Joshi *et al.* [1].The haphazard development of houses in those areas are appallingly lacking in accessible roads, emergency response and basic amenities such as portable drinking water, electricity lines, good sanitary condition, proper solid and liquid waste disposal method and many more which are usually placed parallel to the access roads.These ancient parts or informal settlement range from high density, squalid central city tenements to spontaneous squatter settlements without legal recognition or rights, sprawling at the edge of cities while some are found in the inner ancient parts of the cities and are usually older than the cities themselves as reported by Opala[2].

Design and Mapping of roads in the ancient parts of cities helps in easing the problem of inaccessibility if implemented because the problem of inaccessibility is peculiar to many places in the word. Currently, about one-quarter of the world's urban population lives in haphazard housing structures in ancient settlements that are deprived of access roads, emergency response, safe drinking water, electricity, acceptable sanitation, and

durable housing; in addition to being areas that are overcrowded and lack land tenure security (Amao),[3].These housing structures requires immediate upgrading to become accessible.

Barry and Ruther [4], lamented that, better housing and in-situ slum upgrading is achieved with good access roads which contribute in reducing social inequalities and improving urban safety through its social and spatial impacts. Indeed, smart and productive cities as seen today are those in which slums are turned into vibrant neighborhoods that are fully integrated into the city's fabric and urban management systems, rather than remaining as vast islands of informality, social exclusion, poor housing and underdevelopment. Providing road networks in the ancient parts of older cities to help ease the problem of inaccessibility, emergency response as well as improved infrastructure, makes social and economic sense. Socially, upgraded slums improve the physical living conditions, quality of life, and access to services and opportunities in cities.Additionally, Carazzai [5], lamented that, informal settlement in developing countries experience the primacy of growth, whenever access roads and other social amenities were provided thus transforming them from their traditional or pre-colonial setting.These transformation processes are only possible through the act of surveying, enumeration, mapping, planning, access road design, layout design, etc that are currently done using Geospatial techniques.

Economically, the adoption and construction of motorable access roads in the ancient parts of cities or informal settlement has triggered local economic development, improve urban mobility, ease emergency response from fire and medical institution and brought in an enormous economically productive sphere into the physical and socio-economic fabric of the wider city as witnessed in Hyderabad India where practical tools, knowledge resources and expertise in geospatial techniques were used in designing and mapping of access roads that were used in transforming the informal areas to be environmentally sustainable and affordable (Venugopal)[6].

Statement of the Problem

The present houses or buildings and road patterns in majority of the areas in someancientparts of Yola town such as Makama 'A', Makama 'B', Bako, Toungo, Adarawo, and Mbamoi Wards to mention few do not represent any pattern for accessibility and convenience in social service provisionsand utilities such as emergency response, electricity lines, pipe borne water, drainages, garbage collection centers etc to individual residents and other dividends of an urban neighborhood. As a result, inadequate access roads, water scarcity, fire disasters, flooding and foul smelling have become a norm in those areas thereby making it inconvenient for habitation. These problems have necessitated the need todesignandmap the roads in the ancient parts of Yola for accessibility and emergency response.

Aim and Objectives of the Study

The aim of this study is design and mapping of roads in the ancient parts of Yola for emergency response which was achieved through the following objectives: -

i. To map the existing Access Roads in the Study Area.
ii. To identify Areas that are inaccessible in the Study Area.
iii. To design the Propose Access Road for the Study Area.
iv. To determine the extent served by the existing and the Propose Access Road in the Study Area in case of Emergency Response.
v. To compare the services of the existing and the Proposed Access Roads through overlay analysis.

Justification of the Study

Like most ancient or informal settlements in West Africa and Nigeria in particular, some ancient parts in Yola town such as Adarawo Ward and Makama 'A' Ward in particular face service provision challenges which include the following:

i. Inadequate access roads for accessibility and emergency response: existing paths were only designed for pedestrians. Cars were not catered for, making it difficult or impossible for mobility and emergency service vehicles to gain access.
ii. The absence of a proper drainage system: This is most evident in high levels of flooding during rainy season because there are no enough drainage systems to channel the run-off water.
iii. Lack of formal electricity: This results in a high rate of informal electrical connections to households and their subsequent disconnection by PHCN officials whenever discovered.
iv. Lack of essential services: Not all households have facilities like running water and proper refuse collection facilities.

These challenges need to be addressed to ease the problems faced by the inhabitants of those areas.

In addition, the establishment of Abti American University and Nigeria Law School has attracted many students and academicians from different parts of Nigeria, Africa and the world at large to visit Yola and pursue education. But majority of the areas in Yola are informal and slum in nature having haphazard development of houses which are not esthetic to the sight of the visitors.
The study addressed the problem of haphazard development of houses in the study area by producing an access road map for accessibility and emergency response to those areas that are not accessible at all which is designed using geospatial techniques for the first time in Yola town. Such a map can be used in widening or expanding the existing roads to provide accessibility for all types of vehicles.

The Study Area

The study was carried out in Yola town which is the capital of Yola South local area of Adamawa State, Nigeria that shares border with Yola North, Fufore, Girei and Mayo-Balwa local Govt. areas and lies between latitude(Ǿ)[09^0 14' 31''N and 09^0 17' 10'' N] of the equator and longitude (λ)[12^0 28' 32''E and 12^0 31' 13''E] of the Greenwich meridian as shown in Figure 1.1, It has eleven (11) wards namely: Adarawo, Bako, Bole/'Yolde Pate, Makama 'A', Makama 'B', Mbamba, Mbamoi, Namtari, Ngurore, Toungo, and 'Yolde-kohi Wards with a population of 140,555 out of 196,607 People (NPC),[7].

Yola town is predominantly inhabited by the Fulani and Hausa ethic groups where Fulfulde and Hausa are the main languages spoken throughout the town, but English is the official language. Other minority ethnic groups are Verre, Bata and Lakka. Islam and Christianity are the two major religions practice by those ethnic groups in the town.
In terms of occupation, some people in Yola are involved in commercial activities and civil service while majority are farmers and the crops produced include rice, millet, maize, ground nuts, guinea corn and cassava. As a Fulani area, It is also an important breeding center for cattle, sheep and goats. A lot of dry and rainy season vegetable gardening is being undertaken at Boramji low-lands. Fishing is also done in river Benue (Alkasim),[8].

