An analysis of the effects of urbanization on urban drainage systems in Ankpa, Dekina and Oguma Towns of Kogi State in North Central Nigeria

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Abstract: Managing complex environmental problems such as flood disaster require up to date technology. Much of these disasters can be prevented and reduced through the use of technology such as Geographic Information Systems (GIS) and remote sensing as well as questionnaire administration. The spatial analytic capacity of GIS is employed to carryout hydrological analysis such as drainage network, DEM, Slope, flow direction and accumulation, stream order. Also land use and land cover analysis was done to examine the changes in land cover pattern across the study area. Different datasets were extracted from satellite imagery (landsat TM and OLI) of the Study area. ArcGIS 10.8 and Idrisi Terrset were used for the land cover change spatial analyses. The results from image analysis revealed that built-up area have been increasing significantly in the area due to increasing population pressure, it increases from 11.70%, 9.74% and 13.15% in 1990 to 18.12%, 16.05% and 19.37% in 2021 for Ankpa, Bassa and Oguma (Dekina) respectively. The flood risk vulnerability map reveals that about 15.44% (835.73 km^2) and 15.81% (856.25 km^2) of the study area have very high and high susceptibility to flooding inundation, respectively. The vulnerable zones are located on the lowest part of the plain which is responsible for the high flood vulnerability experienced in this area. It can be deduced that the magnitude of the flood hazard of a given area is a function of both the distance to the river and the elevation of the area in question. The result of the questionnaire analysis indicates that 67.55%,65.96% and 61.48% strongly agreed that shallow drainage channels in Ankpa, Dekina and Oguma are the major drainage challenges in the study area while 65.70%, 56.73% and 56.46%, strongly agree that several homes are destroyed when drainage fail and 56.20%, 63.32%, and 57.26% strongly agree that availability of social services is responsible for the increase population upsurge to urban centers. It is believed that the result of this research can be used as a means of regulating development along the plain and also serve as a decision support when making policies relating to drainage and flood management around urban centres.

Key words: urbanization, drainage systems, North Central, flood disaster

I. Introduction

A good proportion of the world population live in developing countries of Asia and Africa, mostly residing in horrible conditions in slums in major towns and cities including their suburbs. Poor drainage facilities are peculiar problem associated with this settlement types resulting in constant contact with contaminated water and flooding (WHO, 2006). According to the World Health Organisation (2006), drainage unfortunately wasn't even one of the Millennium Development Goals (MDGs), even though an estimated 2.4 billion total of the world population does not have access to improved sanitation in 2015. Presently, about 2.6 billion people live without proper sanitation of which Africa is not exempted (Olukanni, 2013a); WHO/UNICEF, 2012).

Today, the agenda to make cities more sustainable and combat climate change has come on board as part of the Sustainable Development Goals (SUGs) of 2030. In the view of Geldof and Stahre (2006) the introduction of concept of sustainability has, in the field of urban water systems, among others led to an increase interest for source control and open drainage of storm water within the urban environment. This however creates the need to provide proper sanitation facilities to match up with the ever-increasing population growth (Banergee and Morella, 2011).

Urban drainage is that part of the water infrastructure which seeks to avoid interruption to the free movement of pedestrians and vehicles, material damage from torrential flows, and danger to health and environment from rainfall in urban areas. Armitage (2011) defined urban drainage as the removal of all unwanted water from urban areas. Such water includes wastewater, including sewerage and greywater and stormwater. Urbanization at various levels has in one way or the other impacted on urban water removal infrastructure.

The effects of urbanization on drainage channels have been documented by several researchers. Offiong et al., (2009) observed that major urban environments in Nigeria are faced with countless problems regarding poor drainage systems and watertight structures which are responsible for the growing rate of flooding. Belete (2011) defined urban flooding as the inundation of land or property in built environment by rainfall overwhelming the capacity drainage system, particularly around more crowded area. Bad drainage system with heavy rainfall also could result in flooding in urban areas Trucci, (2001) observed also that urban flooding is a condition characterized by its repetitive and systemic impacts on communities whether the affected communities are located within the flood plain or near any body of water. Flood volume and flood peaks are increased when excess runoff water flow into drainage system from substantial impervious surfaces and artificial drainage that require large channel capacity, bank erosion and channel widening results in humid urbanized areas.

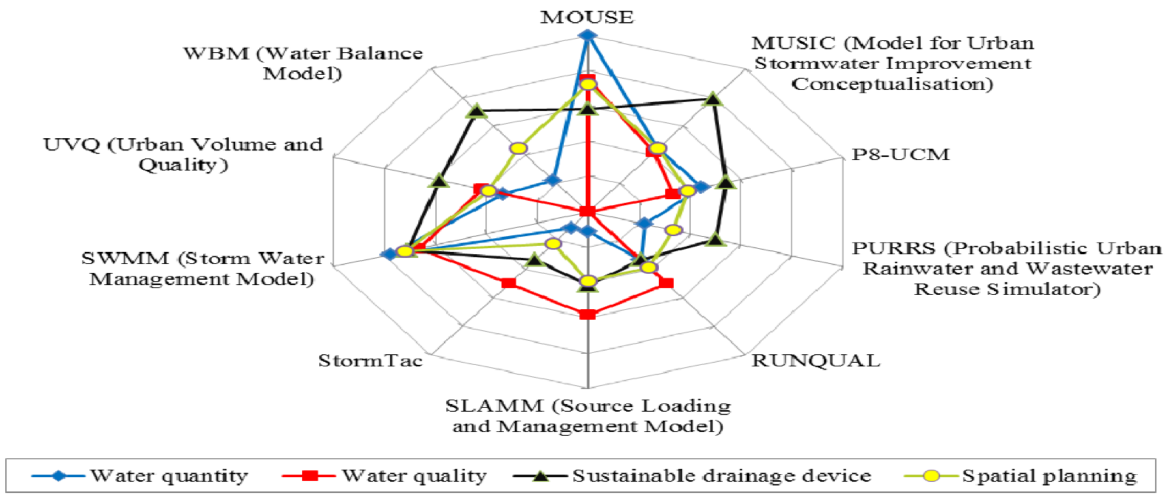

Figure 1.1: Accelerating development of urban areas.

In developing countries, the main problem is still to manage the quantity of storm runoff so as to avoid loss of life and damage to property. The practice of urban drainage in developing countries encounters more serious problems than those of developed countries; this is because urban development occurs under more difficult socio-economic, technological and climatic conditions. The specific factors inhibiting modernization of urban drainage in developing countries, basically by means of infiltration and retention of storm runoff, can be grouped under the following headings (Table 1). Developing countries experience fast-tracked urbanization (Figure 1) without adequate investment in infrastructure, and against a background of deficient public services for water treatment, collection and treatment of foul sewage, garbage collection, urban drainage, transport and health.

