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IMPLICATIONS OF THE PHYSIOGRAPHY OF MAIDUGURI METROPOLITAN ON URBAN PLANNING AND DEVELOPMENT

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Abstract

The need for early urban planning of the Maiduguri Metropolitan Area cannot be overemphasized as it will help in preventing premature urbanization and overcrowding of areas. Urban planners depend on some physiographical data such as the topography, drainage and hydrology, soil and vegetation to maximise effective urban planning. Only a small part of the entire Maiduguri Metropolitan Area was planned and has been developed or developing so far. Vast land area without master plan is still available and waiting for development. There is the need for Urban Planners and related Urban Development Agencies to start the planning of the development processes and stages into which the entire Metropolitan Areas will be utilized for sustainable development. The planning and development of any area are largely influenced by the physiography of the area which calls for assessment of the physiography of Maiduguri Metropolitan Area for urban planning and development. The actual location of Shehu's palace was determined through the use of Germin 76 GPS. The Buffer module of ArcGIS 10.7 was used to determine the 25 km^2 radius from the already generated position of the Shehu's palace. The relief or topography of the area was derived through the use of SRTM DEM data which was processed and classified into five main classes: low floodplains, high floodplains, lowland areas, moderately upland areas and upland areas. The rivers and streams within the Maiduguri Metropolitan area were also generated from the SRTM DEM data through the fill, flow direction, flow accumulation and stream order modules of ArcGIS 10.7. Alau dam and Jere bowl areas were delineated from the 2022 satellite image of the Maiduguri Metropolitan area. Landsat 8 (OLI) image of December 2022 was acquired and classified into the landcover types using NDVI indices. The results show the location and spatial pattern of the extent, relief, drainage and vegetation within the Metropolitan area. Some important feature that may impact urban planning and development such as Bama Beach Ridge, River Ngadda, Jere Bowl and Alau dam were also mapped and analysed. The vegetation of the area was also found to be depleting, while land degradation is expanding in the area. It was recommended that early urban planning and development of the area should be put in place using geospatial techniques, while the interaction of the Ngadda River with Jere Bowl and Alau dam should be strengthened to ensure water provision and irrigation services in the Metropolis.

Keywords: Bama Beach Ridge, Jere Bowl, River Ngadda, Maiduguri Metropolitan Area, Urban Planning and Development, Physiography,

1.1 Introduction

The term Metropolis comes from the combinations of two Greek words: *meter* which means 'mother' and *polis*, meaning 'city'. Metropolis is defined as a large and densely populated urban area, which may include several independent administrative units (Tom, 2018). Waziri, (2011) also defined Metropolitan area as usually combines a contiguous built-up area with peripheral zones not themselves necessarily urban in character, but closely bound to the center by employment or commerce. World

Population Review (2023) put New York City in United States in America as the largest Metropolitan area in the world with 12, 093 km^2 built-up land areas but with a population of 20, 902,000 people. In Africa, based on the report of World Population Review (2023), Cairo is the largest Metropolitan area with a land area of 2,734 km^2 and 28,504,352 people, that is a population density of 10,425 persons per km^2 as at January, 2023

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According to Waziri, (2011), the Borno State Urban Planning and Development law in 2001defined the Metropolitan area of Maiduguri the State capital of Borno State as all areas not exceeding 25 kilometres radius from the Shehu's palace. The area becomes a definitive area of jurisdiction to Urban Development Board for issuance of Certificate of Occupancy, urban planning and development control. Maiduguri is not the only city in Nigeria to have defined their urban boundary with radius. The geographic boundary of Makurdi the capital of Benue State was also defined by radius. The extent of the present day Makurdi is a 16 km radius from the General Post Office along the Beach Road in Makurdi (Ajene and Ogorry 2016), with a total land area of about 819.86 km^2. There is the need for urban planners and related Urban Development Agencies to start the planning of the development processes and stages into which the Metropolitan town will be used for sustainable development. Only a small region of the core of Maiduguri has been planned (Charles *et al,* 2019). The need for early urban planning of the Maiduguri Metropolitan Area cannot be overemphasized as it helps in: preventing premature urbanization and overcrowding of areas, minimize regional disparities, recognize the futuristic urban realities (revolution in the field of transportation and communication, rural isolation and increased interaction between rural and urban communities, increased volume of traffic and trades, increased population mobility both inter regional and intra-regional and finally new regional boundaries with intensified integration), and altered the population-resources relationship in many areas. Urban planners depend on some physiographical data such as the topography, drainage and hydrology, patterns of vegetation and soil units to maximise effective urban planning. It is against this background that this study was carried out to assess the physiography of Maiduguri Metropolitan Area for future urban planning and development with the main objective of analysing the physiography (topography, significant landforms, drainage and vegetation of the Maiduguri Metropolitan Area and its influence on urban growth patterns

2.1The Study Area

The birth of Maiduguri city could be traced to the era of Kanem Borno Empire. According to Waziri (2011), Maiduguri city was created by the British colonialists as a new capital for the then Kanem Borno Empire. The process of the birth of Maiduguri city started on 7th, January 1907 when the then Shehu Abubakar Garbai El-Kanemi was advised to relocate to a new location by the British colonialists. The then Shehu named the location where he settled *'Herwa'* or '*Yerwa'* which means *'the place of prosperity'* in Kanuri language, but close to that location was an existing settlement called Maiduguri. Kwaka (2002) in Ikusemoran and Jimme (2014) traced the origin of this existing Maiduguri to the people of the Maidugu (title of a descendant of a ruler) who arrived during their raids and settled around the areas. The hunters who had earlier settled near the river invited the people of the Maidugu to settle with them. The Maidugu took his people and settled with the hunters near the river. They called that place Maiduguri: meaning the town of the Maidugu. Maiduguri latter became an important town because "whatever major road one takes, when you come to that place

from the east, you will stay, from the south, you will stay there and from the north, it will be that place where you will stop. It became a busy trading center".