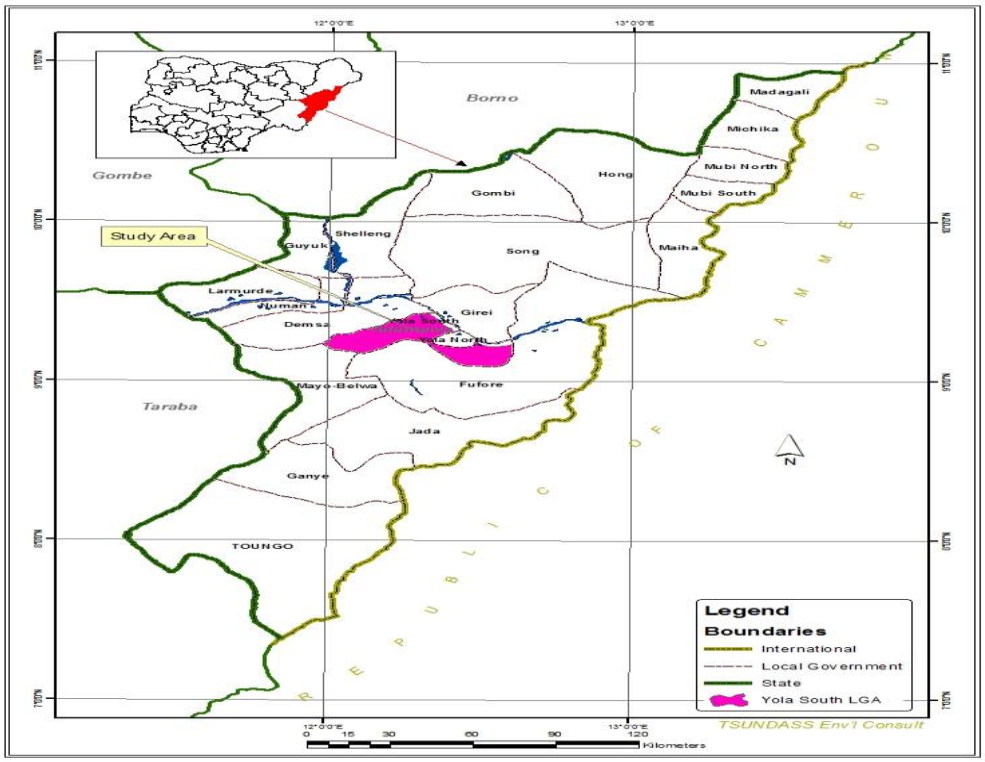

Fig 1.1.Locational map of Nigeria, Adamawa and Yola South (Study Area)

Yola town is predominantly inhabited by the Fulani and Hausa ethic groups where Fulfulde and Hausa are the main languages spoken throughout the town, but English is the official language. Other minority ethnic groups are Verre, Bata and lakka. Islam and Christianity are the two major religions practice by those ethnic groups in the town (Alkasim),[8].

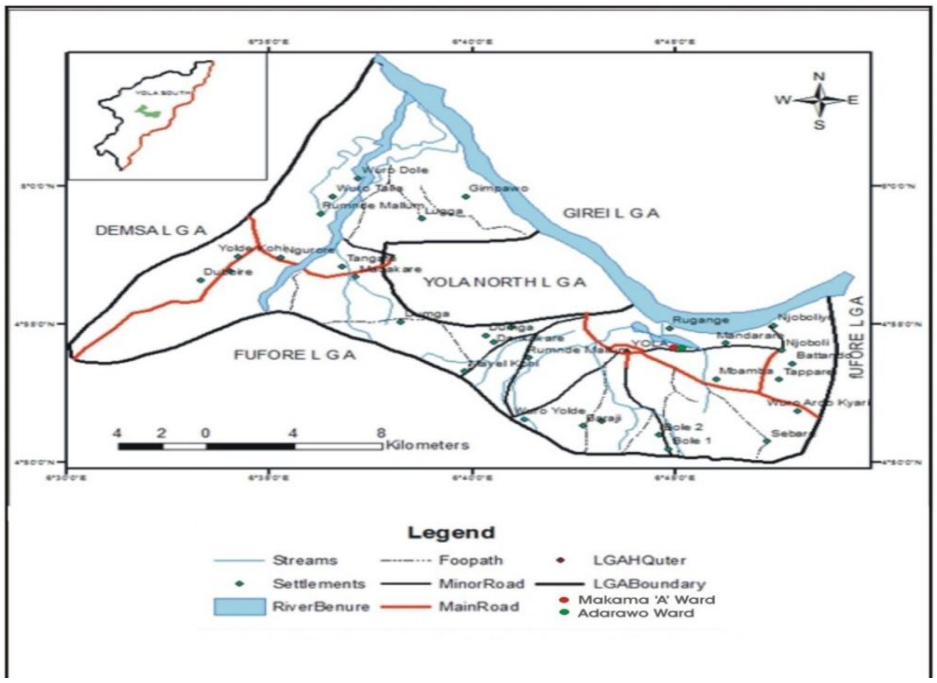

Figure 1.2.Locational Map of Yola South LGA and the Study Area.
Source: Ministry of Land and Survey, Yola.

Plate 1.1.A photo of the clustered nature of some of houses in Makama 'A' Ward Yola Town.

Plate 1.2.A photo of the nature of some houses in Adarawo Ward, Yola Town.

Plate1.3. A photo of narrow foot paths in Adarawo Ward, Yola Town area.

II.Application of Geospatial Techniques in Design and Mapping of Roads

According to Venugopal *et al.,*[9], designing access roads for transforming the ancient parts of an urban area requires qualitative and quantitative information primarily on urban features, settlements, traffic networks, water bodies, vacant lands, etc which are now obtained using Satellite imageries. Raghunath[10], has used the satellite data for geo-referencing the existing cadastral village maps and extracting existing roads and proposing new ones for Dehradun (India) as well as preparing comprehensive urban land use information at cadastral level, which was used in evaluating the amenities of the area. His work has brought out the potential of geospatial techniques in transforming informal areas into vibrant neighborhood.

Alkan and Marangoz[11] made use of Quick Bird and IKONOS imagery, GPS, GIS and Auto Cad Civil for designing access routes for informal settlement upgrading in rural areas of Zonguldak and Bartın in Turkey.Their study used high spatial resolution pan-sharpened IKONOS and QuickBird images that were produced by fusion of high resolution PAN and MS images using PCI Geomatica v9.1 software package. According to them, the parcel, building and road network objects from these datasets have been extracted automatically by initially dividing it into segments and then classifying it using the spectral, spatial and contextual information in eCognition v4.0.6 software package. On the other hand, these objects have been manually digitized from high resolution images using ArcGIS v9.2 software package. The vectors produced automatically and manually have been compared with the existing digital cadastral maps and reference vector maps (scale 1/5000) of the area. The success of object-oriented image analysis results was tested by GIS software; the result indicated higher quality in the ones produced using Satellite imagery than the existing Cadastral layout map produced through the analogue method.

Garba*et al.,* [12], produced a road map for Taraba State University of Nigeria using Google Earth images, GPS and GIS. Their research incorporated the use of Geospatial techniques and functionalities such as geo-referencing, digitizing and geo-database creation to generate the map. The findings of the study revealed that some of the structures in the campus lack good accessible roads while those that are accessible were not labeled for easy navigation.

Musa [13], produced a digital revised map of Jimeta-Yola metropolis using a combination of spot X images and handheld GPS unit in which the GPS coordinates were used in carving out minor roads that are not visible on the satellite image by applying relevant geospatial techniques.

Suleiman *et al.* [14], used geospatial techniques in naming of roads in Mubi based on pixel size using quick bird satellite image. Roads comprising of 3 or more pixels are categorized as major roads and roads with 2 to 3 pixels are categorized as minor roads while those roads with pixel size of 1 to 2 are categorized as access roads.

In terms of emergency response, many researchers advocated the use of GIS in tackling emergency situations by determining the shortest or best routes for emergency response. This was demonstrated by the work of Moh'd et al., [15] on health care facility for Joharbahru city, Malaysia in which a network dataset was created from the feature source but without using GPS data.

Tao and Xiaowen[16], generated emergency response route using mobile based navigation web application system on hinder factors like hospitals, schools, residential areas, traffic lights and the user-controlled factor of traffic and driving speeds without GPS data.

Advani*et al.*[17], also used GIS network analysis to determine the optimal routes from one origin to many destinations in Bhavnagar district area (as a case study) with an objective of minimizing travel distance and travel time of users. Similarly, Zhan et al.[18], have explored the use of optimal route algorithm on extensive road networks. Min and Wei-fang [19] applied GIS network optimal path algorithm to Harbin urban roads.

