**Challenges and potential solutions to pluvial flood risk in urban tropical African communities, a case study using Ijebu-Ode, in South West Nigeria**

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# DEDICATION

This work is dedicated to the Almighty God

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# ABSTRACT

This thesis focuses on challenges and identifying potential solutions to pluvial flood risk in urban tropical African communities, using a case study of Ijebu-Ode in South West Nigeria. There is currently a dearth of literature and research exploring flood risk in mixed formal-informal settlements; this thesis provides a significant contribution to this research gap. Both qualitative and quantitative research methods are applied to enable a wide information base in a 'data poor' region. Perennial pluvial flooding is addressed from a risk perspective, incorporating hazard, exposure and vulnerability of inhabitants in flood-affected areas for policy and decision-making purposes. Seasonal surface water flooding sourced from heavy rainfall during the rainy season conveyed through saturated excess overland flow causes negative impacts and harm on inhabitants. Quantification of climate change is assessed to detect changes that already occurred, as this is valuable in considering current preparedness plans and knowledge, with an awareness of future climate change projections. Inter-annual and intra-annual rainfall changes have been observed in Ijebu-Ode. An upward trend in rainfall and minimum and maximum temperatures over the course of the study period was identified, but there were no discernible trends in annual rainfall, patterns of severe rainfall, or frequency of extreme occurrences, suggesting that any change in the frequency of floods in Ijebu-Ode was caused by non-climatic factors. High exposure and social vulnerability linked with the nature of their living area, as well as the effects of climate change, are the key causes of flood risk. The national curriculum does not provide sufficient information on environmental management/flood risk reduction or management to meet the growing need for environmental education, as such this should be addressed in the future. Overall, the findings suggest that precarity is a significant concern in Ijebu-Ode. A societal strategy that uses awareness and human-capital building to promote changes to individual or community behaviour that fosters future flood-risk resilient populations and society change is required. Sustainable solutions require greater understanding of prevailing conditions engaging with local communities to understand their awareness, anxieties, preparedness and exploring measures that will help in implementation of best adaptive measures. This research makes an important proposal on how inclusion of environmental education into the National Curriculum in tropical African communities could generate opportunities with respect to flood-risk communication and enhance understanding of contemporary environmental challenges. This study uncovers critical areas in geophysical processes, vulnerability risk factors and societal capacities in mixed formal-informal settlements that are poorly acknowledged by existing research.

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| **BBC** | British Broadcasting Cooperation |
| **BNRCC** | Building Nigeria, s Response to Climate Change |
| **CBA** | Community Based Adaptation |
| **CCA** | Climate Change Adaptation |
| **CNRM** | Centre National de Rechersches Mètèorologiques |
| **CRED** | Centre for Research on the Epidemiology of Disaster |
| **CSIRO** | Commonwealth Scientific and Industrial Research Organization |
| **CSOs** | Civil Society Organizations |
| **CT** | Continental Tropical Air-Mass |
| **DM** | Disaster Management |
| **DRM** | Disaster Risk Management |
| **DRR** | Disaster Risk Reduction |
| **DRUs** | Disaster Management Units |
| **EA** | Environmental Agency |
| **EE** | Environmental Education |
| **EMDAT** | The International Disaster Data Base |
| **ENSO** | El Nino-Southern Oscillation |
| **EIA** | Environmental Impact Assessment |
| **EMVs** | Emergency Management Volunteers |
| **EU** | European Union |
| **FEMA** | Federal Emergency Management Agency |
| **FEPA** | Federal Environmental Protection Agency of Nigeria |
| **FGN** | Federal Government of Nigeria |
| **FME** | Federal Ministry of Environment |
| **FRM** | Flood Risk Management |
| **GCM** | Global Climate Model |
| **GCC** | Global Climate Change |
| **GFDL** | Geographical Fluid Dynamics Laboratory |
| **GFDRR** | Global Facility for Disaster Management and Recovery |
| **GIS** | Geographical Information System |
| **GWP** | Global Warming Potential |
| **IAA** | Impact Assessment Act |
| **ICDM** | Institution Capacity for Disaster Management |
| **IFRC** | International Federation of Red Cross |
| **IIED** | International Institute for Environment and Development |
| **IPCC** | Intergovernmental Panel on Climate Change |
| **ISDR** | International Strategy for Disaster Reduction |
| **ITD** | Inter-Tropical Discontinuity |
| **IUCN** | International Union for Conservation of Nature |
| **LEMA** | Local Emergency Management Agency |
| **MPI** | Max Planck Institute |
| **MT** | Maritime Air-Mass |
| **NA** | National Agenda |
| **NAAEE** | North American Association for Environmental Education |
| **NASPA-CCN** | National Adaptation Strategy and Plan of Action on Climate Change for Nigeria |
| **NCA** | National Climate Assessment |
| **NCR** | National Commission of Refugees |
| **NDMF** | National Disaster Management Framework of Nigeria |

| | |
|---|---|
| **NEMA** | National Emergency Management Agency |
| **NELR** | National Effluent Limitation Regulations |
| **NESREA** | National Environmental Standards and Regulations Enforcement Agency |
| **NEST** | Nigeria Environmental Study/Action Team |
| **NFWBP** | National Fuel Wood Substitution Programme |
| **NGOs:** | Non-Governmental Agency |
| **NGSEPCN** | National Guidelines and Standards Form Environmental Pollution Control in Nigeria |
| **NIMET** | Nigerian Meteorological Agency |
| **NIHSA** | Nigeria Hydrological Service Agency |
| **NOA** | National Orientation Agency |
| **NPE** | National Policy on Environment |
| **NRCAP** | National Resources Conservation Action Plan |
| **NSEMA** | Niger State Emergency Management Agency |
| **NWRS** | National Water Resource Study |
| **OBS** | Observation |
| **OCHA** | UN Office for Coordination of Humanitarian Affairs |
| **RCM** | Regional Climate Model |
| **SAMHSA** | Substance Abuse and Mental Health Service Administration |
| **SEMA** | State Emergency Management Agency |
| **SRP** | Seasonal Rainfall Prediction |
| **SD** | Sustainable Development |
| **SDGs** | Sustainable Development Goals |
| **TASUED** | Tai Solarin University of Education. |
| **UNCHA** | Related to United Nations Office for UNDRR and UN/OCHA |
| **UNDP** | United Nation Development Programme |
| **UNECE** | United Nation and Economic Commission |
| **UNEP** | United Nations Environmental Programme |
| **UNESCO** | United Nations Educational, Scientific and Cultural Organization |
| **UNGA**: | United Nations General Assembly |
| **UNGCRP** | United Nations Global Change Research Program |
| **UNISDR** | Related to United Nations Office for UNDRR and UN/OCHA |
| **UN/OCHA** | United Nations Office for the Coordination of Humanitarian Affairs |
| **UNODC** | United Nations Office on Drugs and Crime |
| **WB** | World Bank |
| **WCU** | World Conservation Union |
| **WMR** | Waste Management Regulation |
| **WMR** | World Malaria Report |
| **WMO** | World Meteorological Organization |
| **WWFN** | World Wide Fund for Nature |

# CHAPTER 1
# INTRODUCTION

*The purpose of this chapter is to introduce key themes within this thesis, contextualise the research and present aims and structure of the thesis.*

## 1.0 Introduction

Floods are the most common of all natural hazards (Jha, Bloch & Lamond, 2012) and also affect more people than all the types of natural disasters put together (emergency events database [EM-DAT] 2015). While each country faces individual sets of natural hazards - including cyclones, earthquakes, or wildfires – floods are one of most common and severe hazards to disrupt people's livelihoods around the world (Jun & Melda, 2020). Floods are major weather-related events that continue to cause high economic and human losses all over globe, reaching, on average, tens of billions of $US and thousands of fatalities per year (Zbigniew et al., 2019). Especially in the lower income countries where infrastructure systems – including drainage and flood protection – tend to be less developed, floods often cause extensive damage and suffering (Jun and Melda, 2020). Recent events, ranging from Bangladesh and Nigeria to United States and Vietnam, illustrate that threat is a global reality (World Bank Group, October 2020). However, increases are not evenly spread globally, countries with increased flood exposure were mainly situated in the Asia and sub-Saharan Africa (Matt, 2021). Understanding of mechanisms responsible for temporal change and variability of floods and flood-related variables (i.e., such as precipitation and flood loss) is of importance (Zbigniew et al., 2019). The occurrence of flooding is changing at a significant rate, because of the increasing frequency of heavy rainstorms and storm surges, which result from climate change, variability and rising sea-level (Milly et al., 2002; Meijerink and Dicke 2008; IPCC 2012). There is some evidence that climate change will result in increased flood hazards (Jun & Melda, 2020). Having a better understanding of spatially and temporally organized links between climate variability patterns and flood hazard and the risk at a range of spatial and temporal scale would be a considerable asset in improving preparedness for emergencies (Zbigniew et al., 2019).

## 1.1 Background of study

Flooding is widely acknowledged as the most frequent and widespread disaster in the world, causing devastating effects on the lives of millions of people and their properties, as well as infrastructure and the natural environment (EM-DAT, 2015; Vojinović, 2015). In all UN regions, floods were most frequently reported disaster type, with exception of Caribbean, North America, East Asia, Western Europe and Polynesia, where storms predominate (CRED, 2017). "Meteorological disasters affected 95.8 million people in 2016, the highest number reported since 2006 for this disaster type, which represents 2.4 times the annual average. The 78.1 million people affected in 2016 by hydrological disasters are near the annual average of 82.6 million. The number affected by geophysical disasters (2.2 million) was the third lowest since 2006, 75.2% below the 2006-2015 annual average" (CRED, 2016, 2). As during previous decades, hydrological disasters were, in 2016, most frequent in all continents, except Oceania where more meteorological disasters were reported. UN regions with most people affected in 2016 were East Africa (31.8 million affected), in Nigeria, flooding cost 300 lives and impacted nearly two million people (CRED, 2018).

Floods are a major hazard that are worth studying globally, and in Nigeria in particular. The UN-Water (2011) reports floods, including urban flooding, are responsible for about half of disasters worldwide, and 84% of disaster fatalities are attributed to flooding. Whilst the EM-DAT (2015) database puts this at 55% of all fatalities, with nearly 2.5 billion people affected with more than 30% of global economic losses attributed to natural disasters according to Hallegatte et al. (2013). Irrespective of the specific values, source or database, the contribution to disasters globally from flooding is considerable. Floods are most frequent and widespread in Africa, particularly in sub-Saharan Africa (Douglas et al., 2008). On average 500,000 people per year are affected by floods in West Africa alone (Jacobsen, Webster & Vairavamoorthy, 2012). Ndaruzaniye et al., (2010) state that cumulatively in sub-Saharan Africa, in recent decades floods and droughts alone are responsible for around 80% of disaster-related deaths and 70% of economic losses. In sub-Saharan Africa, 654 floods have affected 38 million people with around 13000 deaths recorded in the last 33 years (Tiepolo, 2014); these figures necessitate urgent need to seek an effective solution to mitigate flood risk in the context of adaptation to climate change.

Current rainfall patterns across Africa exhibit different scales of temporal and spatial variability (Boko et al., 2007 & Hulme et al., 2005). According to the International Strategy for Disaster Reduction (ISDR) (2004: 149), the African continent is exposed to disaster risk from various natural causes, particularly those arising from hydro-meteorological hazards. Urban settlements in African cities are commonly impacted by flash, pluvial, fluvial and coastal flooding (Douglas et al., 2008). Fluvial floods are known as riverine flooding which are triggered by excessive rainfall over a couple of hours causing a river to exceed its limit, overtopping natural or artificial defences and inundating urban areas (Few, 2003; Vojinović, 2015), coastal floods usually affect cities that have close proximity to the ocean or coastal environment as a result of storm surges (Vojinović, 2015), flash floods result from the direct rapid response to high intensity of rainfall mostly occur in steep slopes while pluvial floods occur where infiltration capacity is exceeded, wih urban areas commonly identified with floods arising during intense rainfall which overwhelms the drainage system capacity (Begum, Stive & Hall 2007; Houston et al., 2011; Merz, Thieken & Gocht 2007; Vojinović, 2015).

Flood risks in African cities are exacerbated because of anthropogenic influences, which contribute to flood disaster risk (Agbola et al., 2012; EM-DAT, 2015). Human activities such as rapid urbanization, uncontrolled urban growth and unregulated informal settlements on low-lying floodplains are major contributors to flood risk (Douglas et al., 2008; Eguaroje et al., 2015). However, there are limited studies that detailed the intensity and scale of urban settlements' exposure to flood risk in African cities (Adelekan 2011; Nkwunonwo, Malcolm & Brian, 2015, Loots et al., 2022).

**The 2017 rainy season floods**

According to the UN Office for the Coordination of Humanitarian Affairs (2017), the West and Central Africa region experienced severe flooding during the 2017 rainy season, causing significant material and human causalities across the continent: In the Niger, an estimated 206,513 people were affected by flooding, 56 deaths and approximately 12,000 houses were damaged, 16,000 heads of cattle perished, and 9,800 hectares of cultivated land lost. In Nigeria, weeks of torrential rainfall led to flash floods, high discharges and rivers overflowing in Benue State, north-central Nigeria affecting more than 100,000 people across 21 local government areas. In Burkina Faso, 12 or 13 regions and 30,862 people were impacted by flooding and violent winds. In Guinea, the overnight torrential rain caused a hillside rubbish dump to collapse in Conakry, killing 10, following heavy rain, the Protecture of Nzerekore was also impacted by flooding. In Mali, more than 11,000 people were affected by floods with 3 fatalities, more than 1,200 houses destroyed and over 500 damaged, with pastoral communities affected with 26,000 animals lost. In Sierra Leone, after weeks of heavy rain, the top of Sugar Loaf Mountain collapsed, triggering catastrophic landslides and floods in and around Freetown, over 6,000 people were directly affected and about 600 deaths reported. In Ghana, flood displaced an estimated 11,800 people and caused 7 deaths, 147 communities in 11 districts were affected. In the Central African Republic, due to prolonged rainfall, the town Kouango recorded some 17,500 people affected and at least 276 houses destroyed. It is notable that these widespread floods led to little in the international literature when contrasted to comparable events in North America and Europe, for example the floods in Western Europe in 2021 (Cornwall, 2021).

## 1.2 Aim and objectives

The aim of this research is to gain in-depth understanding of the challenges pluvial flood risk presents in urban tropical-African communities and identify potential opportunities to develop realistic and viable solutions to reduce the flood risk. This will be achieved through use of Ijebu-Ode, in South West Nigeria as a case study and consideration of five objectives:

i. To review and identify the past, present and future urban flood risk challenges in tropical Africa;
ii. To assess whether changes in climate are responsible for a shift in flood risk, by assessing rainfall and temperature trends and associated changing flood incidence, through analysis of the flood history/events (using instrumental and non-instrumental sources) in the city of Ijebu-Ode;
iii. To determine how anthropogenic factors exacerbate flood risk, such as waste management, drainage channels and urbanization;

iv. To identify how communities and individuals continue to live with the devastating impacts of floods and assess how different types of flooding impact communities in Ijebu-Ode;
v. To evaluate the potential of environmental education in school curricula and approaches for raising effective community awareness of flood risk and preparedness as a long-term risk mitigation tool.

## 1.3 Flood risk in Ijebu-Ode

> *"The residents of the Ijebu-Ode city decry that most of their homes had been submerged, roads devastated as a result of the flood events" (NAN, 2015).*

Floods are the most common of all-natural hazards (Jha et al., 2012; Brilly and Polic, 2005), causing more than half of all the fatalities, and accounting for a third of total economic loss from natural disasters globally (Kellens et al., 2011; Jonkman, 2005). Human systems are vulnerable to floods due to their exposure, susceptibility and resilience. Risk is often defined as *"the likelihood that an individual will experience the effect of danger"* (Sjöberg, Moen and Rundmo 2004, p7); with the concept of risk a function of hazard probability, exposure and vulnerability (Samuels and Gouldby 2009; IPCC, 2012). Exposure refers to assets, activities, livelihoods and people in an area in which hazards events may occur (UN-ISDR, 2004), while vulnerability refers to propensity of the exposed elements to suffer adverse effects when impacted by hazard events (IPCC, 2012). Flood risk is determined by summed probability of flood hazards, as well as the assets at risk of these hazards. Exposure of human settlements and critical assets to flood risk is increasing due to climatic change, sea level rise and extreme precipitation as well as development intensification, population increases and economic growth (IPCC, 2014; Lawrence et al., 2013; Pelling and Blackburn, 2014).

Since there is no instrumental river flow data, the only sources of current flood risk information that can be used to assess the risk in Ijebu-Ode are qualitative ones, like the analysis of newspapers and other publications that have previously and recently documented flood events. News organisations interview people to learn about the scope of the flood and the issues that the population is facing. For the objective of determining how previous flooding affected the residents of Ijebu-Ode, significant quotes that captured the vulnerabilities of the occupants (people) were examined. In recent years, especially during the rainy seasons in Ijebu-Ode, the flood risk problem has increased and now occurs frequently (nearly yearly).

> *"Residents of Ijebu-Ode and it's environ cried out that the whole area has been flooded due to persistent rainfall. Each time it rained, situation was very critical, as water flooded the roads leaving no space on either part of the road (Daily Trust Newspaper, 10th August, 2008)".*

> *"Flood ravages Ijebu-Ode an Area of Ogun State, Southwest Nigeria after heavy long hours of rain and led to severe flooding which caused traffic gridlock in the town on the major roads such as Ejinrin road, Talbot Road, Imowo road, Omo-Owo Road, Ondo Road by Epe garage motor parks and other areas for almost seven hours (Pm News October 5th, 2011)"*

> *"Many areas in Ijebu-Ode, were recently flooded after a sudden downpour or first rain in the year which lasted for more than one hour devastating many areas like Talbot, Osinubi, Igbeba, Molipa, Ondo Road etc. flooding the roads and making them impassable due to the level of water on them and damaging properties (Tribune Newspaper on Monday February, 2012)"*

> *"Floods are affecting our businesses, even children, most times, cannot go to school when access to community is blocked by flood. It is an eyesore which continuously increases cost of living for us in the community," as reported by the inhabitants (NAN, 2015)"*

> *"Ogun abandoned channelization turn to gully of deaths, swallow houses and farms. Gully sliced Owa Kurudu, Mayo-Mayo & Logun communities in Ijebu-Ode. Sadly, erosion ravaging the communities for some years has swallowed houses which left their owner distraught. One of the owners of house lamented that there was no gully or any*

*life-threatening situation in 1989 when they moved in, the poor channelization caused destruction encountered (Sunday Punch Newspaper September 23$^{rd}$, 2018)"*

### 1.3.1 Drainage system management, maintenance & misuse

Ijebu-Ode frequently experiences flooding, which is typically brought on by excessive rains and inadequate drainage systems, which frequently cause major floods. Most drainage canals overflow when there has been a lot of rain, which has a negative impact on people (Figures 1.2 and 1.8). For many years, Ijebu-Ode's drainage systems have been in a terrible shape, which has posed major environmental problems for the local population and surrounds. In many cases, deluges of rain so intense they literally submerged entire settlements, blocking traffic and rendering roads impassable for both pedestrians and drivers (Figure 1.3; 1.8). This prevented people from leaving their homes and forced those who were inside to stay inside. While some bodies are located and others are not, some people are fatally washed away by the powerful floods. Floods result in evictions, threatened or actual building collapse, destruction of goods and property, and business closures. *"Year 2019 is the worst of flood we've had since I've lived in this area," said a respondent in one of the flood-prone areas in Ijebu-Ode. Reinforcements were created in the shape of iron and concrete walls, but they were unable to withstand the flood pressure. The Community diverted the drainages and hired employees to clear the clogged drains so that water could flow freely, but regrettably this was not done in other areas of the community and the same issue still exists. Individually, people have, however, exerted their best effort.*

During one of his inspection tours to areas of Ijebu-Ode in 2019, which included flooded areas in Igbeba, Paramount, Moborode, Italapo, Degun, and Imowo-Ibadan, the state's current governor, Dapo Abiodun, said:

> *"From what we have seen here, the biggest problem we have in Ijebu-Ode is that the drains that crisscross the town are small concrete drains that are covered, so they don't allow for maintenance, they are very tiny. Ijebu-Ode requires a big open drain that can easily be serviced and maintained, so we are going to have a comprehensive plan aimed at resolving these problems once and for all. Residents were further*

*advised to desist from habit of dumping refuse in drainages and other water channels causing flooding and attendant dangers" (Local News 15th June, 2019; The Sun Newspaper 16th June, 2019).*

*"These roads here are roads that have accounted for a lot of flooding in Ijebu-Ode because of poor drainage facility. That is why we have focussed on starting from here and once we are able to ensure that the roads are properly constructed with the right drainages, then would have solved 60 per cent of the issue of perennial flooding in Ijebu-Ode" (Governor Dapo Abiodun of Ogun State, September 7, 2019).*

People's vulnerability is made worse by the poor condition of the drainage systems in Ijebu-Ode, which can be attributed to poor urban governance, poor urban planning, unsustainable living practises, poor attitudes among locals, and inadequate funding for ongoing maintenance (see Sections 5.2.2, 5.2.3, 5.2.4, 5.2.5, 5.3.2, 5.3.3, and 5.3.6). Although the town has recently experienced fast urbanisation, settlement expansion, and development, drainage systems built in the past to support a small population are still primarily in place and are too small or poorly designed for present needs. The most likely cause of the serious exacerbation of the flood problems in Ijebu-Ode appears to be the insufficient drainage system and ongoing misuse by people who dump waste products into the channels (Figures 1.4, 1.5, 1.7 and 1.8). Due to a lack of waste infrastructure, waste is frequently dumped in public areas or on streets (Figures 1.6 and 1.8). Urban flooding causes land or property to be flooded in a built environment (Figure 4.8), especially in more populated areas, and is a result of inadequate drainage systems in Nigeria's urban environments (Offiong et al., 2009). Urban flooding is also a result of rainfall exceeding the capacity of drainage systems (Tucci, 2001). Ismail Adenuga, the director of flood in the Ogun State Ministry of Environment, emphasised that a thorough re-engineering of Ijebu-Ode's drainage system would be necessary to lessen the problem of flooding in the town in particular. Publications in National Daily newspapers support this viewpoint:

*"Pm News gathered that on the part of the people, any time that it is about to rain, they will go and dump their waste and refuse in the gutters which are not much spacious and deep, and will be blocked.*

*Investigation reveals that most of the roads have big potholes all over because of lack of drainage channels in the town (Pm News October $5^{th}$, 2011)*

*According to the News Agency of Nigeria (NAN, 2015), the residents have attributed incessant flooding to persistent rainfall; ineffective drainages; poor waste collection and disposal and poor town and urban planning.*

*The Odo Kala canal in Ijebu-Ode Southwest Nigeria is notorious for killing several people. According to the residents, many have drowned in it. The residents of Ijebu-Ode in their unsustainable attitude aggravated flood disaster annually. They have turned the canal to a dumpsite, on each side of the bridge is huge refuse dump where the gully is located. One of the residents said to the correspondents that, refuse dump is the reason for flooding after heavy rain (Nigeria Investigative Reporting Project (NIRP), 2016) Ogun State Commissioner for Environment, Bolaji Oyeleye and the State Governor, Senator Ibikunle Amosun attributed flood disasters in the State to the attitude of residents who dump refuse into drainages, along medians and canals and building on the waterways (Tribune Newspaper July $17^{th}$, 2018)*

*National Emergency Management Agency (NEMA) in their assessment discovered that the causes of flood disaster in Ogun State include building on the flood plains and waterways and poor waste management (Tribune Newspaper, July $17^{th}$, 2018)*

*Ogun State government war against refuse. Refuse dump in the state has got to a worrisome stage according the Deputy Governor of the State (Mrs Yetunde Onanuga). The former Governor of Ogun State, Senator Ibikunle Amosun said the residents of the State lost their lives and valuables in the heavy downpour which destroy public & private buildings due to perennial flooding caused by the indiscriminate dumping of refuse inside the drains and channels which is responsible* *for the blockages during the rains, and subsequently flooding. Residents turned road medians in particular new roads across State to refuse dumps as cases of flooding subsided. From the major cities Sango-Ota to Ado-Odo, Ilaro, Ewekoro, Abeokuta, Ibafo-Mowe, Sagamu, Ijebu-Ode the story is the same. Waste management has been huge challenge in the State. The government is advised to develop an industrialized dumpsite somewhere around the State so that waste generated can be processed for the overall benefit of the State (Daily Trust Newspaper, Thursday, March 28$^{th}$, 2019)"*

Estimates have shown that 30 – 50 per cent of solid wastes generated in Nigeria cities are uncollected and disposed of indiscriminately (Falade, 2001; Olukanmi and Akinyinka, 2012; Olukanmi, 2013a). Presently, about 2.6 billion people are living without proper sanitation, of which Africa is not exempt (Olukanmi, 2013a; WHO/UNICEF. 2012). The need to provide proper drainage and sanitation facilities is essential to match up with the ever-increasing population growth (Bernajee and Morella, 2011).

**Figure 1.1:** a) Flooded church; b) residential area during heavy rainfall in Ijebu-Ode.

**Figure 1.2:** a) Flooded school; b) shops flooded following heavy rainfall in Ijebu-Ode.

**Figure 1.3:** a) clogged drain and flooded road; b) silted drain with growing plants and its impact on roads in Ijebu-Ode.

**Figure 1.4:** a) blocked small old concrete ring drain; b) completely silted-up drain that crisscross Ijebu-Ode

**Figure 1.5:** a) poor waste collection; b) excessive rubbish in the drain in Ijebu-Ode.

**Figure 1.6:** a) wastes dumped on road dividers; b) uncollected waste in the neighbourhood in Ijebu-Ode.

**Figure 1.7:** a) & b) impact of poor drainage systems and flood on roads asphalt in Ijebu-Ode.

**Figure 1. 8:** a) & b) flooded streets/roads and narrow and blocked drainage in Ijebu-Ode.

Investigating the vulnerability-driven elements (such as climate history and public awareness) is essential for developing suitable risk reduction and adaptation strategies. This is covered in the following chapters.

According to the study's findings (Figures 1.1 to 1.8), people living in Ijebu-Ode areas are very vulnerable and exposed to risk, but they also have poor levels of resilience and adaptability. The observation and identification of local climate change (Chapter 4) gives a hint of climate change and variability. Residents of Ijebu-Ode have been attempting to reduce stress brought on by climate variability and the risks that go along with it at the household and communal levels for many years (Chapter 5).

### 1.3.2 A visual representation of Ijebu-Ode's pluvial flood risk's elements

The following figures (1.9-1.11) depict the different challenges and approaches applied within this PhD, visualising the physical and social relationships that cause flooding in Ijebu-Ode (Figure 1.9), the risks and failures within the system (Figure 1.10), and the impacts on society in Ijebu-Ode (Figure 1.11); in visualising these different elements the challenge of flooding in Ijebu-Ode is presented.

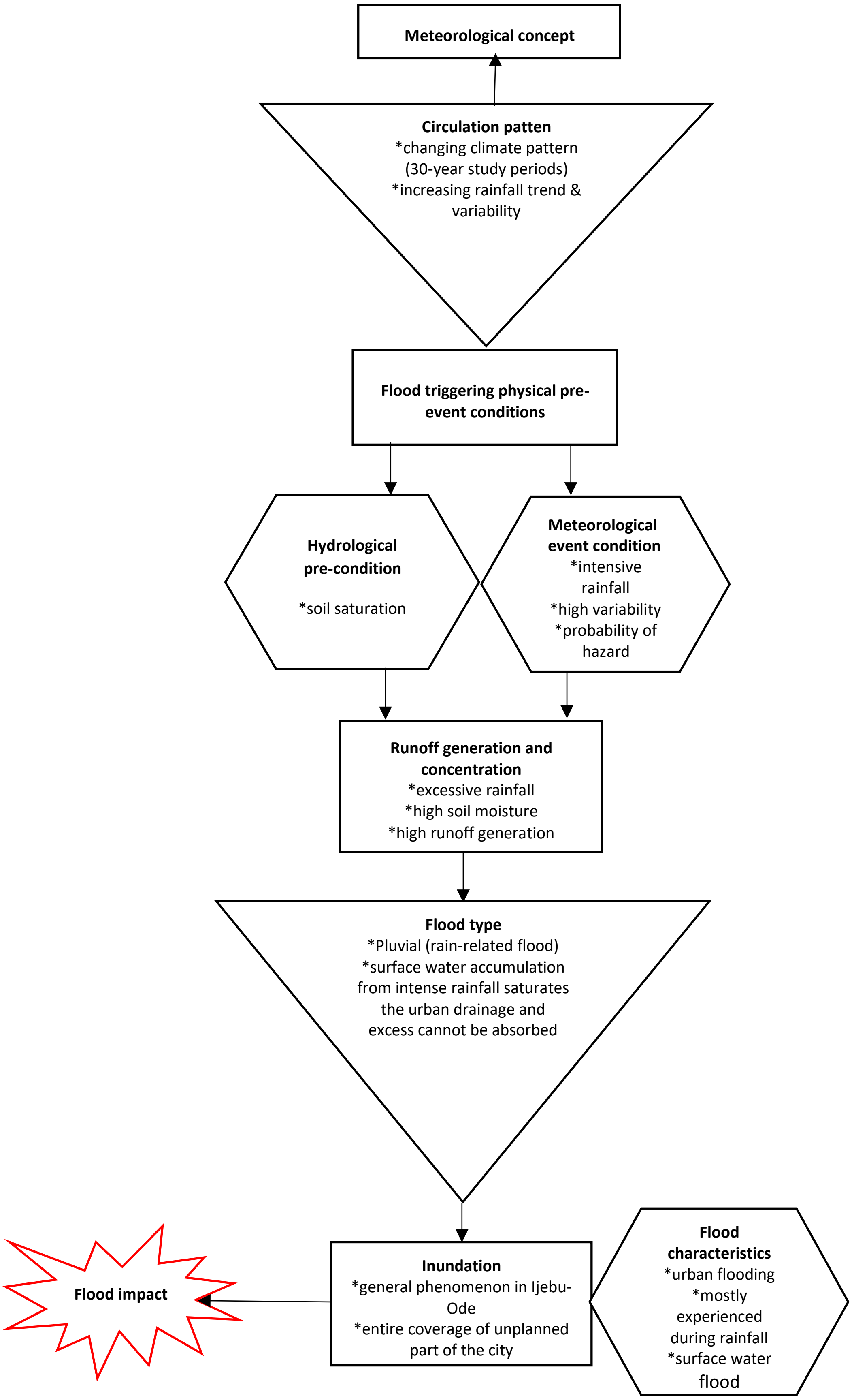


**Figure 1.9:** Schematic diagram showing summary of classification of the flood causal factors in Ijebu-Ode.

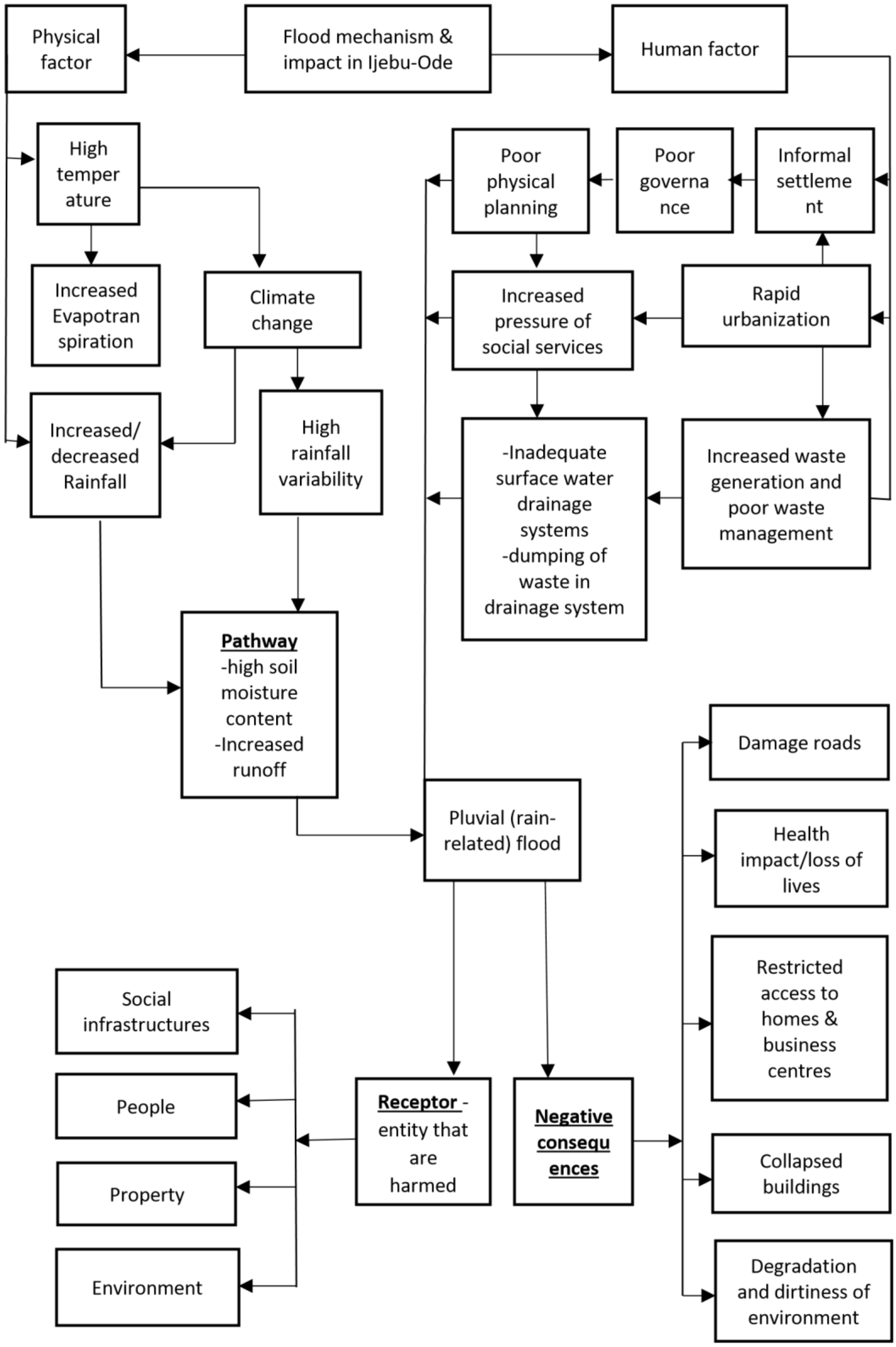


**Figure 1.10:** Schematic diagram showing summary of flood mechanism in Ijebu-Ode and some of the associated risks.

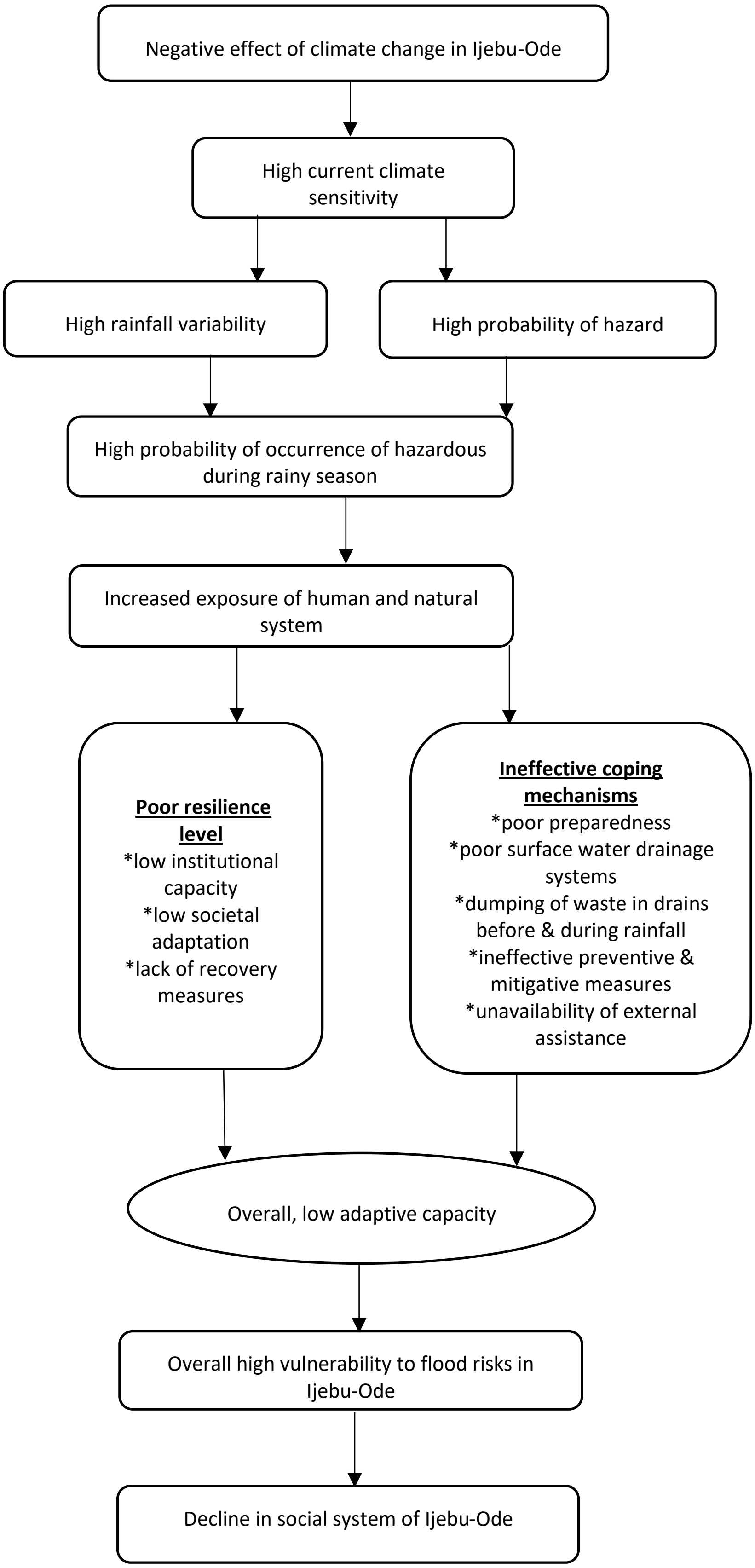


**Figure 1.11:** Schematic diagram showing summary of long-term local vulnerability of climate impacts on inhabitants of Ijebu-Ode.

## 1.4 Flooding in Nigeria

Nigeria is an independent nation in West Africa that borders the Gulf of Guinea. Nigeria, which has a land area of 923,768 km2, has two main rivers: the Niger, from which it derives its name, and the Benue, which is the Niger's forerunner. Nigeria is the third-largest country in Sub-Saharan Africa based on physical size. The landscape of the nation is made up of lowlands in the south that combine into hilly formations in the south-east, hills and plateaus in the central belt, and plains in the far north. Nigeria is a tropical country with a year-round humid and wet environment. Four different climate types, which are often ranked from south to north, have an impact on Nigeria. The South primarily experiences equatorial climates, whereas the North and centre of the country experience tropical climates (Ekoko, 1990). With a population of about 160 million (as of the 2006 census), it is also the most populated country in Africa. The Republic of Chad and the Republic of Niger form the country's northern and western borders, respectively, while the Atlantic Ocean forms its western and southern borders. Nigeria is rich in natural resources, the most significant of which are petroleum and natural gas, which are found in the Niger Delta regions of the nation. All around the land, you can find coal, iron ore, tin, limestone, zinc, lead, gold, precious stones, and uranium. There are several ethnic groupings, which can be broadly divided into majority and minority ethnic groups. The Hausa-Fulani of the North, the Yoruba of the South-West, and the Igbo of the South-East make up the majority groups. According to estimates, there are more than 250 different ethnic groups in the nation (Osaghae, 1998). Nigeria is the only country in which English is the official language, as it was once a British colony.


**Figure 1.12:** Context of Nigeria within Africa

> *"The Nigeria's flooding is mostly human induced exacerbated by human-nature interactions." (Aderogba, 2012; pp 3)*

Flooding, although a common phenomenon all over the world is more widespread in developing countries like Nigeria (Andejelkovic, 2001). The 1948 flood occurrence in Ibadan capital of Oyo State is one of the earliest and oldest experiences recorded in Nigeria history of flooding (Etuonovbe, 2011); according to Adeleke (1978) more than half of the thirty-six states in Nigeria were impacted by flooding. States such as Kano, Niger, Jigawa, Kaduna, Adamawa, Benue, Kogi and many others in the southern parts of Nigeria have been severely devastated by floods, for example, thousands of people were displaced in Kano and Jigawa States in August 2001 because of flooding caused by the overflowing of rivers Challawa and Tiga, reportedly killing twenty people in Kano and 180 in Jigawa State. According to Onwuka et al. (2015), the total number of people affected by the 2001 floods was well above 143,000; four years later in August 2005, the worst floods in forty years occurred in the northern city of Jalingo, the Capital of Taraba state, after a heavy down pour of rain that lasted for eight hours, killed over 100 people, with thousands of others displaced. The torrential rainfall that lasted for 24 hours in Zamfara state Nigeria in September 2006 caused the collapse/failure of a dam washing away hundreds of houses and destroying property worth millions of dollars. In August 2007, the unusually heavy rainfall which seriously impacted nine states (i.e., Lagos, Ogun, Plateau, Nassarawa, Bauchi, Sokoto, Yobe, Borno and Kebbi) led to more than 46 deaths and displacement of over 2,500 families. The floods were caused by poor drainage systems, ill-timed discharge of water from dams and indiscriminate infrastructural development along riverbanks (Action aid, 2006). Similarly, in 2010, dam failures in conjunction with the opening of flood gates and torrential rains contributed to flooding in northern states in Nigeria. Over 2 million people and 5,000 communities were affected and about 50,000 families were left homeless. In 2011, at least 102 deaths were recorded, and 2,000 families were displaced in and around the south-western city of Ibadan as a result of floods from heavy rainfall that collapsed bridges and caused a dam to overflow (Action Aid, 2006). In June 2011, the ancient city of Kano experienced extensive rainfall which led to flooding in some parts of city causing 24 deaths, collapse of houses and displacement of 700 people (Akinbobola et al., 2015; Essien et al., 2018).

The worst but most recent of flood events caused devastation across the geopolitical zones in the country was the July 2012 event. The flood (termed the worst in 40 years), occurred in at least 33 of the 36 Nigerian states, as a result of heavy rainfall which caused extensive damage, loss of lives and properties (UNCHA, 2012; NEMA, 2012). According to the EM-DAT: International Disaster Database in 2012 alone, about 7,000,867 lives were affected by widespread flooding, with 363 fatalities and ~ $500,000 worth of economic damages recorded (Guha-Sapir et al., 2013). The 2012 floods in Nigeria began in early July and according to Nigeria Emergency Management Agency (NEMA, 2012) the flood killed 363 people and displaced over 2.1 million others as of November 5, 2012. The agency also stated that estimated damages and losses caused by the floods were put at N2.6 trillion. NEMA noted that there had been intense rainfall as well as rises in water level across the country. The seriousness of the flooding, was attributed to a combination of two events: heavy localised rainfall and the release of excess water from Lagdo Dam in the neighbouring Republic of Cameroon. NEMA (2016) warned that flood alerts from Republic of Niger to the north may result in a rise in water level, with Nigeria suffering severe floods comparable to those experienced in many states in 2012. The Director General of NEMA, Mr Sidi, stated, the “Niger Basin Authority notified Nigeria that rainy season, which started in the Middle Niger, Burkina Faso and Niger Republic in June, 2016, has led to gradual rise of level of River Niger in Niamey, Niger Republic, and high level of water is already spreading to the Benin Republic, and invariably to Nigeria". NEMA further indicated that "If the heavy rainfall continues in intensity and duration within those regions of the river Niger, imminent flood situation similar to that of the year 2012 may occur". NEMA identified states along the river Niger and those along its major tributaries as being most vulnerable. The 2012 floods killed 363 people, displaced 2.1 million people and affected seven million people in 30 of 36 states in Nigeria, according to the National Emergency Management Agency, NEMA (2018).

The rains and floods across Nigeria in 2018 according to the Vanguard Newspaper (August 11, 2018) claimed no fewer than 141 lives, and at least 19,369 persons were displaced on account of their 5,732 houses and sources of livelihood among others destroyed. Following the floods of 2018, the high incidence of floods in Nigeria over the last decade, attract significant media attention (OCHA, 2013; OCHA, 2015; Vanguard Newspaper, Aug 11, 2018)

> *The overall report indicated that distortions had occurred in the pattern of rainfall leading to variation in the amount of rain expected in the country. The Nimet's 2018 SRP warned so much water would be made available on the surface once it rains between last week of July and end of August and ground cannot comfortably contain and absorb the water making it to runoff and resulting in so much water on surface, however, the warnings were only partially heeded (Vanguard Newspaper, August 11, 2018)*

Douglas et al. (2008) opined that flood risks in Nigeria are caused by lack of adequate drainage coupled with poor management of the existing drainage infrastructure. Floods occur because of a combination of meteorological and hydrological extremes (Adeaga, 2008) and often exacerbated by human activities (Olanrewaju & Fadairo, 2003). Uncollected wastes often litter the streets ending up in drains thereby blocking and obstructing the free flow of water, contributing to flooding (Zurbrug, 2002). The practice of dumping wastes in drainage and river channels is common in urban areas (Onibokun and Kumuyi 1999; Olaseha and Sridhar 2004), where there are no provisions for waste bins by the government and people are unable to organize private refuse collectors, either because of lack of communal cohesion or because such services are not affordable.

According to Odjugo and Uriri (2011), one of the main causes of flooding is obstruction of drainage system. Odemerho (2004) and Nwafor (2006) identified a main cause of flooding as inadequate drainage to cope with urbanization. Several studies have attributed flooding in different regions of Africa to poor drainage systems (Odermerho, 1988; Aderogba, 2012; Chag et al., 2013; Nwigwe and Emberga, 2014; Aderogba et al., 2016); poor waste management (UN/ECE, 2003; World Bank, 2010; Bolanle et al., 2012; Lamond et al., 2012); poor land use (Aluko, 2000; Ali, 2005; Douglas et al., 2008; Potchin, 2009; Adeloye and Rustum, 2011; UNISDR, 2012); with many studies also attributing flooding to rapid growth/urbanization (Orulobuye 1995; Mujumba 2001; UN 2007; Raaijmakers et al., 2008; Peduzi et al., 2009; Alayande and Agunwamba 2010; Dutta et al., 2013). Developing nations such as Nigeria are at great risk of flooding due to urbanization (Ijeoma, 2012), as buildings are constructed adjacent to flood channels, thereby restricting free flow of water. According to Babatunde et al. (2012) several anthropogenic factors are responsible for floods in Ibadan City in Oyo State (26th August 2011), Southwest Nigeria, these include heavy rainfall; dumping refuse in drainage channels; expansion of impervious surfaces; inadequate housing development monitoring; building close to river banks; changing river courses during development; riverbed sedimentation; river channels covered with the weeds; dam breaking; deforestation; and the lack of early warning information. Historically, rainfall induced floods in the Ibadan, Southwest Nigeria, occurred in 1951; 1955; 1960; 1963;1969; 1973; 1978; 1980; 1982;1984; 1986; 1987; 1997; and 2011 (NEST 1991; NWRS, 2011; Akintola and Ikwuyatum 2012).

Flooding is fast becoming a serious environmental problem in urban areas across Nigeria, resulting in huge loss of lives, property and arable land (Onwuka et al., 2015). Floods have rendered many people homeless and disrupted socio-economic activities, impacted infrastructure e.g., roads (Akukwe and Ogbodo, 2015; Etuonovbe, 2011) and forced millions of people from their homes, destroy businesses, polluted water resources, and increase the risk of diseases (Baiye, 1988; Edard-Adebiyi, 1997), with consequences on social well-being (Strahler and Strahler, 1978; Ward and Smith, 1998). In Nigeria, aside from droughts, floods cause almost 90 percent of damages resulting from natural hazards (Adeleke, 1978). The impacts of floods are not equal across society with the greatest impacts on vulnerable groups (women and school children) in Nigeria (Durojaiye, 1999; Folorunsho & Awosika, 2001). In Nigeria, malaria remains a major public health problem (Klinlerberg et al., 1999), as Tapsel and Tunstall (2008) assert without careful management, surface water can accumulate resulting in health consequences for affected community. As previously noted, many urban areas have experienced physical environmental deterioration in form of blocked and broken drains, which facilitate breeding habitats for mosquitoes. The anopheles mosquito species seems to be adapting to urban ecosystems (Chnery, 1990), as people move into cities and industrialization proceeds, urban malaria is on the increase in Nigeria. The World Malaria Report (2017) stated that Nigeria contributed 27% of the 216 million malaria cases and 23% of 445,000 malaria deaths globally in 2016 (Punch Newspaper, Thursday, April 26th, 2018).

Despite the availability of advanced technological capabilities for dealing with the floods, including preventive options, such as structural and non-structural measures, flood damage in Nigeria continues and appears to be worsening (Ologunorisa, 2004; Folorunsho and Awosika 2009). Onwuka et al., (2015) states that the reason for this annual trend is an increasing population shift from rural to urban areas, increasing the population of those living in flood vulnerable areas such as flood plains and riverbeds. In research conducted by Nwoko (2013) in Abia State, Nigeria they show that increasing population caused an unprecedented change in land use, that resulted in the exceedance of the local carrying capacity, characterized by the improper waste disposal, blocked drainage systems, poor planning, uncontrolled development, paved or tarred surfaces thereby impeding infiltration of rainwater and promoting flooding. United Nation and Economic Commission for Europe (UN/ECE, 2003) stated that although floods are natural phenomenon, human activities and human interventions into the process of nature, such as alteration in drainage pattern from urbanization, agricultural practices, deforestation have contributed to flooding. Kyessi and Mwakalunga (2009) state that rapid urbanization has increased pressure on the social services, most of which have not been sustainably provided to match socio-economic and demographic growth.

### **1.4.1** Projection of future climate change & uncertainty over Nigeria

> *"Floods have become a perennial challenge with increasing intensity each year, leaving colossal losses and trauma (The BBC, 27/09/2018)".*

Thakur et al. (2011) identified climate change, rainfall intensity, duration, and frequency, topography, degree of land cover, and nature of soils as some of the physical factors that predisposed locations to floods, with climate change potentially altering storm occurrence and intensity leading to local changes, particularly in urban areas (due to alterations of urban land surface and water pathways, compounded by such activities as construction, paving, soil compaction, and removal of vegetation). Climate change is one of most important issues of twenty-first century: increasing extremes of temperature, precipitation and evaporation have been identified in the recent decades (McMichael et al., 2013). The UN referred to climate change as long-term shifts in temperatures and weather patterns, which is attributable directly or indirectly to human activity that alters composition of the global atmosphere, which is in addition to natural climate variability observed over a comparable time-period (Odjugo, 2009).

Studies (IPCC, 2007; Meehi et al., 2007; UNFCCC, 2007; IPCC, 1998; IPCC, 2012; Ranger and Fisher, 2012) have shown that progressively over time, climate change is likely to increase flood risk significantly and exposure of human systems to increased climate variability (Seneviratne et al., 2012). Since the 1980s each decade has been warmer than previous one, this trend is expected to continue because of record levels of heat-trapping greenhouse gases in the atmosphere (WMO, 2020). World Meteorological Organization's consolidated analysis of leading international datasets reveals that average temperatures for five-year (2015-2019) and ten-year (2010-2019) periods were the highest on record, with the year 2019 the second warmest year on record after 2016 (WMO, 2020).

Past Nigerian climate impact assessments have been plagued by inadequate treatment of uncertainty. To avoid this shortcoming and better assess the range of future climate variability, extremes, and impacts, a high-resolution regional climate model (RCM) was used to simulate and project climate changes from 1971 through to 2065 under an A1B emission scenario, which represents a median between most extreme (optimistic and pessimistic) storylines developed in the Intergovernmental Panel on Climate Change (IPCC) (Raffaelo et al., 2013). Rainfall in Nigeria is driven by seasonal migration of the intertropical convergence zone, where hot and dry easterly winds from the Sahara meet humid air from the Atlantic (Raffaelo et al., 2013: Chapter 4; pp 49-54). The climate is semi-arid in the north and humid in the south; wet and dry seasons are distinct. The rainy season varies between three and seven months from the northeast of Nigeria to the south. Mean annual rainfall nationwide is estimated at 1,150 mm, about 1,000 mm in the centre of the country, 500 mm in the northeast, and up to 3,500 mm along the coasts (Raffaeolo et al., 2013). Ayoade (1970, 1973) reported that southern zones of Nigeria showed no trend in precipitation in the middle of the 20th century, but two decades later a nationwide study highlighted a reduction in the precipitation during the second half of century (BNRCC, 2011), with a decrease in tropical area; attributing change to removal of forests resulting from loss of evapotranspiration (Aina and Adejuwon, 1995). NIMET (Nigerian Meteorological Agency) data from 1941 to 2000 suggest that the rainfall trends are more spatially heterogeneous than temperature trends (BNRCC, 2011). Whilst the annual rainfall increases were projected in some parts of country and decreases in others, all areas show rainfall increasing during at least part of the year. A general increase in rainfall and temperature extremes but with more uncertainty where rainfall was concerned were predicted (BNRCC, 2011).

The air surface temperature average over Nigeria (Figure 1.13a) shows an increasing trend. At the beginning of the 21$^{st}$ century climate ranged from 27.2°C (observations) to 27.6°C (regional climate models); it is expected that by the 2060s this may increase to 28.8°C–30.0°C. Considering uncertainties within climate change models, as illustrated by the perturbed results (Figure 1.13a) average temperatures will be 1–2 degrees higher in 2050 than they are at present. Figure 1.13b. shows precipitation time series averaged for all of Nigeria for 1976–2065. No significant trends can be detected in most of the 2001–65 precipitation time series obtained through GCM-based perturbations; only the data perturbed through GFDL model shows a significant negative trend. The perturbed precipitation average over Nigeria at the beginning of the 21$^{st}$ century ranges from 3 to 3.5 mm/d with a spread of 0.5 mm/d, which becomes 1.4 mm/d at the end of the century. By 2020 53% of Nigeria's area is expected to be wetter, 10 percent will have less rain, 35 percent will be stable, and for the remaining 2 percent precipitation projections are highly uncertain (Figure 1.14). In 2050, 41 percent of the country is expected to be wetter, 14 percent drier, and 20 percent stable, but the area subject to uncertainty increases from 2 to 25 percent (Figure 1.14). Evident clusters of drying areas in the short and medium term are concentrated in the southeast plateau and along southwest littoral, with stable areas in the centre and along central and eastern coastal zones. Wetting areas are in north, and uncertainty is evident mainly in the arid/semi-arid regions in medium term.

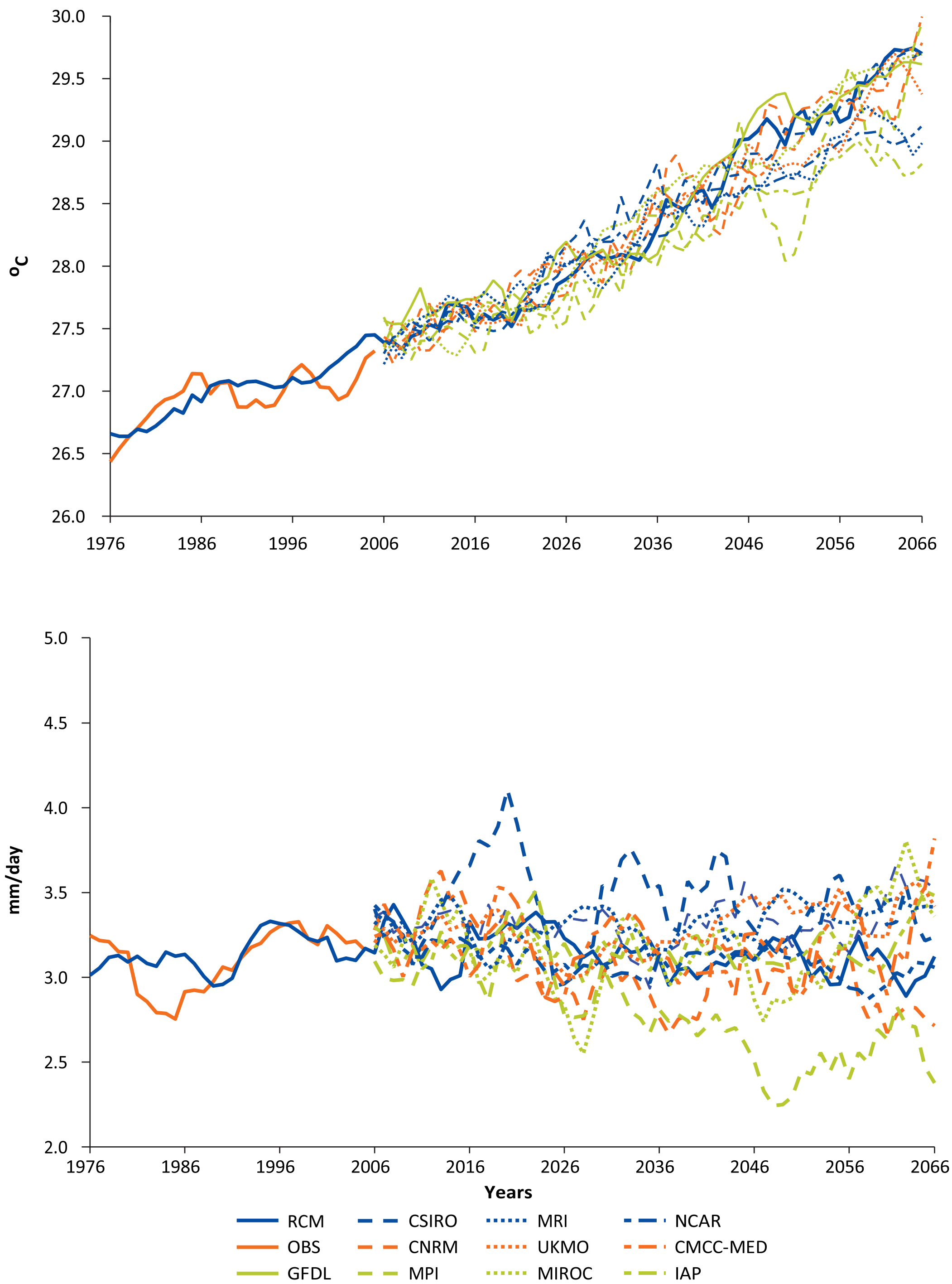


**Figure 1.12:** a) Average air surface temperature projections and b) Annual precipitation over Nigeria 1976-2065 (Raffaello et al., 2013). The lines represent trended observation (solid orange line) and climate model simulations from 2006. Observation (solid orange); Regional Climate Model (solid blue); Geophysical Fluid Dynamics Laboratory (solid green); Centre National de Recherches Météorologiques (dash orange); Commonwealth Scientific and Industrial Research Organization (dash blue); Max Planck Institute (dash green); Institute of Atmospheric Physics (IAP); Center for Climate System Research (MIROC); Meteorological Research Institute (MRI); National Center for Atmospheric Research (NCAR); United Kingdom Meteorological Office (UKMO); Euro-Mediterranean Center on Climate Change (CMCC-MED).

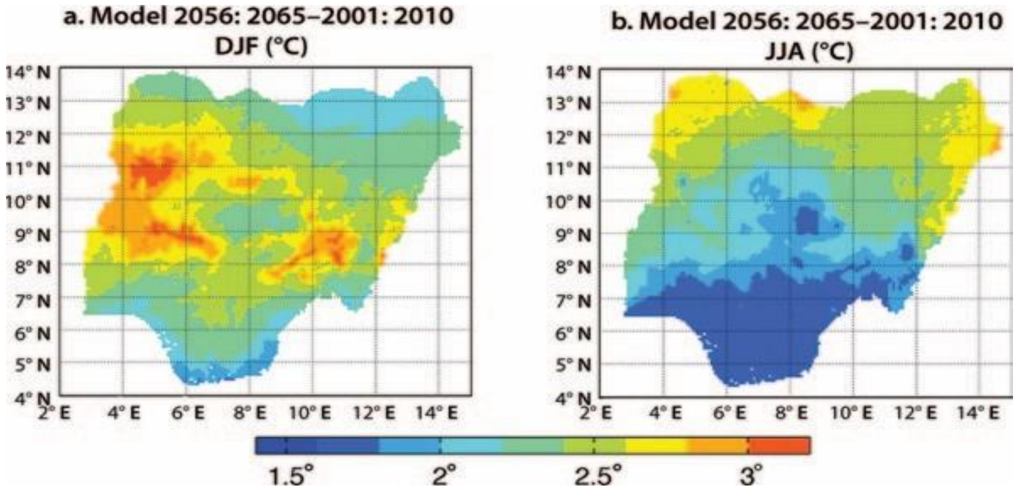


**Figure 1.13:** Air surface temperature increases in 2056-65 compared to 2001-10 (Raffaello et al., 2013)**.** A): winter season (December, January, February); b) summer season (June, July, August).

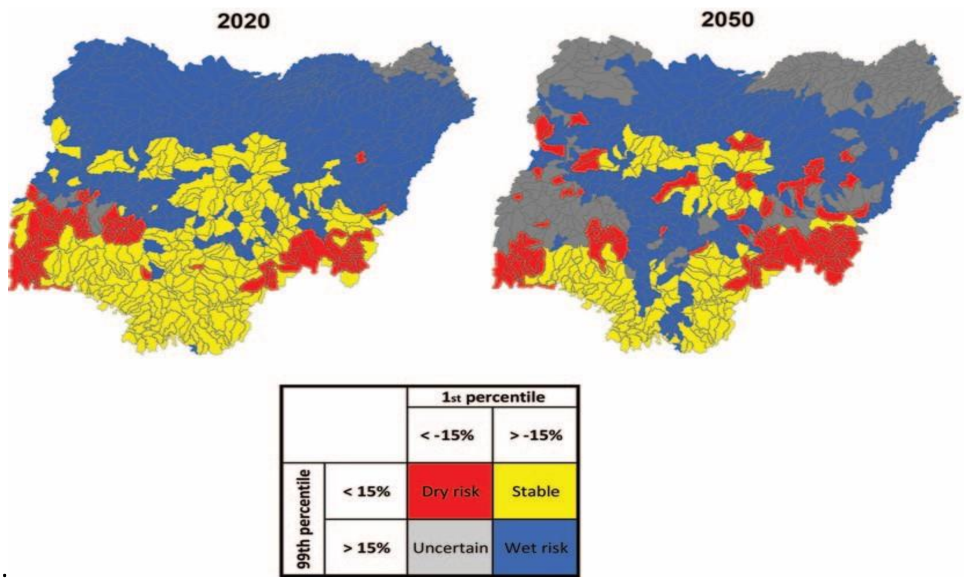


**Figure 1.14:** Projected changes in average water flows by sub-basin, 2050 compared to 2020 (Raffaello et al., 2013).

## 1.5 Flood disaster management

In developing countries like Nigeria, flood disaster management is mainly reactive, concerned only with emergency responses and flood recovery. Flood disaster management in Nigeria is mainly conducted by government; participation from non-governmental and private sectors is limited. Increased flood events coupled with the lack of coping capacity and high levels of vulnerability of people have continued to put many lives and properties at risk (Komolafe et al., 2015). Lack of coordinated spatial planning, poor land use management and absence of good corporate governance characterizes urban development in Nigeria (Adedeji et al., 2012; Abaje et al., 2015; Dalil et al., 2015). The absence of an urban development planning process has over the years resulted in distortion of ecological systems and, in the words of Odufuwa et al. (2012) abuse of flood plains, especially in the low-lying cities.

In tackling flood risk in Nigeria, the focus has been on structural measures coupled with an over dependence on imported expertise and technologies (Oladokun & Proverbs, 2016). Unfortunately, these structures are usually handled by foreign contractors and experts in engineering with limited understanding of local situations, and there is limited knowledge transfer from indigenous experts or communities (Ugochukwu & Onyekwena, 2014). Such structures, which are usually copies of solutions adopted in some distant countries and different socio-ecological settings, without sufficient adaption for local conditions create other socio-technical problems. Such projects lack the right mix of 'soft' elements like advocacy, education, stakeholders' participation, and consultation that can engender a sense of project co-production and ownership. For instance, several flood canals and drainage systems have turned into refuse dumps only a few years after commissioning (Nkwononwo et al., 2015; Agbola et al., 2012; Komolafe et al., 2011; Adewole et al., 2014). Corruption, mismanagement and incompetence of facilities, coupled with substandard construction led to their failure before their expected life span (Lanrewaju, 2012). Stakeholders in Nigeria are slowly recognizing the need to explore non-structural flood risk management (FRM) measures (Ajayi et al., 2012).

Poverty is a major challenge to development in Nigeria (Lame & Yusoff, 2015; Ike & Uzokwe, 2015) that has consequences for flood resilience. The number and population of informal residential areas in major Nigerian cities have continued to rise. The fragile and inadequate sewage systems have become overburdened and failed, with refuse and solid waste management facilities become overstretched to the extent that drainage networks become blocked and flooding becomes inevitable (Oladokun & Proverbs, 2016). Hence, there is a vicious cycle of flooding, poverty and deprivation (Adelekan, 2010; Douglas et al., 2008). While there have been various interventions in the past, there is a lack of integrated and sustainable FRM systems and practices in Nigeria (Adedeji et al., 2012).

Sustainable FRM systems reflect the ecological make up, infrastructural development, institutional behaviour and other techno-socioeconomic characteristics of its environment (Storbjörk, 2010; Tran et al., 2009).

### 1.5.1 Flood risk perception and communication

Public perception of flood risk and flood risk communication is now seen as one of the main components in flood risk management. This study will explore existing flood risk perception and their effectiveness in improving inhabitant resilient behaviour and introduce new ways in which information could be presented to increase action to limit flood impacts. Risk perception refers to the subjective judgement of individuals and groups at risk, in the context of limited and uncertain information, with perception being influenced by a range of cognitive, socio-cultural, and experiential factors (Slovic 2000). Based upon the psychometric paradigm (Slovic 1987), people tend to make quantitative judgements about current and desired level of riskiness, and the desired level of regulation for each type of the hazard (Raaijmakers et al.,2008). For natural hazards dread is often characterised as *worry*. Knowledge of risk among those who are exposed is defined as *awareness* and control over risk as *preparedness* (Slovic et al. 1984). Risk perception is a function of the relationship between awareness, worry and preparedness. Flood risk awareness increases when (1) a society is confronted with a hazard; and (2) information and education about hazard is more widely available, and this information has implications for appropriate actions (King 2000). Preparedness (i.e., pre-flood) is both the capability of coping with a flood throughout the inundation period, and post-flood recovery capability and strategies (van der Veen and Logtmeijer 2005; Flood site 2006). However, a society or community tends to forget about the risks associated with infrequent events, as a result awareness may decline (Arthurton 1998). Provision of information to, or education of the public usually increases awareness. For example, in the European Union, improvement of environmental observation increased the availability of flood risk data for flood experts as well as policy makers (Mitchell 2003).

Flood risk communication encompasses two phases: first, identifying areas at risk of flooding, and second, informing those at risk when flooding is likely (Rollanson et al., 2018). Both phases are crucial to helping those at risk prepare for, anticipate and to act, with the aim of lessening the consequences. This is a vital element of developing community resilience; flood impacts can be significant, extending beyond those whose homes directly flooded, and for prolonged periods following a flooding event (Rollanson et al., 2018). Communication of flood risk information is a key element of FRM which aims to ‘strengthen people’s risk awareness and to motivate the population at risk to take preventive actions and to be prepared’ (Hagemeier-Klose and Wagner 2009, p. 564). The communication of flood risk is a valuable way to link expertise and management undertaken by practitioners with local-level resilience in an at-risk community (de Moel et al. 2009; Butler and Pidgeon 2011).

Since floods are one of the most predictable hydro-meteorological risks, communication is an efficient means to reduce risk, especially by reducing people's exposure (Emanuele et al., 2020). The assumption that the public has a right to know about hazards and risks (Wogalter et al., 1999) and the availability of information allows informed choices to be made regarding risk, thus facilitating decision making and risk sharing (Reynolds and Seeger, 2005). The provision of seasonal rainfall predictions by the Nigerian Meteorological Agency (NIMET) in last few years is a new development that has potential to assist in flood forecasting and early warning (Daily Sun, 2011a). The communication of the predictions to the public is however an issue to be considered.

## **1.6** Behavioural and Education Theory

Behavioural change theories will provide necessary insight and guides in formulating and developing effective teaching methods (i.e., pedagogy), suitable for achieving effective learning outcomes (i.e., improve learners way to think and talk about what they have learned). Education is a method for developing and training learners mental and moral faculties (i.e., training their awareness) in achieving the ability of changing their actions (i.e., behavioural change). Mosser (2007) observed the need for effective communication, public outreach and education to increase support for policy, collective action and behavioural change, a pressing context for anthropogenic climate change.

Behavioural change theory or models focus on environmental, personal, and behavioural characteristics as major factors in behavioural determination. For example, social learning theory considers how both the environmental and cognitive factors interact to influence human learning and behaviour. It is a theory of learning process, acquiring new understanding, knowledge, behaviour, skills, values, attitudes and preferences and social behaviour, characterised by the interaction and exchange among members which proposes that the new behaviours can be acquired by observing and imitating others (Albert Bandura, 1971). It states that leaning is a cognitive process, the mental action or process of acquiring knowledge and understanding through thoughts, experience, and the senses, encompassing many aspects of intellectual function and process such as: attention. The formation of knowledge, therefore takes place in social context, as the immediate physical and social setting in which people live, or in which something happens or develops, can shape their behaviour. This is particularly important within communities where literacy rates can be low and understanding of complex ideas needs to be communicated effectively, as such flood risk and climate change. Whilst behavioural theories rely on the association between stimuli and/or association between behaviours and their consequences, social cognitive theories emphasize the role of observational learning.

Hence, “educational theory” (i.e., pedagogical, instructional and learning theory) refers to theories that will help to explain the application, interpretation and purpose of learning and education. These theoretical constructs explore how we best learn, so that those who teach can apply corresponding research findings to applied practice. Learning is a complex process by which we are able to convert the information and experience into knowledge, skills, behaviours, and attitudes (Claire and Muaed, 2014). Illeris (2002) broadly defines learning as “any process that in living organisms leads to permanent capacity change and which is not solely due to biological maturation or aging." To clarify and describe what is occurring, we turn to learning theories. A learning theory is used to explain how adults and children learn, allowing us to fully understand the complex processes involved in learning (Claire and Muaed, 2014). There are various learning theories which help to explain how we learn.

- *Cognitivism and Behaviourism*

  Cognitivism is reflected in the work of theorists such as Dewey (1938), Piaget (1964), Vygotsky (1978), and Gagné (1970); there are, however, no clear lines separating the different theories of learning and they often blur into one another. Gagné (1968) has also been associated with behaviourism, which identifies the behaviours that can be observed. Differences with behaviourism is that the entire thought processes that occur in the mind of the learner are not fully considered. The primary concern is that of stimuli and responses to those stimuli, as can be seen in the works of Pavlov

(1927), Watson (1928), Thorndike (1913), Skinner (1938), and Gagné (1970). There are three types of behaviourism: methodological, psychological and analytical.

- *Methodological, Psychological and Analytical Behaviourism*
  Methodological behaviourism is concerned with the behaviour of a person rather than their mental state. Watson (1928) wrote extensively on this type of behaviourism. Psychological behaviourism attempts to explain behaviour in terms of external physical stimuli, responses, learning histories, and in certain cases, reinforcements. Both Pavlov (1927) and Skinner (1938) were early supporters of this theory of learning. Analytical or logical behaviourism claims that the very idea of a mental state or condition is idea of a behavioural disposition or family of behavioural tendencies, manifested in how a person behaves in one situation rather than another. Analytical behaviourism may be found in the work of Ryle (1949).

The communication of flood risk information is a key element of FRM which aims to 'strengthen people's risk awareness and to motivate the population at risk to take preventive actions and to be prepared' (Hagemeier-Klose and Wagner 2009, p. 564) as such understanding both behavioural and educational theory are important. According to Van Alphen et al., (2009), over the last decade flood risk management (FRM) has evolved to develop and enhance the community resilience to flooding, rather than simply focus on controlling flood waters using engineering solutions. For example, the UK Environment Agency's prime purpose for flood risk communications is to encourage participation in local FRM and develop community resilience (Environment Agency 2011). Communication of flood risk is a valuable way to link expertise and management undertaken by practitioners with development of local-level resilience in an at-risk community (de Moel et al. 2009; Butler and Pidgeon 2011)**.** Flood risk communication encompasses two phases: first, identifying areas at risk of flooding; second, letting those at risk know when flooding is likely to occur (Rollason et al., 2018), both phases are crucial to helping those at risk prepare for, anticipate and act to lessen the consequences of flood events. This study will explore existing flood risk communication and their effectiveness in promoting resilient behaviour, and introduces new ways in which information can be presented to increase action and awareness to limit flood impacts.