Therefore, two prominent places (Yerwa and Maiduguri) with close proximity were existing but the colonialists prefer calling both locations Maiduguri. Durkwa (2019) noted that Maiduguri actually consists of two cities: Yerwa to the west and old Maiduguri to the east. Old Maiduguri was selected by the British as their military headquarters in 1908 and became the seat of the British resident commissioner. In 1957, Yerwa became the designated name of the urban centre, while Maiduguri was officially applied as the name of the surrounding rural area. Today both Yerwa and Maiduguri exists but have no distinct boundary because they have since merged together. Maiduguri has been an administrative headquarters for several decades; it was the Divisional headquarters of Borno Native Authority and the Provincial headquarters of Borno Province. In 1967 when North-East Region was created, Maiduguri became the regional capital. It also maintained Borno State headquarters when Borno State was created in 1976 till date. Maiduguri Metropolitan Council (MMC) came to being when Borno State was created in 1976 and Maiduguri Metropolitan became the headquarters of Maiduguri LGA. In 1991, Jere LGA was carved out of MMC with Yerwa area maintaining the MMC. Waziri, (2011) concluded that 'Maiduguri and Yerwa should be seen as a single city with two names; Maiduguri as the formal name and Yerwa as the traditional name'. At present the most reliable map of Maiduguri Metropolitan area is that of the Maiduguri Reference map (OCHA, 2018) with a rectangular area of about 647.73km^2 but with only about 130.84km^2 (20.20%) developed area (Durkwa, 2019). The present Metropolitan area contains the all the core Districts of Yerwa (Shehuri North and South, Jabbamari, Limanti, Fezan, Mafoni, Bulabulin, Hausari among others) and some of those at the peri-urban areas such as Dusuman, Gongolo, Old Maiduguri, Tamsu/Ngamdua, Bolori (1&2) Dalori/Walori, Galtimari and others as well as parts of Jere, Konduga, Mafa and Magumeri LGAs. The road networks within the Metropolitan areas to all directions from the center shows that Maiduguri is a nodal city.The land areas and the percentages of each of the riparian LGAs are shown in Table 1. Fig.1 shows the extent and the riparian LGAs of the Metropolitan Area.

The 25 kms radius from Shehus palace in Maiduguri covers a total land area as calculated in this study using Geographic Information System (GIS) techniques as 1963.36 km^2 which is very similar to that of Waziri, (2011) with a perimeter of 157.08 kms. The Maiduguri Metropolitan area cuts across five (5) LGAs; that is the whole area of Maiduguri Metropolitan Council (MMC)

Table 1. Land areas and percentages of the LGAs within Maiduguri Metropolitan area

LGAs	Land Area	Land Area within Maiduguri City	Percentage of LGA	Percentage of Maiduguri City Area
Jere	851.64	709.31	83.29	36.13
Konduga	5941.90	860.61	14.48	43.83
Mafa	2852.55	216.77	7.60	11.04
Magumeri	4727.39	37.45	0.79	1.91
MMC	139.22	139.22	100	7.09
		1963.36		100

Source: Calculated from Borno State Reference map (OCHA, 2018) using GIS technique

