Bima Journal of Science and Technology, Vol. 8(1B) Apr, 2024 ISSN: 2536-6041

DOI: 10.56892/bima.v8i1.611

Analysis of Landforms Distribution in Gombe Metropolis, Gombe State, Nigeria

Abashiya, M. and Sule, S.

Department of Geography, Gombe State University, Gombe, Nigeria

Corresponding Author: mabashiya@gmail.com

ABSTRACT

This study provides identification and classifications of recent progress in landforms analysis of Gombe metropolis using Geospatial techniques. It focuses on some topographic factors that are important in characterizing the biophysical functions of topography: elevation, contours, topographic position and spatial scale. The Digital Elevation Model (DEM) map showed the three terrain classes as well as their heights, where the least elevation found in areas that includes Bogo, Yelenguruza and Nasarawo with 368m above sea level, with the Liji hills peaking at 670m above sea level. The 10m contour interval clearly differentiated the plains from the highlands with wide and close contour lines respectively. The relief of the metropolis as revealed in conformity with the description that the topography consist of undulating, rugged, and hilly to the southeast and north-eastern part and flat open plains in the central and north-west. The area covers a total of 95.26 square kilometer with 48.08% of plains, 28.74% uplands and 23.18% covered with highlands. However, human activities such as settlements, farming, grazing and mining on the hills and their slopes will continue to modify the topography if not checkmated. The study recommends that human activities on the hills should be well controlled, local communities around the hills or valleys should be educated by the local authority about the dangers associated with their activities. Also more research on automated terrain analysis, especially on the use of topographical features in Gombe metropolis should be carried out.

Keywords: Analysis, Geospatial Techniques, Gombe metropolis, Hills distribution, Landforms.

INTRODUCTION

In the realm of geomorphology, landforms play a vital role in determining the decision making of where certain infrastructures and developments can be located in the city as well as the activities of Man in the settlements (Gustavsson, 2005). Prior to the use of Digital Elevation Models (DEMs), landforms were only manually identified by means of surveys through interpretation of aerial photographs (Garbrecht and Martz, 2000). During the 19th and early 20th century, the study of the landforms aimed at the production of physiography maps (Thornbury, 1965). Since World War I, aerial photographs were extensively used to give a view of the enemy's area, aiming at a description of the landforms, during this period, aircrafts were equipped with cameras to record army movements (Pavlopouloset et al., 2009). In the early 60's when Nigeria got her independence, the need for national mapping arose which led to the generation of aerial photographs of the country between 1969 and 1970 (Abdullahi, Odihi1 & Wanah, 2015). Subsequent topographical maps based on the aerial photographs were derived and from then till now, no any form of national aerial photography has been embarked upon. Apart from the non-coverage of the 1960s aerial photographs of some parts of the country, information generated from these aerial photographs that were taken more than four decades ago are usually regarded as obsolete because so many activities on the terrain must have taken place within the long periods, hence, the need for recent data on such areas. This calls for the need for digital terrain analysis of Gombe metropolis.

Terrain analysis is the interpretation of topographic features using field observations,

DOI: 10.56892/bima.v8i1.611

measurements, remote sensing and geographic information systems. Such features include slope, aspect, view shed, elevation, contour lines, hill shading and other landforms features (Chakraborty & Joshi, 2014). Landforms are specific geomorphic features on the Earth, ranging from large-scale features such as plains, uplands and highlands ranges to minor features such as individual gullies, rock outcrops, spurs and valleys that have a definite range of physical and visual characteristics (Goudie, 2006). The intention is to have a geographical abstraction of surface terrain in order to delineate landscapes and create an understanding of the relationship between geomorphic processes and physical landscapes (Meena & Gupta, 2017). Some topographic factors that are important in characterizing the biophysical functions of the topography: elevation, contours, slope, surface shape, topographic position, spatial scale and their distribution over space is the thrust of this study.

