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Application of Physical Planning Strategies to Flood Control in Maiduguri, Borno State, Nigeria

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Abstract: Flood is a global natural disaster that has hugely cost the world in human and property loss with Nigeria having her own share of the menace at different times, the greatest of which occurred in 2012 when the country lost up to 363 people and 1.4% of her GDP to flood. This study which aims at providing permanent solutions to flooding and its attendant's effects in the study area was carried out in the six wards of Maiduguri metropolis most vulnerable to flood. Data obtained in respect of socio-economic characteristics indicated most inhabitants of the areas are in low income cadre earning living from farming, petty trading and artisanship with 0nly 17.6% as civil servants. Findings revealed that the area which though according to master plan, was originally designated for farming has been fully built up. About 62% of inhabitants had hitherto experienced flood, yet are still occupying the area for various reasons ranging from cheapness of land and rent, poor finance, family origin and only available space. The study discovered that varying degree of efforts from government agencies, community self-help programmes and individuals are on-going to mitigate the flood hazard but the result of which are unnoticeable due to lack of policy framework, inadequate finance and crude nature of some of the efforts. An integrated approach involving relocation of residents of the High Risk Zone in areas ranging from 10-150 m radius around Rivers Ngada and Alou, flood reduction and living with flood concepts by others in the Middle Risk and Lower Risk Zones through progressive renewal, reclamation, construction of deep drainages and embankments, proper solid waste management and adequate development control strategies, are recommended as physical planning strategies much required to mitigate flood incidence and its attendants effects in Maiduguri.

Keywords: Application, control, flood, physical planning, strategies

INTRODUCTION

A flood is simply seen as an environmental hazard that occurs when there is an overflow of water that submerges land which is usually dry. Adewusi (1990) viewed flooding as when soil is exposed to heavy rainfall and the blockage of the water way necessitates it to fight for its normal course. He further identified human activities such as rapid population growth and urbanization, bush burning, removal of woods for fuel, infrastructural development etc, as some of the factors that expose soil, hence blockage of existing water routes. Sada and Odemarho (1988) defined flooding as discharge, often leading to inundation of an area which is not normally covered with water. Flooding may occur as an overflow of water from water bodies, such as a river or lake resulting in some of that water escaping its usual boundaries or it may occur due to an accumulation of rainwater on saturated ground in an areal flood. Floods can also occur in rivers when the flow rate exceeds the capacity of the river channel. Eh-Shah (1994) considers sediment accumulation on flood plains as the major cause of increase in the water shed areas. Some floods develop slowly while others such as flash flood, can develop in just a few minutes and without visible signs of rain. Flood disasters are caused by different factors, natural or artificial especially when man puts himself at the risk of developing and occupying floodplains. These desires disrupt the physical and ecological conditions of the environment thereby leading to flooding (Oriordan, 1995). Additionally, floods can be local, impacting a neighborhood or community, or very large, affecting entire river basins. Adeyanju (2008) stated that 90% of flooding in our locality is human induced; mostly caused by blockage of drainages by silts and debris, building of houses along river banks and on drainage systems. These channels' obstruction always keep the flood plain soil saturated with water, making them areas liable to flooding giving the slightest rise in channels' flow (Moffat and Linder, 1995). Also human factors like deforestation and overgrazing are some of the causes of flooding, adding however that, flood could be as a result of collapse of dams leading to water overflowing their banks. It may also be as a result of heavy storm or storm surge and it is equally today attributed to climatic change.

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Flood is one of the most common global environmental hazards which often cause damage to homes and businesses if they are in the natural flood plains of rivers. In Rio de Janeiro, for instance, several thousands of families lost their homes due to floods in 1998 alone. The number was particularly high that year because the rains were especially heavy and several hundreds were routinely destroyed (Menezes, 1991).These huge losses, stern directly from the way the urban ecosystem, including land and services are managed. As in many cities in developing world, poor maintenance results in drains clogging with debris. Furthermore all the streams and rivers that provide natural drainage to the metropolitan regions are substantially silted over, due to the vast quantities of solid waste dumped into them. Freeman (1999) noted that 60% of deaths are from natural disaster, 45% of which are as a result of flood. Similarly, Chatterjee and Fried (1999) pointed out that flooding at Daqing in China's largest oil field, closed down 527 oil wells reducing output by more than 2 million gallons per day. Estimated cost of reconstruction was put at about 181 million US dollars. They further explained that Dhaka the largest city of Bangladesh with per capita income of 288 million US dollars with 9 million inhabitants, suffered serious flood damages. These cut across deaths, infrastructural facilities, utility and services, as well as diarrhea, due mainly to the contamination of drinking water.