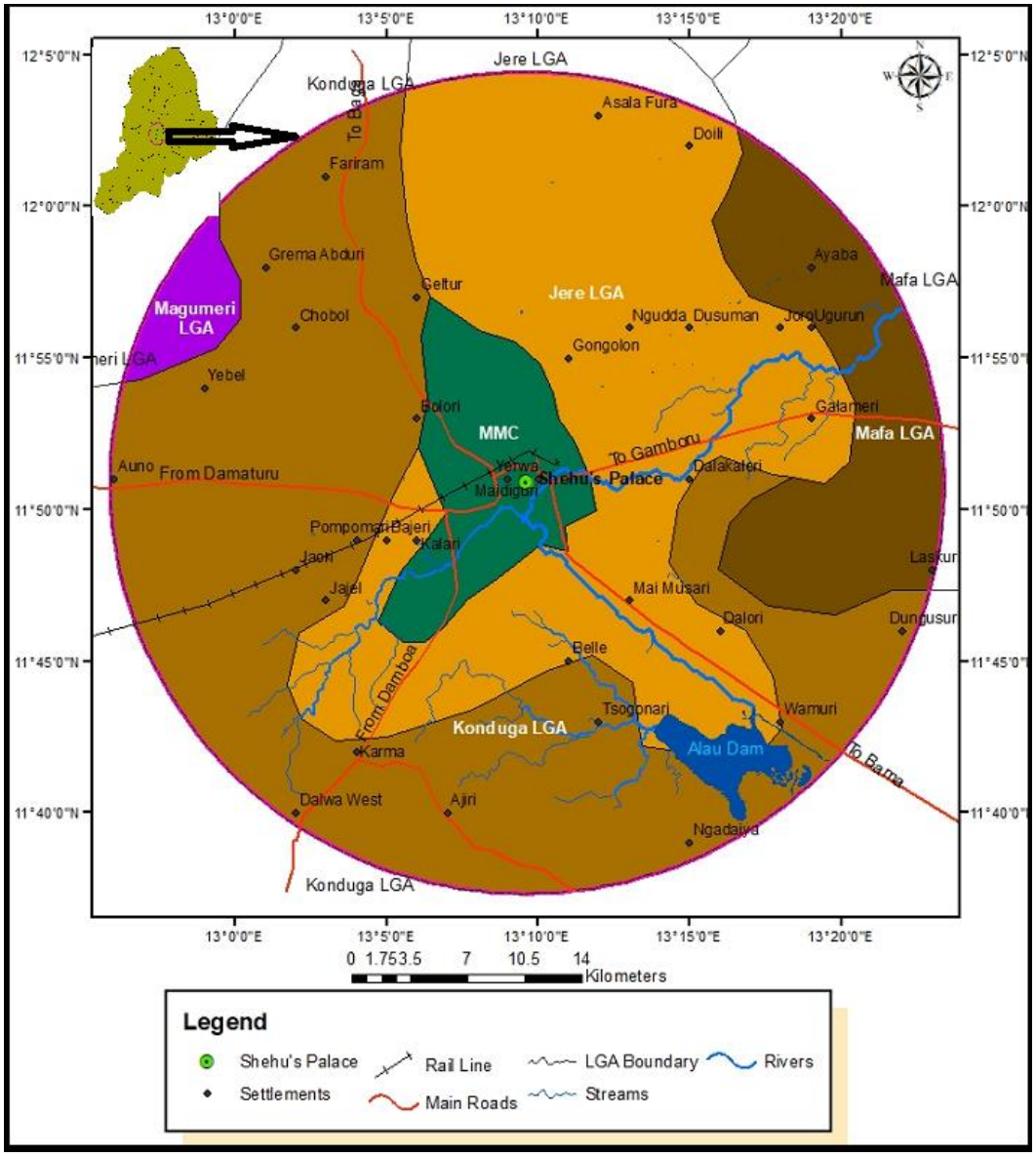

Figure 1. The study area showing the riparian LGAs
Source: Generated from the Political map of Borno State (Ikusemoran and Jimme 2014)

Table 2 shows the main villages in each of the LGAs within the Metropolitan area

S/N	LGAs	Important Villages
1	Jere	Asala Fura, Bajeri, Belle, Doili, Dalakaleri, Dalori, Dusuman, Galameri, Gongolon, Joro, Kalari, Mai Musari, Nguda, Ugurun and Wamuri
2	Konduga	Ajiri, Auno, Dalwa West, Dugunsuri, Bolori, Chobol, Fariram, Geltur, Grema Abduri, Jajel, Jaori, Karma, Ngadalwa, Pompomari, Tsogonari and Yebel.
3	Mafa	Ayaba and Laskuri
4	Magumeri	
5	MMC	Yerwa and Maiduguri

Source: Generated from DivaGIS settlement locations

3.1 Methodology

The following data were utilized from this study; Germin 76 Global Positioning System (GPS), political map of Borno State obtained from UN-OCHA (2018), Landsat 8 OLI Satellite image of Maiduguri Metropolitan,

SRTM DEM Data of Maiduguri Metropolitan, settlement pattern maps and road map. Google Earth Pro software and ArcGIS software were also utilized for the analysis of the acquired data. The actual location of Shehu's palace was determined through the use of Germin 76 GPS. The Buffer module of ArcGIS 10.7 was used to determine the 25 km^2 radius from the already generated position of the Shehu's palace. The Borno State Reference map (UN-OCHA 2018) comprising all the LGAS was digitized in ArcGIS environment, while the point representing the position of Shehu's palace and the 25km^2 radius were overlaid on the Borno State digital map. All the parts of the five riparian LGAs that fell within the Maiduguri Metropolitan radius map were clipped in ArcGIS environment while the areas of the entire LGAs and parts within the radius were calculated using the area calculation module of ArcGIS. The settlements map of Nigeria was also overlain on the Maiduguri Metropolitan radius map while those within the radius were extracted through the clipping module of ArcGIS. The roads were digitized from Google Earth Pro and overlain on the Maiduguri Metropolitan radius map.