Focus on flood risk communication is intended as a contribution to fostering the inhabitant's perception of risk that could contribute to raising of sufficient awareness, preparedness, response and resilience to flood risk and vulnerabilities. Communication can be described as a verbal or non-verbal, written or visual interaction between two or more individuals, with the purpose of exchanging information. It is of utmost importance not only to communicate but also effectively communicate. “Human communication has been conceptualised, theorised and studied mainly as a process of communication and interaction among and between two or more human beings—that is person to person with language and technology as medium" (Mowlana, 2018). The term communication theory refers to body of theories that constitute our understanding of communication process (Littlejohn, 1983). Communication theories refer to three things- a sender, a message and a receiver. When the receiver gets the information, he or she decodes the message and gives the sender certain feedback.

The communication of risk-related information has become an important element in risk governance that concerns various stakeholders (Renn, 2008). In the case of flooding, risk communication plays a pivotal role in a wider paradigm shift from engineering-based flood defence to more integrated risk-based management, and there has been an explosion of research assessing its effects on risk perceptions, behavioural responses, and institutional management (Demeritt and Nobert, 2014). Effective risk communication is needed to evoke underlying beliefs, touch people’s attitudes, and address their self-responsibility (Slovic et al.,2004; Keller et al., 2006; Zaalberg et al., 2009; Terpstra,2011; Visschers et al., 2012). The population needs to be aware of risks and provided with knowledge about how to prepare (Maid & Buchecker, 2015).

Risk communication is explored in my study through the physical science knowledge and public knowledge. Explores the historical climate (i.e., rainfall and temperature) covering 30-year study periods by using the non-instrumental and instrumental records; explores social understanding of flood risk in Ijebu-Ode by conducting subjective assessment of risk using both the quantitative and qualitative data collection methods – the risk perception at household, community and government level, flood risk measurement, and flood risk management activities are engaged; explore measures of reducing causes /consequences of vulnerability with view of increasing resilience and reducing vulnerability of populations to climate change impacts. Specifically, it proposes the inclusion of ‘’flood risk education an integral part of environment education’’ in the teacher education program as a new educational policy to communicate, stimulate and foster student’s active participation, as well as assessing and enhancing their existing knowledge, skills and resources, to increase resilience to local communities and reduce vulnerability.

## **1.7** Meteorology

In the context of this research, meteorology is concerned with long-term trends in climate and weather, and their potential impact on human populations. Climate change is one of most debated issues in recent decades, especially considering its real and anticipated effects on humans and other components of the environment (Dessler and Parson, 2019; Walter et al., 2019, Schipper et al., 2020). At different temporal scales and in different part of the globe, increasing flood risk is being recognized as one of the most important sectoral threats from climate change, with impacts documented on flood duration, intensity, frequency, seasonality, variability, trend and fluctuation in flood rich (poor) periods (Blöschl et al., 2020, 2017; Seneviratne et al., 2012, p 111; UN, 2020). Extreme climate events, variability and outright change in climate have been identified as impacts of climate change significantly impacting human livelihoods and survival (Popoola et al., 2020). Whereas climate change can be associated with the long-term plans, extreme climate events, which are often localised, unexpected, unusual, unseasonal, severe and extreme historical occurrences typically require immediate and prompt actions (Eludoyin et al., 2017; Abatan et al., 2018; Ranjan et al., 2019).

## **1.8** Climate change adaptation

The concept of climate change adaptation has its roots in policy discourses emanating from the Intergovernmental Panel on Climate Change (IPCC, 2001), and their recognition of climate change as a sustained and worsening problem threatening human development (see also The World Bank, 2010)**.** Vulnerability is the “propensity or predisposition (of a system) to be adversely affected” and, until AR4, was viewed as comprising of three elements: exposure, sensitivity, and adaptive capacity (IPCC, 2007a). IPCC concurrently suggests that ‘Adaptation can reduce vulnerability’ (IPCC, 2007: 14)**.** However, in IPCC (2012), vulnerability focuses only on sensitivity and capacity, with exposure more appropriately incorporated into the concept of risk (IPCC, 2012, Section 2.2). The implication is that ‘harm’ or ‘vulnerability’ is caused by climate change itself, thus positing adaptation to climate change as a means of reducing such harm or vulnerability. Human and natural systems have a capacity to cope with adverse circumstances but, with continuing climate change, adaptation will be needed to maintain or increase this capacity (IPCC, 2012).

## 1.9 Flood risk management

Flood risk management is an important component of flood disaster management, it aims to reduce the human and socio-economic losses caused by flooding while considering the benefits from floods. Flood risk management is defined by Sayers et al. (2013) as the 'process of data and information gathering, risk analysis and evaluation, appraisal of options, and making, implementing, and reviewing decisions to reduce, control, accept or redistribute flood risks. Flood risk management can effectively reduce flood damage; however, flood risks cannot be entirely avoided; thus, they must be managed. Consequently, flood management does not strive to eliminate flood hazard but to reduce, manage and mitigate them. It also involves the process of continuous and holistic societal analysis, adjustment and adaptation of policies, and actions taken to reduce flood risk as well as modifying the vulnerability and resilience of the systems threatened (Gouldby and Samuels, 2005; Sayers et al., 2013). Flood risk management has assumed the dominant paradigm in public policy and the engineering practice dealing with floods (Hall et al., 2003) as evident in many developed societies (see Klijn et al., 2008). The modern approach to management of flood risk embraces a full spectrum of management processes, from technical analysis to the institutional arrangements (Merz et al., 2010) and the involvement of all actors and stakeholders within system of concern. Basic steps of the risk management (Figure 1.15) are: risk assessment before and after implementing flood mitigation measures, to reduce flood risk, it is mandatory to evaluate the performance of implemented measures and to reassess residual risks (WMO/GWP, 2008).

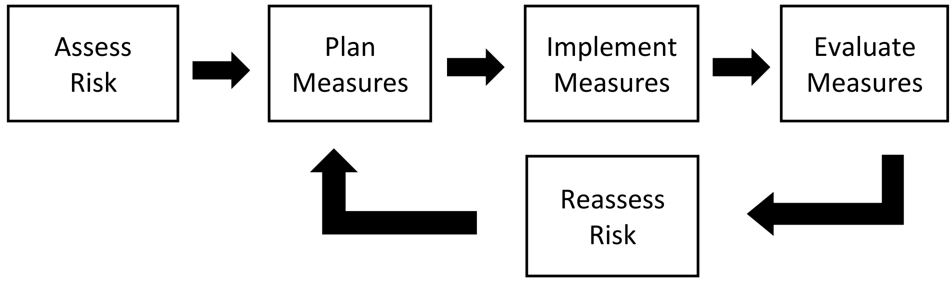


**Figure 1.15:** Steps of risk management (WMO/GWP, 2008)

According to Tingsanchali (2012), an integrated flood disaster management strategic framework is a cyclical process including four elements: preparedness, readiness, emergency response and recovery and rehabilitation. Batica (2015) states that flood risk management plans focus on five pillars: preparedness, prevention, protection, emergency response and recovery measures, which can be categorized under the activities before, during and after the flood event. Preparedness measures attempt to prevent potential risks turning into disasters, both at societal level as well as at the individual level. This involves mitigation of flood risks to an acceptable and affordable level and develop activities to cope with the residual risk. Flood fighting by people help to reduce flood damage during the flood impact (UNESCO, 1995). The response measures are implemented during or immediately after a flood; however, they need advance planning to prepare for effective responses.

The repetition of risk assessments after implementation of structural and non-structural flood control measures (ESCAP/UNDP, 1991) allows judgment of the effectiveness of each of specific measure and identification of those components of risk which require further mitigation. Structural measures may be implemented to mitigate urban floods due to overbank flow, by detaining or diverting run-off, examples include polders and basins, bypass channels, widening of stream and channels, levees and embankments.

Effective urban planning is increasingly recognized as the central means to prevent urban flood disasters, because it can lead to more effective and economically more efficient solutions than traditional means of developing exposed areas and then protecting them by dykes (Moll, 2005). By combining flood models with scenarios of urbanization in scenario modelling, the delineation of zones which define the probability of flooding and the respective type of land use to minimize flood damages can be effective (Tingsanchali, 2012). However, such approaches only work well in formal settlements, if spaces are not made for water to use the floodplain these areas can quickly become informal settlements, particularly where space is at a premium. Informal settlements are common in Nigeria (Section 2.2). Another approach is the reduction of physical vulnerability by developing workable evacuation plans in close cooperation with the affected community. Provision of evacuation shelters, supply of fresh water, food, medicine should be considered in the evacuation plan (Tingsanchali, 2012). The development of building codes plays an important role in decreasing physical vulnerability of houses and infrastructure, providing regulations with reference to type of construction material, structural features of the construction and in some cases also the occupancy and use of the houses (Tingsanchali, 2012), however they again relay on a 'formal' settlement pattern. Flood warning systems need to communicate with communities at risk, success of such a system is closely related to people's knowledge of flood risk and their familiarity with emergency response to incoming floods, however within informal settlements there may be several socio-economic and cultural reasons why such approaches may not work, with no studies of such systems within informal tropical-African settlements.

The primary objective of flood risk management is to employ structural and non-structural methods to achieve acceptable residual risk for sustainable development (Klijn et al., 2008). Structural measures designed to control floodwater by physical construction or by environmental management and non-structural measures focused on planning and management of the urban environment (Jha, Bloch, & Lamond, 2011). Lee et al. (2016) states that structural measures are effective to manage urban flooding, however they are time consuming and expensive. Non-structural measures do not require construction of engineered infrastructure, but rather the need for a good understanding of the flood risk and adequate forecasting systems. Implementing non-structural measures will maximize the flood mitigation efficiency (Lee et al., 2016). Resilience approaches play a leading role in assessing the sustainability of urban environment to minimize flood risk (Batica, 2015). The resilience approach of urban flood management is efficient and cost effective engaging both structural and non-structural measures. According to Batica (2015), it helps to establish flood resilient communities that have effective means to increase adaptation capacity of flooding. Flood resilience measures related to activities that improve the capacity building of human resources, better land use management, increased flood preparedness and emergency measures that are taken during and after flood events (Manaye et al., 2020). The final strategy should be developed through participatory processes, according to Batica (2015) integrated flood risk management is a holistic approach to address flooding problems by participating all stakeholders.

## 1.10 Environmental precarity

This research recognizes environmental precarity as a fundamental problem, an emerging abandonment that pushes the vulnerable population (people) away from a liveable life, which are dependent on chance circumstances, unknown conditions, or uncertain developments. Within the context of tropical Africa, when dealing with (in)formal settlements, precarity of the population at risk requires consideration. Precarity describes the way life is exploited, how the lives of the marginalised and vulnerable groups or individuals in informal settlement offers little opportunity to be prepare, or develop, personal resilience when the daily focus is given to survival (Gaillard et al., 2019). Olajide et al., (2018) states that living in precarious conditions is obviously not the ideal for any human being, but is socio-economic reality which the political-economy and governance system presented to the poor majority in much of Africa. As indicated in the study of Adekola and Lamond (2018); since the end of the Nigerian civil war and accompanying oil boom of the 1970s (Orubuloye, 1995), the country has become increasingly an urban society with the proportion of people living in urban areas has increased from 16% in 1970 to more than 20% in 1980 (Metz 1991) and is currently over 46% (The World Bank 2016). According to The World Bank (2016), the urban population stands at 83 million with over 15% of the country's population living in urban agglomerations of more than one million people. Nigeria's urban population is expected to continue to grow relatively quickly in the coming decades (Jiang and O'Neill 2017). The World Bank (2022) under the Nigeria poverty assessment and economic review identifies that over 40% of the population in 2018 live below the national poverty line. A complex mix of factors contributes to precarity including, poverty, inequality, and failures in governance (Islam & Winkel, 2017) and corruption (Lipset and Lenz, 2000). Corruption has been identified as one of the main challenges of Nigeria's ambition to achieve the 2030 Agenda for Sustainable Development and of its aspiration to lift more than 100 million Nigerians out of poverty in the next 10 years (UNODC, 2019).

Precarity of individuals in dealing with disaster risk and climate change is a fundamental problem all over the world but found to be more precarious in developing nations such as Nigeria (Osoba, 1996; Olorunfemi & Raheem, 2007; Olorunfemi, 2008; Adekoya, 2008; IPCC, 2015; Abah, 2015). Individuals' low-income, increasing poverty, inequality, social marginalization, weak institutional capacity and failures in governance and corruption all exert disproportionate effects on the level of precarity in Nigeria. It is expected that disadvantaged groups will be disproportionately exposed and susceptible to damage caused by climate hazards, with a decreased ability to cope with and recover from disasters (Soto, 1989, 2000; Lipset & Lenz, 2000; Adekoya, 2008; IPCC, 2014; Abah, 2015; Wahab, 2017; Islam and Winkel, 2017). There is high confidence that if policies addressing vicious cycles of poverty and inequality are formulated and implemented in a holistic manner climate-resilient sustainable development can be achieved (IPCC, 2019).

This research recognizes the precarity issues as – a political and social mosaic, but it is bigger than this thesis, and persistent in any consideration of vulnerability, sustainability, resilience and life.

## **1.11** Guiding Concepts of the study

This research is novel and significantly provides a mechanism to better understand challenges and potential solutions to pluvial flood risk in urban tropical African communities. This will serve as advancement in knowledge of pluvial flood risk challenges in the urban cities in Nigeria and provide a platform for more research on flood risk in urban tropical-African communities. The guiding concepts used is described in more detail in Chapter 3. It encompasses Education theory (see section 1.6), Meteorology (see section 1.7), Climate Change Adaptation (CCA) (see Section 1.8), Disaster Risk Reduction (DRR) (see Section 1.9), Environmental precarity (see section 1.10), and Chapter 2 is discussed before my guiding concepts because it will help frame the present research to gain an in-depth understanding of the scale of flood risks challenges in urban tropical-African areas and to clearly illustrate cause-and-effect relationships (i.e., hazard, exposure and vulnerability).

DRR is a systematic approach to identifying, assessing and reducing risks of disaster. It aims to reduce socio-economic vulnerabilities to disaster as well as dealing with environmental and other hazards that trigger them. The UN Office for Disaster Risk Reduction (UNISDR) defines DRR as: "The conceptual framework is considered with the possibilities to minimize vulnerabilities and disaster risks throughout society, to avoid (i.e., prevention) or to limit (i.e., mitigation and preparedness) adverse impacts of hazards, within the broad context of sustainable development" (UNISDR, 2004: 17). As pointed out in the introduction, flooding is widely acknowledged as the most frequent and widespread disaster in world, causing devastating effects on the lives of millions of people and their properties, as well as infrastructure and natural environment and seen as a part of nature, that have existed and will continue to exist due to the climate and meteorological events. It may therefore, not be feasible to remove flood risks. What is important therefore is to fully understand flood risk and associated effects within the framework of Disaster Risk Reduction (DRR). The Disaster Risk Management (DRM) is the application of Disaster Risk Reduction (DRR).

## **1.12** Thesis structure

**Chapter 1: Introduction** provides an overview of this thesis. The chapter provides a review of key issues in global flood management, narrowing it down to flood management in urban tropical-Africa urban cities and finally on Nigeria with emphasis on the challenges and severe impacts of flood risk on vulnerable (people), total environment and the socio-economic development. It focuses on links between socio-economic development and the impacts of flooding, the projection of future climate change and the uncertainty over Nigeria; flood disaster management; flood risk perception and communication, flood risk management and the environmental precarity. It presents the aim and objectives and the conceptual framework of the study and explains the thesis structure.

**Chapter 2: Urban flood risk in tropical-Africa**, provides a review of the literature on perennial flood challenges encompassing Africa, specifically in four tropical-African areas (Ghana, Kenya, Burkina Faso and Nigeria) and specifically in Nigeria. This review is necessary because few studies exist exploring flood risk, intensity, vulnerability and exposure in tropical-African regions. This chapter explores flood risk challenges and identifies common hydrological challenges that impact tropical-African urban cities and regions. There are few studies examining flooding in tropical Africa, this thesis explores a range of different data sources that may be used in data sparce regions, in better understanding flood risk, including newspapers, magazines, social media and other non-instrumental records; flood risk mitigation approaches; past flood disaster accounts in tropical Africa (1900-2019); identify types of urban flooding in Africa town and cities; examine the history and causes of flooding in tropical-Africa urban areas; identify household, community and government coping strategies; explore the role of the state and local government in urban flood risk management; and, identify proposed recommendations given by local communities for addressing flood situations in tropical-Africa and flood risk in a changing African/Nigerian climate.

**Chapter 3: Research methodology** outlines methods that this research will employ to collect/gather, collate, and analyse data.

i. Instrumental climatic and hydrological data of 30-year study period (1989-2018) will be collected from the national organisation (Nigerian Meteorological Agency - NIMET).
ii. Qualitative data will be collected in the form of surveys and interviews with local communities and officials responsible for flood management in Ijebu-Ode
iii. Data analysis of climatic data includes:
    - Statistical characterisation and data quality control of precipitation and temperature data;
    - Box and whiskers plot (focussing on average monthly statistical analysis and variability of local climate & to observe percentile based central tendency, dispersion, asymmetry and extremes);
    - Rainfall Seasonality Index
    - Trend and shifts over time analysis– (considering decades to daily)
iv. Description of fieldwork research design

**Chapter 4: Flood risk in Ijebu-Ode**, this chapter is focused on ascertaining the specific type flooding by examine human-nature interaction and historical climate and hydrology -temporal variability of rainfall and temperature for 30-year study period in Ijebu-Ode. It also considers how climate change may impact the region.

**Chapter 5: Social understanding of flood risk in Ijebu-Ode**, examines the challenges of formal-informal settlement. This chapter will examine results of the survey and interviews, alongside analysis of the qualitative historical flood record. These questionnaires and interviews aim to assess and identify current public understanding and feelings towards flood risk (i.e., the people's popular opinion and underlying phenomenon) including the political perceptions of the problem.

**Chapter 6**: This chapter has been submitted to the *International Journal of Disaster Risk Reduction;* the full citation is provided below. TA undertook the conception, data collection, analysis and writing. HS, SC provided support in the writing and analysis, whilst NM provided support to the research design and writing.

*Aiyewunmi T., Sangster H., Clement S., & Macdonald N. (Submitted) Implications of gender-related differences for pluvial flood risk perception and precarity in Nigerian cities, International Journal of Disaster Risk Reduction, xx:xxx-xxx*

**Chapter 7: Flood risk education,** focuses on understanding of climate and flood information, waste management practices, school & educational needs; it examines the types of environmental hazard that severely affects people's lives, properties and that damages/destroys the environment in Nigerian cities and towns. It will examine current flood risk management approaches at local government level; performance of relevant Ministries, Agencies & Institutions at local government levels; the current goals of philosophy of education in Nigeria in relation to environmental education. It will also suggest policy actions by integrating environmental education (EE) in school curricula. The policy goals will be centred on environmental education and flood risk curriculum design. However, it includes all efforts to educate the public and other audiences, including print materials, website, media campaigns (UNESCO, 2014a & b).

**Chapter 8: Discussion**, this chapter will summarise and synthesis key points from preceding chapters, identifying key themes and contextualise results within the wider international literature.

**Chapter 9: Conclusion,** this is where I will highlight that my research objectives have been achieved and how I have successfully addressed the aim and objectives of the project, summarising the key outcomes.

# Chapter 2
# LITERATURE REVIEW

This chapter provides an overview of current understanding of urban flood risk challenges in tropical-Africa in general and Nigeria specifically. It explores common concerns, examines similarities and differences in flood management practice across African countries and identifies some of the specific challenges in the region.

## **2.1** Introduction

This chapter seeks to review current understanding of flood risk in tropical-African urban areas and flood risk management practices, such as the people's capacities at household, community and government levels (i.e., state & local government), the existing flood resilience, and flood risk in a changing African/Nigeria climate. The review is necessary because it will help frame the present research to gain an in-depth understanding of the scale of flood risks challenges in urban tropical-African areas. Detailing flood risk for the entire sub-continent of tropical-Africa is an enormous task, hence, this chapter will review common concerns shared with specific emphasis on Nigeria. The chapter addresses six major themes: 1) Environmental precarity; 2) understanding of climate change vulnerability in Africa; 3) flooding in Nigeria; 4) flood risk management: institutional roles; 5) past and current flood mitigation measures; and 6) flood risk moving forward in a changing climate. This review will provide basis for the subsequent more in-depth analysis in later chapters; however, it also demonstrates that assessing flood risk is complex and integrates multiple factors from both the physical, economic, cultural and social dimensions.

## **2.2** Precarity of the population at risk

In considering flood risk management in tropical-Africa, the precarity of much of the (often local) population requires consideration. As noted in Section 1.9, precarity is a pressing challenge for much of the population of tropical Africa, challenging any meaningful attempts to increase a population's capacity to be resilient. Whilst it is beyond the focus, or capacity, of this thesis to fully assess and determine all aspects of environmental precarity, it is important that it is considered throughout the thesis, and it underpins much of what is, and is not possible in much of tropical Africa when considering flood risk vulnerability, management and adaptation. Precarity is a challenge to resilience, an enduring feature of the vulnerable population that are denied access to basic amenities such as efficient flood relief channels. The recent World Bank and GFDRR report notes that poor people around the world live in homes that are vulnerable in a disaster (SAMHSA, 2017), as a result their experience of disaster may involve material losses, greater damage to, or destruction, of their homes and often have less protection. Precarity has been caused by the effects of global neo-liberal capitalism in increasing worldwide inequality as "more extensive and less visible patterns of the global dispossession" and "relatively unstable and dispersed conditions of deprivation and insecurity gain ground" (During 2015, Agamben, 1998). Henderson (2004) revealed that level of risk and vulnerability in urban areas of developing countries is attributable to socio-economic stress, aging, and inadequate physical infrastructure. According to Wahab (2017), those on low-income are usually inhabitants of informal settlements which characterize much of Nigeria's urban environment.

> *"The urban poor, [are] not only characterized by low-income levels, but by poor quality and over-crowded housing, the lack of secure tenure, insufficient access to the safe water supplies and sanitation, drainage and solid waste collection, as well as the healthcare, emergency services and policing, and commonly located in environmentally vulnerable areas, are those most at risk from the effects of climate change (IIED, 2018)."*

The absence of social security and inability of the urban poor in Nigeria to recover from the impact of flooding leaves them most vulnerable (Salami, von Meding, and Giggins 2017).

> *"Examining the precarity conditions and how it is lived is therefore not only a means of critiquing the zones of exception on the margins of societies, but also a path to understanding how those who are thrown into precarious circumstances find ways to live otherwise".*

Both economic and political channels of influence of inequality play a role in determining location and livelihood.

### 2.2.1 Precarity and urban governance - political channel

Precarity is “a politically induced condition” (Butler, 2009, 25) in which certain populations suffer more than others from failing social and economic networks of support (i.e., social marginalization), becoming differentially exposed to injury, violence, and death; a situation often caused by failures in the national state. Precarity is fundamentally concerned with politics, and the effects of inequality are identified to be fundamentally transmitted through political channels (Abah, 2015), which works through state power. For example, research in sub-Saharan African contexts has highlighted informal settlements as a product of “disjointed urbanization”, emphasizing the legacy of the colonial era in underinvesting in inclusive urban infrastructure and urban governance (Paul, 2017). Informal settlements are increasingly seen by state and city governments as a constraint to attracting city investment, suppressing market forces and constraining globalization (UN-Habitat, 2014; Zhu, 2010). Much of what affects life chances of the urban poor lies with the market and private businesses, agencies of the central state or the collective voluntary action of civil society that determine the daily experiences of urban dwellers (Avis, 2016).

Hence, ineffective urban governance and dysfunctional urban governance in many urban centres, has resulted in increasing cases of inequality and limited provision of basic public services and amenities, which may be fragmented, insufficient and disproportionately affects the poor (Avis, 2016). In an unequal society, the advantaged groups usually “capture” or exert dominating influence on the state and skew its policies in their favour (Islam & Winkel, 2017); as a result, they can deploy more public (state) resources for their protection against environmental hazards, leaving disadvantaged groups less protected. Complex political interplays and self-interest groups also strongly contribute to perpetuating urban inequalities (Fox, 2014). The Elite Theory on corruption which describes and explains power relationships is symbolic of Nigeria’s circumstances, where power is concentrated in the hands of the few, who occupy top positions in society and have access to political power (Abah, 2015). This elite group decides “who gets what and how”, and has been entrenched at National, State and Local government levels and influences the allocation of budget, socio-economic resources and other vital resources, thereby hindering overall development and actualization of Flood Risk Management (FRM). According to Osoba (1996), “corruption is an anti-social behaviour conferring improper benefits contrary to the legal and moral norms and which undermine authorities to improve living conditions of the people". According to Abah (2015), corruption continues to damage government structures, capacity legitimacy, thereby hindering effective public administration and governance, endangers democracy and erodes social/moral fabric of nation; corruption is endemic in all governments, and it is not peculiar to any continent, religion and ethnic group (Lipset and Lenz, 2000).

This research viewed urban resilience as an important outcome of good urban governance and can be regarded as a prerequisite for growth and prosperity in communities.

### **2.2.2** Precarity and vulnerability - economic channel

Based on the discussion in Section 2.2 & 2.2.1, it can be inferred that people living in informal settlements are dealing with a high level of precarity, as they are largely constituted by low-income and marginalized groups are exposed and vulnerable to floods because they lack access to services and therefore lack the capacity to cope and recover from such events. Generally, disadvantaged groups find themselves compelled to live in these areas because they cannot afford to live in safer areas, complexity multiplies risk, which comes from increasing poverty, inequality, and failures in governance (Islam & Winkel, 2017). Adekoya (2008) notes that corruption occurs in many forms, contributing to poverty and misery for a large proportion of Nigeria's population. As noted within Oladokun and Proverbs (2016, p. 6):

> *The "propensity to award contracts to build more structural flood defences, canals, embankments, culverts & bridges without sufficient consideration for less costly and more sustainable, and non-structural solutions is evident in Nations (Nigeria) budgets (Oladokun and Proverbs, 2016). These structures are usually handled by foreign contractors and experts with limited understanding of the local situation resulting in limited knowledge transfer to indigenous experts (Ugochukwu and Onyekwena, 2014). Such structures, which are usually copies of solutions adopted in some distant countries & different socio-ecological settings without sufficient adaptation for the local scenario, create other socio-technical problems. Due to corruption, mismanagement & incompetence, many of facilities are substandard and collapse long before their expected life span)".*

The AR4 noted that "socially and economically disadvantaged and marginalized people are disproportionally affected by climate change" (IPCC 2014, p. 796; italics added). Similarly, Skoufias (2012, p. 6) notes that "climate change impacts tend to be regressive, falling more heavily on the poor than rich." Inequality aggravates disadvantaged group's position in society vis-à-vis climate change impacts in the following three ways: increased exposure to climate hazards; susceptibility to damage caused by climate hazards; and, decreased ability to cope with, and recover from, the damage (Islam & Winkel, 2017).

Poor communities often live in the most hazardous and unhealthy environments in urban areas, building homes and growing food (Stephens et al., 1994) in precarious locations such as floodplains or on steep, unstable hillsides, or foreshores on former mangrove swamps or tidal flats (Douglas, 2008). In large cities of low latitude countries, it is common for much of the low-income population to live in areas at risk from flooding, (Hardoy et al., 2001) and this population is most likely to be affected by factors related to climate change (Adger et al., 2007). Barbier (2010) and Barrett et al. (2011) show that lack of resources often forces disadvantaged groups to cope with the environmental hazards in detrimental ways that places their future adaptive and growth capacity at risk. 'Risk' refers to potential for the adverse effects on lives, livelihoods, health status, economic, social and cultural assets, and services (including environmental), and infrastructure due to uncertain states of world (IPCC, 2014).

### **2.2.3** Precarity and flood risk management in African cities

While recognising the significance of precarity and vulnerability in the setting of tropical African towns is not surprising, there are numerous practical barriers to tackling it. A critical assessment of the difficulties identified is growing informal settlements, corruption, infrastructural shortages, and the sheer enormity of the problem of preserving geopolitical stability are some of the barriers limiting substantial operationalisation of flood management initiatives in African cities (Cobbinah et al., 2015). Informal urbanisation, for example, is both a process and a manifestation of urban poverty, inequality, access, and legality of tenure within the urban space (Soto, 1989; 2000). Worryingly, the United Nations reports that the future of African cities is dependent on their ability to manage the effects of unplanned urbanisation and climate change (UN-Habitat, 2012). Westgate (1981, 23) described the state's attitude towards informal settlements, squatters, and slum dwellers as ranging from “blind intolerance to blatant hostility”. As a result, many city officials in developing countries have treated these informal communities as a “cancerous growth (s) on the city” to be removed, covered up, or totally neglected (Laquian, 2005, 353). According to West & Marion (2007), a high percentage of urban population growth occurs in informal settlements. They are an overcrowded population and an insecure tenure of stay (Ziervogel et al., 2013). High population density coupled with suboptimal locations of many informal settlements, a result of urban growth compounds existing vulnerabilities (Abunyewa et al., 2017).

> *“The official of the built environment department at the Ghana EPA said, ‘rapid population growth, especially in the slum communities and the corruption in the urban land administration system also make it difficult to prevent expansion of informal settlements & provide physical infrastructure for flood management’. The dominance of traditional land ownership and administration system in Accra remains major contributor to failure in flood response efforts”. (Michael et al., 2020).*

According to Satterthwaite et al., (2007), hundreds of millions of urban dwellers have no all-weather roads, no piped water supplies, no drains and no electricity supplies; they live in the poor-quality homes on illegally occupied or the sub-divided land, which inhibits any investment in more resilient buildings and often prevents infrastructure and service provision. According to Olorunfemi, (2011), a high proportion of these are tenants, with limited capacities to pay for the housing – and their landlords have no incentive to invest in better-quality buildings. Most of low-income urban dwellers face serious constraints in any possibility of moving to less the dangerous sites, because of their need to be close to income-earning opportunities and lack of alternative, well-located and safer sites (Olorunfemi, 2011). The Nigerian urban areas are typical examples of this, with high levels of risk and vulnerability (Olorunfemi, 2008; Olorunfemi and Raheem, 2007). Satterthwaite et al. (2007) attribute the lack of sustainable flood management in cities of developing counties to deliberate attempts by city and state governments to ignore the poor urban dwellers due to their informal and sometimes ‘illegal’ status, lack of awareness of damages, their impacts on urban economy and inadequate data to demonstrate the extent of the problem.

Developing nations such as Nigeria are at great risk of flooding hazards (Ijeoma, 2012) as a consequence of building construction adjacent to flood channels, thereby restricting free flow of water. Odemerho (2004) and Nwafor (2006) identified that often the cause of flooding as inadequate drainage. Studies have shown that the increasing intensity of flood problems in space and time is related to rapid and unplanned rates of urban expansion, while adequate urban runoff disposal systems are lacking (Ayoade and Akintola, 1980). Another prominent issue noted by researchers is high rates of urbanization manifested in the form of high population and of overcrowding overwhelming existing facilities. The behaviour of informal settlement dwellers, such as the use of available storm drains as refuse areas, exacerbates their vulnerability and impacts to environmental hazards (Pelling, 2003). When we consider the overall precariousness (i.e., a source of multiple risks), this describes uncertainty, instability, and the inability of urban tropical-African communities to plan for (i.e., present and future flood risk management) and enhance resilience in the face of difficulties like natural disasters and climate change. The process of resolving the persisting flood problems had been hindered, increasing communities' exposure and sensitivity despite the rising awareness of the serious challenges posed by existential precarity.

The informality of African settlements and livelihoods is deeply ingrained in precarity, which could continue to obstruct effective flood risk management. For example, investing in inclusive urban services and infrastructures, ensuring among other things equality/social inclusion/ability to access basic services, healthy living conditions/standard housing, population control/planned urbanisation, bottom-up approach/access to information and proper communication, and sustainable environment education/knowledge and awareness are all potential solutions or ways to lessen the challenges that the population faces.

### **2.2.4** (In)formal settlement flood risk challenges

> *There is also a general lack of financial and logistical capacity to respond appropriately to flooding [in informal settlements]. Regrettably, such settlements are nearly ubiquitous in African cities, it is in these areas where most vulnerable people live (Jankowska et al., 2011, p. 5 & 20).*

Climate change presents a significant challenge for urban systems worldwide and its effects will likely intensify over coming decades (Shalaby & Aboelnaga, 2017). This subsection takes a critical look at the importance of the settlement types to flood risk management. Diverse researchers have shown that both climate change and settlement development are significant determinants on the level of flood risk (Douglas et al., 2008; Lukas et al., 2017). Understanding distinctions between settlement types is crucial for both climate change adaptation and flood risk management. The human settlement is a *place* where *people* live, it refers to communities with all the social, material, organizational, spiritual, and cultural elements that sustain it. According to Turner (1976, cited in IUCN, 2006) there are two major types of settlements based on their nature, namely formal and informal settlements. Formal settlements are settlements where housing development follows formal channels, including development regulations and legal procedures. Overall planned development includes road facilities, drainage, open space, mass management patterns, infrastructure etc. Informal settlements as places built outside land-use schemes and without planning permission and are composed mainly of makeshift houses that deviate from standard building regulations (Abunyewa et al., 2017). They are self-planned settlements, as some opt to call them (e.g., Fekade, 2000), where societal regulation in the land delivery system plays a pivotal role. The result is that informal settlements may involve the illegal occupation of land, non-adherence to building codes and infrastructure standards, or a combination of these (Fekade, 2000).

A clear distinction between formal and informal settlement could be predicated on a planned development (formal) having good physical planning processes and unplanned developments (informal) having poor physical planning processes. Planned development is associated with formal spatial planning and urban governance structures that could provide clear responsibilities and processes for reducing flood impacts. Unplanned developments tend to have poor spatial planning and lack formal governance structures, which means responsibilities and pathways to reducing flood risk are unclear, leading to increased vulnerability to flooding. According to Okechukwu (2008, 272) "the incursion of unplanned and uncontrolled development into urban structure facilities, violate major objectives of physical planning and consequently result in misuse of land, thereby creating disorderly arrangement of urban landscape and the occurrence of flood that is mostly evident in the cities of third world countries" and further stressed by Abolade et al., (2013, 2355). Moreover, areas marked as informal settlement often have inadequate access to safe water and sanitation facilities, irregular supply of electricity and road for emergency access (Abunyewah et al., 2018). According to Jimor et al. (2013), three key factors account for unmanaged growth of informal settlements in urban centres in developing countries:

(i) lack of planning for future urban growth and management;

(ii) poverty; and,

(iii) inequality**.**

Informal settlements are characterised by low access to political power, poor levels of education together with culturally and linguistically diverse minority groups (Abunyewah et al., 2018).

It is acknowledged that those living in unplanned settlements suffer greater levels of spatial, economic and social exclusion from the benefits of urbanization compared to other segments of the urban population (Paul, 2017). The urban poor often dwell in "unplanned" settlements, not authorized by the State. As such they suffer marginalization which expose inhabitants to the impacts of environmental crisis such as climate change and climatological stresses (e.g., floods and droughts), because of deprivation of access to essential infrastructural services (Paul, 2017). Abunyewa et al. (2017) opined those urban authorities have side-lined planning in informal settlements based on the perception that they are problematic and lie outside the planning arena. As a result, informal settlements are characterized by inadequate access to infrastructure such as electricity, wastewater systems, potable water supplies and storm drains. The inadequate access to storm drains and lack of maintenance of infrastructure coupled with poor waste management reduces the ability of run-off to move safely and swiftly (Abunyewa et al., 2017).

At a global level, challenges that those residents endure in informal settlements have been documented (UN-Habitat, 2016; Das, 2017; UN-Habitat, 2003; Boo, 2012; Davis, 2006; Neuwirth, 2005; Obermayr, 2017; Sakijege, 2014; De Risi, et al., 2013; Ohhusi et al., 2015). These can be summarized as follows:

- Lack of basic services and infrastructure, such as water supply, sanitation, roads and waste management, noting the burden of inadequate and poorly accessible water supply often has the greatest impact on women;
- substandard housing, including inadequate and structurally unsafe buildings;

- overcrowding and high density, noting this varies between regions, towns and cities;
- rise in unhealthy conditions arising from the high spatial concentration of population, animals and resultant disease (such as the impact of Avian bird flu), environmental risks, physical conditions, and a lack of basic services;
- development of high-risk hazardous locations, such as flood prone lands where impacts are exacerbated by adverse housing construction, non-engineered physical adaptation measures, and high population densities;
- insecure rights over land and housing and hence, uncertain and vulnerable tenure; and,
- the presence of poverty including exclusion from other human rights, such as the ability to vote and access services.

Nigeria's government is aware of the housing crisis, yet has chosen to ignore the needs of informal settlements in their largest city, focusing instead on other concerns. Since Abuja became Nigeria's capital city in 1993, the government has put a lower priority on funding development and infrastructure, including housing, for Lagos (Awofeso 2010, 68). The government, in an effort to promote growth, "has encouraged the private sector to build lavish accommodation for the middle class and the elites, displacing the helpless masses into the suburbs, where there is little to no infrastructure in place" (Awofeso 2010, 71). A higher proportion of public funds was used to build housing allocated for high and middle-income earners than low-income earners (Ibem 2011, 202). Influential factors include spatial policies, inability of urban poor to access housing credit, bad politics (politicians without the interest of the people at heart), and class discrimination and inequality (Githira, 2016). City lifestyle, class segregation and inequality are strong factors driving the growth of informal settlements. Poor governance is also noted as a factor generally considered to be driving the growth of informal settlements (City Alliance, 2014; Olajuyigbe, Popoola, Adegboyega & Obasanmi, 2015: 312, in Fekade 2000). Moreover, bribery and corruption seem to have penetrated almost all facets of society, with planning function as no exception (Wahab & Agbola, 2017). Case studies in Enugu City in Nigeria shows that most of the programmes towards the improvement of informal settlements have only addressed the symptoms rather than the causes (John-Nsa, 2021).

In Africa, failure to address housing issues has led to the continued growth of slums and poorly serviced informal settlements on the urban periphery, where between 75% and

99% of urban residents in many African cities live in squalid slums of ramshackle housing (Giddings 2007:11; Carrington 2015). For example, in South Africa, Cloete (1995:35) posits that the present government faced great difficulties and enormous backlogs because of the apartheid legacy. This was corroborated by Malpass (1990:5) in his view that the apartheid state's lack of investment in housing created an unprecedented housing shortage and resulted in the proliferation of squatter camps. While the foregoing facts are indicative that the extent of the present informal settlements challenges derives not only from the enormous size of the housing backlog and the desperation and impatience of the homeless, but stems also from the extremely complicated bureaucratic, administrative, financial and institutional framework inherited from the previous government (White paper on housing 1994:1). Historically, the city of Nairobi has engaged in slum clearance without providing its residents other housing alternatives (Macharia 1992, 221). Slums whose residents are allegedly involved in subversive political activity or with large populations of ethnic minority groups are often targeted (Macharia 1992, 230). Macharia, Kinuthia (1992). Slum Clearance and the Informal Economy in Nairobi. The Journal of Modern African Studies, 30, 2, 221-236.

Low levels of literacy in informal communities hinder their capability to decipher warning information and access to preparatory and recovery information (Cutter et al., 2003). Also, the inability of informal settlement dwellers to monitor and predict accurately changing weather patterns is another explanation for the rising impacts of disaster hazards (Abunyewah et al., 2018). Doberstein & Heather (2013) suggest that increased vulnerability among residents in informal communities is a major facilitator to rising impacts. Growth of informal settlements is difficult to prevent, especially in developing countries where policies to check urban population growth is inadequate and lacking (Abunyewah et al., 2018). According to Omoboye and Festus (2014), Nigeria's flooding is inextricably linked to poor urban development practices (Omoboye and Festus 2014). UNECE (2015a) opined that a common reason for continued growth of the "Informal Settlement" was that government failed to adopt "pro-growth" policies. Absence of local governance importantly further hinders response to climate-induced risk at the local level. Flood risk management seems a complex task to achieve in an informal settlement, as a consequence of poor spatial planning, upsurge of population density which directly or indirectly raises hazard vulnerability and often high levels of exposure.

The UN habitat report states that flooding is one of the major factors that prevents Africa's growing population of city dwellers from escaping poverty and stands in the way of the United Nations 2020 goal of achieving 'significant improvement' in the lives of urban informal settlement dwellers (ActionAid, 2006), as many African cities lack infrastructure to withstand extreme weather condition. Flood risks in African cities have been exacerbated because of anthropogenic influences (Agbola et al., 2012; EM-DAT, 2015), which includes rapid urbanization, uncontrolled urban growth, and unregulated informal settlement on low-lying floodplains areas (Douglas et al., 2008; Eguaroje et al., 2015). Disasters create serious disruption and economic loss which impair the ability of communities (i.e., particularly poorer people) to recover. A substantial part of flood risk management lies in sustainable spatial planning and good urban governance, including recognising the importance of social, environmental, land-use and flood risk communication which provide a strong foundation from which hazard exposure and vulnerability can be reduced.

However, to achieve this a firm understanding of the underpinning hazards presented from the environment is required, and how these may be changing.

## **2.3** Understanding climate change vulnerability in Africa

According to UN Climate Change News (27 October 2020), increasing temperatures and sea levels, changing precipitation patterns and more extreme weather are threatening human health and safety, food and water security and socio-economic development in Africa. During 2019, several high-impact events affected continents and were associated with loss and damage to vital aspects of communities and populations, resulting in issues relating to food security, population displacement, and safety, health and livelihoods of the people (Mlaba, 2021). Water resources are subjected to high hydro-climatic variability over space and time and are a key constraint on the African continent's continued economic development (Niang et al., 2014). Overall adaptive capacity in Africa is considered low; most adaptations remain autonomous and reactive to short-term motivations (Niang et al., 2014). Africa is one of most vulnerable continents due to its high exposure and low adaptive capacity (Niang et al., 2014). The African continent is witnessing high vulnerability because exposure to climate risks is high, sensitivity of the system is high and adaptive capacity is low; all of which are major conclusions from previous IPCC assessments (Niang et al., 2014) (see Table 2.1).

### **2.3.1** Exposure of urban tropical-Africa areas to climate risks

Every year several disasters occur in Africa, and these are becoming more prevalent (CRED Crunch, 2019). Disasters across the African continent in the past 20 years show that floods and droughts were the most prevalent and impactful type of disasters on the continent, from 2000-2019, floods were responsible for 64% of disaster events, followed by storms at 15% (CRED Crunch, 2019). Many populations in countries throughout the African continent have suffered from such hazard impacts, which have killed thousands and caused injuries to many others (CRED Crunch, 2019). Floods, droughts, and high temperatures have historically been recorded across many parts of Africa. Changes in precipitation levels, likely increases in temperature extremes and rising sea levels will have a wide range of direct and indirect impacts on Africa (UNEP, 2012). Boko et al., (2007) & Hulme et al., (2005) observed that, in current records, rainfall patterns across Africa vary and exhibit different scales of temporal and spatial variability. The variability can be seasonal, inter-annual, and decadal or over longer time scales (Lebel and Ali, 2009). Hulme et al., (2005) describes the climate of Africa as both *varied* and *varying.* Climates *varied*, because they range from humid equatorial regimes, through seasonally arid tropical regimes, to sub-tropical Mediterranean-type climates; & *varying* because all climates exhibit differing degree of temporal variability, particularly regarding rainfall (Hulme et al., 2005). Africa, while currently responsible for a negligible amount of the total global greenhouse gas emissions, is under significant threat from climate change (UNEP, 2012). Yet Africa is not a driver of climate change, but a victim (Commission for Africa, pp 249, 2005).

Instrumental and observational conditions in Africa continue to exhibit changes (Julius, 2011). The weather is becoming increasingly volatile in Africa (Commission for Africa, pp 51, 2005), and the continent of Africa is generally noted to be hot and dry with current trends showing warmer spells than it was 100 years ago (Hulme et al., 2005). The net effect of climate change is to make an already variable climate more volatile and challenging in Africa (Niang et al., 2014). Impacts of the climate change in Africa is also worrisome, many studies have considered the continent as globally the most vulnerable (Boko et al., 2007 – IPCC; Awojobi & Tetteh, 2017). According to the International Strategy for Disaster Reduction (ISDR) (2004: 149), the African continent is exposed to disaster risk from the various natural causes, particularly those arising from the hydro-meteorological hazards (Clements, 2009; World Wide Fund for Nature, 2006; Paul et al., 2023)**.**

Serious flood incidents generated by unprecedented rainfall in Africa over past decades include torrential rains in 1999 which led to Kainji, Jebba and Shiroro dams in Nigeria being overwhelmed, resulting in a heavy death toll and property losses (Bhattacharya & Lamond, 2011). In the same year, in Ghana, overflowing of the White Volta River caused loss of life and homes. Flooding of Komadugu Yobe Valley in Nigeria in 2001 killed over 200 and displaced 35,000. Likewise, in 2009, following the heaviest rainfall in 90 years, floods in Burkina Faso left seven dead and 150,000 homeless (UN Habitat, 2010). The UN through the BBC News Channels (2007) reported that at least 14 countries were hit in West, Central and East Africa by some of worst rains in memory. Scores of people died and hundreds of thousands were displaced by floods that submerged much of the continent's most productive farmlands. UN spokeswoman Elisabeth Byrs BBC News Channel (2007) stated: "The rains are set to continue and we are really concerned because a lot of people are homeless and infectious diseases could emerge". "We have 500,000 people affected, 12 countries in West Africa, and also in East Africa – like Mali, Burkina Faso and Niger – the poorest nation in the world – are badly affected".

### **2.3.2.** Sensitivity of urban tropical-African areas to climate risks

Studies (Boko et al., 2007; IPCC, 2018; Paul et al., 2023; UNFCCC, 2020) have shown that Africa is highly vulnerable to impacts of climate change threatening sustainable development. Climate change in historically and at present exerts a significant negative impact at regional, local, household and community scales and is also expected to increase the risk of flooding in Africa (Adelekan & Asiyanbi, 2015; Boko et al., 2007; Douglas et al., 2008; Nkwunonwo et al., 2016; Onwuemele, 2018; Paul et al., 2023). In recent years, attention has shifted from flood hazard control to flood impacts and risk assessment (Bubeck et al., 2011; Ke et al., 2012). Flood risk is a function of hazard, exposure, and vulnerability (Cardona et al., 2012). According to United Nations office of disaster risk reduction (UNISDR), risk is defined as combination of the probability of an event and its negative consequences (UNISDR, 2009a; 2009b; 2013a; 2013b). The negative consequences cannot be established until levels of vulnerability and exposure are known

(Alexander, 2000; White et al., 2005), with consequences including fatalities, damage to homes, businesses, and nature.

Floods are the most frequent and widespread natural hazards in Africa, particularly in the sub-Saharan Africa (Douglas et al., 2008) becoming a more frequent problem in the most African cities, with adverse consequences for the urban poor and vulnerable (Paul et al., 2023). The West African sub-region has had the worst urban flood events. Sighommou et al., (2013) identified that devastating floods occurred across West Africa in 2007, 2009, and 2010 in addition to those identified by Global Facility for Disaster Risk Management and Recovery (GFDRR, 2011b) in 1982, 1991, 1995, 1998 and 1999. According to Sarr (2011), the number of flood events in West Africa has increased on average from less than two per year before 1990 to more than eight per year during the 2000s; with an average of 500,000 people per year are affected by the floods in West Africa alone (Jacobsen, Webster & Vairavamoorthy, 2012). Devastating flood events in recent years have killed thousands of people and caused significant material damage in Central and West Africa (IFRC, 2008), with the hardest hit countries Burkina Faso, Senegal, Ghana, and Niger (UN Office for Coordination of Humanitarian Affairs (OCHA, 2009). In Nigeria, the 2012 flood disaster affected 32 of the country's 36 states, with 24 states severely affected, and an estimated total of 7.7 million people (Nkwunonwo, Whitworth & Baily, 2015). In East Africa, according to Douglas et al. (2008), flooding and mudslides wreaked havoc in countries like Kenya, Burundi, Rwanda, Tanzania and Uganda, leaving tens of thousands of people displaced from their homes with more than 112 human casualties. Many in West and Central Africa such as Guinea, Ghana and Democratic Republic of Congo have been struggling with exceptionally heavy rain, mudslides, hurricanes and floods (IFRC, 28 October, 2019). Etuonovbe (2011) asserted flooding is the most common environmental hazard in Nigeria. According to Ali (2005) and Ologunorisa and Tersoo (2006), causes of flooding in Nigeria urban areas include long duration (hours) rainfall events. Ayansina et al. (2009) noted that seasonal and annual rainfall variability in some parts of Nigeria continues to increase as an element of climate change and variability. Few (2003) and Tschakert et al. (2010) believed that the flood events in West Africa are closely linked to meteorological conditions and changes in the rainfall patterns resulting from climate change. Douglas et al. (2008) and Aich et al. (2015), indicated that the occurrence of flooding in West Africa to be caused by heavy rainfall events/increasing rainfall intensity and land-use change. Flood risks in African cities have been largely exacerbated due to anthropogenic influences, which include urbanisation, uncontrolled urban growth, population growth (4.4% in Nigeria against global average of 2.5%; Douglas et al., 2008, p. 188; UN Habitat, 2011), unregulated informal settlements on low-lying floodplain areas, disregard to waste management and poor maintenance of drainage (Douglas et al., 2008; Eguaroje et al., 2015). With the impact exacerbated by a lack of preparedness, low adaptive capacities, increasing population densities, urban poverty, and growth of slums and conflicts increase vulnerability of African cities (Adelekan, 2010).

The African continent ranks second hardest hit by flooding after Asia in terms of number events, damage and death (Tschakert et al., 2010). However, in last decade, the number of flood events recorded in Africa is higher than the rest of the world (Jha et al., 2011b). The number of floods disasters reported in some parts of Africa has increased sharply in recent decades (Appendix G and Appendix H). In sub-Saharan Africa alone, 654 floods have affected 38 million people with around 13000 deaths recorded in the last 33 years (Tiepolo, 2014). Tiepolo affirms that these figures necessitate an urgent need to seek for effective solution to mitigate flood risk in the context of adaptation to climate change. Over the period 1900-2019 (Appendix G) the EM-DAT disaster database records a total of 1086 flood disasters in Africa ranging from pluvial, flash, riverine and coastal flooding, with severe consequences on physical, social, economic and environmental wellbeing of the vulnerable. The continual impact of flooding continues to cripple the capacity of urban Africans to improve their conditions of living and overall wellbeing.

## **2.4** Flooding in Nigeria

Nigeria hosts two of West Africa's great rivers (Figure 2.1):

- the Niger which enters the country from the north-west; and,
- the Benue, which flows into Nigeria from its eastern neighbour Cameroon

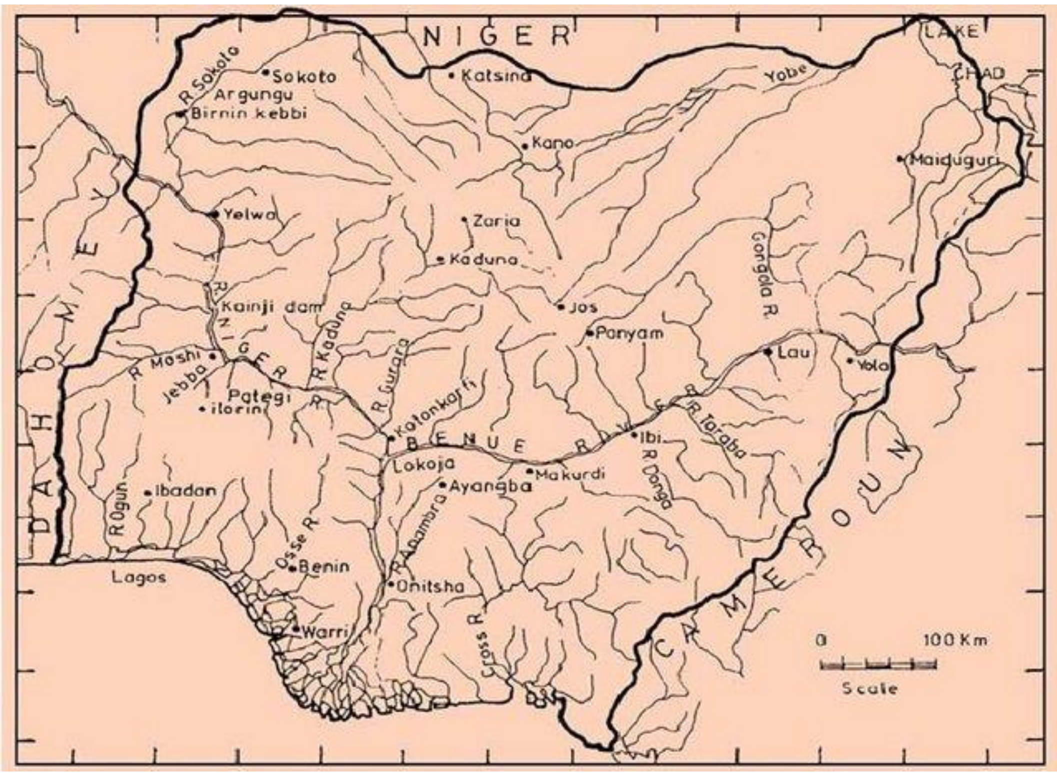


**Figure 2.1**: The important rivers in Nigeria (Taiwo et al., 2012).

Nigeria declared a 'national disaster' following severe floods that have left at least 100 people dead in several states across the country. Nigeria's two major rivers burst their banks, sweeping away homes in the central part of the country (CNN, September 18, 2018). By October 9, 2018, a total of 103 Local Government areas across 10 states in Nigeria, were impacted by severe flooding with an estimated 1.9 million people affected. These two waterways meet in central Nigeria and then flow south as a single river on to Atlantic Ocean. Much of Nigeria's flooding occurs along these two rivers as their banks overflow in the rainy season, in 2012, hundreds of thousands of acres of land were flooded in Nigeria when the Benue and Niger over-spilled (BBC News, 2018). In 2012 the Niger River reached a record-high level of 12.84m (42ft). In 2018, levels reached 11.06m, with fears that the heavy rain, expected to continue through the October that year, could lead to similar heights. In 2020 and 2021, The minister of Water Resources and Rural Development, Suleiman Adamu, during the public presentation of 2021 Annual Flood Outlook (AFO) warned that the states contiguous to rivers Niger and Benue, including Kebbi, Niger, Kwara, Adamawa, Taraba, Benue, Nassarawa and Kogi, were likely to experience river flooding. Others are Anambra, Delta, Edo, Rivers, and Bayelsa states (Sunday Magazine, 18 July, 2021).

The yearly rainfall showed a growing tendency between 1981 and 2017, according to data from the Nigerian Meteorological Agency that was analysed for 13 affected locations (BBC NEWS, September 27, 2018 - https://www.bbc.com/news/world-africa-45599262). Flood Risk Management (FRM) is a challenging process in Nigeria due to experts' belief that flooding there is more human-induced (NIGERIAN TRIBUNE September 28, 2021). But it's not just rain falling in Nigeria itself, heavy precipitation upstream on the Benue and Niger rivers - in Cameroon, Mali and Niger contributes large volumes of water to Nigeria's river systems (Musa 2018). Another factor in Nigeria's are dams; Nigeria's three main electricity-generating dams, at Kainji and Jebba on the Niger river and the Shiroro dam on the Kaduna River and the incomplete Zungeru dam, in Niger state, which is part-funded by the Chinese government, is also believed to be affecting areas once free from flooding. On the Benue River, the main concern is the Lagdo Dam, in neighbouring Cameroon, which has previously caused the river to swell during water releases. In 2012, water flowing in from the Lagdo dam was blamed for 30 deaths in Nigeria.

Heavy seasonal rains are a regular feature of life in Nigeria and towns close to the country's main rivers are particularly vulnerable**.** Historically, Nigeria’s urban centres have experienced major floods, with a long oral history of flooding in major cities (Tremearne 1910). Instrumental records of flooding in Nigeria back to the 1950s (i.e., the data just from the 1950s onward) (Bashir et al., 2012; Douglas et al., 2008). Etuonovbe (2011) asserts that flooding is the most common environmental hazard in Nigeria. According to Action Aid (2006), four types of flooding can be recognized in Nigeria: localised flooding which occur many times in a year due to few and blocked drains; small streams in urban areas which flood quickly after heavy rain, when passing through small culverts under roads; major rivers flowing through urban areas and wet season flooding in lowlands in coastal areas. However, this report fails to recognise the role of pluvial flooding, indeed in recent years pluvial flood events have arguably been more widespread (Olajuyigbe et al., 2012). Pluvial floods usually occur mostly frequently during the height of the rainy season, which tends to be from July and September, and it is often a time of anxiety for many communities living in the flood-prone areas (Olajuyigbe et al., 2012). Heavy rains combined with poor drainage systems and blocked waterways cause rainwater to flow through the commercial and residential dwellings. Town planning expert Aliyu Salisu Barau told the BBC that ‘Nigerian authorities and ordinary citizens are ill-prepared for such disasters’ (BBC Africa’s Ishaq Khalid, 30 July, 2017). As Adebayo

(2014, p 447) notes “Nigeria will continue to labour under the pains of flood disaster unless there is a radical approach to avert the disaster”.

Well documented devastating flood events in Nigeria can be dated back to the 1963 in Ibadan city, when the Ogunpa River was over-flown causing loss of lives and property; these hazardous events reoccurred in 1978, 1980 and 2011, with estimated damages and deaths of 30 billion naira ($37,823,388) and 100 people respectively (Adegbola and Jolayemi, 2012; Agbola et al., 2012)**.** Flooding in various parts of Nigeria has forced millions of people from their homes, destroyed businesses, polluted water resources, and increased the risk of diseases (Akinyemi, 1990; Adebayo, 1997; Baiye, 1988; Bashir et al., 2012; Edward; Ugonna 2016). Recent flooding incidents in 2011, 2012, 2013, 2014, 2015, 2016, 2017, and 2018) have impacted major cities in the North and South of Nigeria. Climatic conditions and changes to weather patterns have contributed to extensive flooding being witnessed in many Nigerian states, with lives lost, and sources of livelihood worth billions of Naira destroyed (Adekola, 2013).

In considering the floods of 2018, the Director-General of NiMet, Prof. Sani Mashi, stated “distortions had occurred in the pattern of rainfall leading to variation in the amount of rain expected in the country. He said that in line with the NiMet’s 2018 Seasonal Rainfall Prediction, SRP, so much water would be made available on surface once it rains, and the ground cannot comfortably contain and absorb the water making it to runoff and resulting in so much water on surface. Vanguard’s checks indicate that the warnings were only partially heeded. Drainage channels were blocked and the cases of people building houses on flood plains persist. It was, therefore, not surprising that floods wreaked heavy damages in many parts of the country. …In most cases the authorities do not make provision to clear the drainage systems until it is already rainy season…. [and that] tackling persistent flooding in Nigeria requires long-term planning."

Recent flooding in 2020 “killed 68 people, affected 35 states including FCT, 320 LGAs and over 129,000 people. It led to loss of lives, it destroyed houses and washed away farmlands across the country, thereby having (a) negative impact on the food security,” NEMA (2020). Whilst in 2021 severe flooding in Jalingo, Taraba State in North Eastern Nigeria occurred after heavy rain from 09 July 2021, heavy rain on 16 July swamped roads in Lagos, the country's largest city, with local media stating as many as 4,000 people were displaced by the floods (Richard Davies – Africa News, 2021). The Director General of NIMET warned of the possibility of most parts of the country experiencing a shorter, more intense rainy season. In Yola State flooding began in early August 2021 with dozens of houses damaged or destroyed in the Shelleng Local Government Area (LGA) around 11 August 2021, with populations temporarily displaced and sheltering nearby until floodwaters receded. The UN warned of an increased risk of cholera in the region.

> *"The recent flooding incidents (which typically contaminate water sources) raised concerns about a possible spike in AWD/cholera cases over the coming weeks. The number of suspected cholera cases continued to climb across 6 LGAs of Yola North, Yola South, Shelleng, Gombi, Girei and Fufore. As of 7 September, 169 cases and 7 fatalities had been reported" (Richard Davies – Africa News, 2021).*

A critical examination of the major records of flood disasters is provided in summary Table 2.1, and a more extensive record provided in Appendix I within different parts of Nigeria covering all the geo-political zones (Table 2.2) Specific flood occurrences are viewed through the states where they occurred, type of disaster, causes, associated hazards, affected population, dates. Disaster type indicates the prominent disaster experienced, though secondary impacts may also be record which could be linked to the impact (i.e., social, economic, and environmental), giving a state of its exposure and vulnerability.

**Table 2.1:** Notable flood occurrence and hazards record in Nigeria: Data updated Oluseyi (2017)

| State | Disaster | Associated Hazards | Affected Population | Year |
|---|---|---|---|---|
| **Oyo** | Ogunpa flood, Ibadan flood | 500 houses demolished, properties destroyed, bridges collapsed; 300+ houses destroyed in 2017 | 50,000 displaced, 300+ in 2017 | 1933, 1948, 1963,1978,1980,1982,1985, 1987, 1990, 2011,2017 |
| **Lagos** | Lekki flood | Building collapsed, markets submerged, properties destroyed | 300,000+ | From early 1970s to date |
| **Kano** | Flood/windstorm | Schools, houses, farmlands, animals destroyed | 300,000+ displaced in 1988;20,445 in 2001 | 1988,2001 |
| **Zamfara** | Flood | Buildings submerged, farmlands destroyed, properties damaged | 12,398 | July, 2001 |
| **Yobe** | Flood, fire and drought | Houses and farmland submerged, houses razed, animals affected | 100,000+ | April and September, 2001 |
| **Sokoto** | Flood, fire and windstorm | Houses and farmland destroyed | 16, ooo+ | July 2001 |
| **Taraba** | Flood | 80 houses swept away; 410 houses extensively destroyed | 50,000+ displaced | August 2005 |
| **Osun** | - | Houses and schools destroyed | 17,000+ | April 2001 |
| **Ondo** | - | Houses and schools destroyed | 800 | April 2001 |
| **Niger** | Flood | Houses, schools, animals and farmlands affected | 200,000+ displaced | 1999,2000 |
| **Kogi** | Flood | Houses, schools, animals and farmlands affected | 1500 displaced | March and May 2001 |
| **Jigawa** | Flood | Houses, schools, animals and farmlands affected | 35,00 displaced in 1988; 450,150 displaced in 2001 | 188, March, April and August 2001 |
| **Imo** | Flood | 1000 houses; 150 electric poles; 40,000 oil palms destroyed | 10,000+ displaced | April 2001 |
| **Ekiti** | Flood | Public school, 890 houses | 2100 affected | April 2001 |
| **Edo** | Flood | 560 houses destroyed in 2001; State-wide devastation in 2012 | 820 affected in 2001; 3.8 million affected in 2012 | March 2001, 2012 |
| **Delta** | Flood | Houses, schools, markets and farmland submerged | 425,839 affected between all the three incidences | 1999, March and April 2001 |
| **Balyesa** | Flood | Houses, schools, markets and farmland submerged | 273,266 affected in 1999; 382,000 affected in 2001 | 1999, March 2001 |
| **Akwa-Ibom** | Flood | 367 houses washed away | 4000 | March 2001 |
| **Adamawa** | Flood | Houses and farmlands destroyed | 500 | April 2001 |

| | | | | |
|---|---|---|---|---|
| **Rivers** | Flood | Residential houses, churches, public and private facilities | 300+ affected year-in-year-out | 2006, 2012, 2013, 2017 |
| **Cross River** | Flood | Entire communities, public and private facilities | 25,000+ affected | 2017 |
| **Anambra** | Flood | Residential houses, farmland, public schools And market places destroyed | 500,000+ affected in several communities | 2012, 2017 |
| **Ogun** | Flood | Residential houses, public and private buildings collapsed, market places destroyed, farmland washed away | 350,000 affected in several communities | 2012, 2017 |

**Table 2.2:** List of Geopolitical Zone with their States (36) in Nigeria

| **Nigeria Geopolitical Zones** | **Number of States (36)** | **States** |
|---|---|---|
| North Central | 6 | Benue, Kogi, Kwara, Nasarawa, Niger, Plateau and FCT (Federal Capital Territory Abuja/Environ) |
| North East | 6 | Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe |
| North West | 7 | Jigawa, Kaduna, Kano, Katsina, Kebbi, Sokoto and Zamfara |
| South East | 5 | Abia, Anambra, Ebonyi, Enugu, and Imo |
| South South | 6 | Akwa-Ibom, Balyesa, Cross-River, Delta, Edo, and Rivers |
| South West | 6 | Ekiti, Lagos, Ogun, Ondo, Osun, and Oyo |

## **2.4.1** Identified causes of flooding in Nigeria

Most common factor responsible for observable flooding in Nigeria is high rainfall variability, coupled with heavy local rainfall and runoff generation, often exacerbated by anthropogenic activities (see Table 2.3). Most of the Nigeria's states are increasingly suffering from annual flooding during rainy seasons caused by the increased precipitation linked to climate change (Aja and Olaore 2014). Flood occurs through combination of meteorological and hydrological extremes as well as the activities of man on drainage basins (Adeaga, 2008). According to Aderogba (2012), while climate change has led to more rains than in past which has increased incidence of flooding, Nigeria's flooding is mostly human induced, exacerbated by human-nature interactions. IPCC (2014) relates recent impact from climate change to the extreme events such as floods and significant vulnerability and exposure of many human systems to current climate vulnerability.

**Table 2.3:** Key components of urban flooding in Nigeria (Nkwunonwo et al., 2016)

| No | Parameters/Indicators | Different factors |
|---|---|---|
| **1** | Climate and meteorological events | high rainfall variability<br>runoff generation |
| **2** | poor urban planning | rapid population growth and urbanization and poor planning to cater for the growth increase;<br>lack of proper and comprehensive land use planning |
| **3** | Urbanization | rapid population and cities expansion<br>informal settlement growth<br>lack of security of tenure, basic services and city infrastructure |
| **4** | anthropogenic activities | lack of & poor drainage networks/inadequate & silted drainage systems/ poor management of existing drainage;<br>inadequate waste management/ dumping of refuse into water channels;<br>lack of technical know-how, inadequate equipment for waste separation;<br>weakness of solid waste management guidelines and compliance of people;<br>low political will;<br>Poor implementation of environmental laws and regulations;<br>uncoordinated institutional functions;<br>poor data information for planning,<br>poor environmental regulatory framework;<br>poor flood emergency preparedness;<br>poor weather prediction, forecast & alert; poor river system monitoring; and<br>poor attitudes of residents toward the environment and sanitation. |

Poor or non-existent drainage systems are a major human-induced exacerbator of flooding experienced in Nigeria (Ogundele and Jegede 2011). The urban environment in Nigeria is faced with myriad of issues regarding poor drainage systems (Offiong et al., 2008; Odunuga et al., 2012). According to the study of Douglas et al., (2008), flood risks are caused by lack of adequate drainage coupled with poor management of the existing drainage and poor drainage systems (Ojo, 2008). Jimoh (2008) opined that inadequate integration between road and urban water drainage coupled with poor and inefficient drainage facilities aggravates flooding. Aderogba (2012) revealed that no cities and towns in Southwest Nigeria that have ≥50% of the built-up areas connected to drains. Most residential areas in Nigeria have no drainage system and rely on natural drainage channels, and it is common for buildings and other infrastructure to be constructed in a manner that obstructs theses drainage channels, which results in the flooding during rainy season (Nabegu 2014).

Urban settlements in African cities are commonly suffer by flash, fluvial, coastal and pluvial flooding (Douglas et al., 2008). Fluvial floods are triggered by excessive rainfall causing a river to exceed its channel, overtopping natural or artificial defences and inundating areas (Few, 2003; Vojinović, 2015). Coastal floods usually affect cities in proximity to the ocean or the coastal environment (Vojinović, 2015). Flash floods resulting from direct rapid response to high intensity of rainfall, often in steep slopes environments, while pluvial floods usually occur when the precipitation exceeds infiltration rates, in urban areas this often occurs during intense rainfall which overwhelms the capacity of drainage systems (Houston et al., 2011; Merz, Thieken & Gocht 2007; Vojinović, 2015). According to Houston et al. (2011) pluvial (rain-related) flooding in urban areas often presents an 'invisible hazard', occurring following short intense downpours. As pluvial flooding does not have an easily defined floodplain, it can be challenging to predict and plan for, and is poorly understood by the general public (Houston et al., 2011). The lack of regular maintenance of hydraulic conveyance systems in many African settlements predisposes them to blockage from debris and urban wastes, effectively reducing their capacity, thereby increasing the frequency of flooding (Douglas et al., 2009). Extensive urban and suburban growth in combination with insufficient sewer systems (Swan, 2010) as well as climate change aggravates the problem (Semadeni-Davies et al., 2008a, Semadeni-Davies et al., 2008b).

Nigeria is witnessing high urbanization rates without commensurate provision of urban infrastructure and amenities (Aderogba 2012), with over 50% of the Nigerians living in urban areas (Farrell 2018). According to Adeloye and Rustum (2011), Nigeria's increasing urbanization has seen a growing proportion of ground surfaces concreted, obstructing the percolation of water, with inadequate drains to capture additional surface runoff.

Echendu (2020) opined that lax implementation of planning laws mean construction of projects on natural floodplains and stormwater paths are approved, which exacerbates flooding problems and impacts on sustainability. It is not uncommon for the unauthorized use of land, the alteration of approved construction plans in areas that obstruct drains & natural waterways, sub-standard construction of infrastructure like bridges which subsequently collapse during the rains (Oladokun and Proverbs, 2016). Echendu (2020) stated that people also capitalize on loopholes of ineffective development control and extend their buildings over drainage pathways, with insufficient drainage one of main causes of urban flooding in Nigeria.

Poor waste management is one of the principal anthropogenic factors contributing to and exacerbating the flooding problem in Nigeria (Ojo and Adejugbagbe 2017). Causal indiscriminate dumping of refuse in drainage channels and poor drainage conditions have been observed by Agbonkhese et al., (2013). The poor attitude of Nigerians to waste disposal has been widely discussed in various studies (Eneji et al. 2016; Ojo and Adejugbagbe 2017; Olukanni, Adebayo and Tenebe 2014; Sridhar and Ojediran 1983), as are blockages linked to the poor sanitation practices in highly populated urban areas (Echendu, 2020). Roadside dumping, canal dumping, and the dumping in rainwater channels is commonly practiced among a large proportion of the population, this causes blockage and results in flooding during the rainy season (Onwuemele 2012). Adebo and Ajewole (2012) observed that there is a rise in illegal dumping and proliferation of permanent piles of rubbish in commercial, industrial, and residential areas of Nigerian urban areas. Adebo and Ajewole (2012) recognise that there is a widespread lack of resources, technical and administrative capacity to properly implement sound mechanisms for waste management in Nigeria

Agricultural lands are also increasingly being converted to residential areas to accommodate housing needs and development is undertaken without proper controls and infrastructure in place, thus worsening the flooding problem (Dan-Jumbo, Metzger, and Clark 2018). Urban planning in Nigeria is poor and is compounded by numerous compliance problems; thus, poor planning is a primary cause of the flooding being experienced in Nigeria (Echendu, 2020). Nigeria's flooding is therefore inextricably linked to poor urban development practices (Omoboye and Festus 2014). Potschin (2009) asserted land use is an important determinant of the state of the environment. Regulation of building construction is a task that seems to overwhelm the relevant government authorities in Nigeria and other parts of the developing world. Land tenure in Nigeria is governed by the Land Use Act of 1978 under which all land in all states of the federation is vested in the Governor. Access to land is by way of a 'right of occupancy' granted by government. This development had led to controversies in acquisition, disposal, use and administration of land both in rural and urban areas. More disturbing is the implication of this form of ownership for land development, housing provision and access to decent living. Political interference in planning practices, understaffing and a lack of working equipment are factors that negatively impact effective planning and the execution of duties by planners (Nnaemeka-Okeke 2016; Oluwaseyi 2019). The lack of proper spatial planning, poor land use and the absence of good corporate governance characterizes urban development in Nigeria (Adedeji et al., 2012; Abaje et al., 2015; Dalil et al., 2015). Lax planning and lack of valid building approvals are root cause of irresponsible developments (Adeloye and Rustum, 2011).