Study Area

Gombe metropolis is located between latitudes $10^0 14' 10''$N and $10^0 19' 00''$N of the equator and Longitudes $11^0 07' 00''$E and $11^0 12' 50''$E of the Greenwich meridian. It is bounded by Kwami LGA to the North, Akko LGA to the Southwest and Yamaltu-Deba LGA to the East as shown in Figure 1. The climate of the area is characterized by two distinct seasons (Dry and wet seasons), with an average annual rainfall of 850mm. Temperature is between 35-40^{O}C in the months of March and April while minimum temperature is recorded during the harmattan period (Abashiya, et al., 2019). The rainfall is concentrated between the months of July and September with a single maximum in August and average annual total of 850mm (Abashiya *et al.,* 2017). The study area forms part of the sedimentary Upper Benue trough, which is structurally controlled by pre-existing Basement Complex rock consisting of granitic rocks overlain by the sequence of folded Cretaceous sedimentary rocks (Ikusemoran, Didams, & Abashiya, 2018). The metropolis is drained by ephemeral streams in a dendritic pattern such as Kundulun, Kurba, and Arawa in the northeast and Bagadaza, Pantami and Bogo, in the south, which take their sources from the Akko escarpment and flow eastwards. There are also ravines and gullies that serve as waterways and "death traps" during sudden storm events particularly in the months of July-September (Abashiya, et al 2017). The soils are formed from the intensive weathering of the Basement Complex rocks. They consist of unconsolidated wind-blown or water deposited sand and clay-rich mostly to the southeast of the metropolis along the valley of Pantami catchment (Amos, Musa, Abashiya & Abaje, 2015). The vegetation is the Sudan savanna type, which has replaced the guinea savannah of the 1970s due to anthropogenic activities and climate change with many tree species becoming extinct (Mbaya, 2016). The population of Gombe town in 1919 was only about 300 people. In 1986, the figure rose to 130,000 people. According to the report of the 2006 Census, Gombe metropolis had a population of 266,844 people (National Population Commission, 2009). Using the exponential method of projection as recommended by the NPC with growth rate of 3%, the figure was projected to 444,372 for 2023. Over the years, the metropolis has witnessed a drastic increase in infrastructural development such as roads and residential buildings (Makadi, Didams, Abashiya, Dan and Yason, 2017), to enhance better living standard.

