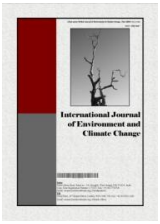

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Evaluation of Flood Management in Nigeria: A Case Study of Yauri Local Government Area, Kebbi State

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Authors' contributions

This work was carried out in collaboration among all authors. Author DHG did the data collection. Authors IKS and MIJ were involved in the design of the study and data analysis respectively. All authors read and approved the final manuscript.

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ABSTRACT

An evaluation of management in Nigeria with focus on Yauri Local Government Area of Kebbi State was carried out. The study made use of ASTER data of 2017 with spatial resolution of 30m, topographical map at a scale of 1:50,000, monthly rainfall data for 35 covering the study area and soil map at a scale of 1:50,000. Thematic maps for soil, rainfall and elevation were produced converted to raster data in GIS environment. Each data set in a single map was given weight by pair-wise comparison; reclassification of each map was done based on the weights generated from the pair-wise comparison of each dataset. The weights generated revealed that rainfall with 46 as its weight has the greatest influence on flood occurrences in the study area. Elevation accounted for weights of 24, slope accounted for 12 while drainage density, soil and LULC accounted for 10, 8 and 3 respectively. The settlements of Gumbi, Yauri, Unguwa Damisa, Zamare and Jijima that make up the study area lie along the zone of very high flood vulnerable land. Among the causes of flooding, excess rainfall and coastal location of the various settlements are responsible for flooding. Besides, the relief of the study area is such that encourage flooding as all the settlements are situated along the river course. The predominant coping and adapting strategies adopted to check flooding in the study area are temporary relocation and the raising of the floor of their houses among others.

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1. INTRODUCTION

Floods and flood-related disasters are among the most damaging catastrophes in the world and as observed by [1] that over the years and in almost every part of the world, excessive rainfalls due to climate change have resulted in flooding, which has claimed lives and properties. Flood results when a stream runs out of its confines and submerges surrounding areas [2]. Similarly, [3] defines flood as an overflow of an expanse of water that submerges land. Though, flood may be temporal covering of land by water as opined by the European Union, but the effects may not be temporal when such occurrence claims lives and properties. Flood does not only affect the victims, but also has a great gross effect on the national economy of the country where poverty level rises due to the incidence [4]. Nigeria has been assessed in literature to be very vulnerable to flood [5,6] and [4].

Flooding is considered as one of the most hazardous, frequent and widespread natural disasters and yet, floods seem to be part of the lives of some communities in the world [7,8,9]. With the on-going climate change and climate variability and their consequential effects of increasing weather and climatic extremes, including heavy and concentrated precipitations, coupled with other environmental woes, flooding has become a major problem of the whole world including Nigeria [10,4].Flooding mostly exacts adverse socio-economic impact on the wellbeing of flood prone communities. It does cause displacement of people, collapse of buildings, loss of lives, damage to valuable documents, unplanned migration, among others.

1.1 Statement of Problem

Severe flooding events have become a frequent phenomenon facing communities and authorities in Nigeria each year. For example, in 2010 and 2011 extreme flood events resulted in devastation and economic damages worth millions of naira in the affected urban cities such as Lagos, Kano and Ibadan and rural settlement communities in Sokoto and Kebbi State. Nigerian Red Cross and NEMA (2012) estimated displaced persons in Kebbi State as 45,000 (cumulative since beginning of the flooding). Twelve LGAs were severely affected: Augie, Argungu, BirninKebbi, Kalgo, Bunza, Suru, koko/Bese, Bagudo, Shanga, Yauri. Jega, and Maiyama. Bagudo is the most affected with over 80 villages flooded, with 26 in Augie, 19 in Argungu, 14 in BirninKebbi, 5 in Kalgo and 12 in Bunza. Furthermore, in 2015, some 37,610 hectares of farmland, 5,495 houses and 25,950 people were affected by floods in 12 local Government Areas of Kebbi State. Sequel to the above, this study attempt to evaluate the impact of flood and how best it can be managed in flood prone area of Yauri local government area of Kebbi state in Nigeria.