Therefore, the related literature above dealt with extraction of roads from satellite image, map revision, road naming and mapping while some were tailored on determining shortest route only but not on design and

mapping roads for emergency response. This is the gap in the research and knowledge that this project bridged by designing and mapping roads in the study area with the view to produce a map for emergency response.

III. METHODOLOGY

Instruments for Data Collection

The instruments that were used in this research work are categorized into hardware and software such as Garmin 76sx Hand held GPS unit, Digital Distance Rolling wheel, Digital Camera (Cannonshot 482), Hp 625 Laptop Computer, Printer HP CL M400 1a and ArcGIS Version 10.4 software Package.

Data Collection

The primary dataset comprising of GPS coordinates (x, y) of the study areaas shown in appendix 1and II and that of someroadswere collected during the image data validation surveys as shown in table 3.1below.The attribute data of the road made up of non-spatial descriptive information were obtained from field work and published/unpublished records kept by statutory bodies. The records were sourced from Ministry of Land and Surveying Yola and Survey unit Yola South Local Govt Council.
The secondary data for the study was the 2019, 0.5m resolution SASplanet Satellite image covering the ancient part of Yola, Makama A and Adarawo ward in particular and Google earth image (for updating purpose) as well asAdministrative and Base map of Yola for complementing Satellite data.

Table 3.1.GPS Coordinates of Some Road Junctions in Yola Town

E (m)	N(m)	Description
223740	1019052	Jimeta-Yola Road Junction
223560	1019413	Polo Road Junction
225571	1019514	Makama Road Junction
224589	1018999	Wuro-Hausa Road Junction
225897	1017958	Butchers Road Junction

Data processing

Geo-Referencing

TheGoogle Earth Satellite image of the entire Yola was downloaded from Geo-eye Satellite at 0.5m resolution and was exported to ArcGIS 10.4 for geo-referencing using the collected GPS coordinates from the study area. The GPS coordinates of five points (Jimeta/Yola road junction, Polo road junction, Makama road junction, Wuro Hausa road junction and butcher's road junction) were used as tie points. Another set of GPScoordinatesas shown in appendix 1 were taken in both makama A and Adarawo word for defining inaccessible areas in the study area.
The image covering the study area (figure 3.1 below) was clipped out from Google Earth map. The geo-reference Google Earth satellite image was used in updating the road network and identifying the ward locations and inaccessible areas within the study area. Thus, all data sets were transformed into the ArcGIS data format (shape file). The clipped Google Earth Satellite image of the study area was geo-referenced to UTM zone 33 N and to the "Minna-Nigeria" datum (WGS 1984) by using the GPS data (Table.3.1) as ground control points and the geo-referenced data of Yola town was overlaid on the very high resolution SASPlanet satellite imagery which serves as check or reference data as shown in figure 3.2 and 3.3 below.

Image Digitization

The Google earth satellite image of the study area and Base map of Yola was digitized in order to update the existing map of study area. The processes involved, shape files of the entities in the study area which were first created in Arc-Catalogue. The shape files were added to the Arc Map environment for digitizing. The process of digitization involved the use of Editor Tool Bar to trace out the features in the satellite imagery and other points of interest (as shown in figure 3.4). In addition, the spatial data were captured and organized into different layers with on-screen digitization. Finally, the layers were populated using attribute data gathered from the field and the records of Ministry of land and Survey, Yola. The layers created are as follows:

(1) The road network layer: That describes the road network pattern according to their design speed which involved; (i) the first class i.e. the high way which was design 60km/hour, (ii) the second class road was

design 30km/hour i.e. the major town road, (iii) the third class road which is residential street (access roads) was design 20km/hour, and each contains the road name, class, length, speed mode, calculated travel time, and condition. This layer shows the spread of a city network road and can be overlaid onto a location map of the study area to examine their relationships. The updated road shape file; network dataset was built on it to enhance the running of network analysis.