The relief or topography of the area was derived through the use of SRTM DEM data which was processed and classified into five main classes: low floodplains, high floodplains, lowland areas, moderately upland areas and upland areas. The Rivers and streams within the Maiduguri Metropolitan were also generated from the SRTM DEM data through the fill, flow direction, flow accumulation and stream order modules of ArcGIS 10.7. Alau dam and Jere bowl areas were delineated from the 2022 satellite image of the Maiduguri Metropolitan. Landsat 8 (OLI) image of December 2022 was acquired and classified into the land use and landcover types using NDVI indices with the following formula: NDVI = (NIR – Red) / (NIR + Red), For Landsat 8 data: NDVI = (Band 5 – Band 4) / (Band 5 + Band 4). The NDVI value varies from -1 to 1. Dense vegetation is delineated from the values of the NDVI because higher value of NDVI reflects high Near Infrared (NIR), that is, dense vegetation. Vegetation indices were used for the classification of the image based on the following: NDVI = -1 to 0 = water bodies, NDVI = 0.1or close to 1; = barren rocks and sand, NDVI = 0.2 to 0.5 = shrubs and grasslands and NDVI = 0.6 to 1.0 = dense vegetation (Kshetri, 2018).

4.0 Results and Discussion

4.1 Implications of the Physiography on Urban Planning and Management

4.1.1. Topography

Fig. 2 shows the relief of Maiduguri Metropolitan with elevation of the area ranging from 291 to 352 m above sea level. This shows that the entire Metropolitan area can be said to be generally in a low relief region since the highest spot in the area is only 352 above sea level. This finding is a great advantage to the metropolitan because developmental projects and expansion of the Metropolis will be easier than places in rocky topography. Omole and Owoeye (2012) stated that the topography of an area is the pivot on which its growth and development revolves. In the physical development of any settlement, either rural or urban, a relatively flat land is for expansion and internal development is very essential.

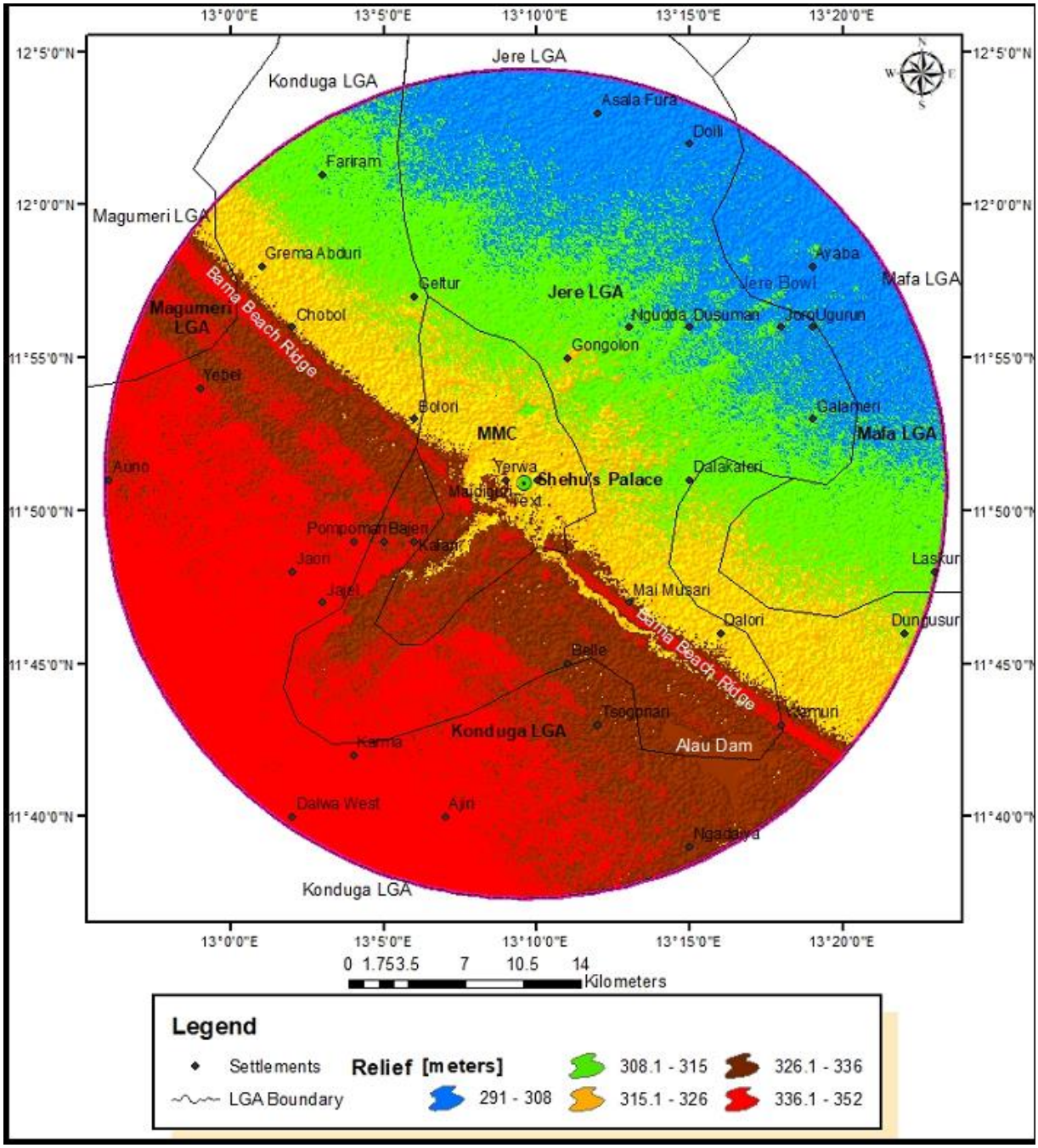

Figure 2. The relief of Maiduguri Metropolitan
Source: Generated from SRTM DEM Data