1.2 Location of the Study Area

Kebbi State, with its capital in Birnin Kebbi, is located within latitude 10° 8'N and 13°15'N and longitude 4°30'E and 6°02'E covering a total land area of 36,800 Km^2 with a population of 3, 256, 541 (NPC Census, 2006). The state has both Sudan and Sahel-savannah. The southern part is generally rocky with the Niger River traversing the state from Bennin Republic to Ngaski LGA. The northern part of the state is sandy with the Rima River passing through Argungu to Bagudo LGA where it empties in to the Niger. The state is administratively structured into 21 Local Government Areas (LGAs), four emirate councils and 35 districts. The area bordered with Sokoto State to the North-Eastern, Zamfara State on the Eastern part, Niger State on the Southern part and Republic of Niger on the Western part.

Kebbi State has diverse ethnic groups, the dominant among which are Hausas, Fulanis, Kabawa, Dakarkaris, Kambaris,Gungawa, Dandawa, Zabarmawa, Dukawa, Fakkawa and Bangawa. The ethnic groups speak diverse languages and dialects, with the Hausa language dominantly spoken. The study focuses on Yauri. The Local Government area is most valuable to flood due to its location to the major rivers of the state (River, Zamfara and Rima) (Fig. 1).

The climate of the study area is tropical continental is largely controlled by two air masses, namely Tropical Maritime and Tropical Continental, blowing from the Atlantic and the Sahara Desert respectively. The mean annual rainfall of the study area is about 800mm in the north and 1000 mm in the south. Temperature is generally high with mean annual temperature of about 260C.

The drainage system of the study area is dominated by River Rima system with major atributaries like Gawon, Zarnfara and Gubin Ka. These tributaries take their sources from the Basement Complex formation of Sokoto State and flow westward to join the Rima. To the southern part of the study area are smaller rivers, streams and tributaries such as Danzaki, Soda and Kasanu which flow to the southern part of the state and empty their waters in River Niger.

The natural vegetation of the study area consists of Northern Guinea Savannah in the south and south-eastern part of the study area. They are characterized by medium sized trees such as Parkia Clappertoniana (locust bean tree) and Bytyrosfperrriurn (Shea butter tree) and Combretum species. To the northern part of the study area is the Sudan Savannah consists of open woodland with scattered trees such as acacia aibi da (gawo), Parkia Clappertoniana, Porassus and dum palms.

Two group of soils can be identified in the northern part of the study area, the upland and fadama soils. These two soil groups characterize the entire Sokoto Rima Basin. While the upland soils are sandy and well drained, the fadama soils are generally clayey and hydro morphic, especially in the back swamps. In the south and south eastern parts of the study area, the weathering of the Basement Complex rocks has given rise to three types of soils.

Agriculture is the main occupation of the people of Kebbi State especially in rural areas apart from civil and public service. Crops produced are mainly grains; animal rearing and fishing which are common.