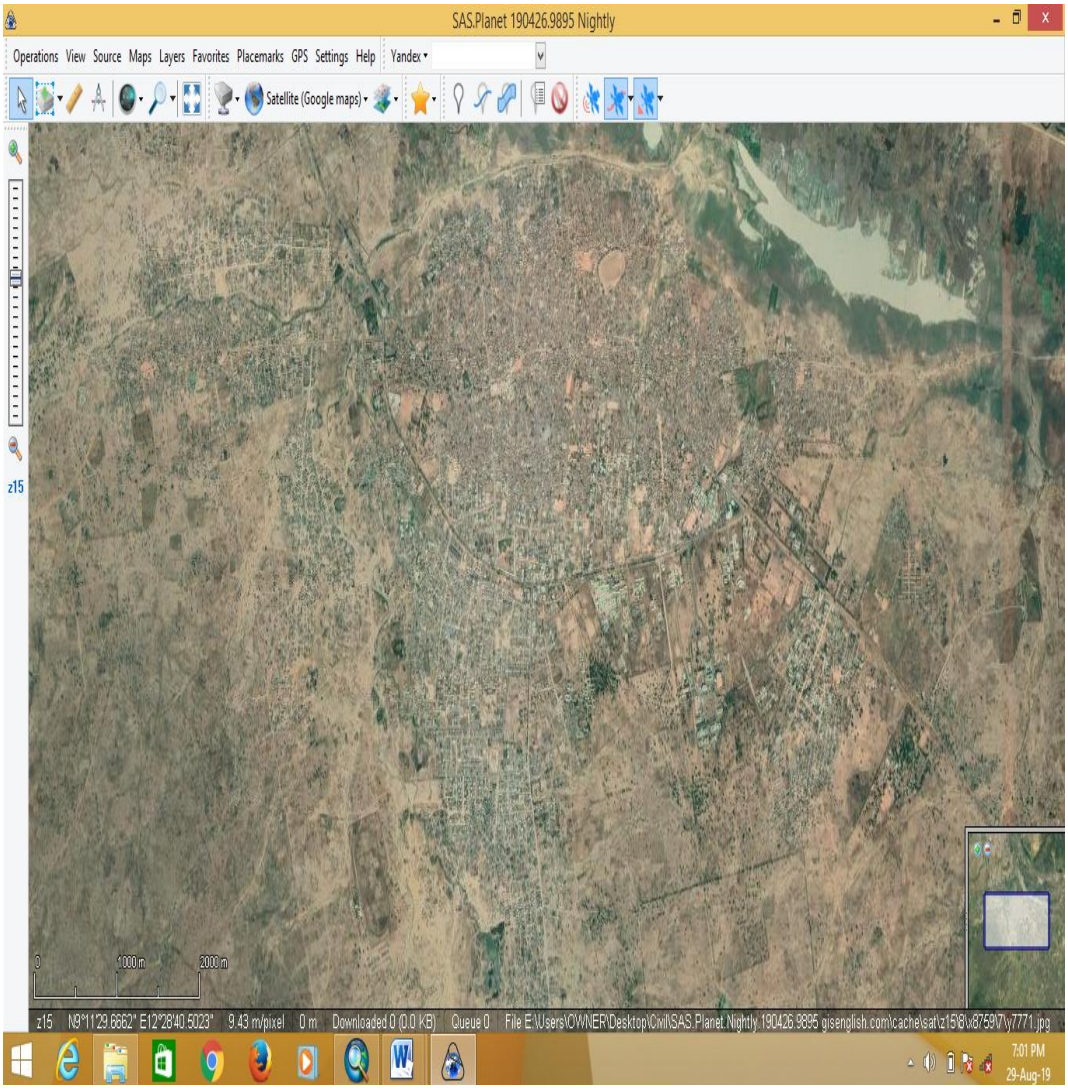

Fig 3.1 SASplanet Satellite image of the study area

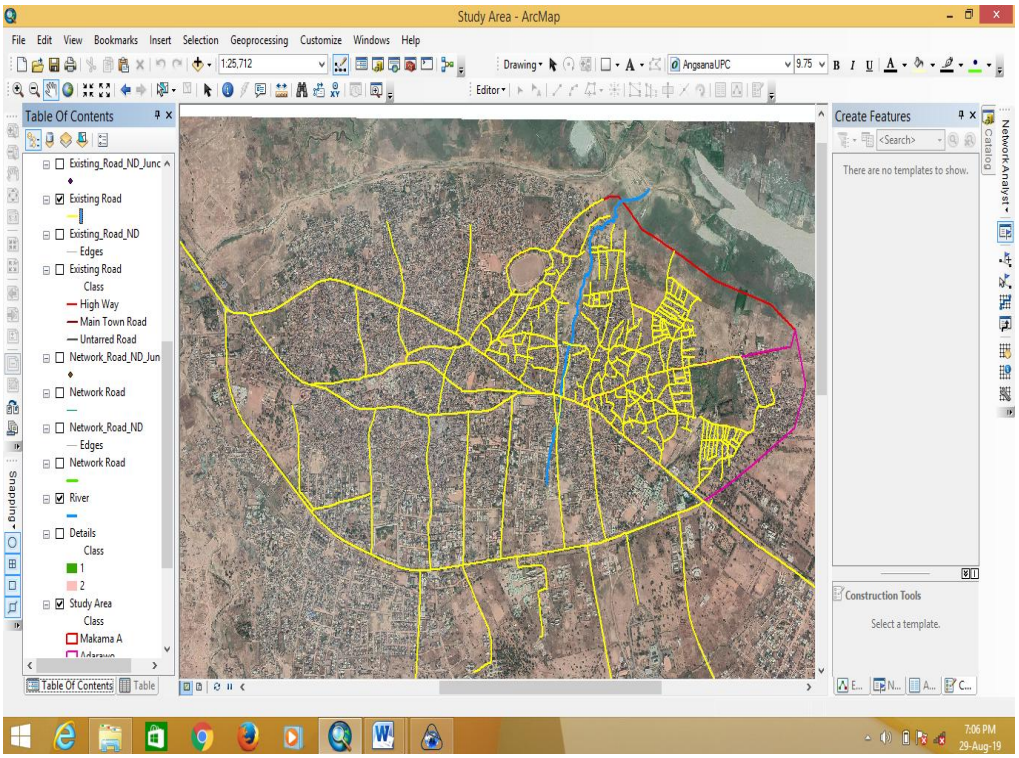

Fig.3.2 Overlay of the digitized Google Earth image on SASplanet Image

(2) The road accessibility location of Yola town layer: contains a record of road name, locations and wards in Yola town which was used to achieve the optimal location and spatial analysis of road accessibility within the study area.

(3) The administrative boundary or service extent of the road accessibility layer: is a polygon layer that shows the spatial extent of the road accessibility and emergency response.

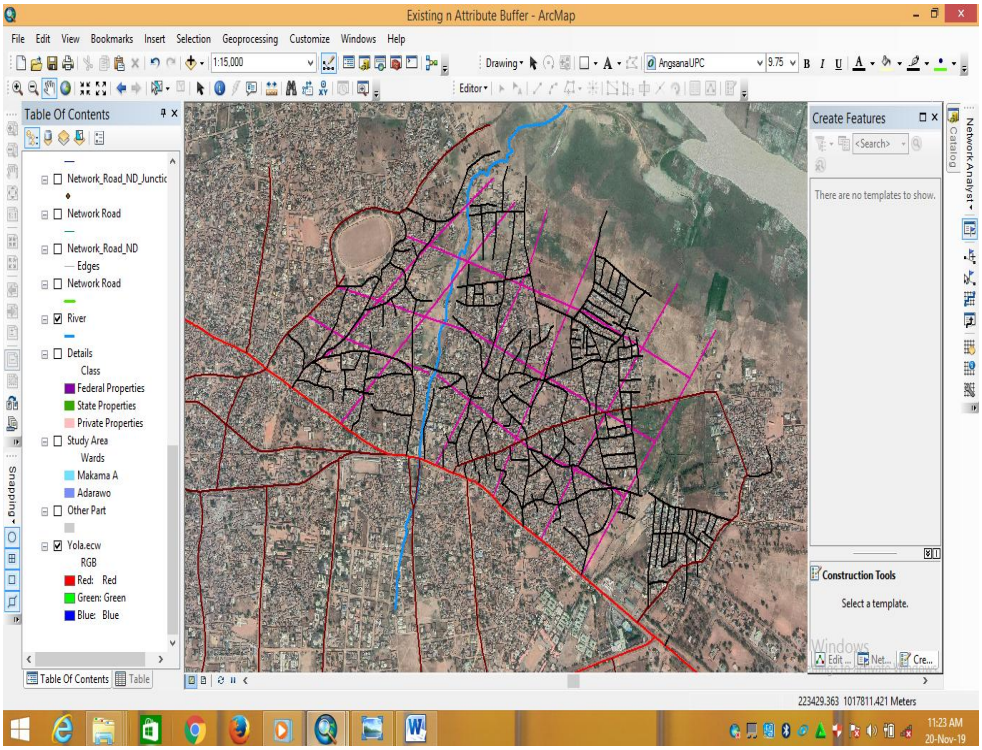

Fig3.3 Digitization & Design Process of the existing & the proposed access Roads

VI. RESULTS PRESENTATION AND DISCUSSION

Figure 4.1 below represent the digitized up-to-date existing roads of the study area at the scale of 1:10,500. Various symbols in the ArcGIS software were used to represent dynamic features of the existing road map as supported by Claramunt*etal.*[20], the roads are categories into three classes that is highway, major and existing access roads using different colors for each category. Federal properties such as NYSC camp and FMC Yola, State properties comprising both local and State include schools, primary healthcare centers, Polo ground, Yola Graveyard as well as private properties such as AUN, Abti Printing Press, Residential compounds were also represented in different colors in the legend on the map.

The existing roads (fig.4.1) in the study area is one of the first products of the research result which depicts the distribution of the roads throughout the study area which is inadequate, too narrow and irregular as a result of haphazard encroachment of structures into the street space. In some areas, the street was as narrow as one meter while the maximum size before was 4 meters with the exception of Polo road. This revealed the relative positional location of these roads prior to further analysis. Due to the nature of these roads, majority of the people who live in the ancient parts of Yola town have to park their vehicles at schools, clinics and those houses that are located along the few motorable roads and walked down to their houses because there are no motorable access roads to the interior areas of the town.