Table1. Specific factors inhibiting modernization of urban drainage in developing countries

Factors	Characteristics
Concern for the environment	Less familiar than conventional sanitary planning
Legal or clandestine urban development	No effective control
Runoff quality	Highly contaminated
Urban sediment and garbage	Large quantities transported in runoff
Climate	Increase risk of epidemics and construction costs
Engineering 'know-how'	Shortage concerning modern approaches
Population and administrators relations	Lack of interaction for seeking solutions

In developing countries, the large cities seem to have reached saturation point regarding conventional sanitary solutions to urban drainage. So much money has been spent on canalizing water courses, but this has not solved the problems. The recent time is a period of transition, in which the 19th-century sanitary model is being abandoned and the environmental model adapted. The difficulties brought about by this change are discussed in the following sections.

1.1 Statement of Research Problem

Urban drainage management includes removal of all unwanted water from urban area (Mcdonough and Braungart, 2002). Several scholars did some works on urban drainage in developing countries, some of them include Pickford (1995), Mara (1996), Kolsky (1996), Parkinson and Mark (2005), Parkinson et al. (2007) and Jimoh (2008). A general weakness of these works, though, is the

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failure to see the problem of urban water management in a holistic manner. Pickford (1995) and Mara (1996), focused on sanitation and sewerage, Kolsky (1998), Parkinson and Mark (2005) and Parkinson et al (2007) focused almost exclusively on storm water drainage but Belete (2011) expressed that high urban population growth rate also results in drainage system challenges. Jimoh (2008) observed that inadequate integration between road and urban storm water drainage can be attributed to natural causes such as intensive rainfall. He also did not also look at urban drainage management holistically paying little attention to the human related urban drainage management factors. It is upon this premise, that this research evaluates impact of urbanization and challenges of urban drainage management in the study area.

1.2 Study Objectives

The aim of this research is to evaluate the impact of urbanization and challenges of urban drainage management in the study area. The specific objectives are to:

i. Examine the land use and land cover dynamics of the study areas

ii. Analyzing the effect of urbanization on urban hydrological system in the study area.

iii. Evaluate the Socio economic Impacts and causes of urban drainage problem and failure in the study area. Tensions are usually exacerbated by severe resource constraints. (Jiusto and Kenney, 2015)

II. The Study Area.

This research was conducted between the months of June to mid-October 2022. Three local governments out of the twenty-one local government areas Kogi State are used for this study. These three LGAs were selected from the eastern part of the state. Their various LGA Headquarters has been considered for this study. These are Dekina, Ankpa and Oguma towns in Kogi State. Dekina is located on latitude 7º35'N; 7º12'E and Longitude 7.583ºN with area of 2,461km ($250m^2$) and a population of 260, 316 (NPC, 2006). Ankpa is located on latitude 7º26'N; 7º38'E and longitude 7.433ºN with a total land area of 1,200km ($500m^2$) and a population of 267, 353 people (NPC, 2006). Oguma is located on latitude 7º54'N; 7º03'E and longitude 7.900ºN having a total land area of 1,925km ($743m^2$) and a population of 139, 993 (NPC, 2000).

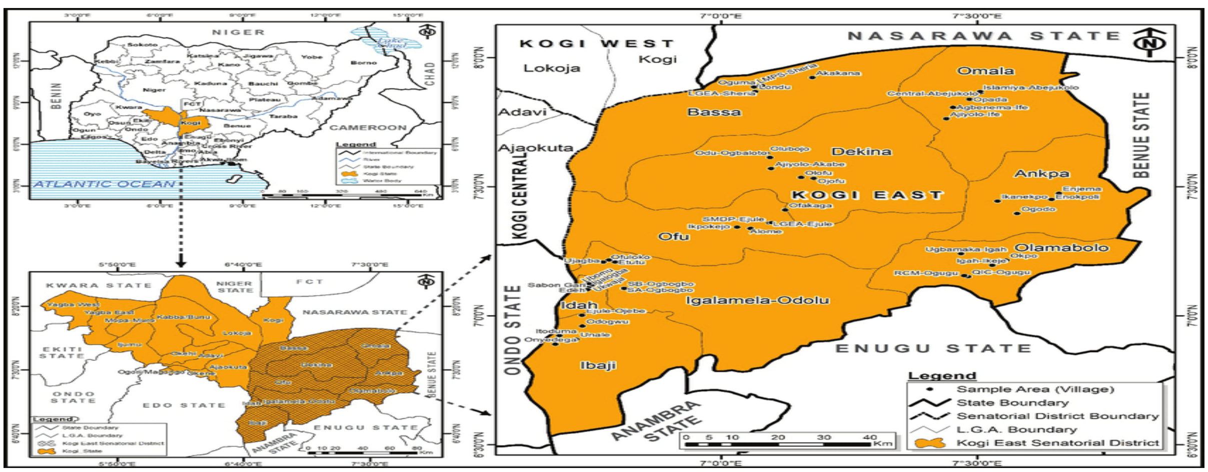


Figure 1.4: map Kogi showing study area.

III. Materials and Methods

The materials used for this study include global positioning system for picking of coordinates, computer, recording book, pen and paper. The types of data used comprise of both primary and secondary. The primary data was collected from the study area through the field work. It involved personal observation, structured questionnaire and the used of handheld GPS, while secondary data include satellite imagery (Landsat) for two (2) decade (1990 and 2021) other data was obtained through library and internet search. IDRISI Terrset was used for the development of land use and land cover maps for the study areas. ArcGIS 10.8 was used in developing, displaying and processing of the hydrological and location maps. A total of three hundred and seventy-nine (379) questionnaires were administered in three study domains addressing the causes of drainage problems, effects of drainage failure, reasons for rapid urbanization were addressed. A total of 379 represent 92.44% were returned. Ankpa has the highest percentage of response (94.84%) while Bassa and Oguma (Dekina) recorded 96% and 94% response respectively (Table 4.). A simple descriptive statistics was adopted using tables and percentages, in interpreting the analyzed data. Landsat images of thematic mapper (TM) 1990 and operational land imager of 2021 obtained from earth explore website at 30m on path/row of 189/054 and

ISSN No. 231-2705 | DOI: 10.51244/IJRSI | Volume X Issue V May 2023

055 resolution was used to derive the land use and land cover, a digital elevation model was used to derived the DEM, slope, flow direction and accumulation, flood vulnerability map and drainage map of the area. The study area was extracted from the Landsat scene, and a supervised maximum likelihood classification method was carried out based on level 1 classification of Anderson *et al*. (1976). Three basic operations namely image reconstruction to extract area of interest from the general satellite scene, image enhancement to improve visual interpretation by increasing apparent contrast among various features in the image and image classification to classify the various land use and cover types (built up area, cultivated land, grassland, forest and water bodies)

IV. Results and Discussions

(a) Analysis of Land use/land covers Classification of 2021 Satellite Imagery for Ankpa

The 1990 map figure (a) portrays five (5) categories of land use/land covers; built-ups, wetlands, farmland, vegetation and water bodies. The areal extent of these classes reveal that the dominant class is grassland which covers 656.42 km^2 (51.94%), followed by cultivated land with 283.3. km^2 (22.41%), forest covers 172.68 km^2 (13.66%). This is seen scattered mostly at the eastern section of the map as well as the south west, while Built-up covers 147.89 km^2 (11.70%) and water bodies with 3.64 km^2 representing 0.29% of the total area as the less dominant classes.