Bima Journal of Science and Technology, Vol. 8(1B) Apr, 2024 ISSN: 2536-6041

DOI: 10.56892/bima.v8i1.611

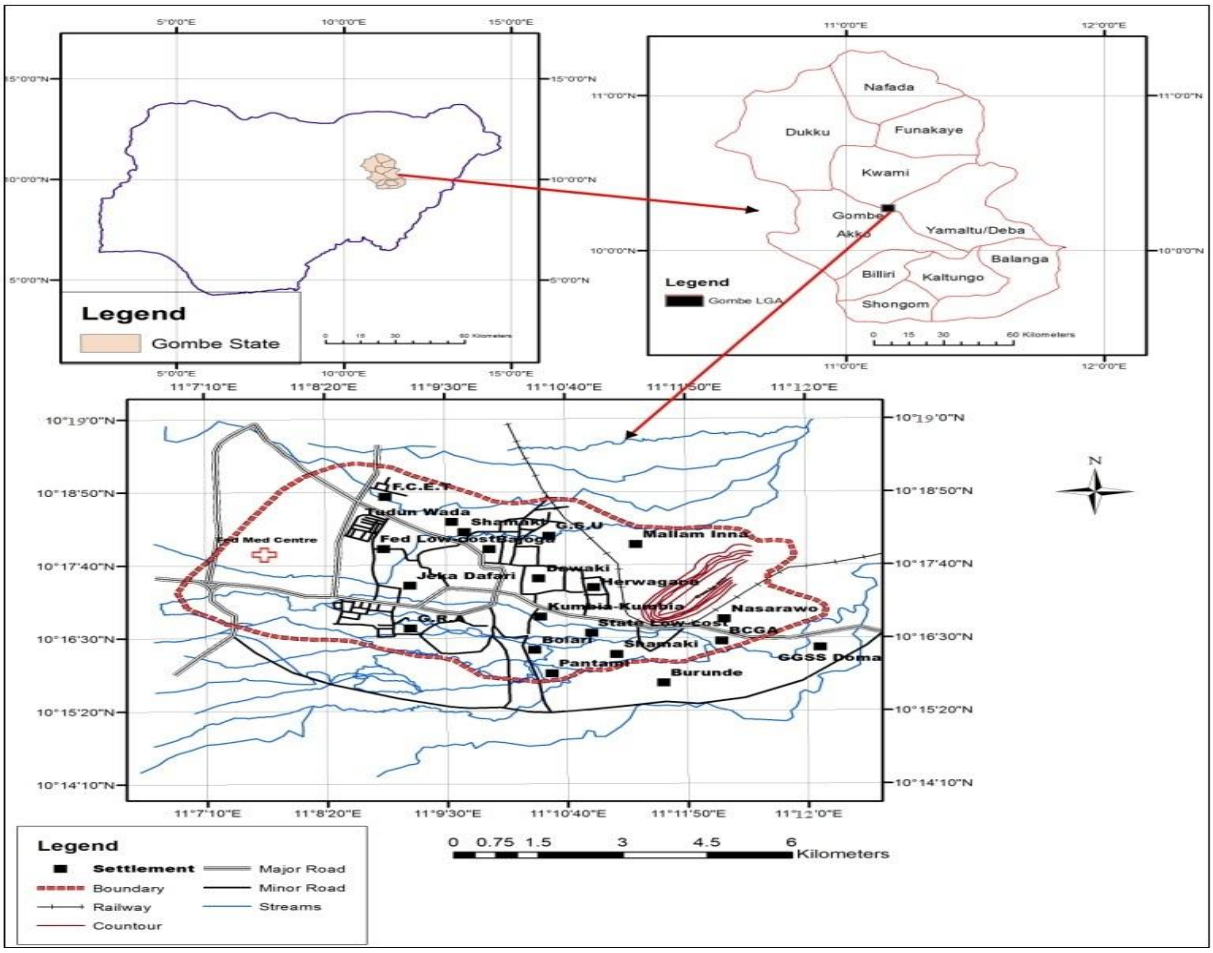

Figure 1: Map of Gombe Metropolis.

Source: Authors' GIS Analysis, 2023

MATERIALS AND METHODS

Digital Elevation Modeling (DEM) of Gombe metropolis was generated through DEM creation module of ArcGIS software, using Digital Elevation Dataset from SRTM obtained on line (www.glf.com/globallandfacility,2022).

Global Positioning System (GPS) Garmin 76, for coordinate's locations of hills. ArcGIS 10.5 and ILWIS (Integrated Land and Water Information System 3.3) software sourced from National Centre for Remote sensing (NCRS) Jos 2022 was used for land surface analysis map. The data obtained from field observation and measurements, were analyzed using descriptive statistics such as tables. The raster DEM was polygonized and classified into the following three classes using the conversion and the symbology classification modules of ArcGIS 10.5 respectively: Plains or low lands with heights ranging from 368- 437m above the sea level, Uplands with heights ranging from 438 - 530m above sea level, Highlands with heights ranging from 531 -670 m above the sea level. The areas in square kilometers of each of the classes within the metropolis were derived and calculated through the extraction and area calculation modules respectively of ArcGIS 10.5 software. Contour lines were processed from the DEM image for subsequent analysis. Thematic map of the metropolis containing the topographical features (hills, highland, plains or low lands and upland) was acquired and referenced to the DEM image, the

DOI: 10.56892/bima.v8i1.611

features were then digitized and overlain on the DEM images.

RESULTS AND DISCUSSION

The Digital Elevation Model (DEM) map showed the three terrain classes as well as their heights. The DEM image showed that the least elevation is 368m above sea level, while the highest elevation is found around the highland areas with an altitude of 670m above sea level which is the Liji hills. The 10m contour interval of the metropolis, generated from the DEM clearly distinguished the plains from the highlands with wide and close contour lines respectively. Moreover, some highlands areas such as the Liji and Gombe hills were found to be steep sided. The shapes of some of the hills were clearly identified as conical and dome-shaped. The relief of the metropolis as revealed in conformity with the description that the topography is characterized by undulating, rugged, and hilly to the southeast and north-eastern part while the central, north and west were characterized by flat open plains. The metropolis covers a total area of 95.26 square kilometer which consists of about 48.08 % of plains, 28.74 % uplands and 23.18 % highlands (table 1).

Table 1: Terrain class in the study area

Landform	Area in square kilometer	Percentage (%)
Plains	45.80	48.08
Uplands	27.38	28.74
Highlands	22.08	23.18
TOTAL	95.26	100.00

Authors' Analysis, 2023

The identified landforms, elevation and contour maps through the use of the 3D visualization of the terrain were clearly shown with their pattern of distribution (figure 2). The plains range from 368m to 437m heights above sea level. These include areas such shamaki, Ajiya Dawaki, Bagadaza, kagarawal Gabuka, herwagana and Bolari east. The upland areas are generally higher in altitudes than the plains which were ranged from 475m to 533m above sea level. These include areas such as Jeka-dafari, Nayi-nawa, and Pantami. The highlands comprise high hills with altitudes greater than 534m with the highest peak of 670m above sea level. The major highland areas include the thin hill range at the extreme southern part of the metropolis, also the Liji and Gombe hills, while other areas include Shongom estate, Orji estate, Tumfure settlement which extended towards Akko escarpment west of the metropolis.