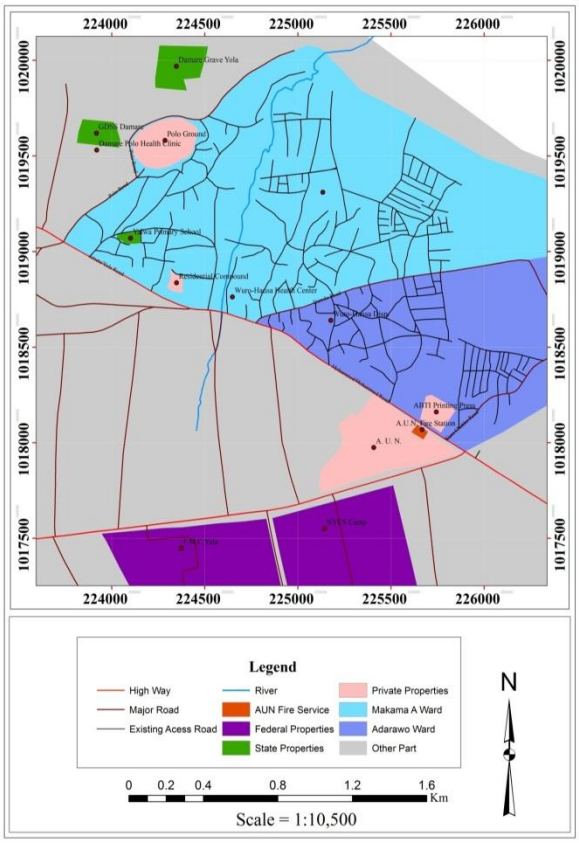

Fig.4.1 Map of Existing roads in the study Area

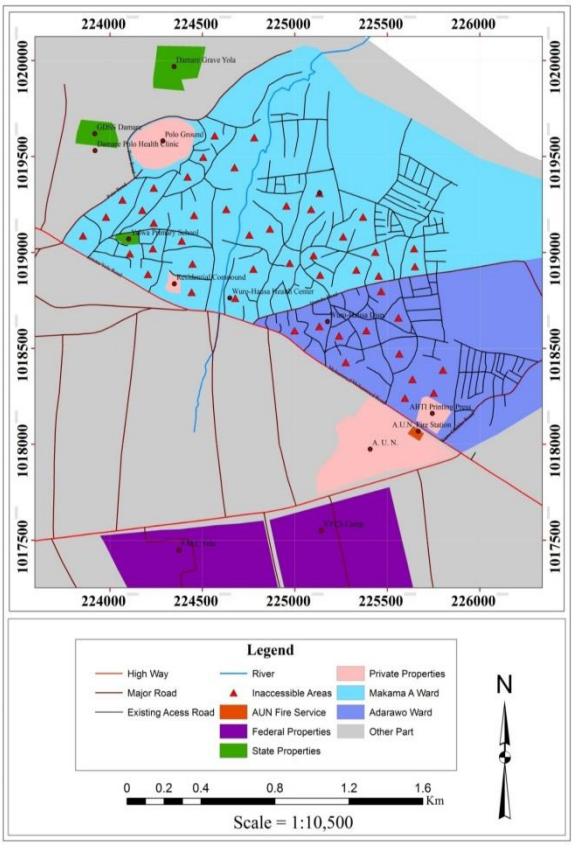

Fig.4.2MapofExisting roads & inaccessible areas in the study area.

Fig 4.2 is the digitized up to date map of the existing roads and the inaccessible areas in the study area at a scale of 1:10,500.The map shows the inaccessible areas using firm red triangular symbols as shown in the legend.The inaccessible areas as shown in figure 4.2 are not even connected to the existing motorable roads and are devoid of basic social amenities because the provision of basic social amenities are usually done along the access roads and streets. Many individual dwellings lack social amenities due to their inaccessibility to even the existing few access roads in study area. Emergency response, Garbage collection, electricity distribution, Pipe born water supply, drainages etc are appallingly lacking. Where it is provided in the case of electricity, the means of that provision is illegal and informal. Water scarcity is a common phenomenon in that area as the source of water remains Hand pump boreholes, individual boreholes and water vendors known as Garuwa pushers up till date. Annual flooding and fire disaster is a yearly occurrence in those areas.

Figure 4.5 represent the proposed access road designed for the study area which comprises all 1.5mm infill black polylines of regular pattern having design speed of 20km/hour derived from the spatial and attribute data of the existing roads.The proposed access roads are regular in nature except in few cases to avoid important social context such as health centers or schools and having 13.5 meters size constituting 2 lanes of 4.5 meters each, with a storm drainage of 1 meter on each side, while the remaining 2.5 meters are to be used for laying utilities such as Pipe born water and installing Poles for electricity distribution as supported by Sylvia [21] and Wanjiru [22].

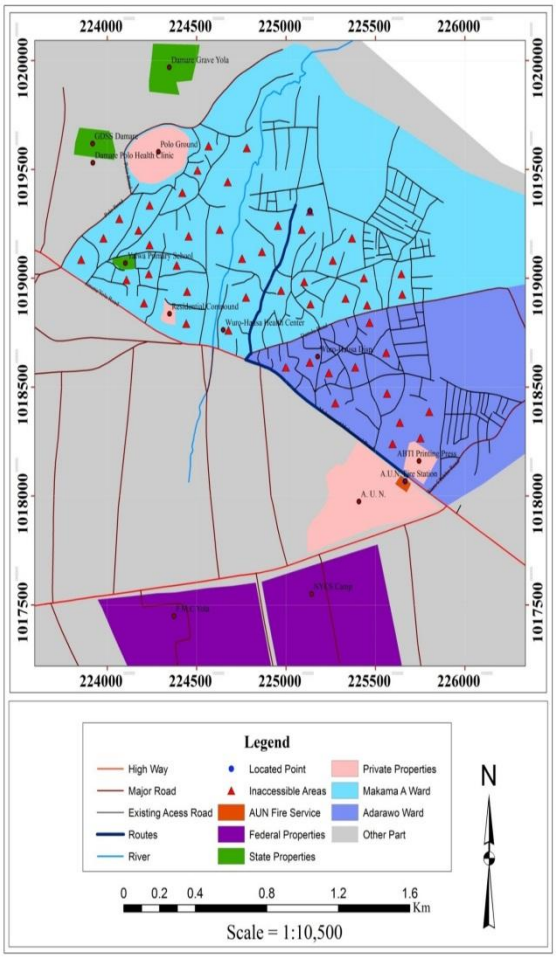

Fig.4.3 Map of existing roads & inaccessible Areas For emergency from AUN fire service

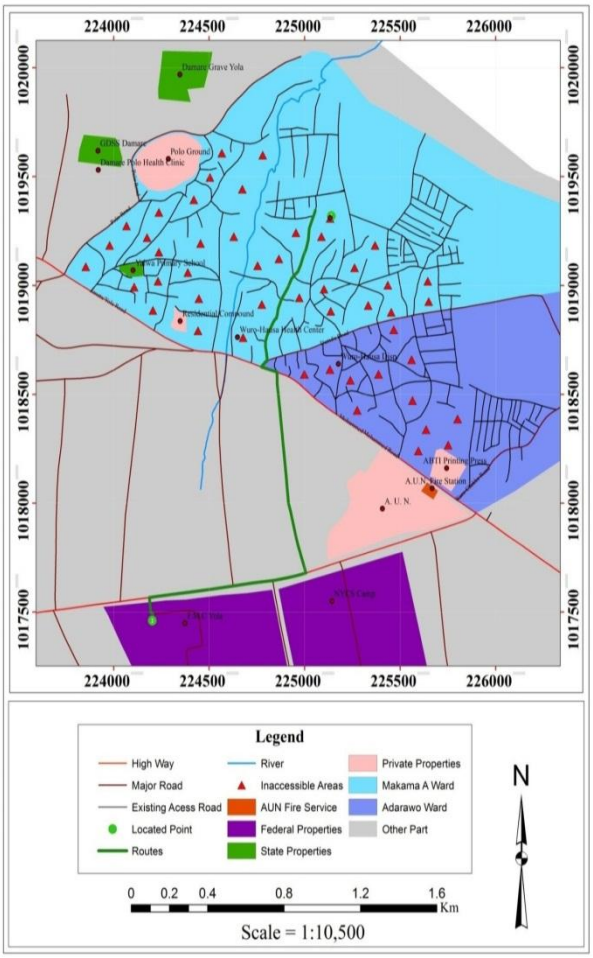

Fig.4.4 map of existing roads & inaccessible areas for emergency from & to FMC Yola

The Proposed access roads will provide accessibility and emergency response to all areas in the study area and also serve as the pathway forpipes, power lines, street lighting and drainage systems.

