Assessment of Effects of Flood Risk on Social Vulnerability in Gombe Metropolis, Nigeria

[1]Thlakma, R.S., [1]Ibrahim, M.M., [2]Choji, I.D., [3]Murtala, M., [1]Adamu, M.K. and [1]Bandi, G.M.

[1]Department of Geography, Federal University of Kashere, Gombe State Nigeria
[2]Research Directorate, NIPSS, Kuru, PMB 2024, Bukuru, Plateau State
[3]Department of Geography, Sule Lamido University, Kafin Hausa, Jigawa State, Nigeria.
Email of corresponding author: profsrthlakma@gmail.com

Abstract

In the last three decades, the effect of flood risk on social vulnerability has resulted in loss of lives and properties. This study assesses the effect of flood risk on social vulnerability in Gombe Metropolis. The survey research design was used for data collection. 250 questionnaires were administered using systematic sampling procedure. The data was sourced from the field through personal observations, structured and unstructured interviews. The objective was achieved using inferential statistical. The findings revealed that heavy rain fall is ranked the number one factor that is responsible for flood incidence in Gombe metropolis (52%), follow by poor waste management (24%) and lack of good layout plan (15%). More so, some respondent opined that if there were good constructed drainages, flood incidence and its effects would have reduced by 75% in Gombe metropolis. The study findings revealed that the effects of flood risk on social vulnerability in Gombe metropolis is becoming more worrisome to residents living within the urban areas, as 61% of the respondents admitted that they were affected by flood disasters financially, 19% socially and 7% were psychologically affected. Flood incidence took place almost every year in some places within Gombe metropolis especially areas like Tudun wada and Jekada fari, while places like G.R.A., Federal low-cost, Bolari haven't experienced flood. Moreover, the nature of waste management and building plan also contributed to the occurrence of the flood and loss of live and properties. Based on the findings, the study recommended multi-disciplinary approach by the relevant authorities in reducing the effects of flood risk on residents of the town.

Keywords: Coping strategies, Flood risk, Gombe Metropolis and Social vulnerability.

Introduction

Flooding has been observed globally as one of the natural damaging phenomena. It is one of the most serious environmental hazards. The high volume of storm water or rain water during rainy season can result in severe damage to properties and force several people to evacuate an area thereby rendering them homeless. This may result in major disasters involving structural and erosion damages, disruption of socio-economic activities, transport and communication, loss of life and property, contamination of water and the environment in general.

Flood risk is generally defined as the function of hazard, the probability of a flood event; exposure of the population and value of assets subject to flooding; and vulnerability, the capacity of a society to deal with the event (IPCC, 2012; Kron, 2005). While the understanding of hazard and exposure has greatly improved over the years, knowledge of vulnerability remains one of the biggest hurdles in flood risk assessment to date (Mechler *et al*, 2014; Mechler & Bouwer, 2014; Visser *et al*, 2014). Traditionally, studies assessing flood risk and the feasibility of flood risk management (FRM)

policies include the physical vulnerability of structures and goods as an indicator of flood risk (Filatova, 2014; Jongman *et al,* 2014a). Okorie (2017) observed that floods are common natural disaster occurring in most parts of the world.

Nigeria is not an exceptional victim of flood, resulting to damage and loss of human life and livelihood sources, deterioration of environment and retardation to development. According to Geo-science Australia (2018), flooding can simply be described as "water where it is not wanted." It can also be conceptualized as a situation that results when a part of the earth surface that is usually dry is inundated and covered with water due to high amount of rainfall or the over flowing of a water body. Among all the natural hazards to which humans are exposed, floods are the most common and widespread natural hazards. Dilley *et al* (2015) estimated that more than one-third of the world's land area is flood prone affecting some 82 percent of the world's population. Globally, floods have been reported to have damage properties worth billions of dollars in many regions of the world. The problem of flood in Nigeria and particularly in Gombe has spanned over a long period, and is associated with many factors. Among these factors is the increase in population and rapid urbanization aggravated by urban sprawl, unplanned development, overgrazing, and excessive land cultivation. So, vulnerability can be defined as the state of a system before an event triggers a disaster.