Figure (b) indicates the areal extent of 2021 classes reveal that the dominant class is still grassland which covers 579.01 km^2 (45.82%), followed by cultivated land with 381.26 km^2 (30.17%), which witness an increase of 7.76% which can be attributed to increased agricultural activities to meet up demands for food. Also forest covers reduced drastically from 172.68 km^2 (13.66%) in 1990 to 70.31 km^2 (5.56%) a decrease of 8.1%. this can be attributed to increase lumbering activities for either fuelwood, charcoal or other uses thereby depleting the forest resource. Furthermore, built-up areas cover 229.01 km^2 (18.12%) and water bodies with 4.19 km^2 representing 0.33% of the total area as the less dominant classes.

Land use and land cover Maps of Akpan, Bassa and Dekina

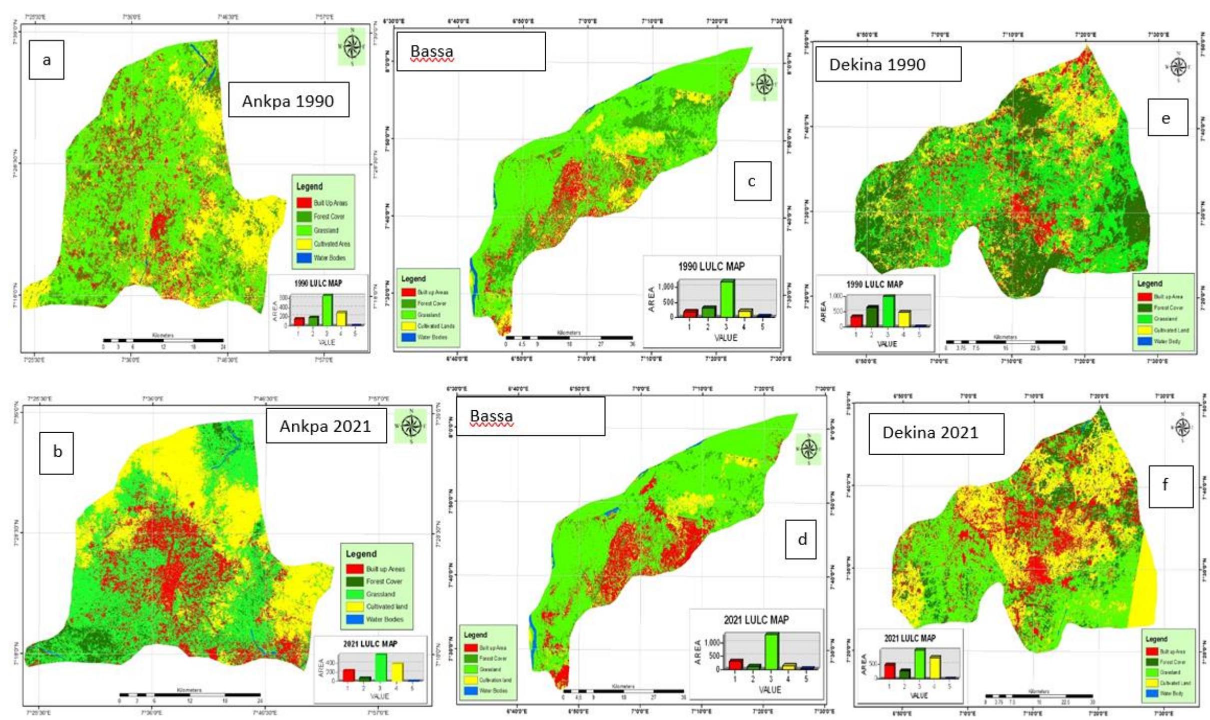


Table 1-3 indicates the area statistics of the three locations of Ankpa, Bassa and Dekina

Table 1 land use and land cover Distribution Area Statistics for Ankpa (1990 & 2020)

Land Cover Category	1990 Area (Sqkm)	Area covered (%)	2021 Area (Sqkm)	Area covered (%)
Build up	147.89	11.70	229.01	18.12
Forest cover	172.68	13.66	70.31	5.56

ISSN No. 231-2705 | DOI: 10.51244/IJRSI | Volume X Issue V May 2023

Grassland	656.42	51.94	579.01	45.82
Cultivated Land	283.30	22.41	381.26	30.17
Water Bodies	3.64	0.29	4.19	0.33
Total	344.97	100	344.97	100

Table 2 land use and land cover Distribution Area Statistics for Bassa (1990 & 2020)

LULC	**1990**		**2021**	
Land Cover Category	Area (Sqkm)	Area covered (%)	Area (Sqkm)	Area covered (%)
Build up	186.62	9.74	307.59	16.05
Forest cover	309.01	16.12	127.44	6.65
Grassland	1192.67	62.23	1313.02	68.52
Cultivated Land	212.19	11.07	148.59	7.75
Water Bodies	15.94	0.83	19.62	1.02
Total	1916.44	100.00	1916.26	100.00

Table 3 land use and land cover Distribution Area Statistics for Dekina (1990 & 2021)

LULC	**1990**		**2021**	
Land Cover Category	Area (Sqkm)	Area covered (%)	Area (Sqkm)	Area covered (%)
Build up	326.87	13.15	481.31	19.37
Forest cover	661.03	26.60	280.55	11.29
Grassland	1008.56	40.59	994.64	40.02
Cultivated Land	486.67	19.58	725.66	29.20
Water Bodies	1.86	0.07	2.94	0.12
Total	2484.98	100.00	2485.10	100.00

Figure (c) indicates the maximum likelihood supervised classification of Bassa local government area of Kogi State which shows the area extent covered by five LULC classes, these are (built-ups, forest cover, grassland, farmland cultivated land and water body). The result reveals that grassland was the major Land use/land cover type in the area as at 1990, it covers an area of 1192.67 km2 (62.23%) of the total area. It is closely followed by forest cover which occupies an area of 309.01 km2 (16.12%) while built up covers an area of 186.62 km2 (9.74%) while cultivated land and water body covered 212.19 km2 (11.07%) and 15.94 km2 (0.83%) respectively.