## **2.5** Flood Risk Management: Institutional roles

The means of addressing flooding and its consequences in Nigeria remains a complex challenge and reflects a plethora of social, cultural and environmental components. Unlike some disasters, pluvial flooding can often be managed with proper planning and provision of the necessary infrastructure (Agbonkhese et al. 2014; Satterthwaite 2017)**.** This suggests that designing and implementing adequate FRM strategies comprising of proper spatial planning and infrastructure would help in controlling floods which adversely impact Nigeria’s sustainable development (Ouikotan et al. 2017). Historically, Nigeria has been focused on post-disaster flood response than the control (Cirella and Iyalomhe 2018). In 2017 alone, the Nigerian government released N1.6 billion ($2,018,329.16) as a post-flooding response (Adekola and Lamond 2018). Funds are readily released for post-flood recovery, but little is directed to flood prevention (Echendu, 2020). The absence of an active national Flood Risk Management (FRM) strategy or comprehensive flood risk maps are indicators of the lack of attention paid to Nigeria’s flooding problem (Oladokun and Proverbs 2016). A national framework, now in place, aims to move reactive flood response and recovery to pro-active risk management, however, little practical or strategic advancement has been achieved, a national FRM strategy to ensure harmonization of practice is still not in place (FGN, 2013; Okoye, 2019).

Lack of relevant legal and policy frameworks is another indication of the low importance given to controlling and managing flooding in Nigeria at all three levels of federal, state and local governments, with to date, little effort shown by government to resolve this problem (Cirella and Iyalomhe 2018; Okoye 2019). Inadequate attention has been paid to flood control and management, lacking coordination and to date have therefore failed (Okoye 2019). Despite evidence of flood interventions in the past, a lack of an integrated Flood Risk Management (FRM) practice means that sub-optimal solutions are adopted and in numerous cases, more problems are created in the process (Echendu, 2020) and despite a comprehensive post-disaster needs assessment conducted in 2012 by the federal government with international collaboration, a lack of political will continues to hinder the achievement of stated goals (Echendu, 2020). Therefore, urgent attention is still required to engage an active robust national Flood Risk Management (FRM) strategy and a comprehensive flood risk map, if Nigeria's flooding problems are to be effectively mitigated.

A shift from ideology of flood hazard prevention to flood risk mitigation is increasingly the critical component of FRM, and a vital tool for the formulation of flood risk mitigation policies at all scales (Sayers et al., 2013; Mees et al., 2016 & Muhammad et al., 2020). In Nigeria the impacts of flooding are poorly documented. To minimize impact, various levels of government, community and other stakeholders have been active with measures to tackle flooding (Olorunfemi, 2011). These measures have been criticized as ad-hoc, non-generalizable and not well established (Obeta, 2014). It is well known that success of flood risk reduction depends to a large extent on knowledge-based decisions, robust institutional framework, and flood risk communication (Raaijmakers et al., 2008; Ologunorisa & Adeyemo, 2005), these factors are missing in Nigeria and where they exist, they are poorly addressed Nkwunonwo et al., 2015).

### **2.5.1** Disaster Management in Nigeria

Institutional frameworks for addressing the threat of flooding in Nigeria date to the early 1960s with the establishment of federal and state ministries of works (Ibitoye, 2007). Institutional frameworks, refer to government response procedures which include policies, regulations, guidelines, and agencies engaged in planning and managing flood emergency condition or in helping victims to cope with and recover speedily from extreme flood events (Obeta, 2014). However, the increasing frequency and severity of floods across the country prompted the establishment of the Federal Environmental Protection Agency (FEPA), as a unit in the Federal Ministry of Works and Housing in 1998 (Obeta, 2009) and Federal Ministry of Environment (FME) in 1999 (FME, 2012). Adefioye (2015) argues that throughout the 1970s successive Nigerian governments made feeble efforts to address flood risk, however, in 1999, the establishment of the National Emergency Management Agency (NEMA) under Act 12 of 1999 as amended by Act 50 of 1999 to manage disaster in all forms and ramification (NEMA, 1999:1) the stage was set for the country to move away from response/relief-giving centric that characterized emergency management before this period, to a more proactive mitigation/preparedness-centric approach. With FME comes various ministries and agencies for tackling flooding in Nigeria: Federal Emergency Management Agency (FEMA), National Emergency Management Agency (NEMA), the State Emergency Management Agency (SEMA), Local Emergency Management Agency (LEMA), National Orientation Agency (NOA), National Commission of Refugees (NCR), National Environmental Standards and Regulation Enforcement Agency (NESREA) which by 2009 Nigerian Acts supersedes the FEPA, Nigerian Meteorological Agency (NIMET), Nigeria Hydrological Services Agency (NIHSA), NEST (Nigeria Environmental Study/Action Team) and Building Nigeria's Response to Climate Change (BNRCC).

However, to achieve the huge task set before it, The Federal Government of Nigeria, through NEMA, came up with the different strategies and programmes, and one of such was the National Disaster Management Framework (NDMF), a comprehensive Disaster Management document. NDMF was to serve as a foundation upon which all plans, policies, programmes, and procedures for DM can be created, developed, and sustained (NEMA, 2001: 1). Disaster management is the coordination & integration of all activities necessary to build, sustain, and improve capability to prepare for, protect against, respond to, and recover from threatening or actual natural or human-induced disasters (NDMF, 2010:2). The key role of the FME towards flooding risk reduction in Nigeria is to assess flood risk as well as design, determine, develop and/or authorize development of the appropriate flood reduction measures for the country (FME, 2012).

Institution capacity for disaster management (DM) under the auspices of the NDMF was designed to form the bedrock for the overall DM activities in Nigeria, the principle of shared responsibility and need to ensure proper integration and collaboration among stake holders (NDMF, 2001: 8). Other articles of the framework include:

- There shall be National Emergency Management Agency (NEMA) at the Federal level, State Emergency Management Agency (SEMA) at state level, and Local Emergency Management Agency (LEMA) at local government level. Designed to strengthen capacities of the Federal, State and Local Government levels to reduce the likelihood and severity of disasters.
- Every tier of government shall build the capacity of their agencies to prepare for, prevent against, response to and recover from disaster events.
- Federal, State and Local government, Departments and Agencies (MDAS), military, police, para-military and Civil Society Organizations (CSOs) shall develop their capacities in disaster management capabilities as first responders, Emergency Management Volunteers (EMVs) shall be established to compliment organized structures. Disaster Management Units (DRUs) shall be established in different military formations across the country to aid civil authority during emergencies.

The NEMA is basically a coordinating body for disaster management in Nigeria. Action towards addressing threats of flooding which the agency coordinates include, but are not limited to: policy formulation, leasing with, and assessing state of preparedness of all other relevant agencies, data collation from relevant agencies, education of general public on flooding and interaction with SEMA towards distribution of relief materials to disaster victims within states and local government (Nkwunonwo et al., 2015). Issues relating to flood insurance are coordinated by the Federal Ministry of Environment (FME) agency, which makes federally funded insurance protection available for property owners in Nigeria. Policies relating to flood victims at the state and local government levels are coordinated by SEMA and LEMA which are overseen by NEMA.

### **2.5.2** Challenges with Disaster Management in Nigeria

Lack of coordination, implementation and fulfilment of mandates among relevant agencies is an indication of the low importance given to controlling and managing flooding in Nigeria at all three levels of federal, state, and local governments, with to date, little effort shown by government to solve this problem. Integration and coordination are lacking among existing government bodies who undertake flood control projects (Oladokun and Proverbs 2016). Despite seeming organized, the nature of Nigeria's institutional approach to flood risk reduction remains flawed (Obeta, 2014; Agboola et al., 2012; Kolawole et al., 2011). As it has failed to improve the country's capacity to *live with* *floods* (Adelekan, 2010; Seto & Shepherd, 2009; Akintola & Ikwoyatum, 2012). The government does not lack research institutions and agencies with skills required to design an effective flood risk management strategy, for instance, National Emergency Management Agency (NEMA) has a department of planning utilizing Geographical Information System (GIS) to work on flood data, but there are still no effective national early warning system in place at federal, state, and local governments, while the National Meteorological Agency (NIMET) provides seasonal rainfall predictions (SRP), communication remains a problem (FGN. 2013).

Echendu (2020) identifies that FRM in Nigeria is mainly undertaken by state government, with inadequate federal input, but there is also a lack of coordination of practice among states with cities presenting similar environmental problems and characteristics. Some of the state-level FRM have been critiqued for being deficient, for example, FRM of Lagos state has been critiqued for lacking evaluation and early warning systems which makes it ineffective (Adelekan 2016; Ugonna Nkwunonwo, Whitworth, and Baily 2016). The lack of flood data has also been decried in the FRM plan of Oyo state (Egbinola, Olaniran, and Amanambu 2017). However, present low levels of inter-agency coordination coupled with the absence of system integration is a hindrance to such holistic approaches. Apart from the federal government, there are also 36 autonomous state governments in Nigeria, over 750 local authorities, hundreds of private organizations, companies, NGOs, the individual property owners implementing various FRM solutions without appropriate coordination and collaboration. Often these entities put in place FRM measures that are sub-optimal for their own immediate regions and may end up exacerbating damage or inducing worse floods downstream (Alayande et al., 2012)

Local government is unable to build the capacity because of poor funding (i.e., first responder) of LEMAs to prepare for, prevent, respond and recover from disaster events. There is an obvious absence of functional emergency management in most of the 36 states and 774 local councils.  Most states with SEMAs are yet to assume optimal operation, since they came into existence, after the extensive floods of 2012. The 774 LGAs have become dysfunctional primarily because of undemocratic tendencies of state governors that have largely failed to respect section 7 of the 1999 constitution, to ensure that democratic structures are institutionalized at grass root levels (Onwubiko, 2012:3). Both state and local government continue to approach NEMA for support following disasters (IIallah, 2012: 2). However, NEMA have been hampered by poor funding, for instance, in 2012, the budgetary allocation for the agencies was 1.46B naira, which was highest in 12 years (2000-2012) (FGN, Budget, 2012:11). This figure cuts across the length and breadth of capital, re-occurring, and the emergency response expeditions. At state and local levels, the situation is worse. According to Adefioye (2015) the general disposition of nonchalance, despondency, cynicism, mistrust, and despair by Nigerians towards the government establishments, and in particular, emergency situations is concerning.

## **2.6.** Past and current flood mitigation measures in Nigeria

The implementation of adaptation policies and pre-emptive coping practices to flooding at household, community and government levels is low. The incapacity of the municipality (first responder) to help alleviate flood risk means that communities have responded and attempted to adapt themselves to improve living conditions before, during and after flood occurrence. Approaches toward management of climate change impacts must consider reduction of human vulnerability with changing levels of risk (Olorunfemi, 2011). A key challenge and opportunity therefore lay in building bridges between current disaster risk management efforts aimed at reducing vulnerabilities to the extreme events and the efforts to promote climate change adaptation (Olorunfemi, 2008, Few et al. 2006)**.** Within the context of extreme weather events and especially flooding, management strategies must meet present needs while providing a path of adjustment for the future – sustainable adaptation (Pahl-Wosll, 2006; Ashley et al., 2007; Miller, 2007). Flood resilience approaches at household, community and government levels in Nigeria are similar and are summarised in Table 2.4.

### **2.6.1** Nigeria National Policy on the Environment

Nigerian environmental protection provisions are generally embedded in different pieces of legislation (pre- and post-independence from the British in 1960) and are not under one main legislation (Babsal and Co., 1998). The 1980s are the start of environmental consciousness in Nigeria, with the Federal Military Government which came to power between December 1983 to August 1985 vocal about environmental protection. The development of Nigerian environmental laws can be divided into two time-periods (Ijaiya and Joseph, 2014):

**Pre-1988 era**

The Pre-1988 environmental laws lacked adequate policies for coordinating environmental laws and making them effective (Ijaiya and Joseph, 2014). There were also no mechanisms for the collection and management of the environmental statistics, no waste transporters, companies' emission data and other anti-pollution tools (Ijaiya and Joseph, 2014). The major concern of the government was sanitation and not eradication of environmental pollution, desertification, deforestation, use of pesticides and the other core environmental problems (Ijaiya and Joseph, 2014). These enforcement deficiencies however prevented an effective enforcement of the environmental laws.

**The post 1988 era**

The Federal Military Government set the pace with massive environmental propaganda while State military Governors had to implement policy guidelines by translating propaganda into legal reality. The States thus lack the initiative to enact environmental laws (Ucheghu, 1988). Following Koko Port Toxic dumping incident in June 1988, Nigerians became more aware of need to protect their environment through laws and statutes, coordinated policies and central authority (Idowu, 2000). Thus, Federal Environmental Protection Agency of Nigeria (FEPA) was created by Decree 58 of December 30, 1988, with statutory responsibility for protection and development of the environment in general. The National Policy on the Environment passed into law by Federal Government of Nigeria (FGN, 1988) aims to achieve sustainable development in Nigeria, and to:

- secure a quality of environment adequate for good health and well-being.
- conserve and use the environment and natural resources for the benefit of present and future generations.
- restore, maintain, and enhance the ecosystems and ecological processes essential for functioning of biosphere to preserve biological diversity and the principle of optimum sustainable yield in the use of living natural resources and ecosystems.
- raise public awareness and promote understanding of essential linkages between environment, resources, and development, encourage individuals and community's participation in environmental improvement efforts.
- and co-operate with other countries, international organizations, and agencies to achieve optimal use of trans-boundary natural resources and effective prevention or abatement of transboundary environmental degradation.

**Table 2.4** Identification of flood mitigation measures

| No | Parameters | Coping strategies adopted |
|---|---|---|
| **1** | Coping strategies at household level Olorunfemi | Support from friends and relatives; Olorunfemi (2011); Adelakun, (2015)<br>Personal savings accounted for the way large proportion of the victim's cope with the immediate impacts of the disaster;<br>Borrowing from local money lenders;<br>Borrowing from banks;<br>Majorly is ensuring proper disposal of solid waste and cleaning of immediate environment;<br>Protect unaffected property and survivors;<br>Abandoned our dwellings and relocate to safer area of the city;<br>Flood proofing buildings by raising the wall/foundation of buildings;<br>Construction of wooden walkways;<br>Construction of drainage channels;<br>Evacuation of water out of building using water pumping machines;<br>Prayers;<br>Help ourselves/affected people; Seeking government attention and assistance;<br>Raise funds;<br>Replacement of damaged item;<br>Planting trees (Buttler, 2005). |
| **2** | Coping strategies at the community level | Constant clearance of the drainage channel (Douglas et al., 2008; Adelakun, 2015);<br>Using sand to raise the entire area to a higher level. Organised sand filling of roads;<br>Use of sandbags;<br>Building wooden bridges as walkways within the community;<br>Clearing drainages of solid waste and silt to allow free flow of storm water;<br>Levying of households within neighbourhoods for purpose of carrying out structural measures;<br>Use of canoes for movement is adopted because of severity of flooding experienced;<br>Request the assistance of the local or state government. |
| **3** | Coping strategies at government level | More focused on post-disaster flood response than control Cirella and Iyalomhe (2018);<br>Reactive flood response and recovery has been in operation from inception (Oladokun & Proverbs, 2016);<br>Main focus has been on the structural measures;<br>Over dependence on imported expertise and technologies; limited knowledge transfer to indigenous experts (Ugochukwu & Onyekwena, 2014);<br>Projects lack right mix of soft elements like advocacy, education, stakeholders' participation (Adewole et al., 2015; Agbola et al., 2012; Kolawole et al., 2011; Nkwunonwu et al., 2015). |

The Federal Republic of Nigeria (1988) in its national policies on the environment states:

*"In order to promote (environmental) goals and awareness objectives, actions will be keen to raise public awareness, promote understanding of the essential linkages between environment and development and to encourage individual and community efforts through:*

- *adopting community-based approach to public education and enlightenment through social groups, voluntary associations and occupational organizations;*
- *intensify use of mass and folk media at Federal, State and Local Government levels;*
- *encourage inclusions of environmental awareness and enlightenment studies in the educational curricular at all levels;*
- *campaign for a "safe environment" in conjunction with health for all";*
- *provision of information on the appropriate methods and technologies for the treatment and disposal of waste."*

It is pertinent to note that most of these environmental laws are written on paper but are yet to be implemented (Ijaiya and Joseph, 2014). The enforcement agencies, police, courts, state and local governments lack effective enforcement strategies for the implementation of the laws. This is further exacerbated as the agencies themselves are not financially viable to meet their obligations and perform their functions effectively.

Nigeria formulated its first national policy on the environment in 1991. It was revised in 1999, and last revised in 2016 to capture emerging environmental issues and concerns. Thus, the purpose of the *National Policy on the Environment* (2016) is to define a new holistic framework to guide the sustainable management of the environment and natural resources for the country. In addition to existing 1991 and 1999 draft policy documents, this policy derives its strength from the fundamental obligation for the protection of the environment as stated in section 20 of the Constitution of the Federal Republic of Nigeria (1999), which provides that the "State shall protect and improve the environment and safeguard the water, air and land, forest and wild life of Nigeria" (Constitution of Federal Republic of Nigeria, Chapter II; section 20). The strategic objective of National Policy on the Environment (Revised 2016) is to coordinate environmental protection and natural resources conservation for sustainable development (Food and Agriculture Organization of the United Nations, 2016).

This goal will be achieved by the following strategic objectives:

i. securing a quality of environment adequate for good health and wellbeing;
ii. promoting sustainable use of natural resources and the restoration and maintenance of the biological diversity of ecosystems;
iii. promoting an understanding of essential linkages between environment, social and economic development issues;
iv. encouraging individual and community participation in environmental improvement initiatives;
v. raising public awareness and engendering a national culture of environmental preservation; and
vi. building partnership among all stakeholders, including government at all levels, international institutions and governments, non-governmental agencies and communities on environmental matters

Good urban governance needs to be transparent, inclusive, collective and efficient to reduce existing disaster risks and avoid creating new ones.

> *"The Nigerian national policy on environment has been ineffective in achieving a sustainable economic growth and development because it was not based on certain fundamental principles which could lead to sustainable development of Nigeria. More importantly, this policy has been frustrated due to implementation gap issue arising from lack of the community participation in the drafting and implementation of policy guidelines and failure to take into cognizance cultural diversity and circumstances in which the document is to operate. We, therefore, recommend that government should decentralise environmental responsibilities and create a timeline for policy implementation in order to achieve a sustainable national policy on environment and to preserve our biodiversity." (Akamabe & Kpae, 2017)*

## **2.7** Flood risk moving forward in a changing climate

Several climate change projection and impact studies in Nigeria have identified significant impacts on livelihoods and the broader economy, whilst the rising temperatures, extreme heat, and changing precipitation patterns will induce new challenges and exacerbate existing ones (Abraham & Fonta, 2018; Akande, et al., 2017; Amanchukwu, et al., 2015; Anabaraonye, et al., 2019; BNRCC, 2011; Ebele & Emodi, 2016; Edema et al., 2021; Elum & Mamodui, 2017; Enete, 2014; Federal Government of Nigeri, 2013, 2014; Haider, 2019; Jibrilla, et al ., 2018; Madu, 2012, 2016; Matemilola, 2019; NEST, 2011; Ogbuabor & Egwuchukwu, 2017; Olaniyi, et al., 2019; Onwutuebe, 2019; Osuafor & Nnorom, 2014; Sayne, 2011; Solomon & Edet, 2018; World Bank Group, 2012). According to the WMO (2019), climate in Africa was characterized by continued warming temperatures, rising sea levels and increasing impacts associated with the extreme weather. It constitutes a snapshot within a continuum of rapidly rising longer-term climate-related risks associated with global warming. The WMO (2019) asserted that temperature and precipitation are two key indicators that characterizes that affect the living conditions in African societies, inexorably linked to agriculture, food security and water resources. The WMO (2019) report determines that urgent efforts are required to pursue enhance resilience through appropriate prevention and risk management strategies, with Africa considered a 'hot spot' for climate variability and change impacts. African temperatures in recent decades have been warming at a rate comparable to that of most the other continents, and thus somewhat faster than global mean surface temperature (UN, 2020), with several studies identifying increased rates of night-time warming (Ageena et al., 2014).

Nigeria's climate has been changing, with increases in temperature (Akande et al., 2017; Amanchukwu et al., 2015; BNRCC, 2011; Enete, 2014, 234; Federal Ministry of Environment, 2014; Oladipo, 2010); variable rainfall (Haider, 2019; Oladipo, 2010, 7); sea level rises and coastal flooding (Akande et al., 2017; Ebele and Emodi, 2016; Federal Ministry of Environment, 2014, 31; Olapido, 2010, 38); drought and desertification (Amanchukwu et al., 2015; Haider, 2019; Olapido, 2010); land degradation; more frequent extreme weather events (Akande et al., 2017; Amanchukwu et al., 2015); affected freshwater resources and loss of biodiversity (Elisha et al., 2017; Ebele and Emodi, 2016; Olaniyi et al., 2013). The duration and intensities of rainfall events have increased in the last three decades, producing increased runoff and flooding (Enete, 2014), with rainfall extremes projected to increase (Haider, 2019). Droughts have also become more frequent in Northern Nigeria, arising from a decline in precipitation and rise in temperature (Amanchukwu et al., 2015; Olapido, 2010). Many sectors of the country's socio-economy are vulnerable to climate change. Further, extreme weather events have become a yearly occurrence, for which people have not learned to prepare (Enete, 2014; BNRCC, 2011). Nigeria has also experienced an increase in climate extremes in the recent years (Akande et al., 2017; Amanchukwu et al., 2015). Floods are the most common, recurring disaster in the country (Federal Government of Nigeria, 2013, xix).

Most studies indicate that climate will continue to change with far reaching implications on environment and human livelihood (Olorunfemi, 2010). However, it is important to note that the spatial and temporal distributions of these changes may result in increased flooding or droughts, or both. Climate change – and likely increase in disasters – threatens to block pathways out of poverty in developing countries, especially those in Africa (Lemons and Tompkins, 2008). According to ISDR (2008), any increase in disasters, whether large or small, will threaten development gains and hinder implementation of the Millennium Development Goals.

There is a pressing need to improve the dissemination, access and public awareness and understanding of the impacts of climate change. This includes access to information regarding historical climate, future climate change projections, potential impacts, causes of vulnerability, technologies and measures for managing climate risks and implementing new technologies (BNRCC, 2011).

In the coming decades, climate change is expected to exacerbate the risk of disasters, not only from more frequent and intense hazard events, but also through greater vulnerability to existing hazards (ISDR/UN, 2008, p. 2). Cities in developing countries are particularly vulnerable to climate change impacts, especially changes in rainfall (Vogel 2000), because of exposure to extreme weather events and dependence on natural resources (Vogel, 2002). According to Satterthwaite et al. (2007), the scale of the devastation to urban populations and economies caused by extreme weather events in recent years highlights their vulnerabilities. Henderson (2004) revealed that level of risk and vulnerability in urban areas of developing countries is attributable to the socio-economic stress, aging and the inadequate physical infrastructure. Approaches toward management of climate change impacts must consider the reduction of human vulnerability under the changing levels of risk.

### **2.7.1** Education, climate change and disaster risk

The poor perception of flooding among local communities is a major issue which underscores the current activities of National Orientation Agency (NOA) within the Nigerian institutional framework (Ologunorisa and Adeyemo, 2005; Ajibade et al., 2013). The importance of local communities being aware of flooding and actively participating in discussions and decisions which might increase their resilience and adaptability to hazard are highlighted in the roles of NOA, which re-orientates and keeps Nigerians informed about the ways of taking part in issues that affects them (Nkwunonwo et al., 2015). The level of public awareness on issues related to climate change in Nigeria is low (BNRCC, 2011). Adaptive capacity is the ability of individuals and communities to adjust to climate change, to moderate potential changes, to take advantage of opportunities or to cope with the consequences (BNRCC, 2011, xiii). It depends on the sufficient education, assets, information and income (Madu, 2016). Information and knowledge sharing must be made accessible to a wide range of the people, particularly those most vulnerable (Anabaraonye et al., 2019; BNRCC, 2011). Hence, there exists a need to channel flood-risk awareness and preparedness through both formal and informal education to strengthening community-based adaptation (CBA) (Ajaero and Anorue, 2018; Amadi and Udo, 2015; Amanchukwu et al., 2015; Anabaraonye et al., 2019; Ayanlade et al., 2017; BNRCC, 2011; Duru and Emetumah, 2016; Haider, 2019; Huq, 2011; IPCC, 2014; Nkechi et al., 2016; Nzeadibe et al., 2011; Otitoju and Enete, 2016; Ozor et al., 2012, 243; Patwardhan et al., 2009; Reid et al., 2009, p. 13; Reid et al., 2015; Warrik, 2011; WeAdapt, 2017). Studies indicate that the Nigerian media has given insufficient attention to climate change issues (Ajaero and Anorue, 2018). Nigerian children and youth are not yet educated on these issues and thus do not have sufficient knowledge on how to deal with situations caused by climate change (Duru and Emetumah, 2016; Amanchukwu et al., 2015). The efforts of the government and different agencies in Nigeria to educate the populace have been inadequate (Ifeanyi-obi and Nnadi, 2014).

### **2.7.2** Effective and focused communication

NEMA's failure to pay specific attention to localised contexts, including how inhabitants earn their livelihoods and prevailing high illiteracy levels, contribute to ineffectiveness of the mass media in conveying flood alerts (Ebhuoma and Leonard, 2021). Despite the advantage of achieving wide coverage within a short timeframe and being cost effective, a major limitation of mass media is the disparity between broadcasting and end-users need for the knowledge. Effective communication requires weather/hazard warnings to be presented in respective indigenous languages, failure to do so can impede understanding of the messages content (Ebhuoma and Leonard, 2021). A crucial reason why use of mass media was unsuccessful in communicating the 2012 flood warnings was the inability to provide vulnerable communities with downscaled forecasts. While weather forecasts are often broadcast through the radio, it is not produced for specific communities. NIMET generates weather forecasts specifically for the major cities in Nigeria, unless a state government requests NIMET's assistance to generate a forecast for a specific rural agrarian community. The need for NIMET to produce weather information and more robust and reliable forecasts at different spatial scales is recognised (Federal Ministry of Environment, 2014). The NiMet Director General regretted that most states and local government areas are not captured in the weather prediction system, so that weather changes in those areas could be monitored (THISDAY Newspaper 23rd September, 2022).

## **2.8** Summary

A key repeating point from case studies is that rainfall and river flow on the African continent show high levels of variability across a range of spatial and temporal scales. This poses several complex challenges for management of floods in unplanned urban tropical African communities. Flood events in tropical-African are closely linked to the hydro-meteorological conditions and changes in rainfall patterns. Urban settlements in African cities are commonly ravaged by the flash, fluvial, coastal and pluvial flooding, exacerbated by diverse anthropogenic factors. Overall flood risks are high due to high levels of exposure and as a function of their low adaptive capacity. Within urban tropical-Africa communities flooding is often human induced, a result of poor urban planning practices and insufficient physical infrastructure. Political stagnation and/or interference in planning is negatively impacting effective planning and capacity for effective execution of duties by planners. The main indicators and contributors to flood risk are poverty, social inequality and marginalisation, poor risk perception and understanding, poor risk communication, lack of understanding of current and future risks and implications at the city scale, lack of long-term planning, poorly integrated and comprehensive planning, weak institutional frameworks, absence of comprehensive flood risk maps, lack of flood data, ineffective legal and policy frameworks, poor policy implementation, lack of integrated flood risk management practice, lack of political will and coordination among states, poor funding, endemic corruption, weak municipality capacity, and poor implementation and enforcement of environmental law. Attempted to ameliorate flood impacts are complicated by complex interlinked political, socio-economic and environmental changes.

Coping strategies employed by the vulnerable inhabitants across African cities, including those in Nigeria to pluvial flooding are often focused on household and local community actions (Table 2.4). Approaches reliant on structural flood control measures such as drainage systems and other flood defences are generally found to be unsustainable outside major cities.

# CHAPTER 3

# RESEARCH METHODOLOGY AND DESIGN

This chapter examines the methods and procedures employed to enable the research within this project. The focus of this research is to have an in-depth understanding of challenges and potential solutions to pluvial flood risk in urban tropical African communities. This will be achieved through the use of Ijebu-Ode, in South West Nigeria as a case study.

## **3.1** Introduction

This chapter describes the methods and procedures for conducting this research, which adopted a mixed methods design using both qualitative and quantitative research methods. A combination of the two approaches were considered most appropriate for this study because it provided a wide information base and enabled data collection aligned with the objectives, with instrumental records (i.e., Rainfall and Temperature), non-instrumental records (Newspaper and National news), questionnaires and interviews being the main form of data collection. The thesis aims and objectives (section 1.5) were realised through the use of Ijebu-Ode in South west Nigeria as a case study. The roles of policy makers and implementers in flood management were explored. This chapter is subdivided into the following components:

(1) Guiding concept of the study;
(2) Interdisciplinary approaches to flood risk management;
(2) Mixed method approach;
(4) Data analysis for the instrumental records;
(5) Questionnaires and interviews;
(6) Question design
(7) Interview design
(8) Data analyses; and,
(7) Historical hydrology and archives

The research was undertaken as a mixed methods study, so each method is descried in subsequent sections. Mixed method approaches are well-suited to interdisciplinary research that seeks to assess both 'what' and how' questions. This research adopted the complementary approach of employs rigorous quantitative research method (Nnadi et al., 2019) to assess the magnitude of the problem and undertake rigorous qualitative research to explore meaning and understanding of the context (Kaur, 2016). The purpose of using the mixed methods research, of combining qualitative and quantitative research components, was to expand and strengthen a study with heightened knowledge and validity (Schoonenboom and Johnson, 2017).

Both qualitative and quantitative research in this study enabled in-depth insights. The type of information required, and the techniques used for obtaining information are dictated by the objectives of the study and accessibility to existing data. The climatic data were collected and analysed; conducting a survey was crucial to understand flood risk perception levels - appropriate survey methods was considered - questionnaires (i.e., street survey method) and interviews (personal structure interview method).

## **3.2** Guiding Concepts of the study

The conceptual framework that is considered most appropriate and applied to guide this research encompasses the Disaster Risk Reduction (i.e., DRR) (see Section 1.9), Meteorology (see Section 1.7), Environmental Precarity (see Section 1.10 and 2.2), Climate Change Adaptation (see Section 1.8), and Education Theory (see Section 1.6). At a global level, flood management has evolved from flood control approaches to flood risk management (Quikotan et al., 2017). As mentioned earlier (section 1.9), flood risk management encompasses assessment of risk of flooding from all flood mechanisms, identification of flood mitigation measures and improving the capability of a community or region to cope with floods (Figures 1.9-1.11), and aims to implement measures for risk and vulnerability reduction (De Bruijn, 2005; Sayers et al., 2013, p 3 & 4). This study explores potential sources of flooding, adverse effects and socio-cultural, economic and environmental losses caused by flooding by considering four main indicators, namely hazard, exposure, vulnerability and community resilience. The conceptual framework is a rationale for choice of indicators and the way in which they are connected. The logic in this integrated flood risk management framework (Figure 3.1) suggests that once we are successful in fostering community resilience, we will greatly reduce the flood risk(s).

Reducing risk is undertaken in terms of creating awareness for behaviour change, but also through the creation of new knowledge - awareness-raising is a process that seeks to inform and educate people about a topic or issue with the intention of influencing their attitudes, behaviours and beliefs towards the achievement of a defined purpose or goal (Sayers, 2000. p. 11-12), and can mobilize the power of public opinion in support of an issue and thereby influence the political will of decision makers (UNDP and DCAF, 2008. P 74). A change in behaviour could be, or result in, changes in political commitment for reduction in precarity and vulnerability (Dwek, 2007; Dike, 2015; Neblier, 2020; Senge, 2006), or changes in individual or community behaviour in relation to flood risk (Aerts et al., 2018; Priest, 2021; Tonn et al., 2019). For example, the challenges facing Nigeria in terms of their leaders mind-sets have been investigated and its impact on decision making (Acemoglu & Robinson, 2012; Scharmer & Kaufer, 2013; Senge, 2006 and Dike, 2015).

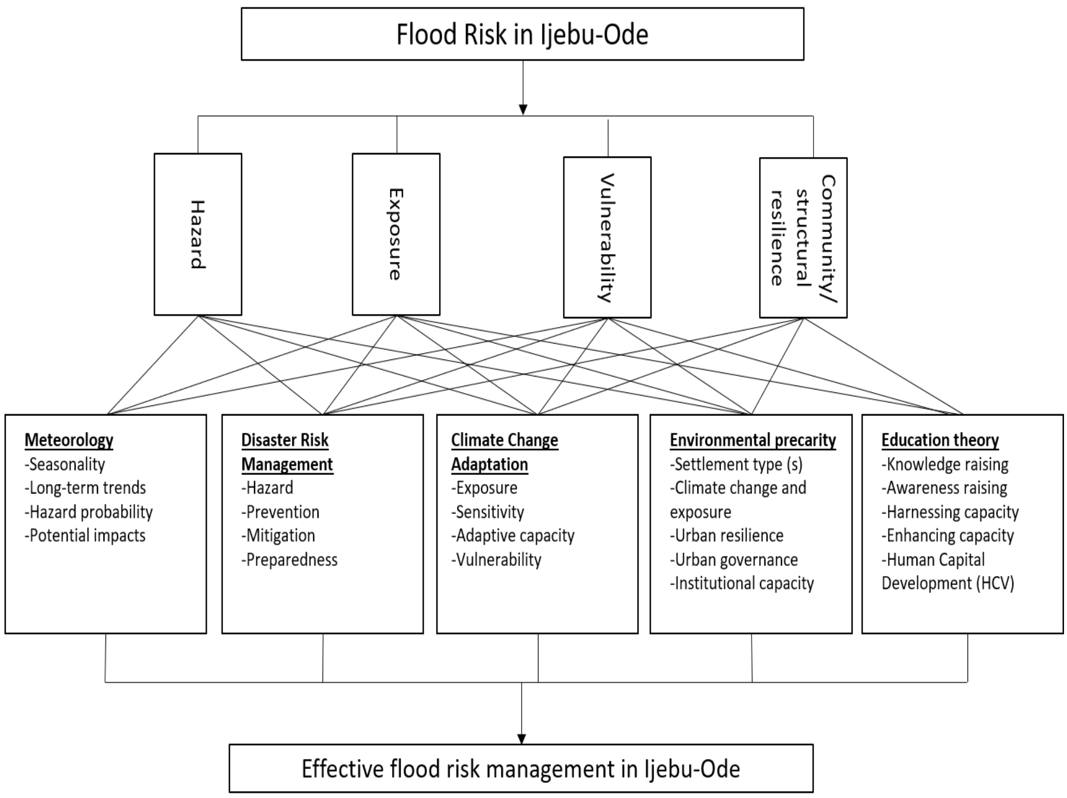


**Figure 3.1:** Integrated guiding concepts for this research

**Table 3.1**: Research objectives and data collection methods for a study of pluvial flood risk in mixed formal-informal settlements

| Research objectives | Data sources (samples) | Methods | Example of questions |
|---|---|---|---|
| 1. To review and identify the past, present and future urban flood risk challenges in tropical Africa. | -Peer review journal articles and professional journals;<br>-Statistical government data;<br>-Professional association materials;<br>-Newspaper publications | Literature review | -What is the scale of flood risks challenges across African countries?<br>-What are common concerns, similarities and differences in flood management practice across African countries? |
| 2. To assess whether changes in climate are responsible for a shift in climate risk, by assessing rainfall and temperature trends and associated changing flood incidence, through analysis of the flood history/events (using instrumental and non-instrumental sources) in the city of Ijebu-Ode. | -Nigerian Meteorological Agency, Ijebu-Ode Station<br>-Daily newspapers (Flood chronology: 1933-2019) and National News | Data was purchased from Nigeria Meteorological Agency, Ijebu-Ode station (NIMET) and collected through national portal | Are there significant trends/patterns in extreme rainfall, frequency of extreme events, or a pattern of increased daily maximum precipitation over the study period?<br>Is there decadal variability over the study period?<br>Do minimum and maximum temperatures change? |
| 3. To determine how anthropogenic factors exacerbate flood risk, such as waste management, drainage channels and urbanization. | Residents of study areas and community leaders. | Questionnaire and personal structured interviews. | **See** Appendix B & C. |
| 4. To identify how communities and individuals continue to live with the devastating impacts of floods and assess how different types of flooding impact communities in Ijebu-Ode. | Residents of study areas and community leaders. | Questionnaires and personal structured interviews | **See** Appendix B & C. |
| 5. To evaluate the potential of environmental education in school curricula and approaches for raising effective community awareness of flood risk and preparedness as a long-term risk mitigation tool. | Educators and targeted high-profile interviews. | Questionnaires and personal structured interviews | **See** Appendix D & E |

## 3.3 Interdisciplinary approaches to flood risk management

Interdisciplinary approach is explored in this study because perennial flooding in Ijebu-Ode is addressed from viewpoint of risk perspective incorporating hazard, exposure and vulnerability. Hence, substantively understanding the influence that floods have on Ijebu-Ode communities and proffering potential solution requires an interdisciplinary approach which demonstrated the value of:

(i) engaging with meteorological and hydrological and social factors;
(ii) engaging with the local community to understand their concerns, aspirations and adaptation ideas;
(iii) exploring measures that will help in the implementation of the adaptation measures while responding to formal-informal settlements; and,
(iv) exploring measures that will prompt high level of flood risk communication, coordination and integration among various agencies, and formulation of policies needed to improve flood resilience, overall, flood risk management (FRM).

The issues of FRM do not fit neatly into a disciplinary boundary and an interdisciplinary approach is particularly suitable (Lawson et al., 2014). The increasing trends in global flood risk are driven by a complex web of interactions among natural, built environment and social systems (Tate et al., 2018), solutions to reduce flood risk and improve community resilience therefore depend upon contributions from natural and social scientists. Tate et al. (2018) opined that physical science contributes to understanding the role of the meteorological, hydrogeological, and ecological processes, with engineering knowledge essential to describe overland flow, built environment, and flood extents and timing whilst the social science research helps explain the influence of social, economic, psychological, and political factors that may increase or reduce flood risk. Holistic, interdisciplinary approaches are increasingly endorsed as the most effective way to provide sound science and tackle the environmental and societal problem of flooding, while avoiding partial framing of the FRM debate (Lowe & Phillipson, 2006). Interdisciplinary research may also be more responsive to public needs and concerns and a valid means of generating science policy (Lowe & Phillipson, 2006).

## 3.4 Mixed Methods Approach

As noted previously, a mixed methods approach was best suited to answering the research questions. Use of both qualitative and quantitative research in this study enabled in-depth insights and improved understanding of challenges and potential solutions to pluvial flood risk in the urban tropical-African communities. Although not universally accepted, a dual approach in research is gaining increased acceptance in social and physical sciences (Tashakkori and Teddlie, 2010) because it helps offset weaknesses exhibited by each individual approach (Creswell and Clark, 2007; Newman, 2008). The data collected in qualitative research are usually in narrative rather than the numerical form, such as the transcript of an unstructured, in-depth interview (Marja and Ann, 1997). Analysis of qualitative data organizes, summarizes, and interprets these non-numerical observations. The goal of qualitative research is development of concepts that help clarify phenomena in natural, rather than the experimental, settings, giving due emphasis to meanings, experiences, and views of all the participants being studied (Marja and Ann, 1997). Quantitative research is usually deductive, relying on experimental and survey methods to test the specific hypotheses based on general principles (Marja and Ann, 1997), it is strong in inductive reasoning, building, and expanding theories concerning relationships among phenomena. In actual practice of the scientific research, theory and research interact through a never-ending cycle of deduction, induction, deduction, induction and so forth (Babbie, 1992).

Quantitative research generates reliable outcome data that are can be generalizable to some larger populations, whilst qualitative research produces rich, detailed, and valid insights on participant's, rather than the investigator's, perspectives and interpretations (Steckler et al., 1992). Both quantitative and qualitative research have weaknesses that to some degrees are compensated for by the strengths of the other. Quantitative research is well suited to establishing cause-and-effect relationships, to testing hypotheses and to determining the opinions, attitudes, and practices of a large population, whereas qualitative research lends itself to developing hypotheses and theories and to describing processes such as the decision making or communication processes (Marja and Ann, 1997). Marja and Ann (1997) opined that the nature of inquiry is similar in both quantitative and qualitative research, it is couched in the human desire to understand and explain behaviour and events, their components, antecedents, corollaries and consequences. If differences among researchers exist, it is not because they aspire to different ends, but because they have operationalized their methods for reaching those ends differently (Dzure and Abraham, 1993). Even though both approaches are different from one another, one is not necessarily inferior to the other.

Planning and implementing the two approaches simultaneously require more time and resources than implementing either of the two methods individually (quantitative or qualitative), (Horch, 2009; Curtis and Watson, 2014). In addition, the dual approach requires a variety of expertise, often making it difficult for an individual researcher to execute (Gerrish and Lacey, 2010). Whilst Tashakkori and Teddlie (2010) argue that may present difficulties in drawing generalisable conclusions from collected data exist, this can be offset when quantitative research is used in combination, as the latter enables researchers to draw more generalised conclusions. Several authors (Terry, 2011; Ary et al., 2013; Glenwick, 2016) have argued that a limitation of quantitative research is that it ignores or underrepresents local contextual issues, however, this can be avoided by using a dual approach which incorporates qualitative data, which is better suited to explore some of these more specific local/regional contextual issues.

The type of information required, and the techniques used for obtaining information are dictated by the objectives of the study and accessibility to existing data. The climatic data (instrumental records) were collected from the Nigeria Meteorological Agency, Ijebu-Ode station through the national portal. To date, there are no public or official data (non-instrumental) or records (official documents) exist detailing flooding in Ijebu-Ode. A wide survey was conducted to gain an in-depth insight into past flood occurrence in the study area, following an investigation of past documentary accounts (e.g., newspapers and news reports) of flooding. Conducting a survey was crucial because it offers the opportunity to gather vital empirical data on flooding issues confronting Ijebu-Ode residents, and types of flood risk management approaches that might be utilised by residents and relevant authorities. Once it had been established that there were no pre-existing data sources on flooding in Ijebu-Ode, the use of the appropriate survey methods was considered - questionnaires and interviews. Previous research has suggested that surveys can be presented in many formats, such as the personal interviews, mail questionnaires, group interviews and telephone surveys (Kothari, 2004).

Qualitative data was gained via interviews with selected community leaders and environment workers at the local government level, additional interviews were held with lecturers in teaching education institutions and relevant state government Agencies for the purpose of identifying key policy formulation gaps and to examine the principal causes of perennial pluvial flooding, vulnerability, coping strategies engaged at household, community and local government levels and best approaches to mitigate future flood disaster risks. Before commencing the research study, an application was made to/and approval was granted by the Research Ethics Committee at the University of Liverpool (see Appendix A). The primary data collection was focussed around:

- Daily newspapers (Flood chronology: 1933-2019);
- Community & official reports from relevant government institutions (NIMET, NEMA, FME etc.);
- Particular surveys and questionnaires;
- Interviews;
- Personal structured interview was used to examine perception of participants understanding of the flood risk and to explore community interaction with existing flood relief and drainage channels.

Rainfall and air temperature (maximum and minimum) data - 30-year study period (1989-2018) was collected from (NIMET) Ijebu-Ode station through the national portal.

## **3.5** Data analysis for the instrumental records

In order to examine the impacts of climate variability and change (CVC) on the rainfall, meteorological data for the recent 30-year period was used, as defined by WMO (WMO, 2017). To examine the seasonal variability and changes in rainfall (CVC), this study used monthly rainfall and it was sufficient to explain the seasonal variation in rainfall in the LGA, this helps overcome issues of data gaps at the daily level. Meteorological data were analysed using trend and time series analysis to explore the seasonal and annual variability and change. Time series analysis of monthly and annual rainfall values were used to illustrate the trend of rainfall and in estimating seasonal variation (Ekwe et al., 2014). Trend analysis included computation of annual rainfall trends and annual rainfall anomaly (ARA). Anomaly here is the deviation of a mean annual or seasonal rainfall and temperature from a long-term mean (Juma, 2015). Regression analysis was performed to ascertain the effect of changing climate time (years) on rainfall variations.

### **3.5.1** Descriptive statistics

In respect of objectives outlined (see Section 1.4), a number of statistical approaches are used for data analysis to investigate the temporal changes in rainfall, temperature and potential evapotranspiration. Descriptive statistics are selected to provide concise information and to facilitate the analysis. Descriptive statistics are used to describe basic features of climatic data, they may be a pre-cursor to future research because it can be helpful in identifying variables that can be tested. Data collection allows for the gathering of in-depth information that may be either quantitative (surveys) or qualitative (observations or case studies) in the nature (David, 2005).

#### ***3.5.1.1*** *Box and whisker's plot*

Box plot is one way of graphically focusing, conveying and illustrating statistical information on location and datasets variability (Tukey, 1977). It offers a graphical summary of the climatic dataset characteristics, including central tendency, dispersion, asymmetry and extremes, arrived at through percentile rank analysis and plotting of maximum and minimum data values. Banacos (2011) opined that since the box and whisker plots display measures of central tendency and spread free from assumption of a normal distribution, it provides an effective way of identifying asymmetrical attributes in meteorological datasets. Standard Deviation is a measure of dispersion, but it uses the 'mean' rather than 'median' as its standard from which the average variation (or 'deviation') of all other values is measured. The larger the standard deviation, the greater the variability of observations in sample is (Nunnally & Bernstein, 1994). The standard deviation is vulnerable to outliers. Coefficient of variation (CV) determines the percent of the results that are equal to the mean of the data. It shows the extent of variability in relation to mean of dataset and forms a statistical measure of the dispersion of data points around the mean. The range of parameters presented within the box and whisker plot are demonstrated in Figure 3.2. According to (Banacos, 2011), box plot is a standardized way of displaying the distribution of data based on the five-number summary: minimum, first quartile, median, third quartile, and maximum. The median. Median is the middle data observation in a ranked of any dataset and as a measure for central tendency of the data and the same as the 50th percentile of a data.

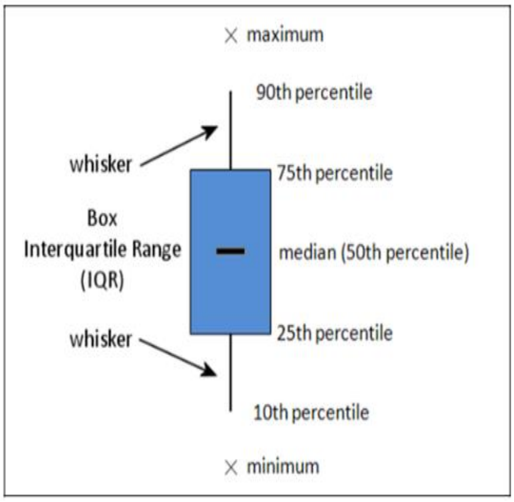


**Figure 3.2:** Example of box-plot when interpreted (Wang, 2013)

The advantage of the box-plot method is that it is able to compare multiple datasets side-by-side, as idealized (see Figure 3.3). Important characteristics of each dataset (i.e., central tendency, skewness, dispersion, and extremes) are very easy to interpret and visualize (Song, 2016).

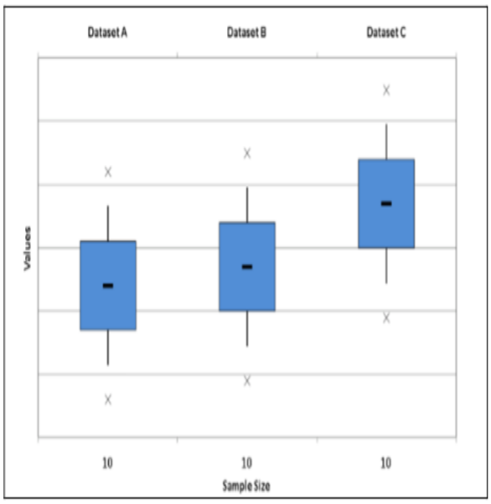


**Figure 3.3:** Example of dataset compared side-by-side (Wang, 2013)

Studies have shown that, if data is skewed, IQR is a more appropriate measure of variability than the standard deviation and coefficient of variation. In measuring the rainfall variability through the dataset in a more appropriate measure, the interquartile range (IQR) is employed (Bhandari, 2020; Frost, 2018; Samuels & Gilchrist, 2014; Whaley, 2015). Statistically, the IQR is calculated to be Q3-Q1, (the distance covering the middle 50% of the data). The larger the IQR, the more variable the data set is.

#### ***3.5.1.2*** *Rainfall seasonality index*

The first attempts to quantify rainfall regimes were made by Ayoade (1970), Markham (1970) and Nieuwolt (1974). The study of rainfall seasonality in Ijebu-Ode city using an individual seasonality index is a numerical value used to evaluate seasonal trends, inter-annual rainfall variability and the statistical significance of the findings. Walsh & Lawler (1981) observed that rainfall seasonality is a complex concept, that incorporates a number of independent components, they indicate that it assesses seasonal contrasts in rainfall amount, and not dryness or wetness in the absolute sense.

The correlation of seasonality index (SI) (the sum of the absolute deviation of mean monthly rainfall from the overall monthly mean divided by the mean annual rainfall) was initially determined, is another means of characterizing fluctuations in rainfall by showing different rainfall regimes (Walsh and Lawer, 1981, Adenodi, 2018). The SI, proposed by Walsh and Lawler (1981) were applied to quantify the annual rainfall regime, the index varies from zero (when all months share same amount of rainfall), to 1.83 (when all rainfall incidences occur in a single month). Depending on the distribution of rainfall throughout the year, an area's climate might be described as relatively seasonal with a short dry season or marked seasonal with a protracted dry season. (Patil, 2015).

Overall, the rainfall seasonality index helps to evaluate rainfall seasonal trends, inter-annual rainfall variability and irregularities, contrast in rainfall, confirm rainfall regimes, spot shifts, characterize rainfall fluctuation, instability and gives great insight to the problems that may arise. Many researchers are interested in water resource planning and management, hydrological modelling, flood frequency analysis, flood hazard mapping, agricultural planning, climate change impacts, water resource assessments, and other environmental assessments through seasonality index analysis, according to Hasanain (2017) and Sadiq (2020).

## **3.6** Questionnaires and interviews

The study selected communities prone to, and experiences of, perennial flooding within Ijebu-Ode city. The survey data were collected through a household and organizational/parastatal questionnaire survey, personal interviews, policy-maker interviews that focused on inhabitant's perceptions on the causes and impacts of flooding and their coping strategies during and after extreme weather events. Participants for the household street survey and parastatal survey were randomly selected, whilst community leaders and policy-makers were formally contacted for personal interviews. The first segment of the household survey and community leaders' interview was conducted in the months of April and July of 2020, whilst the second segment of the teacher education lecturers survey and policy-maker interviews were conducted in June and August, 2021. All respondents were 18+ years old. The current study complies with the University of Liverpool ethics with informed consent obtained.

### **3.6.1** Street survey (paper based)

Questionnaires (paper copy) were randomly distributed to draw facts from voluntary participants who are resident the in ten (10) flood prone areas/zones i.e., (Yidi/paramount/Sakasiru, Folagbade/Nepa, Irewon, Ibadan Road/Bonojo, Molipa Express, Ibgeba, Molipa Road/Degun, Adefisan, Abeokuta Road/New Road, Sabo) of Ijebu-Ode city by the researcher. The adults living within local residential areas received questionnaires (i.e., all participants involved are also non-vulnerable 18 years and above). A street survey was selected as most appropriate in this instance as there is no formal postal system, with many homes/streets lacking clear addresses, as such postal surveys would be poorly suited to working within the formal/informal settlements (Allo, 2010; Frhd and Iwnoha, 2012; Nigeria Postal Service, 2001; Orolugbabge, 2011; Universal Datadase, 2021). Street surveys also overcame concerns of language and literacy, as sections or greater explanation could be offered (Adelore and Majaro-Majesty, 2008; UNESCO, 2003), if necessary, with several languages commonly spoken within the communities of Ijebu-Ode (Danladi, 2013 and Ofulue, 2011). The field observation was used to improve validity of information obtained from instrumental records. Respondents' perceptions were analysed and compared with findings from meteorological data on seasonal and annual rainfall and length of the rainy season days.

The survey attempts to capture and engage with the local community, identifying levels of awareness and understanding. Community participation has – at least in principle – been for over 30 years at the core of any development policy and emergency intervention involving people, based on the assumption that a “top-down” approach is not adequate for its implementation, both development policy and emergency intervention need to be driven by grassroots or “bottom-up” approach (WMO, 2017). According to WMO (2017) people and communities are no longer seen as recipients; rather, they have become critical stakeholders who have a major role to play in management of community flood management programmes. The community-based flood mitigation approach is found to be crucial and important because it considers people’s perception of how to solve the problem and therefore ensure success (Fordham, 1998). Public opinion can be defined as the complex collection of opinion of many different people and the sum of their views. This is important because it identifies information required to address organizational or service issues. In research conducted by Morgan (1997) on public perception, understanding and values, the findings show that what the public knows, and it thinks, can have important implications for design and success of various systems and activities. Public perceptions are important in modifying public policy or public behaviour and if ignored result in failure of technically good innovation (Morgan, 1997). Public participation has become an increasingly important aspect of natural resources management and environmental action, that would not exist without the help of dedicated volunteers (Ryan et al., 2001). Most importantly, understanding individual and community vulnerability is key for successful flood management, as altering the vulnerability of an exposed population is most likely to reduce the effects of hazardous events (Bankoff, 2001).

### **3.6.2** Community leader interviews

The information captured here develops and expands hopefully on that collected within the surveys, it also allows elements raised within the surveys to be explored more fully with local community leaders. Interviews were undertaken during the daylight hours with a total of eight (8) local community leaders and a participant who hold a public role (i.e., Local Government Authority in Ijebu-Ode) were interviewed. These focused on capturing local political and governmental responses/actions to local flood risk across the city. In undertaking semi structured interviews, a more detailed exploration of the current challenges and achievements of local flood management can be explored (Amujo and

Otubanjo, 2012; Keeffe et al., 2015; Nwakasi et al., 2021; Oyinlola, 2020). The leaders interviewed all represent local communities and are selected by the landlord association (non-elected representatives, but recognised by local government authority's) and are required to be long-term neighbourhood residents (Abdul-Rahman and Adebajo, 2019; Famakinwa et al., 2019; Ozor and Nwankwo, 2008; Udensi et al., 2012). In addition, the local government authority officer responsible for 'water resources and environmental management' in Ijebu-Ode, was contacted to provide formal explanations of current governmental positions on themes (waste, drainage and environment) discussed. The responses of the leaders will be anonymise using 'interviewee (s) and 'environmental officer for the local government authority officer.

### **3.6.3** Educators (paper based)

Twenty-five (25) questionnaires (paper copy) were randomly distributed to draw facts from the voluntary teacher education lecturers in three main departments encompassing Geography, Social Studies and Primary Education Studies at the Tai Solarin University and College of Education, Ogun State, South West Nigeria.

### **3.6.4** Targeted high-profile interviews

In addition, four (4) targeted interviews were conducted with high profile individuals, these interviews explored higher level political positions in respect to flooding, government processes and actions and environmental education. These four targeted interviews support the questionnaires detailed within sections 3.6.1-3.6.3.

i. Respondent 1 is a Vice-Chancellor of a University of Education in Nigeria, a tertiary institution teaching both the curriculum subject contents and the pedagogy for effective transfer of knowledge. The mission is to enhance the quality of teaching and learning and continuously update the method and skills of knowledge providers by equipping them with modern technology and services delivered by skilled and motivated members of staff to meet the contemporary and future needs of Nigeria with the capability to compete globally.

ii. Respondent 2 is a senior officer at the Ministry of Education, the role is responsible for providing an education system that delivers equitable and excellent outcomes; develop and deliver strategic policies, programmes and services focused education sector and improving the community's knowledge of, and participation in, the education system; undertake education research and analysis and monitor education sector capability and viability, make sure that education providers have the resources and support they need to deliver services to students.

iii. Respondent 3 is a senior officer at the Ministry of Environment. The role aims to create a better living environment for the people. Specifically, the departments of planning, research and statistics of the Ministry is in charge of environmental education, creation of environmental awareness and processing research findings and,

iv. Respondent 4 is a senior officer at the Ministry of Local Government. The role is responsible for the formulation of policy guidelines for the administration of local governments in the State. Coordinate the activities and affairs of all the twenty (20) Local Government Council Development Areas of the State and to ensuring good governance and spread of dividends of democracy to people at the grassroots.

## **3.7** Questionnaire design

Primary data gathering was accomplished through administration of a purposively designed questionnaire forms (i.e., questionnaire used in the survey – paper copy). Series of discussion and consultation processes was engaged with my supervisors to evaluate content and structure of the questionnaires. In general, the questions were evaluated based on their content and development of ideas and themes. Questionnaires are an effective and widely-used approach to studying flood vulnerability and risk assessment; it is also relatively economical for collecting large amounts of data (Dolmans and Ginns, 2005)**.** Questionnaires can be defined in a number of ways, but most commonly accepted definition is that it is a set of questions, answered by the respondents within closely, well-defined parameters (Lucia, Herrmann and Killias, 2007). A significant benefit of questionnaires is that by using them, the researcher predetermines the type of data that will be obtained. For example, in the context of the present study, questions about the home area, means that it is logical to assume that conclusions relating to the type of settlement could be drawn from the responses.

Three main questionnaire types are noted in the broader literature; postal, face-to-face and telephone questionnaires (Edwards et al., 2009), with each one offering their own relative merits and limitations. Face-to face questionnaires were distributed and collected from participants by the researcher. Participation in voluntary study's where participants are assured of anonymity and confidentiality of information received from them. The questionnaire(s) are designed in a closed and open-ended format, to elicit quantitative and qualitative reliable information(s).

Quantitative data (i.e., questionnaire – paper copy) required were gathered through a street survey (section 3.6.1) and from official offices (educators, section 3.6.3). Distribution of questionnaires on the street and collection from participants by the researcher were used because as the most suitable approach in an environment where properties are a mix of formal and informal, reflecting an absence of local planning requirements. The approach of distributing questionnaire on the street is a method that is mainly used by researchers in such local communities (Atufu and Holt, 2018; Lambu, 2017); whilst some streets have a recognized names and identifiers, others streets are not identifiable (no name or numbers - informal). Other approaches are not suitable in these communities because they do not have postcodes, the postal service in Ijebu-Ode is considered unreliable and inefficient by the local population, in terms of coverage and the frequency of delivery. Questionnaires were distributed and collected by researcher, though it is a time-consuming approach it fits with the cultural and societal convention and also yielded a high return rate (Atufu et al., 2018; Boynton, 2004; Erhun, 2015; The Ministry of Information and Culture, 1988). The purpose of the study was explained to all the participants that were randomly selected for the street survey (questionnaires). The random sampling technique is one of most popular types of sampling, any potential approach to sampling includes the risk of bias (Ghauri and Gronhaug, 2005; Sharma, 2017; Taherdoost, 2016). The use of a street sampling approach results in greater likelihood of capturing particular populations subject to time or day sampling took place, for example parents during school hours or younger adults in the early evening.

A combination of closed and open-ended questions is used. Several studies have used closed-ended questions in their investigation on flooding and have helped in identifying the main factors responsible for exacerbating flood impacts. The use of closed-ended questions provides limited options to respondents to choose from, whilst relatively easy to answer they offer limited capacity for expansion of explanation though they can be easily analysed statistically. In contrast open-ended questions, offer a variety of choices to select from, or require respondents to write down their own opinion(s) (Chang, 2016). Open-ended questions permit respondents to provide more information that could help in understand their perspective or arguments. According to Fan et al., (2013), many studies have used both open and closed questionnaire, with the aim of evaluating their research and successfully understanding issues.

The questionnaire is designed to be semi-structured using a combination of question types and has been used in previous research to understand the flood vulnerability. The questionnaire may use Likert scale (Lionell et al., 2021; Skaife et al., 2009; Sullivan and Artino, 2013), so that respondents can determine strength of view, whilst retaining a high degree of statistical analysis capacity. The use of structured or semi-structured questionnaires allows a focus on specific, pre-determined issues; which are often easier to comprehend by the respondents and can be kept relatively short (Yazdanpanah, 2016). Likert scales are thought to be most convenient option in questionnaires for both interviewer and interviewee (Norman, 2010). The Likert Scale is an ordinal psychometric measurement of attitudes, beliefs and opinions (LaMarca, 2011; Moors, 2010), in each question, a statement is presented in which a respondent must indicate a degree of agreement or disagreement in a multiple-choice type format. They are the most universal method for survey collection; therefore, they are easily understood. The responses are easily quantifiable and subjective to computation of some mathematical analysis. The Likert scale is one of the most reliable ways to measure opinions, perception, behaviours and produces accurate and quality information, reducing measurement errors and allows to perform analysis necessary to achieve research objectives (Boone & Boone, 2012; Brown, 2000; Joshi et al., 2015; Lionello et al., 2021; Warmbrod, 2014). In view of the advantages, the weakness of Likert scale-based questions is that people cannot clarify their response with further free-text, nor provide any further details. However, the Likert scale is uni-dimensional and only gives 5-7 options of choice, and space between each choice cannot possibly be equidistant. Therefore, it fails to measure the true attitudes of respondents (LaMarca, 2011; Moors, 2010), such as their response style (RSs) bias (see, e.g., Baumgartner & Steenkamp, 2001; Kankarasˇ & Moors, 2011; Moors, 2010; Moors, 2011; Paulhus, 1991; VanHerk, Poortinga, & Verhallen, 2004; Thomas et al., 2014; Warmbrod, 2014; Welkenhuysen-Gybels, Billiet, & Cambre, 2003). Additionally, the researcher needs to operate on the premise that the information given was based on a similar understanding of the questions asked (Yazdanpanah, 2016).

According to Yang, Ding and Dong (2014), there are a number of challenges associated with the application of questionnaires in the field. For instance, researchers may struggle to be trusted by respondents and hence, find it difficult to receive responses or truthful responses to their questions. More practically, researchers (Bhandari, 2012; Kelley, 2003; McLeod, 2018; Satya, 2012) have reported low success and low response rates where respondents have felt that questionnaires are too general and irrelevant to their everyday lives. On the other hand, (Debois, 2012; Geisen, 2018; Giles & Field, 1978; McNeely, 2012, p. 380-381) have found that questions that tend to dig deep into personal lives of individuals (such as level of education, income and occupation), might often be left unanswered by the respondents.

A basic aim of any household questionnaire (paper copy) is to collect information relating to demographic and socio-economic characteristics of the people living within the household. For this purpose, direct questioning is the most appropriate choice (Tharenou, Donohue and Cooper, 2007). Next to explore the home area, flood risk indicators, resilience indicators and mitigation approaches to flood risk reduction are assessed, followed by exploration of more substantive causes of flooding, severity of the effects and effectiveness of flood control of those in the household.

The street survey questionnaires (section 3.6.1) comprised of a total of 88 main questions and 9 subsections. The questionnaire opened with a cover letter which explained the purpose, importance and objectives of study, and provided information on the institution conducting the study (Appendix B). A total of five categories were defined under which the questions were arranged, so that it became easy to interpret and administer the information. The first category comprise of four sections with a total of 31 questions exploring: participants information, home area information, flood risk indicators, and resilient indicators; the second category is focused on the substantive causes of flooding with a total of 20 questions; the third category focused on the severity of flood disaster with a total of 15 questions; the fourth category focused on the effectiveness of flood control with a total of 20 questions; whilst the fifth category focused on sustainable mitigation approach considered by participant as necessary for the effective flood risk management in Ijebu-ode with a total of 2 main questions and 9 subsections. The categories used in first set of questionnaires (Appendix B) are:

**Section 1:** Participant's information, covering socio-demographic characteristics and were related to economic factors. These were also mostly factual MCQs (questions 1-4).

**Section 2:** Focused on the participant's home area information. The questions were related to settlement type, flood perception, awareness, information and emergency response. These were also mostly factual MCQs (questions 5-13).

**Section 3:** Focused on the flood risk indicator. The questions were related to the causes of flood vulnerability, months of the year with major flood events and disaster and number of days impact is felt (questions 20-21). The is comprised of both open and closed ended questions which will help in identifying factors causing the flood vulnerability, impact and flood type and requires respondents to write down their opinion (s) regarding the questions under investigation (questions 18, 20 & 21). Their purpose was to examine the factors responsible for the perennial flooding, the main flood type, and other exacerbating factors.

**Section 4:** Focused on the resilient indicators. The questions were related to the coping measures put in place by the inhabitants to minimize damages during times of flooding, both structural and emergency responses and flood recovery (questions 25-31). This is comprised of both nominal scale questions and also requires respondents to write down their opinion (s) regarding the questions under investigation (questions 20 & 31). Their purpose was to evaluate the risk of people and infrastructure (low or high) and provide guidance on how to improve resilient in Ijebu-Ode city.

**Section 5:** Focused on the resident's perceived causes of flooding in Ijebu-Ode. The questions were related to a psychometric testing to measure respondents' attitude, beliefs and opinion regarding the questions under investigation (20 questions). Their purpose is using flexibility in the holistic evaluation of the substantive causes of flooding in the study area and having an in-depth insight into the problem and informing flood risk management required.

**Section 6:** Focused on the respondents' awareness of the effects of flood disasters. The questions were related to a psychometric testing to measure respondents' attitude, beliefs and opinion regarding the questions under investigation (15 questions). Their purpose is to evaluate the severity of effects of flood disaster and having an in-depth insight into the interaction between flood events and their aftermath, assess the enormity of the flood impact on the inhabitant's wellbeing and inform urgency for a sustainable flood risk management.

**Section 7:** Focused on the respondents' perspective of the effectiveness of flood control. The questions were related to a psychometric testing to measure respondents' attitude, beliefs and opinion regarding the questions under investigation (20 questions). Their purpose is to evaluate the structural and non-structural coping measures used by the people to reduce effects of the perennial flood disaster risk. This section gives an in-depth understanding of the flood problems, the most applied coping measure, informing the main exacerbating factors, main flood type and type of sustainable flood risk management urgently required to ameliorate the inhabitant's sufferings.

**Section 8:** An opinion section, where the respondents' opinions on flood risk management achievement and sustainable mitigation considered necessary for effective flood risk management in Ijebu-Ode were examined (2 main questions and 9 subsections). The purpose of this section is to understand individual and community vulnerability, their awareness about the vulnerability, achievability of flood risk management, and mitigations measures mainly required to alter the vulnerability of exposed population which is key for a successful flood management and most likely to reduce the flood risk.

The second set of questionnaires distributed to educators (section 3.6.3) comprised of a total of 35 main questions and 6 sections. The questionnaire opened with a cover letter which explained the purpose, importance and objectives of study, and provided information on the institution conducting the study (Appendix D). A total of six categories were defined under which the questions were arranged, so that it became easy to interpret and administer information. Section A (i.e., participants information) has a total of 6 questions; Section B (i.e., climate information) has a total of 6 questions; Section C (i.e., flood information) has a total of five questions; Section D (i.e., waste management information) has a total of 6 questions; Section E (i.e., school information) has a total of 9 questions and Section F (i.e., educational needs) has a total of 3 questions. Using fewer categories for questions in a questionnaire is considered to be a better option, as it simplifies the information for both the researcher and the respondent (Harkness et al., 2010).

The categories used are (Appendix D):

**Section A:** Participant's information, covering socio-demographic characteristics and were related to their respective departments and position/rank. These were also mostly factual MCQs (questions 1-6).

**Section B:** Focused on the participants climate information. The questions were related to reality of climate change, flood hazard knowledge of communities, importance of climate change education, unsustainable living habits of the people, knowledge of climate change adaptation and flood risk management, and inclusion of flood risk education in teacher education programme. These were also mostly comprised of both open and closed ended questions (questions 7-12).

**Section C:** Focused on flood information. The questions were related to major environmental hazard impacting the people and their environment, factors exacerbating incidences of flood and vulnerabilities, existing flood knowledge, achieving desirable behavioural change and raising awareness of climate change and impacts by designing a robust climate flood risk education (questions 13-17). Comprised of both open and closed ended.

**Section D:** Focused on waste management information. The questions were related to the state of current waste disposal and collection, level of public perception and awareness on proper waste management approach and effectiveness of institutions, people's habit on their waste disposal especially during rain, effect of uncollected wastes on drainages, increasing household level of awareness on environmental implications of poor waste habit through environmental education, the role of good governance and effective institutional capacity in fostering proactive responses domestic waste and flood risk management at local level (questions 18 & 23).

**Section E:** Focused on school information. Questions were related to 'concerns' of Ministry of Education to 'issues' on environmental education, status of environmental education in Nigerian schools (i.e., compulsory or passively taught), common environmental issues and problems, pupils/students level of awareness on environmental issues and problems, level of desired awareness and perception of pupils/students capable of reducing flood risk, current Nigeria curriculum programme in relation to environmental education, status of environmental education in teacher education institutions, level of practising classroom teachers knowledge in imparting flood risk education in Nigeria, and contribution of school management in ameliorating environmental issues (questions 24-32)

**Section F:** Focused on educational needs. The questions were related to the willingness and readiness of practising classroom teachers to impart environmental management knowledge in the students and important teaching aids and material that will help teachers in achieving their behavioural objectives including other important comments (questions 33-35).

## **3.8** Interview design

For this research, face-to-face structured interview (schedules have a standardized format, same questions are asked to each interviewee in same order), were conducted (recorded and transcribed for analysis). Structured interviews are ideal for large-scale, comprehensive studies (Brinkmann, 2014). These kinds of surveys can be useful in obtaining information about a daily or regular routine or activities, such as the household survey. Personal interviews are considered to be the most appropriate and effective tool for collecting in-depth data (Di Cicco-Bloom, 2006). A personal interview is a conversation between two people in which one person (i.e., the interviewer), aims to draw out the required information from another person (i.e., the interviewee), (Quintero, 2009). The interviewer will not deviate from interview schedule (except to clarify the meaning of the question) or probe beyond the answers received. Most interviews involve open-ended questions that allow the interviewee to openly express their points of views, beliefs, convictions, attitudes and assessments (Reja et al., 2003). For interviews conducted on community leaders and policymakers, structured interviews with open-ended questions are selected.

In this research, interviews allow for a deeper insight into the role played by individuals, community and government in flood risk management. A further advantage of the interviews is that the researcher can ask follow-up or supplementary questions, which can be helpful in clarifying certain points and improving the quality of the data (Rohde, Lewinsohn and Seeley, 1997).

The potential participants were made aware of the format and nature of the interviews, and were informed that the interviews would be transcribed. The Consent form and a document outlining the nature of the research (information sheet – ethics clearance from University of Liverpool) were presented to the participants which will be duly signed by them as an approval to conduct the interview. In regard to qualitative data, the interviews obtain data concerning government and local community leader's roles in the flood/water management and in creating flood disaster risk management policies. Interviews help to understand prevailing issues and understanding of flood water management and the potential of environmental education within the communities. Transcripts interviews with government officials/policy makers and community leaders will be analysed using thematic analysis. No risks are perceived to the interviewee as a result of taking part, participants are asked about current policy, their knowledge of the water systems and potential future scenarios. The government representatives will not be asked question that will directly critique their government's policy unless they offer information freely. Anonymity will be preserved where individual request this.

Local community leaders were interviewed at their residential properties (these are their official places of operation) because they do not have separate offices (section 3.6.2), while the government official (i.e., senior officer at Water and Environmental Sanitation Department of Ijebu-Ode Local Government Area; Vice Chancellor of University of Education in Nigeria; senior officer for Education; senior officer for Environment; senior officer for Local Government and Chieftaincy Title are interviewed in their office of work (section 3.6.4). Access to the participants who hold a public office was gained through pre-existing contacts, the researcher initially approached them through a phone call, however, in the consent form they will be informed that they have the right to withdraw from the interview at any time.

The first set of oral interviews began with ten standardized question formats, which were all open-ended. This was because open-ended questions provide flexibility to respondents and often result in more detailed answers (Reja et al., 2003). The ten standardised questions were followed by supplementary questions that were developed in response to the leading questions and direction of the interview. The ten opening questions were (Appendix C); the second set of oral interviews (i.e., 20 questions in all) for policy implementers (see section 3.6.4) began with nine standardized general questions to all interviewees, followed by six (6) specific questions to the senior officer for Education, whilst five (5) specific questions were directed to the senior officer for Environment and senior officer for Local Government and Chieftaincy Administration. All the questions are open-ended. The nine (9) opening questions were general questions for all the interviewees (Appendix E), the following six (6) questions were specific for Ministry of

Education and the last five (5) questions were specific for both Ministry of Environment and Ministry of Local Government Administration:

## **3.9** Data analysis

Both statistical and qualitative contextual methods of data analysis were employed for data collection. The hand completed paper-based questionnaires were imputed into an electronic spreadsheet format. The data was analysed using statistical methods where there are pre-populated answer choices for respondent to choose from (i.e., limited responses to close- ended questions were used to generate a set of quantitative data); while an open-ended question asks the respondent to provide feedback in their own words. Exploratory in nature, they offer the researcher rich, qualitative data. Qualitative data was analysed using thematic analyses (Braun and Clarke, 2006). Thematic analysis is a qualitative data analysis method that involves reading through a data set (such as transcripts from in depth interviews or focus groups) and identifying patterns in meaning across the information. The qualitative data obtained from interviews was analysed through descriptive and content analysis (see e.g., Ayres, 2007b; Braun & Clark, 2006; Desantis & Noel, 2000; Giorgi, 1992; Holloway & Todres, 2005; Hsieh & Shannon, 2005; Polit & Beck, 2003; Sandelowski & Leeman, 2012; Sparker, 2005; Ten Have, 2004; and Vaismoradi et al., 2013). To start the analysis, answers of the eight interviewees to ten structured questions were carefully reviewed and participant responses to each of the questions were carefully read and synchronized and categorized under appropriate themes. Similar answers that were related to each other were also categorised together. Such a methodology made it easier to identify patterns in the answers provided by community leaders and government officials. Editing transcripts also helped to avoid unnecessary repetitions and removed any unrelated material.