Social vulnerability refers to potential harm to people. It involves a combination of factors that determine the degree to which someone's life and livelihood are put at risk by a discrete and identifiable event in nature or in society. Vulnerability can also be defined in terms of the likelihood of the outcome of the losses of a system measured in the form of economic or human life losses. Another view is that vulnerability is a combination of a particular state of that system with other factors such as capacity to cope and recover; the latter introducing the concepts of resilience and resistance (Galderisi *et al,* 2010). Vulnerability assessment has now been accepted as a requirement for the effective development of emergency management capability, and assessment of social vulnerability has been recognized as being integral to understanding the risk to natural hazards (Blaikie *et al,* 1994). Social vulnerability is most apparent after a hazard event has occurred, when different patterns of suffering and recovery are observed among certain groups in the population (Cutter & Finch, 2003).

The 'social vulnerability perspective' aims at identifying and understanding which groups of people may be more sensitive and susceptible to the impacts of natural disasters and why. This knowledge base will enable more targeted 'solutions' and strategies and will therefore enhance the opportunity for effective mitigation and increasing future social capacity and resilience (Mileti, 2009). Social vulnerability refers to the social, economic, demographic, and built characteristics of a community that affect its ability to respond to, cope with, recover from, and adapt to environmental hazards (HVRI, 2019; Cutter & Finch, 2003). In the United State of America (USA), Cutter and Finch (2003) pioneered methods that assessed social vulnerability at the county level. They selected indicators of economic resources included, demographic attributes of residents, type and density of infrastructure to be aggregated into a single index. Their Social Vulnerability Index (SoVI) applied factor analysis to 42 variables, which clustered along 1 factor accounting for roughly 76% of the variance among over 3000 USA counties. Building on the SoVI approach and methodology, other researchers have included additional variables, applied the analysis to various geographic scales, and used different statistical analysis and aggregation

methods (Holand & Lujala, 2013; Chen *et al,* 2013; Tate, 2012; Fekete, 2010; Finc *et al,* 2010; Sherrieb *et al,* 2010; Tapsell *et al,* 2010; Cutter & Finch, 2008; Schmidtlein *et al,* 2008)

In the last three decades, the impacts of flooding have increasingly assumed from significant to threatening proportions, resulting in loss of lives and properties in Gombe town. Markets places and farmlands are submerged for weeks and sometimes are washed away (Dabara *et al,* 2012). The effect of flooding has led to deplorable condition of living of people in the area which had made many people either to evacuate or abandoned some houses, commuters and transporters are faced with the problem of flooding of routes in the area concerned (Saidu, 2015).

The study set out to answer the following research questions: How frequent does flood incidence occur in the study area? What are the causes of flood in the study area? How does the flood affect social vulnerability in the study area? What are the determinants for flood coping strategies? Based on the research questions, the study is aimed at assessing the effect of flood risk on social vulnerability in Gombe metropolis. To achieve the aim, the following specific objectives were outline; to examine the flood frequency in the study area, to identify the causes of flooding in the study area, assess the effects/impact of flooding on the social vulnerability and assess the determinants for flood coping strategies.

Description of Study Area

The study area is Gombe metropolis (Figure 1). It is located between latitude 10° 04'N and 10° 17'N and longitudes 11°2' E and 11° 10'E (NIPOST, 2009). It is bounded by Kwami LGA to the North, Akko LGA to the Southwest and Yamaltu-Deba LGA to the East. Gombe LGA (Local Government Area) has an area of 52km² and a population of 266,844 persons according to 2006 population census (NPC, 2006). Today the population is projected to 399,531 persons in 2019 using 3.2% growth rate (National Population Commission Gombe State Office). Gombe state was created out of the then Bauchi state on 1st October 1996 with its headquarters situated in Gombe town. The state is located between latitude 9°30' N and 12°30'N and longitudes 8° 45'E and 11°45'E of the Greenwich Meridian. It shares common borders with Borno state to the east, Yobe state to the north, Taraba and Adamawa state to the south and Bauchi state to the west. A large part of the existing town is at the foot of the Akko escarpment and on a shallow dish-like site.