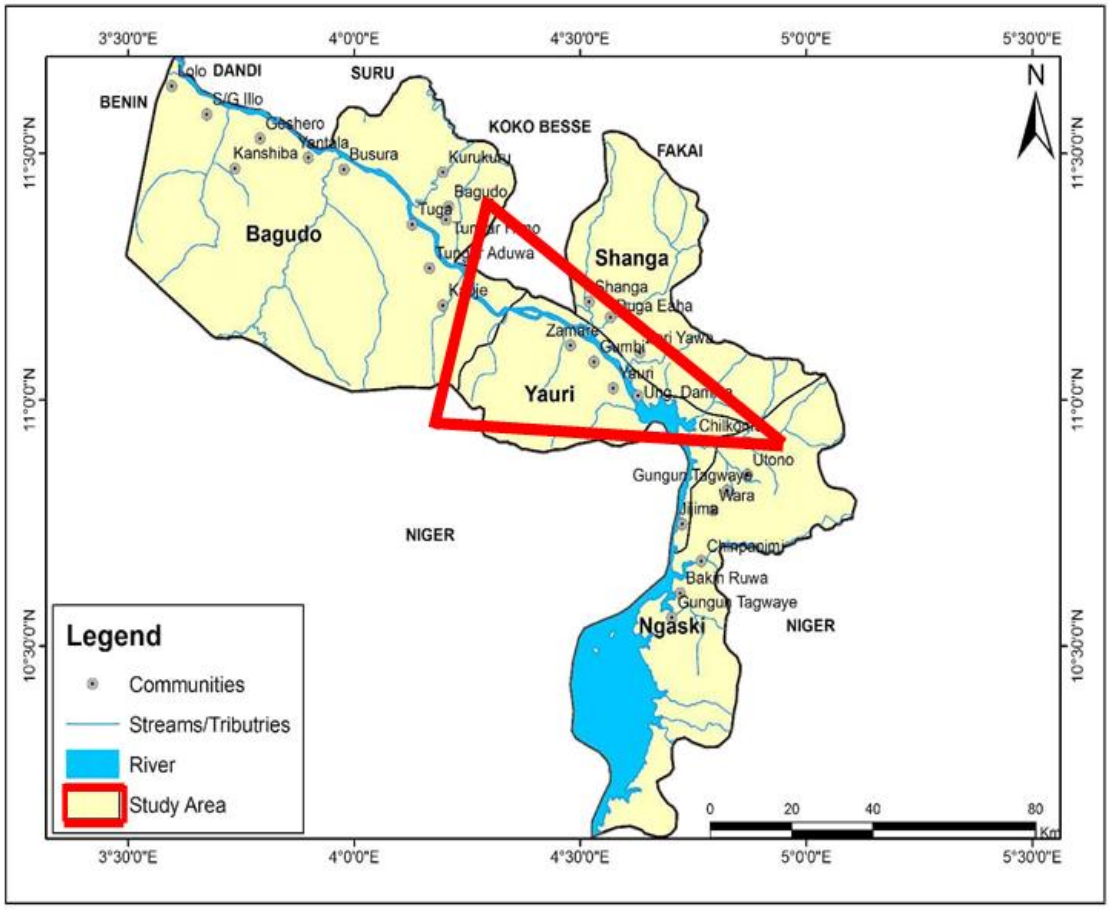

Fig. 1. Map showing the study area

2. MATERIALS AND METHODS

2.1 Sources of Data

The data required for this study was acquired from both primary and secondary sources.

2.2.1 Primary sources of data

Primary data include; demographic characteristics, flood experience, cause(s) of flooding, coping and adaptation strategies being adopted and socio-economic impact of flooding were collected through administered questionnaire. A total of 68 questionnaires were administered and 64 were returned among the communities sampled in the study area as shown in Table 1.

2.2.2 Secondary sources of data

The secondary sources of data include the following:

i. ASTER data of 2017 with spatial resolution of 30m was acquired from the United State Geological survey (USGS) to generate Slope and Elevation layers
ii. Topographical map of Kebbi State at a scale of 1:50,000 was acquired from the office of the Surveyor's General of the Federation for generation of Drainage Density layer
iii. Monthly rainfall data for 35 years over 3 stations in the study area was acquired from Nigerian Meteorological Agency, Abuja, Nigeria for generation of Rainfall layer
iv. Soil map of Kebbi State at a scale of 1:50,000 was acquired from the Department of Soil Science, Ahmadu Bello University, Zaria, Nigeria for generation of soil layer

2.3 Data Analysis

Thematic maps were produced for six factors that influence flood occurrence in the study area and imported into GIS environment for proper analysis. The dataset includes land use/cover categories, drainage density, soil, rainfall, elevation and slope. All data layers derived are converted to raster data sets having the same pixel size. Each data set in a single map was given weight by pair-wise comparison; in addition, the six (6) factor maps were compared with each other in pair-wise comparison. Reclassification of each map was done based on the weights generated from the pair-wise comparison of each dataset.