Nigeria has had its own share of the problem in many states and at different times. William (1999) in his study of Loko river basin in Adamawa State flood disaster of August 1998 asserted that properties, animals and houses worth millions of Naira were destroyed. He further explained that the effects included structural and erosion damages, loss of lives and contamination of water and the destruction of other socio-economic activities. Not left out were transportation and communication facilities, including agricultural lands. So also, some other states were not spared. For instance, the collapse of Bagauda dam, with a capacity of 22 million cubic meters caused a lot of damage to properties like farmland, houses and crops. Also in 1988, Hadejia and Gumel local government areas of Kano State were flooded. In 1994 alone, there were incidents of flood in almost all the states in northern Nigeria, causing a lot of damages. Not forgetting however, the yearly release of water from Lagdo Dam in the Republic of Cameroon which always leads to flooding of some local government areas in Adamawa and Taraba States. This usually results in the destruction of properties worth millions of Naira (Areola and Akintola, 1980).

Akinola and Odihi (1985) have in their various studies on Ibadan city, reported the extent of Ogunpa floodplain encroachment and the results of damage between 1955 and 1980. Similarly, the worst recorded devastating flood of September 1994 in Maiduguri is still fresh in the memories of people, because it caused unprecedented damages, rendered thousands of people homeless, stranded and turned many others into refugees under trees and public buildings. Deaths and several injuries were recorded. Private and public properties worth millions of Naira were lost (Daura *et al*., 2001). Isong and Adinna (1999) also stated that Yellow Duke river, flood annually and displaces families and the offices of Calabar Polytechnic.

Table 1 shows a time-line summary of some major flood occurrences in the country.

Maiduguri has a total landmass of about 400 km^2. The already built up areas is about 121 km^2 representing 30.3% of the total landmass (Borno State Ministry of Land and Survey, 2008). The city has eighteen wards in five districts; Gwange, Bolori, Yerwa, Maiduguri and Khaddamari districts. Six wards in these districts based on history and physical observation, are seriously threatened by flood hazard. The affected wards are Kachallari, Maisandari and Mashimari in Khaddamari district. Others are Ngomari, Moduganari and Dusuman in Gwange district.

The relief and the landscape revealed by the spatial analysis of the maps, show that the area is flat with the highest point at about 700 m above sea level in the southern area and 228 m as the lowest level in the northern area at the shore of Lake Chad Basin in the north east (Maxlock, 1976). There are several bridges along the rivers/roads and the natural drainage structures of Alou and Nggada discharges north east, towards the Jere-Plain, as ascertained by observation of the direction of flow during rainy season (Field survey, 2014) Fig. 1.

Table 1: Summary of some major flood occurrences in Nigeria

Year	Description of flood occurrence
1994	There were incidents of flood in almost all the states of northern Nigeria, causing a lot of damages.
1998	Kano witnessed windstorm and flood which affected about 300,000 persons.
1999	Bayelsa and Delta states experienced heavy flood that rendered hundreds of people homeless
2001	Abia, Adamawa, and Akwa-Ibom states witnessed heavy downpour and rainstorm which affected about 5000 people. About 12, 300 persons were also displaced by torrential downpour which damaged properties, destroyed farmlands and submerged buildings in Zamfara. Bayelsa, Kano and Delta states were also hit by flood.
2005	Taraba states experienced heavy rainfall resulting in flood which displaced over 500,000 people.
2011	Lagos and Ibadan were wreaked by extensive havoc caused by flood.
2012	363 people were killed, 5,851 injured, 3,891,394 affected, 3,871,530 displaced and N2.9 trillion (1.4% of the nation's GDP) lost due to widespread of flood that cut across about 33 states (Borno state)