Gombe metropolis has a tropical continental type of climate, classified as Koppen's Aw. It is characterized by rainfall seasonality with distinct wet and dry season (Oladipo, 1995). Gombe has two distinct seasons, the dry season (November to March) and the rainy season (April to October). The rainfall is concentrated between the months of May and September with the highest in August, and the average annual rainfall totals is about 863.2mm^3 (Amos, Musa, Abashiya & Abaje, 2015). The geology consists of sandstones of cretaceous age, covered by tertiary and quaternary deposits. Gombe metropolis is a low-lying, undulating landscape sloping from Akko escarpment in the West to Liji hill in the East which is the highest point of about 500masl. The metropolis is drained by some ephemeral streams and ravines which took their sources from the Akko escarpment and flow eastwards. The soils are highly ferruginous, formed as a result of intensive weathering of the basement rocks (Amos *et al*, 2015). The vegetation is of the Sudan savannah type, characterized by shrubs, scattered trees and grasses (Amos *et al*, 2015). The predominant tree species include: Parkia (*Parkia clappertoniana*), Baobab (*Adansonia digitata*), Tamarin (*Tamarindus indica*), date palm (*Phoenix doctylifera*) and Neem (*Azadirachta indica*) (Abaje, 2007).

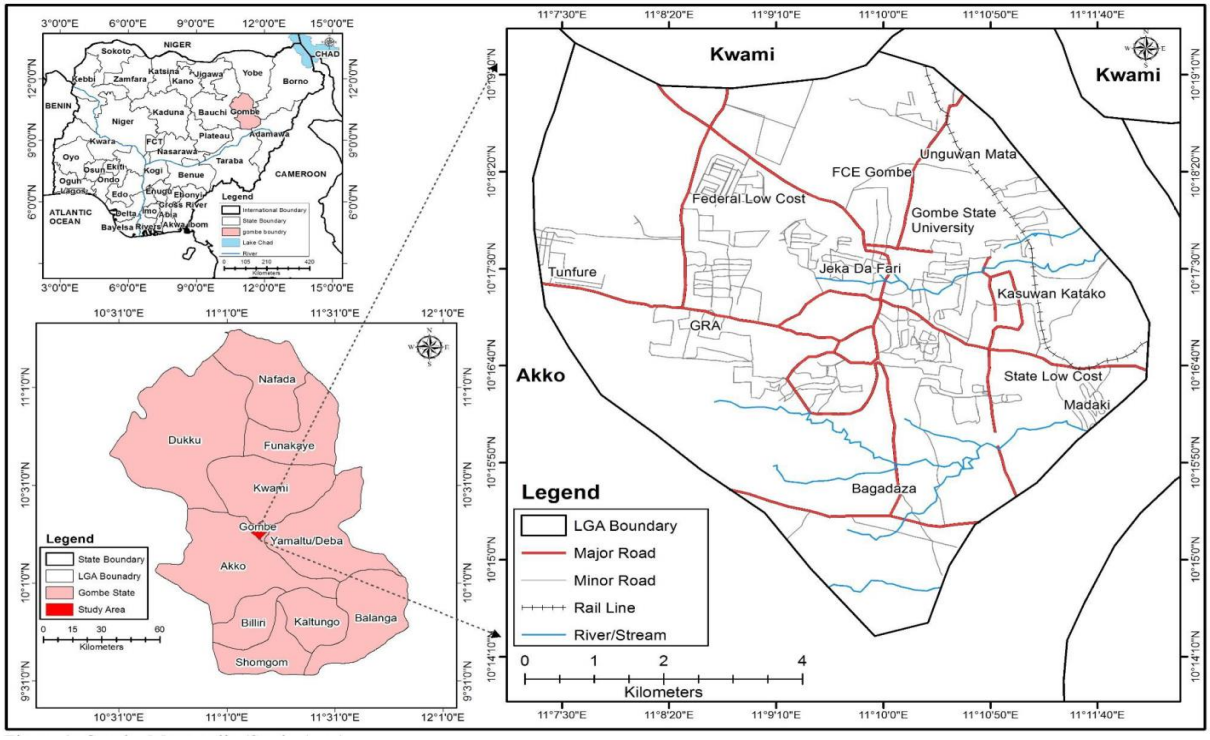


Plate 1: Gombe Metropolis

Source: Adopted and modified from the administrative map of Gombe state.

Methodology

In this study, the survey research design was used to collect data from the study area. The targeted population for this study consisted of 1,189 households in flood prone areas in Gombe metropolis. 20% of the population was used as sample size. The stakeholders involved cut across civil servants, business men/women, and farmers. The stratified sampling technique was adopted in choosing the sampled wards. The sampled wards included: GRA, Pantami, Checheniya, Federal low-cost, Jekadafari, Herwagana, Bolari/Kumbiya-Kumbiya and Tudun Wada. Primary and secondary data were used in this study. The primary data was sourced from the field work through personal observations, structured and unstructured interviews, as well as a structured questionnaire 250 questionnaires was administered to household heads in the study area. Secondary data were sourced from documented materials (journals).

