Annals of Geographical Studies
Volume 4, Issue 1, 2021, PP 16-26
ISSN 2642-9136
DOI: https://doi.org/10.22259/2642-9136.0401003

Effectiveness of Flood Adaptation Strategies to Land Use Dynamics in Ngoketunjia Division, North West Region of Cameroon

Sunday Shende Kometa*, Dereck Mbeh Petiangma & Edwin Mua Kang ****

Department of Geography, University of Bamenda P.O. Box 39, Bambili, Cameroon,

**Corresponding Author: Sunday Shende Kometa, Department of Geography, University of Bamenda P.O. Box 39, Bambili, Cameroon.*

ABSTRACT

In unavoidable hazard zones, living organisms are obliged to either adapt, migrate, or become extinct. This study was designed to assess the effectiveness of flood adaptation strategies in Ngoketunjia Division which is an endemic flood prone zone based on FEMA recommended standards. The two-stage random sampling technique was used to administer questionnaires to 384 household heads who were predominantly farmers and occupants of flood prone areas. Each 4th household within the accessible target population was sampled. Questionnaires were the principal instrument of data collection though photographs of some structural adaptation strategies were taken to supplement it. Descriptive statistical techniques embedded in Microsoft Excel were used to analyse survey data. Findings revealed that flood adaptation strategies at the level of settlements are largely ineffective and below FEMA recommended standards. 82.03% of buildings in the zone were not designed by certified engineers, 61.72% were constructed with fragile sundry blocks which does not comply to FEMA recommended flood resistant building materials while 72.66% of building foundations were found to be less than the 0.6 (2 feet) above the highest adjacent grade recommended by FEMA for areas where Base Flood Elevation is yet to be determined. Findings revealed that 72.16% and 23.81% of houses constructed with sun-dry blocks and cement blocks respectively have either collapsed or developed cracks while 64.52% of foundations with heights of less than 0.6m (2 feet) and 17.24% of those with heights between 0.6-0.7m have been submerged at least once. Non-structural adaptation strategies with little or no blue-print for assessment of their effectiveness were found to be moderately effective. The study recommends both structural and non-structural flood resilient strategies in the already fragilized topographic plains of the area.

Keywords: *Effectiveness, adaptation strategies, land use, flood, Ngoketunjia*

INTRODUCTION

Floods have been known to cause untold damages to lives and property worldwide with the current trend not indicative to be declining in the near future. Population growth and economic development which are major drivers of the hazard continue to increase unabated (Jongman *et al.*, 2012). A diversified approach is required for effective adaptation to rising flood risk ranging from structural protection measures, early warning systems, risk informed land use planning, nature based solutions, social protection to risk financing instruments (Aerts *et al*, 2014, cited in Jongman, 2018). IPCC (2007) cited in Lawrence and Quade (2011) defines adaptation as "the adjustment in natural, or human systems in response to actual or expected climatic stimuli or their effects which moderates harm or exploit beneficial opportunities. International standards and guidelines for engineered flood management structures exists such as the International Levee Handbook and the Coastal Engineering Manual. Similar standards are yet to be crafted for nature-base measures (World Bank, 2017). In consonance with this, FEMA (2008) added that standard measurements and proper maintenance are also aspects that must be taken into consideration. Policies provide different standards of protection for residential, industrial, and agricultural land uses and in the UK, it ranges from 1-300 years depending on land use (DEFRA, as cited in Scussolini *et al.*, 2016). Adaptation at building levels can be applied on a home and there are three main adaptation levels in this dimension- elevation (on stilts or raised foundations), dry-floodproofing (external protection of buildings to prevent water from entering) and wet-floodproofing (water allowed to enter buildings but measures such as transferring utilities and vulnerable elements to higher floor taken) (Global Water Forum, 2019). The design emphasizes on issues of foundation requirements, elevation of lowest floor, wet and dry flood proofing, utility installations, flood load and building access (FEMA, 2012). Though, more economically effective than elevation method, the dry-floodproofing provide no risk reduction if a structure's height is exceeded by inundation depth (Global Water Forum, 2019).

According to Sayers *et al.* (2013), the Achilles heel of flood mitigation structures is maintenance. More effort is usually placed on initial construction than the maintenance and upgrading of facilities. Without sufficient support, new defences can rapidly depreciate and fail to provide the level of performance they were designed to provide. In most cases, this often result in the collapse of the entire plan. China recognises this and is promoting the maintenance and reinforcement of flood control structures through a series of policies, regulations, and actions to ensure normal operation of flood control systems. Kreibich *et al.* (2017) reiterated that, the reinforcement of flood control infrastructures reduces damage and exposure despite the fact that policies, legal changes and enforcements are required in areas of land use planning. FEMA (2012) added that dry flood proofing systems require a certain degree of inspection and maintenance to ensure normal functioning during floods and that some of the components to be checked include electrical systems, walls for cracks and leakages. All structural and non-structural building materials in flood prone zones at or below Base Flood Elevation (BFE) must be resistant irrespective of flood duration. "Class 4" and "class 5" building materials have been recommended for these zones. Flood resistant material is any building material that can withstand direct and prolong contact with flood waters without sustaining any significant damage.