Authors, 2014

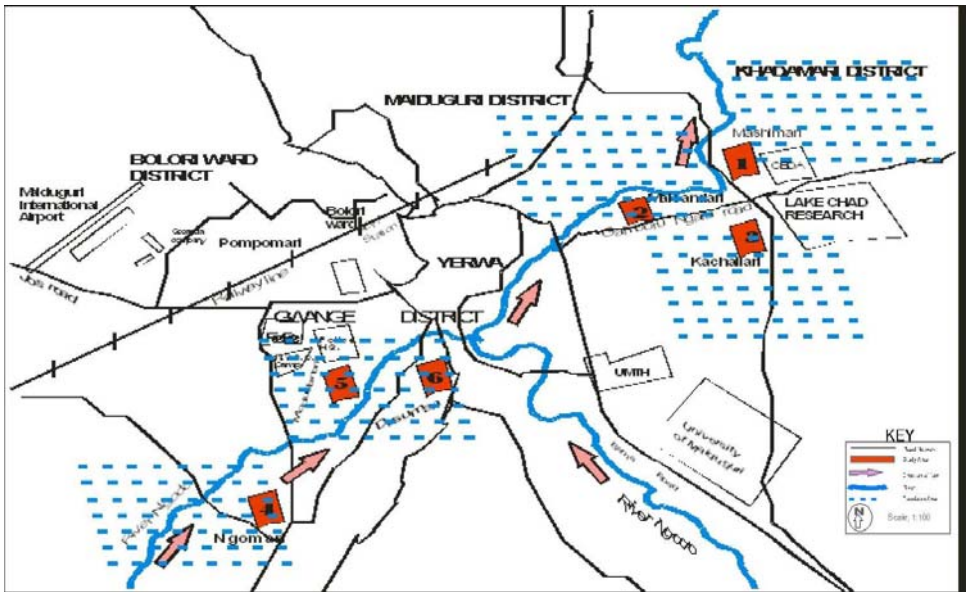

Fig. 1: Map of Maiduguri showing the study areas; Source: Borno State Ministry of Land and Survey, 2008

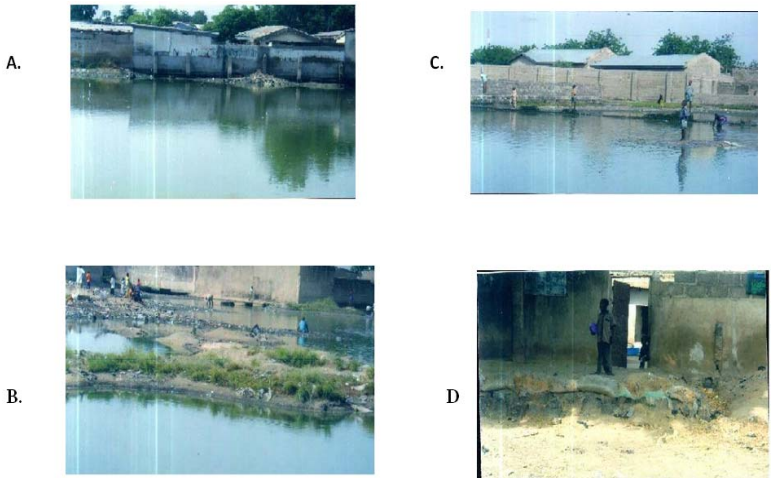

Fig. 2: Photographs A, B, C, and D show some flood incidence in the study areas

Field Survey Observation showed that some efforts are being made to mitigate flood in the areas through government's projects, community self-help programmes and individual efforts. The Local Government Councils collaborate with State Government in providing 79 drainages/channels in all the study areas, relief materials were distributed to victims and the camps for flood victims were renovated. The Federal Government also through Chad Basin Development Authority in collaboration with the state government attempted to dig Nggada channels with bank bunch stabilization and dykes; and also made effort towards damming River Alou. The state government through her agencies, Bureau of Land and Survey and Urban Planning Board, equally made some efforts at approving buildings and checking developments. The Borno State Environmental Protection Agency (BOSEPA) also tried to clear some garbage on roads and in drains. Some community and individual efforts were also observed in the study areas. Such efforts include construction of drainages and narrow channels with simple equipment such as diggers and hoes through physical labour, sandfilling and sandbagging.