The target populations include all the stakeholders in the study area that were affected in one way or the other. This was purposefully selected because they have adequate knowledge of the flood occurrences in the study area. Houses were systematically selected and, in this case, three wards were randomly selected out of the nine (9) wards. Within the selected wards, systematic sampling was applied to select the houses. Starting from the beginning of the area, one house was selected after every two houses until the desired number was obtained. Five stakeholders were interviewed in each area giving a total number of forty-five (45) stakeholders on the strategies of copying with flood incidents in the study area. The objective was achieved using inferential statistic.

Result of the Findings

Flood frequency in the study area

The result of the study on flood frequencies in the study area is shown in Table 1.

Table: 1. Flood frequency in the study area.

frequency of flooding	Frequency	Percentage (%)
Every year	82	34.45
Once in every two years	51	21.43
Occasionally	45	18.91
Once at all	31	13.03
Not at all	29	12.18
Total	**238**	**100.0**

Source: ***Field survey 2020.***

Table 1 reveals that there are certain parts of Gombe state that have never experienced flood incident. This is as a result of the topographical nature of the area, and the effort made by government in constructing well designed drainages which allow the running water to flow smoothly without having any impact to the lives and properties of the inhabitants in the area. Among these places are; G.R.A., Federal Low-cost, Bolari/Kumbiya-Kumbiya, while other communities do experience flood incidence occasionally (from time to time) among which are; Pantami and Herwagana. However, some areas experience flood incidence frequently (every year) which includes; Tudun-wada, Jekadafari and Checheniya with consequent loss of lives and properties.

Causes of Flooding in the Gombe Metropolis

The result of the findings of the study on the major causes of flooding in Gombe metropolis is presented in Table 2, Plate 1 to 6.

Table: 2. Causes of flooding in the study area.

Causes of flooding	Frequency	Percentage (%)
Heavy rain fall	123	51.70
Poor waste management	58	24.40
Sporadic building plan	36	15.10
Drainage	21	8.80
Total	**238**	**100.0**

Source: ***Field survey 2020.***

From Table 2, heavy rain fall is ranked the number one factor that is responsible for flood incidence in Gombe metropolis, where 52% of the respondents attributed the reason of flooding in the study area to heavy rain fall which leads to the overflow of rivers to the adjacent land.