All the vulnerability indicators collected through the questionnaire survey will be analysed using simple statistical method. Frequencies and percentages are computed for nominal and ordinal variables. The significance of the results will be evaluated. In addition, descriptive statistics and inferential analysis is conducted when the aim of the research is to determine whether relationships or differences between variables exist in the population under investigation. Descriptive analysis provided summary statistics of survey questions, and the inferential analysis explored the patterns of and connections between the different variables under key interest in study.

## **3.10** Historical hydrology

Flood vulnerability, as well as the impacts on the inhabitants of Ijebu-Ode will be analysed from the historical flood documentary evidence collected and collated within this study. Collation of documentary information as a tool for acquiring knowledge of past flooding, where instrumental information does not exist offers a valuable way to increase knowledge and understanding (Benito et al., 2015; Kjeldsen et al., 2014; Macdonald, 2006; Wilhelm et al., 2018). Information related to historical floods is mostly qualitative, and estimation of their severity is a significant problem (Benito et al., 2003). Information about historical floods was systematically collected during the last decades of the 18th century, as part of more general information about weather and natural disasters (e.g., Pilgram, 1788, in Austria). Baker et al., (2002) and Benito, (2003) have both suggested that historical hydrology offers considerable potential to further hydrological investigations in information deficient regions (Kjeldsen et al., 2014; Wilhelm et al., 2018). Considerable progress in historical hydrology has been achieved in recent years in Europe partly as a by-product of the research on weather extremes in historical climatology (e.g., Brázdil et al., 2005b).

Historical flood evidence enriches flood studies by covering impacts of hydrological extremes on human society, as well as their human perception during the cultural history (Rudolf and Zbigniew, 2006). Historical flood information provides a powerful tool in flood risk education in urban areas, since stone marks of former flood levels can be easily understood by the public, thus improving flood risk perception (Rudolf and Zbigniew, 2006). Information about floods in the pre-instrumental period can be retrieved from documentary evidence **(**Rudolf and Zbigniew, 2006), historical hydrology or palaeohydrology provides knowledge of hydrological events outside of the instrumental records. A historical documentary source is a document, a unit of information such as a manuscript, a piece of printed matter (i.e., book, newspaper etc.), a picture or an artefact (e.g., a flood mark or an inscription on a house), which refers to the hydrological patterns or impacts of hydrological extremes (Wilhelm et al., 2018). The term documentary evidence includes all kinds of human sources from which several types of direct or indirect data can be derived. Documentary evidence about floods can be derived from different sources used in historical climatology (Brázdil et al., 2005b). Historical archives in this context refers to the documentary evidence about perennial flooding in Ijebu-Ode. Within this study documentary flood evidence is derived from reported and published flood events in the national daily newspapers. Newspapers may contain information about recent and contemporary floods (Rudolf and Zbigniew, 2006), such information is particularly valuable if it refers to a period before regular hydrological observations. However, a long record of flood events within both historical and contemporary periods can permit validation of impacts /severity / extent based on comparable locations or descriptions, enabling ranking or reconstruction of events (Benito et al., 2015; Herget and Meurs, 2010). Past reports of floods which occurred in a specific location frequently contain information about the causes and the course of floods which can facilitate an analysis of how impacts on local communities have changed through time.

## **3.11** Summary

This chapter has detailed the general research methods and procedures that were engaged in conducting the research, and explained how research approaches (instrumental records, interviews and questionnaires), were applied for data collection. It has also demonstrated that the application of specific methodologies was dictated by the nature of the study and its objectives. The chapter has also explained procedures used to collect and analyse data which were a combination of quantitative and qualitative approaches. Further specific details will be provided in subsequent chapters where approaches are applied.

# Chapter 4
# FLOOD RISK IN IJEBU-ODE

This chapter assesses flood risk in Ijebu-Ode through the hydrological information reported and published by the approved agencies in national dallies and examine instrumental records covering a 30-year study period (1989-2018) to gain in-depth knowledge and understanding of the local climate and past trend.

## **4.1.** Introduction

This chapter analyses understanding of flood risk in Ijebu-Ode by exploring both the non-instrumental and instrumental records. It outlines important features of Ijebu-Ode and considers how these directly or indirectly influence residents' habits, lifestyles and attitudes to flooding and climate change. Risk of floods in past decades appear to be becoming more frequent, with most occurring during the rainy seasons, impacting the lives of inhabitants and their surroundings. The aim of this chapter is to develop an in-depth knowledge of underlying causes of hazard exposure in Ijebu-Ode by assessing historical flood records reported in national dailies, and also the geophysical processes involved in the causal flood chain (i.e., process and state), and their causes and effects. Precipitation and temperature are two of the most important variables in the field of climate sciences and hydrology frequently used to trace the extent and magnitude of climate change and variability (IPCC, 2007; Mc Michael et al., 2013; NCA, 2014; USGCRP, 2014 & 2016). Analysing past trends, monitoring change and assessing variability in a precipitation time series is crucial for predicting potential impacts of future climate change over a region (Tabari and Talaee, 2011; Abbas et al., 2014; IPCC, 2014; Ahmed et al., 2015).

## **4.2** ITCZ and the African Climate

The Inter-Tropical Convergence Zone (ITCZ) is a band of clouds that circles the earth near the equator and consists of showers and sporadic thunderstorms (NOAA, 2023 - updated).

Perhaps Hubert (1926) was the first to recognise an object similar to the ITCZ above Africa. The ITCZ's seasonal excursion is frequently cited as the explanation for how the rainy season develops across Africa, and this paradigm dates back to the days when it was believed that tropical rainfall was primarily related to localised convection (Nicholson, 2018). In the tropics, it is simple to identify the Inter-Tropical Convergence Zone by a line of cumulus clouds. Here, winds from both the Southern Hemisphere's southeast and the Northern Hemisphere's northeast converge. ITCZ placements fluctuate according to the seasons because they follow the Sun; in the Northern Hemisphere, in the summer, they go north, and in the winter, they do the opposite.

Extremely high temperatures have been recorded during the dry season (pre-monsoon seasons) when the effects of the cold tropical continental (CT) airmass (Figure 4.1) have weakened, leaving the atmosphere dry and warm, whereas extremely low temperatures have been recorded during the peak rainy season when there has been an increase in rainfall events that lowers daytime temperatures and increases cloud cover that reduces the amount of solar radiation that reaches the equator. This geographic variance has an impact on rainfall in the equatorial region, causing the tropics' wet and dry seasons rather than the cold and warm seasons of higher latitudes.

Rainfall in West Africa and Nigeria in particular is progression or regression of the zone of influence of tropical maritime air mass (MT) and its associated zone of discontinuity. Nigeria experiences a hot and humid climate due to the Inter-Tropical Convergence Zone (ITCZ)'s migration north and south of the equator (see Table 4.8 & 4.9). When the ITCZ is south of the equator and the north-east winds are the prevailing wind direction, Nigeria experiences the dry season. As the ITCZ moves into the Northern Hemisphere, the south westerly wind predominates deep inland, delivering rain throughout the rainy season. The dry season and the wet season, Nigeria's two primary seasons, have different lengths from north to south. The Inter-Tropical Discontinuity (ITD) is most popularly accepted medium that influence rainfall distribution in Nigeria (Clackson, 1960; Lamb, 1968; Ayoade, 1988; Adejuwon et al., 1990). In other words, the rain falls mostly when an area is overlain by the Continental Tropical (CT) air mass. This makes position of ITD a great determinant of most rainfall attributes in the region. ITCZ exerts significant control on tropical rainfall over both oceans and land.

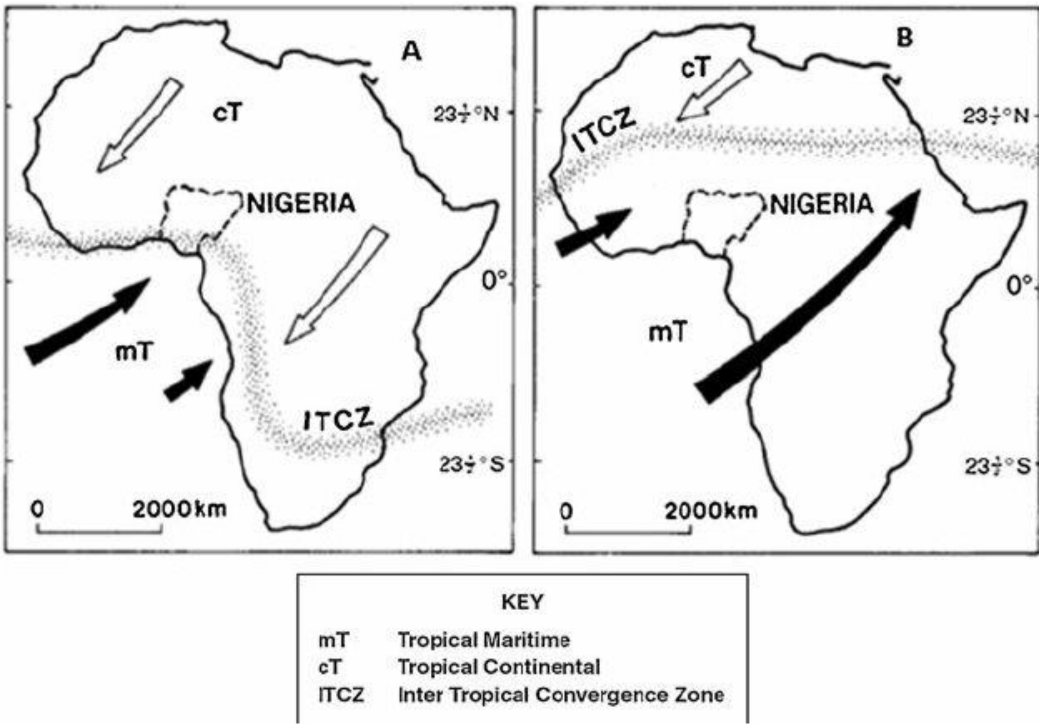


**Figure 4.1:** Direction and movement of air masses and the Inter Tropical Convergence Zone (ITCZ) in dry (a) and rainy (b) seasons (Eludoyin and Adelekan, 2012)

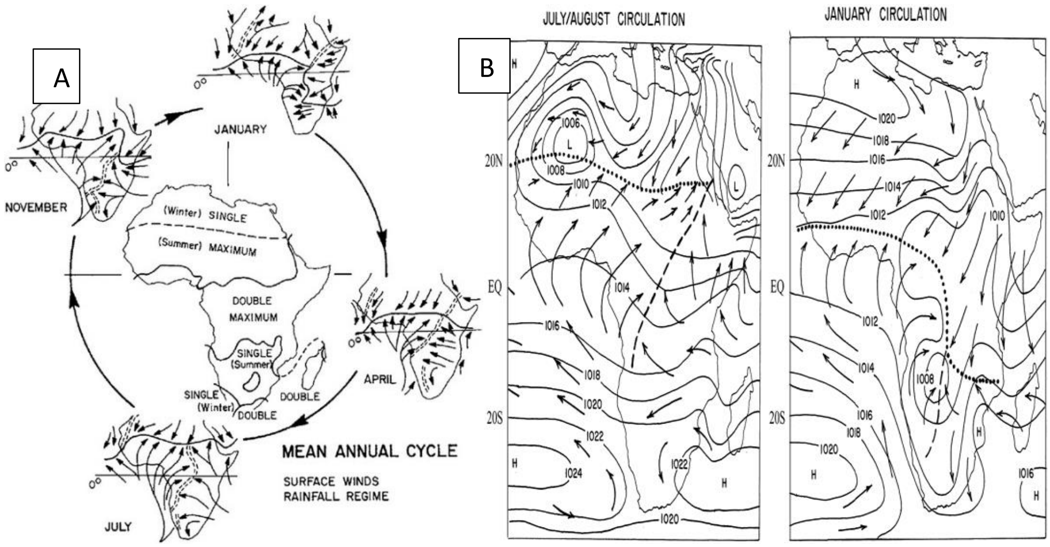


**Figure 4.2**: Mean monthly location of the ITCZ over Africa (from Dhonneur, 1974). The ITCZ (dotted line) over Africa in Jul–Aug and Jan (from Nicholson, 2011). The dashed line is the Congo air boundary.

However, it has long been disputed that the ITCZ over Africa is a significant factor influencing tropical rainfall across both oceans and land (Nicholson, 2011). The adoption of this paradigm has persisted despite suggestions from tropical meteorologists that it is not suitable for the seasonal cycle over equatorial Africa. In a study by Nicholson (2018), it was stated in the overall conclusion that more research is still needed to fully understand the seasonal cycle in Africa's equatorial regions. It has long been believed that the intertropical convergence zone (ITCZ) exerts significant control on tropical rainfall over both oceans and land.

## **4.3** Drivers of Seasonal Rainfall Prediction (SRP) over Ijebu-Ode

Climate variability refers to variations in mean state and other statistics; according to Oguntade et al., (2012), knowledge of climate variability over the period of instrumental records and beyond on different temporal and spatial scale is important to understanding the nature of different climate systems and their impact on environment and society. The global climate has changed rapidly with the global mean temperature increasing by 0.7 $^{0}$C within the last century (IPCC, 2007). This impact of global warming is not limited to global and regional changes in temperature alone, it also has significant impact on regional rainfall patterns, which may not only alter rainfall amount but rainfall distributions and patterns (Adefisan, 2018). The Intergovernmental Panel on Climate Change (IPCC) defines climate change as: Any change in climate over time, whether due to natural variability or because of human activity (IPCC, 2007). Intergovernmental Panel on Climate Change (IPCC, 2007) reported to United Nations that earth’s climate system is undoubtedly getting warmer. At higher temperatures the atmosphere may contain more water vapour, thus increasing the probability of heavy showers (Berg *et al.,* 2013). Heavy rain has far-reaching consequences for society, and these could worsen at higher temperatures. Precipitation changes can affect society more directly than variations in most other meteorological observables (Trenberth et al., 2003; Allan & Soden, 2008; Allen & Ingram, 2002), however precipitation is difficult to characterize because of the fluctuations on nearly all temporal and spatial scales.

These floods' physical (pre-) event conditions are made worse by changing seasonal soil water storage, which is primarily caused by changes in evapotranspiration. As a result, soil water storage increases during the rainy season and decreases during the dry season (see Section 4.9; see Figure 4.21), which has an impact on both runoff generation in Ijebu-Ode city. The inability of the surface water drainage system to handle the extra water buildup increases the likelihood of flooding during the rainy seasons (see Section 4.9 see Figure

4.21). Flood favouring hydro-meteorological patterns vary between the seasons and are linked to flood types (Neid et al., 2014). The study of Neid et al., (2013) highlights that flood magnitude and extent arise from different flood generation processes and concludes that soil moisture pattern as well as weather patterns are not only beneficial to inform on possible flood occurrence, but also the flood processes ad resulting flood characteristics.

The annually released Nigerian Meteorological Agency Seasonal Climate Prediction (SCP) report on rainfall amounts, these reports are used as a guide for various sectors of the country as a tool for understanding current resources and water resource management. This section is focussed on understanding of drivers of microscale/local climate of Ijebu-Ode, Southwest Nigeria, located in the tropics where climate is seasonally damp and very humid (see Section 4.2; Table 4.8 & 4.9). The El Nino/Southern Oscillation is considered as a significant cause of rainfall variability over space and time in West Africa (Adedokun, 1978; Rasmusson, 1985; Burroughs 1992; Kripalani and Kulkani, 1997; Kane, 2000; Chang, 2002). The prediction model is based on a strong teleconnection between El Nino/Southern Oscillation (ENSO - a recurrent abnormal shift in winds and ocean currents centred in the South Pacific region that produces extreme weather and climate conditions in many parts of the world), Sea Surface Temperature (SST) anomalies and rain-bearing weather systems over Nigeria. Over Nigeria in particular, correlation between global SST and rainfall has been established e.g., Adedoyin (1989) and Omogbai (2010). with SST is a good predictor of rainfall in Nigeria.

According to the Nigerian Meteorological Agency (NiMeT), rainfall predictions over Ijebu-Ode for 2010-2018 covers a range of El-Nino (i.e., dryness/drought), La-Nina (i.e., cold/more rainfall) and Neutral phases (i.e., normal weather) of the ENSO phenomenon. Continuous transition of El-Nino, La-Nina and Neural phases establishes continuous rainfall variability and changes. Whilst the Southern Atlantic is some distance from the equatorial Pacific, the ENSO focal region, the cycle of the Walker Circulation system means that many regions of the southern hemisphere experience some relationship with ENSO. Today SST appears to be most widely accepted parameter, by which ENSO is investigated in West Africa (Adedokun, 1978; Barnett, 1988), unusually low SST is recognized in the Gulf of Guinea (Bjerkenes, 1969; Kruger and Wiston, 1975; Adedokun, 1978; Hougton and Colin, 1987), with an upwelling of cold water at the coast, believed to be affected by combination of cold under current – the Benguella current and two-sided divergence of

Ekman current found within the Guinea Coast (Flohn, 1971), as such the role of the Southern Annular Mode (SAM) is also important (Wang & Cai, 2013).

## **4.4** Study area - Ijebu-Ode

This research is conducted in the ancient city of Ijebu-Ode situated in Ogun State Nigeria. Ijebu-Ode is one of the 20 Local Government Areas (LGA) that makes up Ogun State with a total area cover of 190.543km (Topographic map, Ijebu-Ode Sheet 280 NE, 1963; Landsat 8 OLI/TIR, 2021) (Olayowola and Salau, 2022) and a population of 233,310 at the 2006 census (National Population Commission, NPC). Ijebu-Ode is located at latitude $6^0$ 28’ N and 60 44’N of the equator and Longitude 30 10’E and 30 55’ E of Greenwish Meridian (Olayiwola and Salau, 2022) in Southwest Nigeria, at an elevation of 74 meters above sea level (Figure 4.3). The city is third largest urban centre in Ogun State in terms of infrastructural facilities, being next only to Abeokuta and the state capital. Ijebu-Ode city importance as an administrative headquarters and commercial centre predates the colonial period. It is bounded in the north by Ijebu-North Local Government, bounded in the East by Ijebu-East Local Government, bounded in the West by Odogbolu Local Government and in the South by Epe Local Government Council of Lagos State.

The climate of Ijebu-Ode, SW Nigeria, is characterised by distinct wet and dry seasons, enabling the occurrence of lowland tropical rain forest. The region on an annual basis is under the influence of hot-wet tropical maritime air mass during rainy season (April-October) and hot-dry tropical continental air mass during dry season (November-March). Ijebu-Ode has humid tropical climate (Table 4.8 & 4.9 & Figure 4.14), annual rainfall is generally intense with peaks occurring in July and September (double maxima) coupled with, high temperature and relative humidity (Adejuwon & Agundiminegha, 2019). The annual rainfall is between 1575mm and 2340mm and the average annual temperature is 27.5°C (Oluwatobi & Oluwakemi, 2016; Fayemi, 2020; Onanuga *et al*., 2022). The vegetation is tropical rain forest dotted in some parts by derived forest being altered by human activities (Ezekiela *et al*., 2016; Adejuwon & Agundiminegha, 2019). The rain may be unduly prolonged in some years while their onset be delayed by a “August Break” which is usually experienced between late July and Mid-August. The August Break may be due to the African-Easterly jet being overlain by the Continental Air-Mass as observed by illesanmi (1981) and Omotosho (2007). Continuous transition of the three ENSO phenomenon (i.e., La-Nina, El-Nino and Neutral phases) influences the local climate of Ijebu-Ode (NiMeT). Rainfall prediction models are based on strong teleconnection between El-Nino/Southern Oscillation (ENSO), Sea Surface Temperature (SST) anomalies and rain-bearing weather systems over Nigeria. The town being of low latitude is liable to flooding during the raining seasons.

Historically, Ijebu-Ode is an ancient city situated in an inland area, which is centrally located in relation to the other human settlements around; several smaller towns and villages mostly referred to as Egure "this way to"; includes towns such as Ogbo, Ijagun, Ala, Ososa, Erunwon, Ogbogbo, Isonyin, and Imoru amongst others. Ijebu-Ode consists of three parts- Iwade, Ijasi and Porogun. Ijebu Ode is the traditional and cultural headquarters of Ijebuland, the only kingdom that survived the political turbulent and anarchy that destroyed many Yoruba settlements during the inter-ethnic rivalries of the 18th and 19th centuries (Mabogunje & Kate, 2004; Fahm, 2015). The Ijebus are found in the south-central part of south western Nigeria (Olayiwola and Salau, 2022). Whereas the largest part of Ijebu land is in Ogun State, modern Nigeria political division has placed three Ijebu-speaking Local Government Council Areas (Epe, Ibeju Lekki and Ikorodu) under Lagos State (Abimbola, 2011; Fahm, 2015). The Ijebu-Ode metropolis is the commercial centre of the Ijebu geopolitical area of Ogun State, Southwest Nigeria. During the last two decades, the city has rapidly expanded.

Ijebu Ode, Nigeria, has seen a dramatic increase in built-up areas between 1986 and 2000 by 11%, 2000 to 2014 (65%), and 2014 to 2021 by 131%, according to the overall findings of a study by Olayiwola and Salau (2022) that used satellite imagery data to evaluate the nature and extent of urban land use change in Ijebu Ode, Nigeria, between 1986 and 2021. The findings showed that the carpet area (CA) of the built-up region more than quadrupled from 2014 to 2021, indicating a faster rate of urbanisation in the research area from 2014 to 2021 compared to earlier times. Reduced bare land (1986 to 2000, 16%; 2014 to 2021, 98%) and increased cultivated land by 48% between 1986 and 2014 both contributed to the growth of the built-up area (Olayiwola and Salau, 2022). Olayiwola and Salau (2022) assert that the encroachment of built-up areas onto agricultural land may be attributed to the availability of other more lucrative income sources in addition to farming, as well as the need for additional land to accommodate urban facilities required to support the rapidly expanding population. This tendency, according to Ramachandra & Aithal (2013) and Richards (2022), is an example of land use invasion and succession. The study found that the study area's landscape patterns and urbanization processes were influenced by the location of spatial structures, and it recommended routine monitoring of the built-up area growth to prevent impending urban sprawl (Olayiwola and Salau, 2022).

According to Olayiwola and Salau (2020), land use and land cover change (LULCC) is an ongoing process with effects on both the spatiotemporal environment. It is essential to have a thorough grasp of the "challenges and potential solution (s) to pluvial flood risk in urban tropical African communities, a case study using Ijebu-Ode in South West Nigeria."

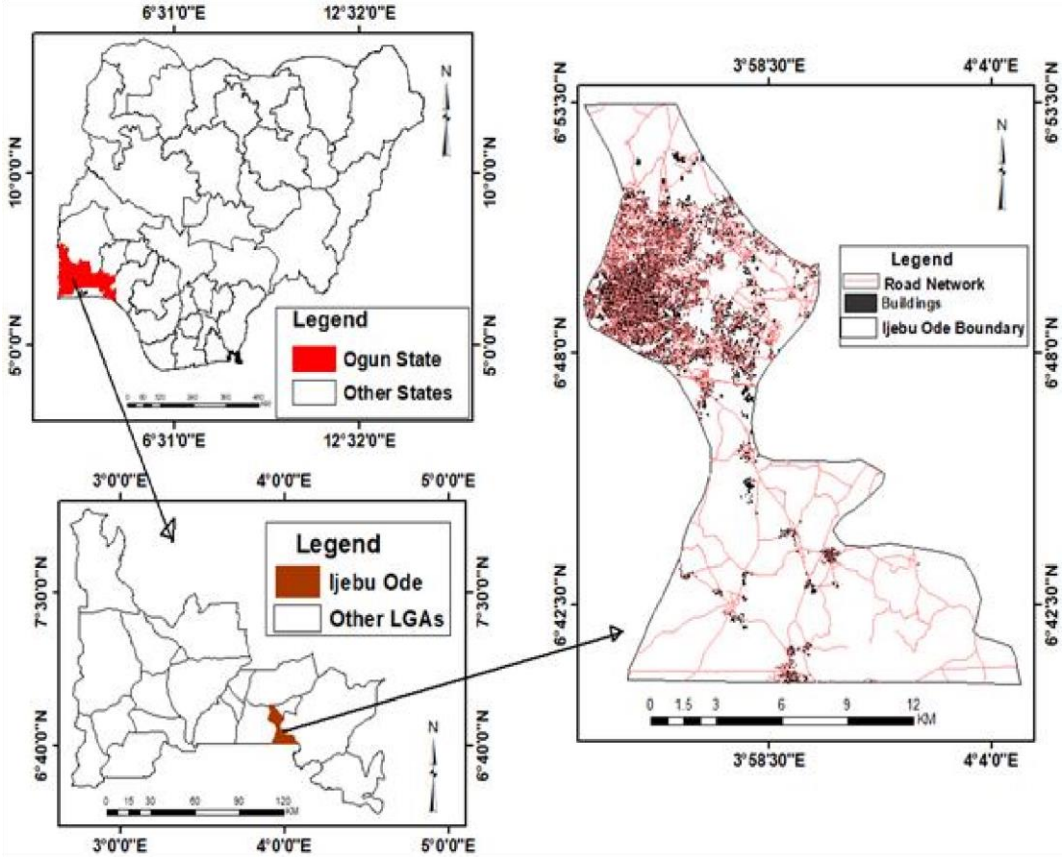


**Figure 4.3:** Location of Ijebu-Ode in Ogun State, Southwest Nigeria (Olayowola and Salau, 2022)

## **4.5.** The source of non-instrumental flood information

The Ijebu-Ode community have witnessed devastation from perennial flooding that has long resulted in exposure and susceptibility to flooding, impacting their lives and assets, particularly in areas that are flood-prone. Flood disaster history of Ijebu-Ode is not documented in archives (detailed data on past flood damage or potential exposed items do not exist). The residents of Ijebu-Ode have not kept quiet on the threat flooding presents to the city; recurring flooding widely experienced during the rainy seasons (Figure 1.1; 1.2). Unfortunately, flood problems have remained unabated, hence the need and relevance for this research. In the absence of instrumental data documenting flood discharges or depths non-instrumental records offer an opportunity to assess flood risk in Ijebu-Ode and to gain an in-depth understanding of the hazard and vulnerability presented based on past experiences. The need for a better understanding of flood events is especially important for long-term flood disaster prevention, mitigation and preparedness. Exposures to flooding and potential changes in flood risk are a function of climate variability, and the inhabitant's low adaptive capacity.

Due to non-existing official flood records, this research explored historical flood archives documented in the National Daily newspapers as a valuable source of records and information (Table 4.1). Newspapers and journal publications were both found to be good as a source of information for this research, however, they had a limited time span in Nigeria, much shorter than in many other parts of the world (e.g., Macdonald and Sangster, 2017). Historical flooding is often described in a qualitative fashion, this is a valuable tool for studying flood risk in Ijebu-Ode. Historical hydrology intends to help reconstructing long-term records of temporal flood occurrences, extreme events, investigate meteorological and anthropogenic causes, and past vulnerability to extreme hydrological events (Wilhelm et al., 2019). Historical archives allow insight into truly extreme flood events and their variability in space and time, due to the long timeframes they document (Kjeldsen et al.,2014; Sangster et al., 2018). The historical flood evidence found within these records has potential to improve flood risk assessments necessary for sustainable development of Ijebu-Ode (Table 4.1), with accounts often capturing a range of information, concerning the hazard itself (flood), impacts and societal responses

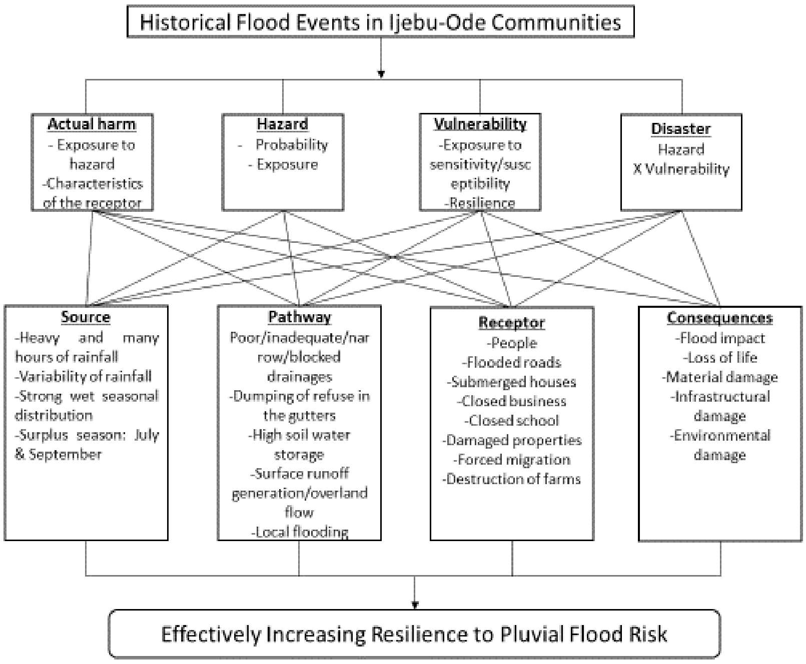


**Figure 4.4:** Linkage between hazard and risk including drivers of pluvial flood disaster in Ijebu-Ode

## **4.5.1** Reconstructing a historical record of flooding

This section takes a critical look at major records of flood disasters in Ijebu-Ode, it viewed places within the city where floods had occurred, the causes, associated consequences, years and months. Months of occurrence vis-à-vis the natural causes is good for paleoclimate reconstruction and time series analysis, rainfall-seasonality periods, the human factors and causes that may exacerbating flood disasters. The disaster type indicates prominent disaster that are experienced over time which could be linked to natural causes and vulnerability (social, economic and environmental) thereby giving a clear state of flood risk in the study area. Studies of historical floods based on the documentary evidence focus on:

(a) analysis of outstanding individual floods;

(b) compilations of long-term series of historical floods and interpretation of flood patterns (Rudolf et al., 2006).

Benito (2003) recognized the importance of information about the historical floods as a possible factor which may help improve flood risk estimates and the understanding of the relationships between floods and climate over a long period of time.

First, it should be noted that COVID had a significant impact on the original goals of this research in terms of limitations imposed by administrative activities that necessitated a change in strategy (i.e., identified newspapers and libraries as alternative sources of past floods and flooded areas), but many of these had limited or no access, necessitating time-consuming personal arrangements to visit local newspapers to browse back issues (limited copies). Second, though it can be challenging, searching the web is one of the qualitative processes investigated by this research to interact with web-based search tools (such as the Google search engine) to describe residents' perceptions (i.e., most of the newspapers and news information needed in this section), with a primary function to better understand and aid in interpreting the pluvial flood risk phenomena within "real life" context - which led to making generalisations in this section. Finding new views on web-based human-computer interaction was one result of research into online information seeking.

Use of newspaper information revealed evidence for past trends and patterns in climate over different time scales for Ijebu-Ode. The historical flood series suggests Humid climate (Figure 4.14 and Table 4.8 & 4.9) intra/interannual fluctuations (Figure 4.5, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14 & 4.23 & Table 4.1). Floods in Ijebu are caused by the hydro-meteorology generating mechanisms and influenced by a number of anthropogenic factors. The pluvial floods are often attributed to intense multi-hour torrential rainfall, which are exacerbated mainly by insufficient drainage channels and waste disposal into drainages (Figure 4.7. 4.8, 4.9, 4.10, 4.12, 4.13 & Table 4.1, 4.8 & 4.9). The pluvial floods are found to be common during rainy seasons, mainly in month of July (primary rainfall peak period and surplus season) when rainfall is highest and soil water storage has reached saturation (100%) (see Section 4.9.2), yet are also occurred in the dry season (February) (see Table 4.1) coinciding with utilization season when the air temperature is at primary peak and surfaces are hardened by the heat limiting infiltration of rainfall (Figure 4.21 & 4.22). Pluvial flooding occurs when the rate of water falling on an area exceeds the rate of infiltration into the ground, and the piped sewer systems are unable to handle higher flows because they have reached their maximum capacity, resulting in overflows from the minor to major drainage system (Wheater, 2006). Pluvial flooding is frequently associated with localised, high-intensity, short-duration rainfall episodes that are extremely difficult to predict (Rubinat et al., 2019).

Socio-cultural and economic vulnerabilities are often observed during floods in Ijebu-Ode (Figure 1.1 - 1.8), driven by the changes in hydrology, with many buildings in inundated areas affected, there is loss of life, stress, loss of personal articles, direct and indirect financial losses by damage to properties, assets and businesses, others are rendered homeless and displaced. The flood makes roads impassable, causing traffic gridlock, increased cost of living and raising risks and overall severe damage to the city; as such these impacts are often captured within flood reports which enables the impact of past floods to be assessed. Flood exposure is higher for socially vulnerable populations (Lee and Jung 2014; Rolfe et al., 2020), especially for inland floods (Qiang 2019). Social vulnerability results when social, political, and economic process combine to produce heightened susceptibility to hazards for some populations (Cutter et al., 2003; Emrich and Cutter 2011). Two common socio-economic characteristics of floods are material damage and human losses. This involves number of fatalities, wounded, or relocated people in flood ravaged communities - consequences of a flood will impact on exposed individuals or group of people (Weichselgartner, 2000).

The disastrous consequences of a flood will impact on socio-economic system (Weichselgartner, 2000). Rudolf et al. (2006) opined that magnitude of flood impacts is, to a considerable extent, a result of interaction between the physical parameters (river discharge, water level, inundated area, flood duration) and vulnerability of societies. The latter involves the awareness and preparedness for such events (e.g., in the adaptation of land use and the setting up of a forecasting and warning system), which fluctuates in both space and time. As such qualitative accounts that capture such information offer valuable sources of information on the vulnerability of the community impacted by the flood and the causes and mechanisms that generated the flood event. However, this is reliant on archival copies being retained, within rural areas there are no local archives that store such records in many parts of Nigeria, therefore such source materials can be piecemeal in availability. Some central publishers may retain copy; however, these were unavailable within this study if so, because of COVID restrictions, though publishers were contacted most only offered digital offices during the study period. The result was that the analysis of newspapers and media is reliant on those accounts retained within digital media over the last couple of decades.

In context of this study and available information, analysis of the historical flood records, is classified as 1, 2, or 3 for lower impact events and 4 or 5 as worse impact events. Hence, inferring from Table 4.1, impact of flood is lowest in year 2008 and may be ranked as 1 whilst the impact of flood is worse in 2012-2018 and may be ranked as 5. For example:

> *Ogun State Government, raised alarm over an impending flooding in various places in the state as predicted by the Nigerian Meteorological Agency (NIMET) in its 2017 seasonal rainfall prediction. Briefing journalists in Abeokuta, the state capital, the state Commissioner for Environment, Mr Bolaji Oyeleye said areas to be affected by the flood include Abeokuta, Ewekoro, Ijebu Igbo, Ijebu Ode, Ikenne, Ota among other towns in the state (Channels Television, March 30, 2017).*

As rightly noted by Ndujihe (2018), flood disasters which followed the devastating 2012 event have usual trend/pattern of submerging houses, deaths of people, population displacement, washing away of farmlands, and destruction of people sources of livelihood which have implications on growing incident of impoverishment among affected Nigerian population.

The results in Table 4.1 showed that the historical flood records are quite seasonal, with a shorter dry season (between 0.4 and 0.59) that has become more prevalent over the past 16 years (2006-2018), indicating a lengthening of the wet season (see Figure 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.12, 4.13 & Table 4.5, 4.8, 4.9). and the other aggravating elements (see Table 4.1) are to blame for the ongoing risk of pluvial floods, particularly between June and July and September and October (Figure 4.21).

The results of this study indicate that the Humid climate (Table 4.8, 4.9 and Figure 4.14), seasonal instabilities (Table 4.5  4.7) and increased rainfall amounts (i.e., exposure to extremes) had resulted in flood scenarios that negatively impacted the presence of the people, livelihoods, services and resources, infrastructure, socio-economic assets, and susceptible - sensitive to and lacking the ability to resist the flood due to lack/poor flood relief channels, poor waste management, poor physical planning, and poor urban governance as presented in Figure 1.1 – 1.8).

**Table 4.1:** Historical record of flood reports in Ijebu-Ode (National newspapers/ National news/ Government agencies flood reports)

| Area/ City | National Newspaper Date | Natural Causes | Human Causes | Primary Indicator | Secondary Indicators | Date | Class. (rank) |
|---|---|---|---|---|---|---|---|
| Ijebu-Ode | Daily Trust Newspaper (Aug 10, 2008) | Persistent rainfall/Each time it rained | - | Flooded roads | - | 08/2008 | 1 |
| Ijebu-Ode LGA, Ogun State-Oyingbo, Obalende, Italapo junction, Ejinrin road, Talbot road, Imowo road, Omo-Owo road, Ondo road by Epe motor parks etc. | P.M.News (Oct 5, 2011) | Heavy rain | Lack of drainage channels; Dumping of refuse in the gutters; Narrow and shallow gutters | Flooded roads; Many were trapped in the flood for 7hrs +; Traffic Gridlock, Roads with big and wide potholes. | severe damage. | 10/2011 | 5 |
| Ijebu-Ode-mostly Igbeba road | Hot News (Feb 10, 2012) | Heavy rainfall; High volume of water flowing from Ibadan garage & Bonojo road | Culverts under construction | Submerged houses and shops, flooded roads; Loss of properties. | - | 2012, Feb | 5 |
| Ijebu-Ode- Talbot, Osinubi, Igbeba road, Molipa, Ondo road Areas etc. | Tribune Newspaper (Feb 27, 2012) | Sudden downpour, which lasted for more than 1 hour. | - | Flooded the roads making it impassable; Damaged properties | - | 2012, Feb | 5 |
| Ijebu-Ode-Igbeba road affected most | Ogun State Today News (2012) | Many hours of rainfall | Construction of culverts which started 3 days before the rain, prevented free flow of water | Flooded major roads and submerged houses and shops | - | 2012 | 5 |
| Ijebu-Ode- Irewon, Molipa, Igbeba, Obalende, Owakurudu, Epe garage, Serico | Sundiatapost (july 24, 2015); News Agency of | Whenever it rained | Poor drainage | Usually trapped at homes; Impassable roads; submerged homes, | Increased cost of living, forced migration | 2015, July | 5 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Nigeria (NAN 24, 2015) | | | Devastated roads, Closed business, Closed schools | | | |
| Ijebu-Ode | Vanguard Newsper (July 4, 2017) | Little rain/high flood | Blocked drainage | - | - | 2017, July | - |
| Ijebu-Ode | New Flakes News, Nigeria (Jul 14, 2018) | Heavy rainfall | - | Properties worth millions of naira destroyed; many people rendered homeless; several vehicles and houses were trapped/submerged | - | 2018, July | 5 |
| Ijebu-Ode | Vanguard Newspaper (July 15, 2018) | Multi-hour downpour | - | Swept away 2 mothers, 3 children and many valuables in Abeokuta the State Capital while the thunderstorm killed a young man in Ijebu-Ode | - | 2018, July | 5 |
| Ijebu-Ode-Owakurudu, MayoMayo, Logun communities | Sunday Punch Newspaper (Sept 23, 2018) | Rainfall | Inadequate drainages | Poor/Abandoned water Channelization | Abandoned - channelization turned to gully of death, swallowed houses and farms; leave owners of houses distraught | 2018, Sept | 5 |
| Ijebu-Ode- Degun, Molipa' Balogun-Kuku, Asafa, Ojofa, Obalende, Fusi-gboye Road. | Gateway Times (July 31, 2019) | Heavy downpour | Poor drainage systems | Clogged drainages; Increased Population High Urbanization; Indiscriminate Dumping of refuse Along waterways; Construction work. | Flooded roads -& Houses; Destruction of properties; roads and vital Infrastructures. | 2019, July | 5 |

## 4.6 Instrumental records data analysis

The aim of this section is to understand the climate of Ijebu-Ode, have an in-depth insight into the issues relating to perennial and apparent flooding in the city by assessing and examining rainfall and temperature trends, patterns, variabilities and extremes and rainy seasons through the daily, monthly, annual and decadal statistical analysis. Understanding patterns, trends and variability of climatic factors is important for detecting the impacts of climate change, most importantly when considering impacts on water resource planning and management. Analysing past trends, monitoring changes and assessing variability in a precipitation time series is crucial for predicting potential impacts of future climate change over a region (Abbas et al., 2014; Ahmed et al., 2015). An attempt was made to install a weather station to the roof of the College in Ijebu-Ode; however, this was unsuccessful as the upload connection was incompatible; hence data was purchased from NIMET for the purpose of examining the climate of Ijebu-Ode. Climatic data was purchased covering the period 1989-2018, as this represented the most complete period, with data quality before 1989 less complete. Box plots are employed mainly for the descriptive analysis of mean monthly rainfall, minimum and maximum temperature. According to Turkey (1977) and Chambers (1983), box and whiskers plot are an excellent tool for understanding variability of datasets. Attaining an in depth understanding of the challenges and potential solution to pluvial flood risk in urban tropical-African communities is crucial for this research.

### 4.6.1 Rainfall

This study uses daily synoptic rainfall from Ijebu-Ode city station obtained from the Nigerian Meteorological Agency (NIMET), for the 30-year period 1989-2018. Rainfall in Nigeria and at Ijebu-Ode has a strong 'wet' seasonal distribution, for months June-September. Maximum annual rainfall at Ijebu-Ode city station is 2125.6mm, with a standard deviation of 147.26mm (Figure 4.6). The highest monthly rainfall (569.4mm) is recorded in June 2009, with the subsequent highs recorded in September 2010 (554.4mm) and July 1994 (517.6 mm), whilst the highest daily rainfall (174.8mm) was recorded in 30/06/2007, followed by 172.2mm in 08/06/2007 and 160.1mm in 02/07/1994.

#### **4.6.1.1** *Descriptive analysis showing assessment of statistical significance of the rainfall, minimum and maximum temperature trends.*

The Mann-Kendall (MK) trend test is used for trend analysis. MK is a popular non-parametric trend test for detecting trends in rainfall time series (Dinpashoh et al., 2011; Gebremedhin et al., 2016; Tabari et al., 2015; Tian et al., 2016; Yue et al., 2002). The purpose of the Mann-Kendall (MK) test (Mann 1945; Kendall 1975) is to statistically assess if there is a monotonic upward or downward trend in the variable of interest over time. Hirsch, Slack and Smith (1982, 107) indicate that the MK test is best viewed as an exploratory analysis to identify significant change at stations. This method makes no assumptions about the underlying distribution of the data, and its rank-based measure is not influenced by extreme values. This method mainly gives three types of information.

- The Kendall Tau, or Kendall rank correlation coefficient, measures the monotony of the slope. Kendall's Tau varies between -1 and 1; it is positive when the trend increases and negative when the trend decreases.
- The Sen slope, which estimates the overall slope of the time series. This slope corresponds to the median of all the slopes calculated between each pair of points in the series.
- The significance, which represents the threshold for which the hypothesis that there is no trend is accepted for rainfall. The trend is statistically significant when the p-value is less than 0.05.

The Mann–Kendall test statistic *S* is given as follows:

$$S = \sum_{k=1}^{n-1} \sum_{j=k+1}^{n} sign\ (x_j - x_k)$$

where $x_i$ and $x_j$ are the data values at time *i* and *j*, *n* is the length of the dataset and sign () can be computed as:

$$sign\ (x_j - x_k) = \begin{cases} if(x_j - x_k) > \\ if(x_j - x_k) = \\ -if(x_j - x_k) < \end{cases}$$

The test was conducted on an annual basis (Table 4.2) positive value of S indicating of increasing trend, as well as a positive value of Sen's slope, indicates an upward or increasing trend (for both rainfall and temperature) in the time series. The outcome (Table 4.2) revealed that rainfall patterns are not statistically significant because the p-value (0.109) exceeds the Alpha value of 0.05. In general, both minimum and maximum temperatures for the observed period (1989-2018) show a (warming) increasing trend (Sen's slope = 0.245 and 0.189) and are considered statistically significant

**Table 4.2:** Mann-Kendall Trend Analysis

| **Analysis** | **Annual Rainfall** | **Maximum Temp** | **Minimum Temp** |
|---|---|---|---|
| Kendall's tau | 0.209 | 0.333 | 0.297 |
| Sen's slope | 6.869 | 0.189 | 0.245 |
| *S* | 91 | 145 | 129 |
| *p*-value | 0.109 | **0.009** | **0.022** |
| Alpha | 0.05 | 0.05 | 0.05 |
| Significance | Not Significant | **Significant** | **Significant** |

An innovation trend analysis (ITA) method is used to assess trends in yearly rainfall and minimum and maximum temperatures (Figure 4.5). Sen (2012) introduced the ITA methodology, which does not call for constrictive presumptions like those frequently used in the Mann Kendall trend test and Spearman's rho test. According to Dabanl et al. (2016), the ITA approach is more useful than the MK test for identifying trends in hydro-meteorological series. The idea is based on the observation that scatter points for two identical time series will almost always fall along the line 1:1 (45°). First, two equal sections of the hydrometeorological time series are split and organised independently in ascending order. The first half is placed on the X-axis and the second on the Y-axis to create a scatter plot. There is no significant trend in the hydrometeorological recordings if the scatter is on, or near, the 1:1 (45°) straight line point fall above (below), the 1:1 straight line (45°) a rising (decreasing) trend in the time series is identified (Dabanli et al., 2016; Sen 2012, 2014). The results of Figure 4.5 show an increase in rainfall as well as minimum and maximum temperatures over the research period

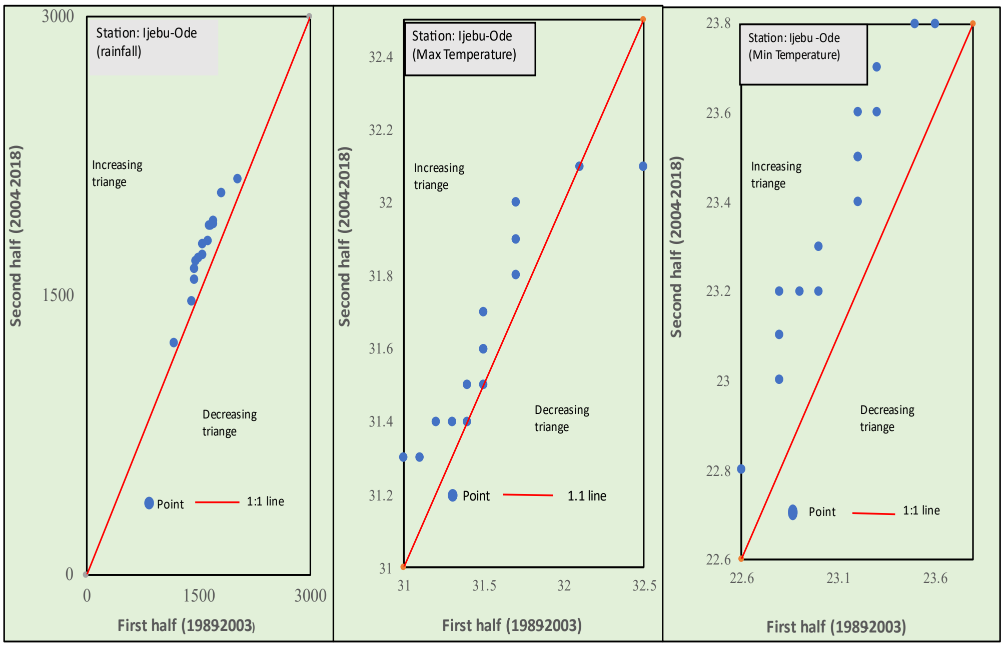


**Figure 4.5:** An innovative trend analysis (ITA) of the annual rainfall, minimum and maximum temperatures in Ijebu-Ode (1989-2018).

### 4.6.1.2 *Annual rainfall distribution analysis*

Rainfall data records were analysed for 1989-2018, a 30-year period, the selection of the 30-year window permitted an assessment of climate using the 30-year window recommended by the World Meteorological Organisation (2010 & 2015). Annual total rainfall is calculated for each year and the average rainfall plotted against its corresponding year (Figure 4.6). The annual rainfall distribution indicated a notable upward trend during the study period; however, it is not statistically significant (Table 4.2 & Figure 4.5). The average annual total rainfall is calculated at 1673.4 with a standard deviation of 223.24mm. Figure 4.6 shows that the total annual rainfall is highest for 2006 (2125.6mm), followed by 2007 (2056mm) and coming third with 1996 (2032.4mm), while it is lowest for 1998 when only (1173.3mm) of rainfall fell, 2015 (1244.9mm) and 2002 (1426.5mm), with a range of 952.3mm. Skewness of annual total rainfall distribution stands at -0.087, implying distribution is approximately symmetrical. Kurtosis 0.043 for annual rainfall revealed the distribution with a negative kurtosis value and was highly platykurtic.

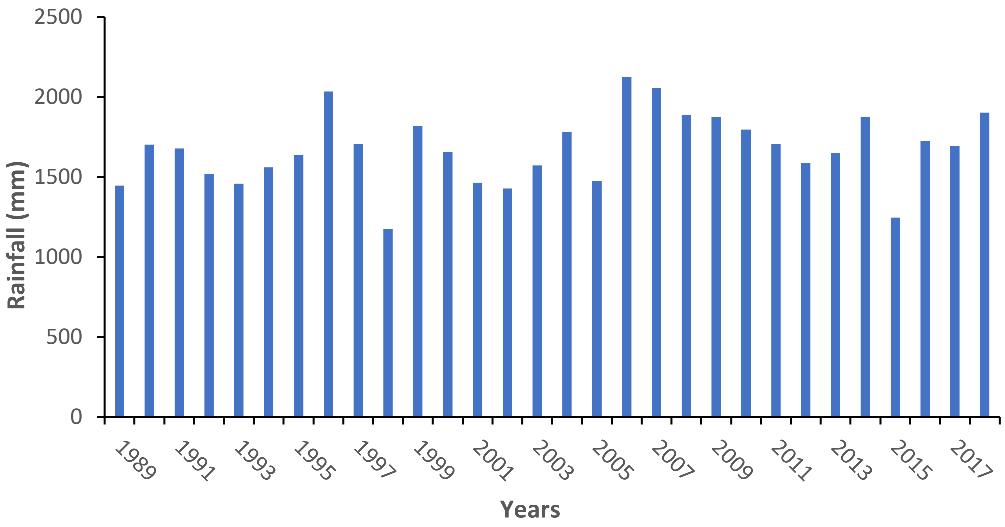


**Figure 4.6:** Annual total rainfall distribution for Ijebu-Ode (1989-2018).

Figure 4.7 depicts the observed seasonal rainfall distribution across the wet seasons (April, May, June, July, August, September, & October) and the dry seasons (November, December, January, February, & March) for each year studied.

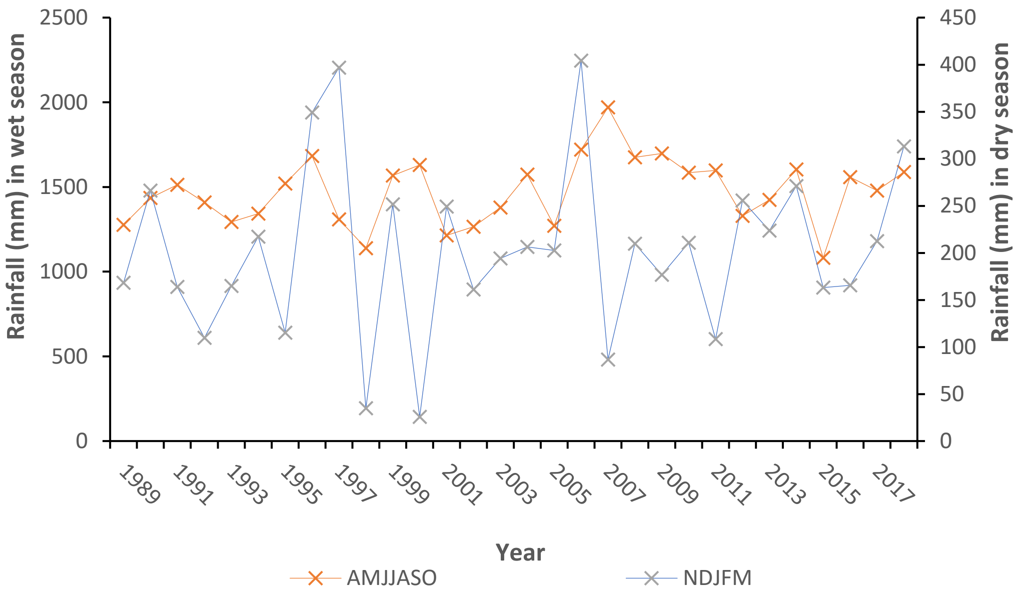


**Figure 4.7:** Season precipitation (April-Oct – orange line & Nov-Mar – blue line) over Ijebu-Ode.

The average annual rainfall ranges from 95.6 to 177mm (Figure 4.8). April through October is typically the wet season, and November through March is the dry season. Rainfall is usually the first event, hence the average amount of rainfall over Ijebu-Ode might be considered the main input, especially when surface runoff is included.

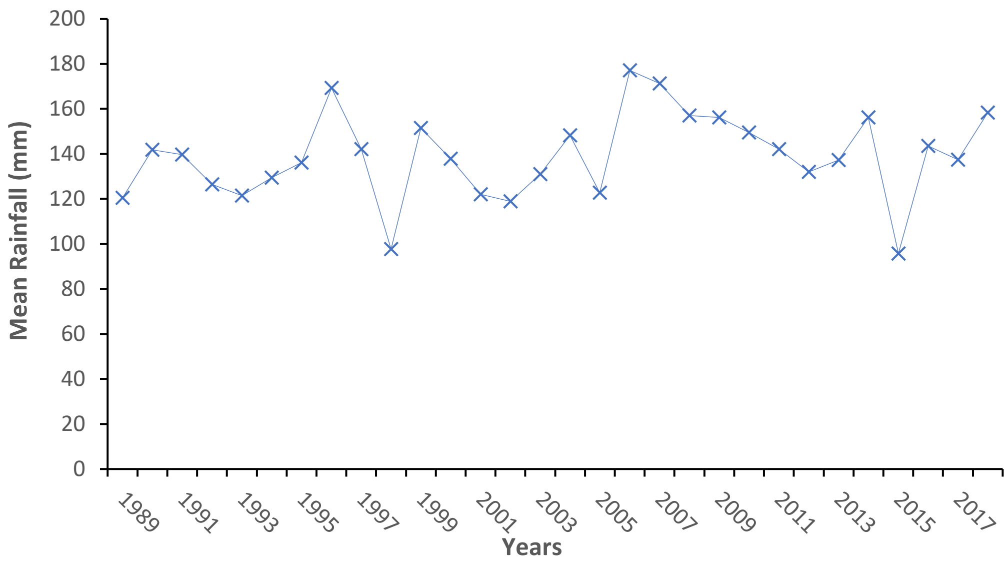


**Figure 4.8:** Mean annual rainfall for Ijebu-Ode (1989-2018)

The anomaly approach was also used for this study (Table 4.8 & Figure 4.9). It enables the determination of rainfalls that are higher than normal (wet) and lower than normal (dry), designated by positive and negative values respectively. The average climatic was calculated on the mean of 1989-2018, as recommended by NiMet (2010; 2015). Annual average rainfall anomaly results (Figure 4.9) identify the highest negative anomalies were recorded in 1998, 2015, 2002 with -500.13mm (29.87%), -428.53mm (25.61%) and -246.93mm (14.76%) respectively. The highest rainfall above the reference period of 452.17mm (27.02%), 382.57mm (22.86%) and 358.97mm (21.45%) respectively were recorded in 2006, 2007 and 1996.

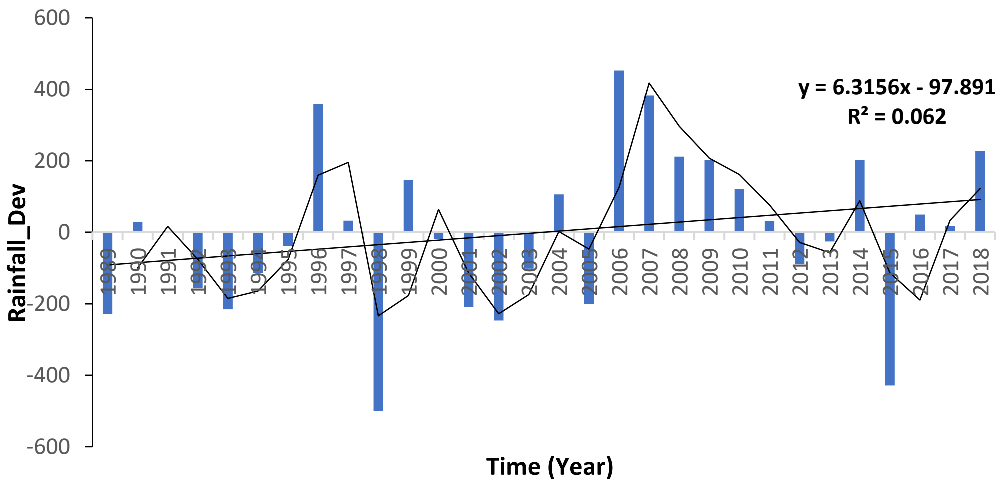


**Figure 4.9:** Annual average rainfall deviation about the mean and two period moving average in Ijebu-Ode (1989-2018)

Another strategy used to analyse the climate variability for this study was the Coefficient of Variability (CV) approach (Figure 4.10). The discussion of Coefficient of Variation (CV) in this section is primarily to determine the inter-annual variability of yearly rainfall totals, i.e., the standard deviation of year-to-year change. The coefficient of variation expressed as percentage (%) was determined by dividing the standard deviation by the mean. It contrasts the size of the standard deviation from the climatic data's mean. According to the parameters of the CV that were modified for this study, (CV <0.1) denotes low variability, (CV 0.1-0.4) denotes moderate variability, (CV 0.4-0.9) denotes high variability, and (CV >0.9) denotes very high variability (Ukhurebor & Uzuazo, 2020). Coefficient of variation (CV) ranges from 0.71mm to 1.10mm for all years, indicating high inter-annual variability of rainfall is present. Year 1992 (Figure 4. 10 &Table 4.2) had the highest CV of 110% (1.10) for rainfall in the period 1989-2018. This indicates that rainfall is very highly varied in that year with highest CV, and this is supported by minimum and maximum value of 0.69mm and 1.10mm respectively, as well as mean value of 169.37mm. 1997 had the lowest CV of 0.69mm which indicates that rainfall variability is high in this year while 1992 had the highest CV which indicate that rainfall variability is very high. According to Dewar and Wallis, (1999) the variation of CV values indicates existence of strong variability in the rainfall. This suggests that the climate in Ijebu-Ode can be described as having high/very high rainfall variability over time. Statistics show that the study period's average annual deviation of rainfall is 122.98mm. Overall, the results show how the rainfall in Ijebu-Ode varies from year to year. however no notable or statistically significant trends are identified.

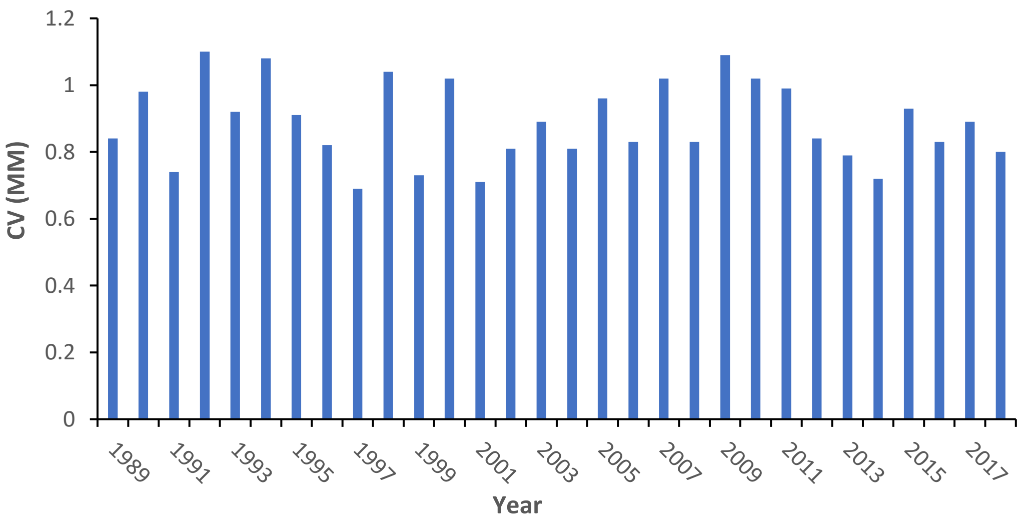


**Figure 4.10**: Coefficient of Variation (CV) for Ijebu-Ode (1989-2018)

Another strategy used to analyse the climate variability for this study was the annual rainfall range approach. Annual rainfall range indicates variability of annual rainfall and hence denotes how reliable the rainfall is in terms of its persistence as a constant and stable replenishing source of water in Ijebu-Ode communities. Figure 4.11& Table 4.3 show rainfall ranges which signifies the difference between highest rainfall and lowest in the year. The result shows that the difference between the highest rainfall for 2009 is 569.4mm and the lowest rainfall for 19 years is 0mm. This result shows the level of variability between the years.

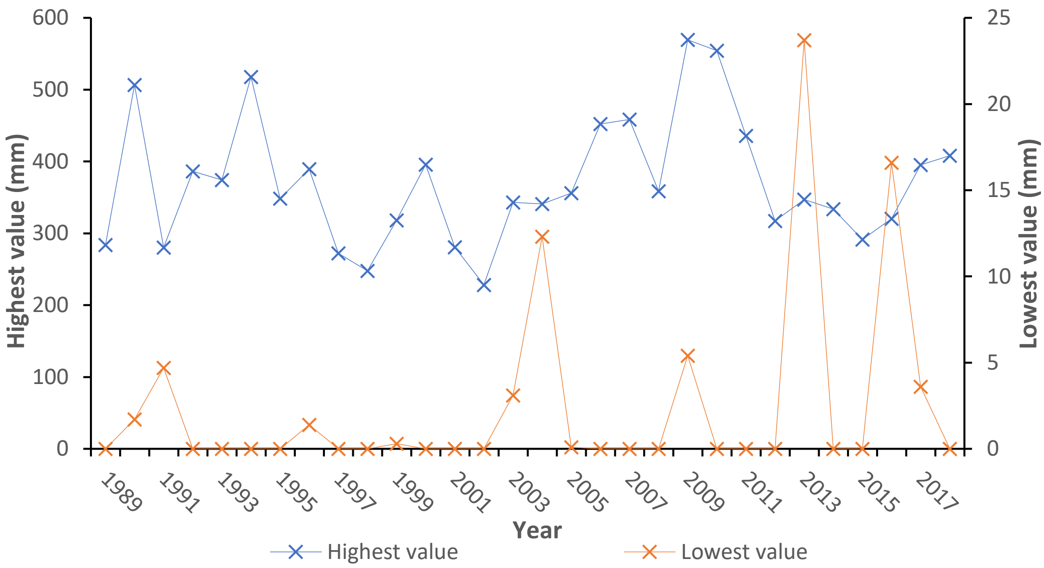


**Figure 4.11:** Annual Rainfall Range (i.e., lowest and highest) for Ijebu-Ode (1989-2018)

**Table 4.3:** Descriptive analysis of data to confirm yearly rainfall measures for temporal variability and dispersion using Mean, SD and CV (1989-2018).

| Years | Annual Rainfall Total (mm) | Mean Rainfall (mm) | Highest value | Lowest Value | Range | Standard Deviation | CV = SD/Mean R/F |
|---|---|---|---|---|---|---|---|
| **1989** | 1445.5 | 120.46 | 283.7 | 0 | 283.7 | 100.86 | 0.84 |
| **1990** | 1701.8 | 141.82 | 508.5 | 1.7 | 506.8 | 138.49 | 0.98 |
| **1991** | 1676.9 | 139.74 | 285.1 | 4.7 | 280.4 | 103.80 | 0.74 |
| **1992** | 1517.9 | 126.49 | 386.1 | 0 | 386.1 | 139.45 | 1.10 |
| **1993** | 1458.1 | 121`.51 | 374.3 | 0 | 374.3 | 111.97 | 0.92 |
| **1994** | 1558.9 | 129.51 | 517.6 | 0 | 517.6 | 140.31 | 1.08 |
| **1995** | 1634.6 | 136.22 | 348.3 | 0 | 348.3 | 123.40 | 0.91 |
| **1996** | 2032.4 | 169.37 | 391 | 1.4 | 389.6 | 138.42 | 0.82 |
| **1997** | 1705.7 | 142.14 | 272.3 | 0 | 272.3 | 98.28 | 0.69 |
| **1998** | 1173.3 | 97.78 | 247.8 | 0 | 247.8 | 101.79 | 1.04 |
| **1999** | 1819.4 | 151.59 | 318.3 | 0.3 | 318 | 110.30 | 0.73 |
| **2000** | 1655 | 137.92 | 395.7 | 0 | 395.7 | 140.55 | 1.02 |
| **2001** | 1464.2 | 122.02 | 280.5 | 0 | 280.5 | 86.45 | 0.71 |
| **2002** | 1426.5 | 118.86 | 228.3 | 0 | 228.3 | 95.90 | 0.81 |
| **2003** | 1572 | 131 | 346 | 3.1 | 342.9 | 116.76 | 0.89 |
| **2004** | 1778.9 | 148.24 | 353 | 12.3 | 340.7 | 120.15 | 0.81 |
| **2005** | 1473.3 | 122.78 | 356.3 | 0.1 | 356.2 | 117.50 | 0.96 |
| **2006** | 2125.6 | 177.13 | 452.1 | 0 | 452.1 | 147.26 | 0.83 |
| **2007** | 2056 | 171.33 | 458.4 | 0 | 458.4 | 174.46 | 1.02 |
| **2008** | 1885 | 157.08 | 358.6 | 0 | 358.6 | 129.79 | 0.83 |
| **2009** | 1875.4 | 156.28 | 569.4 | 5.4 | 564 | 169.95 | 1.09 |
| **2010** | 1795 | 149.58 | 554.4 | 0 | 554.4 | 152.40 | 1.02 |
| **2011** | 1705.1 | 142.09 | 435.9 | 0 | 435.9 | 141.19 | 0.99 |
| **2012** | 1584.4 | 132.03 | 317.2 | 0 | 317.2 | 110.43 | 0.84 |
| **2013** | 1648 | 137.33 | 370.8 | 23.7 | 347.1 | 109.10 | 0.79 |
| **2014** | 1874.8 | 156.23 | 333.9 | 0 | 333.9 | 112.85 | 0.72 |
| **2015** | 1244.9 | 95.76 | 291.3 | 0 | 291.3 | 89.37 | 0.93 |
| **2016** | 1723 | 143.58 | 336.9 | 16.6 | 320.3 | 119.18 | 0.83 |
| **2017** | 1690.5 | 137.38 | 398.9 | 3.6 | 395.3 | 122.97 | 0.89 |
| **2018** | 1900.8 | 158.36 | 408.1 | 0 | 408.1 | 125.93 | 0.80 |

#### 4.6.1.3 *Rainfall Seasonality Index over Ijebu-Ode*

The seasonality index (SI) is a measure of intra-annual rainfall variability for Ijebu-Ode area. SI is calculated using historical rainfall data (1989-2018), a historical average value is represented for Ijebu-Ode (i.e., locality) in Table (4.4).Temporal rainfall seasonal variation trends and major rainfall regimes over Ijebu-Ode (1989-2018) are investigated via a seasonality index (SI) (Table 4.4), by applying a classification based on SI values (Table 4.3). Rainfall seasonality is related to the temporal distribution of rainfall on a monthly basis which can be estimated by the Walsh and Lawler (1981) index. The proposed method (SI) is very simple with few data required for the calculation (a) the sum of the absolute deviations of the monthly rainfall (b) the sum of average monthly rainfall, and (c) the total annual rainfall of the given year. The method aims to characterize the distribution of precipitation throughout the year and to classify the climate of Ijebu-Ode. A period of at least 30 years data is necessary (1989-2018). The categories of rainfall and their limits are presented in Table 4.3

Seasonality Index (SI), derived by Walsh and Lawler (1981).

$$SI = \frac{1}{Ri} \sum_{n=1}^{n=12} \left| Xin - \frac{Ri}{12} \right|$$

Where Ri is the total annual precipitation for the particular year under study and Xin is the actual monthly precipitation for month n. The index, SI, is the sum of the absolute deviations of the monthly rainfall from the mean monthly rainfall (see Table 4.10), divided by the total annual precipitation of the given year (Table 4.5). This study considers how the investigation of the seasonal index and the monthly rainfall patterns appear to include significant overlap. The annual seasonality indexes for all years were determined, for Ijebu-Ode city the SI indicates that climate is characterized by two rainfall regimes: *rather seasonal with a shorter drier season* (between 0.4 – 0.59) and *seasonal* (0.60 – 0.79) for the study period. Five (1989, 1993, 1998, 2001, 2002) of the six years that experience *seasonal* rainfall, fall within the first half of the study period (Table 4.5), with only 2015 within the second half of the study period. The *rather seasonal with a shorter drier season* is found to have become a regular occurrence in last 16 years (2006-2018), implying an increase in wet season length and shortening of the dry season. With peaks in 0.74 (1998), 0.41 (2006), and 0.7 (2015), respectively, analysis of the long-term seasonality index score shows that the year-to-year rainfall regime in Ijebu-Ode over the last three decades is relatively stable but susceptible to seasonal instabilities in precipitation (Figure 4.12 & Table 4.5).

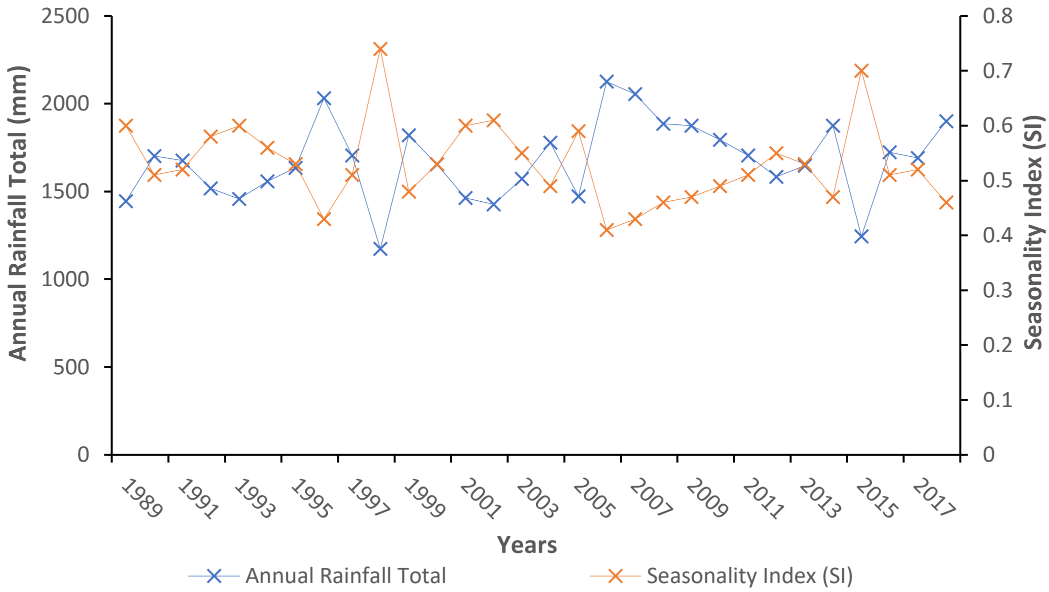


**Figure 4.12**: Annual total rainfall distribution and fluctuation of the SI over Ijebu-Ode

Findings in Figure (4.12) and Table (4.5) suggest that Ijebu-Ode local climate can be characterised by temporal variability of rainfall and have experienced a change and shift in rainfall distribution and seasonality and getting wetter. The rainfall seasonality index classifies the type of climate in relation to water availability, the lower the seasonality index of a region (Table 4.4) the greater the water resources variability and surplus in time, the more vulnerable the area to excess soil moisture and overland runoff when there is infrastructural deficit. Climate change is modifying the earth's atmospheric conditions, thus leading to potential increases in extreme meteorological events (Easterling et al. 2000; Mikhaylov et al. 2020); this includes the alteration of total annual rainfall which in effect will alter the precipitation distribution in seasonality and interannual variability (Feng et al. 2013). An important climate parameter, seasonality index (SI), which is the representation of variability of monthly rainfall amounts within a year, has received scant focus regarding its potential behaviour under climate change scenario (Imteaz and Hossain, 2023). The findings give an insight to the flood risk and chance of addressing it/got significant impact on the water resources planning and management.