The study problem arises from the fact that it appears more than 60% of Ngoketunjia Division is made up of the Ndop plain. The plain extends into the West Region in the south but is bordered in the west, north and parts of the east by the Balikumbat hills/plateau, the Sabga hills, Oku Mountain range and the Wainamah hills. This topographic configuration presents vast plain notorious for flooding. Ironically, more than 70% of the approximately 250.000 inhabitants of the Division live either in the plain or depend on it for their livelihoods. Within the past 10 years, the Division has experienced five separate flood events in Babessi Sub Division alone with the most recent being the August 5th, 2019 flood that destroyed houses, rendered many homeless and washed away farmlands. Risk zones in the Division especially flood plains, wetlands and steep slopes are increasingly being colonised by farmlands and settlements and this trend is expected to continue given the human development signatures on the already fragilized landscape. Since the geography of the area makes human interaction with its fertile and rich but risky flood plain a condition sine-qua-non, man is left with fewer options than to adapt. Previous flood related studies in the area have focussed mainly on the causes and effects of flood hazards, neglecting the assessment of adaptation strategies which are indispensable to enhance resilience and enable man to fully exploit the rich soil and water resources of the plain. This study was designed to bridge this theoretical void and reoriented flood related studies in the area.

STUDY AREA

Ngoketunjia Division lies between latitudes 5° 15' and 6° 10' N and longitudes 10° 15' and 10°40' E (Wirsiy, 2011). The Division is bordered to the west by Mezam Division, north by Boyo and Bui Divisions and in the south and east by the West Region (Figure 1). Ngoketunjia Division is one of the seven divisions that make up the North-West Region of Cameroon.

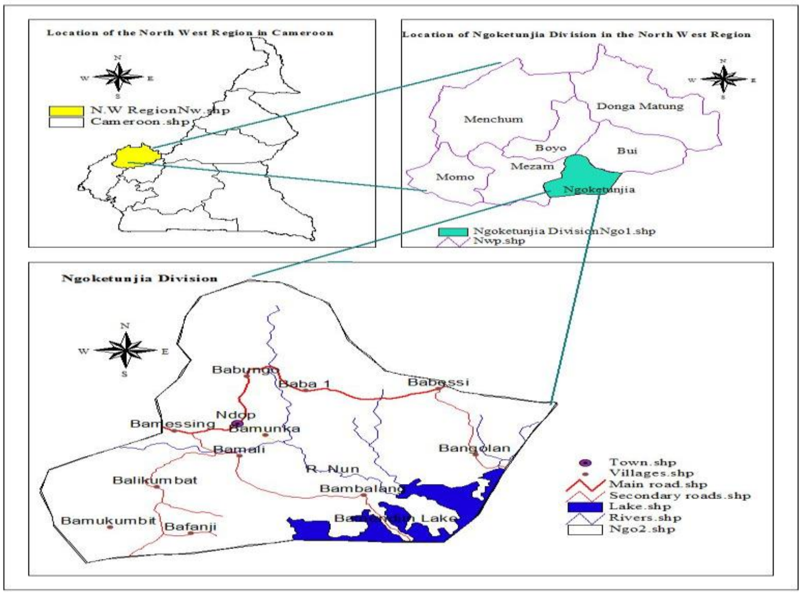

Figure 1: *Location Map of Ngoketunjia Division*

Source: Digitized using ArcView GIS 3.2.

Ndop the headquarter of the Division is about 40km from the North-West Regional Headquarter Bamenda along National Road Number 11 which links Bamenda and Kumbo. The Division is made up of 13 villages.

MATERIAL AND METHODS

The study employed both primary and secondary sources of data collection techniques. Field observation were undertaken at different intervals in the different seasons of the year. The essence was to observe more especially households' adaptation strategies to flood incidence given the regular occurrence and vulnerability of the plain to hydrological excesses. Field observation was accompanied by the distribution of questionnaires using a two stage random sampling technique. The two-stage random sampling technique was preferred to other probability sampling techniques because of its greater efficiency in larger geographical areas. In the first stage of the sampling process, the 13 villages of the Division were grouped into three pots corresponding to her 3 sub divisions. Two villages were randomly selected from each pot to constitute the sample frame for second stage sampling. In the second stage sampling process, the systematic random sampling technique was used to administer questionnaires to the sample population. Every 4^{th} household within the accessible population was surveyed.