Plate 1: Flooding as a result of heavy rainfall at Tudun Wada

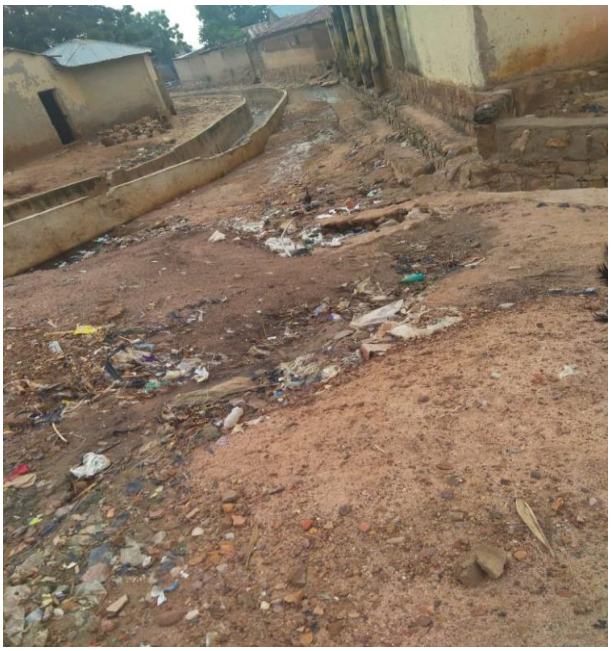
With respect to the refuse dumps in waterways (poor waste management), 24% of the respondents admit that the cause of flooding in the area is as a result of dumping of waste into the waterways which block the drainage channels.

Plate 2 and 3: Waste disposal in waterways at Pantami and Tudun Wada

However, the sporadic urban development (lack of good layout plan) rank the third driving factor for flooding in the study area where 15% of the respondents claimed that flooding incidence usually occur in the area that do not have well planned layout as in Plate 4.

Plate 4: Houses build on waterways

Lastly, lack of proper drainages with 9% of the respondents supporting this. Though it is the least among the causes of flooding in the area, some respondents believed that if there were good drainages, flood incidence would have reduced by about 75% in the study area.



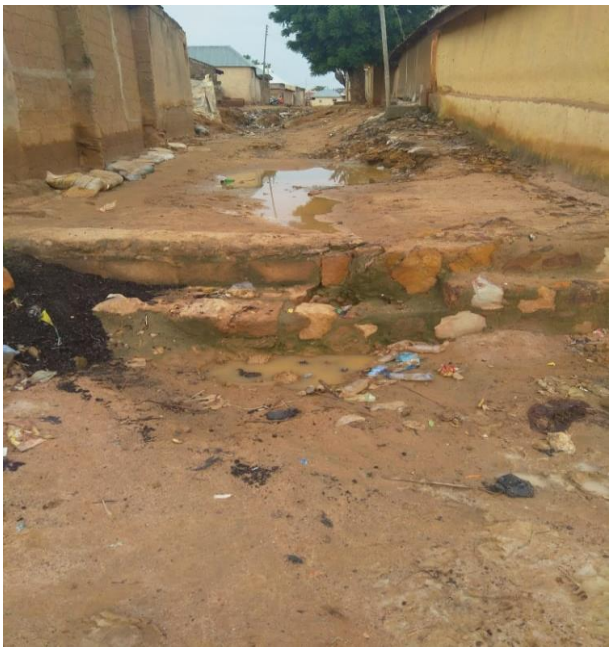


Plate 5 and 6: Poor drainage system

The findings of the study revealed that most of the flood incidence taking place in Gombe metropolis is due to excess rain fall experienced in the study area, however, this usually take place

during the raining months of July to early October. Moreover, waste management in the study area is another driven factor of flood incidence in the area due to refuse dumped in the waterways that lead to blockage of the water ways. Another driving factor of flood incidence in Gombe metropolis is lack of appropriate building plan. Due to the sporadic urban development within Gombe metropolis where structures (buildings) are developed anyhow, even on water ways also leads to flood incidence. Lastly, poor drainages also contributed to the flood incidence in Gombe metropolis especially in few years back. An improvement in the provision of drainages, refuse dumps and a good layout plan will help in the mitigation of flood incidence in Gombe metropolis (Saidu, 2015).