The service extent provided by the existing and the proposed access road in the study area involved both the region that encompasses all accessible streets (i.e. streets that are within specified impedance) and those that are inaccessible. For instance, if any incident such as fire disaster occurs which requires emergency response for fire service department and ambulance for onward evacuation of victims to health centers within the study area as shown using leaf green route and dark blue route in figure 4.3 and 4.4 respectively will be impossible because the inaccessible areas has no access to emergency response due to the lack of roads. Consequently many houses used to get burned due to the cluster nature of the houses and lack of access for the fire service department to reach those areas. But the extent served by the propose access roads as shown in figure 4.5, 4.6 and 4.7 encompasses all the access roads that are regular in pattern and wider than the existing ones which accommodate all modes of transportation involving vehicles which in turn allows fire service department and ambulance to respond to cases of emergency promptly without hitch. The emergency response routes which is the shortest and the quickest route as revealed by the analyst tool is indicated in fig 4.6 and 4.7 using leaf green routes for both AUN emergency fire service response and FMC Yola Ambulance emergency response.

It was discovered that, with the existing roads that are irregular and narrow, the services provided in the study area is very minimal, because many areas were found to be inaccessible as shown in the figure 4.2.Consequently the areas lack basic social amenities such as electricity, pipe born water, drainages etc as these amenities are usually laid along the access roads or streets. But, the propose access roads that are regular in pattern and wider according to standards, tackles the problem of inaccessibility and emergency response in those areas as shown in figure 4.5, 4.6, 4.7 and 4.8