The target population consisted of heads of households who were predominantly farmers and inhabitants of flood prone zones. In line with the sample frame of Taherdoost (2016), the sample size population was determined at 95% confident level (and a margin of error of 5) deduced from the total population of about 250.000. Hence, a total of 404 questionnaires were administered to households within the plain. The number of questionnaires administered in each sub division was directly proportional to the ratio of the sub division's population to that of the Division. Questionnaires on the standards of adaptation strategies were designed and structured to elicit responses on the following themes: the use of experts in the design of structures, the types of building materials used, and the heights of foundations of buildings among others. This was complimented by actual field observation and measurements of heights of foundations and other structures. Mud lines and water marks on building were used to determine flood heights. Questionnaires on the effectiveness of adaptation measures were designed to obtain information on the performance of the different adaptation strategies against floods. Secondary data were sourced from journals, articles and salient documents from councils and offices of divisional officers. The Federal Emergency Management Agency's (FEMA) guide on engineering works in flood prone zones was used to assess and rate the standards of the different structural measures. Descriptive statistical techniques especially, charts and tables were used to present the result of the analysis. Data on effectiveness were analysed both quantitatively and qualitatively. The standards of the different structural adaptation strategies were assessed by comparing findings with FEMA recommended standards while the effectiveness of the different adaptation strategies was assessed based on their actual performances.

RESULTS

Effectiveness of Adaptation Strategies for Buildings and Building Design

FEMA in collaboration with other institutions such as the Associated Programme on Flood Management (AFPM) have developed a more comprehensive standard for construction and retrofitting of buildings to enhance resilience in flood prone zones. The guide specifies standards for building design, building material as well as heights of foundations and other accessories. This guide was used to make a comparative analysis with what prevails in Ngoketunjia Divsion and Cameroon at large. FEMA recommends that certified engineers should be contracted to design and construct all types of buildings in flood prone zones. The institution equally recommends building designs such as storey buildings and buildings enclosed by floodwalls as suitable designs in flood zones. Figures 2a and 2b present summaries of surveys in which household heads in the flood prone zones were asked to identify the designer of their buildings and building designs respectively.

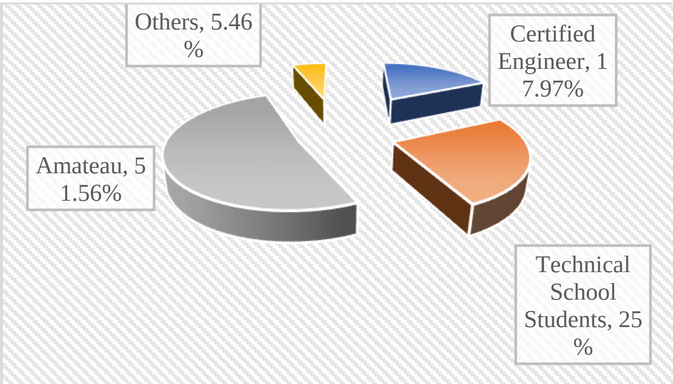

Figure 2b: *Common building Designs*

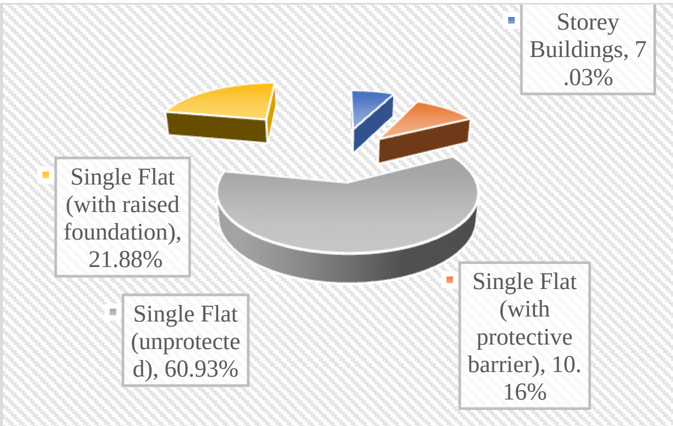

Figure 2a: *Common building designers*

Source: Fieldwork, (2019)

Figure 2 shows that 51.56% of houses in the flood prone zones of Ngoketunjia were designed and constructed by amateurs whereas FEMA recommends the use of highly qualified engineers for the design and construction of buildings in such zones. Findings revealed that s low percentage (17.97%) of houses here were constructed do not follow the standard level by certified engineers. Even the 25% of houses designed and constructed by technical school students are below standards since the students are yet to be certified. Figure 2a and 2b indicates that 60.93% of residential buildings in the flood prone zones of Ngoketunjia are single flat buildings having neither a flood wall nor a raised foundation. This implies that their occupants and the structures are not only exposed but are highly vulnerable to flood hazards. About 39.07% of houses (21.88% with raised foundation, 10.16% with a protective barrier and 7.03% storey building) were designed with the intention of better coping with flood hazard in the disadvantaged zone. However, the existence of the designs does not guarantee resilience. FEMA apart from recommending such designs prescribed certain standards on their heights and other characteristics to enhance their effectiveness. Figure 3 shows the perceived effectiveness of the building designs in Figure 2 based on their performance (resilience/vulnerability) by respondents.