The Bama Beach Ridge which runs from the South-East to North-West area within the Metropolis divide the landscape into high (upland area) and low terrain (floodplains areas). The western side of the Bama Beach Ridge within the Metropolis covers a total land area of about 1042.13 km^2 which is about 53.08% of the Metropolitan land area. The elevation of the area ranges from 291 to 326 km^2. For effective urban planning, the upland areas are suitable for estate development, residential expansion, industrial educational and development because the areas are less prone to flooding due to their relatively high relief. In the low relief areas which constitutes the larger parts of Jere bowl, Green areas and agricultural development can be sited in such places. It must also be noted that transport development and maintenance will be easier

at the upland than the low relief areas. Fig. 2 also revealed that the valleys of Rivers Ngadda and Ngaddabul are gradually being degraded, hence, effective soil erosion and flood management strategies must be put in place in the areas now for sustainable urban planning and development.

4.1.2 Bama Beach Ridge

The most remarkable physical feature in this area is the Bama Beach Ridge (BBR). Kagu and Yelwa (2009) defined BBR as a place which has withstand the test of geologic time amidst geologic processes which occurs at an elevation that is relatively higher than its surrounding. The BBR has been described as a long sandy ridge made up of layered sand and gravel bands (Ijere and Daura, 2000; Abafoni and Funtua, 2014). It was also believed that the Ridge marked the extent or the margin or the terminal edge of the Chad Mega Lake (Abafoni and Funtua 2014, Zarma and Tukur, 2015, Nyangaji, 2009). Bama Beach Ridge has been noted to have run from the foot of Mandara Mountains in North-East Nigeria through; Bama, Konduga, Maiduguri to the Geidam in Yobe State with estimated distance of about 300 kms (Kagu and Yelwa, 2009), The BBR within the Metropolitan area stretched for about 50 kms distance from South-East in Konduga LGA to the North-West in Magumeri LGA (Fig..). The height of BBR within the Metropolitan area fall within the range of 336.1 to 352 m above sea level which conforms with the earlier findings of Nyangaji (2009) that the relief of BBR is about 338 m asl west of University of Maiduguri. The BBR is a feature of preservation, hence, all efforts by the Urban planners should be geared towards preserving the BBR for future, reference, documentary, research and academic purposes. BBR has been discovered to have been interrupted by sand dunes especially at Gudumbali in Borno State (Ijere and Daura, 2000), soil erosion along the valleys of Rivers Ngadda and Ngaddabul has also successfully cut through BBR at Maiduguri (Fig. 2). Therefore, land control and preservation mechanisms around the area must be put in place to prevent the BBR from total extinct in the area. Finally, Kagu and Yelwa observed excessive sand mining on the BBR in Maiduguri which has degraded some parts of the BBR which also call for control in the face of its provision for raw materials and sources of employment to some people

4.2 Drainage

The main rivers within the Metroplotan Area is River Ngadda and Ngaddabul which is the major tributary to Ngadda. There are other streams at the northern part of the Metropolitan Area. All the rivers and streams within the area are however seasonal as River Ngadda that was once perennial is now more of seasonal. The banks of the two main Rivers within the Metropolis are annually prone to floods while the downstream area especially at the custom side are used for irrigation.