Figure (d) shows LULC map of Bassa, the result reveals that grassland occupies the major Land use/land cover type in the area in 2021, it covers an area of 1192.67 km^2 (62.23%) in 1990 but increased by 6.29% of the total area in 2021. It is followed by built up areas which occupies an area of 307.59 km^2 (16.05%) while forest covers an area of 127.44 km^2 (6.65%) while cultivated land and water body covered 148.59 km^2 (7.75%) and 19.62 km^2 (1.02%) respectively Table 2. Built up areas are found more in the southern section of the map while water body flows from the northern section to the southern section.

Similarly, figure (e) is a classified LULC map of Dekina showing the five classes under study. It reveals that grassland, forest cover, and cultivated land are the largest with 1008.56 km^2 (40.59%), 661.03km^2 (26.60%), and 486.67 km^2 (19.58%) respectively. Built-up and water body are the smallest with about 326.87 km^2 (13.15%) and 1.86 km^2 (0.07%) respectively of the total land area under study. The forest cover can be found in the North-western, eastern, west and other sections of the map, cultivated land is found majorly at the northern section while built up is found in the southern section as well as the northern section

ISSN No. 231-2705 | DOI: 10.51244/IJRSI | Volume X Issue V May 2023

Furthermore, figure (f) indicates the classified **Land use/land cover** map of Dekina. Findings reveals that grassland, cultivated land, and built up areas are the largest with 9994.64 km² (40.02%), 725.66 km² (29.20%), and 481.31 km² (19.37%) respectively. Forest cover and water body are the smallest with about 280.55 km² (11.29%) and 2.94 km² (0.12%) respectively of the total land area under study (table 3). The forest cover has reduced drastically over the years as a result of increased forest resource exploitation, it is found in patches at various sections of the map, cultivated land is increase greatly with 9.62% found majorly at the northern, centrally, south eastern section while built up is found centrally and in other areas of the map.

Summary of the Spatio-temporal Analysis of Land use/Land cover distribution across the Study locations

Table 4 and Figure 7 show the mean statistic of the comparative analysis of land use and land cover category of the study locations (Ankpa, Bassa and Dekina). Result shows Dekina has the highest for all the classes considered, this is followed by Bassa while Ankpa has the lowest. Built up and water bodies areas in Dekina has 404.09 km^2 and 2.40 km^2, Bassa has 247.11 km^2 and 17.78 km^2 for built up and water whereas Ankpa is lowest with 188.45 km^2 and 3.91 km^2 for built up and water respectively.

Table 4: Summary of the Spatio-temporal Analysis of LULC of the Study Areas (1990 and 2021)

Land Cover Category	Ankpa	Bassa	Dekina
Build up	188.45	247.11	404.09
Forest Cover	121.49	218.23	470.79
Grassland	617.72	1252.85	1001.60
Cultivated Land	332.28	180.39	606.16
Water body	3.91	17.78	2.40

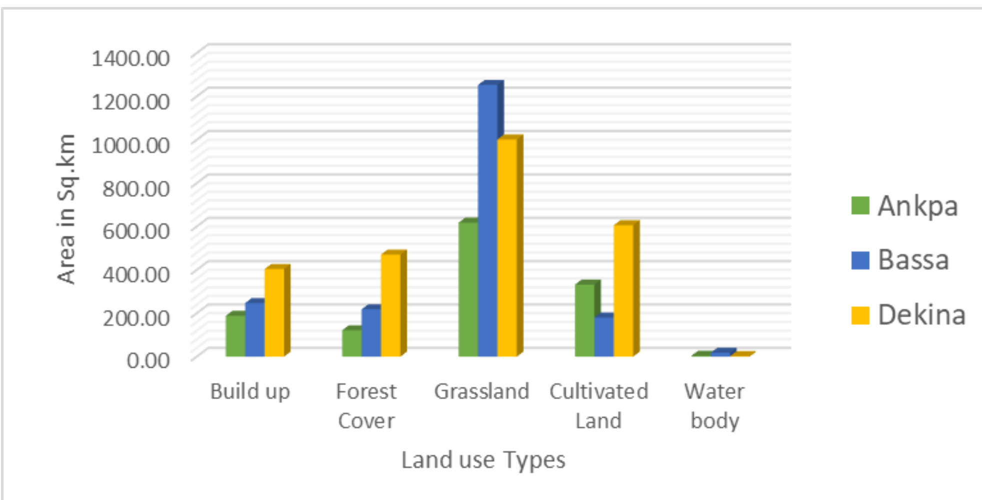


Fig. 7 Summary of the Spatio-temporal Analysis of LULC of the study areas (1990 and 2021)

4.1 Analyzing the effect of urbanization on urban hydrological system in the study area

The hydrological analysis of flood conditioning factors, their classes, rating values, area coverage percentage were done using the DEM and Slope

DEM (Elevation)

One of the factors used to assess food risk is elevation. Generally, the lower elevated areas have a higher probability of flood occurrences compared to higher elevated areas because lower elevated areas have comparatively higher river discharge and get flooded faster by the flow of high water (Hong *et al*. 2018; Chakrabortty *et al*., 2022; Zzaman *et al*. 2021). The altitude of the study area ranges from 30 to 545 m above sea level as shown in Fig. 8, areas with low elevation which are located in the western and south-western parts of the study area (altitude below 100 m above sea level) are the most vulnerable areas to flood inundation. About 15.44% (835.73 km^2) and 15.81% (856.25 km^2) of the study area have a very high and high susceptibility to

ISSN No. 231-2705 | DOI: 10.51244/IJRSI | Volume X Issue V May 2023

flooding inundation, respectively (Table 8). The very-high-risk zone is concentrated on the western side of the area and in the coastal area especially in Bassa local government areas. These areas are the main residential areas according to the land use map classification. These areas are mostly characterized by clay with flat elevations and gentle slopes. This risk area is also located along the river line, facing the risk of river flooding due to its proximity to river Niger. Most areas of agricultural land and grasslands are also included in the high-risk zone of flooding.