Although the landuse proposed for the plain of Maiduguri according to the master plan of the metropolis, is agriculture, (Max Lock, 1976). Field survey however, showed that the area is already built-up with buildings indiscriminately erected and fully occupied. As a result of continuous loss of life and properties due to flooding in the area, the study was carried out to review and investigate the major causes of flooding in the area and the reasons for the springing up of development as against the recommendation of

Table 2: Study sample

Wards	Population	No of households	Sample Size (30% rounded up to nearest whole number)
Moduganari	5.824	319	96
Dusuman	4748	255	77
Kachallari	1043	51	16
Ngomari	1369	72	22
Maisandari	1161	59	18
Mashimari	1417	74	21
Total	15562	830	250

MMPHCU, 2008 and Authors, 2014

the master plan. It equally studies the existing flood control and management strategies in Maiduguri so as to determine the reasons for flood persistence and thereby apply physical planning strategies that will provide permanent solutions to this natural disaster (Fig. 2).

RESEARCH METHODOLOGY

Both primary and secondary sources were explored to obtain the required data for this study. The primary sources were the raw data collected through Field Survey Assessment (FSA), questionnaires' administration and oral interview. A set of questionnaires containing open and close-ended questions were administered on 30% of the total households i.e., 250 household heads (Table 2) using simple randomization of picking without replacement on the already established numbering system in the wards by the Maiduguri Metropolitan Primary Health Care Unit. Different sections of the questionnaires were used to obtain information on the socio-economic characteristics of the inhabitants of the six political wards vulnerable to flood in Maiduguri, reasons and duration of their stay in the areas, reasons for not relocating, occupational status and existing flood control strategies.

Journals, textbooks, internet, unpublished theses and maps obtained from library and institutions, were the secondary sources explored. The data were analyzed using simple statistical tools including percentages, tables and charts.

DATA ANALYSIS AND DISCUSSION OF FINDINGS

Age variation in active participation in flood control in Maiduguri: The result of the findings revealed that the active age group that mostly participates in flood control in Maiduguri range between 20-32 years forming 72.0% of the respondents, 22.4% are of 33-45 years and 5.6% fall into 46-57 years age bracket Fig. 3.

Occupational status of the respondents: From the study, the result revealed that civil servants in the study areas form only 17.6%.Traders make up 20.4%, farmers, artisans and others such as labourers etc are 21.2% each. This is shown in Table 3 and Fig. 4.

Table 3: Occupational status of respondents

Wards	Civil servant	Trader	Farmer	Artisan	Others
Moduganari	20	15	22	20	19
Dusuman	7	20	24	21	5
Kachallari	6	3	-	-	7
Ngomari	6	2	3	5	6
Mashimari	3	5	1	-	9
Maisandari	2	4	1	7	7
Total	44	49	51	53	53
%	17.6	19.6	20.4	21.2	21.2

Authors' Field Survey, 2014

Table 4: Income level of respondents

	Income Level (N)				
Wards	< 9000	9001-18000	18001-27000	27001-36000	>36000
Maduganari	25	51	11	7	2
Dusuman	18	45	3	6	5
Kachallari	7	8	-	-	1
Ngomari	5	12	4	1	-
Mashimari	5	7	3	1	2
Maisandari	3	9	5	4	-
Total	63	132	26	19	10
%	25.2	52.8	10.4	7.6	4.0

Source: Authors Field Survey, 2014

Table 5: Causes of the floods as observed by households in Maiduguri

Wards	Absence of drainage	Blockages	Topography	All of the above
Moduganari	23	37	20	15
Dusuman	34	17	6	20
Kachallari	3	7	6	-
Ngomari	5	-	15	2
Mashimari	15	-	2	1
Maisandari	10	-	10	1
Total	90	61	62	39
%	36.0	24.4	24.8	14.8

Authors' Field Survey, 2014

Income Level: As shown in Table 4 below, 78% of the inhabitants of the study area earn below the minimum wage benchmark of N18000.00 in Nigeria. This is as a result of the nature of their occupation and this perhaps suggest the different reasons they gave for their continuous stay in the area despite the annual threat of flood.