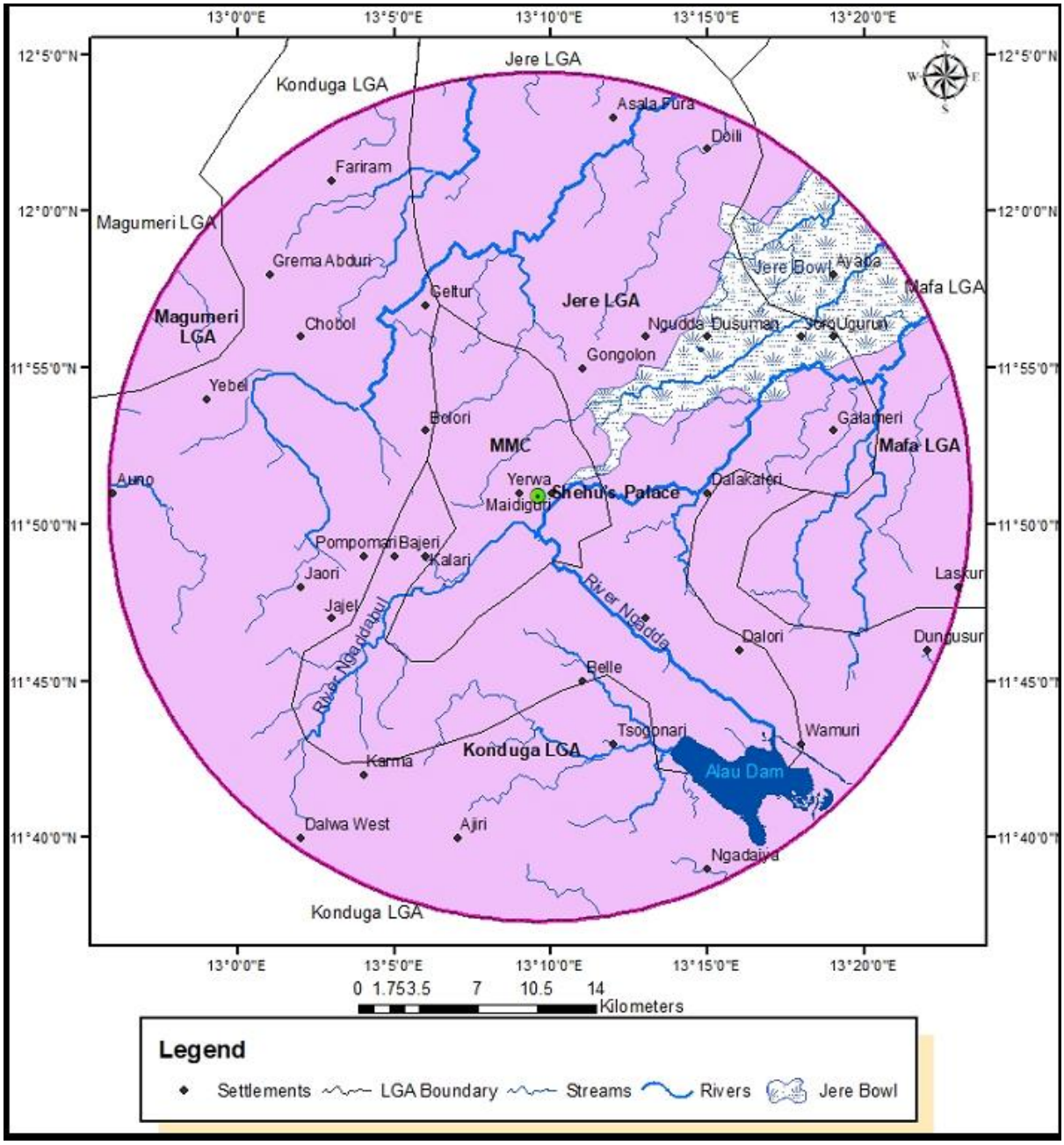

Figure 3. Drainage in Maiduguri Metropolitan
Source: Generated from SRTM DEM data

4.2.1 Alau Dam

The construction of Alau dam on River Ngadda in Konduga LGA which began on 1st August 1984 was completed in 1986 However, the spillways were not installed until 1989 (Babagana *et al*, 2015). The reservoir was impounded mainly for domestic and industrial water supply for the inhabitants of Maiduguri metropolis and for irrigation of over 8,000 ha of farmlands within the reservoir Bankole, 2011; Babagana *et al*, 2015). According to Borno State Hotels and Tourism Board (2020) the current location of Alau dam was the spot where Idris Aloma who was a famous warriors, hero and charismatic leader of the ancient Kanem Bornu Empire was buried, which gave rise to the naming the dam as 'Alau'. Babagana *et al*, (2011) also reported that Alau Dam received water from River Yedzram and River Gombole which meet at a confluent at Sambisa and flow as River

Ngadda into Alau Dam. Borno State Hotels and Tourism Board (2020) itemised the following benefits from Lake Alau; intensive farming, especially irrigation agriculture where spinch, onions and. tomatoes are being cultivated. Fishing activities (domestic and commercial) at the Lake's shores. Bukar (2006) also reported that Alau dam supplies water to substantial part of Maiduguri urban and environs with maximum yield of about 25, 000,000 litres per day.

Besides all these derivable benefits of the Alau dam, numerous problems have also been associated with the dam. For instance, Babagana *et al*, (2015) opined that since the completion of Alau dam, natural inflow of the Ngadda into Jere Bowl had reduced or completely ceased. This assertion was corroborated by Ijere and Odo (2002) that Alau dam was constructed by the Borno State government for two main purposes: urban (Maidugri) water supply and Jere Bowl Rice Irrigation scheme. However, in the post dam era, annual rainfall fell below the average and was not enough to sustain the two schemes which makes the State government to jettison the Jere Bowl Rice Irrigation Scheme and concentrate only on Urban Water Supply. Since then rice production in the wetlands reduced till date. Another associated environmental problem to Alau dam is that at the peak of rainfall in August, the flow within the channel causes serious flood incidences. The major excessive flood years after the impoundment of the dam were 1992, 1994 and 2012 leading to loss of lives and properties (Babagana *et al*, 2015). Abbagana, (2021) also reported that due to the opening of the spill ways of Alau dam on the 17th, August, 2021, a child drowned in the swirling waters of the Ngadda River. Water pollution was also reported by Dammo and Sangodoyin (2014) in their findings which revealed pollution with high concentration of nitrate (260–230 mg-NO_3/l), phosphate (22–28 mg/l) and *Escherichia coli* (13–24 n/100 mg). This arose from improper sanitary management, inadequate public education on irrigation, indiscriminate waste disposal and some farming practices. Since the construction of Alau dam was to provide water for Maiduguri urban as well as for irrigation of agricultural activities in the Jere Bowl but currently the Alau dam could not provide water for irrigation at the Jere Bowl, Urban Planners can revisit the operation of the dam and assess whatever can be done to derive the two objectives from the dam. The associated problems to Alau dam especially flooding can also be minimized with proper urban planning and enforcement of laws guiding the city development.