Effects/impact of flooding on the social vulnerability in Gombe Metropolis

The effects of flood disaster in Gombe metropolis is becoming more worrisome to residents living within the town. Table 3 shows that 61% of the respondents indicated that they were affected by flood disasters financially, 19% and 7% were affected socially, and psychologically respectively.

Table 3. Major effects of flood in the study area.

Causes of flooding	Frequency	Percentage (%)	Ranking
Financially	146	61.34	1
Socially	45	18.91	2
Others	31	13.03	3
Psychologically	16	6.72	4
Total	**238**	**100.0**	

Source: ***Field survey 2020.***

Plate 7: A house filled-up with water and collapsed at Jekadafari

Source: Field survey 2020.

From the information collected in the field, some of the respondents had their residential buildings collapsed as in the case of Plate 7 and the shops and business premises destroyed by flood. However, some of the respondents reported that they loss their loved ones as a result of flood disaster in Jekadafari ward, Gombe metropolis where 2.3% of the respondents attributed that to flood in the study area (Table 3). Almost every year, many lives and properties worth millions of naira are lost to flood disaster in Gombe metropolis as supported by (SEMA, 2020). The August

20th 2004 flood was the worst flood disaster experienced in Gombe metropolis since the creation of the state in 1996. The State Emergency Management Agency (SEMA) reports that over 120 people were reported dead, while many houses were swept away completely and several others collapsed. As a result, several thousands of families were rendered homeless (SEMA, 2020). Many shops were destroyed and roadside drainages were blocked by silt and sand. Some roads were rendered impassable as heavy deposits of sand covered everywhere. Vehicular traffic was disrupted for few days. Service lines such as electricity poles, NITEL lines and Water pipes were badly affected.

The Determinants for Flood Coping Strategies

The findings of the study on the determinants of the flood coping strategies in the study area is presented in Table 4.

Table: 4. Household head's education level and capacity to capture flood-forecasting information

Capacity to capture flood-forecasting information	Literate		Primary School		Secondary school		Graduate and above		Total	
	HH	%	HH	%	HH	%	HH	%	HH	%
YES	17	28.8	24	55.8	46	77.9	66	85.7	153	64.3
NO	42	71.2	19	44.2	13	22.1	11	14.3	85	35.7
TOTAL	59	100.00	43	100.00	59	100.00	77	100.00	238	100.00

Note: HH means number of households
Source: ***Field survey 2020.***

Thus, capacity to understand flood forecasting varies among people with different educational levels. Table 4 shows that almost all household heads with undergraduate-level education (85.7%) and some two-thirds with secondary-school-level education (77.9%) are able to capture flood-forecasting information, whereas the numbers gradually decrease among household heads with primary-school-level education and among those who are illiterate. Education level of the respondents is one of the important determinants of coping strategy as well as for adaptation to ensure survival and to enhance one's quality of life (D'Oyley, Blunt & Barnhardt, 2004). Education level is very important in generating awareness of flood forecasting. Flood warnings can reduce the tangible and intangible damage experienced by flood victims (Parker & Tunstall, 2011). However, people's response to flood depends on appropriate dissemination and reliability of flood-forecasting information. Hence, the higher the education level, the greater one's capacity to understand flood forecasting and to reduce one's vulnerability to flooding.