**Table 4.4:** Classification of seasonality index (SI) according to Walsh & Lawler (1981) & Kanellopoulou (2002)

| **Rainfall regimes** | **Seasonality index (SI)** |
|---|---|
| Very equable – Rainfall spread throughout the year | ≤ 0.19 |
| Equable with a definite wetter season – Rainfall spread throughout the year, but with a definite wetter season | 0.20 – 0.39 |
| Rather seasonal with a shorter drier season | 0.4 – 0.59 |
| Seasonal | 0.60 – 0.79 |
| Markedly seasonal with a long drier season | 0.80 – 0.99 |
| Most rain in 3 months or less | 1.00 – 1.19 |
| Extreme seasonality, with almost all rainfall in 1 to 2 months | ≥ 1.20 |

**Table 4.5:** Descriptive analysis of data for evaluation of temporal rainfall seasonal variation and major rainfall regimes using seasonality index (SI).

| Years | Annual Rainfall Total (mm) | Seasonality Index (SI) | Rainfall regime |
|---|---|---|---|
| **1989** | 1445.5 | 0.60 | Seasonal |
| **1990** | 1701.8 | 0.51 | Rather seasonal with a short drier season |
| **1991** | 1676.9 | 0.52 | Rather seasonal with a short drier season |
| **1992** | 1517.9 | 0.58 | Rather seasonal with a short drier season |
| **1993** | 1458.1 | 0.60 | Seasonal |
| **1994** | 1558.9 | 0.56 | Rather seasonal with a short drier season |
| **1995** | 1634.6 | 0.53 | Rather seasonal with a short drier season |
| **1996** | 2032.4 | 0.43 | Rather seasonal with a short drier season |
| **1997** | 1705.7 | 0.51 | Rather seasonal with a short drier season |
| **1998** | 1173.3 | **0.74** | Seasonal |
| **1999** | 1819.4 | 0.48 | Rather seasonal with a short drier season |
| **2000** | 1655 | 0.53 | Rather seasonal with a short drier season |
| **2001** | 1464.2 | 0.60 | Seasonal |
| **2002** | 1426.5 | 0.61 | Seasonal |
| **2003** | 1572 | 0.55 | Rather seasonal with a short drier season |
| **2004** | 1778.9 | 0.49 | Rather seasonal with a short drier season |
| **2005** | 1473.3 | 0.59 | Rather seasonal with a short drier season |
| **2006** | 2125.6 | **0.41** | Rather seasonal with a short drier season |
| **2007** | 2056 | 0.43 | Rather seasonal with a short drier season |
| **2008** | 1885 | 0.46 | Rather seasonal with a short drier season |
| **2009** | 1875.4 | 0.47 | Rather seasonal with a short drier season |
| **2010** | 1795 | 0.49 | Rather seasonal with a short drier season |
| **2011** | 1705.1 | 0.51 | Rather seasonal with a short drier season |
| **2012** | 1584.4 | 0.55 | Rather seasonal with a short drier season |
| **2013** | 1648 | 0.53 | Rather seasonal with a short drier season |
| **2014** | 1874.8 | 0.47 | Rather seasonal with a short drier season |
| **2015** | 1244.9 | 0.70 | Seasonal |
| **2016** | 1723 | 0.51 | Rather seasonal with a short drier season |
| **2017** | 1690.5 | 0.52 | Rather seasonal with a short drier season |
| **2018** | 1900.8 | 0.46 | Rather seasonal with a short drier season |

**Source:** Classification of seasonality index (SI) according to Walsh & Lawler (1981).

Because rainfall is unpredictable and seasonal (Figure 4.12 & Table 4.5), it is essential to monitor using meteorological indexes (Table 4.6, 4.7 & Figure 4.13) (Juliana Alcântara Costa et Gláuber Pontes Rodrigues, 2017). A monitoring system for the characteristics of dry and wet periods may be created as a result (DA SILVA et al., 2009). The Rainfall Anomaly Index (RAI), created by Rooy (1965), is used to categorise the positive and negative severities of rainfall anomalies in this context. Because it just requires precipitation data, it is regarded as an index of outstanding procedural simplicity (Freitas, 2005; Fernandes et al., 2009). The goal of RAI, according to Rooy (1965), is to make it possible to compare precipitation deviations across regions. More recently, Arajo et al. (2009) used RAI as a tool and discovered parallels in the precipitation pattern -positive and negative anomalies are taken into account by the RAI (Rainfall Anomaly Index). The information on rainfall is first arranged in descending order and a threshold for positive anomaly is created by averaging the ten highest results, while a threshold for a negative anomaly is created by averaging the ten lowest values. The mean of the 10 most extreme positive and negative anomalies has been given the arbitrary threshold values of +3 and -3 (Samuel et al., 2003). The relative rainfall anomaly index is then scaled against a range of nine abnormality classes, from highly wet to severely dry conditions. Positive or negative precipitation anomalies are related to the sign, which may be positive or negative.

The Annual Rainfall Anomaly Index (RAI), which was derived from the precipitation data, was developed to examine the frequency and severity of the dry and rainy years in the research area. To examine the distribution of rainfall in the years with the biggest anomalies, the monthly RAI was also calculated for certain historical series years. RAI is made up of the following equations and was created by Rooy (1965) and first utilised by Freitas (2005). Equation 1 states that RAI is equal to +3 (N - N)/ (S2 - N) for positive anomalies and equation 2 states that RAI is equal to -3 (N - N)/ ($\bar{X}$ - N) for negative anomalies.

N = current yearly rainfall (mm);

N = yearly average rainfall of the historical series (mm);

M = average of the ten highest yearly rainfall of the historical series (mm); and

$\bar{X}$ = average of the ten highest yearly rainfall of the historical series (mm); and,

Positive anomalies have their values above average and negative anomalies have their values below average.

**Table 4.6**: The classification of the index used by van Rooy (1965)

| **S/N** | **RAI** | **Class description** |
|---|---|---|
| **1** | >3.00 | Extremely wet |
| **2** | 2.00 to 2.99 | Very wet |
| **3** | 1.00 to 1.99 | Moderately wet |
| **4** | 0.50 to 0.99 | Slightly wet |
| **5** | 0.49 to -0.49 | Near normal |
| **6** | -0.05 to – 0.99 | Slightly dry |
| **7** | -1.00 to -1.99 | Moderately dry |
| **8** | -2.00 to -2.99 | Very dry |
| **9** | <3.00 | Extremely dry |

**Source:** van Rooy (1965)

**Table 4.7**: Classification of Rainfall Anomaly Index Intensity

<table>
<tr><td rowspan="7">Rainfall Anomaly Index (RAI)</td><td>RAI range</td><td>Classification</td></tr>
<tr><td>Above 4</td><td>Extremely humid</td></tr>
<tr><td>2 to 4</td><td>Very humid</td></tr>
<tr><td>0 to 2</td><td>Humid</td></tr>
<tr><td>-2 to 0</td><td>Dry</td></tr>
<tr><td>-4 to -2</td><td>Very dry</td></tr>
<tr><td>Below -4</td><td>Extremely dry</td></tr>
</table>

**Source:** Freitas (2005) adapted by Araủjo et al. (2009)

**Table 4.8:** The annual rainfall total for the research area's wet circumstances for the past 30 years (1989-2018).

| **Year** | **Total annual rainfall** | **Annual average rainfall deviation** | **Annual rainfall anomaly index (RAI)** | **Rooy (1965) Class description** | **Freitas (2005) adapted by Araùjo et al. (2009) Classification** |
|---|---|---|---|---|---|
| 1989 | 1445.5 | -227.93 | 0.477O21 | Near normal | Humid |
| **1990** | **1701.8** | **28.37** | 0.044459 | Near normal | Humid |
| **1991** | **1676.9** | **3.47** | 0.005438 | Near normal | Humid |
| 1992 | 1517.9 | -155.53 | 0.325499 | Near normal | Humid |
| 1993 | 1458.1 | -215.33 | 0.450651 | Near normal | Humid |
| 1994 | 1558.9 | -114.53 | 0.239693 | Near normal | Humid |
| 1995 | 1634.6 | -38.83 | 0.081265 | Near normal | Humid |
| **1996** | **2032.4** | **358.97** | 0.562552 | Slightly wet | Humid |
| **1997** | **1705.7** | **32.27** | 0.050571 | Near normal | Humid |
| 1998 | 1173.3 | -500.13 | 1.046691 | Moderately wet | Humid |
| **1999** | **1819.4** | **145.97** | 0.228754 | Near normal | Humid |
| 2000 | 1655 | -18.43 | 0.038571 | Near normal | Humid |
| 2001 | 1464.2 | -209.23 | 0.437885 | Near normal | Humid |
| 2002 | 1426.5 | -246.93 | 0.516785 | Slightly wet | Humid |
| 2003 | 1572 | -101.43 | 0.212277 | Near normal | Humid |
| **2004** | **1778.5** | **105.47** | 0.165285 | Near normal | Humid |
| 2005 | 1473.3 | -200.13 | 0.41884 | Near normal | Humid |
| **2006** | **2125.6** | **452.17** | 0.708608 | Slightly wet | Humid |
| **2007** | **2056** | **382.57** | 0.599536 | Slightly wet | Humid |
| **2008** | **1885** | **211.57** | 0.331557 | Near normal | Humid |
| **2009** | **1875.4** | **201.97** | 0.316513 | Near normal | Humid |
| **2010** | **1795** | **121.57** | 0.190516 | Near normal | Humid |
| **2011** | **1705.1** | **31.67** | 0.049631 | Near normal | Humid |
| 2012 | 1584.4 | -89.03 | 0.186325 | Near normal | Humid |
| 2013 | 1648 | -25.43 | 0.053221 | Near normal | Humid |
| 2014 | 1874.8 | 201.37 | 0.315573 | Near normal | Humid |
| 2015 | 1244.9 | -428.53 | 0.896844 | Sightly wet | Humid |
| **2016** | **1723** | **49.57** | 0.077683 | Near normal | Humid |
| **2017** | **1690.5** | **17.07** | 0.026751 | Near Normal | Humid |
| **2018** | **1900.8** | **227.37** | 0.356318 | Near normal | Humid |

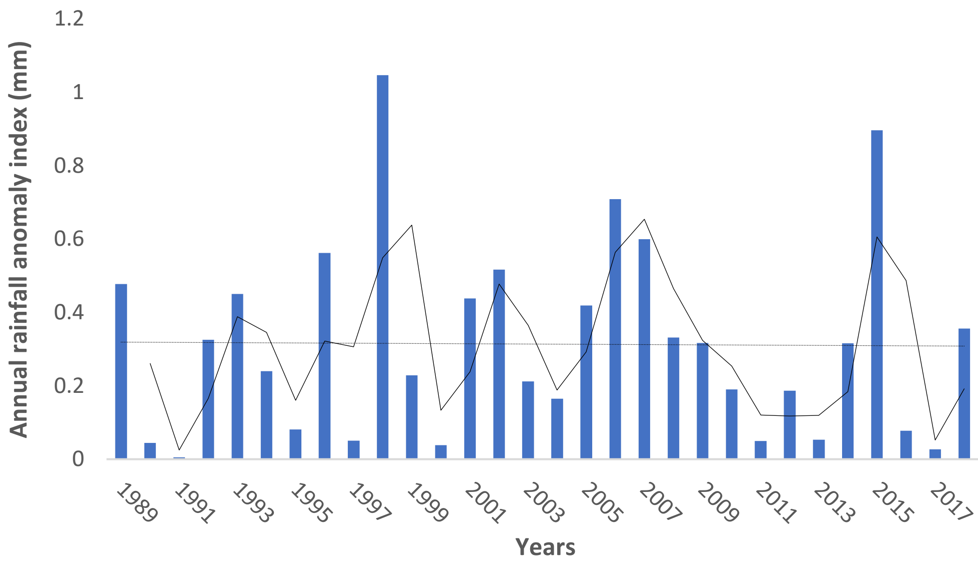


**Figure 4.13**: Rainfall Anomaly Index (RAI) for Ijebu-Ode communities, indicating Linear Forecast and Two Period Moving Average

As shown in Figure 4.13 and Table 4.8 for the years 1989 to 2018, ranging from moderately wet (one year), slightly wet (five years), and near normal (24 years) according to the classification of the index (Table 4.6) used by van Rooy (1965), all humid years (30 years) with varying degrees of intensity according to the classification of the index (Table 4.7) used by Freitas (2005) and modified by Araủjo et al. (2009). Highest Positive values (M) = 1.046691 ÷ 30 (years of which positive anomalies occurred within the study period) = 0.0348897 near normal.

The findings (Table 4.8) showed that Ijebu-Ode is suitable for classification as a humid environment, which is used to describe an atmosphere with relatively high levels of water vapour and is typically very hot (warmer climates increase evapotranspiration, putting more moisture into the atmosphere that is then released as rain). The outcome suggested that the humid weather is causing the already damp environment to become even more damp. This implies that the ongoing flood risk (s) in Ijebu-Ode will be increased or made worse by additional wet weather, i.e., heavy showers. The communities of Ijebu-Ode are therefore asked to be vigilant and ready.

**Table 4.9:** The average of the 10 highest and lowest historical series (mm) shows the years when wet and normal conditions occurred in Ijebu-Ode LGA during the course of 30 years, from 1989 to 2018.

| Index classification of Van Roy (1965) | Years |
|---|---|
| **Moderately wet** | 1998 |
| **Slightly wet** | 1996, 2002, 2006, 2007, and 2015 |
| **Near normal** | 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1997, 1999, 2000, 2001, 2003, 2004, 2005, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2016, 2017, and 2018 |
| | |
| **Index classification by Freitas (2005) adapted by Araủjo et al. (2009)** | **Years** |
| **Humid** | 1989-2018 |

To assess the frequency and severity of dry and rainy years, rainfall data are used to calculate the Annual Rainfall Anomaly Index (RAI). The "rainy years" of the historical series were displayed (Tables 4.9 and Figure 4.14). The RAI was seen to fluctuate over the study periods.

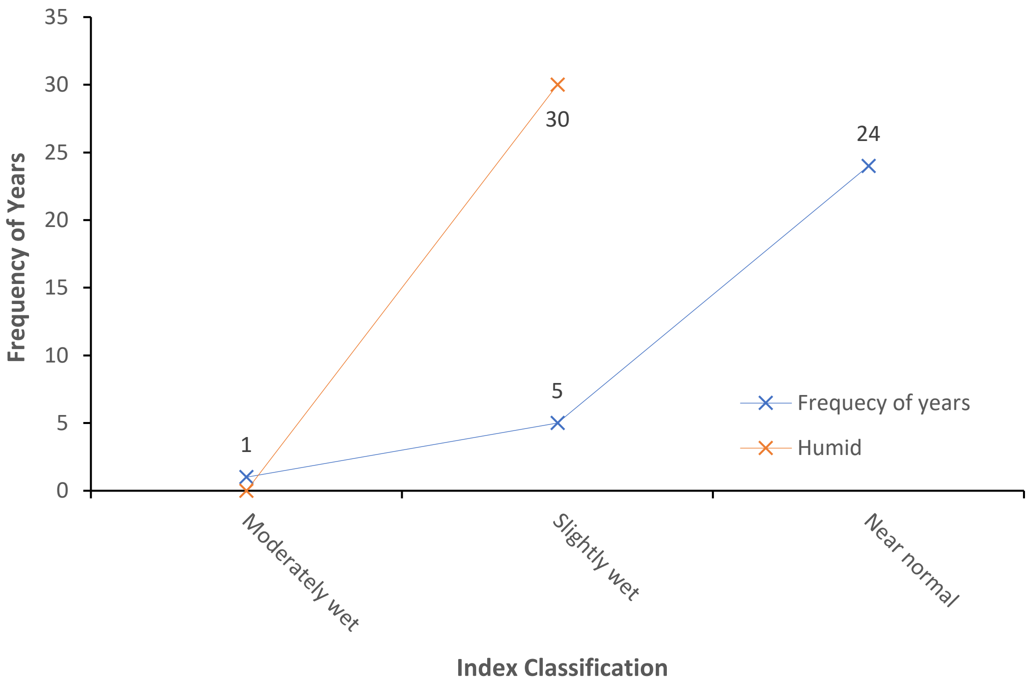


**Figure 4.14:** Displays the frequency distribution of the rainfall anomaly index for wet and normal and humid conditions in the Ijebu-Ode LGA from 1989 to 2018 (30 years), using the average of the 10 highest and lowest historical series

#### **4.4.1.4** *Monthly rainfall analysis*

The maximum average monthly rainfall value is 278.15mm (July) and the lowest 10.76mm (January), producing a range of 267.39mm (Figure 4.15). The month of June received the highest rainfall (569.4mm) whilst January has the minimum rainfall value having 100% of its rainfall being within (57.3mm). The average monthly rainfall recorded in July contributed 16.62% to the annual total, followed by June with 16.33% with lowest in January 0.64% and December 0.82%. The range in the overall average values suggests a relatively high variation and dispersion in the monthly rainfall values.

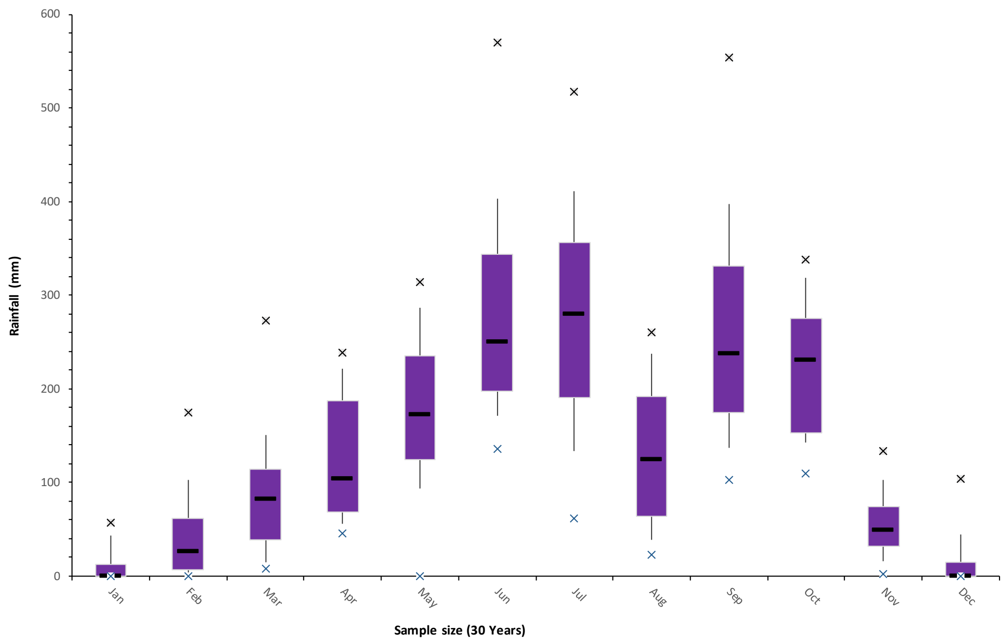


**Figure 4.15:** Monthly rainfall for Ijebu-Ode, S/W Nigeria (1989-2018), Solid Bar-Median Monthly Value; Boxes 25$^{th}$-75$^{th}$ Percentile; Whisker's 10$^{th}$/90$^{th}$ Percentile (*extreme monthly values (1989-2018)).

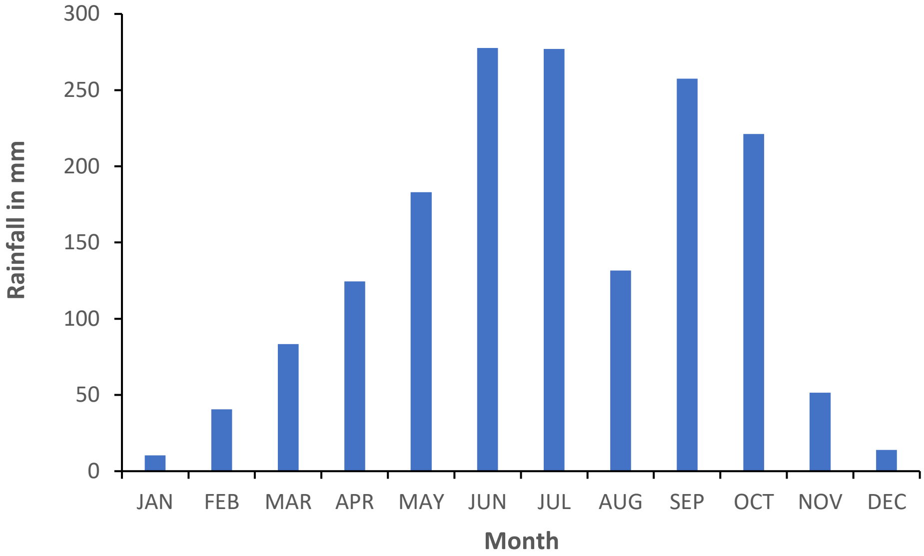


**Figure 4.16:** Monthly rainfall distribution over the study-period (1989-2018)

The classification of the months into their appropriate seasons is essential because the rainfall seasonality index only assesses annual rainfall regimes, intra-annual rainfall variability, and seasonal contrasts in rainfall volume, not dryness or wetness in absolute terms (Table 4.5 & Figure 4.12). As a result, the months of November through March are deemed dry (<100mm), whilst the months of April through October are regarded rainy (>100mm), with the latter having a standard deviation less than their corresponding mean (Table 4.10). The monthly precipitation data are highly and positively skewed, signifying deviation from normal distribution, therefore cannot be disregarded. According to WMO (2017), affirmed statistical descriptor of climate element includes the commonly use arithmetic mean, but can include the values such as standard deviation, percentile points, number of exceedances of threshold or extreme values. Studies show that IQR is a more appropriate measure of variability than standard deviation and coefficient of variation if the data is skewed. The larger the IQR, the more variability and dispersion of the middle quartile are identified. Months April to October indicate high variability of the middle quartile whilst January, February, March, November and December indicated low variability.

**Table 4.10.** Descriptive analysis showing monthly rainfall temporal variability, skewness and dispersion of data points in relation to Mean, IQR, Median, SD, CV & Range (1989-2018).

| Month | R. Maximum Value (mm) | R. Minimum Value (mm) | Mean | SD | CV = SD/M | Q3 ($75^{th}$.P) (mm) | Q1 ($10^{th}$.P) (mm) | IQR (Q3-Q1) (mm) | Median (mm) | Skew-Ness |
|---|---|---|---|---|---|---|---|---|---|---|
| **Jan** | 57.3 | 0 | 10.8 | 17.0 | 1.58 | 12.0 | 0 | 12.0 | 0.05 | 1.88 |
| **Feb** | 178.8 | 0 | 41.0 | 43.7 | 1.07 | 61.5 | 0 | 61.5 | 25.7 | 1.05 |
| **Mar** | 272.3 | 7.9 | 84.1 | 68.8 | 0.82 | 114.0 | 14.1 | 99.9 | 81.8 | 0.10 |
| **Apr** | 238.7 | 45.5 | 124.7 | 65.0 | 0.52 | 186.9 | 55.9 | 131 | 103.5 | 0.98 |
| **May** | 313.4 | 0 | 181.9 | 76.9 | 0.42 | 235.0 | 93.9 | 141.2 | 172.5 | 0.37 |
| **Jun** | 569.4 | 135.5 | 273.3 | 102.1 | 0.37 | 343.6 | 171.6 | 171.9 | 249.5 | 0.70 |
| **Jul** | 517.6 | 61.3 | 278.2 | 116.6 | 0.42 | 356.0 | 132.9 | 223.1 | 280.1 | -0.05 |
| **Aug** | 260 | 22.1 | 131.0 | 74.4 | 0.57 | 192.0 | 39.1 | 153.0 | 124.1 | 0.28 |
| **Sep** | 554.4 | 102.7 | 259.9 | 111.0 | 0.43 | 331.4 | 137.3 | 194.1 | 237.3 | 0.61 |
| **Oct** | 338 | 109.8 | 222.3 | 68.6 | 0.31 | 275.5 | 142.2 | 133.3 | 230.2 | -0.34 |
| **Nov** | 133.4 | 1.4 | 53.0 | 32.9 | 0.62 | 74.5 | 15.5 | 59.0 | 48.84 | 0.38 |
| **Dec** | 103.6 | 0 | 13.7 | 23.6 | 1.72 | 14.4 | 0 | 14.4 | 0 | 1.14 |

The rainfall pattern (Figure 4.15 & 4.16) occurs in such that it rises steadily from February and gets to first peak in July before falling in August into what is locally known as the "August break", it then rises again to a lower peak in September before falling to a low in January. A double maxima rainfall is experienced, characterized by two high rainfall peaks (i.e., July and September), with a short dry season (i.e., August) and a longer dry season falling between and after each peak. Adefoalu (1972), Adekoya (1979) and Omotosho (1988) found that the "August Break" occurrence in Nigeria is limited and are peculiar to the South-western part between $4^0 – 9^0$N and $3^0 – 7^0$E. According to Hamilton & Achibold, (1945) & Ilesanmi, (1972, 1981), the Little Dry Season (LDS) is widely recognized as a major climatological phenomenon noticeable by end of July through August. Studies conducted on the onset and retreat of rainfall in Nigeria (Ilesanmi 1972a, 1972b; Olaniran, 1983; Adejuwon 1988; Odekunle 1997, 2003), have previously identified these same patterns.

**Table 4.11:** Descriptive analysis showing the rainfall boundaries, and weak and strong outliers including months/years of occurrence (1989-2018)

| Months | Upper-inner fence Q3 + (1.5 X IQR) (mm) | Years showing weak outliers (mm) | Months | Upper-outer fence Q3 + (3.0 X IQR) (mm) | Years showing strong outliers (mm) |
|---|---|---|---|---|---|
| **Jan** | 29.88 | 1990 (42.7mm)<br>1994 (31mm)<br>2003 (31.8mm)<br>2009 (46.4mm)<br>2013 (43.4mm) | **Jan** | 47.8 | 2006 (57.3mm) |
| **Feb** | 153.75 | 2018 (174.8mm) | **Feb** | 246 | - |
| **Mar** | 263.79 | 1997 (272.3mm) | **Mar** | 399.56 | - |
| **Apr** | 383.35 | - | **Apr** | 524 | - |
| **May** | 446.79 | - | **May** | 564.68 | - |
| **Jun** | 601.32 | - | **Jun** | 687.64 | - |
| **Jul** | 690.67 | - | **Jul** | 892.36 | - |
| **Aug** | 421.5 | - | **Aug** | 611.92 | - |
| **Sep** | 622.60 | - | **Sep** | 776.44 | - |
| **Oct** | 475.39 | - | **Oct** | 533.08 | - |
| **Nov** | 162.96 | - | **Nov** | 235.88 | - |
| **Dec** | 35.95 | 1997 (47.1mm)<br>2013 (41.7mm) | **Dec** | 57.52 | 1990 (103.6mm)<br>2001 (58.6mm) |

Months and years with minor or weak outliers include January 1990 (42.7mm), 1994 (31mm), 2003 (31.8mm) and 2009 (46.4mm); February 2018 (174.8mm); March 1997 (272.3mm); December 1997 (47.1mm) and 2013 (41.7mm) whilst the months and years showing strong outliers include January 2006 (57.3mm); December 1990 (103.6mm) and 2001 (58.6mm) (Table. 4.11). The rainy season and dry season in Ijebu-Ode is clear and established, this is crucial for redesigning seasonal flood management of Ijebu-Ode. Grubbs (1969) indicate an outlier as an observation that is statistically detached from rest of the data.

#### 4.4.1.5. *Daily rainfall analysis*

A total of 3493 days (10950) recorded rainfall (>0.1mm) at Ijebu-Ode, 1989-2018. The maximum daily rainfall rates are generally observed in the month of July. The distribution for extreme daily rainfall events at Ijebu-Ode covering the thirty-year period 1989-2018 is presented in Figure 4.17. No significant trends or patterns in extreme rainfall or frequency of extreme events over the study period are evident, suggesting any change in flood occurrence is a function of non-climatic factors at Ijebu-Ode. However, an absence of intense precipitation events exceeding 120mm, between 1989 and 2005, except for 1994 (160.1mm), may have led to a low public perceptions of flood risk, before intense precipitation events in 2006 and 2007, both exceeding 170mm, with events in 2010 (144mm), 2012 (132.5mm) and 2014 (128.9mm) exceeding the 120mm $d^{-1}$; the distribution of events exceeding 120mm $d^{-1}$ all occur in the second half except the 1994 event. In the first half of the period 83 events compared to 92 events in the second half occurred above the 0.5 percentile, with 6 events in the first half exceeding 100mm $d^{-1}$ compared to 9 in the second half of the record. The pattern of increased daily maximum precipitation whilst not statistically significant may support perceptions of increased flooding in Ijebu-Ode.

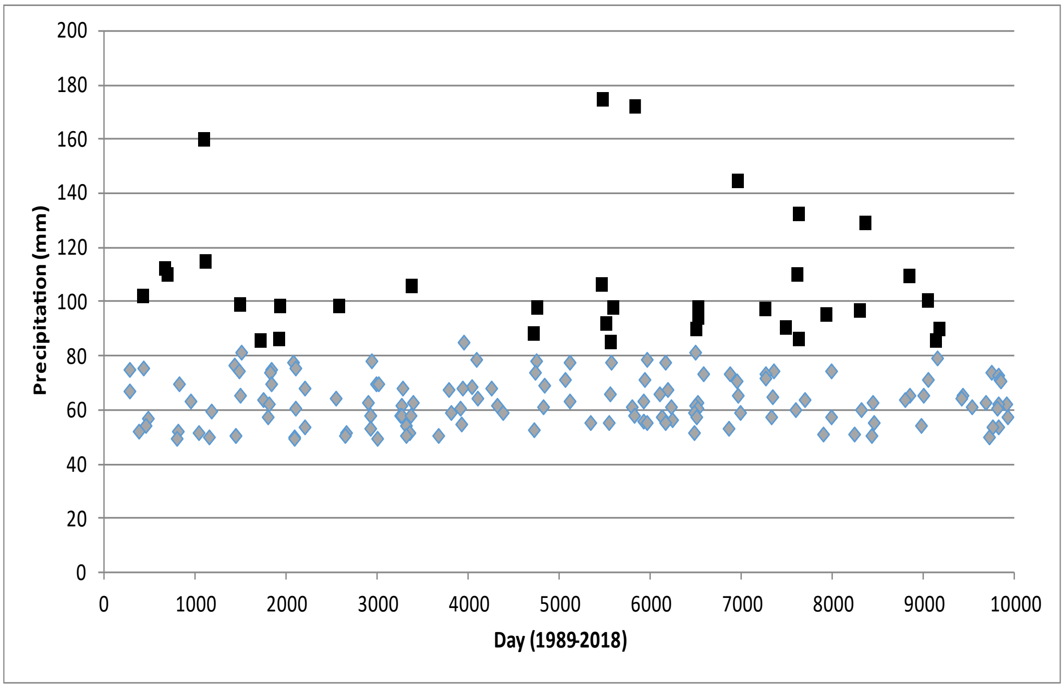


**Figure 4.17**: Maximum daily rainfall, 0.1 percentile (black squares) and 0.5 percentile (grey diamonds) for Ijebu-Ode covering the thirty-year period 1989-2018.

### **4.7.1** Atmospheric Temperature

This study uses daily synoptic atmospheric temperature from Ijebu-Ode city station obtained from Nigerian Meteorological Agency (NIMET), for 30-year period 1989-2018.

#### **4.7.1.1** *Monthly minimum temperature analysis*

The monthly minimum temperature was obtained from the daily values each month and year (Figure 4.18). The highest mean monthly minimum temperature is 24.5$^{0}$C (March) and the lowest 22.4$^{O}$C (January); April (1998), was the warmest month on record (25.8$^{O}$C), whilst January (1989) the lowest minimum monthly temperature (19.2$^{O}$C).

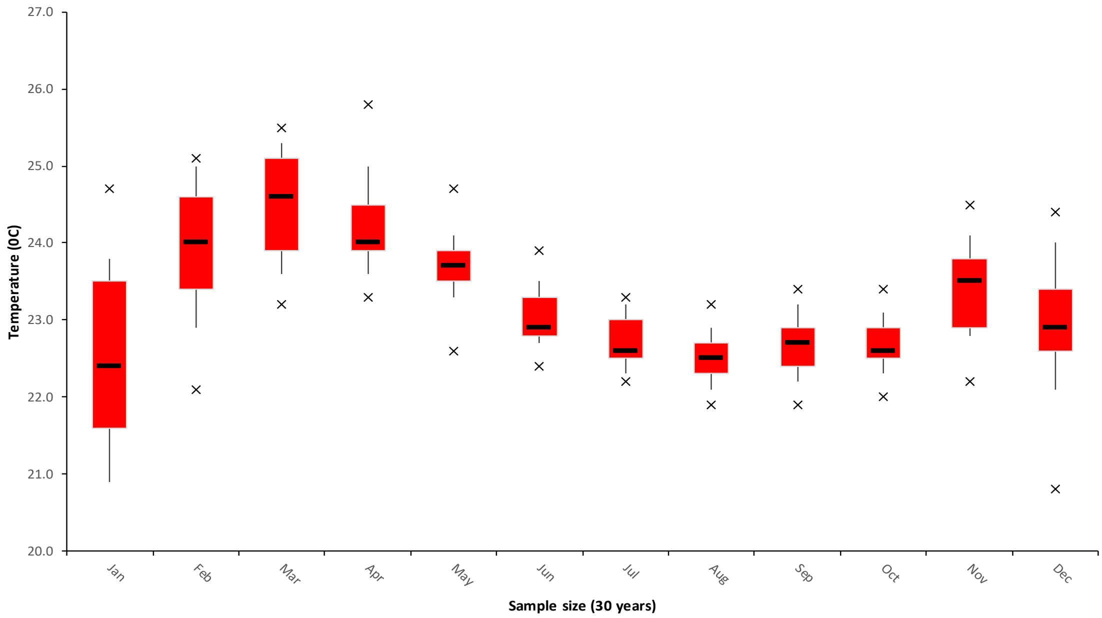


**Figure 4.18:** Monthly minimum temperature of Ijebu-Ode, S/W Nigeria (1989-2018) Solid bar-median Monthly Value; Boxes 25$^{th}$-75$^{th}$ Percentile; Whisker's 10$^{th}$/90$^{th}$ Percentile (x – extreme monthly values 1989-2018).

The minimum monthly temperature rises steadily from February and gets to first peak in March before falling gradually to the lowest point in August, it then rises again to a lower peak in November before falling gradually in January (Figure. 4.18). Mean monthly minimum temperature was statistically determined to be at 23.2$^{0}$C, with a standard deviation of 0.7$^{0}$C and a narrow range (2$^{0}$C). The average minimum temperature was high in the dry season and low in the wet season in Ijebu-Ode. The highest variability occurred in January with IQR of 2.6$^{0}$C and the lowest in May-June, August, October with IQR of

0.6$^0$C (see Table 4.7). IQR and standard deviation for all the months are low, implying relatively low variation and dispersion. Overall, minimum temperature coefficient of variation for the months of January through December ranges between 0.1$^0$C – 0.6$^0$C (<1) suggesting a relatively low variability (see Table 4.12).

**Table 4.12:** Descriptive analysis showing monthly minimum temperature temporal variability and dispersion of data points in relation to the Mean, IQR, SD, CV and Range (1989-2018).

| **Month** | **Mean ($^0$C)** | **SD** | **Q3** | **Q1** | **IQR (Q3-Q1)** | **Lowest** | **Highest** | **Skew** | **CV = (SD\M)** |
|---|---|---|---|---|---|---|---|---|---|
| **Jan** | 22.4 | 1.3 | 23.5 | 20.9 | 2.6 | 19.2 | 24.7 | 0 | 0.06 |
| **Feb** | 23.9 | 0.9 | 24.6 | 22.9 | 1.7 | 22.1 | 25.1 | -0.3 | 0.04 |
| **Mar** | 24.5 | 0.6 | 25.1 | 23.6 | 1.5 | 23.2 | 25.5 | -0.5 | 0.03 |
| **Apr** | 24.2 | 0.6 | 24.5 | 23.6 | 0.9 | 23.3 | 25.8 | 1 | 0.03 |
| **May** | 23.7 | 0.4 | 23.9 | 23.3 | 0.6 | 22.6 | 24.7 | 0 | 0.02 |
| **Jun** | 23.0 | 0.3 | 23.3 | 22.7 | 0.6 | 22.4 | 23.9 | 1 | 0.01 |
| **Jul** | 22.7 | 0.3 | 23 | 22.3 | 0.7 | 22.2 | 23.3 | 1 | 0.01 |
| **Aug** | 22.5 | 0.3 | 22.7 | 22.1 | 0.6 | 21.9 | 23.2 | 0 | 0.01 |
| **Sep** | 22.7 | 0.4 | 22.9 | 22.2 | 0.7 | 21.9 | 23.4 | 0 | 0.02 |
| **Oct** | 22.7 | 0.3 | 22.9 | 22.3 | 0.6 | 22.0 | 23.4 | 1 | 0.01 |
| **Nov** | 23.4 | 0.5 | 23.8 | 22.8 | 1 | 22.2 | 24.5 | -0.6 | 0.02 |
| **Dec** | 22.9 | 0.8 | 23.4 | 22.1 | 1.3 | 20.8 | 24.4 | 0 | 0.04 |

**Table 4.13:** Descriptive analysis showing boundaries of the inner and outer fence and minor/weak outliers and months/years of occurrence for minimum temperature (1989-2018).

| Months | Upper inner fence (Q3 + (1.5 X IQR) ($^0$C) | Lower inner fence Q1 – (1.5 X IQR) ($^0$C) | Years showing minor/weak outliers ($^0$C) |
|---|---|---|---|
| **Jan** | 27.4 | 17 | - |
| **Feb** | 27.15 | 20.35 | - |
| **Mar** | 27.35 | 21.35 | - |
| **Apr** | 25.85 | 22.25 | - |
| **May** | 24.8 | 22.4 | - |
| **Jun** | 24.2 | 21.8 | - |
| **Jul** | 24.05 | 21.25 | - |
| **Aug** | 23.6 | 21.2 | - |
| **Sep** | 23.95 | 21.15 | - |
| **Oct** | 23.8 | 21.4 | - |
| **Nov** | 25.3 | 21.3 | - |
| **Dec** | 25.35 | 20.15 | - |

#### **4.7.1.2** *Monthly maximum temperature analysis*

The maximum temperature was obtained by totalling the daily values for each month (Figure 4.19). The maximum average temperature is recorded in February (34.6$^0$C) and lowest in August (28.2$^O$C), producing a range of 6.4$^O$C and standard deviation of 2.2$^0$C (Table 4.10). The month of February 1998 received the highest monthly temperature (36.7$^O$C), and the lowest was in August, 1992 (27.2$^O$C). The maximum temperature rises steadily from January and gets to peak in February before falling gradually to lowest point in August, it then continues to rise steadily again (Figure 4.19).

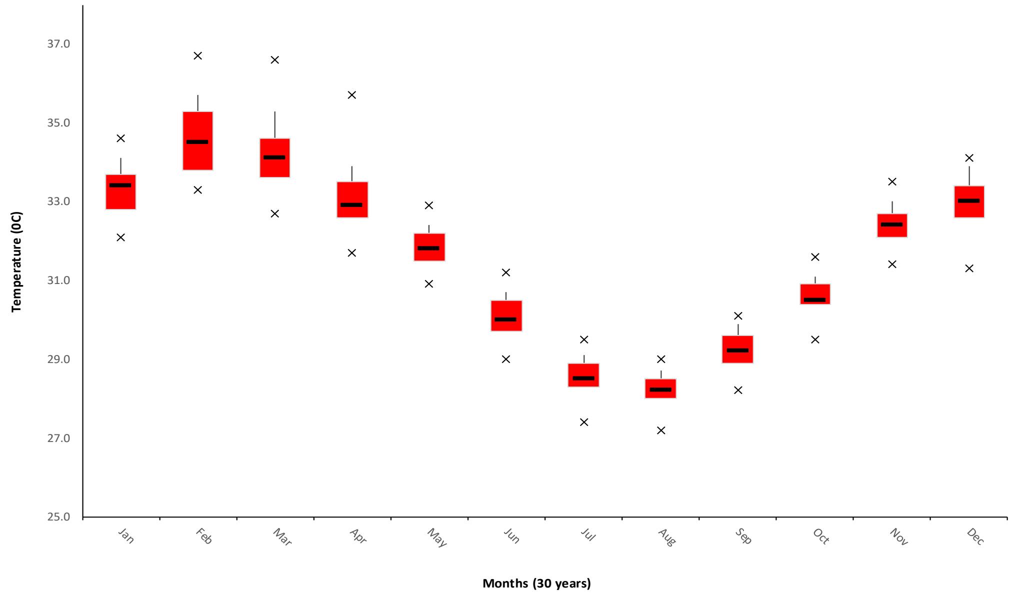


**Figure 4.19:** Monthly maximum temperature of Ijebu-Ode, S/W Nigeria (1989-2018) Solid bar-median Monthly Value; Boxes 25$^{th}$-75$^{th}$ Percentile; Whisker's 10$^{th}$/90$^{th}$ Percentile (x – extreme monthly values 1989-2018).

**Table 4.14:** Descriptive analysis showing the monthly maximum temperature temporal variability and dispersion of data points in relation to the Mean, IQR, SD, CV and Range (1989-2018).

| Months | Mean ($^0$C) | SD | Q3 ($75^{th}$P) | Q1 ($10^{th}$P) | IQR (Q3-Q1) | Lowest value | Highest value | Skew | CV = SD/M) |
|---|---|---|---|---|---|---|---|---|---|
| **Jan** | 33.3 | 0.7 | 33.7 | 32.4 | 1.3 | 32.1 | 34.6 | -0.43 | 0.02 |
| **Feb** | 34.6 | 0.9 | 35.3 | 33.7 | 1.6 | 33.3 | 36.7 | 0.33 | 0.03 |
| **Mar** | 34.2 | 1.0 | 34.6 | 34.4 | 1.2 | 32.7 | 36.6 | 0.3 | 0.03 |
| **Apr** | 33.0 | 0.8 | 33.5 | 32.3 | 1.2 | 31.7 | 35.7 | 0.38 | 0.02 |
| **May** | 31.8 | 0.5 | 32.2 | 31.0 | 1.2 | 30.9 | 32.9 | 0 | 0.02 |
| **Jun** | 30.1 | 0.5 | 30.5 | 29.4 | 1.1 | 29.0 | 31.2 | 0.6 | 0.02 |
| **Jul** | 28.5 | 0.5 | 28.9 | 27.9 | 1 | 27.4 | 29.5 | 0 | 0.02 |
| **Aug** | 28.2 | 0.4 | 28.5 | 27.8 | 0.7 | 27.2 | 29.0 | 0 | 0.01 |
| **Sep** | 29.2 | 0.5 | 29.6 | 28.6 | 1 | 28.2 | 30.1 | 0 | 0.02 |
| **Oct** | 30.6 | 0.5 | 30.9 | 30.2 | 0.7 | 29.5 | 31.6 | 0.6 | 0.02 |
| **Nov** | 32.4 | 0.5 | 32.7 | 31.8 | 0.9 | 31.4 | 33.5 | 0 | 0.02 |
| **Dec** | 33.0 | 0.7 | 33.4 | 32.2 | 1.2 | 31.3 | 34.1 | 2.14 | 0.02 |

It is evident (Table 4.14) that the months of January and December recorded low variation of middle quartiles (Q2-3), with months of August, October and November having lowest variability from the mean and range (0.7$^0$C-0.9$^0$C), whilst the remaining months have relatively low variability (1$^0$C-1.6$^0$C). The IQR and standard deviation for all the months is low, implying relatively low variation and dispersion. The findings (Table 4.15) show months and years with minor or weak outliers to include March 1990 (36.5$^0$C), 1998 (36.5$^0$C), 2000 (36.6$^0$C) and April 1998 (35.7$^0$C). The findings established that monthly average maximum temperature was relatively high in the dry season and low in the wet season in Ijebu-Ode.

**Table 4.15:** Descriptive analysis showing boundaries of both the inner and outer fence and minor/weak outliers and months/years of occurrence for the maximum temperature (1989-2018).

| Months | Upper inner fence (Q3 + (1.5 X IQR) ($^0$C) | Lower inner fence (Q1 – (1.5 X IQR) ($^0$C) | Years showing minor/weak outliers. ($^0$C) |
|---|---|---|---|
| **Jan** | 35.65 | 30.45 | - |
| **Feb** | 37.7 | 31.3 | - |
| **Mar** | 36.4 | 31.6 | 1990 (36.5$^0$C); 1998 (36.5$^0$C); 2000 (36.6$^0$C). |
| **Apr** | 35.3 | 30.5 | 1998 (35.7$^0$C) |
| **May** | 34 | 29.2 | - |
| **Jun** | 32.15 | 27.75 | - |
| **Jul** | 30.4 | 26.4 | - |
| **Aug** | 29.55 | 26.75 | - |
| **Sep** | 31.1 | 27.1 | - |
| **Oct** | 31.95 | 29.15 | - |
| **Nov** | 34.05 | 30.45 | - |
| **Dec** | 35.2 | 30.4 | - |

## **4.8.** Combined monthly rainfall and atmospheric temperature (minimum and maximum) analysis.

A summary analysis of monthly rainfall, minimum and maximum atmospheric temperature data for 30-years study period (1989 to 2018) is presented in Figure 4.20. Overall, skewness of monthly total rainfall distribution stand at 0.162, implying distribution is approximately symmetrical. Kurtosis -1.601 for mean monthly rainfall revealed distribution has a light tail than the normal distribution and was highly platykurtic. Skewness of monthly total minimum atmospheric temperature distribution stand at -0.663, implying distribution is approximately symmetrical. In the same vein, skewness of the monthly total maximum atmospheric temperature distribution stand at -0.283, implying distribution is approximately symmetrical. Mean monthly minimum and maximum atmospheric temperature are skewed, suggesting distortion or asymmetry in the normal temperature distribution. The kurtosis -0.947 for the mean monthly minimum atmospheric temperature revealed distribution with negative kurtosis, was highly platykurtic. In the same vein, the kurtosis -1.325 for the mean monthly maximum atmospheric temperature show distribution with negative kurtosis, was highly platykurtic.

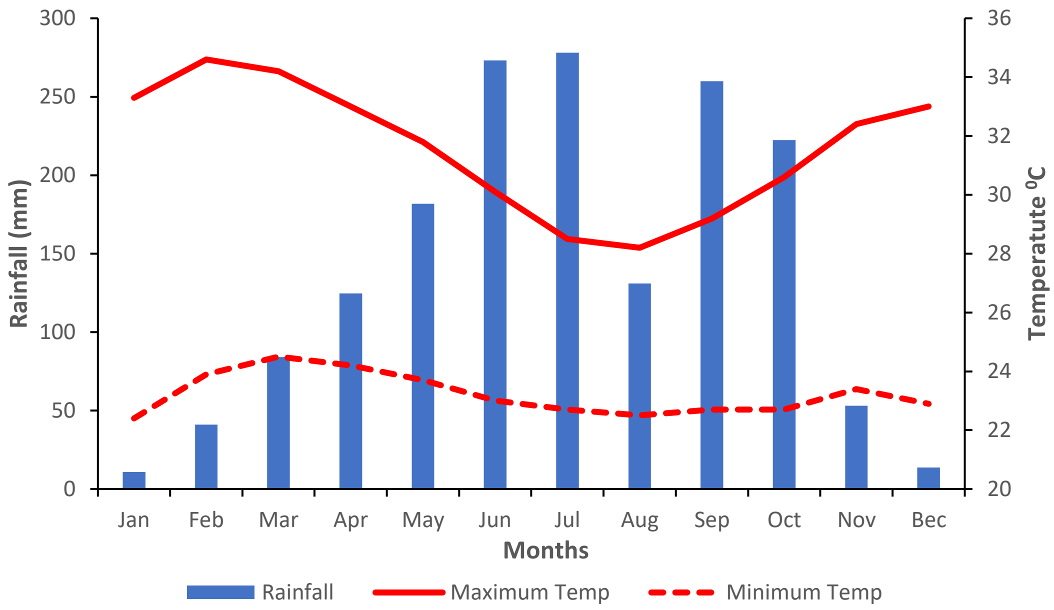


**Figure 4.20.** Combined mean monthly rainfall, minimum and maximum temperature variation (1989-2018).

## 4.9 Implications of climate change projection over Ijebu-Ode

In this section, a straightforward technique of calculating monthly soil water balance in relation to evapotranspiration—the Thornthwaite model—is investigated since it is more empirical, straightforward, easily accepts input data, and exhibits variability. Because the Thornthwaite (1948) technique requires less climatic data than Penman's, the equation is simpler (Subedi & Chávez José, 2015). The findings of statistical data computations on precipitation, temperature, and evapotranspiration can be used to analyse the water balance in the region (Moghaddam and Mohammadkhan, 2017). The Thornthwaite water balance (Thornthwaite, 1948) uses an accounting procedure to analyse the allocation of water among various components of the hydrologic system. The main inputs to the model are mean monthly temperature and mean monthly rainfall. Outputs include monthly potential and actual evapotranspiration, soil moisture storage, surplus, recharge, utilization, deficit and runoff. The model takes into account evapotranspiration and soil. Evapotranspiration is one of the most important components to be estimated in determining the soil water balance. Estimated values of evapotranspiration and soil moisture storage were generated and observed and plotted.

### **4.9.1:** Temperature and evapotranspiration

Findings indicated that as temperature is increasing potential evapotranspiration (PET) and evapotranspiration (ET) is increasing (Figure 4.21 &Table 4.16, 4.17 & 4.18). Findings of this section suggests that temperature directly determine the PET, Soil moisture storage capacity, soil moisture storage, and actual evapotranspiration (AE) while, rainfall directly determine direct runoff, soil moisture storage capacity, soil moisture storage and surplus runoff. Actual evapotranspiration (AE) and potential evapotranspiration (PET) differ from one another in how they relate to soil moisture storage. The AE takes variations in soil moisture storage in land surfaces into consideration, whereas the PET simply considers atmospheric potential (heat) as a factor in water removal from land surfaces. According to Moghaddam and Mohammadkhan (2017), potential evapotranspiration refers to the ability of the atmosphere to remove water from the land surface. The AE is therefore equal to the P less the changes in soil moisture storage P > PE AE = PE (Xu, 2002; Roy & Ophori, 2012). Overall, high potential evapotranspiration, high field capacity during the rainy season, and soil moisture oversaturation in the months of July, September, and October are all factors that have the potential to cause an excessive response in hydrological extreme phenomena, such as high flows and associated floods that can severely increase the risk of flooding and harm the environment in Ijebu-Ode. The variable runoff generation processes and concentrations will be impacted by the soil moisture pattern caused by seasonal fluctuations in evapotranspiration rate. This may then lead to an overabundance of water building up in the drainage systems.

Projection of future climate change by increasing the atmosphere temperature by $1^0$C & $2^0$C in (Figure 4.21 & Table 4.17 & 4.18) presents uncertainty (variability of rainfall) and risk (exposure) over the study area, as this may continue to have impact on flood risk. Increase in temperature and evapotranspiration could lead to increased stress on vegetation cover which may exacerbate flood risk.

### **4.9.2** Soil moisture storage

In order to predict potential flood occurrence, flood processes, and subsequent flood features in Ijebu-Ode city, it is helpful to consider soil moisture and weather patterns. The results indicate that soil moisture storage is still saturated due to the excessive rainfall because rainfall (W) is more than potential evapotranspiration (PET) in the months of June through July and September through October. Due to the stability of soil moisture storage, actual evaporation (AE) equals potential evapotranspiration (PET). On the other hand, it was found that rainfall (W) in the months of January through May, August, and November through December was less than potential evapotranspiration (PET), demonstrating variations in the soil's ability to store moisture. Findings suggests that Ijebu-Ode might be going through a distinct dry season because rainfall (W) is found to be less than potential evapotranspiration (PET). The annual precipitation is regularly found to be lower than the yearly potential evapotranspiration in many tropical regions with distinct dry seasons (Mohammadi & Seif, 2014).

Soil moisture (see Figure 4.21) is generally found to be high in June to November and highest in July, September, October (major wet season), when the soil has reached its field capacity of 100%, hence additional water to the soil runs off and have implications for flood risk over Ijebu-Ode. The findings of this study indicate that high soil moisture content and runoff generating mechanisms are related to excess soil water storage. Thornthwaite (1948) mentioned that the water surplus means seasonal additions to subsoil moisture and ground water. June and August are found to be the recharge months when rainfall exceeds potential evapotranspiration but the soil hasn't yet reached its field capacity; utilization season is found in the month January, February, November and December when water is withdrawn from the soil moisture (+ΔST) and potential evapotranspiration exceeds rainfall, but the soil moisture storage has yet to reach 0 (dry soil) whilst deficit season were observed in March, April and May when potential evapotranspiration exceeds rainfall and soil moisture storage reached 0. This is a period when there is no water for plants. Seasonal soil moisture changes are mainly attributable to seasonal changes in evapotranspiration, leading to soil moisture depletion in summer and rise in winter and spring (Perrajka et al., 2010). Flood favouring hydro-meteorological patterns vary between seasons and be linked to flood types (Neid et al., 2014). Global climate has changed rapidly with increasing mean temperature. This was found to have significance impact on both global warming and rainfall pattern, amount and distribution (IPCC, 2007; Adefisan, 2018).

Soil moisture pattern could be attributable to seasonal changes in evapotranspiration rate which together will affect the varying runoff generation mechanisms and concentrations. This in turn can result in the accumulation of excess water in the drainage channels. The soil moisture and weather patterns are beneficial to inform possible flood occurrence, flood processes and resulting flood characteristics in Ijebu-Ode city. This study suggests that it is legitimate to be concerned about the hydrologic capacity of the examined locality when taking future growth into account. Excellent hydrologic capacity, particularly in terms of water availability, is present in the examined area. The flood relief channels and other ingrained environmental precarity cannot withstand prolonged periods of high soil moisture content and significant disasters. The community of Ijebu-Ode's exposure, susceptibility, and climate impact must be lessened through the execution of a thorough water management and city development plan.

**Table 4.16**: Monthly water balance in response to temperature at actual calculated mean over Ijebu-Ode.

| **Month** | **J** | **F** | **M** | **A** | **M** | **J** | **J** | **A** | **S** | **O** | **N** | **D** | **Year** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **P** | 11 | 41 | 84 | 125 | 182 | 273 | 278 | 131 | 260 | 222 | 53 | 14 | 1674 |
| **T** | 33.0 | 35.0 | 34.0 | 33.0 | 32.0 | 30.0 | 29.0 | 28.0 | 29.0 | 31.0 | 32.0 | 33.0 | |
| **F** | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| **RAIN** | 11 | 41 | 84 | 125 | 182 | 273 | 278 | 131 | 260 | 222 | 53 | 14 | 1674 |
| **SNOW** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **PACK** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| **MELT** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **W** | 11 | 41 | 84 | 125 | 182 | 273 | 278 | 131 | 260 | 222 | 53 | 14 | 1674 |
| **PET** | 142 | 176 | 189 | 201 | 297 | 194 | 180 | 159 | 152 | 150 | 140 | 138 | 2028 |
| **W-PET** | -131 | -135 | -105 | -76 | -25 | 79 | 98 | -28 | 108 | 73 | -87 | -124 | |
| **SOIL** | 3 | 1 | 0 | 0 | 0 | 79 | 100 | 76 | 100 | 100 | 42 | 12 | |
| **/\SOIL** | -9 | -2 | -1 | 0 | 0 | 79 | 21 | -24 | 24 | 0 | -58 | -30 | |
| **ET** | 20 | 43 | 85 | 125 | 182 | 194 | 180 | 155 | 152 | 150 | 111 | 43 | 1440 |
| **W-ET-/\SOIL** | 0 | 0 | 0 | 0 | 0 | 0 | 77 | 0 | 84 | 73 | 0 | 0 | 233 |

**Table 4.17**: Monthly water balance in response to temperature at $1^0C$ increase over Ijebu-Ode.

| Month | J | F | M | A | M | J | J | A | S | O | N | D | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **P** | 11 | 41 | 84 | 125 | 182 | 273 | 278 | 131 | 260 | 222 | 53 | 14 | 1674 |
| **T** | 34.0 | 36.0 | 35.0 | 34.0 | 33.0 | 31.0 | 30.0 | 29.0 | 30.0 | 32.0 | 33.0 | 34.0 | |
| **F** | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| **RAIN** | 11 | 41 | 84 | 125 | 182 | 273 | 278 | 131 | 260 | 222 | 53 | 14 | 1674 |
| **SNOW** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **PACK** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| **MELT** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **W** | 11 | 41 | 84 | 125 | 182 | 273 | 278 | 131 | 260 | 222 | 53 | 14 | 1674 |
| **PET** | 150 | 185 | 199 | 211 | 218 | 205 | 190 | 168 | 160 | 158 | 148 | 145 | 2139 |
| **W-PET** | -139 | -144 | -115 | -87 | -37 | 68 | 88 | -37 | 100 | 64 | -95 | -131 | |
| **SOIL** | 3 | 1 | 0 | 0 | 0 | 68 | 100 | 69 | 100 | 100 | 39 | 10 | |
| **/\SOIL** | -8 | -2 | 0 | 0 | 0 | 68 | 32 | -31 | 31 | 0 | -61 | -28 | |
| **ET** | 19 | 43 | 85 | 125 | 182 | 205 | 190 | 162 | 160 | 158 | 114 | 42 | 1484 |
| **W-ET-/\SOIL** | 0 | 0 | 0 | 0 | 0 | 0 | 56 | 0 | 69 | 64 | 0 | 0 | 189 |

**Table 4.18** Monthly water balance in response to temperature at 2$^0$C increase over Ijebu-Ode.

| **Month** | **J** | **F** | **M** | **A** | **M** | **J** | **J** | **A** | **S** | **O** | **N** | **D** | **Year** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **P** | 11 | 41 | 84 | 125 | 182 | 273 | 278 | 131 | 260 | 222 | 53 | 14 | 1674 |
| **T** | 35.0 | 37.0 | 36.0 | 35.0 | 34.0 | 32.0 | 31.0 | 30.0 | 31.0 | 33.0 | 34.0 | 35.0 | |
| **F** | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| **RAIN** | 11 | 41 | 84 | 125 | 182 | 273 | 278 | 131 | 260 | 222 | 53 | 14 | 1674 |
| **SNOW** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **PACK** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| **MELT** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **W** | 11 | 41 | 84 | 125 | 182 | 273 | 278 | 131 | 260 | 222 | 53 | 14 | 1674 |
| **PET** | 158 | 195 | 210 | 223 | 230 | 216 | 201 | 177 | 169 | 167 | 156 | 153 | 2255 |
| **W-PET** | -147 | -154 | -126 | -98 | -48 | 57 | 77 | -46 | 91 | 56 | -103 | -139 | |
| **SOIL** | 2 | 0 | 0 | 0 | 0 | 57 | 100 | 63 | 100 | 100 | 36 | 9 | |
| **/\SOIL** | -7 | -2 | 0 | 0 | 0 | 57 | 43 | -37 | 37 | 0 | -64 | -27 | |
| **ET** | 18 | 43 | 84 | 125 | 182 | 216 | 201 | 168 | 169 | 167 | 117 | 41 | 1530 |
| **W-ET-/\SOIL** | 0 | 0 | 0 | 0 | 0 | 0 | 34 | 0 | 54 | 56 | 0 | 0 | 144 |

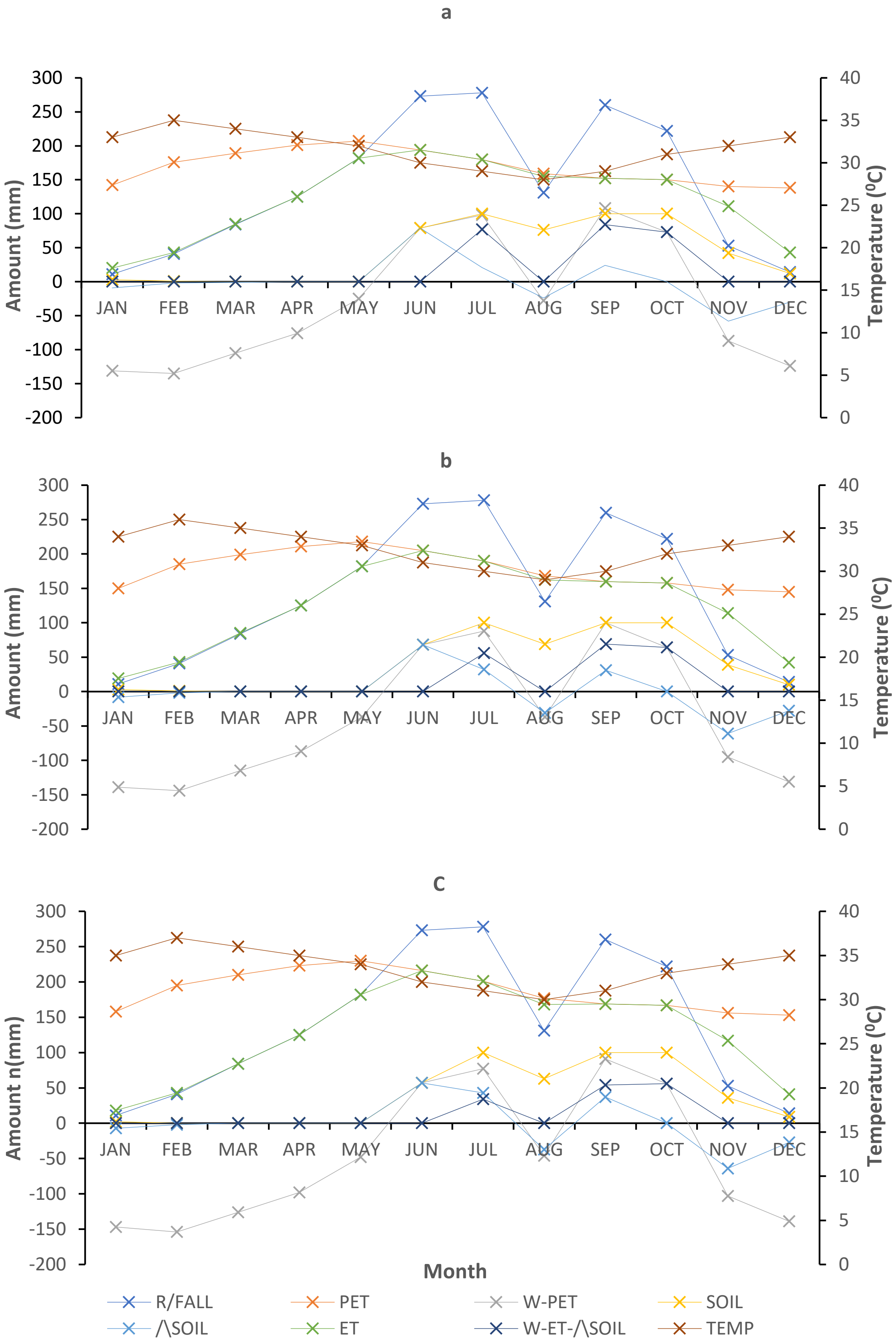


**Figure 4.21**: Monthly water balance in response to temperature at (a) actual calculated mean (b) $1^{0}C$ increase (c) $2^{0}C$ increase over Ijebu-Ode.

### 4.9.3 Precipitation and potential evapotranspiration

The results (Figure 4.21 &Table 4.16, 4.17, 4.18) showed that rainfall (W) is lower than potential evapotranspiration (PET) in the months of January through May, August, and November through December (8 months), resulting in a water deficit (WD), while rainfall (W) is higher than potential evaporation (PET) in the months of June through July and September through October (4 months), resulting in a water surplus (WS) during the study periods (1989–2018). The surplus water in Thornthwaite-Mather method was assumed as water that becomes runoff. In this study, Ijebu-Ode has the most surplus month with only four months (June, July, September and October). The water balance analysis shows that the highest water surplus in Ijebu-Ode is achieved in the month of September with a peak value of 108mm and highest water deficit in the month of February with a peak value of -135mm. Soil-moisture deficit expressed as the difference between actual evapotranspiration and potential evapotranspiration (Thornthwaite & Mather, 1957). When soil moisture reaches the maximum soil-moisture capacity, which is AWC, any excess precipitation become the surplus value, thus makes surplus value equals to P-PE (Roy & Ophori, 2012).

Monthly water balance model has been used to examine the various components of the hydrologic cycle (for example evapotranspiration, soil moisture balance and runoff). Potential evapotranspiration (PET) is widely used in hydrology and is essential for water resources management. In order to calculate the main result of this section on water balance, evapotranspiration is taken into account. In the result showing monthly water balance in response to temperature at actual calculated mean evapotranspiration value (1440mm) s is marginally lower than the mean annual rainfall (1674mm). The annual potential evapotranspiration value (2028mm) is higher than the mean annual rainfall (1674mm). Evapotranspiration goes up dramatically from the month of March-November and drastically lower in December-February. Evapotranspiration is higher during the rainy season April-October, compared to the dry season November-March. The findings of this section (Figure 4.22 &Table 4.19) indicated eight months of accumulated potential loss, this is higher in dry seasons from November-May and most severe in December-February. The accumulated potential water loss is calculated as the cumulative sum of W-PET values during months when W-PET is negative. Accumulated potential water loss increases during dry seasons. It is reduced during wet seasons because of soil moisture recharge. The value would be zero when soil moisture equals the soil's available water holding capacity Roy & Ophori, 2012).

**Table 4.19:** Showing difference between precipitation and potential evapotranspiration (W-PET) at actual calculated mean over Ijebu-Ode.

| Month | J | F | M | A | M | J | J | A | S | O | N | D | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| W | 11 | 41 | 84 | 125 | 182 | 273 | 278 | 131 | 260 | 222 | 53 | 14 | 1674 |
| PET | 142 | 176 | 189 | 201 | 297 | 194 | 180 | 159 | 152 | 150 | 140 | 138 | 2028 |
| W-PET | - 131 | -135 | -105 | -76 | -25 | 79 | 98 | -28 | 108 | 73 | -87 | - 124 | |

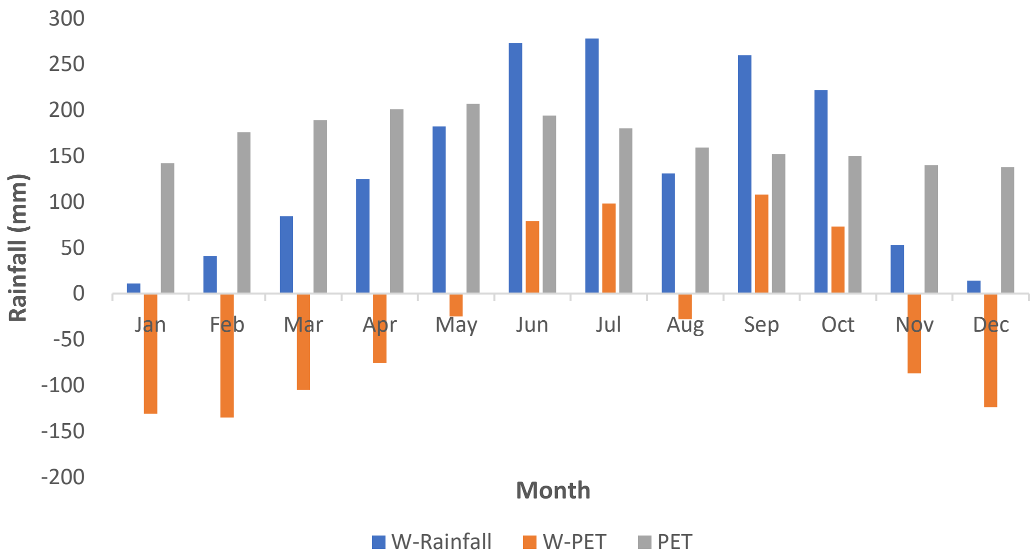


**Figure 4.22:** Difference between precipitation and potential evapotranspiration (W-PET) at actual calculated mean over Ijebu-Ode.

### **4.10.1** Decadal rainfall analysis

The monthly rainfall compared to average rainfall for the 30-year period (1989-2018) revealed decadal variability (Figure 4.23a & Table 4.20), with greater variability during the wet season. This further reinforces the findings on inter-annual and intra-annual variability (Table 4.5 & Figure 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, & 4.14). Ayanlade et al., (2009) posited seasonal and annual rainfall variability in some parts of Nigeria continues to be on the increase as an element of climate change and variability, however at the monthly scale this argument is not supported within this analysis.

**Table 4.20:** Descriptive analysis of decadal rainfall mean and SD on temporal scales

| **Decadal Rainfall** | **Mean (mm)** | **SD** | **1SDA** | **1SDB** | **2SDA** | **2SDB** |
|---|---|---|---|---|---|---|
| **1989-1998** | 132.7 | 117.94 | 250.65 | 14.77 | 368.59 | -103.17 |
| **1999-2008** | 143.80 | 122.99 | 266.79 | 20.81 | 389.78 | -102.18 |
| **2009-2018** | 142.02 | 123.34 | 265.36 | 18.68 | 388.7 | -104.66 |

### **4.10.2** *Decadal minimum temperature analysis*

The monthly minimum temperature compared to the average minimum temperature for the 30-year period (1989-2018) revealed decadal variations, with warming over the 30-year period (Figure 4.23b). Decadal analysis revealed a transition change in minimum temperature mean for different decades as shown in Figure 4.23b & Table 4.21. The mean minimum temperature increased within each decade; the standard deviation is found to be reducing implying mean minimum temperature in last 10 years was higher than the former decades (Figure 4.23b & Table 4.21). The last decade (2009-2018) witnessed the highest increase in minimum temperature at Ijebu-Ode. Over the three decades the average minimum temperature has increased by 0.34$^{o}$C.

**Table 4.21:** Descriptive analysis of decadal minimum temperature mean and SD on temporal scales

| Decadal Min. Temp | Mean ($^0C$) | SD | 1SDA | 1SDB | 2SDA | 2SDB |
|---|---|---|---|---|---|---|
| **1989-1998** | 23.01 | 0.94 | 23.95 | 22.07 | 24.89 | 21.13 |
| **1999-2008** | 23.31 | 0.89 | 24.2 | 22.42 | 25.09 | 21.53 |
| **2009-2018** | 23.35 | 0.92 | 24.27 | 22.43 | 25.19 | 21.51 |

### 4.10.3 *Decadal maximum temperature analysis*

Monthly maximum temperature compared to average maximum temperature for the 30-year period (1989-2018) with 0.29$^0$C warming (Figure 4.23c; Table 4.22). High maximum temperature mostly occurs from November-May, with February the warmest month on average. Mean maximum temperature increased within each decade and standard deviation reduced (Figure 4.23c & Table 4.22). In addition, the high temperature experienced in the last decade (2009-2018) had the lowest standard deviation of 2.13$^0$C which means the temperature did not significantly deviate from the mean (31.74$^0$C). The increase in maximum temperature over the three decades is lower than the increase identified in minimum temperature, reflecting changes previously identified in Africa (Ageena et al. 2014).