Table 1. Sampled communities and questionnaire administered in the study area

S/N	Name of community	Community sample size	
		Questionnaire administered	Questionnaire Received
1	Gumbi	19	19
2	Yauri	17	16
3	Unguwan Damisa	13	11
4	Zamare	11	10
5	Jijima	8	8
	Total	**68**	**64**

3. RESULTS AND DISCUSSION

The climatic, relief, and soil data available for the study were those covering the entire state of Kebbi and the data output were so generated but discussions were focused on evaluation of flood management as it relates to Yauri local government area, the study area.

3.1 Evaluation of Flood Causative Factors

Pair-wise comparison was carried out for the six flood causative factors (Table 2) based on Saaty's Fundamental scale of pair-wise comparison. The weights generated revealed that rainfall with 46 as its weight has the greatest influence on flood occurrences in the study area. Elevation accounted for weights of 24, slope accounted for 12 while drainage density, soil and LULC accounted for 10, 8 and 3 respectively.

3.2 Estimated Area of Flood Vulnerable Land

The areas below 167 meters along the coast where Gumbi, Yauri, Unguwa Damisa, Zamare and Jijima settlements are situated can easily be submerged when the rainfall is high. This affirms [11] who observed that topography consisting of undulating plain interrupted in places by low rising hills play a great role in flood occurrence. The estimated area of flood vulnerable land reveals that areas of very high flood vulnerable land constitute 23.9%(7.2%) of the study area and high flood vulnerable land covers 31.0% (15.1%) while moderate and low and very low flood vulnerable lands constitute 22.7%, 15.1% and 7.2% respectively (Table 3).The output map was thereafter reclassified into five (5)

vulnerability zones of Very Low, Low Moderate, High and Very High (Fig. 2). The settlements of Gumbi, Yauri,Unguwa Damisa, Zamare and Jijima that make up the study area lie along the zone of very high flood vulnerable land.

3.3 Causes of Flood in the Study Area

Causes of flooding as recorded from the data generated from questionnaires across the study area shows that in Gumbi changing climatic condition (5.3%) is responsible for flooding, 26.3% are of the view that dumping of refuse in drains is responsible for flooding. Those that are of the view that poor physical planning is responsible for flooding are 5.3%. While excessive rainfall and coastal location of community with 10.2% and 57.9% respectively were responsible for flooding in the Gumbi settlement (Table 4).