Bima Journal of Science and Technology, Vol. 8(1B) Apr, 2024 ISSN: 2536-6041

DOI: 10.56892/bima.v8i1.611

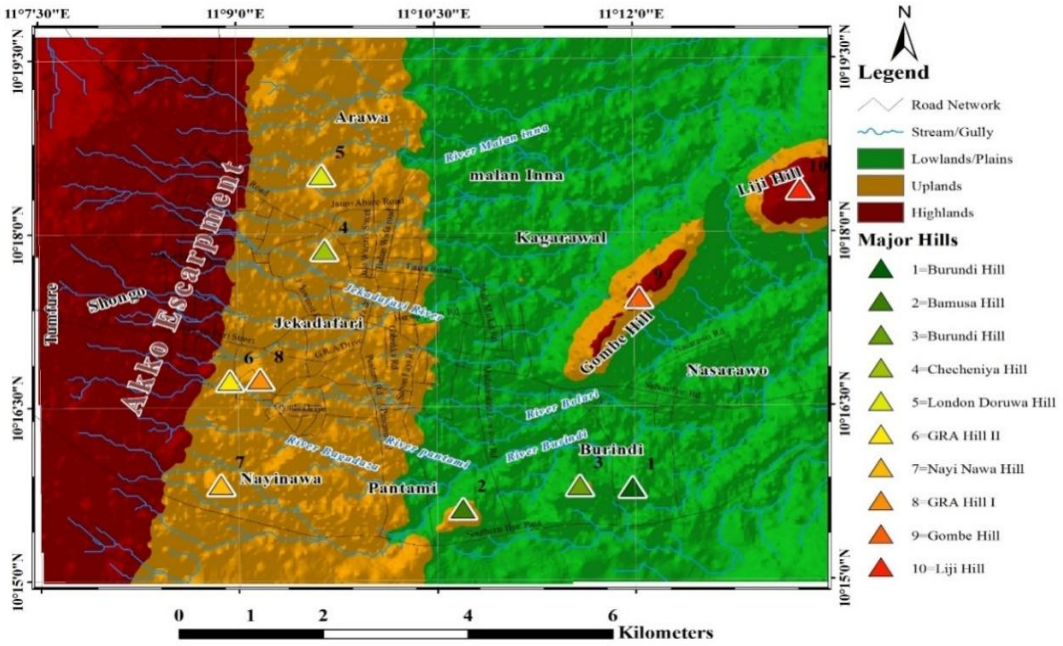

Figure 2: Landforms in Gombe Metropolis

Authors' Analysis, 2023

The digital elevation model map in table 2 shows that Liji hill has the highest point of 670m above sea level while Yelanguruza, Madaki, Nassarawo and Bogo areas were found to be the lowest points with elevation of 368m above sea level. The areas of height 534m to 670m above sea level as observed in the elevation layer include areas around Gombe hill, Liji hill and Akko escarpment extending to upland areas of Tumfure settlement, Orji, and Shomgom quarters. The areas elevation between 475m to 533m above sea level includes; Nayi-nawa, Jeka-dafari, and GRA. Areas of elevation between 438m to 474m above sea level includes; Pantami, Federal low-cost and Arawa. Areas of elevation between 410m to 473m above sea level include; Malam-Inna, kagarawal and Burundi, while Nasarawo and Liji Areas elevations between 368m to 409m above sea level (figure 3).