It is evident from Figure 3 that storey buildings, single flat buildings with protective barrier and single flat buildings with raised foundation were perceived to be relatively more effective and resilient to flood than single flat unprotected buildings. Storey buildings were rated to be 33.33% very effective, 55.56% effective and 11.11% ineffective. Single flat buildings with protective barrier were perceived to be 15.38% highly effective, 30.77% effective, 46.15% and 7.69% ineffective and highly ineffective respectively. Unprotected single flat buildings were rated the most inefficient buildings. That is 3.85% very effective, 5.13% effective, 56.41% ineffective and 33.33% very ineffective. Raised single flat buildings which is the second most dominant design in the area was perceived to be 10.17% highly effective, 32.14% effective, 35.71% ineffective and 17.86% highly ineffective.

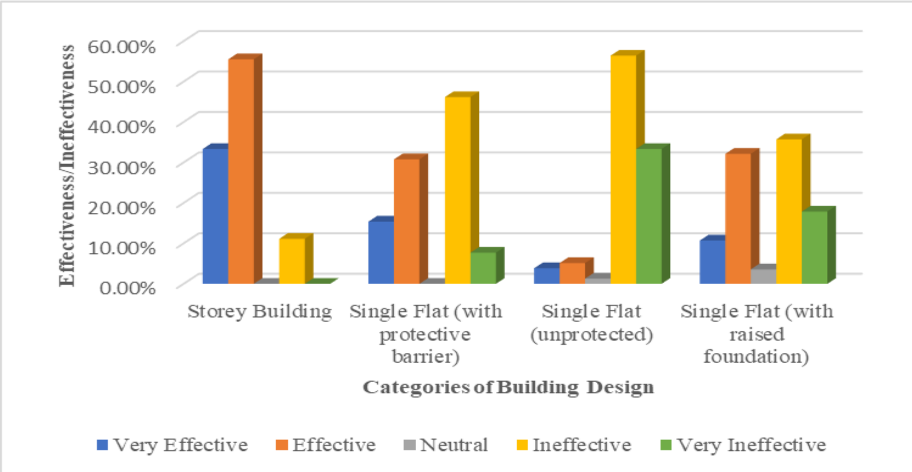

Figure 3: *Effectiveness of Building Designs Against Floods in Ngoketunjia*

Source: Fieldwork, (2019)

Thus, apart from storey buildings which were rated to be almost 80% effective, all other designs including those with raised foundations and protective barriers were rated to be generally ineffective.

Resilience of Building Materials to Flood Incidence

Some building materials are more resistant to water and thus are more suitable for construction in flood prone zones than others. A variety of materials have been used for the construction of houses in the flood prone zones of Ngoketunjia Division. Figures 4 portrays the relative proportions of frequently used building materials in the area while Figure 4 shows the respondents rating of their effectiveness based on certain observable structural frailties. Based on the information on Figure, 61.72% of houses in flood prone areas in the Division have been constructed with sun-dry blocks. This material is weak and does not future on the list of resistant materials recommended by FEMA for construction in such hazard zones.

This probably explains why 55.70% of buildings constructed with it developed cracks, 16.46% collapsed and 21.52% tilted during and after flood events (Figure 5). Cement blocks, concrete and compressed clay recommended for use by FEMA are utilised sparingly in the area as they make up 16.41%, 9.38% and 7.03% of building materials in the area respectively. Surprisingly, the utilisation of these materials did not guarantee absolute resilience of buildings to floods. The results indicate that 14.29% of buildings constructed with cement blocks still developed cracks on their walls, 9.52% collapsed while 4.76% had their walls tilted.

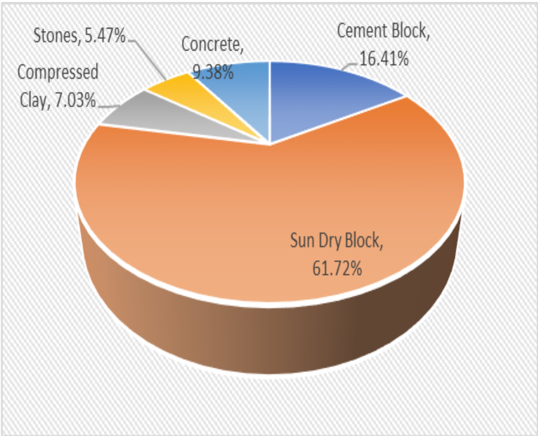

Figure 4: *Frequently used building materials*

Source: Fieldwork, (2019)

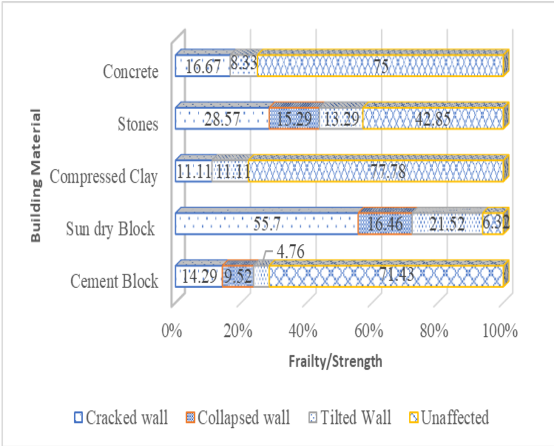

Figure 5: *Structural Frailties Building*

Source: Fieldwork, (2019)

Though no building constructed with compressed clay was reported to have collapsed, 11.11% of their walls developed cracks while a similar proportion tilted. Out of the 5.47% of buildings constructed with stones (Figure 4), 28.57% of their walls developed cracks while 15.29% and 13.29% have collapsed and tilted respectively (Figure 5).