Table 5: Level of Vulnerability in terms of Areas and Percentage

AREA in km^2	Percentage	Level of Vulnerability
835.73	15.44	Very high
856.25	15.81	Secondary
1218.45	22.50	Moderate
1398.12	25.82	Low
1105.85	20.42	Very low
5414.40	100.00	

Slope

The slope of the land controls the velocity of surface water flow. As the slope decreases, the velocity of surface water flow decreases, and the amount of water over the land and the probability of a food increases (Astutik *et al.* 2021; Das and Gupta 2021; Zzaman *et al.* 2021). Mountain areas generally have steeper slopes that prevent the collection of water, whereas lowlands or flatlands with gentle slopes have a higher probability of flood inundation (Wang *et al.* 2015). The reclassified slope map (Fig. 10) shows that about 48.35% (2600.13 km2) of the study area has a slope range from 0 to 2.28 degrees which belongs to very high susceptibility to flooding inundation. About 31.70% (1704.66 km2) and 12.42% (667.80 km2) of the study area are characterized by high (2.28 -5.16°) and moderate (5.16 – 9.41°) susceptibility to flooding, respectively. Areas of low (9.41 – 15.63°) and very low (15.63 – 38.69°) flood susceptibility cover about 5.56% and 1.98%, respectively (Table 10). Gently sloping areas are found in the north-eastern, central, and south-western borders of the study area. Similarly, Yariyan *et al.* (2020) considered slopes from 0 to 15, 15 to 30, 30 to 45, 45–60, and>60 degrees as very high, high, moderate, low, and very low susceptibility to floods, respectively

Table 6: Slope Classification

AREA km^2	Percentage	Slope Range	Flood susceptibility	Rating
2600.13	48.35	0 – 2.28	Very high	5
1704.66	31.70	2.28 -5.16	High	4
667.80	12.42	5.16 – 9.41	Moderate	3
298.87	5.56	9.41 – 15.63	Low	2
106.27	1.98	15.63 – 38.69	Very low	1
5377.74	100.00			

Flow accumulation

Flow accumulation highlights the amount of flow accumulated in each raster pixel based on the cumulative weights of the preceding pixels (Ajibade *et al.* 2021). Flow accumulation is probably the most important parameter for delineating food-prone areas (Kazakis *et al.* 2015). It helps us to map out the convergence zone of surface runoff. High flow accumulation means that the area is more likely to be flooded (Kazakis *et al.* 2015; Mahmoud and Gan, 2018).

Table 7: Flow accumulation

AREA km^2	Percentage	Flood susceptibility	Rating
2250.64	99.30	Very high	1

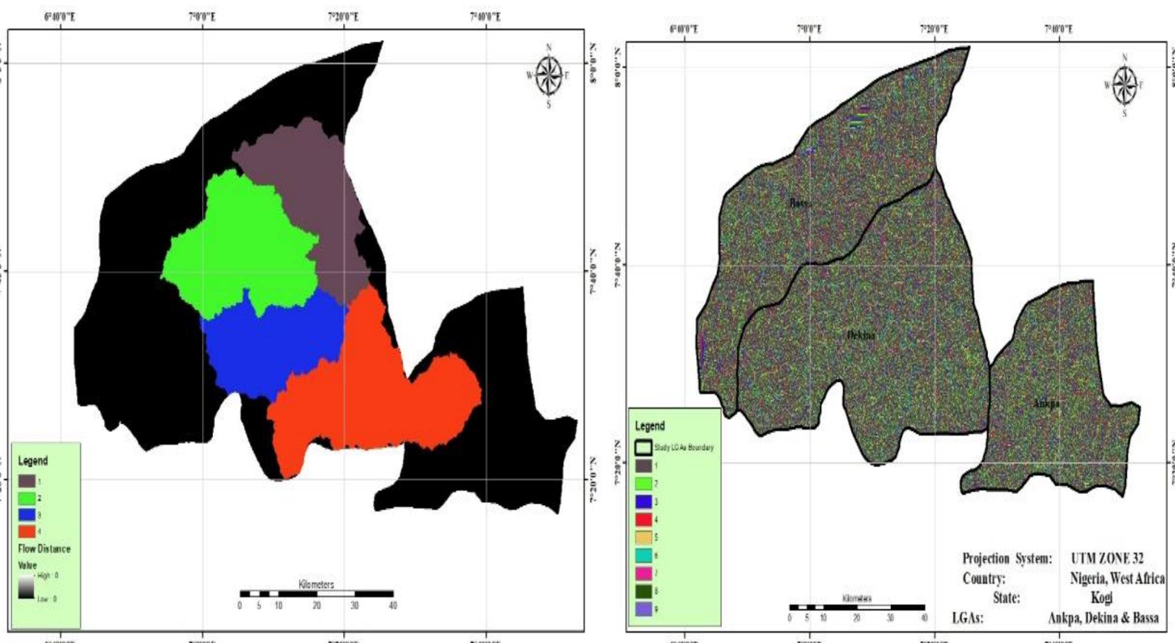
ISSN No. 231-2705 | DOI: 10.51244/IJRSI | Volume X Issue V May 2023

13.32	0.59	High	2
1.95	0.09	Moderate	3
0.55	0.02	Low	4
0.05	0.00	Very low	5
2266.51	100.00		

In this study, the reclassification used by Mahmoud and Gan (2018) was adopted to reclassify the flow accumulation of the study area into five classes. Hence, as shown in Fig. 11 and Table 11, the flow accumulation values are classified into five categories: very low (0.00%). The higher the flow accumulation values in the area, the more vulnerable it is to flooding.