Table 2: Distribution of hills with coordinates and Elevations

s/no	Hill Name	Longitudes	Lattitudes	Elevation in Metres
1	Nayi Nawa Hill	11.147736	10.26378	511.35
2	GRA Hill II	11.148905	10.278789	508
3	GRA Hill I	11.15275	10.278975	515.56
4	London Doruwa Hill	11.160638	10.30832	491.38
5	Checheniya hills	11.160991	10.297531	485.92
6	Bamusa hill	11.178248	10.260193	457.25
7	Burundi hill I	11.193004	10.263477	458.59
8	Burundi hill II	11.199622	10.263221	440.91
9	Gombe Hill	11.200665	10.290496	547.12
10	Liji Hill	11.221061	10.306007	669.83

Authors' Analysis, 2023

Bima Journal of Science and Technology, Vol. 8(1B) Apr, 2024 ISSN: 2536-6041

DOI: 10.56892/bima.v8i1.611

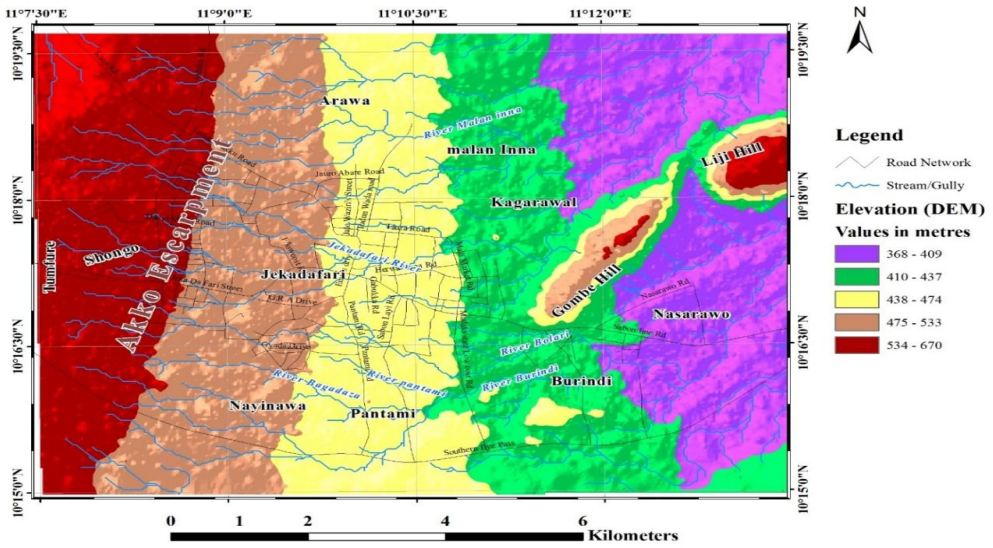

Figure 3: Elevation map of Gombe metropolis

Authors' Analysis, 2023

The Major topographic features as observed in table 2 include the Akko escarpment in the western part of the metropolis, a pass between Gombe and Liji Hills in the eastern part of the metropolis. Steep slopes are among the major features that are common given the considerable number of Hills and Uplands found in the area (Figure 4). The 10m contour interval of the slope map which was generated from the DEM also clearly differentiated the plains from the highland with wide and close contour lines respectively of the eastern part were conspicuous on the map with clustered contour lines. However, the shapes of some of the hills were clearly identified as dome-shaped.

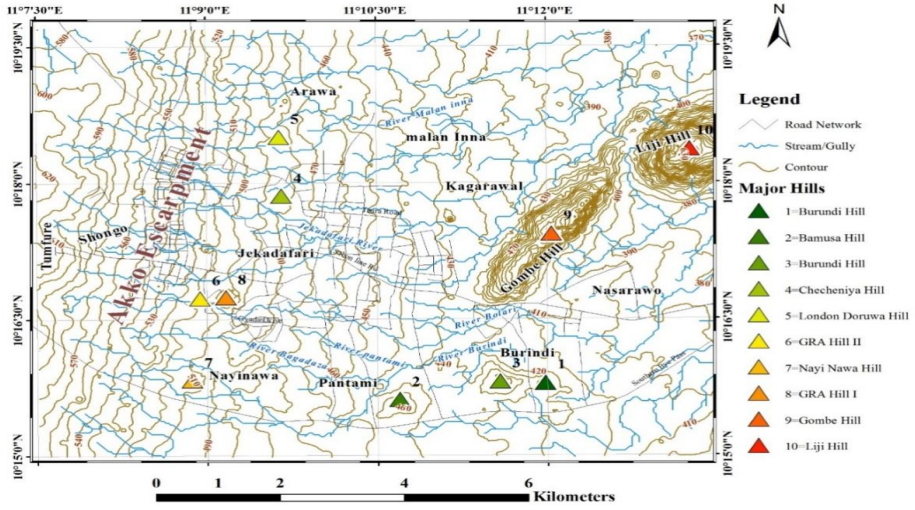

Figure 4: Contour map of Gombe metropolis

Authors' Analysis, 2023

The landform pattern depicts spatial distribution as observed in figure 5 using the 3D view which shows that most of the hills were found in the north-eastern part, comprising Gombe and Liji hills while, the presence of dome-shaped hills as observed were distributed in the south-western part of the metropolis, which include Burundi hill I,

DOI: 10.56892/bima.v8i1.611

Burundi hill II and Bamusa hill. The south-eastern part comprises Nayi-Nawa hill, GRA hill I, and GRA hill II. The northern part of the metropolis is dominated by undulating surface and obviously flat land with the presence of London mai-doruwa hill. However, the western extreme end is occupied by highland settlement areas which comprise Tumfure settlement, Orji and Shongom estates.