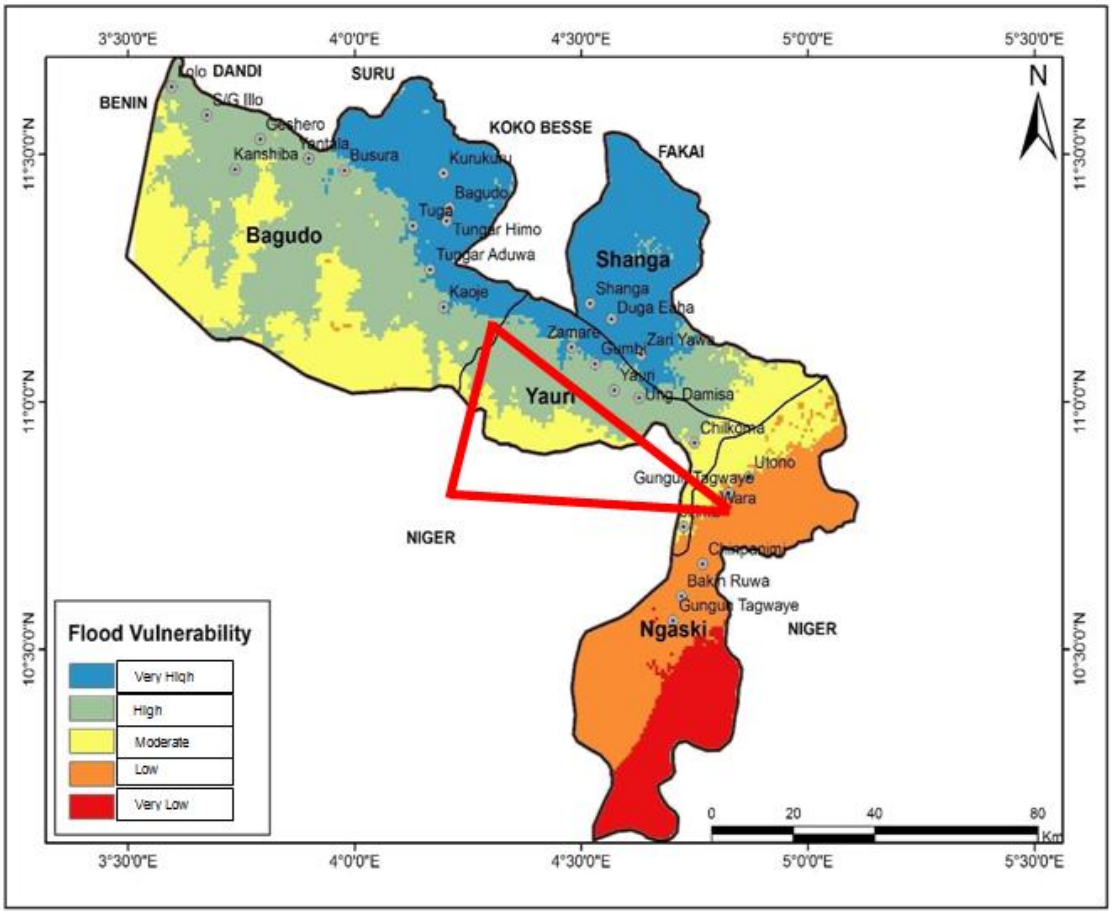

Fig. 2. Flood vulnerability map of the study area

Table 2. Weight for flood causative factors

	Drainage						Weight
	Rainfall	**Elevation**	**Slope**	**Density**	**Soils**	**LULC**	**(%)**
Rainfall	1	3	5	5	7	9	46
Elevation	1/3	1	3	5	7	9	24
Slope	1/5	1/3	1	2	4	5	12
Drainage							
Density	1/5	1/3	½	1	4	5	10
Soil	1/7	1/5	1/3	1/3	1	3	8
LULC	1/9	1/7	1/5	1/5	1/3	1	3

Consistency Ratio= 0.078

In Yauri settlement, 6.2% of the respondents are of the view that poor physical planning is responsible for flooding, While 25.0% and 68.8% of the respondents are of the view that excessive rainfall and coastal location of community respectively are responsible for flooding. 9.1% of the respondents from Unguwa Damisa settlements are of the view that changing climatic condition is responsible for flooding, 27.3% of the respondents are of the view that excess rainfall is responsible for flooding while 63.6% are of the view that coastal location of community is responsible for flooding in the study area (Table 4). In Zamare, 10.0% of the respondents are of the view that changing climatic condition is responsible for flooding, 20.0% of respondent opined that poor drainage system is responsible for flooding, 40% are of the view that excess rainfall is a causative factor in flooding and 30% of the respondents concluded that coastal location of the community is responsible for flooding. In Jijima settlement, 10.5% are of the opinion that changing climatic condition and poor drainage system are responsible for flooding. 5.2% are of the view that dumping of refuse in drains is responsible for flooding while 47.4% and 26.4% of the respondents are of the view that excessive rainfall and coastal location of community respectively are responsible for flooding (Table 4).

3.4 Coping and Adaptation Strategies

The various coping and adapting strategies adopted in the study are shown in Table 5. In Gumbi settlement, 15.8% of the respondents cope and adapt to flooding constructing furrows or canals, 10.5% move to higher ground, 5.3% are involved in raising the floor of their houses. Those involved in cultivation on small portion on higher ground and temporary relocation in coping and adapting with flood are 10.5% and 57.9% respectively.