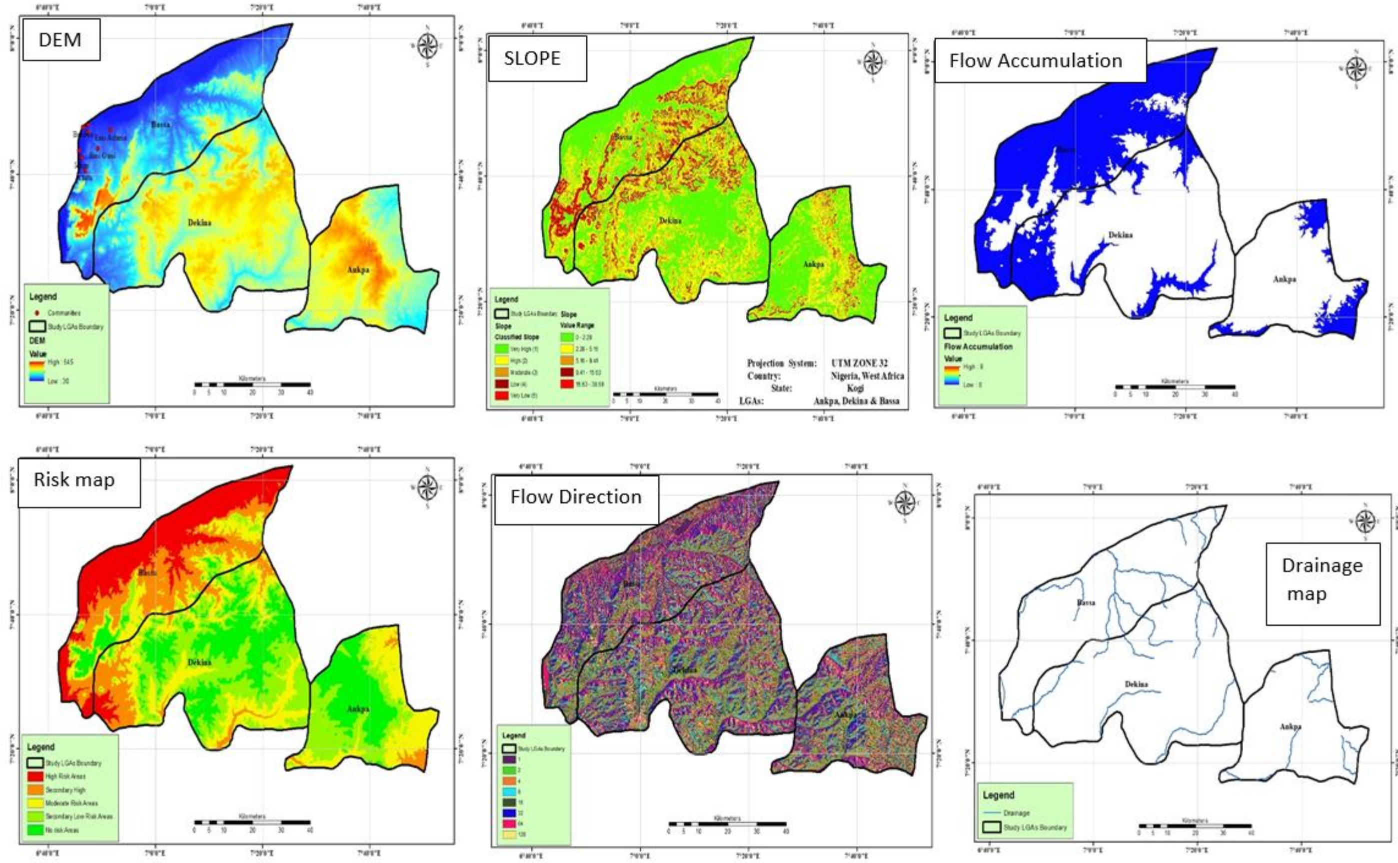
The flow direction map shows the different direction the streams flows, a flow direction raster displays the direction water will flow out of each cell of a filled elevation raster. A widely used approach for deriving flow direction in GIS is the D8 (deterministic eight nodes) method. The figure 12, reveals that most of the drainage streams flows from high slope and elevation areas to lower elevation mainly into the river Niger drainage in Bassa local government area. Four Catchment was identified across the areas; the catchment was derived from the drainage rivers across the areas. Findings from figure 13, shows that catchment 1,2,3 and 4 has an area coverage of 542.59 km^2 (21.54%), 657.35 km^2 (26.09%), 468.03 km^2 (18.58%) and 851.29 km^2 (33.79%). A stream network can be generated from a flow accumulation raster. This is based on a threshold accumulation value. Findings shows there were about 9 stream order and 24 drainage network. However, if overflow it results to flooding across the areas.

The expansion of residential land and changes in on various land use categories due to unbalanced land use has led to an increase in the incidence of flooding due to soil saturation and affects the infiltration capacity of the soil. Changes in land use also change the water runoff and river discharge due to siltation on the river and water body. The spatial analysis results of land use, DEM, flow direction, flow accumulation and slope indicated that the study area has a high and very high risk of 15.44% and 15.81% respectively of the total area, a moderate risk of 22.50%, low risk of 25.82% and a very low risk of 20.42% of the total area. Thus, the study area generally has a high flood risk, which makes the overall risk of flooding in the area moderate to very high of the total area. Therefore, the segmentation of flood-risk zones is essential for development preparation in the study area.



Maps of Hydrological parameters

ISSN No. 231-2705 | DOI: 10.51244/IJRSI | Volume X Issue V May 2023



Evaluate the Socio economic Impacts and causes of urban drainage problem and failure in the study area

Table 9. Demographic and other socio-economic characteristics of the population

S/NO	LOCATION	GENDER	FREQUENCY	PERCENTAGE
1	ANKPA	MALE	212	55.94
		FEMALE	167	44.06
	TOTAL	**-**	379	100.00
2	DEKINA	MALE	198	52.24
		FEMALE	181	47.76
	TOTAL	**-**	379	100.00
3	OGUMA	MALE	210	55.41
		FEMALE	169	44.59
	TOTAL	**-**	379	100.00

Based on gender distribution of respondents across the study locations, table 9 above shows that Ankpa has 212 of the total respondents representing 5.94% which are males while 167 of the total respondents representing 44.06% where females. It shows that the male in this study, were higher in number than females. Similarly, it was also revealed that for Dekina, 198 respondents representing 52.24 % were males while 181 respondents representing 47.76% were females. The males within the total respondents here higher in number. In addition, for Oguma, 210 respondents representing 55.41% of the total respondents were males as 169 of the total respondents representing 44.59% were females. In all, the males (Respondents) in the study areas were slightly more than the male respondents.

ISSN No. 231-2705 | DOI: 10.51244/IJRSI | Volume X Issue V May 2023

Age Of Respondents

AGE GROUP	FREQUENCY	PERCENTAGE
21-30	78	20.58
31 – 40	150	39.58
41 – 50	98	25.86
60+	53	13.98
TO TAL	379	100

Table 2 above reveals that respondents between ages 21 – 30 was 78 of the total respondents representing 20.58%. The adult age between 31 – 40 was 150 of the total respondents representing 39.58%. Those between 41 – 50 age brackets are 98 (25.86%). They made only 58 of the total respondents representing 13.98%. The elderly who responded to the questionnaire were 53 of the total respondents representing 13.98%. This reveals that ages 31 – 40 making 39.58 made the highest respondents closely followed by ages 41 – 50 representing 25.86 while those between 60+ years were 13.98% formed the least number of respondents.