**Table 4.22:** Descriptive analysis of the decadal maximum temperature mean and SD on temporal scales

| Decadal Max. Temp | Mean ($^0C$) | SD | 1SDA | 1SDB | 2SDA | 2SDB |
|---|---|---|---|---|---|---|
| **1989-1998** | 31.45 | 2.28 | 33.73 | 29.17 | 36.01 | 26.89 |
| **1999-2008** | 31.57 | 2.20 | 33.77 | 29.37 | 35.97 | 27.17 |
| **2009-2018** | 31.74 | 2.13 | 33.87 | 29.61 | 36 | 27.48 |

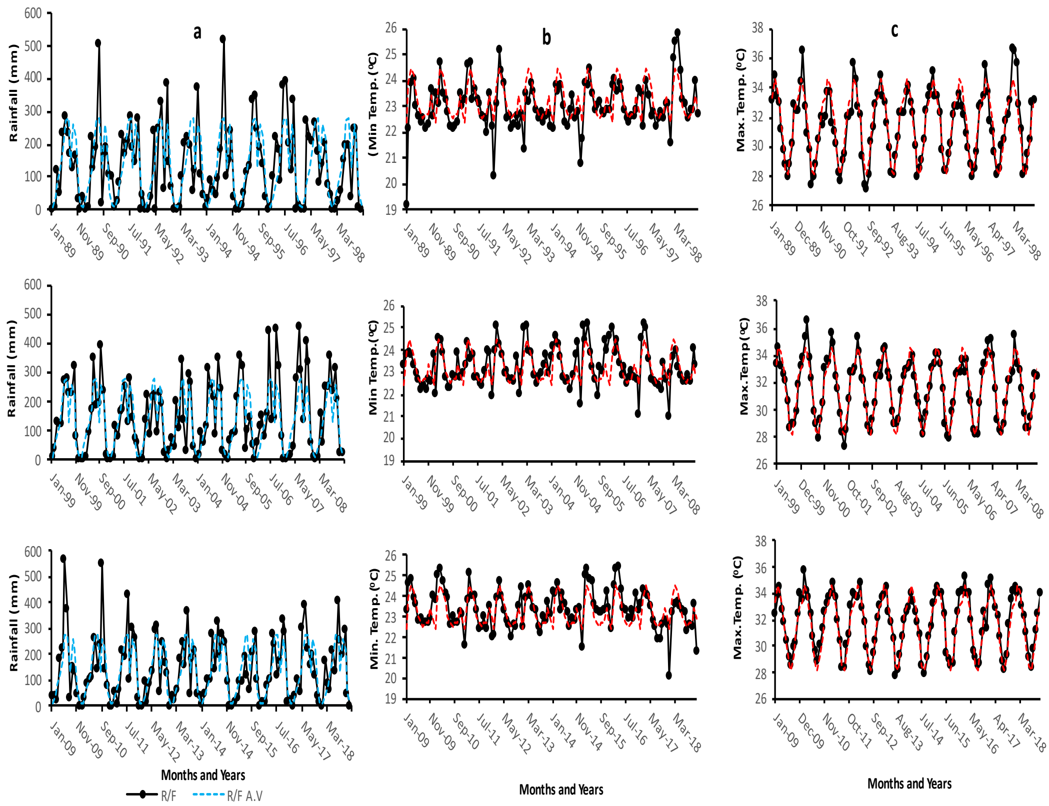

**Figure 4.23: a)** Monthly rainfall (black) compared to average monthly rainfall (blue) for the 30-year period (1989-2018) at Ijebu-Ode for (1989-1998, 1999-2008, and 2009-2018); **b)** Monthly minimum temperature (black) compared to average monthly minimum temperature (dashed red) for the 30-year period (1989-2018) at Ijebu-Ode for (1989-1998, 1999-2008, and 2009-2018); **c)** Monthly maximum temperature (black) compared to average monthly maximum temperature (dashed red) for the 30-year period (1989-2018) at Ijebu-Ode for (1989-1998, 1999-2008, and 2009-2018).

## 4.11 Flood risk in a non-stationary environment

Results showed that minimum and maximum temperatures, as well as rainfall, have been increasing during the research period. During the study period in Ijebu-Ode, rainfall and minimum temperature are marked as having a "increasing monotonic trend" (monotonic positive trend), whereas maximum temperature is marked as having a "increasing non-monotonic trend" (non-monotonic positive trend); however, the minimum and maximum temperature trends are statistically significant, whereas the rainfall trend is not (sections 4.6, 4.6.1.1–4.7.1.2, and 4.10.1–4.10.3; Table 4.2 & Figure 4.6). Rainfall amount in the period of study (1989-2018) has shown fluctuations and instabilities (Figure 4.5, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14 & 4.23). A context for understanding the climate mechanisms has been provided in the findings of this study. Local climate change over the last three decades may also be considered as a plausible factor in changing flood frequencies, with a warming climate. Climate variability refers to variations in the mean state and other statistics of the climate at all spatial and temporal scales beyond that of the individual weather events that persist for an extended period, typically decades or longer (IPCC, 2012).

Climatic non-stationarity can simply be defined as the process that are not stationary and have statistical properties that are deterministic functions of time (Harry, 2012). Harry (2012) states that recently the term non-stationarity has been used to imply a process behaviour that is synonymous, uniquely, with change and, by inference, with climatic change. Milley et al., (2008) argue that "In view of magnitude and ubiquity of hydroclimatic change apparently now under way, however, we assert that stationarity is dead and should no longer serve as central default assumption in water-resource risk assessment & planning". With increasing evidence of changes and variability in climate, and other drivers of flood risk, there is now a growing concern that the past may no longer be a reliable guide to the future (Lancaster University, 2018). However, where no other sources of information exist, some information is better than none, and estimates of future risk can be developed to incorporate the uncertainties associated with climate change, therefore historical/qualitative sources offer valuable insights.

Climate variability refers to variations in mean state and other statistics; according to Oguntade et al. (2012), knowledge of climate variability over the period of instrumental records and beyond on different temporal and spatial scale is important to understanding the nature of different climate systems and their impact on environment and society.

## 4.12 Summary

Rainfall in Nigeria is driven by a seasonal migration of the intertropical convergence zone, where hot and dry easterly winds from the Sahara meet humid air from the Atlantic. Daily and monthly rainfall patterns in Ijebu-Ode rises steadily from February, achieving a first peak in July before falling in August, before rising again to a second but lower peak in September, after which the rainfall decreases. The reduction in August rainfall is spatially limited and a particularity of South-western Nigeria ($4^0 – 9^0$N and $3^0 – 7^0$E). A rise in daily maximum rainfall during the rainy season months leads to maximum flood risk in Ijebu-Ode during peak wet seasons (June-July & September-October). There is high inter-annual rainfall variability across the months and years. A clear seasonal variability is established with dominant rainy season in Ijebu-Ode.

The minimum temperature is highest in March, whilst coolest month is January. The highest minimum temperature anomalies occur during February-May, and November, with relatively low variation and dispersion. The last decade (2009-2018) witnessed the highest mean minimum temperature in Ijebu-Ode, indicating an increasing minimum temperature. Highest maximum temperature anomalies occur in January-April & November-December; February is warmest whilst the coolest is August; with low variation and dispersion. Mean maximum temperature increased within each decade and standard deviation reduced. The analysis of anomalies and extreme events, suggests tendencies to increase for both rainfall and temperature.

Overall, the climate of Ijebu-Ode can be characterised by a strong seasonal precipitation and temperature range, with a distinct rainy season (June-September), which coincides with the coolest months. Knowledge of synoptic patterns and rainfall and temperature trends can help to explain the past flood events. Flood risk challenges over past decades are related to extreme events during the rainy season. Future climate change presents a serious threat to the communities of Ijebu-Ode. Climatic and weather phenomena identified in Ijebu-Ode reflect those experienced more generally across the majority of Nigeria's states, with increased annual flooding during the rainy season (Aja and Olaore 2014**).** While climate change is resulting in increased rainfall, this is being exacerbated further by the human human-nature interactions (Aderogba 2012). The unsustainable use of surface water drainage channels including, poor physical planning, are indicative of significant factors determining and exacerbating pluvial flood risk(s) in Ijebu-Ode's communities.

Result indicated that inhabitants of Ijebu-Ode are vulnerable to floods due to high hazard exposure, susceptibility and poor resilience. Human and socio-economic losses as a result of perennial flooding are a priority, with effective solutions required to mitigate flood risk and adapt to climate change. A recent flood victim in Ijebu-Ode who identified himself as "Baba Olumide", stated:

> *"Just imagine, what people experienced around this town is unbearable. Government should see to this flood matter; it has been problem of Ijebu- Ode for many years. The government is not helping matters at all. "On the part of the people, any time that it is about to rain, they will go and dump their refuse in the gutter and the gutters which are not so much spacious and deep, will be blocked. We must all join hands to tackle this problem" (P.M. News October 5, 2011).*

# Chapter 5

# Social understanding of flood risk in Ijebu-Ode

This chapter explores social understanding of flood risk in Ijebu-Ode by conducting subjective assessment of risk using both quantitative and qualitative data collection methods. Risk perception at household, community & government level, flood risk measurement, and flood risk management activities are engaged.

## **5.1** Introduction

This chapter analyses how local residents understanding of flood risk in Ijebu-Ode through the use of questionnaires, reinforced with interviews with community leaders and the Department responsible for water supply and environmental sanitation in Ijebu-Ode Local Government Area (LGA). The aim is to develop an in-depth understanding of key drivers of social vulnerability and exposure in formal-informal settlements, to floods and associated risks, and explore how the residents are engaging with flood risks at household, community, and local government level, with the intention of developing a policy solution that will help to mitigate future flood risk. It will also examine and consider socio-economic and demographic characteristics of local community, together with perception and understanding of flooding.

The main goal of this chapter, as shown in Figure 5.1, is to determine the degree to which residents of Ijebu-Ode are vulnerable to pluvial (rain-related) flooding and to investigate how flood impacts might be reduced through non-structural methods (i.e., social strategy). In addition to supporting Figures 1.8, 1.9, 1.10, Objectives 3, 4, and 5 (see Section 1.1), Figure 5.1 also supports the core idea of this study (see Section 3.1). Assessments of community exposure, sensitivity, event impacts, and adaptive capacity were examined from the perspective of vulnerability risk factors and related impacts with a view towards achieving DRR. Planning ahead and strengthening resilience in the face of natural disaster and climate change depends on this.

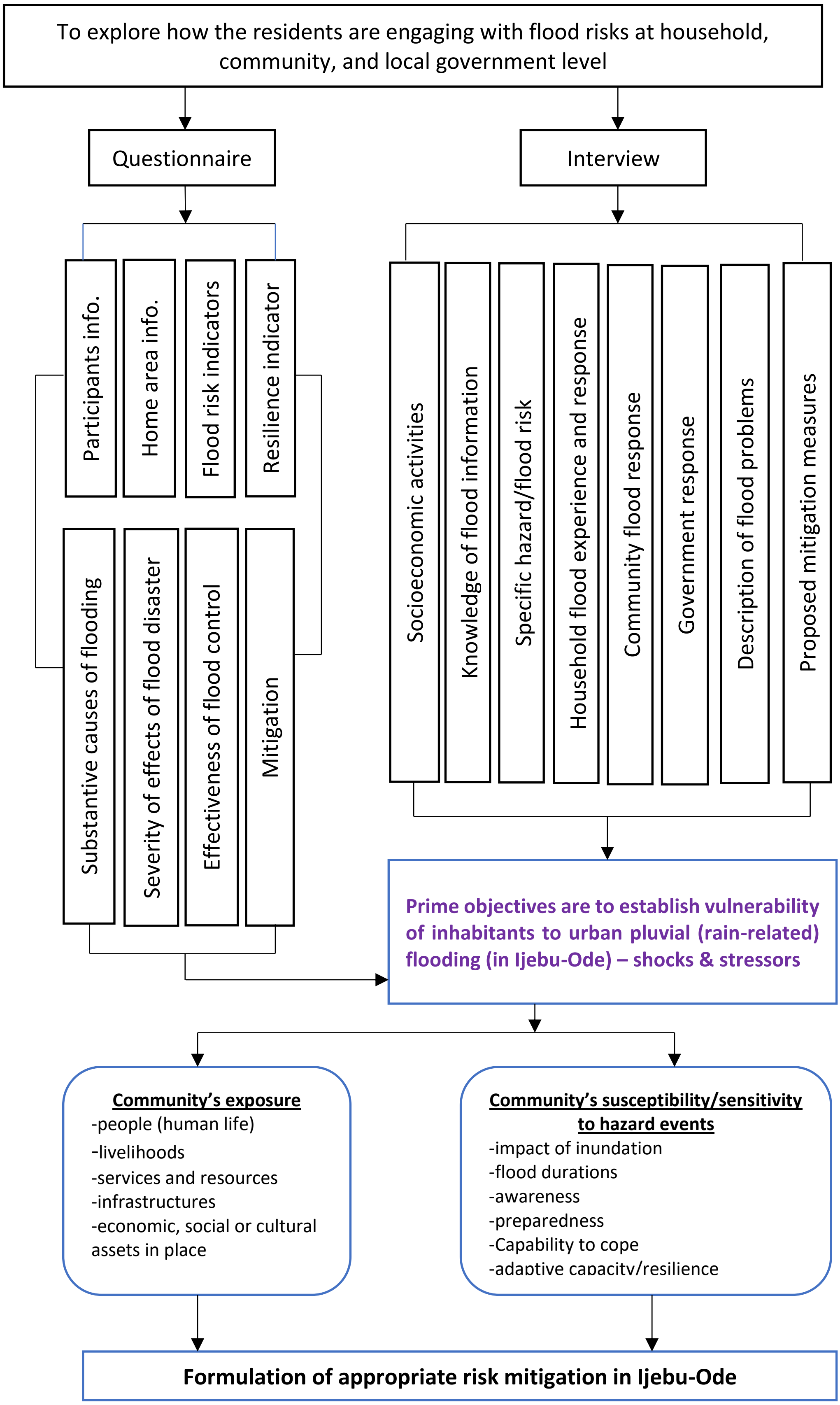


**Figure 5.1:** Schematic diagram showing summary of how risk perception of flood affected communities in Ijebu-Ode is explored.

## **5.2** Analysis of the questionnaire

A field survey was conducted, and three hundred (300) responses were targeted using a street interview technique, justifications for this approach over others are explained in section 3.7. The field survey was undertaken during March to June 2020. Paper copy of the questionnaires were circulated during the survey to the participants/respondents (i.e., paper based). Due to inhabitants' poor access to internet/technology and high level of illiteracy, paper-based questionnaire is considered because no special skill or equipment are required to fill them out. The street survey questionnaires (section 3.6.1) included a total of 88 main questions and 9 subsections, which were followed by 10 standardised open-ended questions with the local community leaders for deeper understanding and useful in defining grey areas.

### **5.2.1** Participant information

Socio-economic and demographic characteristics of the 300 respondents in ten (10) communities surveyed and other vital information are presented (Appendix J, Appendix K, Appendix L, Appendix M and Appendix N; Figures 5.2, 5.3, 5.4). In total, 299 completed questionnaires were returned across the study area. 141 respondents (47.2%) of the surveyed population were male, while 52.5 % were females. The majority (98%) of participants sampled where between age 18-65 and therefore of working age; only those of the age of 18 were sampled. Occupations of the participants varied: 27.09% were public servants, 26.08% of participants are students 20.73% being traders, 14.38% were business executives, with 12.7% representing others. The majority of respondents 186 (62.83%) had a tertiary education, whilst the respondents with secondary and primary education constitutes 77 (26.01%) and 11 (3.71%) respectively, with only 5 (1.69%) having no formal education. Analysis of the data suggests that majority of the participant are literate, have formal education and are predominantly made up of middle-income earners.

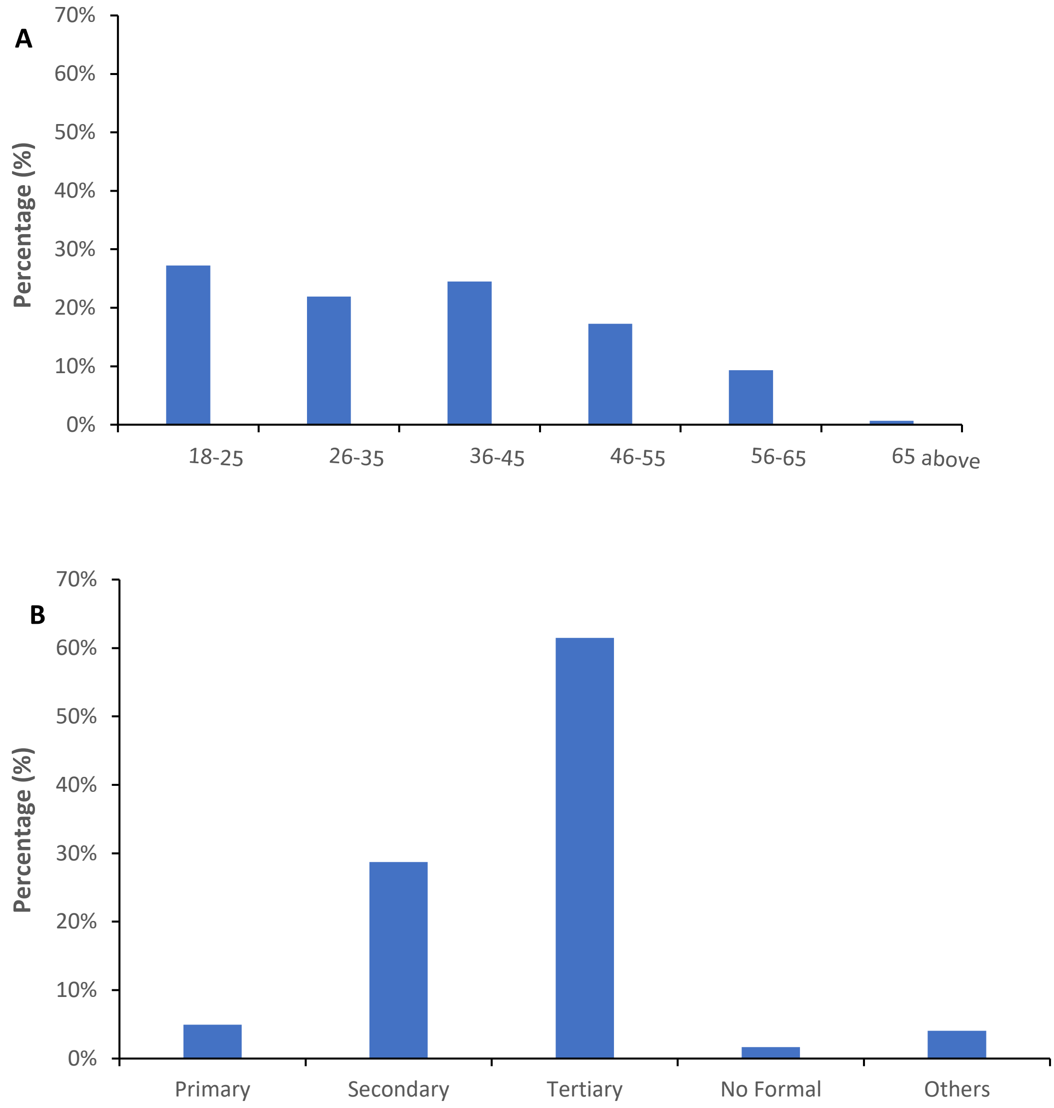


**Figure 5.2:** Participant responses to Q3**:** (a) age, Q4: (b) level of education

## **5.2.2** Home area information

The dominant home ownership type (68.58%) were privately owned properties, whilst 23.74% and 7.69% were declared public and government properties respectively (Appendix K). More than half of respondents (53.4%) are permanent residents in the study area, 41.2% are temporary residents and only 5.41% are visiting (Appendix K). Most houses appear to be 'self-build' based on a walking survey of the area and responses to the questions, this 's when an individual obtains a building plot and then builds their own home on that plot, whilst mostly practised by poorer households and middle-income citizens. These statistics provides credibility for responses as most respondents (83.have lived in the study area for over five years, are permanent residents with most properties privately owned (Appendix K).

The predominant land use (66.6%) was residential (Figure 5.3a; Appendix K), with the dominant building structure materials brick or block (66.3%) and concrete (24.6%) (Figure 5.3b; Appendix K). The predominant house types are single storey buildings (44.2%) and bungalows (42.8%) (Figure 5.3c; Appendix K). The findings implies that most building types in the study area are a single storey building or bungalow, composed mostly of residential housing and constructed of brick comprising of single-family and multi-family residential building. This is an important indicator of sensitivity in the study area to vulnerabilities associated with flooding.

The majority of participants (82.94%) have lived in Ijebu-Ode for 6+ years (Figure 5.3a; Appendix K). Most (51.8%) source their information on flooding through personal observation, with a range of other sources also considered (Figure 5.3b; Appendix K). Most participants have lived in flood prone communities for many years, with the majority believing they receive insufficient information and awareness of flood problems. This is an important indicator of the low knowledge and control over flood risk available to individuals.

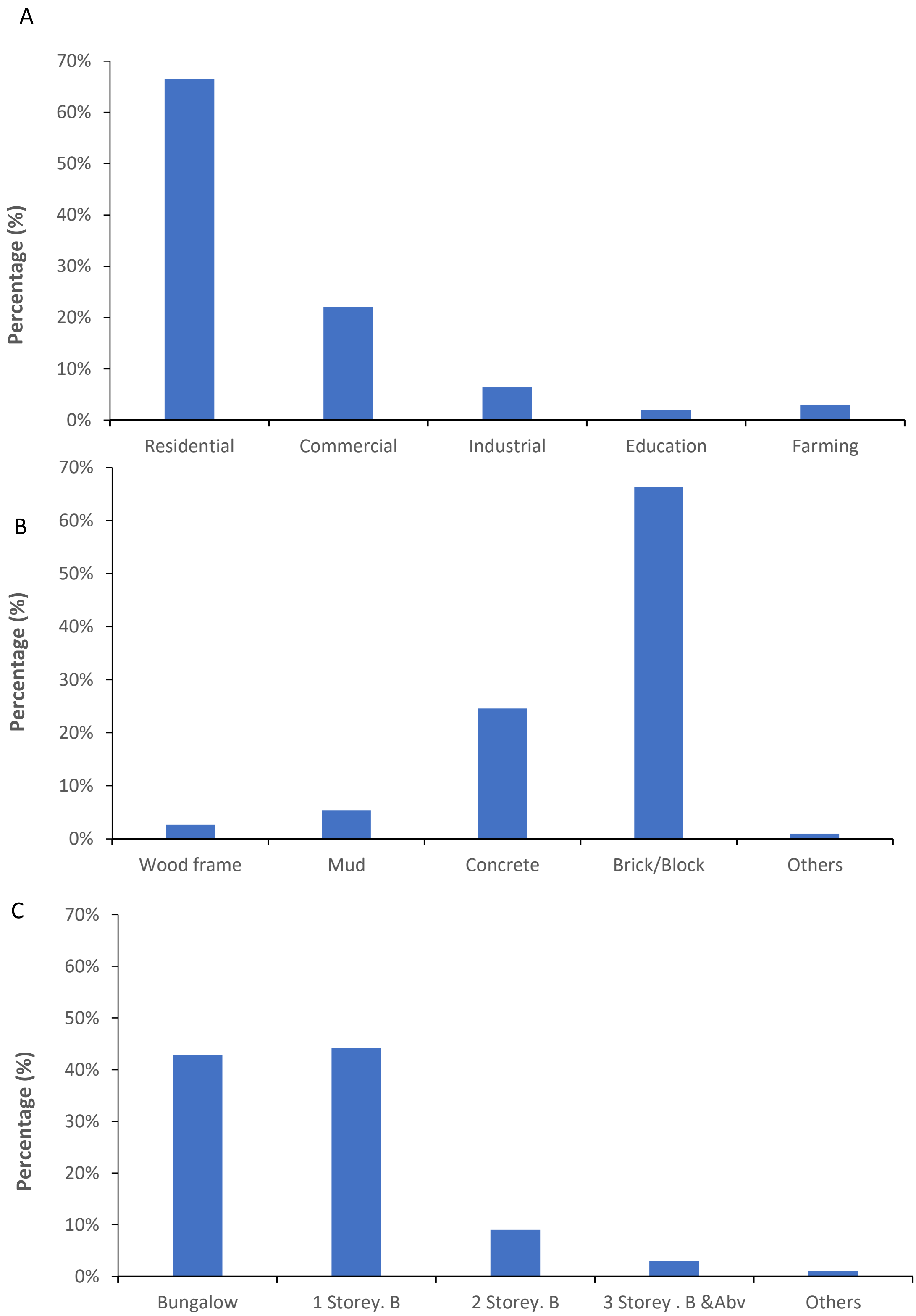


**Fig 5.3:** Participant responses to Q6**:** (a) main land-use where occupancy is, Q7: (b) building material/structure, Q8: (c) residential property form

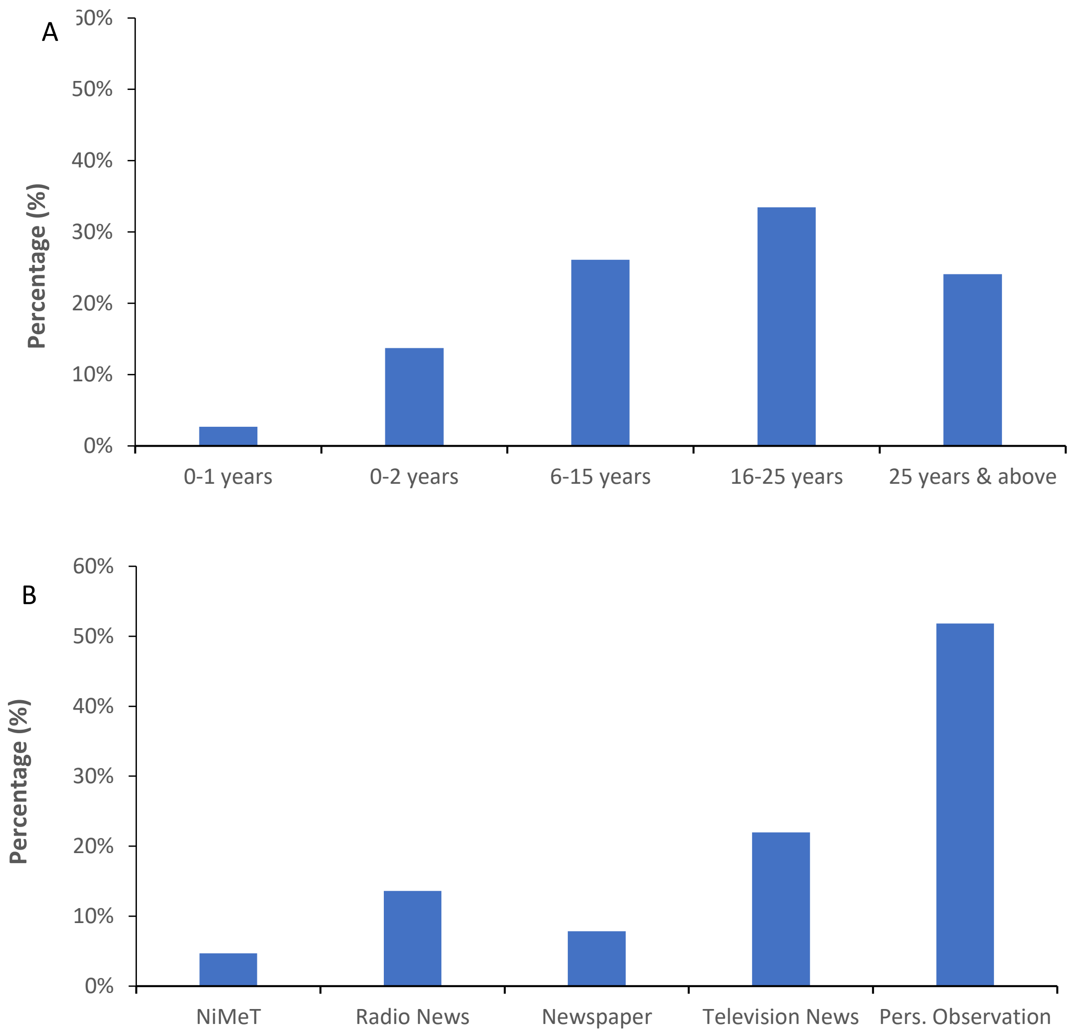


**Figure 5.4:** Participants responses to Q9: (a) residence time (years), Q13: (b) sources of flood information in Ijebu-Ode.

The majority of respondents 82.6% do not have rescue or emergency flood response plan in their respective areas (Appendix K). This is an important indicator of low preparedness in many societies, however in Nigeria this is a function of precarity, poverty and potentially low preparedness. The fact that over 50% are aware of the flood problem, but such a low proportion of uptake in emergency flood response plans (insurance), would suggest that more than a lack of awareness of the flood risk can be argued. Penning-Rowsell and Priest (2014) in the UK context identified that there is a substantial difference based on household income, with insurance penetration in the lowest decile at ~25% rising to ~80% in the highest deciles, demonstrating the relationship between income/precarity and flood insurance penetration.

### **5.2.3** Flood risk indicators

The majority of respondents (83.1%) do not have a river in their area, with 15.13% of respondents indicating they live near or close to a river, with a range of distances stated (Figure 5.5; Appendix L); the slight disparity in reported percentages may result from some uncertainty about local surface flood water drains. Among respondents, more than half (53.7%) said they often experience flooding near or around where they live due to: heavy rainfall/large volume of water on surface; inadequate drainage systems and poor drainage channelization; dumping of wastes in the drainages/poor waste management; bad roads devoid of drainages; lack of proper preparation prior or during rainy season; nonchalant attitude of inhabitants towards environmental issues; bad governance/inability of government to cater for grassroot people; sloppy topography; poor town planning/poor building plan; non-compliance/violation of environmental laws by the inhabitants; construction over drainage pathway; poverty/lack of funds; inadequate environmental routine checks by relevant authorities and overflow of rivers (Appendix L).

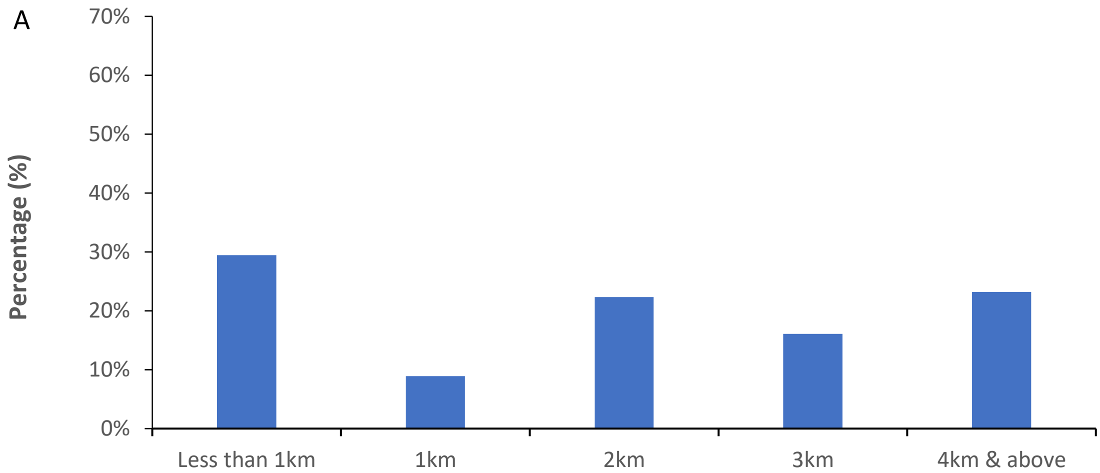


**Figure 5.5:** Response to Q16: Distance covered to a river in Ijebu-Ode.

More than half of respondents (50.5%), representing 95% of the total number of people whose areas have previously been flooded, expect the area to flood because whenever there is heavy rainfall, the whole area is usually flooded because large volume of water from the rain do not have enough and proper drainage channels to convey it/poor drainage pattern; environmental services are not really effective/negligence on part of environmental agencies; people are fund of and keep dumping refuse in the gutters/inappropriate dumping of refuse; poor/improper town planning; some houses and shops were built on drainage channels which disturbs free flow of water; bad governance/not attending to our plights; poor environmental inspection by relevant authorities and officials e.g. Environmental Inspection Agency and Sanitary Inspectors; some of building foundations are not solid and not well raised up to withstand the flood; untarred roads/bad roads/roads are constructed without drainages (Appendix L).

The majority of the respondents (31.9%) and (24.1%) indicated that floods most commonly occur in July and June respectively (Figure 5.6a; Appendix L), with the month with most damaging flood events in Ijebu-Ode poorly defined (Figure 5.6b; Appendix L). The duration of flood impacts was variable, however most respondents (43.5%) indicated they had been affected for up to 5 days (Figure 5.5c; Appendix L).

### **5.2.4** Resilience indicators

Almost half of respondents (48.1%) concentrated on clearance of drainage channels in their areas to reduce flood risk, 33.8% used sandbags, whilst others used excavated holes/channels around their houses, construction of concrete barriers and relocation to reduce exposure and susceptibility to flood risk (Figure 5.7; Appendix M). 77.8% indicated they do not get or receive government support or benefits following floods, whilst 66.8% did not receive aid in form of shelter, financial assistance from any family members, friend's, with and 76.7% not receiving donations from religious bodies and/or charity organizations (Appendix M). 83.3% do not have flood insurance in Ijebu-Ode with a range of reasons presented including: a lack of information/awareness not in place; no idea/have not come across one; not available/not existing in Nigeria; no scheme for it and government did not make provision; ignorance/flooding does not occur in my area/I don't think I need it; costly and unaffordable/no stable income; not easily accessible and process is complicated; most insurance company do not cover flood/not common to hear about (Appendix M). 58.8% think their households are prepared for future flood events, those unprepared households explain this by: did not find it necessary/ignorance; lack of basic amenities; inadequate drainage systems/no drainages in many areas; the force or effect of the flood are too much for a private resident to control; cannot construct drainage systems as individuals; lack of government attention; and lack of funds (Appendix M).

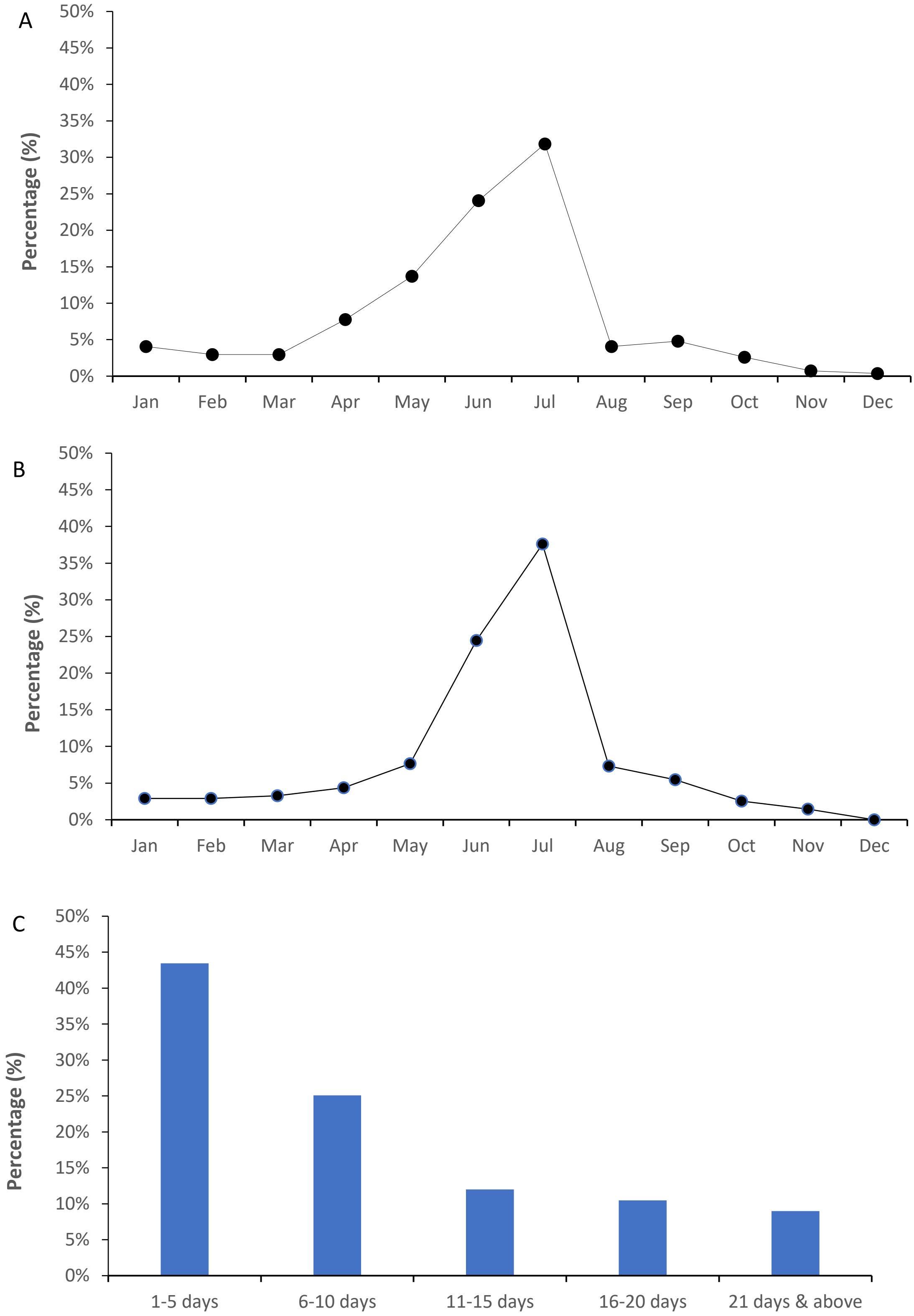


**Figure 5.6:** Participants responses to Q22: (a) months usually experience flood disaster, Q23: (b) months major flood events occur, Q24: (c) number of days flood effect is felt in Ijebu-Ode.

However, respondents advanced the following as actions they could take in preparation for future flood events: regular cleaning of the available drainages; by educating people around not to dump or throw wastes in the drainages/gutters; collaborative efforts by willing landlords to construct drainages; seek the cooperation of the people in the neighbourhood to join hands and efforts in enforcing compliance to environment laws; relocation could have been the ideal thing but due to heavy financial burden/cost, it is most times overlooked; proper construction of roads; contact non-governmental organizations; seek government intervention by crying out and pray to God for help Appendix M). Results indicated inhabitants tried to prevent, mitigate and cope with flood hazards through a pool of capacities (i.e., endogenous resources inhabitants), mostly concentrated on clearance of the insufficient drainage channels. Unequal distribution of socio-economic resources and lack of material and social resources to help moderate harms, including lack of insurance are the most often cited reasons (Appendix M). A small number (4.10%) of participants indicated relocation as a coping measure (section 5.2.4; Appendix M), suggesting inhabitants have difficulty with evacuation, and may continue to experience high exposure and vulnerability and have more serious consequences in flood prone areas of the city.

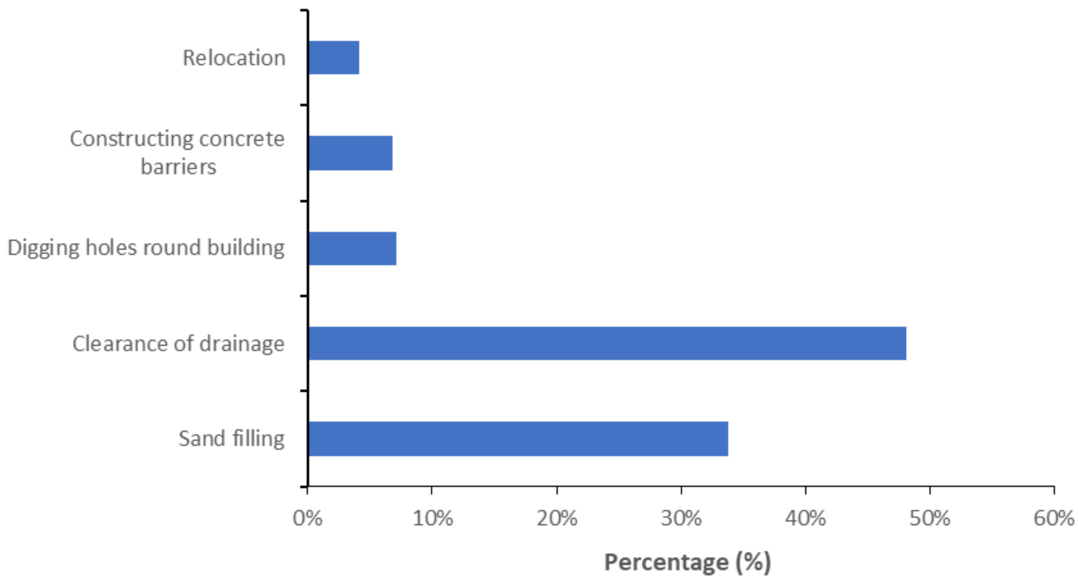


**Figure 5.7:** Response to Q25: Common coping measures used by participants.

### **5.2.5** Substantive causes and impacts of flooding

Respondents showed a high degree of awareness as to the causes of flooding, with 89.0% identifying heavy and prolonged rainfall, increased surface runoff water after rainfall due to blocked drainages (85.2%), blockage of drainage channels by indiscriminate waste disposal (83.2%), inadequate drainage channels (82.8%), poor waste disposal (82.1%), poor physical planning (76.6%) and weak government policies/poor political will (72.6%) in Ijebu-Ode Local Government Area (Appendix O). Other causes include regular flooding (68.8%), non-compliance to environmental laws (67.8%), illegal channelization of the drainage channels (59.9%), lack of environmental education and awareness (59.3%) and building along water channel (57.2%) (Appendix O). Flooding in Ijebu-Ode could be seen as a consequence of the high variability of rainfall; however, the causes of flooding are more complex, reflecting the interplay between the physical and anthropogenic environment. Poor urban planning (i.e., poor settlement pattern and development control), deficiencies in infrastructure, its management and maintenance, and a lack of understanding of flood risk have significantly exacerbated flood risk in the city.

87.9% of respondents confirm flooded streets and restricted passage, destruction of road asphalt and degradation (85.5%), restricted access to the premises by flood (84.2%) as major effects of flood disasters in Ijebu-Ode resulting in poor aesthetics of the environment (78.8%), damaged properties and homes (76.8%), loss of farmland (73.4%), affected business (72.2%), malaria fever (65%) and loss of life (62.4%) (Appendix P).

In states of south-western Nigeria, flood occurrence comes with wide-ranging of impacts, including both direct and indirect impacts on health, with flood waters providing breeding ground for parasites which lead to increased incidences of parasite borne diseases like Malaria (Echendu, 2020). Women and children are especially vulnerable to these diseases, with increased deaths and illness, with 90% of these direct effects having occurred in developing countries like Nigeria (Zorn 2018).

### **5.2.6** Effectiveness of flood control

73.8% of respondents indicated the use of drainages as coping strategy engaged in their communities to control flood risk (Appendix Q). Other strategies include waste/refuse disposal (69.2%), construction of drainages where there are none (68.6%), constant opening and evacuation of solid wastes and silt from the drainages (68.5%), better land use planning (66.7%), channelled and connected drainages (65.6%), adequate provision of wastes disposal facilities (63.3%), increased awareness of flood risk education for students (62.8%), creating environmental education and awareness on the danger of flood (58.8%). Most respondents (62.7%) acknowledged the potential role of schools in raising awareness of flood risk, however, 50.5% of respondents indicated they believe that teachers are insufficiently aware of flood risk problems in Nigeria (Appendix Q). 52.3%, 46.6% and 48.6% of respondent respectively indicated students are aware in terms of flood risk in Nigeria, flood risk practices & positive impact on family. These findings suggest that education and schooling has played little role in flood awareness in Ijebu-Ode, hence, the need to fully embrace environmental education and enhance flood risk knowledge of practicing teachers' (Appendix Q). These findings are similar to those of Douglas et al., (2008) which covered five cities in Africa and explored people's perceptions of causes of flooding and their coping strategies, with lack of adequate drainage coupled with poor management of existing drainage; effects of unplanned and unregulated urban development; lack of attention to the problems by governments and changes in weather patterns highlighted.

### **5.2.7** Mitigation for flood risk reduction

Over 2/3 of the respondents (74.3%) think flood risk management is achievable in Ijebu-Ode, with those that do not believe it is possible citing a number of factors: regular flooding anytime rain falls; due to poor drainage systems; the in-adequate enlightenment on waste disposal; poor waste and environmental management, improper conduction of environmental sanitation; poor risk management; people are ignorant, not ready to change their unsustainable attitude towards environment because nothing was done in previous rain and flood episodes; inhabitants are paranoid towards teaching issues related to flooding; due to poor flood risk awareness programmes; bad and insensitive government; lack of political will and the lack of conscious allocation of funds by central government to manage the flood menace (Appendix N).

In considering the most commonly discussed sustainable approaches to avoiding flooding the majority of respondents (88.1%) indicated proper land use and planning through regulated development as the most effective way of reducing flood risk, with construction of drainage systems next (Figure 5.8; Appendix N). The results imply that settlement development, flood relief infrastructures, waste management, risk communication, awareness, preparedness, urban governance, availability of funds and institutional capability are significant determinants of flood risk in Ijebu-Ode, as such, this requires extensive attention on the short and long term to achieve sustainable DRR.

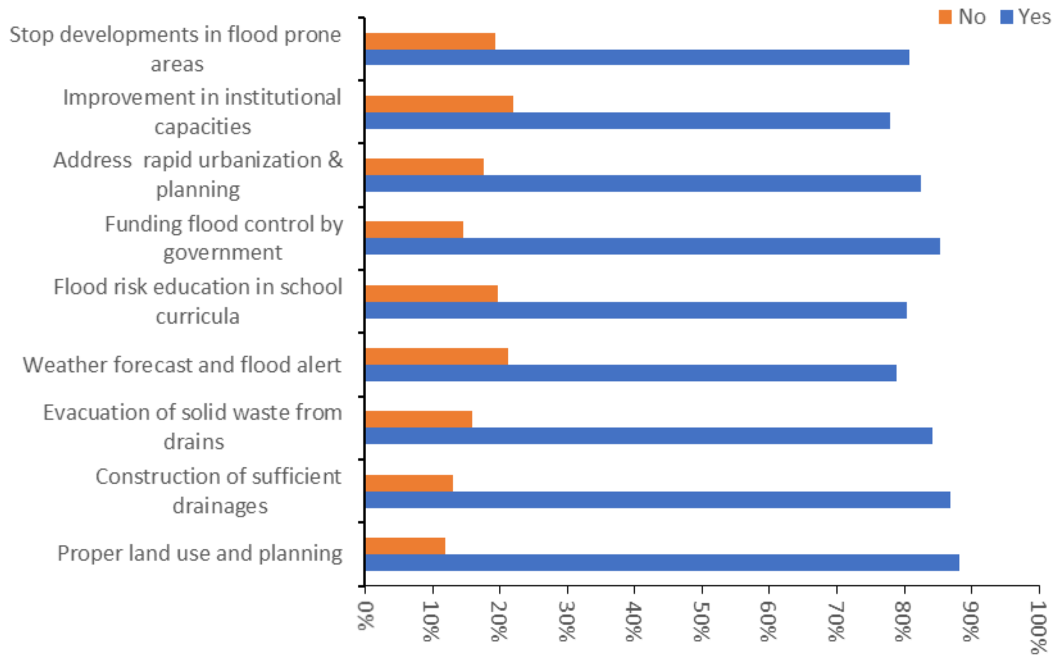


**Figure 5.8:** Responses to Q2 i-ix under 'Mitigation': Participants proposed sustainable measures for effective flood risk management in Ijebu-Ode (Appendix N).

## 5.3 Interview analysis showing participants risk perception

### 5.3.1 Socio-economic activities

Seven community leaders and an environmental officer provided interviews. Communities covered include Molipa express, Yidi and Paramount Road, Sakasiru, Degun, Abeokuta Road, Ibadan Road' Bonojo and Igbeba. Seven males and one female constitute the participants gender, all were above 40 years of age, seven had a tertiary education, and one had received a Secondary education only. The careers of the individuals vary, with one a trader, an engineer, two pharmacists, one a lawyer, one lecturer, one a correctional service worker and one an environmental officer. All participants have lived in Ijebu-Ode for a range of 25+ years, with four having lived in their present area for 15 years.

All the participants indicated that they had experienced flooding both in the past and recently. This was corroborated by the senior environmental officer Water Supply and Environmental Sanitation Department for Ijebu-Ode LGA who stated:

> *"I came to meet issues related to flood matters even on my desk and people still continue to bring in reports and requests in relation to flood risk that is affecting their various communities".*

The participants mentioned the following as the common causes of flooding in their areas: flooding is only experienced when rain starts; common to see people emptying their waste into the drainages when it is about to rain or raining leading to blockage and impeding free flow of water; poor/inadequate drainage, poor channelization and diversions of water; non-functioning of Local Environmental Protection Agencies (LEPA); poor governance/lack of government attention; poor implementation of environmental policies and laws.

### **5.3.2** Knowledge of flood information

Two of the participants indicated that they expected that their areas would be affected by floods and have been regularly experienced flooding due to rainfall, citing inadequate drainage, poor water diversion and unregulated building construction which obstructed the channels conveying water as caused. Whilst five participants indicated that they never expected their areas to be affected by flood because it was a developing area and there were lots of free land where water could flow to. They said:

> *"Flooding started after living in the area for 'few years' and '20 years ago' flooding had become a consistent occurrence in our areas".*

The following factors were advanced as the responsible for flood occurrence: high urban development, settlement expansion, more structures, people, tarred roads; unregulated building constructions; inadequate drainages; heavy rainfall "a heavy rainfall for about 30 mins – 1hr usually caused heavy floods, regular flooded roads and compounds".

The environmental officer said:

*"From field activities that were conducted, it is obvious and there is no doubt Ijebu-Ode would be affected by the flood, it is very evident and glaring. We have some areas that annually recorded flood effects".*

### **5.3.3** Specific hazards/flood risks

Participants established flood as the specific hazard and used expressions such as *"many", "very terrible", "too bad", "numerous", unpleasant"* to describe previous flood events. Flood risk impacts include: forced displacement, migration and evacuation from their homes, offices, business places, schools; withdrawal of pupils from schools especially in severely prone areas; destruction/damage of valuable properties; collapse of buildings and threats to many houses; destruction/damage of roads (economic nerves), drainages, electricity poles, telecommunication facilities etc.; washing away of people both old and young, drowning and killing victims; restriction of movement both pedestrians and vehicles; terrible dirtiness and poor aesthetics; and total disruption of socioeconomic activities.

According to a Senior Environmental Officer, he said it is on record that:

> *"Victims of the severe flooding are mostly sent packing from their various place of residences for [a] number of days and denied access and [have] also [been] sacked them from their various offices, and unable to reach schools, worship centres, hospitals, markets and business places".*
>
> *"Very recently, anytime it is about to rain, it usually creates panic and fear in the inhabitants".*
>
> *"It contributes to recurring diseases associated with breeding in water, most importantly is the female anopheles' mosquitoes, a vector causing malaria fever and other flies of public health importance and concerns."*

> *"Several reports have been made on collapse of buildings and destruction of several infrastructural facilities."*

### **5.3.4** Household flood experience, response/coping strategies

Interviewees submitted that their household flood experiences were unpleasant and mention the following as way they have been responding and coping: ceaselessly contacted necessary authority i.e., LGA through writing but noted pathetically that they have not been responding, except for the State Government who responded in some areas of the town and the situation is getting worse; writing to different medias and granting interviews and having some of them published in newspapers and reported in local radio and television. They have also supported erection of walls around and at entrance of the buildings as barriers to prevent inflow of floodwaters; reconstruction of collapsed walls and parts of buildings; erection of iron barriers in the drainages, mostly common in individuals home frontage to prevent blockages usually caused by wastes and educating people around and within community to discourage the habits of dumping of wastes into drainages. The following are notable comments from two of the interviewees in discussing the flooding problem:

> *"Without proper sensitization of people who are in the habit of emptying their waste in gutters thereby blocking them and obstructing the free flow of water, flood problems will persist in Ijebu-Ode".*

> *"If the people of Ijebu-Ode city can be educated on the environmental and flood management and also imbibe a culture of self-discipline, I believe it will go a long way in reducing and solving the flood problems."*

### **5.3.5** Community (neighbourhood) response/coping strategies

The community leaders identified several collective coping strategies that they have adopted by various communities towards mitigating flood disaster risks and impacts, often involving non-structural steps including, holding meetings, though it's challenging because of lack of government attention and presence; use of enforcement to back-up education to prevent acts or in-action of certain people that can bring disaster to an entire community; mandatory for people to contribute some amount of money every month used for maintaining surroundings and provide relief to reduce flood risk in some areas; by engaging environmental sanitation exercise once in a month, which entails removal of wastes from homes, surroundings and clearing of drainages.

> *"Community people have been making [a] frantic effort to clear drainages and other water ways, but [the] volume of surface runoff sometimes overflows and wash away all the palliative designs put in place."*

> *"In my area, the community channelled drainages and employed labour to evacuate the silted drains in order to enhance free flow of water, but unfortunately this is not replicated in other areas thereby making flood problems to persist."*

> *"The issue is that many people living along my area has not been actually proactive because they believe that it is the responsibility of government."*

> *"We found out that the cost of flood management is too enormous and it is not something that one or few people can embark upon."*

### **5.3.6** Government Response/coping strategies

The interviewees were not satisfied with government and relevant authorities' responses concerning flood risk management in Ijebu-Ode. Participants indicated that no significant mitigation efforts have been embarked upon at the Local Government Area (LGA) level to ameliorate inhabitant's sufferings from flood problems. They noted that State Government response which include: reconstruction of roads; construction of new drainages; expansion of existing drainages; and construction of canal and re-channelization of flow of water, were disproportionately undertaken in the town. All the roads were improperly constructed, both the new and old drainages are disconnected, inadequate desilting of the existing drainages, and poor water flow/channelization. Hence, efforts to mitigate flood risk, has worsened and compounded existing flood problems, most importantly are disconnected drainages which have obstructed free hydraulic flow, thereby increasing and aggravating spill of water into surrounding communities which cause havoc to lives, properties and environment at large. Participants noted this, such as:

> *"There has been the lack of political will by government to proffer a long-lasting solution to recurrent flood problems, we hope one day government will help us to solve the lingering flood problems. Government is aware of our plights and have also visited some of the terrible flood prone areas."*

> *"Except only for visiting, no other efforts have been made by government officials, nothing has been done so far concerning promises made to fix the persistent flood problems. This is what we [are] experiencing year-in-year-out. For example, in 2019, the government officials that visited my area emphasize relocation of the people because of high flood risk, nothing was done about it. As of now, we are dreadful of what will happen in June/July 2020."*

> *"Local government is doing nothing to reduce or stop the flood menace. I thought all rubbish in drainage channels are supposed to be evacuated during dry season but unfortunately nothing was done, even drainages in frontage of Local Government Council Secretariat in Ijebu-Ode are blocked with rubbish dumps and left unattended to."*

> *"Authorities in charge have not properly observe and understand routes and main water channels of Ijebu-Ode. There is also fragrant disobedience by the inhabitants to the environmental laws."*

> *"Most of the roads in Ijebu-Ode are constructed halfway and still waiting for its completion."*

A senior environmental officer at the Water Supply and Environmental Sanitation Department in his response said that Ijebu-Ode Local Government Area (LGA) authority within limited resources has been giving, and will continue to give, attention to the following: desilting of blocked drainage and promptly removing the waste to prevent it being washed back in and ensure people regularly maintain drainages around them; proper sensitization, vigorous campaigns, creating awareness to educate and discourage people from emptying their waste into the existing drainage systems prior to rainfall and back it up with enforcement and encourage people to move away from flood prone areas when weather alerts indicate high levels of rainfall and flooding is likely. The Director also recognised the importance of educating people, to stop construction of permanent structure adjacent to water ways; to imbibe a culture of self-discipline; and continue to produce and erect warning signals and signs posts in the strategic locations to remind, caution/curtail indiscriminate waste disposal into drainages and environment.

A senior environmental officer confirmed that Water Supply and Environmental Sanitation Department of the ILGA have challenges which include personnel, facility, and the unsustainable attitude of the inhabitants. He noted that;

> *"At moment, the department is not having adequate manpower resources and functional equipment's which would have assisted the department in performing more efficiently than [the] level we presently attain and these we have always been reporting to the authority and management. If we have adequate number of personnel and right equipment's and working tools, productivity and performance would not only be enhanced but appreciate tremendously"*
>
> *"Some people (i.e., population) do take advantage of rain to dump their wastes indiscriminately, in this regards we are disabusing peoples mind and curtailing their unacceptable attitudes".*
>
> *The "attitude of the residents is posing enormous challenges in achieving a sustainable environment. Many of inhabitants are so recalcitrant, many are still living in memory of years past and not bringing into cognisance developmental expansion that the town is witnessing"*

The majority of community leaders have made personal decisions to try and reduce future flood disaster risk in their areas, however one community leader stated that he had not made any personal decision to reduce future flood risk because the flood situation in his area is chaotic and overwhelming**.** However, none of the participants have made personal decisions, or plans or are prepared to relocate people away from flood prone areas. Notably none of the community leaders had or intend to purchase flood insurance, this though was a personal decision and the reasons not explored at the time of the interview, but would offer an interesting area for future consideration, and whether they might be effective tools in advocating its use, particularly in flood risk areas.

### **5.3.7** Description of flood problem in Ijebu-Ode

The interviewees collectively described flooding in Ijebu-Ode as a general phenomenon, using phrases such as, "*disaster", "very terrible", "regular", "too bad", "very chaotic"* and "*future tragedy*". Some of the participants recalled their experiences of flooding:

> *"I have my very first direct flood experience in 1988 while I was in the primary school (now a pharmacist). In one of the days when it rained, I was* [nearly] *drowned in the flood and it would have washed me away and probably killed me, but I was lucky to be timely rescued by some people. Sadly, severe floods are still ravaging the same spot today, where many other people who are not fortunate, like me have been drowned, washed away and also killed"* ***– (near St Anthony's Primary School, Igbeba road, an area in Ijebu-Ode)***
>
> *"The family house where I grew up has been under flood threat for many years. Recently, part of our building collapsed due to the massive gully created by flood. The flooding around this area is life threatening"* ***– (Owakurudu an area in Ijebu-Ode)***
>
> *"Flood problems have personally threatened the collapse of my house in the past 6 years. Many buildings are also under same threat particularly in my area and many places within the town generally"* ***– (Sakasiru an area in Ijebu-Ode)***
>
> *"As soon as we feel it is going to rain, we start to panic. We become fearful of going out or to our work places (i.e., office places & business outlets), loosing time and putting economic challenges on means of livelihood. We have had situations in which vehicles will break down and people are not able to get to their homes" –* ***(Molipa road an area in Ijebu-Ode)***

*"In 2018 July, in one of rainy days, I was standing outside my house and suddenly two policemen returning from their duty got drowned and washed away by flood waters and were later found dead. The effects of flooding in my area have to do with life and death"* ***– (Igbeba/Elebute area in Ijebu-Ode)***

*"In 2018, movements are restricted due to lots of water on the roads, situation where buildings were collapsing. Terrible flood moved a 40KVA generator 10mm away from its original location in my church, fences were collapsed, some more buildings collapsed, vehicles were destroyed, a record of people got drowned and died, some families lost their children to flood while returning from school, some domestic fish farms were destroyed and causing huge economic loss" –* ***(Ibadan Road and Degun Street)***

*"Flood that entered into my house on the 26$^{th}$ – 27$^{th}$ July, 2019, destroyed all my clothing, electronics and furniture. I mean my experience is just too bad, beyond expectations and many homes in my area were severely affected too"* ***– (Paramount/Yidi Lane an area in Ijebu-Ode).***

Participants attributed the source of flood water in Ijebu-Ode mainly to rainfall. One of the participants who have lived in the town for over 72 years confirmed that:

*"Rainfall is the main and only source of water to the surface of Ijebu-Ode, I do not know other sources, there is no stream or river in Ijebu-Ode. Flooding is only experienced in Ijebu-Ode when rain starts."*

Some of the participants said:

*"Whenever there is heavy rainfall for about 30 minutes to 1 hour, we usually experience heavy flood, regular flooded roads and compounds"*

Rainfall and anthropogenic factors are exacerbating and aggravating the flood disaster risks) in surveyed communities in Ijebu-Ode.

A senior environmental officer at the Water Supply and Environmental Sanitation Department of the LGA summarized flood problems in Ijebu-Ode to involve culture, practice and attitude of the residents:

> *"The attitude of residents is posing enormous challenges in achieving sustainable environment in Ijebu-Ode"*

### **5.3.8** Mitigation measures proposed by the participants

Participants believe flood problems in Ijebu-Ode Local Government Area are surmountable, hence, the following mitigation measures are proposed as necessary and are capable of providing a long-lasting solution to the flood problems in their individual (household) areas, in Ijebu-Ode Local Government Area in general.

**Structural:**

- Proper observation, re-assessing, re-engineering and upgrading of community drainage structures and systems, to enable effective water removal through a network of aligned and integrated channels with adequate hydraulic flow;
- Regular cleaning and desilting of the drainage channels;
- Sustainable waste management through regular environmental sanitation, provision of appropriate waste collection facilities for household and community use, prompt waste collection and evacuation by authorized government agencies;
- Relocation of the vulnerable living in critical flood prone areas to safe places, and stop building construction and developments in all flood prone areas of the town;
- Need to create flood control space, or reservoirs, for the collection of water during times of high flows, or where water is held during times of flooding and that can then be released/infiltrated/used slowly;
- The re-engineering and upgrading of the existing road network, and construction of new roads that will be in tandem with the settlement pattern.

**Non-structural:**

- Adequate funding for local government departments, employment of experienced environmental personnel, purchase of equipment's and working tools in order to enhance productivity and performance;
- Good governance, political will and adequate funding especially at Local Government Area is key to mitigate flood challenges, improve disaster preparedness, adaptation and future responses;

- Prosecution of the offenders who violate the environmental laws;
- Needs for all Environmental Protection Agencies at the local government level to be functional and responsible to upheld there aims and objectives.

**Societal Strategies:**

- Exploration of use of education (formal and informal) as an instrument to reposition and empower people's psyche and develop knowledge, skills, values and behaviours that is crucial for sustainable living and disaster preparedness in them;
- Development of a strong advocacy campaign at the household and community level on flood awareness and environmental management;
- Use of mass media such as the terrestrial television and radio broadcast to provide and deliver the fastest, and reliable information and effective flood mitigation to the public (household and community people).

## **5.4** Discussion

Formulation of appropriate risk mitigation and adaptation strategies in Ijebu-Ode depends on both physical science knowledge and understanding of public knowledge, perceptions of flood risk and behaviour responses. This section discusses flood perception by participants (i.e., inhabitants) in flood prone communities in Ijebu-Ode.

### **5.4.1** Flood risk in Ijebu-Ode

Flooding in Ijebu-Ode is dependent on heavy rainfall, experienced during the rainy seasons, and is exacerbated by human activities. Floods are a recurring disaster in Nigeria (Federal Government of Nigeria, 2013, xix; Echendu, 2020), however whilst some authors have suggested that the durations and intensities of rainfall have increased in recent decades, producing large runoff and flooding in many places (Enete IC, 2014), the evidence for Ijebu-Ode does not support this argument (section 4.4.1.3). Aja and Olaore (2014) argue that the majority of Nigeria's states are increasingly suffering from flooding during the rainy season(s) caused by increased precipitation linked to climate change, however the nature of the relationship between flooding and intense precipitation is unclear in Ijebu-Ode, with greater uncertainty anticipated in the future (Haider, 2019).

This study identifies pluvial (rain-related) flooding as the main flood type in Ijebu-Ode. Results indicated that inhabitants and their environment are vulnerable to floods due to high exposure and susceptibility to the local climate change (section 4.4.1.1, 4.10, 4.11; section 5.2.5). Flood events and flood hazard occur both in dry and wet seasons suggesting floods are triggered directly by rainfall just a few hours after it falls. Rainfall is the primary source of flood events in the study area, the impacts experienced by different parts of the community vary due to unequal distribution of flood relief channels and other exacerbating influences. The result revealed that flood events have occurred both in the past and recent years causing significant hardships at household and community scales (section 5.3.1, 5.3.3, 5.3.7) in Ijebu-Ode, with most flood events occurring in June and July (section 4.3), with most effects felt within 10 days (section 5.2.3).

Pluvial flooding (surface water flooding) is caused by rainwater run-off from urban and rural land with low water absorbency (Magami et al., 2014), a problem that is often exacerbated by overloaded, inefficient and out-dated drainage infrastructure, a problem recognised by local government officials (section 5.3.6. 5.3.7, 5.3.8). Insufficient surface water drainage systems and lack of regular maintenance of hydraulic conveyance predisposes drains to blockage from debris and solid wastes that reduces their efficiency in Ijebu-Ode (Figure 5.7; section 5.2.3, Appendix O). Result indicated that practice of dumping waste in drainages is common in Ijebu-Ode due to the poor flood awareness, poor habits, poor waste evacuation by local government authority and absence of formal dump sites. Inadequate and poorly maintained drainage networks have been identified as a major contributory factor to increased frequency of urban flooding in Nigeria (Dalil et al., 2015; Ocheri & Okele, 2012). According to Oladokun and Proverbs (2016), fragile and inadequate sewage systems become overburdened and collapse, refuse/solid waste management facilities become overstretched to extent that drainage networks get blocked, leading to flooding. For instance, several flood canals and drainages turned into refuse dumps few years after commissioning (Nkwunonwo et al., 2015; Agboola et al., 2012; Kolawole et al., 2011; Adewole et al., 2014). Echendu (2020) asserted that Nigeria’s flooding is mainly human induced with current poor urban planning practices and the inadequate to non-existent environmental infrastructure contributing to/exacerbating the issue.

Uncollected waste in communities of Ijebu-Ode often litters the streets and end up in drains, thereby blocking and obstructing free flow of water, hence, contributing immensely to the apparent flooding. Aliyu and Adamu (2014) note that vulnerability to disaster is, to a large extent, a function of the human action or inaction and behaviour. Result inferred that there is no provision of waste bins by Ijebu-Ode local government authority departments in charge of environmental sanitation (section 5.2.3; 5.2.4; 5.2.5; 5.2.7; 5.3.1; 5.3.6; 7.4.3). The result is that inhabitants have been unable to organize a private refuse collection because of rare availability of such services, and the lack of affordability where it operates, poor awareness and knowledge and the poor communal cooperation. Overall, the insufficient access to surface water drainage channels and prompt solid wastes collection makes the inhabitants more vulnerable and at risk from the effects of climate change in Ijebu-Ode.

These circumstances, combined with an apparent increase in the frequency of the most extreme precipitation events since 2006, has raised the perceived threat of flooding (section 4.4.1.3). Pluvial flooding can have a rapid onset with severe levels of flooding (Magami et al., 2014). Aderogba (2012) asserted that whilst climate change has led to more rain, Nigeria's flooding problem is mostly human induced and exacerbated by human-nature interactions. Echendu (2020) noted that Nigerian cities are characterized by poor infrastructure which impacts livelihoods and sustainability. The inhabitants have concentrated their efforts predominantly on the endogenous capacities to reduce flood risk and disaster stress, that help prevent and minimise impacts in Ijebu-Ode (Appendix M & Q; Subsection 5.2.4, 5.2.6, 5.2.7).

In states of south-western Nigeria, flood occurrence comes with wide-ranging of impacts, including both direct and indirect impacts on health, with flood waters providing breeding ground for parasites which lead to increased incidences of parasite borne diseases like Malaria (Echendu, 2020). Women and children are especially vulnerable to these diseases, with increased deaths and illness, with 90% of these direct effects having occurred in developing countries like Nigeria (Zorn 2018). None of interviewees have thought about or made decisions to relocate from where they are currently living, none indicated they were ready to purchase flood insurance. Findings indicated that susceptibility of the inhabitants is compounded by their low adaptive capacities (Appendix O; Subsection 5.2.4).

> *"Whenever it rains, they* [residents] *fall into pit of gripping fear as the water pours in torrents; for about two or three hours after it must have stopped raining, floodwater will still be pouring through. The residents lamented that if the government does not do something on time, our houses will continue to be destroyed and people will continue to die. The State Government through Commissioner for Environment stated that "The magnitude of erosion in Ijebu-Ode is beyond what government can handle. He said residents of the community should relocate until the problem is fixed" (Sunday Punch, 2018; https://Odili.net)*

Aliyu and Adamu (2014) state that the level of risk in a society is determined by the level of vulnerability, the degree to which a socio-economic system or physical assets are either susceptible or resilient to the impact of natural hazards combined with the level of probability and intensity of occurrence of a natural hazard. Agbonkhese et al. (2014) and Satterthwaite (2017) argue that unlike some of the disasters, pluvial flooding can be controlled with the proper planning and provision of necessary infrastructures.

Tupale et al., (2012) submitted that coping strategies operate at different levels: individual (household), community (neighbourhood), and institutional (citywide). Flood hazards and impacts on both small and large scales continue to cripple capacities of inhabitants to improve their conditions of living and overall wellbeing in Ijebu-Ode. According to Blaike et al., (2004), coping strategies of the urban poor can be grouped into 'preventive' and 'impact minimising'. The former requires people to make informed choices to avoid being affected by an event, a typical example regularly clearing blocked drainages in the flood prone areas. Generally, both preventive and impact minimizing mechanisms have been used by inhabitants in Ijebu-Ode to reduce flood disaster risks in their areas. The interviews and surveys highlight that local inhabitant capacities have concentrated on the clearance of drainage channels to reduce flood disasters, amongst other measures (Figure 5.7a; section 5.2.4). Past floods have presented a threat to buildings and forced inhabitants to vacate their homes for safety (section 5.3.4), whilst a severe adaptation to the threat, this can be effective in avoiding loss of life, but requires the capability to leave a property or area safely and an awareness of the threat.

### 5.4.2 Why (in)formal settlements are vulnerable to flood risk

The inhabitants of communities in Ijebu-Ode are at the risk of flooding because they are vulnerable as a result of both the unequal distribution of socio-economic facilities and high rainfall variability, with considerable exposure and susceptibility of particular groups e.g., the disadvantaged. Three key groups that have been identified to be most vulnerable to climate change impacts are people living along the coast, people living in informal settlements, and marginal groups living in rural areas (Islam and Winkel, 2017; Williams et al., 2019). Ijebu-Ode's inhabitants' capacities at household and community level are recognized and have proved invaluable in helping to minimize flood impacts. However, high levels of flood risk and vulnerability in Ijebu-Ode are attributable to socio-economic stress and insufficient physical infrastructures, which tend to characterise unplanned settlement development. Settlements in Ijebu-Ode depict a combination or mix of unplanned and planned, but are dominated by informal settlement. The formal-informal settlement pattern in Ijebu-Ode would suggest the inhabitants of informal part are mostly flood prone and at risk of marginalization and social exclusion from the benefits of urbanization, with a lack of access to essential infrastructural services. Results indicate that careless management of flooding in Ijebu-Ode have made the problem to persist and possibly worsen, the absence of functional governance at the grassroot level coupled with the poor physical planning, poor infrastructural facilities, and poor political will have continued to increase inhabitants' vulnerability.

Informal settlements are often characterised by dense settlements comprising of the communities housed in self-constructed shelters under conditions of informal or traditional land tenure (Daniel, 2006). They are common features in developing countries and are typically the product of an urgent need for shelter by the urban poor. The United Nations has used the term "informal settlements" to refer to unplanned settlements where the housing is not in compliance with current planning and building regulations (unauthorized housing (United Nations,2015). Urban planning in Nigeria is poor and compounded by numerous compliance problems; this poor planning is a primary cause of the extent to which communities are flooded in Nigeria. Omoboye and Festus (2014) assert that Nigeria's flooding is therefore inextricably linked to poor urban development practices. Growth and expansion of the urban communities in Nigeria has been poorly managed, with a lack of spatial planning, poor land use management and absence of good corporate governance characterizing urban development (Adedeji et al., 2012; Abaje et al., 2015; Dalil et al., 2015). Common reasons for the continued growth of the informal settlements are that governments failed to adopt so called “pro-growth” policies (UNECE, 2015a).

The result of this study indicates that poor policy implementation is a major setback in achieving sustainable flood risk management. According to one of the policy implementers who was interviewed, the Vice Chancellor of a University of Education in Nigeria:

> *“Poor environmental policy implementation in Nigeria is a major problem. Discontinuity of policy by successive government in many parts of Nigeria is a major problem. If there is continuation of policies by each of successive governments, sustainability is achievable.”*

Inhabitants’ capabilities of coping with perennial flood risk including post-recovery capability and strategies are insufficient. Lack of government and charity organization attention and support throughout inundation periods and after, including the lack of insurance to recover from impact leaves inhabitants of Ijebu-Ode vulnerable. Lack of flood insurance (section 5.2.4), is attributed to a range of factors, including: a lack of information, low awareness, poor governance, ignorance, cost and unaffordability, unstable income, and poor accessibility (section 5.2.4). The findings of this study found poverty to be a major challenge, as most people cannot afford flood insurance, most affected households cannot afford relocation to a safe area. The results that indicated preparedness is poor, hence, recovery is challenging. Flood risk awareness is very low in Nigeria, as insurance schemes are available and/or affordable. Poverty is a major challenge to the development in Nigeria (Lame & Yussof, 2015; Ike & Uzokwe, 2015). Demographic data show more than 64% of the nation’s population, of over 160 million, live on less than $1 a day (Joshua et al., 2014). The results here support previous studies, especially women, in lower income neighbourhoods recorded higher impacts and slower recovery after flooding (Ajibade et al., 2013). Poverty is a primary driver of urban flood risk in Nigeria, with flooding potentially further exacerbating poverty as uninsured residents lose their properties and livelihoods to flood disasters (Oladokun & Proverbs, 2016). Hence, there is vicious cycle of flooding, poverty and deprivation (Adelekan, 2010; Douglas et al., 2008).