Causes of the flood in the study areas: Findings of the study further showed that many factors are responsible for flooding in Maiduguri as expressed by the respondents. While 36.0% attributed it to absence of drainages, 24.4% said it was due to the blockage of drainage channels. 24.8% were of the opinion that flooding in the area is as a result of the nature of topography of the areas. Others forming 14.8% believed that factors such as negligence, poor refuse disposal system etc were more responsible for the hazard (Table 5).

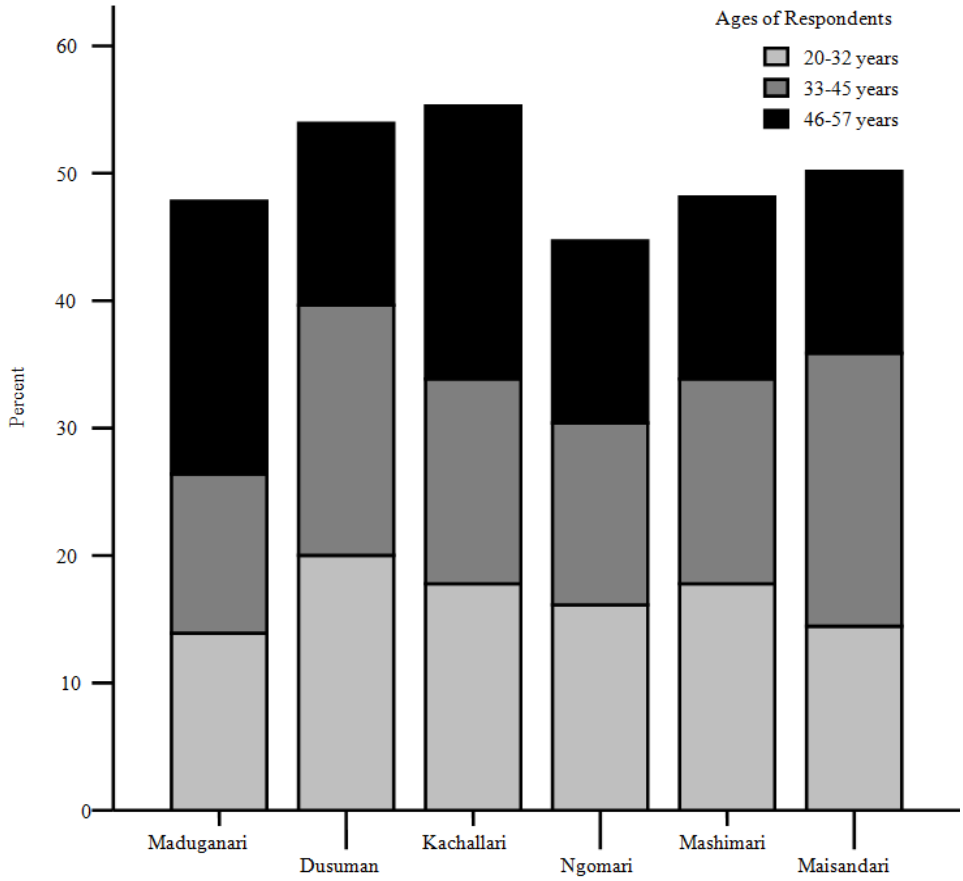

Fig. 3: Age analysis of participants in flood control in Maiduguri

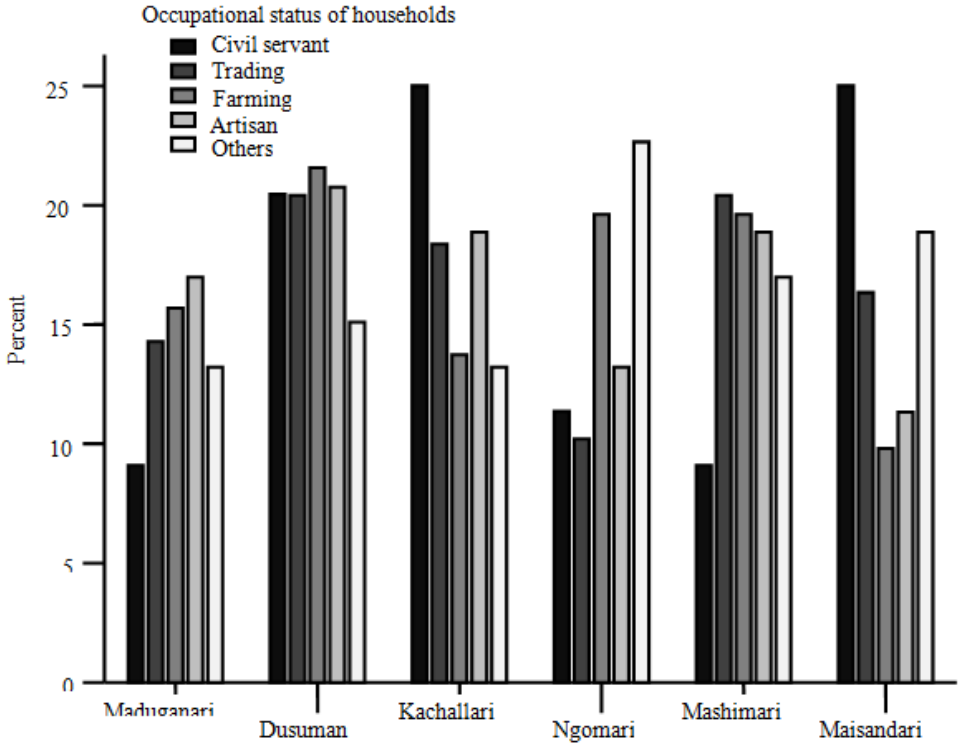

Fig. 4: Occupational status of respondents

Table 6: Peak month of flood occurrence in Maiduguri

		Peak Months of floods Occurrence in Maiduguri				
Wards	Parameters	May	June	July	August	Total