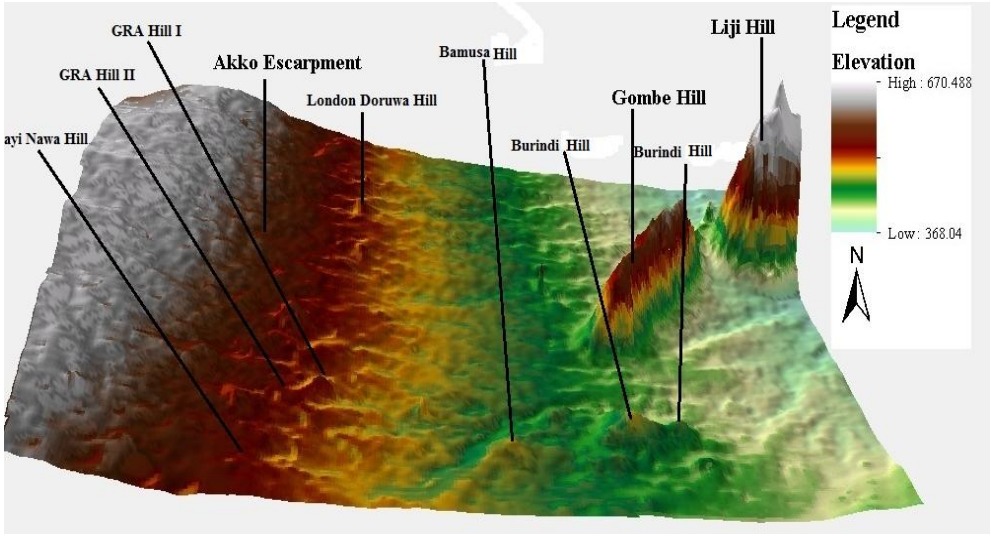

Figure 5: Distribution of Landforms in Gombe metropolis

Authors' Analysis, 2023

The environmental significance of these landforms features is that settlements were built on hills as observed on Gombe and Liji hills areas. Thus, this could be as adaptation strategies against flooding among many other purposes. According to Abashiya, Didams & Sule, (2020) the areas of very low flood risk are high elevations including Akko escarpment, Gombe and Liji hills west and east of the metropolis respectively and it covers only 30% of Gombe metropolis. Landforms utilization is evident on the GRA hill where large reservoir was constructed and the water is flowing by gravity for distribution to the metropolitan area. However in some areas which are relatively flat compared to highland and upland settlements are accommodating on valleys or lowland areas which may be liable to flooding, this can be observed in the Burundi area (plate 1). The study by Abashiya, Didams & Sule, (2020) reveal that about 70% of the low land areas in Gombe metropolis are liable to flood risking. Following the statistics, in table 1, Gombe metropolis has 48% of land area covering 45.80 square kilometer occupied by lowland areas. Hence, agricultural activities are taking place in such areas like Liji, Nasarawo, and Tabra settlements, where vegetables, cereals and rice are cultivated. Also, there have been intensive mining activities taking place in Gombe hill which serve as source of income to the miners.

Bima Journal of Science and Technology, Vol. 8(1B) Apr, 2024 ISSN: 2536-6041

DOI: 10.56892/bima.v8i1.611

Plate 1: Landforms utilization in Gombe metropolis.
Authors' Fieldwork, 2023

CONCLUSION AND RECOMMENDATIONS

Gombe metropolis is a scenic geomorphic environment with many hills and valleys. The need for analysis of the terrain of the area for environmental monitoring and sustainability cannot be overemphasized, because a proper understanding of the terrain characteristics is essential for any scientific pursuit. Occurring on the metropolis the general elevation of the hills is remarkably higher in the north eastern part than the surrounding lowlands. However, slope processes have combined with as well as accelerated by human activities such as settlements, farming, grazing and mining to modify the hills and their slopes through weathering and erosion. If these human activities are not stopped or meaningfully controlled, the hills will continue to be greatly and rapidly modified.