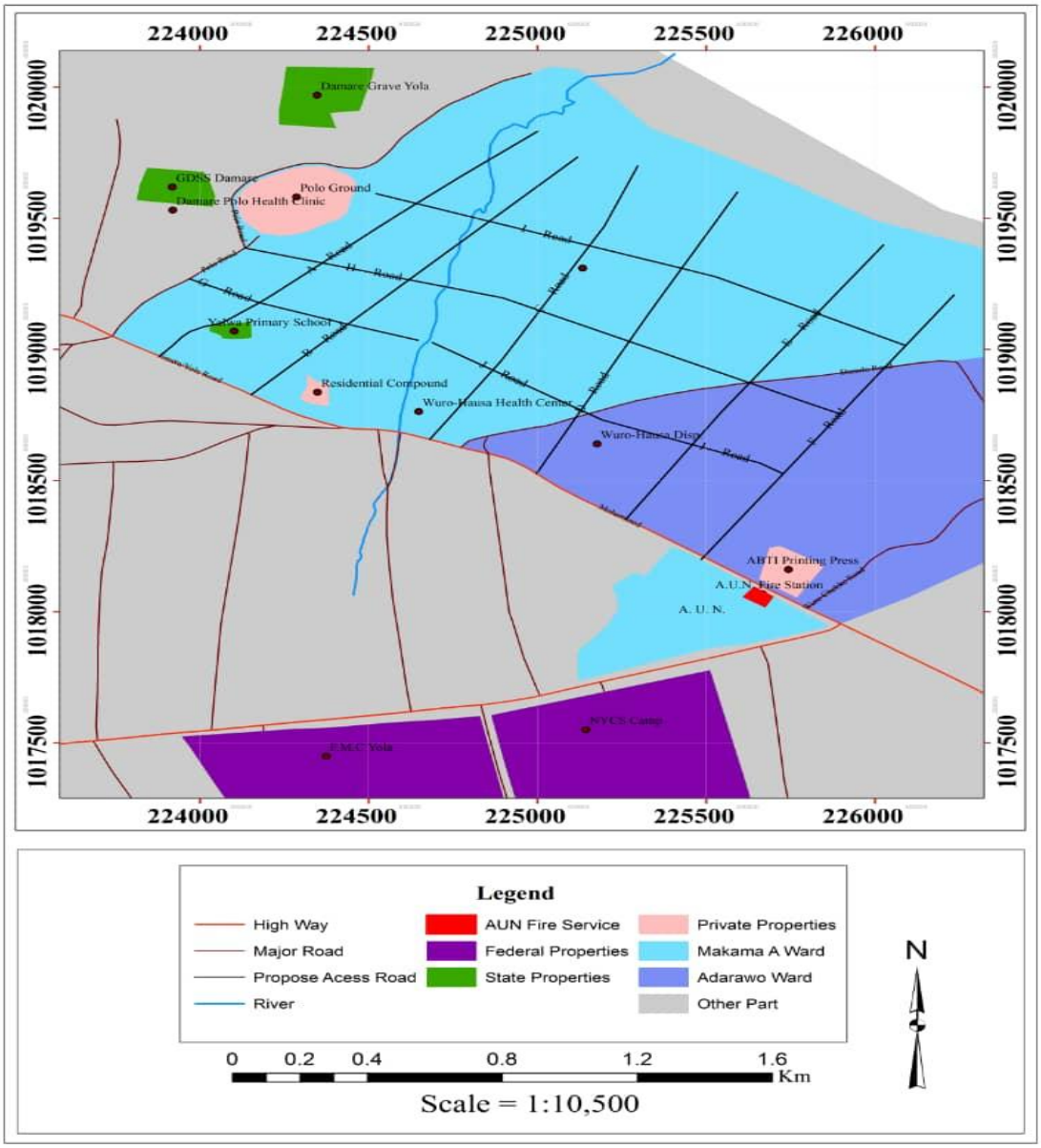

Fig.4.5 Digital map of the proposed Access Roads in the Study Area

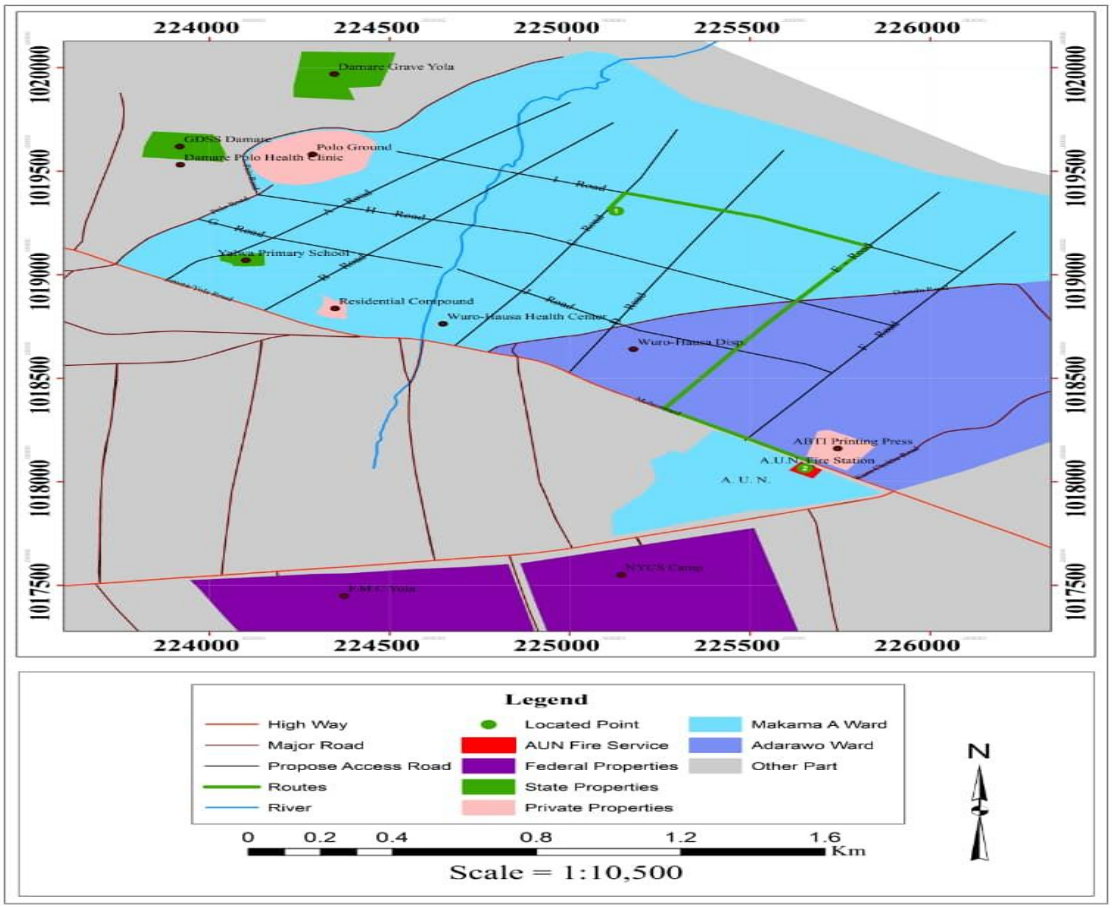

Fig 4.6 Digital map of the proposed Access roads for emergency response from AUN Fire Service

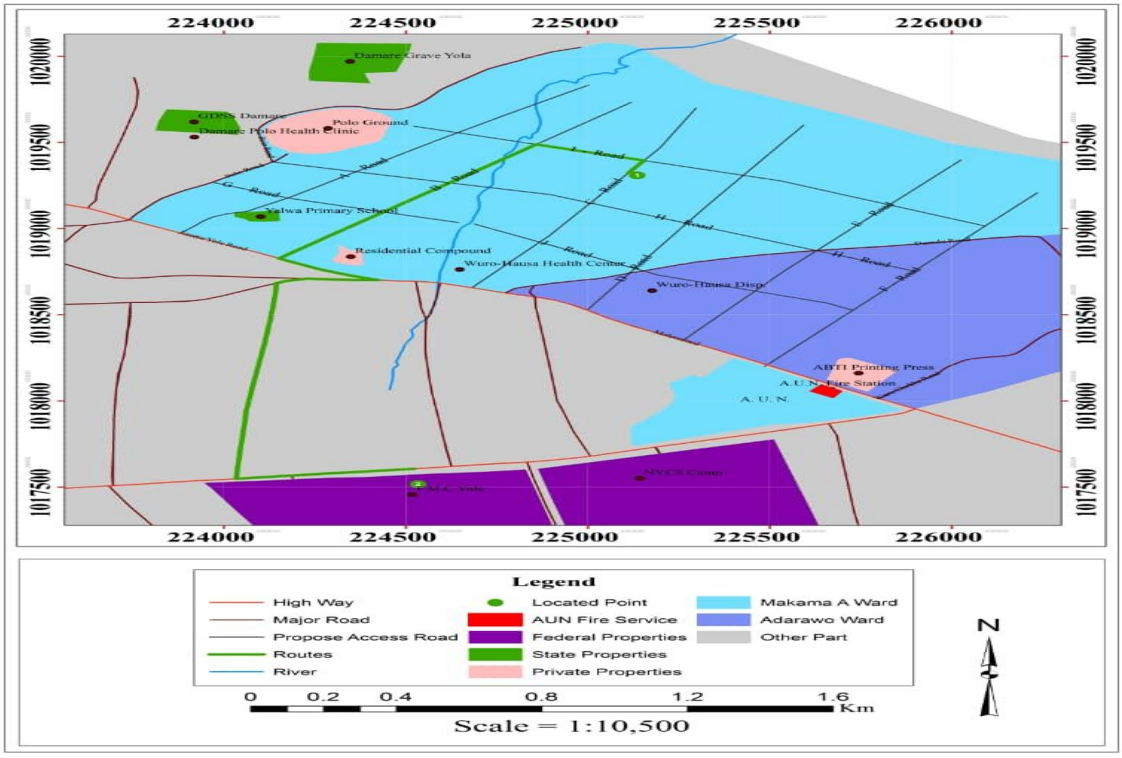

Fig.4.7 Digital map of the proposed Access Roads for emergency Response from and to FMC Yola