4.2 Causes of Urban Drainage Problem

Observation from table 4 clearly shows that 256,250 and 233 of the total respondents representing 67.55%, 65.96% and 61.48% strongly agreed that shallow drainage channels in Ankpa, Dekina and Oguma were responsible for drainage challenges in the study area. 80,86,103 of respondents representing 21.11%,22.69% and 27.18% agreed that urban drainage problems were as a result of shallow channels. It was also observed that 23, 19, 20 of the total respondents representing 6.07%, 5.01% and 5.28% disagreed to the above assertion while 5.28%,6.33% and 6.07% strongly disagreed with shallow drainage channels as cause of urban drainage challenges.

(2) Similarly, 272, 280 and 252 of the respondents representing 71.77% 73.88% and 66.49% strongly agreed that dumping of refuse (solid waste) in the drains were the major cause of drainage problems in the study area. 50,41, and 69 representing 13.19% 10.82% and 18.21% agreed with refuse dumping in drains but of 8,10 and 19 representing 2.11%, 2.64% and 5.28% disagreed while 5.28%, 6.33% and 6.07% strongly disagreed

(3) 178,180 and 104 representing 46.97%, 47.49% and 27.44% observed that inferior construction work was responsible. Then, 101,99 and 175 representing 26.65%,26.12% and 46.17% only agreed whereas, 60,57and 67 respondent representing 15.83%, 15.04% and 17.68% disagreed but 10.82% 11.61% and 8.97% respondents strongly disagreed that inferior construction work was responsible. (4) Similarly, 73.88%, 74.67%, and 57.73%, strongly agreed that heavy rainfall was responsible for drainage problems in the study area. 14.78%, 14.78% and 31.93% only agreed to that but 5.28%, 5.28% and 4.75% of respondents disagreed to the factor of rainfall while 6.07%, 6.07% and 6.60% strongly disagreed. Furthermore, based on functional environmental planning as another challenge observed was maintenance culture 27.70%, 26.39% and 35.62% strongly agreed that the absence of maintenance culture was responsible. 31.66%, 32.98% and 23.75% agreed but 18.21%, 19.00% and 19.79% disagreed while 22.43%, 21.64% and 20.32% strongly disagreed. When there is no functional environmental planning such environment will lack management policies.

Based on environmental planning, 27.18%, 38.26% and 41.69% strongly agreed while 46.44%, 35.36% and 31.93% only agreed but 13.72%, 15.83% and 18.47% disagreed while 12.66%, 10.55% and 7.92% strongly disagreed with environmental planning as a factor responsible for drainage problems in the study areas. (Table 4).

Based on topography of the area 43.01%, 25.86% and 31.43% strongly agreed while 30.61%, 47.76% and 43.80% only agreed but 11.87%, 14.78% and 12.93% disagreed while 14.51%, 11.61% and 14.25% strongly disagreed with topography as a factor responsible for drainage problems in the study areas. (Table)

Table 10: Causes of Urban Drainage Problem

	Strongly Agree						Agree						Disagree						Strongly Disagree					
	Ankpa		Bassa		Oguma		Ankpa		Bassa		Oguma		Ankpa		Bassa		Oguma		Ankpa		Bassa		Oguma	
Shallow Drainag	F	%	F	%	F	%	F	%	F	%	F	%	F	%	F	%	F	%	F	%	Freq	%	F	%

ISSN No. 231-2705 | DOI: 10.51244/IJRSI | Volume X Issue V May 2023

e Channel	256	67.55	250	65.96	233	61.48	80	21.11	86	22.69	103	27.18	23	6.07	19	5.01	20	5.28	20	5.28	24	6.33	23	6.07
Dumping of refuse in drains	272	71.77	280	73.88	252	66.49	50	13.19	41	10.82	69	18.21	8	2.11	10	2.64	19	5.01	49	12.93	48	12.66	39	10.29
Inferior Construction work	178	46.65	180	47.49	104	27.44	101	26.65	99	26.12	175	46.17	60	15.83	57	15.04	67	17.68	41	10.82	44	11.61	34	8.97
Heavy Rainfall	280	73.88	283	74.67	215	56.73	56	14.78	56	14.78	121	31.93	20	5.28	17	4.49	18	4.75	23	6.07	23	6.07	25	6.60
No Maintenance Culture	105	27.70	100	26.39	135	35.62	120	31.66	125	32.98	90	23.75	69	18.21	72	19.00	75	19.79	85	22.43	82	21.64	77	20.32
No Functional Physical Environ. Planning	103	27.18	145	38.26	158	41.69	176	46.44	134	35.36	121	31.93	52	13.72	60	15.83	70	18.47	48	12.66	40	10.55	30	7.92
Lack of Environmental Management Policies	245	64.64	252	66.49	261	68.87	99	26.12	92	24.27	83	21.90	20	5.28	25	6.60	24	6.33	15	3.96	10	2.64	11	2.90
Topography	163	43.01	98	25.86	120	31.43	116	30.61	181	47.76	166	43.80	45	11.87	56	14.78	49	12.93	55	14.51	44	11.61	54	14.25
No knowledge on Impact Awareness	45	11.87	58	15.30	56	14.78	52	13.72	39	10.29	41	10.82	102	26.91	149	39.31	151	39.84	180	47.49	133	35.09	131	34.56

ISSN No. 231-2705 | DOI: 10.51244/IJRSI | Volume X Issue V May 2023

4.3 Discuss on Impacts of Drainage Channel Failure on Residents

Impact in this context means "to have strong and often bad effect on something or someone". Table 5 shows that 65.70%, 56.73% and 56.46%, strongly disclosed that several homes are destroyed when drains fail, 31.66%, 32.72%, and 29.82%, while 2.64%, 10.55%, and 13.72% disagree. Based on pollution impact, 65.96%, 58.05%, and 62.01% strongly agree that has pollution impact on drainage failure. 29.02%, 34.04%, and 31.13%, agree while 5.01%, 7.92%, and 6.86% disagree to the fact that pollution has an impact on drainage failure. Based on waterborne disease 63.06%, 60.69%, and 54.09% strongly agree that waterborne disease is spread through drainage failure. 32.98%, 30.08%, and 29.55%, agree while 3.96%, 9.23%, and 16.36% disagree to the fact that waterborne disease is spread through drainage failure. Based on restriction of movement due to drainage failure 59.37%, 56.99%, and 55.41% strongly agree that there is usually restriction of movement whenever there is drainage failure. 34.30%, 31.13%, and 35.36%, agree while 6.33%, 11.87%, and 9.23% disagree to the fact that there is restriction of movement drainage failure.

Also, based on damages done to public infrastructures as a result failure of drainage channel to accommodate and direct water flow within the environment 64.64%, 67.28%, and 55.94% strongly agree that damages are done to public infrastructures. 30.08%, 28.50%, and 32.19%, agree while 5.28%, 4.22%, and 11.87% disagree to the fact that there is public infrastructures damage as a result of drainage failure. Hence, it is clear that drainage failure has all-round negative impacts on the residents across the study locations.