Analysis of Building Foundation Heights

Amongst the several standardized measurements stipulated by FEMA in flood prone zones is that of building foundations. FEMA insists that the heights of foundations in flood prone zones should be above Base Flood Elevation (BFE) and advises that Design Flood Elevation (DFE) which takes into consideration a freeboard are the most robust. In areas where BFE is not known the institution recommends that the foundation of buildings should be raised by at least 0.61m (2 feet) above the highest adjacent grade. Figure 6 shows the average height of foundations in the flood zones of the three Sub Divisions of Ngoketunjia based on field measurement while Figure 8 shows summary responses on foundation heights based on field survey. Figure 7 reveals that the average height of foundation is 0.38m, 0.46m and 0.53m in Babessi Sub Division, Balikumbat Sub Division, and Ndop Central Sub Division respectively. For the whole Division, the results placed an average foundation height of 0.46m. This means that foundation heights in the Division are generally below FEMA recommended standards since all the values are below 0.61m (2 feet) recommended by the institution for areas with unknown BFE.

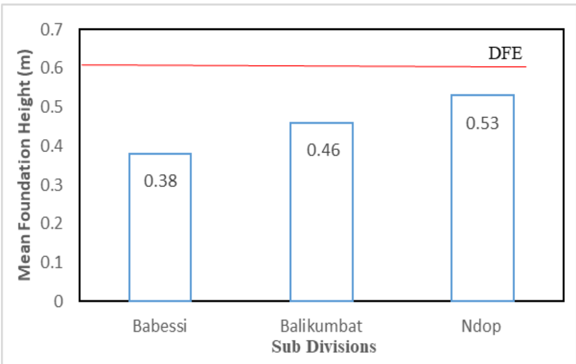

Figure 6a: *Average Height of Foundations*

Source: Fieldwork, (2019)

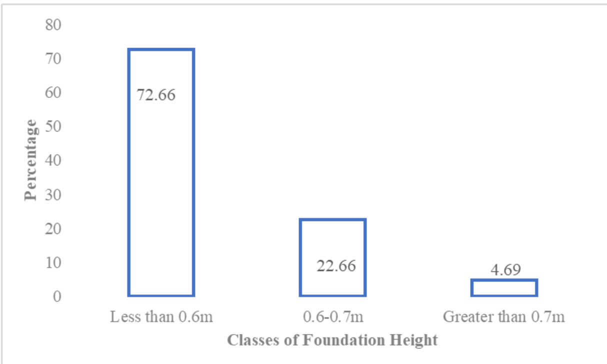

Figure 6b: *Dominant Foundation Height*

Source: Fieldwork, (2019)

This appears dangerous given the dominantly low topographic landscape of the area. Though slightly different, Figure 6b complements the information as 72.66% of building foundations in the Division are perceived to be below 0.6m leaving only 27.35% of houses in the area with foundations of 0.6m (2 feet) and above as recommended by FEMA. Figure 7 presents the summary rating of responses on the degree to which the different categories of foundation have been submerged by flood water level in the area. Based on the Figure, an inverse relationship between foundation heights and the rate at which they have been submerged by flood waters in the Division. A low percentage (5.38%) of foundations with heights of less than

0.6m have never been submerged though it could be argued that 30.11% of the remaining half have rarely been submerged. On the contrary, 65.51% of foundations between 0.6-0.7m have never been submerged while 17.24% of the remainder in the category have hardly been submerged. Their relatively higher degree of effectiveness is probably because their heights fall within FEMA recommended standard 0.61m (2 feet above the highest adjacent grade in areas where BFE is not known). None of the foundations with a height of 0.7m and above were reported to have been submerged.