Moduganari	Count	12	14	13	57	96
	% of response from the respondents in each area	30.0%	33.3%	29.5%	44.5%	38.4%
Dusuman	Count	12	16	16	33	77
	% of response from the respondents in each area	30.0%	38.1%	38.1%	25.8%	30.8%
Kachallari	Count	3	1	4	8	16
	% of response from the respondents in each area	7.5%	2.4%	9.1%	4.4%	6.4%
Ngomari	Count	3	5	3	13	22
	% of response from the respondents in each area	7.5%	11.9%	7.5%	10.2%	8.8%
Mashimari	Count	5	3	4	8	21
	% of response from the respondents in each area	5.0%	7.1%	9.1%	7.0%	7.2%
Total	Count	40	42	44	128	250
	% of Total	9.2%	10.4%	12.4%	68.0%	100.0%

Authors' Field Survey, 2014

Table 7: Residents experience of flood

	Had Flood Experience		Had No Flood Experience	
Wards	No	%	No	%
Moduganari	26	16.9	29	30.2
Dusuman	40	26.1	37	38.5
Kachallari	21	13.6	8	8.3
Ngomari	19	12.3	9	9.4
Mashimari	25	16.2	6	6.3
Maisandari	23	14.9	7	7.3
Total	154	100%	96	100%