Based on the findings of this study, the following are recommended: More research on automated terrain analysis of Gombe metropolis should be carried out for development so as to maintain and sustain the land environs of the metropolis through sustainable utilization, especially on the use of topographical features. Human activities in and around the hills should be well controlled by the local authority so as to ensure sustainable use of landforms. The local communities residing around the hills or valleys should be educated by the local authority about the dangers associated with their activities.

REFERENCES

Abdullahi J., Odihi1 J. O. and Wanah B. B. (2015). Analysis of Morphology of Volcanic Craters on the Biu Plateau, Borno State, Nigeria. *Journal of Geography, Environment and Earth Science International* 3(1): 1-10.

Abashiya, M.; Didams G. and Sule S., (2020) Flood Risk Characterization in Gombe Metropolis, Gombe State, Nigeria. *Gombe Journal of Geography and Environmental Studies (GOJGES)*1 (3): 2714-3201.

Abashiya, M; Abaje, IB; Musa, I; Sule, S; Kollos, PN; Garba, HA (2019),

DOI: 10.56892/bima.v8i1.611

Hydrogeomorphic Characteristics of Urban Flood Triggers in Gombe Town, Nigeria as Monitored in 2014. *Journal of Applied Science and Environmental Management*. 23 (10): 1887-1892.

Abashiya, M. Abaje, I. B. Iguisi, E. O. Bello, A. L. Sawa, B. A. Amos, B. B. and Musa, I. (2017). Rainfall Characteristics and Occurrence of Floods in Gombe Metropolis, Nigeria. *Ethiopian Journal of Environmental Studies and Management,* 10(1): 44-54.

Amos, B. B., Musa, I., Abashiya, M. and Abaje, I. B. (2015). Impact of Cement Dust Emissions on Soils Within 10km Radius in Ashaka Area, Gombe State, Nigeria. *International Journal of Environment and Pollution*. 4(1):0909-0917. Published by the Canadian Center of Science and Education.

Chakraborty, A. and Joshi, P. K. (2014). Mapping disaster vulnerability in India using analytical hierarchy process. Geomatics*, Natural Hazards and Risk*, 20 (10):1080

Goudie, A. (2006). "Global Warming and Fluvial Geomorphology". *Journal of Geomonphology* (79) 3-4.

Ikusemoran,M., Didams, G. and Abashiya, M. (2018). Analysis of the Spatial Distributions of the Geology and Pedologic Formations in Gombe State, Northeastern Nigeria. *Journal of Geology and Geography* 10(1),1916-9779. Published by the Canadian Center of Science and Education.

Garbrecht, J., Martz LW. (2000). "*Digital elevation model issues in water resources modeling"*. In Maidment D, Djokic D. (Eds.) Hydro.

Gustavsson, M. (2005). "*Development of Detailed Geomorphological mapping system.* Bud GIS, Geodata base in Sweden". Licentate, thesis Department of Geography, university of Uppsala, Sweden, 1-40.

Makadi,Y. C., Didams, G., Abashiya, M., Dan,Y. and Yason, B. (2017). Intra-Urban Traffic Flow Problems in Gombe Metropolitan Area,Nigeria. *International Journal of Research and Development in Social sciences,*3(12),149-169).

Mbaya, L. A.(2016).Climate Change Induced Tree Mortality in the Savanna Woodland and its Implication on Rural Livelihoods in Gombe State, Nigeria.*Nigerian Journal of Tropical Geography* 7(1)pp952-968.

Meena, Y. R. and Gupta, A. K. (2017). A Study on Urban Flood Vulnerability in Vrishabhavathi Valley Watershed, Bengaluru, Karnataka Using RS, GIS and AHP Techniques, *International Journal of Advanced Remote Sensing and GIS,* 6(1)2325-2342.

National PopuulationCensus (2009). *A Partial Analysis of Provisional Population for Gombe State Statistical Unit,* Budget and Planning Department.

Pavlopoulos K, Evelpidou N, Vassilopoulos A. (2009). "*Mapping Geomorphological Environments"*. Springer: Berlin, Germany.

Thornbury W.D. (1965). "*Regional Geomorphology of the United States"*. Wiley: New York, USA.