Ineffective urban governance is found to be affecting communities in Ijebu-Ode disproportionately, as “politically induced conditions” with the unequal distribution of socio-economic facilities and differentially exposing inhabitants (section 5.2.3, 5.2.5, 5.3.1, 5.3.2, 5.3.4, 5.3.5). This also presents opportunities for corruption, which helps to describes and explain the unequal allocation of budget and socio-economic resources in Ijebu-Ode, hindering transparency, destroying good governance and general development, and sustainable flood risk management.

### **5.4.3.** Flood warnings and early warning schemes

In spite of increased exposure and susceptibility of inhabitants and their total environment to severity of flood events and risks in Ijebu-Ode (Figure 5.5, Appendix L, O & P), the majority of victims could not access flood warning information (section 5.2.2), with most reliant on past experiences to forewarn them of the flood risk (section 5.2.2, 5.2.3) A perceived increase in flood events coupled with lack of coping capacity and high levels of vulnerability of people have continued to put many lives and properties at risk (Komolafe et al., 2015). The Nigerian urban systems inability to cope with increasing trends and intensity of flooding remains a major challenge (Oladokun et al., 2016; Adelekan, 2011; Adewole et al., 2014), requiring a sustainable approach involving developing resilience of those most exposed to flood risks (Gallopin, 2006; Klein et al., 2003). The survey results indicated whilst some households are not prepared for future flood events (section 5.2.4), others continue to try and access existing resources. Early warning schemes have not yet worked properly as flood damage reduction measures in Ijebu-Ode (section 5.2.3). Ineffective early warning information and flood forecasting have contributed to increased flood risk in Ijebu-Ode (section 5.2.3), with disaster management in Ijebu-Ode is mainly reactive and conducted independently by inhabitants, with little government support (section 5.2.4). Flood risk management comprises measures aimed at reducing likelihood and impact of floods (Echendu, 2020). Okoye (2019) opined that inadequate attention is paid to flood control and management on a nationwide level in Nigeria, with previous efforts having failed because of a lack of coordination. Historically, Nigeria has been more focused on the post-disaster flood response than the prevention and control (Cirella & Iyalomhe, 2018).

### **5.4.4** Learning to live with flooding in Ijebu-Ode?

Communities in Ijebu-Ode are concerned about risk of floods impacting their total well-being (section 5.3.3, 5.3.4, 5.3.5, 5.3.7). The inhabitants are not satisfied with the authorities' response in Ijebu-Ode and noted no significant efforts have been embarked upon at LGA to ameliorate their sufferings from flood problems (section 5.3.4, 5.3.5, 5.3.7). Despite overwhelming challenges, inhabitants continue to engage in an array of practices in dealing with flooding as demonstrated in their positive contribution to DRR at both household and community levels (sections 5.3.4 & 5.3.5). Inhabitants have made up their minds to overcome government, local and state institutions and the outside organisations' neglect and rebuild their lives on their own by always resorting to their pool of endogenous resources, (section 5.3.4, 5.3.5**,** 5.3.8). However, external support is needed by the inhabitants in fostering their sustainable recovery and to avoid the so-called ratchet effect of marginalisation associated with recurring disasters (Gaillard, 2010). Interviewees identify that flood risk management is both government and citizen's issues, and have noted that good flood risk decisions at local government level to a large extent can protect inhabitants from floods. Interviewees identified that flood risk management can be part of people's everyday life through purposeful advocacy, sensitization, education and awareness on environmental sustainability and flood management. Interviewees further noted that imbibing a culture of self-discipline (i.e., change of attitude), such as desisting from deliberate acts of dumping waste in drainages, improvements on flood information, communication, implementation and enforcement of environmental laws could help further strengthen adaptive behaviours, and crucial to achievement of DRR (section 5.3.8).

The focus of flood management in Ijebu-Ode has to a great extent been on structural measures, with little attention given to social processes which frame vulnerability or resilience of flood affected inhabitants. Low levels of preparedness for dealing with the climate-related risk factors are compounding flood-related consequences and cost (i.e., at household level) in Ijebu-Ode. Integration of non-structural approaches to flood mitigation, for which understanding of the social dimensions of flood risk is an important aspect. According to Adekola and Lamond (2018, p. 1150), strategies currently practised/suggested as potential solutions by Nigerian government actors are mainly structural and institutional approaches, with less societal approaches engaged. There is also a near absence of ecosystem-based and behaviour approaches in strategies suggested by government actors (Adekola and Lamon, 2018, p. 1150). Getting people to act or change unsustainable behaviour poses a challenge for contemporary flood management, which places emphasis, on behavioural measures (Fazey et al., 2016) and the role of citizens in taking some responsibility for flood risk management (Buttler and Pidgeon, 2011; Terpstra and Gutteling, 2008). Hence, there is a need to adopt a societal approach (i.e., adaptation options that use education, awareness, networks and human capital building) to promote changes to individual or community behaviour that enhance resilience (Carmin et al., 2015 in Adekola and Lamond, 2018, p. 1148).

### **5.4.5** The role of Education

Survey responses (section 5.2) and interviewees (5.3) demonstrate a high awareness of the threat presented from floods; however, they receive little environmental education and limited support in developing abilities to cope and recover (5.2.4,5.2.5, 5.2.6, 5.3.4, 5.3.5, 5.3.6). The surveys and interviews indicated that student's, families and teachers' awareness are low (section 5.2.6; Appendix Q); as Nigerian children and youth are not yet educated on these issues and thus have insufficient knowledge on how to deal with situations caused by climate change (Duru and Emetumah, 2016; Amanchukwu et al., 2015). Amanchukwu et al. (2015), stated that the challenges include inadequate teacher qualifications and infrastructure, with little consideration during teacher training and inadequate equipment. Whilst the UNISDR (2005) identified that education develops a resilient population by limiting economic, social and cultural impacts of disaster including environmental changes. Amanchukwu et al., (2015) note that under the Education and School Curricula, Nigeria has yet to recognise and adopt education as an effective climate change counterstrategy. The Building Nigeria's Response to Climate Change (BNRCC) committee (2011, xiii) recognise that adaptive capacity is the ability of individuals and communities to adjust to climate change, to moderate potential changes, to take advantage of opportunities or to cope with consequences, however, they have not developed any mechanism to support this within the educational curriculum in Nigeria. To integrate climate change adaptation into every aspect of national life, Nigerians must have an awareness and knowledge – and access to knowledge – of what climate change is, how it is impacting them and how they can adapt (BNRCC, 2011). As Madu (2016) notes 'adaptive capacity depends on sufficient education, assets, information and their income'. The need to be equipped with specialised skills to enable individuals, communities, and the country to address climate change risks and implement adaptation requires efficient and effective sharing of information and knowledge, accessible to a wide range of the people, particularly the most vulnerable (Anabaraonye et al., 2019; BNRCC, 2011).

The level of public awareness on issues related to climate change in Nigeria is low (BNRCC, 2011). Studies indicate that the Nigerian media has given insufficient attention to climate change issues (Ajaero and Anorue, 2018), with the degree of information available influencing levels of awareness on climate change issues (Duru and Emetumah, 2016). Survey (section 2.5.2) and interviews (section 5.3.4, 5.3.5, 5.3.5, 5.3.7) indicated that, local government is unable to build capacity of Local Emergency Management Agency (LEMA) to prepare for, prevent, against, respond to and recover from the flood events due to poor funding and this has been a major limitation to progress, however, funds are readily released for post-floods but not the pre-floods. Institutional capacity building will be necessary for all the institutional stakeholders engaged in climate change adaptation in Nigeria (BNRCC, 2011).

## **5.5** Summary

This chapter demonstrates that the population of Ijebu-Ode are exposed to perennial pluvial flood impacts and have recorded severe losses due to high hazard exposure and susceptibility, whilst inhabitants' resilience in many at-risk communities is low. The major drivers of flood risk are high exposure and social vulnerability associated with nature of their living environment and effects of climate change. Inadequate infrastructure and management of the environment (including waste management), exacerbates societal vulnerability in Ijebu-Ode, however the exposure is linked to poor urban management and the government's inability to deal with perennial pluvial flood issues in Ijebu-Ode. Poor settlement development, unchecked urban expansion, poor behaviour responses and unequal distribution of socio-economic facilities, leads to high vulnerability of some inhabitants to floods. It recognizes inhabitants' capacities, and that their local knowledge proves invaluable in dealing with the pluvial flood events in Ijebu-Ode. A range of measures to increase adaptive capacity of the urban poor are identified that governments at local and state levels should pursue include:

- improved understanding/education of flood risk;
- effective physical planning and enforcement of urban planning laws;
- combination of both the structural (i.e., construction of more primary, secondary and tertiary drainage systems, taking into account storm run-off responses under high intensity rainfall and proper solid waste collection) and non-structural measures;

- involvement of both the internal (i.e., local people) and external stakeholders (i.e., government, non-governmental agencies and charity organizations);
- workable evacuation plan to reduce physical vulnerability of inhabitants in mostly severely flood areas;
- efficient forecasting system; and
- management and environmental education for citizens.

This research contributes to flooding literature by establishing a clear relationship between hazard and vulnerability. Predisposition of in(formal) communities in Ijebu-Ode to be adversely affected by flood hazards is high, hence, threatening sustainable development. This study considers vulnerability as the root cause of flood disasters and, as such, requires an extensive attention on short- and long-term developments to achieve sustainable DRR in Ijebu-Ode. Two key themes emerge which will be explored in the following chapters:

- Increasing adaptation capacities to flooding will help to establish flood resilient communities and minimize the risk, include developing and enhancing capacities, adaptive behaviour and reduce physical vulnerabilities, particularly of those at greatest risk.
- Education is identified as a valuable tool in developing environmental and flood resilient populations. Environmental education has been identified as a way of learning associated with changing attitudes, behaviours and participation in society (Norris and Juliet 2016). Harnessing and enhancing local capacities will help in fostering their participation in DRR. This could be advanced at the national level with the inclusion of environmental education in the national curriculum, with specific content on helping to maximize flood mitigation efficiency.

# Chapter 6

## Implications of gender-related differences for pluvial flood risk perception and precarity in Nigerian cities


### Abstract

Climate change represents one of the most challenging threats to sustainable development for all those living in Africa. There is an increasing need for knowledge focused on flood risk perception, as it is crucial for understanding how to develop effective flood risk management that is inclusive to all. The continent is home to some of the most susceptible populations of the world, because of the sensitivity and fragility of its natural environment to climate change and the precariousness of its populations. Gender inequality can exacerbate these challenges; however, bridging the gender gap can also provide solutions for policy makers and the public. By enhancing flood risk perception and informing more effective adaptation and mitigation strategies, attending to gender inequalities can reduce individual and community vulnerability. Using Ijebu-Ode, Nigeria as a case study, public awareness and understanding of flooding issues are explored, coupled with an assessment of individual and community responses and their adaptive capacity. A questionnaire (n=300) was distributed in-person to communities at risk of pluvial flooding. Our findings provide insights for many other comparable cities in West Africa and beyond, especially those suffering a history of pluvial flooding, characterised by a young population, a mix of formal and informal housing, and a fragmented infrastructure. Although gender differences may be important drivers of vulnerability, our study finds no significant differences in gender understanding or responses to pluvial flood risk in Ijebu-Ode, which suggests that precarity and other wider, deeper-rooted complex issues may be more important with (in)formal settlements.



**Keywords:** gender, precarity, inequality, informal settlement, flood risk perception, natural hazards

## 6.1 Introduction

Floods are one of the most common natural hazards, it is estimated that between 1900 and 2022 floods affected a total global population of more than four billion people and caused more than US$ 1650 billion in damages (EM-DAT, 2022). The exposure of human settlements and critical assets to flood risk is increasing due to global climatic changes; e.g., sea level rise; changing precipitation patterns, intensities, and distributions; compounded by land use and land cover changes and urbanisation (IPCC, 2022b). This poses major challenges to sustainable development of linked natural and human systems. There have been notable recent global floods across continents, in particular in Asia 2022 (Jamil et al., 2023), Africa 2022 (UNHCR, 2022), and Europe, 2021 (Cornwall, 2021), with significant impacts on lives, livelihoods, health and economic, physical, social and environmental assets, highlighting the increased need for effective management of flood risk, with this threat expected to increase with current global climate change (GCC) projections (IPCC, 2022a). Countries in Sub-Saharan Africa have been identified as some of the most susceptible to the impacts of GCC, despite having historically contributed relatively low emissions (World Meteorological Organization (WMO), 2022). Less than 3% of the total global greenhouse gas emissions originate from Sub-Saharan Africa; in comparison the top ten global emitters of greenhouse gases (e.g. Brazil, China, Canada, European Union, India, Indonesia, Japan, Mexico, Russia, and USA) are responsible for over 60% of all the total global emissions (Jones et al., 2023).

Floods are frequent and widespread hazards in Africa (Di Baldassarre et al., 2010), particularly in sub-Saharan Africa (Douglas et al., 2008). On average 500,000 people per year are affected by floods in West Africa alone (Jacobsen, Webster & Vairavamoorthy, 2012). Ndaruzaniye et al. (2010) identify that cumulatively in recent decades floods and droughts alone are responsible for around 80% of disaster-related deaths and 70% of economic losses in sub-Saharan Africa. In sub-Saharan Africa alone, 654 floods have affected 38 million people with around 13,000 deaths recorded (1980-2013; Tiepolo, 2014); demonstrating the urgent need to seek an effective solution to mitigate flood risk in the context of adaptation to climate change. Understanding risk perception is crucial for managing flood risk (Lechowska 2018), and assessing community resilience and preparedness, although the relationship between public perceptions of risk and actions are complex, contextual, and influenced by a variety of factors (Odiase, Wilkinson, and

Neef, 2020). Understanding precarity and power relations is critical for assessing social vulnerability (Rufat et al., 2020; Wisner, 2004). Precarity draws attention to politically induced conditions in which populations suffer from failing social and economic networks resulting in them becoming “differentially exposed to injury, violence, and death” (Butler 2009, 25), providing essential context for hazard and subsequent disaster studies.

Risk perception refers to the subjective judgement of individuals and/or groups when asked to evaluate a hazard, often in the context of limited and uncertain information, with perception being influenced by a range of cognitive, socio-cultural, and experiential factors (Slovic 2000). Risk perception encompasses individual-, community-, and societal-level awareness and assessment of the likelihood of the occurrence of a hazard and its potential impacts (e.g. loss of life, injury, property damage, and disruption to livelihoods). However, as Kellens et al., (2011) note, flood risk perception incorporates human behaviours, consciousness, and emotions concerning the hazard, whilst Raaijmakers et al.(2008) identifies flood risk perception to be a combination of risk -awareness, -worry and -preparedness. Incorporating flood risk perception is necessary for effective flood risk management, as such an understanding of public risk perception is required, and the possible behaviour of that public in the event of a flood. However, Duží et al. (2017) notes that perceived flood risk (by the individual or society) often fails to match that presented by experts, with flood risk often underestimated which can make flood risk management challenging.

The aim of this paper is to explore the relationship between flood risk perception, precarity, and gender in an (in)formal settlement. The factors driving flood risk perception are cognitive but also situational, and gender is one of the many demographic factors that influence risk perception (Lechowska 2018). This is particularly significant as women have been shown to interact with water resources and landscapes in different ways (Ajibade et al., 2013), with little research undertaken to address this issue (Baker et al., 2015). Previous research has identified a gap in the context of risk perception such that, when aware of the risk, women tend to perceive environmental and hydrological risks more acutely than men (Lindel & Hwang, 2008; McCright, 2010), although this is not always the case (Greenberg & Schnider, 1995). In general, women appear to take increased preventative action to mitigate against risk; however, this propensity towards protection does not always appear to translate into the domain of flood-related preparedness behaviours; for example, Bradford et al. (2012) and Scolobig et al. (2012), both find males reporting higher flood preparedness levels than females in European contexts. Such an understanding of gendered differences in perceived flooding risk, can be a powerful tool in targeting flood risk messaging and management (Antronico et al., 2023), but a lack of understanding exists for African contexts. Furthermore, fundamental to the understanding of disasters, and therefore critical in maximising disaster risk reduction (DRR) strategies to their full potential, is that disasters are experienced differently based on individual characteristics, such as gender (Andrijevic et al., 2020; Mcdowell et al., 2016; Neumayer & Plümper, 2007). Cutter (1995) argued that women and children were the 'forgotten casualties' in disasters and has recently reiterated this argument (Cutter, 2017), suggesting that the situation has worsened in the intervening years as a result of greater inequalities, with a continuing need for focused attention. As Jonkman & Kelman (2005) note, recognising differences in gender vulnerabilities in flood disasters is important, but also to understand their specific capacities is crucial. Women's experience and position in many African society's often equips them to better lead community and national climate risk adaptation approaches; reiterating the argument made by Dr. Farkhonda Hassan (Chair of the UN Economic Commission for Africa's Committee on Women and Development) "We are all aware that despite achievements and progress made, African women face major challenges and obstacles… [as the] majority of African women are still denied education and employment, and have limited opportunities in trade, industry and government" (Mutume, 2005). This supports the argument made by Nelson et al. (2010) that greater awareness and engagement with gender was required in mitigating climate change impacts. Despite these calls, to date there have been few studies exploring the role of gender in flood perception and management in Africa, exceptions being Belcore et al. (2020) and (Ajibade et al., 2013). Differentiated gender power relations between men and women and unequal access to, and control over assets, often means that inequalities exist that result in unequal adaptive capacity. Instead, women are characterized by distinct vulnerability and exposure to risk (AfDB, 2011). However, they are endowed with strong coping capacities in the face of climate change and can play an active role in adapting to its impacts (AfDB, 2011). As Gill (2014) notes climate change responses will have a gendered impact if gender is not considered in their design and implementation.

Inequalities in risk perception are exacerbated in situations of high vulnerability, which describes many communities across Africa. Climate change impacts communities in different ways and the consequences of such disasters will be felt unequally (World Bank, 2018). Inequalities arise due to spatial variations in, but are also experienced differently depending on demographics, including gender (Pavageau et al., 2016). Climate change has specific effects on women because of the different roles they often play in society and their differentiated access to social, economic and physical resources (Belcore et al., 2020). In Africa, these disparities result in part from the social positions of women within the family and the community and are often exacerbated by the effects of climate change on access to food, clean water, safe sanitation, and energy supply (African Development Bank, 2009, p. 1). Vulnerability and the capacity to adapt is influenced by many other factors beyond gender, such as economic status, technology, health, education, information, skills, infrastructure, access to assets, and management capabilities (Bob & Babugura, 2014). Many urban communities also live in precarious conditions, partly due to socio-economic factors such as poverty and marginalisation (Amoako & Inkoom, 2018), unemployment or/and inconsistent employment, relative high mortality and poor health (Quinn et al., 2023). Rapid urban expansion without adequate planning or infrastructure in flood-prone areas has also made conurbations in Sub-Saharan Africa more vulnerable (Ramiaramanana & Teller, 2021), especially in informal settlements where infrastructure, structures, and building materials are less resilient to flooding (Satterthwaite et al., 2020). All of this means that African countries require tailored mitigation and adaptation policies (Nyiwul 2021). However, overall adaptive capacity in Africa is considered low, with most adaptations remaining autonomous and reactive to short-term motivations (Niang et al., 2014).

Despite international efforts to reduce the loss of life, exposure to and damage from hazards (i.e. biological, geophysical, hydrological and meteorological hazards), the number of recorded disasters has continued to rise on a global-scale (Coronese et al., 2019). The United Nations Office for Disaster Risk Reduction (UNDRR) plays an important role in coordinating the UN disaster reduction programs, bringing together local, national, and international governments, partners, and communities to reduce disaster risk and losses to ensure a safe and sustainable future for all. The *Sendai Framework for Disaster Risk Reduction 2015-2030* (Sendai), is endorsed and monitored by the UNDRR, is the guiding international policy structure for DRR strategies globally and nationally, with signatories to the framework required to report on their progress in implementing the framework. Sendai seeks to reduce disaster risk through the implementation of integrated and inclusive measures that prevent and reduce hazard exposure and vulnerability to disasters, increase preparedness for response and recovery, and thus strengthen individual and community resilience. Sendai was one of three landmark agreements that was adopted by the United Nations in 2015: the other two post-2015 global sustainable development agendas being, the Agenda 2030 Sustainable Development Goals (SDGs) (UN General Assembly, 2015) and, under the auspices of the 'United Nations Framework Agreement on Climate Change' (UNFCC), the COP21 Paris Climate Change Agreement (Paris Agreement) (UNFCC, 2015). Despite each of these agreements differing in structure, legal context, and their implementation mechanisms, they all acknowledge the strong need for coordination and action on DRR, with greater coherence and alignment between them of policy goals and targets. There are a number of cross-cutting themes and shared priorities that run across a range of these global frameworks, the reduction of gender inequality being one of them; the importance of this priority is reflected in the inclusion of a separate goal on gender equality in the SDGs (SDG 5) that outlines six targets and three means of implementation, highlighting the need for continued action on empowering women and girls in order to achieve inclusive sustainable development (Zaidi & Fordham, 2021).

This paper contributes to current discussions about the challenges and issues involved in untangling inequality, gender and precarity within the context of flood risk. The focus is on a mixed (in)formal settlement in West Africa; a conurbation similar to many that have suffered from pluvial flooding, with a range of socio-economic factors and drivers. Understanding how existing inequalities influence flood risk perception levels and implications for policy making is crucial.

## 6. 2 Flood risk in Ijebu-Ode (Nigeria)

Nigeria has a tropical climate with two precipitation regimes: low precipitation in the North (shortgrass and marginal savanna) and high precipitation in parts of the Southwest and Southeast (rainforest and mangrove). This can lead to aridity, persistent drought and desertification in the north; and erosion and large-scale flooding in the south (Akande et al., 2017; Nkechi et al., 2016). Ijebu-Ode, one of the 20 Local Government Areas (LGA) that makes up Ogun State (one of the 36 states) in Nigeria is used as a case study (Figure

1). Ijebu-Ode with a formal population of 154,032 (2006 census) has a population density of 1,139 per $km^2$; with an elevation of 74 m.a.s.l. and total area cover of 192 $km^2$, situated in southwestern Nigeria.


Figure 6.1: Location of Ijebu-Ode, districts and sampling locations in Ogun State, Nigeria. Districts: A) Irewon; B) Molipa Express; C) Molipa Road/Degun; D) Ibadan Road/Bonojo; E) Igbeba Road; F) Folagbade/NEPA; G) Yidi/Paramount/Sakasiru; H) Abeokuta; I) Local Government; J) Sabo; K) Adefisan.

The climate of Ijebu-Ode is characterised by of Southwestern Nigeria is lowland tropical rain forest with distinct wet and dry seasons. The region on an annual basis is under the influence of hot-wet tropical maritime air mass during rainy season (April-October) and hot-dry tropical continental air mass during dry season (November-March; Figure 2). Rainfall is generally intense with peaks occurring in July and September (double maxima) coupled with high temperature, evapotranspiration and relative humidity, conditioned by several meso and local scale factors. The town being of low latitude is liable to flooding during the raining seasons. Flooding is common and usually experienced during the raining seasons in Ijebu-Ode with heavy rainfall, poor drainage systems usually resulting in severe floods. When rain is very heavy, most of the drainage channels overflow thereby severely affecting the people.

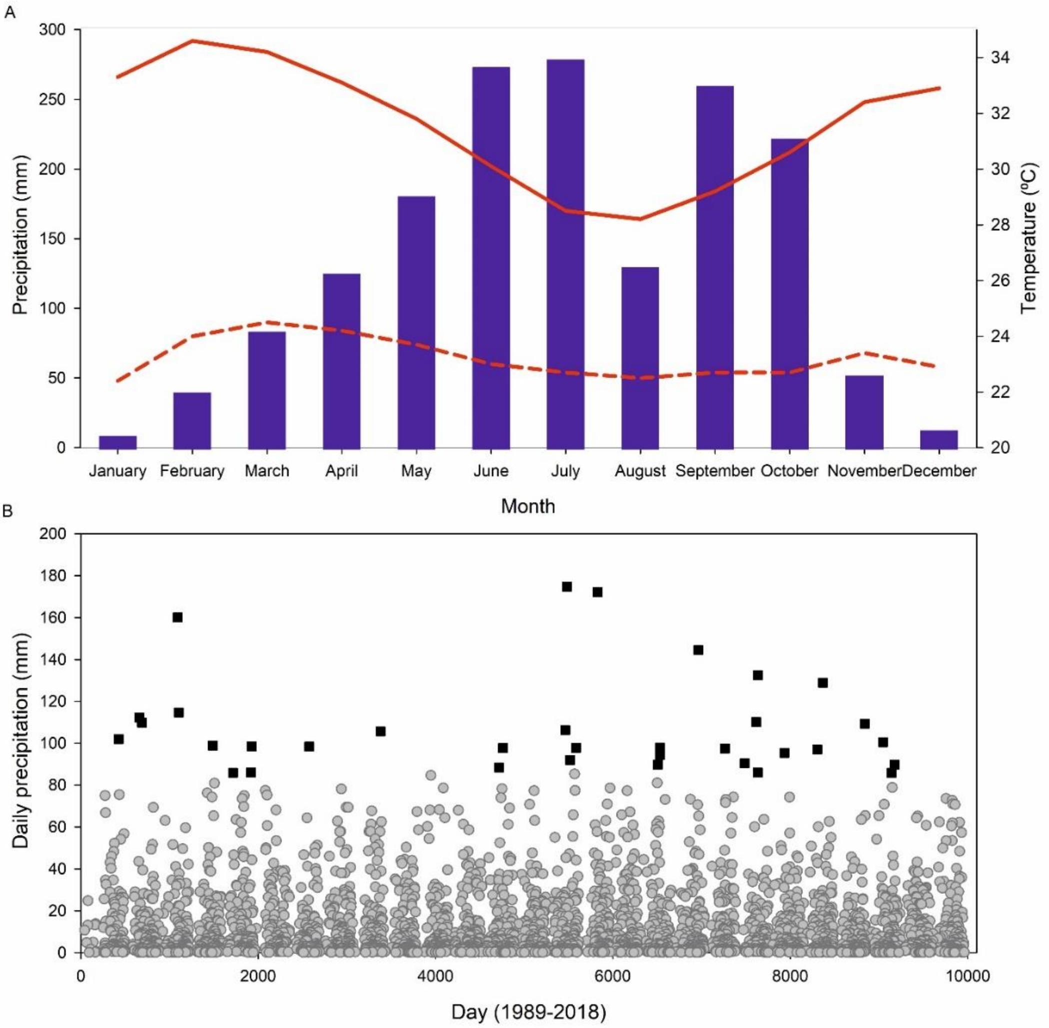


Figure 6.2: Average monthly maximum (solid red) and minimum (dashed red) temperature ($^oC$) and precipitation (mm) for Ijebu-Ode, Nigeria (1989-2018).

The city is the third largest urban centre in Ogun State in terms of infrastructural facilities. Ijebu-Ode is an administrative headquarters and commercial centre which predates the colonial period. Historically, Ijebu-Ode is an ancient city situated in an inland area, which is centrally located in relation to the other human settlements nearby; several smaller towns and villages mostly referred to as Egure “this way to”; including towns such as

Ogbo, Ijagun, Ala, Ososa, Erunwon, Ogbogbo, Isonyin, and Imoru. Ijebu-Ode consists of three districts: Iwade, Ijasi and Porogun and is the commercial centre of the Ijebu geopolitical area of Ogun State, Southwest Nigeria and has expanded rapidly during the last two decades. Studies on flood risk perception in Nigeria have been limited with a focus on fluvial floods and often the capital Lagos (Belcore et al., 2020). Despite the scale and impact of flooding across Nigeria, to date, with notable floods in 1933, 1948, 1963, 1978, 1980, 1982, 1985, 1987, 1988, 1990, 1999, 2000, 2001, 2005, 2006, 2010, 2011, 2012, 2013, 2017, 2020, 2022 the focus has been on fluvial flood events often associated with the River Niger and its tributaries; however, little attention has been given to pluvial flood risk. The high frequency of flood events in Nigeria in recent decades is key, as experiences of flooding are key in shaping perceptions of flood risk, but individuals responses towards risk explain inconsistencies between risk perception and response at spatial and temporal scales (Odiase et al., 2020).

Current available flood risk information in Ijebu-Ode is restricted to qualitative sources such as the study of newspapers and similar publications, which documented flood events, as there is no instrumental river flow data for the area as there are no river systems through the settlement. Information relating to past floods in Ijebu-Ode are not documented in official archives (detailed data on past flood damage or potential exposed items do not exist), however, relevant information pertaining to floods gathered by news agencies including interviews on flood extent and problems impacting the local population are available. Importantly these include information on the inhabitant's vulnerabilities and locations during different events, which were explored for the purpose of establishing impact of historical flooding on people of Ijebu-Ode. Recent floods in Ijebu-Ode have highlighted the threat that climate change presents to the people and communities, yet there is little evidence of any change in the frequency of intense precipitation events in Ijebu-Ode (Figure 2b), as such changes in flood risk may be a function of changing landcover and use. The drainage system constructed in Ijebu-Ode to serve a small population in the past, has failed to expand and develop despite rapid urbanization, settlement expansion and development witnessed in recent years, the result is a system that is of insufficient size or design capacity for current needs. The lack of waste infrastructure within the settlements means that waste is often placed into the public environment or streets (Figure 2), exacerbating the threat presented by flooding. Urban environments in Nigeria face a myriad of issues regarding poor drainage systems

(Offiong et al., 2009), with urban flooding resulting in inundation of land and/or property with rainfall overwhelming the capacity of drainage systems (Tucci, 2001).

## 6.3 Methods: Exploring flood risk perception in Ijebu-Ode (Nigeria)

To understand individual perspectives of flood risk and how socio-cultural aspects shape flood risk awareness and behaviour in Ijebu-Ode, we designed and distributed a questionnaire, receiving 299 responses (Supplementary Materials 1), designed with five sections (1: Participant information; 2: Home area information; 3: Flood risk indicators; 4: Resilience indicators; 5. Mitigation). The questionnaire comprising of a range of 'open' and 'closed' questions, including a series of 5-point Likert scale questions was distributed to communities exposed to, and that have experience of flooding, ten flood-prone areas in Ijebu-Ode were selected (Yidi/paramount/Sakasiru, Folagbade/Nepa, Irewon, Ibadan Road/Bonojo, Molipa Express, Ibgeba, Molipa Road/Degun, Adefisan, Abeokuta Road/New Road, Sabo), these were selected based on newspaper reports and personal experience of past flooding.

There are three primary methods of undertaking questionnaires according to de Vaus (2014) and Edwards et al. (2009), postal; face-to-face and telephone/internet, with each offering respective strengths and weaknesses. A face-to-face approach was selected for the distribution of the questionnaires rather than postal and telephone/internet approaches, as a number of residential areas do not have formal postal addresses which prohibits a postal survey in Ijebu-Ode, and as Dennis et al. (2012) note not online/telephone approaches are not suited to communities where literacy may be low. Telephone/internet-based approaches also assume a high level of coverage, however such technological approaches may miss particular communities (Rohde et al., 1997), which we were particularly interested in capturing in this study. Face-to-face surveys have also been identified as having high response rates (Nakash et al., 2006) and support can be offered to respondents where issues arise, such as poor literacy (Heerwegh & Loosveldt, 2008).

The questionnaire was distributed between April-July 2020 during different times of the day (all during daylight) within the 10 different communities in person on the street to capture a range of groups. Whilst the lead author was based in the UK, the fieldwork season was moved around capacity to visit Ijebu-Ode resulting from COVID restrictions on travel both within the UK and Nigeria, as such only a small test sample was undertaken amongst the community prior to widescale distribution, which resulted in minor amendments. In determining the sample size, the population of Ijebu-Ode is approximately 355,000, a 90% confidence interval on the derived results with a margin of error at 5% (Thompson, 2012) would require an ideal sample of 273, therefore a sample of 300 completed questionnaires was targeted which is comparable to previous studies (e.g. Ho et al., 2008) in examining flood impacts on communities. In total, 299 completed questionnaires were returned across the study area. The analysis focused on descriptive statistics, with multiple combinations of responses considered through the use of pivot tables, correlation analysis (Pearson) with thematic content analysis of the open-ended responses.

## 6.4 Results: Exploring flood risk perception in Ijebu-Ode (Nigeria)

### 6.4.1 Participant information

From the completed questionnaires, 141 respondents (47.2%) identified as male and 157 as (52.5%) female, with 1 (0.3%) providing no response. The majority (98%) of participants sampled where between age 18-65 and therefore of working age (only those of the age of 18 were sampled). Occupations of the participants varied: public servants (27.1%), students (26.1%), traders (19.4%), business executives (14.4%), and 12% represented by others. The majority (62.9%) had a tertiary education, whilst the respondents with secondary (26.1%) and primary education (3.7%), with only 1.67% having no formal education. The majority live within private accommodation (68.6%), with a slightly higher proportion of male (F/M: 33.1/35.1%); however, this pattern is reversed when considering public (23.8%; F/M: 14.7/9%) and government (7.0%; F/M: 4/3%) housing. In considering residence times, the majority of residents have been present between for over 5 years (6-15 years (26.5%) or 16-25 years (33.1%) and >25 years (23.4%), notably the proportion of F/M respondents in the 16–25-year group has the largest difference, with 20.9% of female and 12.2% male (Figure 3A). In exploring the perceived importance of education among respondents (Figure 3B) many felt this was effective to some degree, with the strongest responses recognising the importance of school at increasing awareness in flood risk education, with a slightly stronger response amongst F/M (3.51/3.24 average score). Throughout the five questions exploring aspects of education and flood risk, female respondent scores were slightly higher (on average 0.226 higher on the Likert scale), though not significant statistically, it suggests female respondents may perceive education to be more important.

## 6.4.2 Home area information

Respondents overwhelmingly (81.3%) stated they did not have a rescue or emergency flood response plan in their area (F/M:43.5/37.5%); interestingly those stating they had (16.4%), contained a higher proportion of male (9.0%) to female respondents (7.4%), which supports previous studies (e.g. Bradford et al., 2012). When asked about access to information on flood problems (Q12), 44.5% stated they had information (F/M: 22.7/21.7%) compared to 53.5% stating they had no information (F/M: 28.4/24.8%). The majority (53.7%) of respondents identified they had 'often' experienced flooding (F/M: 27.7/26.1%; Q17), with 43.1% of respondents (F/M: 20.62:22.5%) expecting to experience a flood (Q19). However, if responses are considered by proportion of respondents by gender, a different picture emerges as 51.7% of male respondents expect to experience a flood compared to only 36.6% of female respondents; of those 71.6% and 75.6% (F/M) have experienced flooding. Notably of those that responded 'No', to experiencing a flood, and 'No' to expecting a flood (32.9%) a higher proportion were female (19.64/13.3%), which when considered as proportion of responses by gender (34.8/30.47%). In considering the free text responses to 'Did you imagine or expect that this area would flood (Q19-21), those that responded 'No' typically comment on the existence of 'no river' or other physical landscape aspects (n=12) or 'existing drainage systems' (n=20). Those responding 'Yes' provide a broader range of comments, and many refer to blocked drains (including refuse), maintenance issues of roads and a lack of drains, or a combination of these. When floods occur, most respondents consider them to span between 1-5 (F/M: 22.5/14.6%) or 6-10 (F/M: 8.7/11.8%) days; however, there is variability in these experiences (Figure 3C), with some respondents reporting that they last >21 days (8.8%).

### 6.4.3 Flood risk indicators

In considering the causes of flooding in Ijebu-Ode, a range of different ideas emerge from the respondents. Whilst the most popular is drainage (Figure 4A), the other words included are interesting. Some focus on the cause – either rainfall or blockages, but many focus on impacts or perceived responsibilities. In considering flood insurance, those with insurance (18.10%; F/M: 11/7.1%) is a much smaller proportion than those without (78.5%; F/M: 43.9/34.5%), with no notable difference when respondent response rates by gender are considered (F/M: 77.9/79.3%). Of those that have experienced flooding (Q17) only 4.4% had insurance, with the main explanations given being unavailable and/or unable to afford it (Q29). In considering flood mitigation in the future, the majority believe that flood risk is achievable in Ijebu-Ode (64.1%; F/M: 37.5/26.6%), however 32.5% believe it unachievable. Those who considered flood risk to be unachievable in Ijebu-Ode provided a range of different free text responses, though most focused-on government inaction/funding, drainage or governance aspects (Figure 4B).

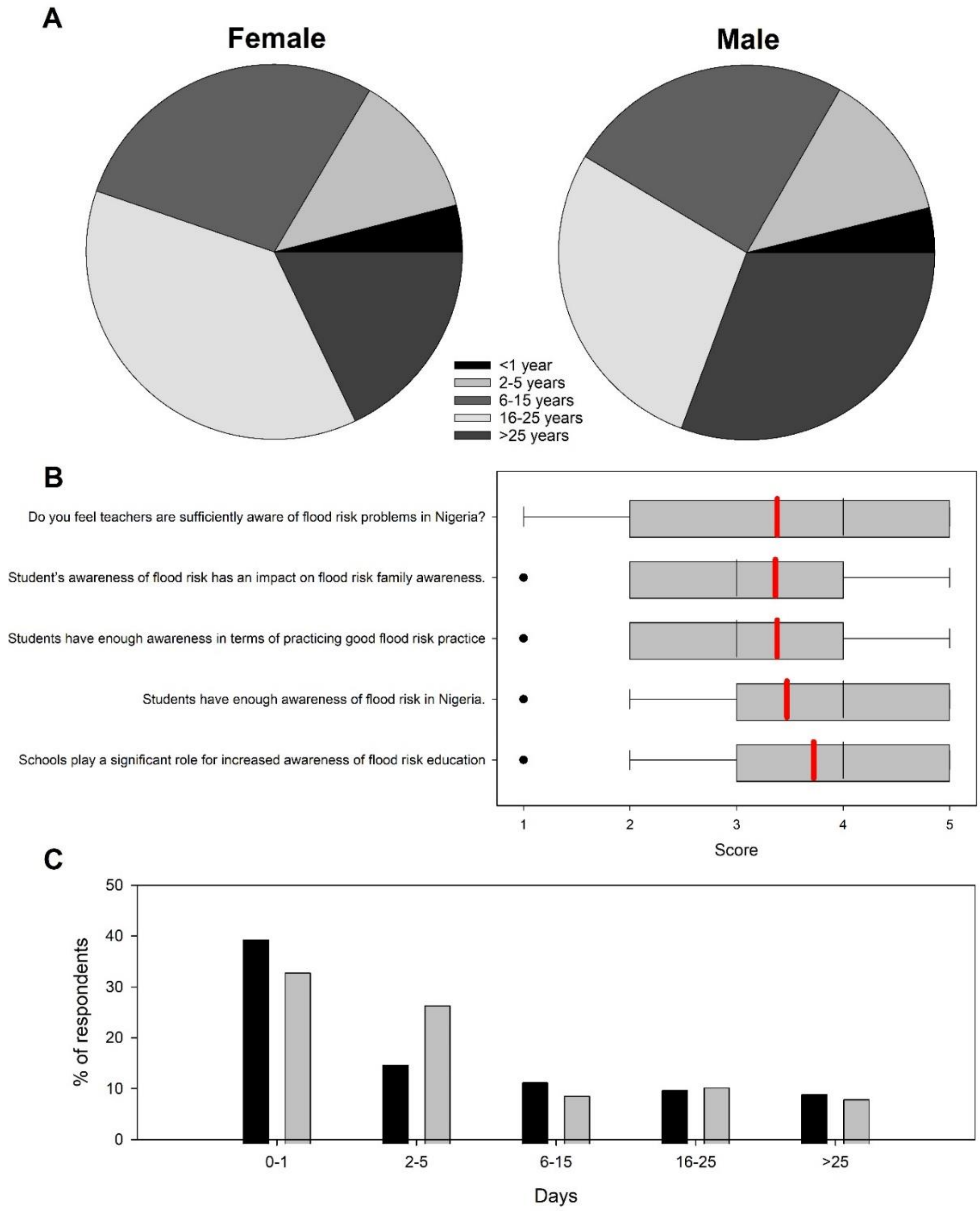


Figure 6.3: A) Residence times in Ijebu-Ode for female (black)/male (grey) respondents; B) Responses to questions on education; C) Number of days respondents reported floods lasting.

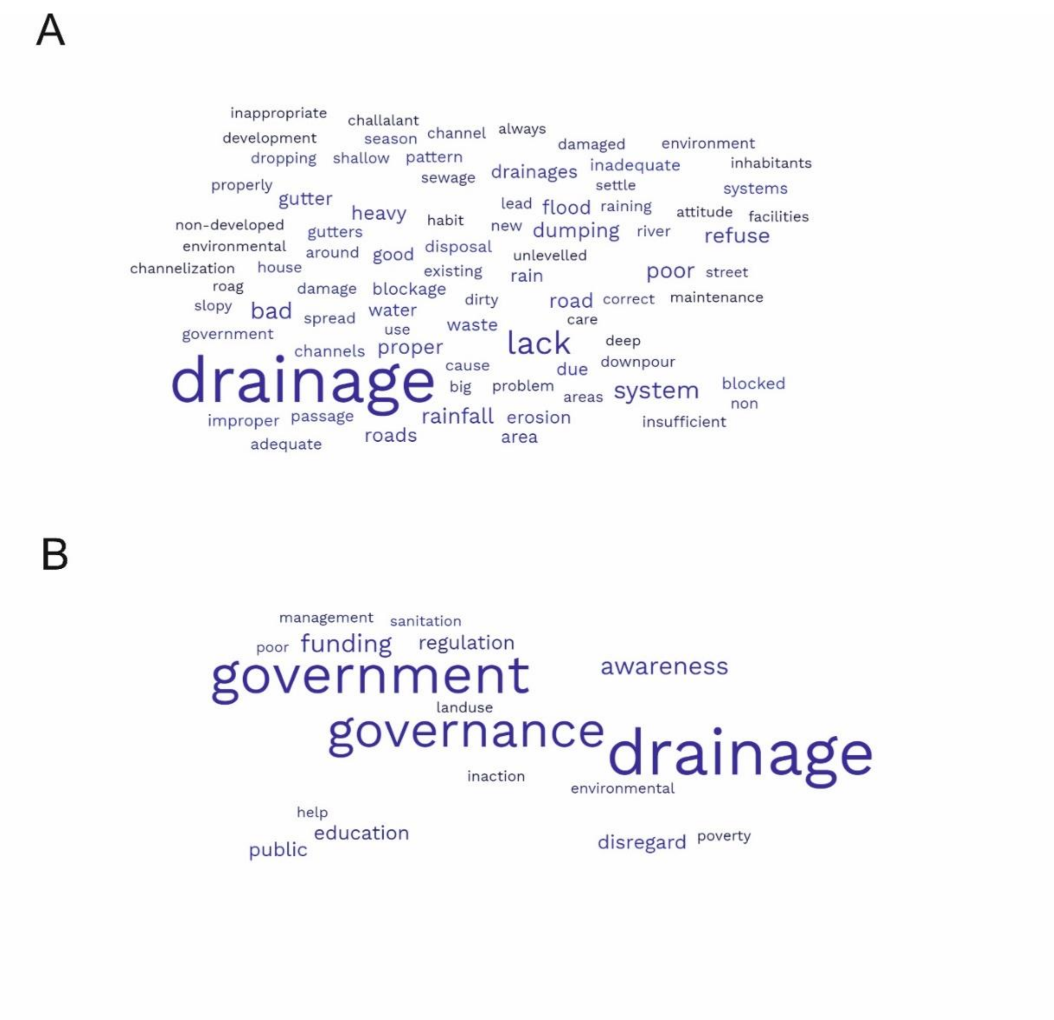


Figure 6.4: Word cloud generated from free text responses, A) Causes of flooding in your area (Q18); B) where respondents stated ‘No’ to ‘Do you think flood risk management is achievable in Ijebu-Ode?’ (Q32).

## 6.4.4 Resilience indicators and mitigation

In considering resilience to flooding, respondents identified several measures, with ‘clearance of drainage’ (44.82%) and ‘sand filling’ (30.43%) clear preferences (Figure 5A). In considering government support, most (78.8%) stated their area did not receive support, with a similar proportion (79.6%) also stating they had no flood insurance (Q29); interestingly 49.8% stated they were prepared for flooding, compared to 34.1% stating not (F/M: 17.7/16.4%). There was relatively little support sought from family and friends (66.81%; F/M: 33.4/33.5%) or religious organisations (76.9%; F/M:42.2/34.6%), but where it was, higher support was attained by female than males from family and friends (F/M:20.5/9.5%), whilst religious support was lower (F/M: 11.7/8.3%). In considering the main impacts and concerns related to flooding, these predominantly focused on roads and properties being flooded, however loss of life was a relatively low concern (Figure 5A and responses). Land use planning, construction of drains and resource management by government were the main elements raised by respondents as requiring action. Lower scores were received for education, institutional capacities and warning systems (Figure 5B).

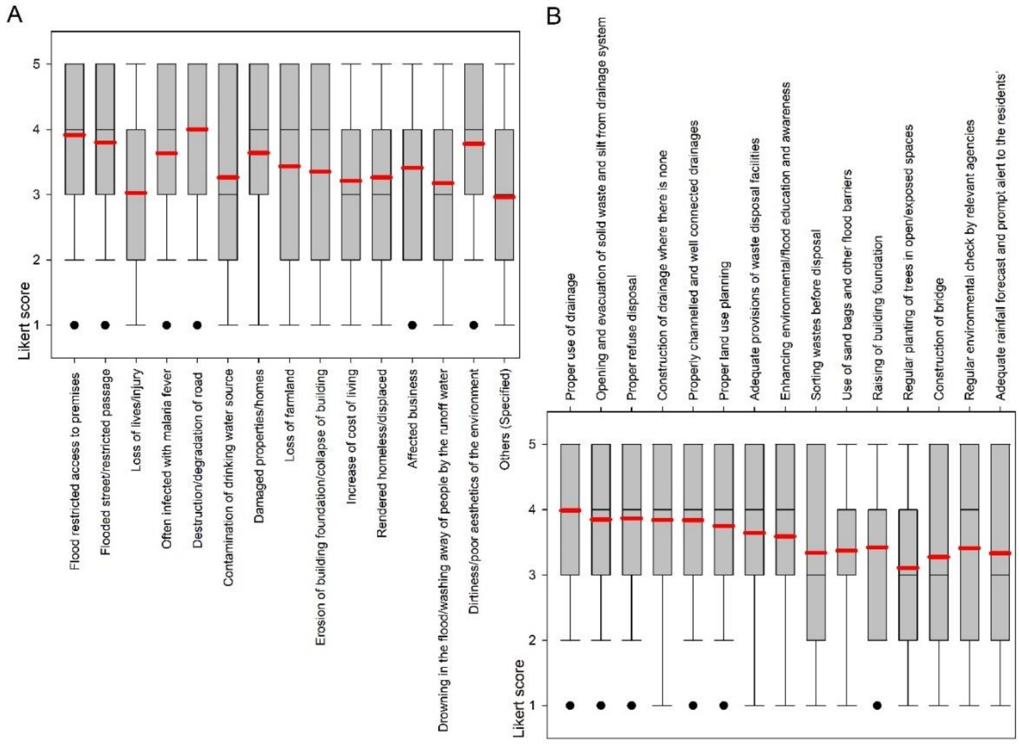


Figure 6.5: Survey responses. A) Respondents' awareness of the effects of flood disasters in Ijebu Ode; B) Respondents' perspective of the effectiveness of flood control. The Likert scale provides a 5-1 scaling, with respondent's selection either - 5A) Very severe; Severe; Not too severe; Not severe; Not so severe respectively, or 5B) Highly effective; Effective; Minimally effective; Not effective; Not effective at all respectively.

## 6.5 Discussion

The results demonstrate that a range of individuals with different characteristics, awareness and behaviours were captured by the survey. It is difficult to determine if this is representative of the whole population of Ijebu-Ode, as limited data exists for comparison, and that which does exist may underrepresent specific communities. In exploring flood risk in Ijebu-Ode, it is evident that a range of issues and concerns are identified. It is also notable that the ideas of flood risk are poorly understood by some; for example, whilst Ijebu-Ode has no river system, 15.2% responded they live near/close to a river (Q15). This may suggest a lack of awareness of the absence of river systems or reflect a broader, less scientific understanding of what constitutes a river, with those responding positively in relation to proximity to a river including drains or drainage system within their understanding, which illustrates the challenges in the potential for misunderstandings. However, the questionnaire demonstrates that respondents recognise the challenges that flooding poses to their community (Q17), but that they also recognise that the challenges likely extend beyond their individual capacity and require a more regional approach and solution (Figure 5).

Despite the emphasis on the need for gender-responsive DRR, including in flood risk management, we did not identify significant statistical differences between female and male respondents. This suggests the issues of flooding in Ijebu Ode are more complex and multifaceted than to be simply defined by gender alone (section 4.3). Taking into consideration the multi-dimensional construction of social vulnerability (e.g. demographic attributes, social class, gender, etc.) is a critical factor in understanding its temporal, spatial and situational dimensions, as Tierney (2019, p.127-128) notes "[…] people are not born vulnerable, they are made vulnerable […] different axes of inequality combine and interact to form systems of oppression – systems that relate directly to differential levels of social vulnerability, both in normal times and in the context of disaster".

The results suggest that precarity, rather than gender, may be a critical challenge in Ijebu-Ode. Evidence of this can be seen through the responses, e.g. in recognising issues with governance and finance (insurance) or flood risk mitigation opportunities (Figure 3A/B, 4A/B & 5A/B). In understanding the nature of the different groups within the respondents, we can attempt to identify those living within informal housing based on responses. A direct question exploring whether respondents resided within (in)formal housing was avoided, as it would likely be answered incorrectly/ignored or viewed with suspicion, as such we can use responses from other questions to approximate the contribution from those residing in informal housing, based on experiences of the community. Informal housing in Ijebu-Ode (and more widely in West Africa) is often constructed as single story (bungalow) (Q8: 43.3/39.2%), made of brick or blocks (Q7: 31.1/30.2), with residents considering themselves to reside in ‘private’ housing (Q5: 17.1/24.77). These responses suggest that approximately 17-25% of respondents may be currently residing in informal housing in Ijebu-Ode; but direct observation of the communities suggests that this value is an underestimation, with a visual estimate being closer to 50%, suggesting a relatively high level of precarity within the community. The potential implications of such a relatively high level of variability between estimated (in)formal housing raises interesting questions as to how such differences may influence risk perception, preparedness and behaviour. As noted by Monteil et al., (2022), individual preparedness may be characterised as storing basic need items e.g. food, water, and essential items; however when living in a precarious state such items are often not in sufficient supply that stores can be made, and therefore they may be incapable of ‘preparedness’. However as Gaillard et al. (2019) notes, natural hazards are a marginal concern when faced with precarity; but care must be taken to also recognise that diversity exists amongst such groups, and therefore they are not homogenous, with a variety of attributes (Vickery, 2017). Within this study we have been unable to explore this question the degree of homogeneity and diversity, or explore the attributes of these communities, as such further work is required in unpacking these aspects of informal settlements.

In discussing flood risk understanding and perception, it is important to recognise differences in gender vulnerabilities, but also to understand specific individual/community capacities and how they intersect and interact with each other. Within the context of flooding, female respondents are often perceived to view flood risk more acutely than their male counterparts (Ho et al., 2008; Lindell & Hwang, 2008); however, this study fails to support any differentiation based on gender alone, with relatively high levels of awareness, of those to have experienced flooding most expected it (F/M 71.6/75.6%). Importantly, 51.7% of male respondents had experienced flooding (F 36.6%) suggesting that male population members are living in high-risk areas and aware of that risk, such experiential differences can have important implications for future flood risk perception and responses during flood events. This study however fails to determine whether this population accept the risk or whether they are in a position where they are unable to individually address it. When the age structure is considered then 69% of those in high-risk areas are aged between 26-55, with most (30.7%) between 36-45.

Understanding such differences may represent a specific target audience for future risk reduction strategies. The low uptake of insurance (21.5%) with no significant gender difference suggests that either it is too costly, is unavailable or perceived to be unnecessary, with free text responses reflecting all these themes, whilst others thought flood risk management to be a government responsibility. The low uptake of insurance supports arguments that those living in precarious states is higher than originally estimated (17-25%), further supporting the argument that the proportion of the population living in informal housing may be closer to 50%, which would support a visual assessment of the communities.

A common theme (Figure 5B and Q20 free text responses) that emerges within the responses relates to waste, and specifically the collection and disposal of waste into the drainage channels in Ijebu-Ode. Where an absence of communal waste collection is available, or private refuse collectors are not viable (either because of lack of community cohesion or because such services are not affordable), materials are often discarded locally or burnt. These findings echo those of previous studies (Onibokun and Kumuyi 1999; Olaseha and Sridhar 2004). Ijebu-Ode lacks a regular formal waste collection service, as such waste is often disposed of locally, with many identifying drainage channels as opportune locations, similar experiences were identified by Odjugo and Uriri (2011) in Benin-City. The result is that when drainage channels are filled with flood waters the waste materials are washed into public spaces and homes, exacerbating the health implications of the floods.

In considering support mechanisms post-flood event, this study found low levels of perceived support provided by religious bodies/organisations or family and or friends. Although these support mechanisms during disasters are important and have been widely discussed (e.g. Richardson et al., 2009; Webber & Jones, 2013), this was not notable among the survey respondents in Ijebu-Ode. A potential explanation for this difference (compared to previous studies focused on North America/Europe) arises from cultural perspectives of accepting support from others (charity) and suspicions as to what is required in return, but also concerns that they would lose 'their land'. Multiple respondents raised concerns in relation to governance, this spans several aspects, including land tenure/ownership, poor regional/central governance, perceptions of corrupt government, long-term inconstancies in government policy and 'policy somersault' resulting in poor awareness and trust, as such poor levels of trust hamper community engagement and development.

These cultural and resourcing issues require further analysis, as they represent an important limitation for current and future flood risk management; and the challenges of good governance are recognised across Africa (UNISDR, 2004). The approach to flooding in Ijebu-Ode is one focused on response and recovery rather than resilience building, with Šakić Trogrlić et al. (2022) identifying similar limitations in relation to flooding in Malawi. In exploring the challenge of pluvial flood risk in Ijebu-Ode, many of the respondents see flood management and mitigation as a government responsibility, however, those same responses (Q31) recognise that local actions can be beneficial, such as local clearing drainage channels of rubbish or digging local channels (Figure 5B). Supporting individual actions within the context of broader governmental support reflects the shift towards a 'shared responsibility' as outlined within the Sendai Framework for DRR and discussed recently more broadly (Crosweller & Tschakert, 2021; Monteil et al., 2022). However, the literature is dominated by case studies from high income countries with well-resourced with well-defined DRR governance regimes (e.g. French, Australian and USA) relative to that of Nigeria. The lack of studies in the literature concerning informal settlements and the availability of African case studies underscores the need for more investment in understanding how these challenges play out – and how they can be overcome – in countries where gender, precarity, and other complex socio-economic issues exacerbate flood risk and vulnerability.

The challenges of flooding crosses many of the UN SDGs, in particular, SDG's 1 (No Poverty), 2 (Zero Hunger), 3 (Good Health and Well-Being), 4 (Quality Education), 5 (Gender Equality), 6 (Clean Water and Sanitation), 8 (Decent Work and Economic Growth), 11 (Sustainable Cities and Communities), 13 (Climate Action), 14 (Life Below Water), and 15 (Life on Land). Opportunities exist for targeting knowledge improvement towards children, the other 'forgotten casualty' of disasters (Cutter, 2017), building understanding and perceptions of flood risk can have significant long term (Carone & Marincioni, 2020) and multigenerational benefits, with little work having been undertaken within an African setting to date such concepts. In considering the respondents of Ijebu-Ode, the role of education in reducing future risk was acknowledged (Figure 3C), whilst a lack of education was given as a reason as to why flood risk management was unachievable (Figure 4C), as such considerable opportunities are available to improve flood risk education in Ijebu-Ode.

Nhamo & Nhamo (2018) identify that whilst advancements are taking place in raising women's role in relation to climate change policy, it varies considerably from country to country. To translate flood risks into human development terms, we need to assess the specific and differential ways in which they affect women and men within these systems. The European Institute for Gender equality reported (EIGE, 2016) that women are, on average, more concerned about the environment and climate change, but are still influenced by a set of gender inequalities. Gender equality does not mean that women and men will become the same, but rather implies equal treatment of women and men in laws and policies, and equal access to resources and services within families, communities, and the society at large (EIGE, 2016). This is crucial moving forward as government and relevant authorities, especially at grassroot levels, should seek to engage with both male and female (i.e., take advantage of "mixed-gender" physical and non-physical behaviour), with a view to balancing and enhancing their flood risk resilience and increasing household participation. There is urgent need for a new policy formulation and implementation that will balance tradition and fundamental human rights, that reduces vulnerability and exposure to climate risk for all.

## 6.6 Conclusion: Moving forward

Our findings suggest that gender differences are not evident within the responses received in Ijebu-Ode in relation to flood risk understanding and perception. This may be partly a function of the sample, with men being more likely to experience flooding or live in flood prone areas, but it also points to the importance of looking beyond gender to complex, often precarious socio-economic situations. Adaptive and response capacities for flood risk are low when considering the everyday challenges and priorities for those living in precarious states, as demonstrated by low levels of insurance and relatively low priority assigned to education in this study. Traditional roles, reduced opportunities, and greater employment insecurities may negatively impact flood risk perception against a backdrop of precariousness for many. Differentiated gender power relations and socioeconomic status mean that men and women may not have the same adaptive capacity, however this research suggests that for those marginalised and vulnerable, living with persistent precarity are not differentiated by gender when considering flood risk in Ijebu-Ode. Previous research has recognized that women's experience and the strategic position in society equips them with the potential to lead efforts at community and national levels, however this may not be realised because of policy deficiencies (Nhamo & Nhamo, 2018); this is reflected in Ijebu-Ode, as the absence of government action or capacity limits opportunities for flood risk reduction, but future programmes can build on opportunities identified, particularly education. When considering climate change – and specifically flood risk – from a gender equality perspective, the low participation of women in policy and decision-making traditionally in Nigeria and Ijebu-Ode should be addressed, engendering more effective and inclusive policies. However, opportunities to engender greater equality in future flood risk reduction are hampered by the socio-economic context, but flood risk reduction practices need to recognise, engage and incorporate cultural and behavioural practices. Moving forward greater understanding of informal settlements and their capacity to adapt to hazards is required, recognising the plurality of those living with such communities, with opportunities to further explore the significance of cultural practices and behaviours in flood risk understanding and ways in which such information could be embedded into flood risk management as local knowledges.

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## 6.8 Disclosure Statement

The authors report there are no competing interests to declare.

## 6.9 References

Ajibade, I., McBean, G., & Bezner-Kerr, R. (2013). Urban flooding in Lagos, Nigeria: Patterns of vulnerability and resilience among women. *Global Environmental Change*, *23*(6), 1714–1725. https://doi.org/10.1016/J.GLOENVCHA.2013.08.009

Amoako, C., & Inkoom, D. K. B. (2018). The production of flood vulnerability in Accra, Ghana: Re-thinking flooding and informal urbanisation. *Urban Studies*, *55*(13), 2903–2922. https://doi.org/10.1177/0042098016686526

Andrijevic, M., Crespo Cuaresma, J., Lissner, T., Thomas, A., & Schleussner, C. F. (2020). Overcoming gender inequality for climate resilient development. *Nature Communications 2020 11:1*, *11*(1), 1–8. https://doi.org/10.1038/s41467-020-19856-w

Antronico, L., Coscarelli, R., Gariano, S. L., & Salvati, P. (2023). Perception of climate change and geo-hydrological risk among high-school students: A local-scale study in Italy. *International Journal of Disaster Risk Reduction*, *90*, 103663. https://doi.org/10.1016/J.IJDRR.2023.103663

Belcore, E., Pezzoli, A., & Calvo, A. (2020). Analysis of gender vulnerability to climate-related hazards in a rural area of Ethiopia. *The Geographical Journal*, *186*(2), 156–170. https://doi.org/10.1111/GEOJ.12321

Bob, U., & Babugura, A. (2014). Contextualising and conceptualising gender and climate change in Africa. *Https://Doi.Org/10.1080/10130950.2014.958907*, *28*(3), 3–15. https://doi.org/10.1080/10130950.2014.958907

Bradford, R. A., O'Sullivan, J. J., Van Der Craats, I. M., Krywkow, J., Rotko, P., Aaltonen, J., Bonaiuto, M., De Dominicis, S., Waylen, K., & Schelfaut, K. (2012). Risk perception – issues for flood management in Europe. *Natural Hazards and Earth System Sciences*, *12*(7), 2299–2309. https://doi.org/10.5194/NHESS-12-2299-2012

Carone, M. T., & Marincioni, F. (2020). From tale to reality: Geographical differences in children's flood-risk perception. *Area*, *52*(1), 116–125. https://doi.org/10.1111/AREA.12552

Cornwall, W. (2021). Europe's deadly floods leave scientists stunned despite improvements, flood forecasts sometimes failed to flag risks along smaller streams. *Science*, *373*(6553), 372–373.

https://doi.org/10.1126/SCIENCE.373.6553.372/ASSET/FF38E2C6-8279-4A40-82B4-54D1B7E4725B/ASSETS/GRAPHIC/373_372_F1.JPEG

Coronese, M., Lamperti, F., Keller, K., Chiaromonte, F., & Roventini, A. (2019). Evidence for sharp increase in the economic damages of extreme natural disasters. *Proceedings of the National Academy of Sciences of the United States of America*, *116*(43), 21450–21455. https://doi.org/10.1073/PNAS.1907826116/SUPPL_FILE/PNAS.1907826116.SAPP.PDF

Crosweller, M., & Tschakert, P. (2021). Disaster management and the need for a reinstated social contract of shared responsibility. *International Journal of Disaster Risk Reduction*, *63*, 102440. https://doi.org/10.1016/j.ijdrr.2021.102440

Cutter, S. L. (1995). The forgotten casualties: women, children, and environmental change. *Global Environmental Change*, *5*(3), 181–194. https://doi.org/10.1016/0959-3780(95)00046-Q

Cutter, S. L. (2017). The forgotten casualties redux: Women, children, and disaster risk. *Global Environmental Change*, *42*, 117–121. https://doi.org/10.1016/J.GLOENVCHA.2016.12.010

de Vaus, D. (2014). *Surveys in Social Research (Sosial Research Today)*. Taylor & Francis Ltd. https://www.routledge.com/Surveys-In-Social-Research/Vaus-Vaus/p/book/9780415530187

Dennis, M., Mead, G., Doubal, F., & Graham, C. (2012). Determining the modified Rankin score after stroke by postal and telephone questionnaires. *Stroke*, *43*(3), 851–853. https://doi.org/10.1161/STROKEAHA.111.639708

Di Baldassarre, G., Montanari, A., Lins, H., Koutsoyiannis, D., Brandimarte, L., & Blschl, G. (2010). Flood fatalities in Africa: From diagnosis to mitigation. *Geophysical Research Letters*, *37*(22). https://doi.org/10.1029/2010GL045467

Duží, B., Vikhrov, D., Kelman, I., Stojanov, R., & Juřička, D. (2017). Household measures for river flood risk reduction in the Czech Republic. *Journal of Flood Risk Management*, *10*(2), 253–266. https://doi.org/10.1111/JFR3.12132

Edwards, P. J., Roberts, I., Clarke, M. J., DiGuiseppi, C., Wentz, R., Kwan, I., Cooper, R., Felix, L. M., & Pratap, S. (2009). Methods to increase response to postal and electronic questionnaires. *Cochrane Database of Systematic Reviews*, *3*.

https://doi.org/10.1002/14651858.MR000008.PUB4/EPDF/ABSTRACT

EIGE. (2016). *Gender in environment and climate change*. https://eige.europa.eu/publications/gender-environment-and-climate-change

EM-DAT. (2022). *The Emergency Events Database* (D. Guha-Sapir (ed.)). EM-DAT :The Emergency Events Database; Université catholique de Louvain (UCL) - CRED,. www.emdat.be

Gaillard, J. C., Walters, V., Rickerby, M., & Shi, Y. (2019). Persistent Precarity and the Disaster of Everyday Life: Homeless People's Experiences of Natural and Other Hazards. *International Journal of Disaster Risk Science*, *10*(3), 332–342. https://doi.org/10.1007/S13753-019-00228-Y/METRICS

Grothmann, T., & Reusswig, F. (2006). People at risk of flooding: Why some residents take precautionary action while others do not. *Natural Hazards*, *38*(1–2), 101–120. https://doi.org/10.1007/S11069-005-8604-6

Heerwegh, D., & Loosveldt, G. (2008). Face-to-Face versus Web Surveying in a High-Internet-Coverage PopulationDifferences in Response Quality. *Public Opinion Quarterly*, *72*(5), 836–846. https://doi.org/10.1093/POQ/NFN045

Ho, M. C., Shaw, D., Lin, S., & Chiu, Y. C. (2008). How Do Disaster Characteristics Influence Risk Perception? *Risk Analysis*, *28*(3), 635–643. https://doi.org/10.1111/J.1539-6924.2008.01040.X

IPCC. (2022a). AR6 Synthesis Report: Climate Change 2022 — IPCC. *AR6 Synthesis Report: Climate Change 2022 — IPCC*, 85. https://www.ipcc.ch/report/ar6/syr/

IPCC. (2022b). *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernamental Panel on Climate Change*. https://doi.org/10.1017/9781009325844.Front

Jamil, H., Liaqat, A., Lareeb, I., Tariq, W., Jaykumar, V., Kumar, L., Tahir, M. J., Anjlee, F., Naseem Shah, S., & Asghar, M. S. (2023). Monsoon and cholera outbreaks in Pakistan: a public health concern during a climate catastrophe. *International Journal of Surgery: Global Health*, *6*(1), e105–e105. https://doi.org/10.1097/GH9.0000000000000105

Jones, M. W., Peters, G. P., Gasser, T., Andrew, R. M., Schwingshackl, C., Gütschow, J., Houghton, R. A., Friedlingstein, P., Pongratz, J., & Le Quéré, C. (2023). National contributions to climate change due to historical emissions of carbon dioxide, methane, and nitrous oxide since 1850. *Scientific Data 2023 10:1*, *10*(1), 1–23. https://doi.org/10.1038/s41597-023-02041-1

Jonkman, S. N., & Kelman, I. (2005). An analysis of the causes and circumstances of flood disaster deaths. *Disasters*, *29*(1), 75–97. https://doi.org/10.1111/J.0361-3666.2005.00275.X

Kellens, W., Zaalberg, R., Neutens, T., Vanneuville, W., & De Maeyer, P. (2011). An Analysis of the Public Perception of Flood Risk on the Belgian Coast. *Risk Analysis*, *31*(7), 1055–1068. https://doi.org/10.1111/J.1539-6924.2010.01571.X

Lindell, M. K., & Hwang, S. N. (2008). Households' Perceived Personal Risk and Responses in a Multihazard Environment. *Risk Analysis*, *28*(2), 539–556. https://doi.org/10.1111/J.1539-6924.2008.01032.X

Mcdowell, G., Ford, J., & Jones, J. (2016). Community-level climate change vulnerability research: trends, progress, and future directions. *Environmental Research Letters*, *11*(3), 033001. https://doi.org/10.1088/1748-9326/11/3/033001

Monteil, C., Foulquier, P., Defossez, S., Péroche, M., & Vinet, F. (2022). Rethinking the share of responsibilities in disaster preparedness to encourage individual preparedness for flash floods in urban areas. *International Journal of Disaster Risk Reduction*, *67*, 102663. https://doi.org/10.1016/J.IJDRR.2021.102663

Nakash, R. A., Hutton, J. L., Jørstad-Stein, E. C., Gates, S., & Lamb, S. E. (2006). Maximising response to postal questionnaires--a systematic review of randomised trials in health research. *BMC Medical Research Methodology*, *6*. https://doi.org/10.1186/1471-2288-6-5

Nelson, V., Meadows, K., Cannon, T., Morton, J., & Martin, A. (2010). Uncertain predictions, invisible impacts, and the need to mainstream gender in climate change adaptations. *10*(2), 51–59. https://doi.org/10.1080/13552070215911

Neumayer, E., & Plümper, T. (2007). The gendered nature of natural disasters: the impact of catastrophic events on the gender gap in life expectancy, 1981–2002. *Ann. Assoc. Am. Geogr.*, *97*(3), 551–566. https://doi.org/10.1111/j.1467-8306.2007.00563.x

Nhamo, G., & Nhamo, S. (2018). Gender and Geographical Balance: With a Focus on the UN Secretariat and the Intergovernmental Panel on Climate Change. *Gender Questions*, *5*(1). https://doi.org/10.25159/2412-8457/2520

Odiase, O., Wilkinson, S., & Neef, A. (2020). Risk of a disaster: Risk knowledge, interpretation and resilience. *Jamba: Journal of Disaster Risk Studies*, *12*(1), 1–9. https://doi.org/10.4102/JAMBA.V12I1.845

Pavageau, C., Locatelli, B., Sonwa, D., & Tiani, A. M. (2016). What drives the vulnerability of rural communities to climate variability? Consensus and diverging views in the Congo Basin. *Https://Doi.Org/10.1080/17565529.2016.1193460*, *10*(1), 49–60. https://doi.org/10.1080/17565529.2016.1193460

Quinn, T., Heath, S., Adger, W. N., Abu, M., Butler, C., Codjoe, S. N. A., Horvath, C., Martinez-Juarez, P., Morrissey, K., Murphy, C., & Smith, R. (2023). Health and wellbeing implications of adaptation to flood risk. *Ambio 2023*, 1–11. https://doi.org/10.1007/S13280-023-01834-3

Raaijmakers, R., Krywkow, J., & van der Veen, A. (2008). Flood risk perceptions and spatial multi-criteria analysis: An exploratory research for hazard mitigation. *Natural Hazards*, *46*(3), 307–322. https://doi.org/10.1007/S11069-007-9189-Z

Ramiaramanana, F. N., & Teller, J. (2021). Urbanization and Floods in Sub-Saharan Africa: Spatiotemporal Study and Analysis of Vulnerability Factors—Case of Antananarivo Agglomeration (Madagascar). *Water 2021, Vol. 13, Page 149*, *13*(2), 149. https://doi.org/10.3390/W13020149

Richardson, R. C., Plummer, C. A., Barthelemy J.J., & Cain, D. S. (2009). Research after Natural Disasters: Recommendations and Lessons Learned. *Journal of Community Engagement and Scholarship*, *2*, 3–11. https://books.google.co.uk/books?hl=en&lr=&id=hC4pZZVwWRUC&oi=fnd&pg=PA3&dq=family+support+following+natural+disasters&ots=THoM2PkLed&sig=Ybq_zORovJw-4mkRz2foP7sE-Qc#v=onepage&q=family support following natural disasters&f=false

Rohde, P., Lewinsohn, P. M., & Seeley, J. R. (1997). Comparability of telephone and face-to-face interviews in assessing axis I and II disorders. *American Journal of Psychiatry*, *154*(11), 1593–1598. https://doi.org/10.1176/AJP.154.11.1593

Rufat, S., Fekete, A., Armaş, I., Hartmann, T., Kuhlicke, C., Prior, T., Thaler, T., & Wisner, B. (2020). Swimming alone? Why linking flood risk perception and behavior requires more than "it's the individual, stupid." *WIREs Water*. https://doi.org/10.1002/wat2.1462

Šakić Trogrlić, R., Duncan, M., Wright, G., van den Homberg, M., Adeloye, A., & Mwale, F. (2022). Why does community-based disaster risk reduction fail to learn from local knowledge? Experiences from Malawi. *International Journal of Disaster Risk Reduction*, *83*. https://doi.org/10.1016/j.ijdrr.2022.103405

Satterthwaite, D., Archer, D., Colenbrander, S., Dodman, D., Hardoy, J., Mitlin, D., & Patel, S. (2020). Building Resilience to Climate Change in Informal Settlements. *One Earth*, *2*(2), 143–156. https://doi.org/10.1016/J.ONEEAR.2020.02.002

Thompson, S. K. (2012). Sampling, Third Edition. *Sampling, Third Edition*. https://doi.org/10.1002/9781118162934

Tierney, K. J. (2019). *Disasters: A Sociological Approach*. Polity Press.