Conclusion

Gombe Metropolis is typically one of the fast-growing cities in Nigeria. Gombe metropolis has witnessed a significant growth immediately after its inception as the capital city of Gombe State in 1996. Since then, flood occurrence has become a seasonal event impacting lives, properties and the environment as a whole. The survey research design was used for data collection in this study. The findings of the study revealed that heavy rain fall is ranked the number one factor that is responsible for flood incidence in Gombe metropolis (52%), follow by poor waste management (24%) and lack of good layout plan (15%). The study findings revealed that the effects of flood risk on social vulnerability in Gombe metropolis is becoming more worrisome to residents living within the urban areas, as 61% of the respondents admitted that they were affected by flood disasters financially, 19% socially and 7% were

psychologically affected. Flood disaster in Gombe town has had devastating impact on the residents not only financially, but in loss of lives and properties.

Recommendations

Based on the findings of the study, the following recommendations were made based;

i. Institutional frameworks at the relevant authorities, especially the local government, should be strengthened for proper and adequate waste disposal.

ii. There should also be improvement of waste management plans by the Ministry of Environment.

iii. Based on the research findings, flood control strategies should be regularly updated by the relevant authorities. There should also be regular inspection on adherence to land policies by the State Ministry of Lands and NESREA.

References

Amos, B.B., Musa, I., Abashiya, M. and Abaje, I.B. (2015). Impact of Cement Dust Emissions on Soils within 10kmRadius in Ashaka area, Gombe State, Nigeria. *International Journal of Environment and Pollution*, 4(1):0909-0917.

Abaje, I.B. (2007). Introduction to Soils and Vegetation. Kafanchan: Personal Touch Productions.

Blaikie, P., Cannon, T., Davis, I. and Wisner, B. (1994). At risk: Natural hazards, people's vulnerability, and disasters. Routledge: London.

Chen, W., S.L. Cutter, C.T. Emrich, and P. Shi. (2013). Measuring social vulnerability to natural hazards in the Yangtze River Delta region, China. International Journal of Disaster Risk Science 4(4): 169–181.

Cutter, S. and Finch, C. (2003). Social vulnerability to environmental hazards. *Social Science Quarterly,* 84(2): 242–261.

Dabara I. D., Okorie A., Ankeli A. & Alabi, J. K. (2012). Evaluation of the Relationships between Urban Infrastructure and Flood Disaster in Gombe Metropolis. *Journal of Sustainable Development;* 5(7) *2012ISSN 1913-9063 E-ISSN 1913-9071*

Dilley, M., Chen, R.S., Deichmann, U., Lerner-Lam, A.L. & Arnold, M. (2015). Natural Disaster Hotspots: *A Global Risk Analysis. The World Bank, US, 150 pp.*

D'Oley, V., Blunt, A. and Barnhardt, R. (2004) *Education and Development: Lessons from the Third World.* Detselig Enterprises, Calgary.

Fekete, A. (2010). Validation of a social vulnerability index in context to river-floods in Germany. Nat. *Hazards Earth Syst. Sci*. 9, 393–403, http://dx.doi.org/10.5194/nhess-9-393-2010.

Filatova, T. (2014). Market-based instruments for flood risk management: *a review of theory, practice and perspectives for climate adaptation policy*. *Environ. Sci. Policy* 37, 227– 242, http://dx.doi.org/10.1016/j.envsci.2013.09.005.

Finch, C., Emrich, C.T. and Cutter, S.L. (2010). Disaster disparities and differential recovery in New Orleans. *Population and Environment,* 31(4): 179–202.

Galderisi., Akter, S. & Mallick, B. (2013) The poverty-vulnerability-resilience nexus: Evidence from Bangladesh. *Ecological Economics*, 96: 114–124"

Geoscience Australia, (2018). What is the Flooding? Retrieved from

http://www.ga.gov.au/hazard/flood/floodbasics/what.html.

Holand, I.S. & Lujala, P. (2013). Replicating and adapting an index of social vulnerability to a new context: A comparison study for Norway. *The Professional Geographer* 65(2): 312–328.