In Yauri, those that are construct furrows or canals and raising the floor of their houses to avoid flood are 18.8%, while 6.2% are involved in the cultivation on small portion on higher ground to avoid flooding.

In Unguwa Damisa, 27.3% of the respondents construct furrows/canal and construction of sand bag, 18.2% of the respondents opined that shifting to higher grounds and temporary relocation is the coping strategy adopted during flooding, while 9.0% are of the view that cultivation on small portion on higher ground is a coping strategy during flood.

In Zamare, 20.0% of the respondents are involved in the construction of furrows/canals and

Table 3. Extent of flood vulnerable land

Vulnerability	Area in Km^2	%
Very High	2485.09	23.9
High	3226.76	31.0
Moderate	2364.82	22.7
Low	1569.63	15.1
Very Low	748.96	7.2
Total	**10395.26**	**100**

Table 4. Causes of flood in the study area

Causes of flooding	Gumbi		Yauri		Unguwa damisa		Zamare		Jijima	
	F	%	F	%	F	%	F	%	F	%
Changing Climatic Condition	1	5.3	0	0.0	1	9.1	1	10.0	2	10.5
Dumping of Refuse in Drains	0	0.0	0	0.0	0	0.0	0	0.0	1	5.2
Poor Drainage System	5	26.3	0	0.0	0	0.0	2	20.0	2	10.5
Spiritual Causes	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Poor Physical Planning	1	5.3	1	6.2	0	0.0	0	0.0	0	0.0
Population Increase	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Excessive Rainfal	2	10.2	4	25.0	3	27.3	4	40.0	9	47.4
Coastal Location of Community	11	57.9	11	68.8	7	63.6	3	30.0	5	26.4
Government Neglent	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	**19**	**100**	**16**	**100**	**11**	**100**	**10**	**100**	**19**	**100**

Table 5. Coping and adapting strategies

Coping and adapting strategies	Gumbi		Yauri		Unguwa Damisa		Zamare		Jijima	
	F	%	F	%	F	%	F	%	F	%
Construction of furrows/canals	3	15.8	3	18.8	3	27.3	2	20.0	5	62.6
Shifting to higher ground	2	10.5	0	0.00	2	18.2	0	0.00	1	12.4
Constructing sand bag	0	0.00	0	0.00	3	27.3	2	20.0	2	25.0
Raising the floor of houses	1	5.3	3	18.8	0	0.00	3	30.0	0	0.0
Cultivation on small portion on higher ground	2	10.5	1	6.2	1	9.0	0	0.00	0	0.0
Temporary relocation	11	57.9	9	56.2	2	18.2	3	30.0	0	0.0
Total	**19**	**100**	**16**	**100**	**11**	**100**	**10**	**100**	**19**	**100**

construction of sand bags in coping and adapting to flooding, while 30.0% are into raising the floor of their houses to avoid flooding.

In Jijima, 62.6% are into construction of furrows/canals in coping with flood, 12.4% shift to higher ground in coping with flood, while 25.0% made do with the construction of sand bag as coping and adapting to flood.

4. CONCLUSION

The study area has often experience flooding year in and year out with most inhabitants of the study area having the view that excess rainfall and coastal location of the various settlements that are responsible for flooding. Besides, the relief of the study area is such that encourage flooding as all the settlements are situated along the river course. The predominant coping and adapting strategies adopted to check flooding in the study area are temporary relocation and the raising of the floor of their houses among others.

The study has shown that flooding will always pose a challenge in the study area as the settlements are along the coast of the river. Sequel to the above, the following measures are recommended that:

i. Dredging of the river should be carried out as this will make the channel of the river to accommodate more water thereby reduce the rate of flooding.
ii. Houses built along the coastal plain of the settlements should hence forth be built with higher foundation to avoid flooding.
iii. The government should carryout adequate town planning to guide building and construction activities in the study area.
iv. Appropriate drainages should be constructed to evacuate rain water as excessive rain is one of the causative factors of flooding in the study area

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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