4.2.2 Jere Bowl

The Jere Bowl is an irrigated land mass formed by the flow of the Ngadda River in Jere LGA, which slope to the direction of Lake Chad. Jere Bowl has a cultivable land area of about 22,000 ha, out of which a gross area of 15,850 ha was identified as suitable for irrigated agriculture (Wakil, 2018). The Jere Bowl moist farmland, has the capability to produce more than 30,000 tonnes of rice annually and also a source of livelihoods for millions of people (FAO, 2019). Susceptibility to flooding, resulting in a perennially moist soil even during dry season, makes the area favourable to rice cultivation. The agricultural potentiality of Jere Bowl depends on the viability of water in Alau Lake and Jere Bowl itself. Most importantly, water inflow into Alau Lake and Jere Bowl depends on the natural inflow of River Ngadda and to some extent run-off from the environs during the rainy season (Ijere and Odo, 2002). Therefore, the success of Alau dam for water provision and irrigation and the use of Jere Bowl for crop

production through irrigation depends on the amount of water inflow of the Ngadda River. The damming of the upstream of River Ngadda at Alau (Alau dam) has greatly negatively impacted on irrigation activities in Jere Bowl. According to Bello *et al*, (2021), underground water through borehole has been the major source of water for irrigation within the Jere Bowl with abundant surface water only from November to January. Irrigation farmers whose major source water is either stream or river mostly have an alternative source of water during scarcity period month of March, the only source of irrigation water in the Bowl is the groundwater. available at 5m to 9m depth at lower elevation in the Bowl during the months of March and April while from May to June it drops to about 9 to 12meter depth. Food production is very essential in the existence and sustenance of the populace. Jere Bowl should be properly preserved and conserved, urban planners, civil and agricultural engineers can study the existing situations and condition of the area to bring back the Bowl for maximum agricultural practices through proper planning.

4.3 Vegetation

Maiduguri urban falls within the Sudan Savannah vegetation belt. (FEWS NET and USAID, 2018). Sudan Savannah is characterized by abundant short grasses of 1.5-2 m and few stunted trees hardly above 15 m and with different types of acacia with an umbellate crown and thorny bushes (Akawu, 2021). The vegetation has undergone severe destruction while desert-like characteristics are setting in due to excessive cultivation, wood exploitation and overgrazing (Odihi, 1996, Waziri 2009). Today, hardly any natural vegetation can be found around the Metropolitan Area (Thiermeyer, 2002). Artificial vegetation however is common in the Metropolitan Area as noted by Ayuba (2009); Ikusemoran and Jimme (2014) that on the major streets of towns in Borno state there are exotic species of *Aza dirachta indica, Gmelina arborea and Eucalyptus spp* which are to protect the environment from drought and desertification, and to supply fuelwood and other minor forest products. On the need for artificial vegetation in the area, Ikusemoran and Jimme (2014) reiterated that the city is protected from intense rays of the sun with trees starting from the colonial authority when tree planting was a priority. Table 3 shows the spatial patterns and the changes in the landcover between 1987 when Alau dam was just impounded and 2017, that is a period of forty years.