Hazards and Vulnerability Research Institute (HVRI)(2019). Social vulnerability index: Frequently asked questions. http://artsands ciences.sc.edu/geog/hvri/faq. Accessed 10 May 2019.

IPCC, (2012). In: Field, C.B., Barros, V., Stocker, T.F., Qin, D., Dokken, D.J., Ebi, K.L., Mastrandrea, M.D., Mach, K.J. (Eds.), Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation: Special Report of the Intergovernmental Panel on Climate Change. 582 pp.

Jongman, B., Hochrainer-Stigler, S. & Feyen, L. (2014a). Increasing stress on disaster risk finance due to large floods. *Nature* 4, 1–5.

Kron, W. (2005). Flood Risk Hazard, Values and Vulnerability. *Water International - WATER INT*. 30. 58-68. 10.1080/02508060508691837.

Mechler, R. & Bouwer, L.M. (2014). Understanding trends and projections of disaster losses and climate change: is vulnerability the missing link? *Clim. Change* 1–13, http:// dx.doi.org/10.1007/s10584-014-1141-0.

Mechler, R., Bouwer, L.M. & Linnerooth-Bayer, J. (2014). Managing Unnatural Disaster Risk From Climate Extremes. *Nat. Clim. Change*, 4, 235–237.

Mileti, D. (2009). *Disasters by design: a reassessment of natural hazards inthe United States*. Washington, DC: Joseph Henry Press, 1999.ISBN: 0309063604.

NIPOST. (2009). Archived from the original on 7 October 2009. Retrieved 20 October 2019. https://web.archive.org/web/20091007011423/http://www.nipost.gov.ng/PostCode.aspx

NPC. (2006). Population and Housing Census of the Federal Republic of Nigeria. Priority Tables (LGA) National Population Commission Volume II.

Okorie, F.C. (2017). Great Ogberuru in its contemporary geography. Owerri: Cape Publishers.

Oladipo, E.O. (1995). Some statistical characteristics of drought area variations in the savannah region of Nigeria. Theoretical and Applied climatology, 50: 147-155.

Parker, D.J. & Tunstall, S.M. (2011). '*Managing flood warning system: The United Kingdom experience'*. Paper presented at the Annual Conference of the Association of State Floodplain managers, Denver, CO, United States, 11 June.

State Emergency Management Agency (SEMA)(2020). Gombe State Report of the Council Committee on the 2020 Flood Disaster (Unpublished).

Saidu, I. (2015). Flood risk inevitability and flood risk management in urban areas: A case study of Gombe metropolis. *Journal of Geography and Regional Planning* http://www.academicjournals.org/JGRP.

Schmidtlein, M.C., Deutsch, R.C., Piegorsch, W.W. and Cutter, S.L. (2008). A sensitivity analysis of the social vulnerability index. *Risk Analysis* 28(4): 1099–1114.

Sherrieb, K., Norris, F.N. & Galea, S. (2010). Measuring capacities for community resilience. *Social Indicators Research* 99(2): 227–247.

Tapsell, S., McCarthy, S., Faulkner, H. and Alexander, M. (2010). Social vulnerability to natural hazards. State of the art report from CapHaz-Net's WP4. London: CapHaz-Net Consortium.

Tate, E. (2012). Uncertainty analysis for a social vulnerability index. *Annals of the Association of American Geographers* 103(3): 526–543.

United Nations Educational, Scientific and Cultural Organization (UNESCO)(2008). Floods. Retrieved on September, 30, 2014, from http://portal.unesco.org/science/en/ev.php

Visser, H., Petersen, A.C. & Ligtvoet, W. (2014). Combining Hazard, Exposure and Social Vulnerability to Provide Lessons for Flood Risk Management. VU Research Portal Economic modelling for flood risk assessment. *Change* 125(3/4); 461–477.