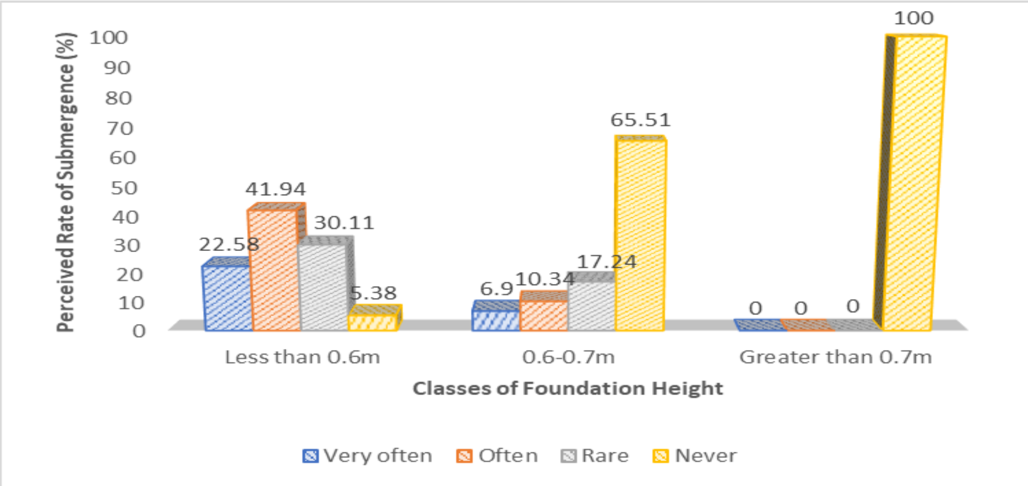

Figure 8: *Rate of Submergence of Building Foundation in Ngoketunjia*

Source: Fieldwork, (2019)

The images in Figures 10a, b,and c flaunt the design heights of some building foundations in the Division. Figures 10a and 10b show substandard foundations in Babessi Sub Division that were submerged during the August 2019 flood. The water mark (delimited by the red line) on both buildings represent the flood height which was approximately 50 cm above the heights of both foundations (height of each block is approximately 20cm). Figure 9c portrays a relatively more resilient foundation designed in the flood prone zone of Ndop Central Sub Division.

Figure 9: *Designed Heights of Some Foundations in the Flood Prone Zones of Ngoketunjia*

Source: Fieldwork, (2019)

Effectiveness of Adaptation Strategies

Considering that no unique blue print was used to assess the effectiveness of adaptation strategies in this domain, different indigenous strategies with varying outcomes that can serve as a blue print for adaptation strategies were unravelled. Table 2 presents the different strategies that have been adopted by the population to minimise crop and farmland damage by floods in the Division. The strategies are generally non-structural and nature friendly.

Table 2: *Strategies Adopted to Limit Crop/Farmland Destruction by Floods in Ngoketunjia*

Strategies Adopted	Frequency	Relative Frequency (%)
Early planting	147	38.28
Late planting	63	16.41

Tree planting	36	09.38
Aquaculture	18	04.69
Cultivation of water tolerant crops	96	25
Others	24	06.25
Total	384	100.01

Source: Fieldwork, (2019)

Table 2 indicates that 38.28% of the population utilise early planting strategy which enables them to harvest their crops before peak flood risk period while late planting after peak period of flood risk is practised by 16.41% of the population. The second most prominent adaptation strategy undertaken by 25% of the population is switching to the cultivation of water tolerant and resistant crops like paddy rice, sugar cane and raffia palm. In addition, 9.38% and 4.69% of the population are involved in tree planting and aquaculture respectively whereas 6.25% utilise other measures which amongst others include the opening of drainage canals and fallowing. These non-structural strategies adopted to minimise damage to crops have varying degrees of effectiveness. Figure 10 shows their levels of effectiveness rated exclusively by the respective proportions of the population utilising each of the strategy. Findings show that aquaculture is the most effective strategy with 66.67%. It is closely followed by the cultivation of water tolerant crops (65.62%), late planting with 61.9%, early planting (44.9%), tree planting (33.33%) and other measures not specified in the study account for about 25%.

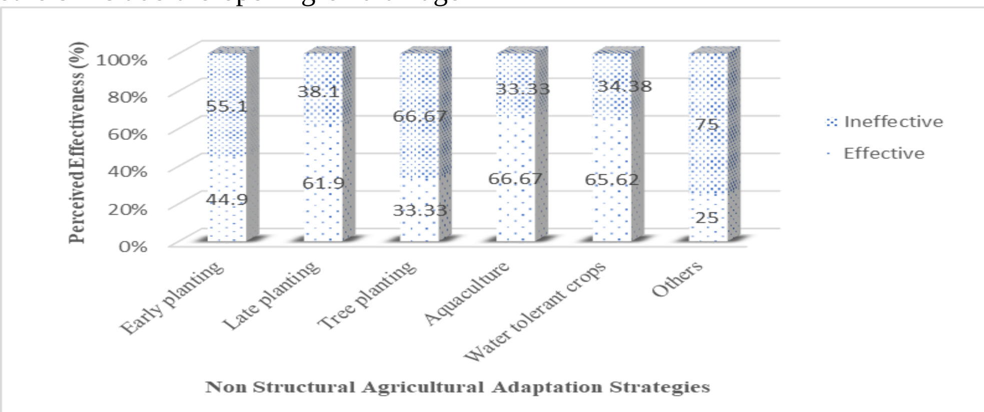

Figure 10: *Effectiveness of Non-Structural Agricultural Adaptation Strategies*

Source: Fieldwork, (2019)

Sand bags have been used in Ngoketunjia Division to control and protect assets from floods and to prevent erosion. FEMA has outlined certain technical standards for the use of sand bags which amongst others encompasses its height in relation to width, alignment, and content. Figure 11 depicts an ideal FEMA recommended standard for the construction of sand bags while Figure 12 displays images of sand bags constructed in some parts of Ngoketunjia Division to combat floods.