4.4 Causes of Urbanization across the Areas

Based on availability of social services is responsible for the shift, 56.20%, 63.32%, and 57.26% strongly agree that availability of social services is responsible for the increase population. 34.30%, 26.39%, and 28.50%, agree while 9.50%, 10.29%, and 14.25% disagree to the fact that availability of social services is responsible for urbanization. Based on fortunes and opportunities in cities that has created population surge in urban areas, 64.91%, 53.56%, and 54.62% strongly agree that fortunes and opportunities in cities that has created population surge in urban areas. 29.02%, 33.25%, and 35.88%, agree while 6.07%, 13.19%, and 9.50% disagree to the fact that fortunes and opportunities in cities that has created population surge in urban areas. Based on unpredictable nature of rural environment possess a push factor, 66.23%, 51.45%, and 70.18% strongly agree that unpredictable nature of rural environment possess a push factor created population surge in urban areas. 30.61%, 27.70%, and 26.91%, agree while 3.17%, 20.84%, and 2.90% disagree to the fact that unpredictable nature of rural environment has created population surge in urban areas.

In addition, based on rural poverty, 54.88%, 56.46%, and 64.64% strongly agree that rural poverty is the predominating push factor on the study areas. 34.04%, 35.09%, and 28.76%, agree while 11.08%, 8.44%, and 11.87% disagree to the fact that Rural poverty is one the major cause of rural-urban migration across the study locations

Impacts Of Drainage Channel Failure on Residents

Questions	Strongly Agree						Agree						Disagree					
Locations	Ankpa		Bassa		Oguma		Ankpa		Bassa		Oguma		Ankpa		Bassa		Oguma	
Destruction of homes	F	%	F	%	F	%	F	%	F	%	F	%	F	%	F	%	F	%
	249	65.70	215	56.73	214	56.46	120	31.66	124	32.74	113	29.82	10	2.64	40	10.55	52	13.72
Environmental Pollution	250	63.06	220	58.05	235	62.01	110	29.02	129	34.04	118	31.13	19	5.01	30	7.92	26	6.86
Spread of waterborne diseases	239	63.06	230	60.69	205	54.09	125	32.98	114	30.08	112	29.55	15	3.96	35	9.23	62	16.36
Restriction of movement	225	59.36	216	56.99	210	55.41	130	34.30	118	31.13	134	35.36	24	6.33	45	11.87	35	9.23
Damage to Public Infra-structure	245	64.64	255	67.28	212	55.94	114	30.08	108	28.50	122	32.19	20	5.28	16	4.22	45	11.87

ISSN No. 231-2705 | DOI: 10.51244/IJRSI | Volume X Issue V May 2023

Causes Of Urbanization

Questions	Strongly Agree						Agree						Disagree					
Locations	Ankpa		Bassa		Oguma		Ankpa		Bassa		Oguma		Ankpa		Bassa		Oguma	
	F	%	F	%	F	%	F	%	F	%	F	%	F	%	F	%	F	%
Availability of social services	213	56.20	240	63.32	217	57.26	130	34.30	100	26.39	108	28.50	36	9.50	39	10.29	54	14.25
Fortunes and opportunities	246	64.91	203	53.56	207	54.62	110	29.02	126	33.25	136	35.88	23	6.07	50	13.19	36	9.50
Unpredictable rural environment	251	66.23	195	51.45	266	70.18	116	30.61	105	27.70	102	26.91	12	3.17	79	20.84	11	2.90
Rural poverty	208	54.88	214	56.46	245	64.64	129	34.04	133	35.09	109	28.76	42	11.08	32	8.44	45	11.87

V. Research Findings

a) The major findings of the image analysis revealed that area under built-up land have been increasing significantly in the area due to increasing population pressure in the making the areas becoming congested resulting to haphazard development at most of the places which has resulted to problem like poor sanitation, poor road connectivity and adverse ratio of public amenities and population. It leads to back foot in sustainable urban development of city.

b) The study also revealed that high and very high vulnerability classes primarily cover the western, south-western, north western, and extreme upstream parts of the study area which is majorly Bassa due to it closeness to river Niger.

c) The results of flood risk and vulnerability assessment and mapping are crucial for the strategic management of flood disaster risk. This can help the government, policy makers, and planning and relief agencies to come up with effective flood reduction and migration measures

d) Most of the drainage channels are shallow causing overflow always.

e) Several forms of solid wastes are deposited in the drains impeding free flow of water.

f) Construction of drains were haphazard and real engineers were not involved.

g) Environmental planning its management policies was absent.

h) Drains were not maintained. No time to time removal of deposited load from flowing water during environmental sanitation.

i) Drainage failure caused flooding in residential areas.

j) Rural poverty was one push factor of urbanization in the study areas.

VI. Recommendation

i. Architectural approaches of flood control measures, such as structure elevation (building structures above the flood level), prevention using watertight emulsion for the exterior walls of buildings, and establishing flood-resilient building codes with regards to occupancy and the use of buildings in areas with low-lying elevations and high-flood-risk areas.

ii. Moreover, land use planning, when coupled with land use restriction policies, provides an effective measure of risk reduction in a particular area

iii. Land use planning and controlled sustainable development must be prioritized to better manage rapid urban growth and infrastructural demands.

iv. In a swiftly urbanizing country, proper land use policy, regulation, construction and development by-laws are essential to keep developers in check. A stringent program to monitor landscape changes and urban development is a critical starting point.

ISSN No. 231-2705 | DOI: 10.51244/IJRSI | Volume X Issue V May 2023

v. It is expected of the government to strictly enforce all relevant laws and planning that prohibit erection of structures along the flood plain

vi. There must be massive investment in dredging and redredging of the existing drainage network and channelization of new suburbs.

vii. Living habits of the inhabitants has to change.

viii. At any point of drainage construction, civil engineers must supervise the project instead of politicians.

ix. Physical planning efforts have to be drastic and deterministic towards sustainable drainage and erosion control.

VII. Conclusion

The present study use of Geospatial techniques with image classification approach has effectively helped in understanding intensively land use/ land cover changes of study area as well as the drainage network across the areas. In addition, questionnaires were used to elicit information from the respondents across the study locations. There is need for proper management of the environment to prevent various environmental disaster such as flood which has become a recurrent phenomenon in the area especial in Bassa due to it low elevation and closeness to river Niger. Hence, all built-up areas need to be drained to remove surface water run-off through channelization of drains so as to reduce flow and volume of surface water to prevent flooding which could result to epidemic condition for water borne diseases.

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