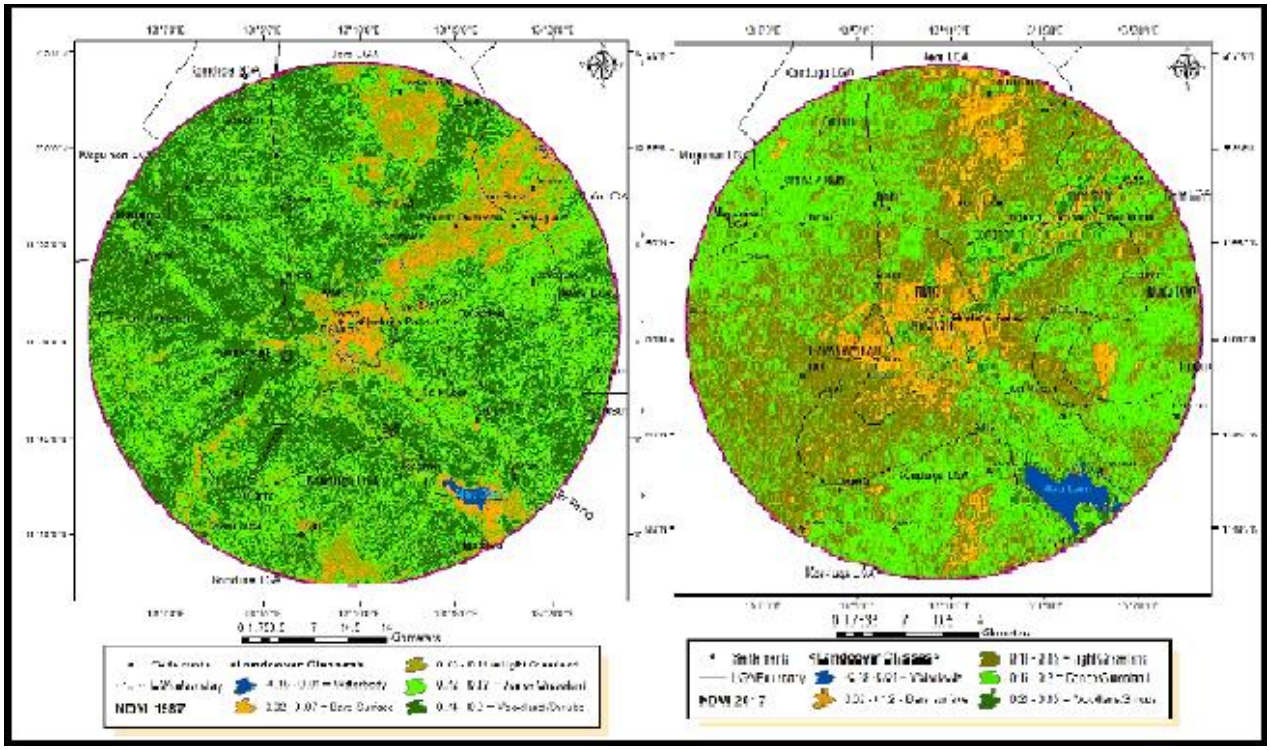

Figure 4a: Vegetation in the Metropolitan in (1987). Figure 4b: Vegetation in the Metropolitan in (2017)

Table 3. Landcover changes in Maiduguri Metropolitan Area between 1987 and 2017

Landcover	1987		2017	
	Area (Km^2)	%	Area (Km^2)	%
Waterbody	10.87	0.55	25.17	1.28
Bare Surface	97.70	4.98	190.67	9.71
Sparse Grassland	257.48	13.11	872.79	44.45
Thick Grassland	728.82	37.12	823.26	41.93
Woodland/Shrubs	868.49	44.23	51.47	2.62
Total	**1963.36**	**100**	**1963.36**	**100**

Source: Calculated from the classified Landsat images of the two-year period

Table3 shows that waterbody in the area increased almost twice of its initial size due to the impoundment of the dam in 2017 as against when water was still accumulating in 2017 (Figures 4a and 4b). Bare surface also increased almost double in size which can be attributed to constant increase in population and built-up areas (Ikusemoran and Jimme, 2014) which has led to land degradation inform of vegetation depletion due to urbanization, cultivation and tree harvesting for fuel wood (Odihi 1996; Waziri, 2009; Ayuba, 2009). Sparse grassland currently covers the largest area within the Metropolitan area. Thick grassland area has also increased. In fact, about 86% of the Metropolitan Area are currently covered by grasses. Woodland/Shrub landcover areas have drastically decreased and giving way to grassland areas. In 1987, woodland and shrubs occupied the largest land area (44.23%) but as at 2017, the landcover became the second to the least land area (after waterbody). This finding shows that vegetation depletion is a serious environmental problem that its preservation through effective planning and conservation cannot be overemphasized for development.

5.0 Conclusion

The physiography of Maiduguri Metropolitan Area has been assessed in this study taking into consideration the location and extent, relief, drainage and vegetation as well as the implications of the features on urban planning and development in the area. The Maiduguri Metropolitan area consists of 25 km radius from Shehu's palace which cuts across five (5) LGAs; that is the whole area of Maiduguri Metropolitan Council (MMC) as well as parts of Jere, Konduga, Mafa and Magumeri LGAs. Bama Beach Ridge almost divides the Metropolitan area into two halves, while the eastern side are of low relief and prone to floods, residential buildings and road construction in such areas may be more difficult. Therefore, development projects are preferred at the higher elevation of the western side of the Metropolis. The Jere Bowl and Alau dam as well as Rivers Ngadda and Ngaddabul which are two main Rivers within the Metropolis are major determinants in the urban development of the Metropolis as these features should be taken into consideration in the planning of the Metropolitan area so as to maintain water provision and irrigation for agriculture while minimising the possible environmental hazards that might be caused by their presence. Vegetation depletion and land degradation (increase in bare surface areas) have been observed in the area, therefore, urgent and effective planning processes should be put in place to conserve the land and vegetation within the Metropolitan area for sustainable development. The impact of the physiography on the Masterplan of the Metropolitan area is suggested for further studies.

6.0 Recommendations

(i) All relevant Ministries and Agencies such as Ministry of Environment, Urban Planning as well as Borno State Geographical Services should embark on urban planning and control of the yet to be developed parts of Maiduguri Metropolitan now in the face of the rapid population growth and resource utilization to prevent premature urbanization and overcrowding of areas and minimize regional disparities as well as minimize potential environmental problems and hazards.

(ii) Ministries of Agriculture and Water Resources should embark on sustainable development and utilization of Ngadda River to increase water accumulation into Alau dam and Jere Bowl for water provision into the Metropolitan Area and irrigation for food production respectively.

(iii) There is the need to conserve and protect important natural features within the Metropolitan such as Bama Beach Ridge and Jere Bowl by the state government in order to harness their existence and their benefits to man and environment.

(iv) The land and vegetation within the Metropolitan should urgently be preserved by the state government to prevent land degradation that can inhibit aesthetic scenery and land availability for future development.

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