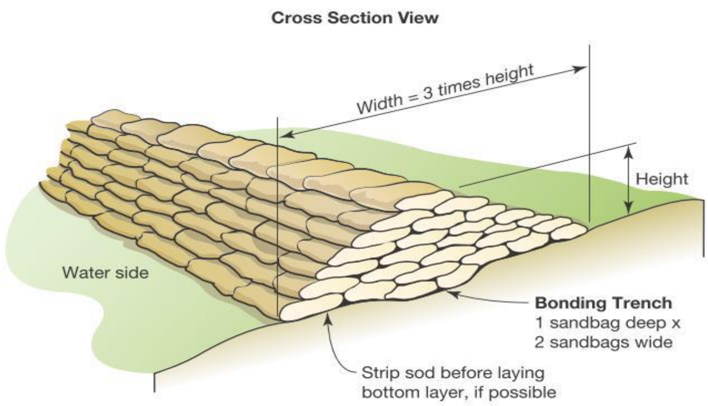

Figure 12: *FEMA Sand Bags Specifications*

Source: FEMA, (2012)

Figure 13a and 13b: *Sand Bags Constructed in Some Parts of the Division*

Source: Fieldwork, (2019)

Comparatively, it is abundantly clear that the sand bags in Figures 13 are below FEMA recommended standards in terms of width and height as exhibited by Figure 12. The sand bags in Figure 13 equally look too "old" and therefore are at variance with FEMA recommendation of regular maintenance since the institution regards them as temporal flood mitigation strategies. In terms of content, field work revealed that a significant proportion of bags in Ngoketunjia Division were filled with soil, casting doubts on whether they should be termed sand bags or "soil bags". Though not adaptation strategies, culverts and bridges in flood zones greatly influence vulnerability. These structures can affect the distribution of relief aid as well as evacuation of population at risks. Based on field results, 17.4% and 30.7% of the bridges and culverts in their neighbourhoods are sometimes submerged by flood water. Though this indicates that most of these structures respect certain standards, it equally indicates that not all are standardised or comply to the norms as spelled out by FEMA..

The gross ineffectiveness and substandard nature of adaptation strategies at the level of settlement corroborates Sakijege *et al.'s* (2014) revelation that flood adaptation strategies in Sangrah (Indonesia) and Keko Machungwa (Tanzania) were below FEMA technical standards. The similarity in findings is probably because both studies utilised survey designs and used FEMA standards as their yard stick for assessment. Despite this synergy, this study failed to reveal why adaptation strategies are largely below standards though it was not one of the objectives of the study. Moreover, climatic differences between the United States and Cameroon makes assessment of adaptation strategies in Ngoketunjia Division and Cameroon based on FEMA standards inappropriate. However, the fact that Cameroon lacks a formal standard for adaptation in flood prone zones obliged a foreign standard for the assessment. This is crucial because the geomorphology of the area which makes it an endemic flood zone leaves man more with the options of adaptation and resilience than flood avoidance. The fertile alluvial soils of the plain and rich biodiversity and water resources of the area further justify this claim. Hence, studies in this dimension would be of enormous value as it can help greatly to enhance the resilience of humans, their habitat, and livelihoods to flood hazards. The moderate effectiveness of non-structural agricultural adaptation strategies is strange given that no standards were used for the assessment of adaptation strategies in this domain.

CONCLUSION

Whilst studies have been conducted on the disastrous effects of floods in the different topographic units especially in the fragilized low lying terrains, man's property and economic activities have been significantly threatened in recent years. This backdrop has accelerated mixed feelings in the phase of effectiveness of adaptation strategies to floods in flood prone zones as it has been remarkable in Ngoketunjia Division. The human adaptive strategies have over the years not yield fruits as the attempted measures seem to be parallel to that recommended by FEMA. Building materials used and the housing foundation level have respected the geology and geomorphology of the area. It is against this background that this study recommends the effective implementation of the standardized norms as stipulated by FEMA in order to serve humankind and property to the trauma of recurrent flood incidence in Ngoketunjia Division in particular and Cameroon at large.