Field survey 2014

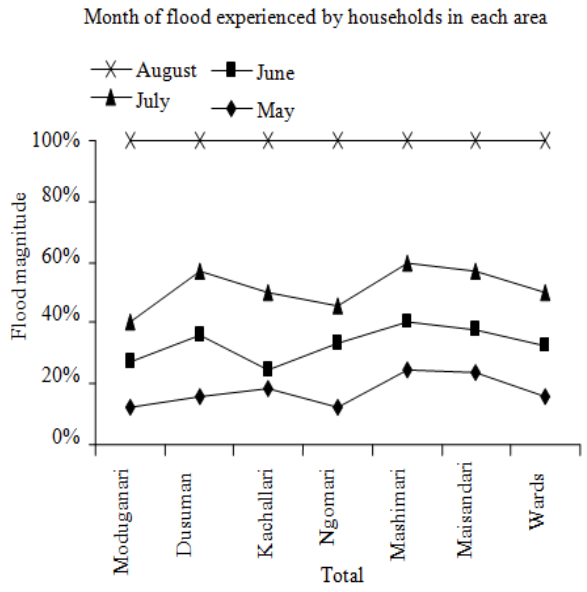

Fig. 5: Months of flood occurrence in Maiduguri

Months of flood occurrence in Maiduguri: The study revealed that the peak month of flood occurrence in Maiduguri based on responses of the respondents in the studied wards is in the month of August every year even though the accumulation of water in depressions begins from the month of May (Fig. 5). This is shown in Table 6.

Expression of flood experience: As shown in Table 7, information was obtained from inhabitants of the study area regarding their experience of flood in the past. The result revealed those 154 respondents representing 61.6% had at one time or the other experienced flood in their dwellings while 96 that make 38.4% had no experience of serious flood in their homes even though the environment may be generally flooded.

Households opinions on reasons for occupying the flood prone areas: The result of the households' opinion on the reasons for occupying the floodable area and not relocating shown in Table 8 below indicated that 21.2% responded to family origin and cheap rent each. 18.4% attributed the reason to inadequate finance and 19.6% said it was due to cheapness of land and availability of space each.

PROPOSAL AND RECOMMENDATIONS

WHO (1991), Parker and Metchell (1996) stated that the principal methods of flood mitigation are river regulation, construction of storage reservoirs and embankment, as well as catchments modification. The flood plains of Maiduguri are within Moduganari, Kachallari, Dusuman, Ngomari, Maisandari and Mashimari covering 30.3% of the total built up areas of the metropolis. The spatial analysis of the maps and the physical observation ascertained that the topography is relatively flat and the major drainage, Alou and Nggada, flow in the northeast direction towards the Jere plain.

Consequent upon the analysis of the results obtained from the data collected in respect of the cultural and socio-economic characteristics of the inhabitants, field observation and investigation of the physical setting, topographical and soil features of the study areas as well as the inferences drawn from them, an integrated approach involving relocation, living with the flood and flood loss reduction concepts are considered appropriate to mitigate incidence of flood and its attendant effects in Maiduguri. In this concept, the vulnerable areas are subdivided into three zones viz: High Risk Zone (HRZ), Medium Risk Zone (MRZ) and

Table 8: Reasons of occupying the flood affected areas in Maiduguri

Wards	Inadequate finance	Family origin	Cheap rent	Cheap land	Available space	Total
Moduganari	31	29	20	15	1	
Dusuman	12	20	16	25	-	
Kachallari	-	4	-	3	9	
Ngomari	1	-	8	-	13	
Mashimari	2	-	-	5	12	
Maisandari	-	-	9	-	12	
Total	45	53	53	49	49	
%	18.4	21.2	21.2	19.6	19.6	

Authors' Field Survey 2008

Low Risk Zone (LRZ). The HRZ are the areas on the fringe of River Nggada and Alou within a radius 10m-150m from the flow way in Khaddamari and Gwange districts. The physical assessment revealed that it is difficult to achieve a substantial reduction of flood damages by mere flood related planning; hence, residents within the zone have to be relocated and the areas be zoned as stabilization of the rivers' banks using levees and embankments; and then greened for recreation and buffer purposes. Habitat (1996) provides guidelines for sitting building construction in flood prone areas.

The MRZ are the areas immediately after the HRZ, they are characterized by depressions and subsidence which eventually turn to water pools that threaten the health of inhabitants as identified in the area. Clustered structures, preventing construction of good drainage network and aligning of street layout and as well the scattered heap of open dump rubbish blocking the few narrow drainages and excavated trenches are common in this zone. This area is recommended for progressive renewal, reclamation and construction of deep drainages. Collection points should be designated for proper disposal of solid waste and sensitization programmes need to be frequently organized to enlighten the residents of the areas on the dangers of their activities on flood.

Developments can be allowed to continue in the LRZ. There should however be proper landuse regulations and development control under the co-ordination of the Borno State Development Board, to ensure the building foundations and elevations are regulated. The existing buildings should equally be subjected to structural test.

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