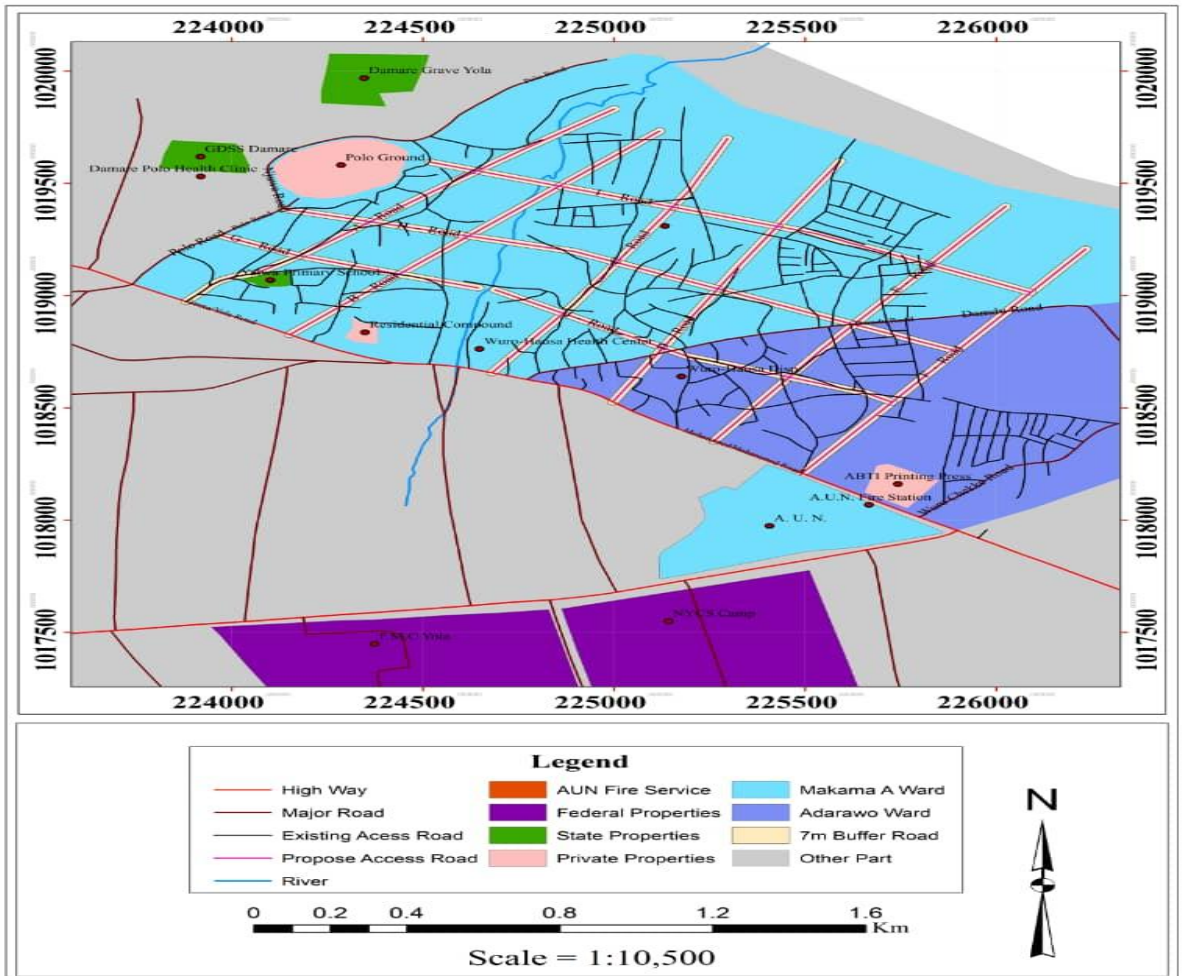

Fig.4.8 Overlay map of the existing and the proposed Access Roads in the Study Area

V.Conclusion

In conclusion, the findings revealed the ancient parts of Yola that are lacking adequate access roads and the few existing roads found there with the exception of Polo road, Damdu Road and Wuro-chekke road are very poor, too narrowed, untarred and having dead ends, that's why most of the population living there are found to be deprived from having access to any emergency response, accessibility and basic social amenities. The access roads are 16 in number with a total distance of 10.506km that ziz-zag across some areas but in an irregular manner and too narrow to allow two vehicles to pass which prove difficult in terms of planning or making a decision for any social amenities to be laid in the study area as it is now. Consequently, a propose access road map was design and a comparison was made between the existing access roads and the new propose access road in terms of extent and service with respect to accessibility and emergency response using network analysis.

Therefore, in the course of this study, it was discovered that, the service provided by the existing access road in the study area is very minimal, as many areas were found to be inaccessible, as shown in figure 4.1, 4.2, 4.3 and 4.4. But, the propose access roads, will help in easing the problem of inaccessibility of those areas if implemented as shown in figure 4.5, 4.6, 4.7 and 4.8 above because the access roads will interconnect all the areas thereby enhancing mobility, emergency respond of any kind throughout the study area even in rainy season as well as water supply, electricity distribution, Garbage collection etc as supported by Wanjiru [21].

Basically, the research has achieved its objectives of mapping the existing roads, identifying inaccessible areas, designing the propose access roads, determining the service extent of the existing and the propose access roads in case of emergency response as well as comparing the services provided by both the existing and the proposed access road through overlay. Findings from this research showed that, the existing access roads that are very few in the study area were narrow and irregular as a result of haphazard encroachment of structures into the street space. In some areas, the street is as narrow as one meter while the maximum size before was 4 meters. This made it very hard for vehicles to navigate their way into interior areas of Makama A and Adarawo ward. But in the proposed design, the current street size is 13.5 meters which constitutes 2 lanes of 4.5 meters each,

storm water drainage of 1 meter on each side of the access roads and the rest is used for infrastructure or utilities installation.

Recommendations

The research has unveiled the current condition of some parts of Yola town particularly the ancient parts hence, the following recommendations were suggested:

1. The existing roads in the study area should be widened or expanded to open up the bad and haphazard development in the study area.
2. Inhabitants of those communities should stop encroaching into the only available street space in their areas to ease the problem of inaccessibility and emergency response.
3. The urban renewal of the ancient parts of Yola town should be carried out through a systematic and participatory renewal programs to reduce the economic burden of the affected areas.
4. Provision should also be made for the periodic revision of the street map and production of more access road maps of major towns in Adamawa State.
5. Damdu road, NjoboliyoroadandYerima Street should be re-tarred.
6. The untarred existing roads that are 7m wide should also be tarred to ease the immediate problem of inaccessibility and emergency response.

Further Studies

This study should be replicated or extended to other areas not covered by the study.

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APPENDIX I. GPS Coordinates of Some Points in the Study Area

Eastings (m)	Northings (m)	Description
224571	1019604	Makama A ward
224776	1019599	Makama A ward
224678	1019443	Makama A ward
224512	1019488	Makama A ward
224432	1019385	Makama A ward
224638	1019224	Makama A ward
224335	1019071	Makama A ward

223370	1019341	Makama A ward
223985	1019193	Makama A ward
223854	1019087	Makama A ward
224239	1019021	Makama A ward
224216	1018883	Makama A ward
224393	1019060	Makama A ward
224454	1018933	Makama A ward
224443	1018790	Makama A ward
224678	1018760	Makama A ward
224774	1018941	Makama A ward
224751	1019083	Makama A ward
224798	1019064	Makama A ward
224870	1019118	Makama A ward
224959	1019237	Makama A ward
225132	1019299	Makama A ward
225090	1019214	Makama A ward
225101	1018975	Makama A ward
225132	1018906	Adarawo ward
225332	1019083	Adarawo ward
225263	1018875	Adarawo ward
225056	1018780	Adarawo ward
225468	1018796	Adarawo ward
225564	1018653	Adarawo ward
225568	1018471	Adarawo ward
225385	1018598	Adarawo ward
225238	1018566	Adarawo ward
225127	1018641	Adarawo ward
225004	1018586	Adarawo ward
225282	1018419	Adarawo ward
225798	1018384	Adarawo ward
225631	1018336	Adarawo ward
225742	1018257	Adarawo ward
225603	1018245	Adarawo ward
225431	1018433	Adarawo ward
225402	1018360	Adarawo ward

APPENDIX II: Attribute Data for the Existing Access Roads in the Study Area

S/No.	Road Name	Nature & Length(m)	Width(m)	Junction point Coordinates	Ending point Coordinates	Condition
1.	Polo road	Tarred-600m Untarred-400m Total=1000m	9m & Shoulder of 1.2m	223560 1019413	224386 1019429	Good
2.	Yerima Street	untarred-600m	6m	223707 1019341	224190 1019394	Bad
3.	Demsa Street	Tarred-500m Untarred-300m Total=800m	7m 4m	2237019 1019422	224461 1019091	Very Bad
4.	Njoboliyo road	Untarred-600m	3-4m	224048 1019106	224386 1019429	Very Bad
5.	Lamdomandara road	Untarred-700m	6m	224335 1019071	224548 1019271	Very Bad
6.	Damdu road	Tarred-1,400m	7m & Drainage of 1m	224589 1018999	226052 1019321	Moderately Good
7.	Wuro-Chekke road	Tarred-1,375m	8m & Drainage of 1m	225628 1018384	226052 1019321	Good
8.	Njuwa road	Tarred-1,111m		2234078 1019955	2247110 1020385	Moderately Good
8.	Unnamed road 1	Untarred-600m	5m	224798 1019064		Very Bad
9.	Unnamed Road 2	Untarred-570m	4m	224265 1019937		Very Bad
10.	7 Unnamed Roads	Untarred-<200m	1-3m	Incorporated in GPS data of the study area.		Very Bad