REFERENCES

[1] APFM, WMO, GWP, & Deltares (2017). *Selecting measures and designing strategies for integrated flood management: A guidance document*, World Meteorological Organisation. Retrieved from http://www.floodmanagement. info/publications /guidance %20-%20 selecting %20measures %20and%20 designing%20 strategies _e_web.pdf

[2] Balgah, R.A., Buchenrieder, G. & Mbue, I.N., (2015) 'When nature frowns: A comprehensive impact assessment of the 2012 Babessi floods on people's livelihoods in rural Cameroon', Jàmbá: Journal of Disaster Risk Studies 7(1), Art. #197, 8 pages. http:// dx.doi.org/ 10.4102/ jamba. v7i1.197

[3] Federal Emergency Management Agency (FEMA) (2012). Engineering principles and practices for retrofitting flood-prone residential structures (Third Edition), *FEMA, P-259*, Catalog No: 11334-1. Retrieved from https:// www.fema.gov/media-library-data/20130726-1506-20490-1062/fema259_front_matter.pdf

[4] Federal Emergency Management Agency (FEMA) (2008). Flood damage resistant-materials requirement for buildings located in flood hazard areas in accordance with the National Insurance Program". *Technical Bulletin 2*, FEMA, Washington DC. Retrieved from https://www.fema.gov/media-library/ assets/documents/2655

[5] Global Water Forum (2019). The impact of scales on flood adaptation decisions. www.globalwaterforum.org/2019/08/26/the-impact-of-scale-on-flood-adaptation-decisions/

[6] Hegger, D., Driessen, P., Wiering, M., van Rijswick, H., Kundzewicz, Z., Matczak, P. Ek, K. (2016). Towards more flood resilience: Is a diversification of flood risk management strategies the way forward? *Ecology and Society*, *21* (4), 52. http://doi.org/10.57 51 /ES - 08854-210452

[7] Jongman, B., Ward, P. & Aerts, J. (2012). Global exposure to river and coastal flooding: Long term trends and changes. Global Environ. Change. http://www.sciencedirect.com/ science / article/pii/s0959378012000830

[8] Jongman, B., (2018). Effective adaptation to rising flood risk. *Nature Communication*, *9* (1986). doi:10.1038/s41467-018-04396-1

[9] Kakulu, I. I., (2014). *Increasing flood resilience in buildings through adaptable designs: Learning from the Bayelsa experience*. Conference Paper November 2014.doi:10.1314 0/RG213878.7680

[10] Kometa. C.G. (2019). Climate change evolution and indigenous methods of flood control in the Upper Nun Valley of Cameroon. American Journal of Traffic and Transportation Engineering, Vol.4, NO.2, 56-66. Doi:10.1164 8/j.atte.20190402.13

[11] Kreibick, H., Baldassarre, G., Vorogushyn, S., Aerts, J., Apel, H., Aronica, G.T., Merz, B. (2017). Adaptation to flood risk: Results of International paired flood events studies. *Earth's Future, 5* (10), 953-965. doi:10.1002 /2017EF000606

[12] Lasage, R., de Moel, H., Veldkamp, T. & Ho, P. (2014). Assessment of the effectiveness of flood adaptation strategies for HCMC. *Natural Hazard and Earth System Sciences*, *14* (6), 1441-1457. doi:10.5194/nhess-14-1441-2014

[13] Lawrence, J. & Quade, D. (2011). Perspectives on flood risk management and climate change implications for local government decision making, NZCCRI report 07, October 2011, the New Zealand Climate Change Research Institute, Victoria University of Wellington.

[14] Sakijege, T., Sartohadi, J., Marfai, M., Kassenga, G. & Kasala, S. (2014). Assessment of adaptation strategies to flooding: A comparative study between informal settlements of Keko Machungwa in Dar es Salaam, Tanzania and Sangkrah in Surakarta, Indonesia. Jamba: *Journal of Disaster Risk Studies 6 (1)*, a131. http://dx.doi.org/10.4102 /jamba.v6i1.131

[15] Sayers, P., Li, Y., Galloway, Penning-Rowsell, E., Shen, F., Wen, K., Chen, Y. & Le Quesne, T. (2013). *Flood risk management: A strategic approach*, Paris, UNESCO. Retrieved from https://www.adb.org/sites/default/files/publication/30246/flood-risk-management.pdf

[16] Scussolini, P., Aerts, J., Jongman., Bouwer, L., Winsemius, H., de Moel, H., & Ward, P. J. (2016). FLOPROS: An evolving global database of flood protection standards. *Natural Hazard and Earth System Sciences*, *16*, 1049-1061. doi:10.5194/nhess-16-1049-2016

[17] Taherdoost, H. (2016). Sampling methods in research methodology; How to choose a sampling technique for research. *International Journal of Academic Research in Management (IJARM)*,*5*(2),18-27. doi:10.2139/ssrn.32050 35

[18] Wirsiy, F.Y. (2011). *Annual report of activities carried out by the Divisional Delegation of Agriculture and Rural Development, Ngoketunjia*. Ministry of Agriculture and Rural Development, Cameroon, p.1-2.

[19] World Bank (2017). Implementing nature-based flood protection: Principles and implementation guidance, World Bank, Washington D.C. https://documents. World bank.org/curated/en/739 421509427698706.

Citation: *Sunday Shende Kometa et.al, "Effectiveness of Flood Adaptation Strategies to Land Use Dynamics in Ngoketunjia Division, North West Region of Cameroon", Annals of Geographical Studies, 4(1), 2021, pp 16-26. DOI: https://doi.org/10.22259/2642-9136.0401003*