UN General Assembly. (2015). Transforming Our World: the 2030 Agenda for Sustainable Development | Department of Economic and Social Affairs. In *United Nations*. https://sdgs.un.org/publications/transforming-our-world-2030-agenda-sustainable-development-17981

UNFCC. (2015). Adoption of the Paris Agreement. In *Conference of the Parties on its twenty-first session* (Issue December). http://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf

UNHCR. (2022). *Millions face harm from flooding across West and Central Africa, UNHR warns*. UNHCR. https://www.unhcr.org/news/briefing-notes/millions-face-harm-flooding-across-west-and-central-africa-unhcr-warns

UNISDR. (2004). *Disaster Risk Reduction for Sustainable Development in Africa*.

Vickery, J. (2017). Using an intersectional approach to advance understanding of homeless persons' vulnerability to disaster. *Https://Doi.Org/10.1080/23251042.2017.1408549*, *4*(1), 136–147. https://doi.org/10.1080/23251042.2017.1408549

Webber, R., & Jones, K. (2013). Rebuilding Communities After Natural Disasters: The 2009 Bushfires in Southeastern Australia. *Http://Dx.Doi.Org/10.1080/01488376.2012.754196*, *39*(2), 253–268. https://doi.org/10.1080/01488376.2012.754196

Wisner, B. (2004). *At risk : natural hazards, people's vulnerability, and disasters*. Routledge.

World Bank. (2018). *World Development Indicators Data-Base*. http://data.worldbank.org

World Meteorological Organization (WMO). (2022). *State of the Climate in Africa 2021*.

Zaidi, R. Z., & Fordham, M. (2021). The missing half of the Sendai framework: Gender and women in the implementation of global disaster risk reduction policy. *Progress in Disaster Science*, *10*, 100170. https://doi.org/10.1016/j.pdisas.2021.100170

# Chapter 7

# Flood risk education

*Flood risk education aims at awareness raising, strengthening students' risk perception and their preparedness intentions, increasing adaptation and mitigation capacities of communities and fostering disaster-resilient areas to prevent the creation of a new risk and reduce exposure to existing climate risk.*

## **7.1** Introduction

Mitigation and adaptation capacities are the set of diverse knowledge, skills and resources people learn and acquire in dealing with hazards and disasters, either individually or collectively. Many of those interviewed in this study were unaware of how their actions can exacerbate flood risk (section 5.3). This lack of 'awareness' can in part be attributed to low levels of risk knowledge and availability of information (section 5.2.2; 5.3.2). Improving their awareness by educating them could be one part of a multi-pronged strategy for facilitating behavioural change to prevent, mitigate, foster preparedness to flood risk. Obeta (2014) opined that flooding and the means of addressing its challenges are critical issues in Nigeria. This chapter discusses different measures for reducing the causes and consequences of vulnerability with the view of increasing resilience and reducing vulnerability of populations to climate change impacts. Specifically, it proposes the inclusion of flood risk education as an integral part of environment education, specifically in teacher education programs; as a new policy to communicate, stimulate and foster student's active participation, enhancing their existing knowledge, skills and resources, to increase resilience of local communities and reduce vulnerability. Environmental education since the 1970s has been characterized as a process that prepares citizens to prevent and solve environmental problems. This policy offers a mechanism for increasing awareness and understanding of flood risk, but more importantly how an individual's or a community's actions can modify risk through their actions.

## 7.2 Current flood risk communication and education in Nigeria

Current flood risk communication in Nigeria is in a poor state, with much work required, reflecting a situation common across many African states. In most cases flood prone communities in Nigeria have often been unprepared when severe flood events occur, as a result of poor disaster management systems often result in significant human and economic losses (Rafiu et al., 2017; Olanrewaju et al., 2019). Levels of public awareness on issues related to climate change in Nigeria are low (BNRCC, 2011). Current formal education on these issues provides insufficient knowledge or information resulting in a lack of awareness (Duru and Emetumah, 2016; Amanchukwu et al., 2015). Flooding in Nigeria with disastrous consequences in 2022 serves to illustrate the country's ill-preparedness and lack of efficient disaster management plans by government and appropriate authorities.

Four interconnected elements are key to effective flood risk management (mitigation, preparedness, response, recovery), with communication serving as a string that binds these elements together. Conventional communication approaches are applied across Nigeria (section 2.7.2); however, they often fail to reach indigenous communities, where reactive behaviours prevail among vulnerable households. Indigenous communication channels including folk media, festivals, storytelling, songs, dance, plays, storytelling and public enlightenment through indigenous organizations such as religious groups, town-hall or village meetings are currently neglected and untapped (Mundy 1993; Nigussie 2017; Ebhuoma 2018) as tools for increasing local community resilience to flooding in much of Africa. Such channels allow information to reach a wider audience, especially since mass media may exclude those who are illiterate and/or do not own radio's/televisions (Mundy and Lloyd-Laney 1992; Nigussie 2017). According to Mundy and Lloyd-Laney (1992) and Nigussie (2017), the centrality of these channels of communication hinges on the interpersonal and social interactions.

Despite modest efforts to mainstream climate change adaptation into development agendas and policies, Nigeria is still grappling with challenges such as capacity building, poor technical skills and communication that reduce the effectiveness of adaptation efforts (FGN, 2021). These challenges are also an important reason given for the poor coverage of environment and safety matters in the Ijebu-Ode Local Government Area

(ILGA; section 5.3.6); as such improved education of flood risk offers an opportunity to help address current knowledge gaps and a workforce skills gap.

Less than 50% of survey participants are aware of flood risk, illustrating the potential role education and schooling can play in raising flood awareness in Ijebu-Ode (section 5.2.2; 5.2.5; 5.2.6). Therefore, greater environmental education is required to enhance flood risk knowledge of practicing teachers' and raise proactive behaviours amongst the public. Flood literacy repositions those at risk as an active agent in managing local flood risk, as they can make informed judgements and decisions on risk and protective behaviour, rather relying on expert knowledge, which may not always be available (Willis et al. 2011). To encourage effective flood literacy through improved flood risk communications, there is a need to re-establish resilience as a process grounded in relationships, critically of social learning and dialogue (Twigger-Ross et al. 2011, 2014; Benson et al. 2016), rather than reliant on 'hard' infrastructure or property (McBain et al. 2010).

## 7.3 Designing a flood risk education programme

There is an urgent need to engage in prevention, mitigation and adaptation to climate change effects, by adopting different policies and strategies. The design and implementation of an educational program on climate change and flooding are part of the strategies for strengthening the resilience of populations. The main purpose of flood-risk education programs is to raise awareness and increasing students' risk perception and their preparedness (Bosschaart et al., 2016). Environmental education should emphasize critical and integrative thinking, develop communication and problem-solving skills, as well as highlight the role of attitudes, values, and commitments in resolving environmental issues (Anderson 1991; Theis 1996a; Simmons 2000). According to Oriola (1989) and Church and Keller (1989), there is a clear need to entrench environmental education in school curricula, reinforced by a strong community awareness (on a national scale) and by strong mass-media support, which can influence behaviour. A fundamental idea of flood risk reduction is for knowledge and awareness raising and to select and implement measures to reduce vulnerability.

The objective of this program is to raise adaptive capacity of individuals and communities to adjust to climate change and to develop awareness of flood risk. Through the design of a curriculum that will support children and adults, from age 6 to 25 years (covering primary, secondary and tertiary educational levels), it seeks to support actions to prevent, protect and adapt to climate change and flood events. This is supported by the Nigerian 6-3-3-4 system education policy, encompassing each level of education (pre-primary, primary, junior and senior secondary schools and tertiary institutions) part of the National Policy of Education (Premium Times & Opinion, January 10, 2017; Nigerian Tribune, January 20, 2022). Adaptation of a program to the cultural context of the country is critical, to ensure national ownership and sustainability of activities. The following steps and activities are proposed to be used to define and implement the program:

1) analyse the situation in Nigeria in terms of climate change and flood risk;
2) identify stakeholders that are involved in curricula development;
3) define the skills benchmark;
4) design the program;
5) share the program that has been developed with all stakeholders and teachers;
6) test and evaluate the program in schools;
7) generalize and perpetuate the program in Nigerian educational system.

The methodological approach that will be adopted shall be based on the involvement of all potential actors in the process (i.e., there are 8 fundamentals educational agencies in Nigeria), and these agencies are:

- National Universities Commission (NUC)
- National Commission for Colleges of Education (NCCE)
- Joint Admissions and Matriculation Board (JAMB)
- National Teachers Institute (NTI)
- West African Examinations Council (WAEC)
- National Examination Council (NECO)
- National Business and Technical Examinations Board (NABTEB)
- Teachers Registration Council of Nigeria (TRCN)

Successful flood risk management requires that city governments develop clear, robust, and forward-looking strategic plans informed by rigorous research, administrative data gathering, dialogue with the public, evaluation, and learning (Egbinola et al., 2017). For example, flood risk education is an important advance in water education for Europe (Dogulu et al., 2015) and Netherland (Bosschaart et al., 2016). Environmental education is a part of the UN Sustainable Development Goals (SDGs), a strategy for more effective environmental management and has also long been part of global discourse on sustainability and has gained global agreement.

## **7.4** Current educator knowledge

Prior to developing a new curriculum or programme, current educators were approached to determine current knowledge, support for a new programme and policy. A total of 25 educators (section 3.6.3) and four senior administrators (section 3.6.4) within the education system were interviewed (Appendix D & E). An explanation on how the interviews were conducted and the topics covered is provided in sections 3.6-3.8.

### **7.4.1** Questionnaire participants (paper copy)

Half of selected participants are lecturers in Department of Social Studies (50%), followed Department of Primary Education Studies (27%) and Geography and Environmental Studies Department (23%) respectively. The three departments are selected as they are fundamental Departments in Education-based programmes in Nigeria to which climate, flooding and human responses might be taught, are school subjects at both primary and secondary levels of education, and generally focus on the study of humans and their environment and provide professional training for the teachers. Social Studies is an interdisciplinary subject consisting of subjects including Geography, History, Culture & Society, Civics, Government and Economics which enables students to acquire skills, knowledge, attitudes and the values necessary for good citizenship, whilst Primary Education Studies introduces students to core subjects at elementary school, including social studies, geography, biology, basic science and technology, basic mathematics, English language and agriculture. Geography is concerned with the people and place and enables students to see how people adapt to environment and how human activities modified the environment. The majority (77%) of questionnaire respondents were male, with 23% female lecturers (Appendix R), with all participants within the age range of 26-65.

Through a range of training courses, student teachers obtain the necessary knowledge and skills required for teaching Social Studies at the primary school level and both Social Studies and Geography at secondary school level, based on the current pattern of the educational system and curriculum implementation in Nigeria. The participants are well educated, with 23% having attained a Bachelor’s degree, with 77% of participants having also received a further education (Master's degree or PhD). 65% of participants falls within the rank of Lecturer Grade 1 and Professors, whilst 45% of the participants are within the rank of Lecturer Grade 2. Considering the participants years of service, the majority (81%) have lectured between 6-21 years, with 19% participants having spent 1-5 years in service. The majority of participants are qualified and have robust knowledge and experience required for in-depth communication of important feedback (Appendix R).

### **7.4.2** Source, route, and receptors of flooding

Most participants strongly agree (68%) or agree (32%) that climate change is real and poses a serious threat, harming people and their environment (Figure 7.1a and Appendix S). Participants identified the following as some of environmental issues and problems that are common in Ijebu-Ode: climate change; flooding and erosion due to heavy rain; flooding as a result of dumping wastes on surface runoff water leading to blockage of drainages; flooding as a result of dumping wastes directly and deliberately into inadequate drainage before and during rain leading to blockage of the drainage, illegal waste dumping on roads and road dividers; late collection of waste; indiscriminate dumping of waste in unauthorised places within town; inadequate drainage systems; poor waste and drainage management; deforestation; land reclamation; oil spillage; gully formation; air and water pollution (Appendix V: Question 26)

The majority of participants (78%) state that flooding is a major and prevailing environmental hazard impacting peoples' lives, properties and the environment in Nigeria (Figure 7.1b, Table 7.1 and Appendix T). Participants identified a range of themes to explain this, with many commenting upon loss of life and damage. A number of responses to Q13 in the educator's questionnaire detailed elements of concern including "flooding is very dangerous to human lives and property if not properly controlled and avoided" (Respondent 23).

#### 7.4.2.1 Residents' awareness of the danger

The majority (87%) of participants agreed there is insufficient knowledge about the hazard posed by floods which increase vulnerability (harm) of communities, (Figure 7.1c and Appendix S), and in same vein, the majority (83%) agreed that insufficient flood knowledge could impair peoples risk perception and their preparedness (Figure 7.1d and

Appendix T). It is well known that the success of flood risk reduction depends to a large extent on knowledge-based decision and flood risk communication (NEMA, 2013; Ologunorisa and Adeyemo, 2005), but these factors are found to be missing in Nigeria and where they exist, they are poorly addressed. Knowledge-based decisions uses the available information relating to flooding to draw conclusions on possible strategies to be adopted for tackling the flooding whilst flood risk communication aims at creating awareness of flooding and its impact in the stakeholders and the general public.

**Table 7.1**: Free text comments to Q13 - Flooding is a major and the prevailing environmental hazard impacting the people's lives, properties, and environment in Nigeria. Please explain reasons why you agree or disagree.

| Respondent | Comment |
|---|---|
| 1 | A. no proper channel of water and the existing drainage has been blocked terribly |
| 2 | A. occurrence of flood affect, so sometimes people cannot move being for social and social and economic purposes |
| 3 | A. havoc cause by flooding had rendered some people homeless, turn some children to orphan and even caused food scarcity as a result of losing farm products to flooding. |
| 4 | A. many lives and properties have been lost to flood especially during raining seasons, this is evident in the current seasons in Ijebu-Ode |
| 5 | A. Ijebu-Ode is a typical example of the effect of flooding which occurred in May, 2021; cattle were drowned, cars and some individuals killed |
| 6 | A. flood is not controlled at all in Nigeria |
| 7 | A. flooding have destroyed the live and properties of people in Nigeria; it has turned some people to homeless while others to lifeless |
| 8 | E. flooding causes environmental degradation and damages to lives and properties |
| 9 | A. many properties and lives had been destroyed by the perennial flooding in Nigeria |
| 10 | A. I agree with this assertion because flooding occur yearly |
| 11 | A. well evident in Ijebu-Ode; it is regular occurrence during raining season |
| 12 | B. flooding is a major environmental hazard because it damages roads thereby reducing mobility and causing great economic loss particularly as it affects movement of goods and services |
| 13 | C. |
| 14 | E. strongly disagree if the impact is negative |
| 15 | A. it constitutes major danger to people's lives and property when it happens |
| 16 | A. flooding creates a significant threat to life and property; another effect is by disruption of services, health impacts such as famine and diseases |
| 17 | B. flooding has caused a lot of havoc and has displaced many people through the destruction of lives, properties and the environment |
| 18 | A. Nigeria is blessed with adequate rainfall hence, the effects of flood; most of the available storm water infrastructure are inadequate which make flood a major hazard in the country |
| 19 | B. many houses have collapsed; many shops have been closed down due to flooding nature of the located environment; properties and lives have been displaced; it remains a major and prevailing hazard influencing the society |
| 20 | A. many people been carry away by flood; and even property have been destroyed through flood |
| 21 | A. flooding causes more harm than good in people's lives and properties |
| 22 | A. people can be injured or killed by flooding; flood water is often contaminated with sewage will could lead to illness and affect clean water; transport network can be affected, such as flood damage to bridges, railways and roads |
| 23 | A. flooding is very dangerous to human lives and property if not properly controlled and avoided |

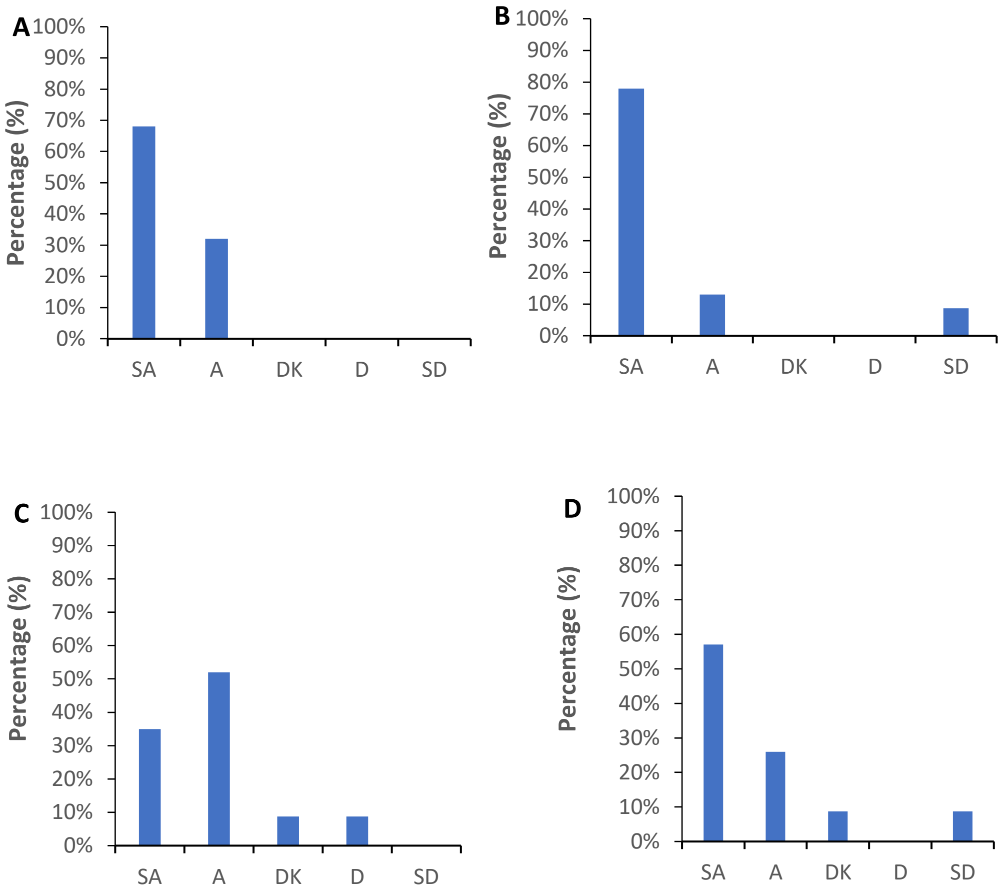



**Figure 7.1:** Responses to: **a)** Q7: climate change is real and posing serious threat **b)** Q13: flooding is a major prevailing hazard impacting people and environment **c)** Q8: insufficient knowledge of flood hazard increase vulnerability **d)** Q15: insufficient flood knowledge impairs people risk perception & preparedness.

### 7.4.3 Attitudes towards waste management

The majority (87%) of participants agreed that solid waste is indiscriminately disposed and poorly collected in Nigerian cities and towns because this is evident in major cities and towns and very common in Ijebu-Ode (Respondent 11 and Question 18; Appendix T), they stated the unacceptable habit (s) and unsustainable act is encouraged due to lack of right technique for waste collection, lack of official dumpsites, corruption, poor monitoring and supervisions by officials in charge of waste collection and disposal, lack of proper waste management, poor physical planning, congestion of cities and towns, non-responsiveness of relevant Ministries, Agencies & Departments, poor hygiene nature, and poor environmental laws, its implementation and the enforcement (Figure 7.2a and Question

18; Appendix U). A number of responses to Q18 – Appendix U & Q14 - Appendix T in the educator's questionnaire detailed elements of concern including "because most cities have no defined dump site" (Respondent 2; Appendix U); "there is insufficient orientation and sensitization on the proper method of disposing waste; also, incinerators were not provided for people to dispose their waste" (Respondent 3; Appendix U); "many societies especially rural areas are fond of dropping/disposing their wastes in the drainages; due to no proper waste management system in those areas or communities" (Respondent 19; Appendix U); "the collection point of solid waste by the local government remains the walk-way dividing the dualized roads in Ijebu-Ode; this has indeed contributed to indiscriminate dumping of waste" (Respondent 5 & 12; Appendix U); "many societies especially rural areas are fond of dropping/disposing their wastes in the drainages; due to no proper waste management system in those areas or communities" (Respondent 19; Appendix U); it is a common phenomenon in the cities and homes; people dispose waste anywhere and government agency that is responsible for collection is not responsive" (Respondent 15; Appendix U); "ignorant culture of domestic wastage is one of factors for prevalence of flood; this is as a result of the unsustainable habits of living by people in society, mostly, those in rural areas (Respondent 19; Appendix T; Respondent 6; Appendix U).

A large number (87%) of participants agreed that when it is about to rain, people are in the habit of emptying and disposing off their waste and rubbish improperly in drainage channels and it is taken away by surface runoff as this is confirmed to be a regular and very common lifestyle and practice in Ijebu-Ode thereby blocking free flow of water in the narrow and inadequate drainages and making roads and houses to become flooded (Figure 7.2b and Question 20; Appendix U). In Nigeria, factors which influence the risk of flooding in the country both presently and in future (if not addressed) has been poor urban planning (especially drainage systems and poorly urban utilities and services) (Adeloye and Rostum, 2005). A number of responses to Q20 – Appendix U in the educator's questionnaire detailed elements of concern including: "Most people have notion or believe that when it is raining drainage water flow will wash domestic waste far from their surroundings" (Respondent 1, 7 & 9; Appendix U). "This has been recurring mentality, unknown to them that it causes more damage than good" (Respondent 2; Appendix U). "People do this often, many drainage channels are always filled with refuse, hence cause flood on the roads" (Respondent 13; Appendix U). "Also, after rains, domestic wastes will litter all over the places, causing fowl smells, dirtiness and overall poor aesthetics of the total environment" (Respondent 15 & 19; Appendix U).

Other factors include inadequate creation of sensitization and awareness by the government, most of this happen among the illiterates due to lack of good orientation by (NOA) - National Orientation Agency (Respondent 23; Appendix U), lack of adequate knowledge about the effects of dumping domestic wastes in drains when it is raining is promoting unacceptable habit (Respondent 3; Appendix U). Vulnerabilities of local government to flooding may indicate, among other factors, an overwhelming level of neglect towards flooding and ways of addressing its challenges in Nigeria (Nkwunonmo et al., 2015), considering some action which characterize a cross section of Nigerian population such as the failure to comply with environmental laws and regulations and to adhere to weather warnings and alerts are possible situations where lack of responsibilities of public is highlighted (Aderogba, 2012a). Also, the inability of government to make adequate provisions for incinerators at the strategic locations within the township encourages indiscriminate waste disposal (Respondent 3; Appendix U). In Nigeria there seems to be a gap between efforts by government and activities by people such that it appears difficult to know peoples' responsibilities towards addressing challenges of flooding (Nkwunonwo et al., 2015). Government claims people are sabotaging her efforts (Nkwunonwo et al., 2015), whilst this claim is hard to be substantiated, attitude of a considerable population of Nigeria towards the environmental management, regulations and rules in the country shows irresponsibility towards threats of flooding. Whilst very few (13%) of participants strongly disagreed (Figure 7.2b and Appendix U).

Majority (87%) of participants agreed large proportion of uncollected municipal wastes ends up blocking the drainage channels, obstructing free flow of water, and forcing excess water to spill on roads and surroundings, causing panic and severe havoc on lives and properties (Figure 7.2c and Question 21; Appendix U). This is evident in many areas of Ijebu-Ode: mountains of refuse are allowed even on major roads, poor practice of waste management by people end up blocking the narrow poor drainage systems due to continued non-functioning of waste management Department (Question 21: Respondent 4 & 6; Appendix U). A number of responses to Q21 – Appendix U in the educator's questionnaire detailed elements of concern including: "Each time it rain, there is panic everywhere because of fear of damage usually caused by flood in pulling down many dilapidated buildings" (Respondent 12; Appendix U). "Being witnesses, flooding in Ijebu-Ode has killed people and destroy properties" (Respondent 1, 19 & 21; Appendix U). Major cause of flooding in Nigeria is the blocked drains and poor water channels due to the indiscriminate solid waste disposal". The more people dump their solid waste in drains, the more the effects of the flooding" (Respondent 18; Appendix U). This is responsible for perennial flood disaster in Nigeria" (Respondent 9; Appendix U). Very few (4.6%) of the participants indicated they don't know whilst also very few (9.1%) of the participants strongly disagree and mentioned no reason(s) (Figure 7.2c).

Majority (78%) of participants agreed that the unsustainable living habits of the people is a confirmation of insufficient flood and environmental knowledge, low risk perception and risk communication (Figure 7.2d and Question 10; Appendix S) because of the deliberate blockage of drains by people, poor habit/indiscriminate disposal of wastes into the environment and drainages when it is about to rain and during rains, and disobedience to lay down rules. Poor knowledge about flood and good environmental behaviour and inadequate information and orientation about environmental issues and problems makes people to overlook risk (s) of flood, live unsustainably, and disobedience to lay down rules, hence, continues to promote dangers (Question 10: Respondent 2, 21, 3 & 4; Appendix S). A number of responses to Q10 detailed elements of concern including: "the fact that people actually block drains carry out other activities that promote flooding are enough reasons and confirmation of insufficient knowledge on flood and environmental risk perception" (Respondent 12; Appendix S). "People are ignorant of their actions or the effect of their actions on the environment during raining season, when they throw their garbage into drainages when it rains" (Respondent 15; Appendix S). "Their level of literacy is low; hence most people are unable to read sign post erected to guide them on issues of flooding" (Respondent 10; Appendix S). Economic status of the people plays a significant role in the unsustainable living habits; irrespective of the risk factor, as long as it meets economic needs, living habits rank above environmental knowledge" (Respondent 18; Appendix S). "Knowledge determines perception of the people about environmental behaviour" (Respondent 11, 6, 3 & 2; Appendix S). However, few (17%) of participants indicated that they don't know whilst very few (4.3%) disagreed (Figure 7.2d and Appendix S).

The majority (89.5%) of participants agreed that unsustainable living habits of people are major factors exacerbating the incidences of floods and vulnerabilities in Nigerian cities and towns (Question 14: Figure 7.2e and Appendix T, because of ignorance of the importance of good domestic solid wastes disposal culture, continuous deforestation, peoples incalcitrant attitude and bad economy and lack of job/unemployment. Very few (10.5%) of participants disagreed (Figure 7.2e and Appendix T). Responses to Q14 include: “The attitude of populace towards flood reduction is appalling, hence causes more incidences of flood and vulnerabilities” (Respondent 17; Appendix T). “Because you cannot give what you do not have, you only give what you have” (Respondent 6 & 11; Appendix T). “Lack of education on flooding result in people are being unfriendly to their environment most especially during rain seasons” (Respondent 15; Appendix T)

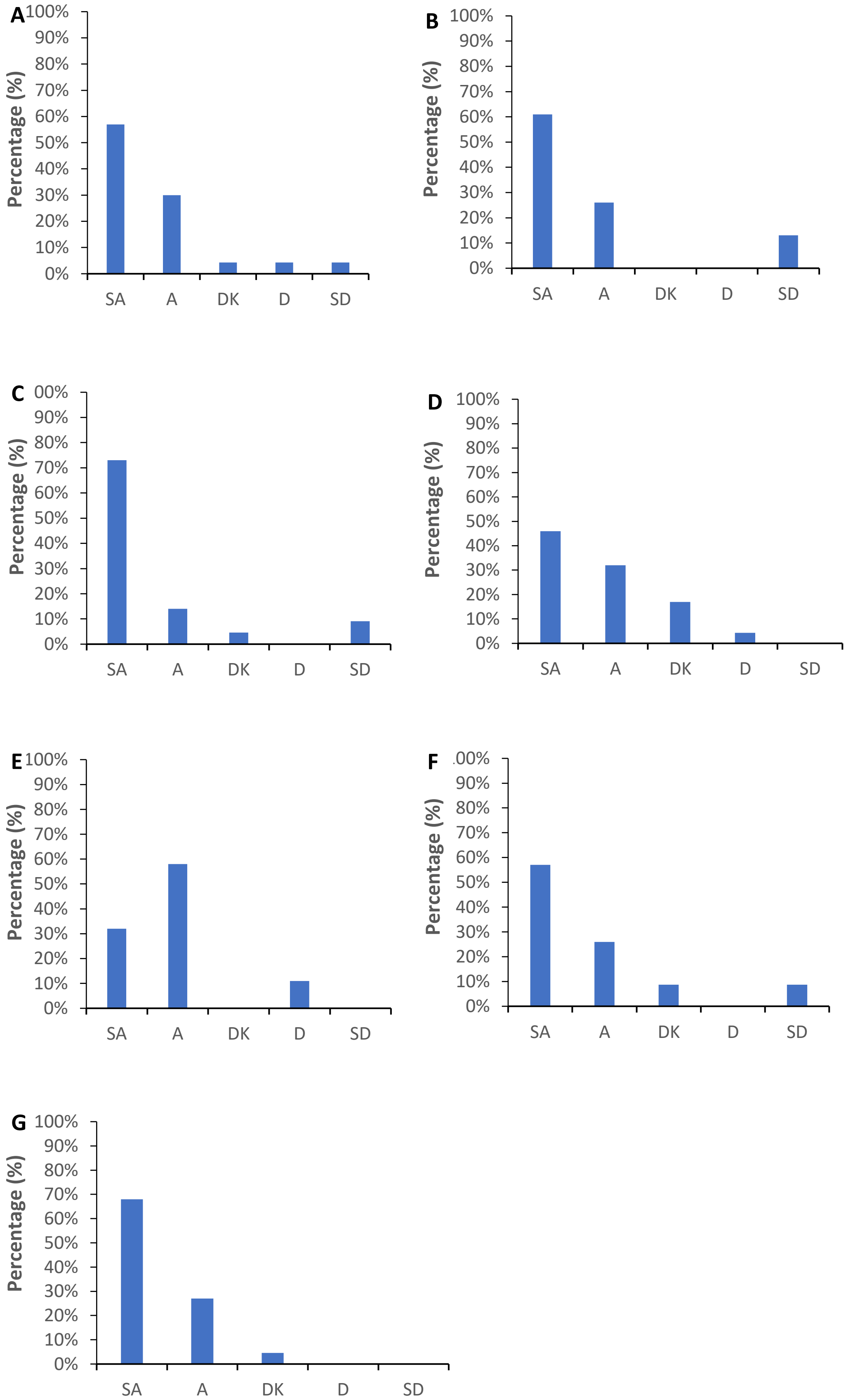
The majority (83%) of participants agreed that poor perception and awareness on proper waste management approach coupled with the institutional weaknesses remains the key drivers of unsustainable habit and poor practice in waste generation and disposal in Nigeria (Figure 7.2f and Question 19; Appendix U), because of the government’s nonchalant attitude, and many do not know and are not aware of how to properly dispose and manage their wastes and this is responsible for the dirty environment (Question 19: Respondent 10 & 4; Appendix U). Majorly the states of Nigeria lack institutional framework for waste management; also, the populace themselves have a poor perception on waste management; these two factors have been a bane to Nigeria (Question 19: Respondent 19; Appendix U). Very few (8.7%) of participants indicated that they don’t know whilst 8.7% of participants disagreed (Figure 7.2f; Table 7.4-Appendix U).

#### **7.4.3.1** The involvement of institutions and the government in waste management

A number of related responses to Q18, 19 & 20 in the educator’s questionnaire detailed elements of concern including: “The illiteracy level in Nigeria is still high especially as regards proper waste management which is the major problem in Nigeria” (Question 19; Respondent 1; Appendix U). “Because government does not create enough sensitization and awareness; also, there is no formidable laws that prohibit people from indiscriminate waste disposal in Nigeria” (Question 19; Respondent 3; Appendix U). “Incinerators were not provided for people to dispose their wastes” (Question 20; Respondent 3; Appendix U). “The collection point of solid waste by Local Government in Ijebu-Ode is by road side and road dividers on major roads and heavy downpour sometimes washes these wastes into the drainages (Question 18; Respondent 5; Appendix U). “Heavy downpour sometimes washes these wastes into drainages thus creating pollution; this is a weakness on government part; while some individuals wait for rain before dumping their wastes into the drainages; a result of insufficient public knowledge” (Question 19; Respondent 5; Appendix U).

Most (95%) participants agreed that good governance and effective institutional capacity and coordination at the local government level (i.e., LEMA & NIMET) could foster proactive response towards domestic waste and flood risk management (Figure 7.2g and Question 23; Appendix U), this is because if the problem of waste disposal is be minimized, the role of environmental agencies like NIMET, FEPA, LEMA cannot be overemphasized; so, these agencies must be empower to perform their constitutional roles (Question 23: Respondent 3; Appendix U). Local government is the closest to the people; an improvement on institutional capacity at the local government level would definitely positively on domestic waste and flood risk management (Question 23: Respondent 18; Appendix U). The role of environmental agencies such as the Local Emergency Management Agency (i.e., LEMA) cannot be overemphasized considering its role in the coordination of policies relating to assisting the flood victims at the local government level whilst NIMET furnishes the country with weather report, and other meteorological information, issues alert and early warning and forecast on impending flood disasters within the country, contributes towards creating awareness of flooding among local communities, hence need to empower relevant Agency constitutional roles at local level. Respondent 2 & 9; Appendix U stated there should be a good government policy, plan and action to curb various environmental problems. They further noted that effective institutional capacity and proper law enforcement will ensure the compliance and proactive response to proper domestic waste disposal and management. Very few (4.6%) of the participants indicated they don’t know (Figure 7.2g and Appendix U).

A number of responses to Q23 raise concerns, including: “I agree they are saddled with such responsibility, but it is quite unfortunate that due to some factors they might not be up to the task” (Respondent 17; Appendix U). “This is leadership problem” (Respondent 6; Appendix U). “Despite the fact that there are very few wastes collection trucks, driving force remain the duty of local government” (Respondent 5; Appendix U). “If the people assigned to do this job are doing it religiously people will be educated on how to manage their wastes” (Respondent 21; Appendix U).


A
B
C
D
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F
G
Percentage (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
SA
A
DK
D
SD

**Figure 7.2:** Response to**: a)** Q18**:** solid wastes are indiscriminately disposed and collected; **b)** Q20: people are in habit of disposing their wastes into drainages and surface runoff when it is about to rain or raining; **c)** Q21: large chunk of uncollected municipal solid wastes end up in blocking drainage channels; **d)** Q10: unsustainable living habits of people is a confirmation of their insufficient flood knowledge, risk perception and communication; **e)** Q14: unsustainable living habits of people are major factors exacerbating floods and vulnerabilities in Nigeria cities and towns; **f)** Q19: poor public perception, awareness and institutional weaknesses are key drivers of unsustainable habit and practices of waste management in Nigeria; **g)** Q23: good governance and effective institutional capacity and coordination at local government level could help foster proactive responses towards waste management.

### 7.4.4 School's role in risk education and communication

Some (36%) of the participants think that pupils/students are aware of the environmental issues and problems but are not or less effectively knowledgeable about cause (s) (Question 27; Appendix V). Monthly environmental sanitation exercise is observed every last Saturday of each month when general movement of people is restricted between 7.00am – 10.00am (Question 27: Respondent 5; Appendix V. For example, Respondent 1 (Appendix V) states, “They are aware but not effectively knowledgeable as to the cause”.” whilst Respondent 23 notes “Some of them are aware because the government through the National Orientation Agency (NOA) is not reaching the people at large”.

The poor perception of flooding in the country should be concerns of NOA (Nkwunonwo et al., 2015). Poor perception of flooding among the local communities is a major issue which underscores current activities of NOA within Nigerian institutional framework (Ologunorisa and Adeyemo, 2005; Ajibade et al., 2013). Recently, a memorandum of understanding was signed with NOA to intensify efforts towards risk management in Nigeria (NEMA, 2013), in which among others is to ensuring importance of local communities being aware of flooding and actively participating in discussions and decisions which might increase their resilience and adaptability to the hazard.

Whilst the majority (64%) of participants think pupils/students are not aware of environmental issues and problems, they noted that currently “Because there is no adequate orientation and education as regards environment (Respondent 3; Q27:

Appendix V). Not emphasized in curriculum" (Respondent 2 & 22; Q27: Appendix V). "Government does not inculcate it into syllabus" (scheme of work) (Respondent 20; Q27: Appendix V; Respondent 14 & 16; Q34: Appendix W). "The education sector is in shamble (Respondent 8). It should be included in the school curriculum" (Respondent 10; Appendix V). There is poor/lack/inadequate environmental education, awareness and orientation as regards our environment, teachers/educators are yet to see it as a necessity to create awareness on the subject matter (Respondent 17; Q27: Appendix V). They noted environmental education is not emphasized as compulsory/core subject in the existing curriculum and school timetable and that poor governance and weak institutional capacity has continued to impact negatively on the teacher's responsibility to educate citizens about the hazards. Most (95%) of the participants think there is no proper structure and enabling environment for pupils/students to get desired awareness and perception, new patterns in value, habits and adaptive capacity (Question 28; Appendix V). A number of responses to Q28 include: "Flood risk are not been emphasized as a real issue or serious risk in schools" (Respondent 1; Appendix V). "Gap in our Educational Sector" (Respondent 8; Appendix V). "Curriculum that we run is not designed for our development" (Respondent 6; Appendix V). "There is poor curriculum coverage on environmental issues" (Respondent 18; Appendix V). "Lack of interest in imparting the pupils/students" (Respondent 12; Appendix V). and "Weak government policy" (Respondent 9; Appendix V).

All (100%) participants absolutely agree that educating young people on climate change and flood risk will decrease vulnerability (Figure 7.3a and Question 9; Appendix S). In same vein most (95%) of participants agreed that increasing the peoples' environmental protection literacy could help in achieving the desirable behavioural changes and sustainable flood risk management in Nigeria communities predicated on fact that information is power whilst literacy is about being informed about issues (Figure 7.3b and Question 16; Appendix T). Whilst very few (4.5%) of the participants disagreed (Figure 7.3b and Appendix T). One of the respondents who completely agree stated this will increase people environmental literacy because persistence will force people to adapt (Question 16; Respondent 10; Appendix T). Overall, help to reduce/minimize risk because people will know how and when to avoid flood risk (i.e., increase preventive and safety behaviours) (Appendix T). Free text comments note: "Environmental protection literacy will expose the Nigerian populace and communities to dangers and remedies to manage the hazards likely to be caused by flooding and other environmental risks" (Respondent

14; Appendix T). “More knowledge of the environmental protection will help create awareness and need for safety” (Respondent 5; Appendix T) “Orientation and sensitization campaign is solution to the flood problems because most environmental issues are caused as a result of ignorance” (Respondent 3, 4 & 23; Appendix T). “Once people have sufficient information on the danger of flooding and possible solution to such, they will adequately do the needful because everyone wants and desires the safety of his live and properly” (Respondent 12; Appendix T). All (100%) participants entirely agree that sufficient knowledge of climate change adaptation and flood risk management will help raise awareness and impart preventive habits in people (Figure 7.3c and Question 11; Appendix S).

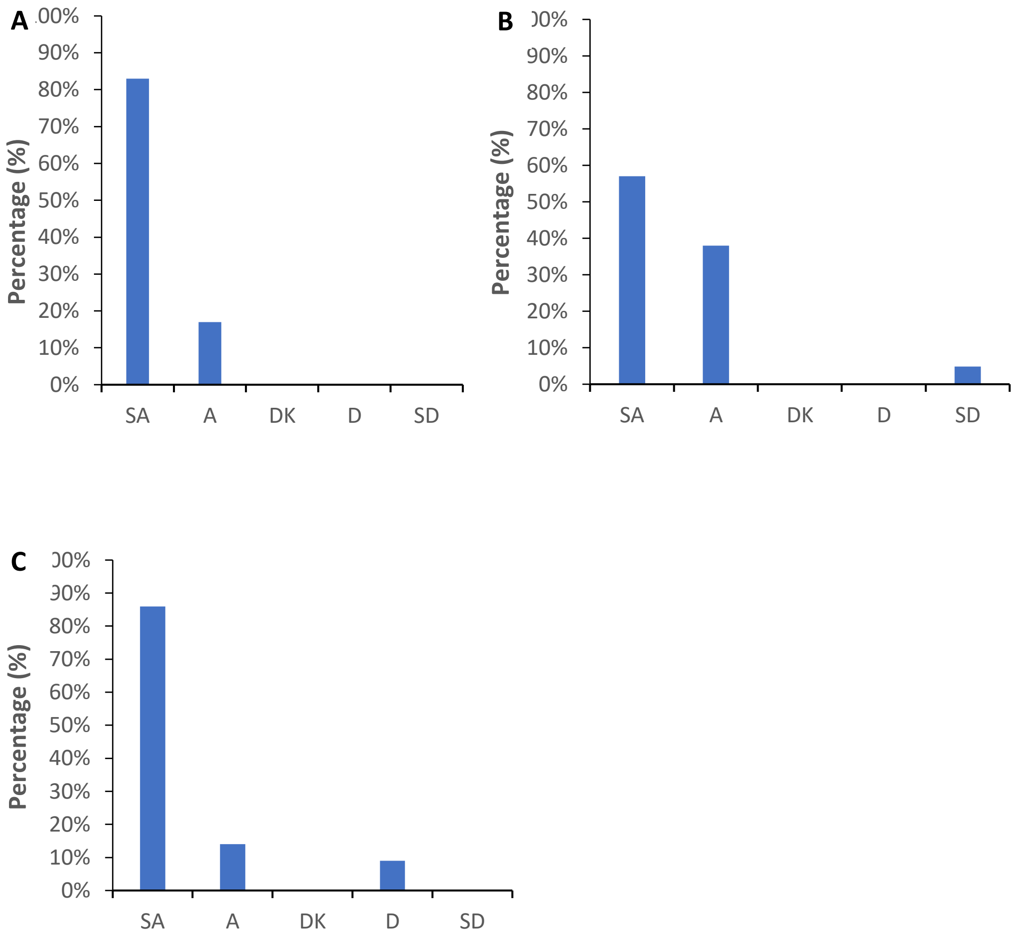


**Figure 7.3:** Response to: **a)** Q9: educating the young people on climate change and flood risk will decrease vulnerability **b)** Q16: increasing the peoples’ environmental protection literacy could help achieve desirable behavioural changes & sustainable flood risk management **c)** Q11: sufficient knowledge on climate change adaptation and flood risk management will help raise peoples’ awareness and preventive habits.

### **7.4.5** Curriculum gaps and their ramifications

Few (14%) participants indicated environmental education is taught as a compulsory subject in Nigeria (Question 25; Appendix V). For example, *"*Environmental education is been taught but not so effective, it is been taught as a required course in many schools," (Respondent 1 & 9; Appendix V). "May be under Geography, it remains a course or subject taught at just primary and junior secondary level, with just a tip of knowledge about the issues, whereas, it's a subject that is important to all at large" (Respondent 6 & 19; Appendix V). Whilst majority (86%) of the participants indicated environmental education is not a separate subject neither a compulsory course/subject at any level of education in Nigeria (Appendix V). "Because our education policy makers do not see environmental problem as a serious problem that cause serious setback in Nigeria" (Respondent 3; Appendix V), and "Environmental education is not taught, particularly in secondary schools because there is no full-fledged curriculum" (Respondent 14; Appendix V). They noted some aspects of environmental education are part of existing curriculum but always taught on periphery and theoretically (Question 29; Respondent 1, 2, 4, 5 and 10; Appendix V). Whilst issues concerning flood risk, flood risk management, hazards of wastes including level of hazard caused by flood are not much discussed/elaborated (Question 28; Respondent 1, 5 & 16; Appendix V).

More than half (52%) of participants think current Nigeria curriculum in areas of some related subjects such as Geography, Social Studies and Civics have some of topics on climate change and flood risk management embedded (Question 29; Appendix V). "The curriculum is not detailed enough to cover the new demand of environmental literacy" (Respondent 23; Appendix V).

Whilst 48% of participants think that the existing and current Nigeria teaching curriculum of aforementioned related subjects does not comprise of subject matters on climate change and flood risk management, and hence indicate and supported that environmental education be included in teacher education and be taught as a subject or course in order to satisfy 'new demands 'of the environmental literacy majorly on climate change adaptation and flood risk management (Question 29; Appendix V).

Findings of this research is corroborated by Terungwa & Torkwase (2013) which identified that study of science and technology in Nigeria is yet to embrace environmental education. Nkwunonwo et al., (2015) noted whilst flooding and climate change are passive subjects in the education curriculum of studies in Nigerian schools, current key issues in flood research such as flood modelling, uncertainty analyses, early warning systems and flood forecasting, vulnerability assessment and climate change models are lacking in the country.

#### 7.4.5.1 Benefits and inclusion of environmental education in school curricula

Most (96%) of the participants agreed that including environmental education in teacher education curriculum will increase flood risk awareness at household level on environmental implications of their poor domestic waste disposal and management because education is key, curriculum will expand the essential practice and proper knowledge for waste disposal (Figure 7.4a and Question 22; Appendix U). The inclusion of environmental education in teacher education curriculum will reinforce the teacher and student alertness on management of wastes (Question 22; Respondent 12; Appendix U). Every society needs an adequate knowledge on environmental education; hence, the teachers play important role in educating society (Question 22; Respondent 19; Appendix **U**). Would-be-teachers undergoing training need to be well informed, so they can impart correct knowledge in the learners. Whilst 4.3% of total participants disagreed. A number of responses note: "The message on environmental protection will penetrate individual homes through their wards and enforcement will become easier" (Respondent 5; Appendix U). "Environmental education should not be limited to school; it should have a wider coverage; the percentage of enrolment in school is low, hence, the low level of awareness on environmental implication of poor waste disposal system" (Respondent 18; Appendix U).

Total (100%) participants agreed that including climate change and flood risk education in teacher education programmes could help raise the peoples' flood knowledge and better their habits towards environment (Figure 7.4b; Question 12; Appendix S). A number of responses to Q12 – Appendix S in the educator's questionnaire detailed elements of concern including: "A. teacher education serves as a means enlightenment; hence, including climate change in its programs will help maximize or eradicate flood. (Respondent 17; Appendix S). "Education was recognized for its ability to empower, inform and motivate those engaged, the wider community and government to take action on climate change” (Respondent 22; Appendix S). “The teachers are one of the primary sources of information in the society; including climate change and flood risk education in their programme will increase awareness of people of all environmental hazards, thereby preventing their consequences” (Respondent 22; Appendix S). “Providing information on climate change will enhance grassroot knowledge of climate change and possible ways of adaptation which in turn will enhance better understanding of people in the community” (Respondent 22; Appendix S).

Most (95%) participants agreed that designing robust climate and flood risk education (curriculum) will help raise awareness of climate change and the impacts of humans on the environment whilst only (4.6%) of participants strongly disagreed without giving reason (s) (Figure 7.4c and Question 17; Appendix T).

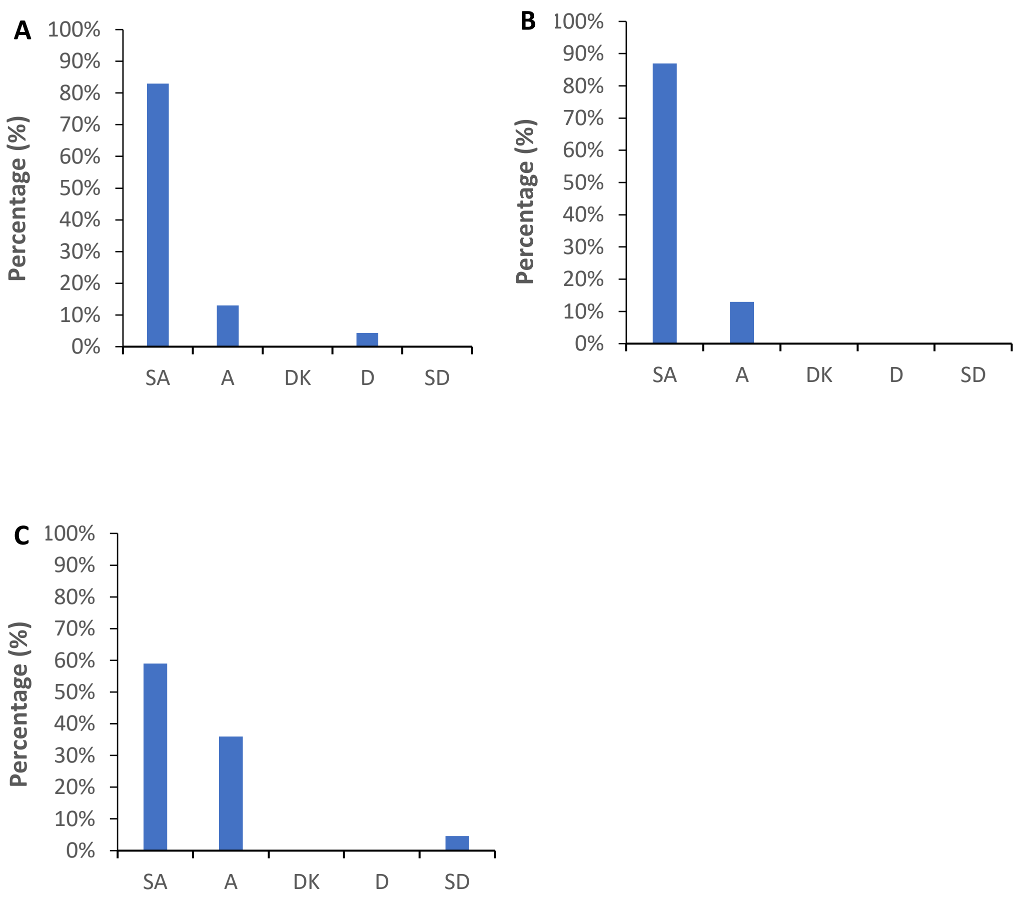


**Figure 7.4:** Response to: **a)** Q22: including environmental education in teacher education curriculum **b)** Q12**:** including climate change and flood risk education in teacher education programme **c)** Q17: designing robust climate and flood risk education curriculum.

Part of topics suggested to be included in curriculum by participants are (Question 34; Appendix W):

- The maintenance of an ideal society;
- Importance of environment in human life;
- Meaning of environment and environmental problems;
- Effect/consequences of damaged environment on human life.

A number of responses to Q34 – Appendix W in the educator's questionnaire detailed elements of concern including:

- "Approval from the Ministry of Education Science and Technology; seminar on the importance of environmental protection and hazard connected to flood and climate change" (Respondent 5; Appendix W)
- "Teachers will need curriculum/curricular adequately planned by environmental curriculum specialists encompassing basic ingredients" (Respondent 14; Appendix W)
- "Teaching material; removal of beau acracy; given incentives to teachers and allocation of better financing of education" (Respondent 5; Appendix W)
- "To ensure effective learning and deep understanding of the subject matter; climate change should be integrated across school curricular, its severe impact and coping measures has to be adapted to address related target groups" (Respondent 16; Appendix W)
- "Teachers will need in-service training to enhance their knowledge in environmental and disaster management" (Respondent 21; Appendix W)

Other important comments advanced by some of the participants in (Question 35; Appendix W) include:

"We should make our environment conducive because a healthy environment is a healthy living; so, our education policy makers should see environmental education as a subject to be included in our curriculum" (Respondent 3; Appendix W)

“The teacher, students and general populace need to develop environmentally friendly attitude for the sustainability of the environment and survival of human race” (Respondent 9; Appendix W)

“The government should implore the National Orientation Agency (NOA) in carrying out their duties” (Respondent 23; Appendix W)

### **7.4.6**. Government, school administration, and teacher commitment to environmental education

Some (41%) of the participants indicated government through the Ministry of Education give ‘much’ concerns to ‘issues’ of environmental education whilst majority (51%) of participants indicated government does not give ‘much’ concerns to ‘issues’ of environmental education (Question 24; Appendix V).

> *“The policy somersault can manifest in form of the lack of consistency in, commitment & conformity to establish perspective, policies, programmes, projects owing to many reasons: misconception, mischief, manipulation, misfit, misinterpretation, misunderstanding, misplacement of priorities & misapplication. In Nigeria, policy somersault has been closely associated with the lack of commitment to consistent policy over time (this is clearly stated in Nigeria’s Transformation Agenda)” (Joel, 2018)*

Whilst 14% of total participants indicated that school management occasionally conduct seminars and workshops on the environmental issues, a majority (86%) noted that there is no programme set aside for seminars and workshops on environmental issues (Question 32; Appendix V).

Few (14%) of participants indicated that student teachers offer environmental education as a compulsory subject/course but noted they do not have adequate environmental education knowledge due to focus on the theory aspect alone (Question 30; Appendix V). According to Ibukun and Aboluwodi (2010), the colonial education which was inherited by Nigeria was criticized for being too theoretical to be able to make meaningful impact on life of Nigerians. Majority (86%) of participants indicated that student teachers does not offer environmental education as a compulsory subject/course (Question 30; Appendix V). A number of responses to Q30 highlight this point: “Environmental education is not seen as a compulsory subject course because it is not related to all disciplines” (Respondent 1; Appendix V) and “Because the curriculum/syllabus does not make provision for environmental education in Nigeria” (Respondent 3, 11, 12, & 18; Appendix V).

The questions which say ‘do you think current practising classroom teachers are qualified to impart climate change and flood risk education in Nigeria?’ received a mixed reactions from the participants. 50% of the participants think that current practising classroom teachers are qualified to impart climate change and flood risk education in Nigeria to extent of the degree of training, orientation and sensitization they have or given them (Question 31; Appendix V).

In the same vein, 50% of participants think the current classroom teachers are not qualified and are not knowledgeable in environmental issues (Question 31; Appendix V), with a “Need for in-service training of teachers” (Respondent 3; Appendix V). All participants indicated that teachers would be happy to teach the students about environment and climate change to achieve improvement in environmental and disaster management (Q33: Appendix W).

## **7.5** Significant findings from questionnaires

Result of this study indicated that climate change is real and posing serious threat, harming people and their environment, flooding and erosion is prevailing environmental problem due to heavy rain and exacerbated by inadequate drainage systems, inhabitants poor habit of disposing of their wastes and rubbish directly and deliberately into the inadequate drainages before and during rain, which are taken away by surface runoff leading to blockage of drainages; and indiscriminate dumping of wastes in unauthorised places within town. Result indicated flood occurs yearly and this continues to cause socio-economic and environmental effects, insufficient knowledge about the hazard posed by floods continues to increase vulnerability (harm) of communities. Solid waste is indiscriminately disposed and poorly collected in Nigerian cities and towns due to inadequate creation of sensitization and awareness by the government, lack of adequate knowledge about the effects of dumping domestic wastes in drains when it is raining, poor hygiene nature of the people, and lack of official dumpsites (this is evident in major cities and towns and very common in Ijebu-Ode). Large chunk of uncollected municipal wastes ends up blocking drainage channels, obstructing the free flow of water, and forcing excess water to spill on roads and surroundings, causing panic and severe havoc on lives and properties most especially during rainfall in Ijebu-Ode.

Result indicated that unsustainable living habits of the people is a confirmation of insufficient flood and environmental knowledge, low risk perception and low risk communication. Poor knowledge about the flood and poor environmental behaviours, inadequate information and orientation about environmental issues and problems, low environmental education literacy level makes the people to overlook risk (s) of flood, live unsustainably, hence, continues to aggravate flood risk in Ijebu-Ode. Unsustainable living habits of the people are major factors exacerbating the incidences of floods and vulnerabilities in Nigerian cities and towns. Poor perception and awareness on proper waste management approach including institutional weaknesses remains key drivers of unsustainable habit and poor practice in waste generation and disposal in Nigeria.

Result indicated that to a large extent pupils/students are not aware of environmental issues and problems, currently there is poor environmental education, awareness and orientation as regards the environment, educators are yet to see it as a necessity to create awareness on the subject matter and few pupils/students that are aware of the environmental issues and problems are not/less effectively knowledgeable about cause (s) of flooding. Environmental education is not emphasized as compulsory or core subject in existing curriculum and school timetable and there is no proper structure and enabling environment for pupils/students to get desired awareness and perception, new patterns in value, habits and adaptive capacity. Educating young people on climate change and flood risk, sufficient knowledge of climate change adaptation and flood risk management and increasing the peoples' environmental protection literacy will help to decrease vulnerability, raise awareness and impart preventive habits in people and could help in achieving desirable behavioural changes and sustainable flood risk management in Nigeria communities.

Result indicated that environmental education is not a separate subject neither a compulsory course/subject at any level of education in Nigeria. Aspects of environmental education are part of existing curriculum but always taught on the periphery and theoretically in very few subjects (i.e., Geography, Social Studies and Civics), the issues bothering on climate change mitigation, adaptation, flood risk, flood risk management hazards of wastes and including its devastating consequences are not discussed elaborately. Few subjects only make reference to environmental problems but nothing more is been taught, hence, the need for detailed emphasis on climate change and risk management in the Nigerian schools. The teaching of environmental education as a compulsory subject at all levels of education i.e., from primary to university levels will be helpful in extensively teaching the environmental problems and increases necessary awareness to protect environment, with a view that everyone should be concerned about environmental health, protection, and preservation. It will enlighten the people and society at large, especially students about danger of flooding, safety and benefit of good environmental sanitation.

Result indicated that including environmental education in teacher education curriculum will increase flood risk awareness at household level on environmental implications of their poor domestic waste disposal and management because education is key, curriculum will expand the essential practices and increase climate and water knowledge. Enlightenment through environmental education will surely help to reinforce teachers and student alertness and give people insight on how to manage and dispose their wastes. Every society needs an adequate knowledge on environmental education; hence, teachers play important role in educating society. Would-be-teachers undergoing training need to be well informed, so they can impart correct knowledge in the learners. Inculcating environmental education and knowledge in would-be-teachers undergoing training will help to build their capacity to transfer climate change knowledge to their students. Including climate change and flood risk education in teacher education programmes could help raise peoples' flood knowledge and better their habits towards environment, this will help as a primary source of information dissemination on effects of floods, serve as a means of enlightenment and sensitization, empower people and broaden knowledge, understanding and awareness of climate change and flood danger, encourage positive attitude, give more insight on preparation and knowledge of implication of actions on environment, foster the individual preventive behaviours, make individuals more environmental friendly especially during the rainy seasons especially by not throwing garbage into drainage systems. Overall, it will help to minimize flooding, reduce expenditure and save lives.

Designing a robust climate and flood risk education curriculum will help raise knowledge and robust awareness of climate change and the impacts of humans on the environment. Investing in the intensive flood risk education program to a large extent will help in fostering inhabitants' adaptive capacity and resilience that protect their livelihoods and assets from the perennial floods. Similarly, building resilient infrastructure will help to reduce exposure to climate risk (s).

## 7.6 Significant findings from interviews

An explanation on how the interviews were conducted and the topics they covered is provided in Section 3.9. Table 7.2 provides a brief overview of the four individuals interviewed and explores why their views were sought.

**Table 7.2**: Showing positions, institutions and roles of interviewees

| No | Name | Position | Institution/Ministry | Ministry Role (s) |
|---|---|---|---|---|
| **1** | Respondent 1 | Head of a University of Education | University of Education in Nigeria: | related to environmental education being "teacher education institution" dedicated to the training of competent professional teachers who have immense knowledge of their chosen subjects/disciplines of study and the requisite pedagogical skills of the subject delivery |
| **2** | Respondent 2 | Senior officer at the Ministry of Education in Ogun State Nigeria | Ministry of Education, Science and Technology Ogun State Nigeria. | The Ministry conducts quality and evaluation exercise in all educational institutions (i.e., both public and private) from the primary level to university level, monitoring and supervising of teachers and learners for effective teaching in schools, planning of school's curriculum in the State and educational policy implementer. |
| **3** | Respondent 3 | Senior officer at the Ministry of Environment in Ogun State Nigeria | Ministry of Environment in Ogun State, Nigeria | The Ministry aim at creating better living and conducive environment for the entire people of Ogun State. More specifically, Department of Planning, Research and Statistic of the Ministry is directly in charge of the environmental education, creation of environmental awareness and processing research findings. Other Departments within the Ministry is Department of Environmental Conservation & Resources, Department of Administration and Supplies, Department of Finance and Accounts and Department of Flood & Erosion Control. |
| **4** | Respondent 4 | Senior officer at the Ministry of LG in Ogun State Nigeria | Ministry of Local Government and Chieftaincy Affairs in Ogun State, Nigeria | Supervise and ensure good governance and spread of dividends of democracy to all the people at grassroots level (20 Local Government a Council Development Areas in the State) |

### **7.6.1** The need for focused environmental education

According to every interviewee, domesticating global knowledge on climate change (i.e., reducing signs into domestic language) is the cheapest way to achieve better environmental management and that it is also implementable if the government takes the proper actions in terms of funding, awareness, and involvement of local governments.

A number of responses from the interviewees detailed elements of concern including:

> *"It is a welcome approach if flood risk education could be included in the curriculum of general studies at the College of Education, Polytechnic and University levels of education and be made compulsory and perquisite for graduation. Students will have adequate residual knowledge transferable for achieving sustainable environmental protection" (Respondent 1).*

> *"A lot can be achieved on environmental sustainability through education, schooling and advocacy. When people are enlightened, know what to do and what not to do, everybody will dwell and live in a safe environment. Most of problem encountered is caused by people's unsustainable attitude towards environment. The people need to know how to take good care of environment and ensure that environmental pollution and degradation, blockage of drainages and building in water pathways are prevented etc". (Respondent 2)*

> *"I have never seen any book on climate change written on local language, we can communicate effectively more using mother tongue, people can relate with locals very well, we need to have a new autography on all the issues of climate change and international treaties." (Respondent 3)*

> *"Local government is closest to/and in educating people, local knowledge is needed to understand the language. Environmental*

*knowledge should be localised based on each of local government"* (*Respondent 4)*

According to the interviews, effective environmental management and preservation are severely hampered by poor communication and insufficient information. People have a habit of dumping rubbish into gutters, clogging them up, making it difficult for water to flow freely, and aggravating the poor condition of the drainage systems already in place. Current flood risk management strategies at the local government level are ineffective due to indiscriminate garbage dumping, people not following building codes, a significant knowledge and skill gap at the local level, and inadequate flood warning signals. Adelekan (2010, p. 433, 440, & 441), who linked flood episodes to anthropogenic drivers like a lack of preparedness and poor adaptive capacities, supports this research finding.

Speaking more on state of drainages in Ogun State in particular and Nigeria in general:

> *Most of tertiary drainages around neighbourhood are being clogged with debris and refuse because people feel they just want to get rid of their wastes by all means and in their bad habit dump refuse in drainages. We have a lot of siltation's in the drainage channels and they are not really flowing well." (Respondent 3)*

According to senior education officers, indiscriminate domestic garbage disposal and collection are caused by a lack of environmental education, awareness, communication, and information. This increases the risk of flooding in many places.

> *"If the people are well educated, they will not put wastes in water ways so as to block drainages. Government is now trying to create awareness and people are getting aware of the hazard that can be caused if they behave otherwise". (Respondent 1).*

> *"People have carefree attitude of dumping refuse indiscriminately either into drainages or places they should not put them so that later when it rained it will be washed into drainages and block them. "Wrong belief, such as when they throw wastes in drainages, water will wash them away, not knowing it will be deposited somewhere else*

*and as more and more are been deposited, it will get to a point that it will eventually block the drains". (Respondent 2).*

*"This is very important, even despite monthly sanitation exercise, people still put whatever they pack out of their homes on the shoulders of roads, dividers, junctions and sometimes it will block whole or part of the road making the entire community very dirty, and when it rains, some of the rubbishes are washed into the drainages." (Respondent 2).*

### **7.6.2** Existing flood risk education at local levels

Academic practises, programmes, and activities at the local government and community level, according to respondent 2, are more focused on advocacy, short courses, townhall meetings, leaflets, and television programming. Respondent 2 believes that integrating environmental education into the teacher education curriculum and adopting "General Studies" where all students are taught how to care for their environment will result in desirable and sustainable flood prevention conduct. There is currently no stand-alone course in Nigeria's existing/current general Goals and Philosophy of Education that covers climate change adaptation and flood catastrophe risk management. Respondent 2 believes that desirable habitual changes such as good environmental cleanliness, taking care of things that can jeopardise environmental safety, and combining people's efforts to reduce substances that can cause environmental degradation: pollution or environmental disaster will be better for all of us and help reduce flood risk in Nigeria.

Respondent 3 stated that the existing curriculum in Nigerian school does not cover climate change adaptation and flood catastrophe risk management.

*"At the school level learners are only educated, enlightened and sensitized about need to take care of their environment through relevant and related subjects like- Social Studies, Civics, Geography, History, Health Education etc.". (Respondent 2)*

*"Having a whole course/stand-alone course or as part of certain general courses on the climate change adaptation and the flood risk management injected into the teacher education curriculum/program*

> *which should be made compulsory for all teachers-in-training is a welcome idea because role of teachers in community is very important – teachers can actually through children reach entire community and it is also important for the teacher to be knowledgeable about environment, environmental disaster and how to prevent and manage it." (Respondent 2)*

The findings suggested that once prospective instructors are adequately educated on the subject matter, the goal is for it to be passed on to students and the broader community. Teachers are always viewed as people who educate the community and, by extension, the entire nation, which is why it is critical to incorporate environmental education in the teacher education curriculum.

> *"Best way climate and flood education could be imparted and inculcated into pupils/students in schools is by making it a point of duty to educate children about their environment and implication of certain unsustainable habits that impact negatively on environment and their prevention such as environmental pollution, degradation and hazards". (Respondent 2)*

> *"Nigeria is not like what operates in the advance countries, where they teach the core subject area and human relations. If you see any university doing that in this part of the world, maybe they just started very recently. Environmental hazard & disaster can be tackled by making environmental education a compulsory general course for all the student teachers under training. This part of world is not really into that aspect". (Respondent 1).*

A well-functioning system, an appropriate information and communication strategy, the development of a good framework for effective communication, and the inclusion of crucial information deeply embedded in the subject matter in a language (or languages) that the local population can understand, i.e., the mother tongue, are all required, according to respondent 2. According to him, upper-level officials only speak to one another and are not in touch with the average public.

The findings showed that there is a demand for greater public education, and that education cannot be provided for free since local governments need funding to carry out their agendas. Current flood risk management measures at the local government level are inefficient, which has led to an increase in flooding and its effects. This is due to a clear knowledge and skill gap at the local government level, which prevents them from knowing how to control floods or to issue flood warning signals. People don't understand the environment, so we need to raise awareness so that people understand why certain things should be done and why they shouldn't. According to those who participated in the interview, the government is making an effort to educate the public about the need of maintaining a clean environment by distributing messages through radio, television, and commercials. There is a need for further action in this area; we can never have enough of that intervention. The media will play a significant role in informing and reminding the public of the necessary information. According to the interviewees, if media is handled properly, it could be beneficial in spreading important information, communicating, and raising public awareness of climate change and flood hazards because the information will quickly reach a large audience.

> *"You don't just tell the people what you want them to hear, there is need to hear from them what they also needed most. It shouldn't be one way but a two-way communication channel to make it a bottom-up approach to addressing issues of climate change and the flood risk management" (Respondent 3).*

Respondent 3 argued that town hall meetings, motorised public address systems, and empathy could all be used to specifically target specific localities and raise awareness of climate change adaptation and flood risk management at the local level. The majority of literature should be written in the local tongues, some of it should be translated into visual forms, and local performers and artists should be used to connect with the audience because people trust and respect them. This will support and enhance effective communication. For instance, since people enjoy watching films, stories that relate to the subject matter could be developed along with them; viewers will become engrossed in the tales and ultimately understand the true message. Create scripts with imbedded storylines that reflect the truth, grab audiences' attention, and deliver a message. According to Respondent 4, the greatest way to gain awareness is through the "Headship" of each community, known in the local dialect as the "Baale" and the "Oloritun," so that they may communicate with/with locals in a language they can better comprehend.

The findings of this chapter are supported by Ikelegbe & Onwuemele (2012) who over 10-years ago noted, *"There is no doubt that low level[s] of environmental awareness in Nigeria could affect [an] individual's behaviour towards his environment. Poor environmental habit and behaviour in Nigeria citizenry calls for government attention".*

.

## **7.7** Summary

The results of this chapter showed that schools' (formal education's) influence on environmental education to raise students' awareness of issues related to climate change adaptation, disaster risk reduction, flood risk management, and environmental citizenship is minimal. The results of this study revealed that curriculum gaps, a lack of school administration support, a lack of time in the lesson plan for integrating environmental education content with other subject areas, and teachers' insufficiencies are the main issues preventing the teaching of environmental education in Nigerian schools. The national curriculum lacks sufficient environmental management content to address the growing demand for teaching on environmental concerns. Special attention must be given to increasing climate and water knowledge of community members and cultivating in them adaptable attitudes and behaviours in order to reduce the ongoing flood issues by incorporating environmental education into teacher education curricula, which will help raise awareness of the long-term negative effects of environmental degradation and unchecked development in Nigeria.

In order to close the knowledge gap, it is urgently necessary to create a new curriculum, hire skilled professionals, and regularly retrain current teachers.

This research proposes:

- Realising new objectives for environmental education in Nigeria that will equip the populace with the abilities, information, drive, and attitude needed to address a variety of environmental challenges and problems or act to enhance the environment;
- Designing a new, comprehensive environmental education curriculum that will be taught as a required, stand-alone course or subject in schools at all levels and be made a general study for all teachers-in-training is essential to the effective development of environmentally conscious people. This is a long-term and short-term plan that would allow Nigerians of future generations to have a strong foundation in environmental education;
- Organising in-service training for the practising teachers to enhance their knowledge of the basic concept of environmental education and ensure adequate knowledge transfer;
- Creating awareness through "Headship" of each community and through other mediums like the film industries will help to enhance information transfer/passage and minimise climate impact.
- The requirement for a suitable information and communication strategy in a language (s) that the local population can understand.
- A new environmental education strategy needs adequate funding and robust curriculum development by experts to ensure its adequate implementation and achievement of purpose.

# Chapter 8
# Discussion

*The purpose of this chapter is to review the findings from the case studies examined in chapter 4, 5, 6 and 7 and to provide an overall analysis of the research in this thesis, together with an appraisal of the conceptual framework used.*

## **8.1** Introduction

The purpose of this study is to establish a thorough understanding of the difficulties that pluvial flood risk poses to urban tropical African communities and identify potential chances for creating workable and practical solutions to lower flood risk. This is accomplished by using Ijebu-Ode, in South West Nigeria, as a case study to explore five main goals (section 1.5). The results showed that while floods are significant weather-related disasters that continue to result in significant economic and human losses around the world, their impact is found to be more catastrophic in low-income/developing nations like Nigeria. When dealing with (in)formal settlements, the precarity of the people at risk is taken into account in order to fully comprehend the dangers associated with pluvial floods within the context of tropical Africa and the research area. This study looked at flood issues from a risk perspective, taking into account hazard, exposure, and vulnerability. It also investigated how populations in Ijebu-Ode have historically responded to climate variability and change at the household, community, and governmental levels. For the purpose of developing effective pluvial flood risk mitigation and adaptation techniques in Ijebu-Ode, it is essential to have an understanding of physical science as well as public perception of risk from hazards and how people behave when faced with them. In this context, this study looks at how individuals in Ijebu-Ode's affected communities and surroundings perceive their danger of experiencing a pluvial flood, as well as local indicators of climate change and local observations of those changes.

## **8.2** Climate change, flood risk, and environmental change

Variations are clearly documented deviations from the established normal in rainfall on a temporal scale (e.g., annual, seasonal, monthly, daily, and decadal) (see Figures 4.9, 4.10, 4.11, 4.12, 4.13; see Tables 4.1, 4.2, 4.4, 4.5, and 4.6). Daily Extremes Rainfall Events (DEPEs) mostly occurred during rainy periods, with some indications of extreme common in June, July, and September (Figure 4.11, 4.12, 4.13), with the month of July having the highest probability of flooding (Figure 4.11, 4.12, 4.13), which corresponds to months that received extreme rainfall anomaly. The excessive wetness (June, July, and September) and dryness (December and January) months and seasons are established. July (first rainfall peak period) and September (second rainfall peak periods) are established (Figure 4.11). However, findings of this study do not support the findings of Ayansina et al. (2009) which stated seasonal and annual rainfall variability in some parts of Nigeria continues to be on the increase and an element of climate change and variability'. Surprisingly, a yearly average rainfall anomaly (Figure 4.10 and Table 4.1) as well as a monthly average rainfall anomaly (Figure 4.11 and Table 4.4) are established. There is a high potential of dangers, including flood risk and drought.

Changes in rainfall seasonality and replicability of rainfall regimes are established; the 'seasonal' is experienced every 5 years, whereas "rather seasonal with a shorter drier season" is determined to have occurred consistently during the last 16 years (2006-2018) (Table 4.2, 4.3). It is known that the rainy season is becoming longer (i.e., wetter in recent decades) than the dry season. The months of July and June have the highest probability of flood disaster and erosion, with large flood events occurring in July (Figures 4.11, 4.12 and Figures 5.5 a & b). Figure 4.13 and Table 4.6 show the decadal variability and anomaly of rainfall in Ijebu-Ode. These findings are corroborated by several studies on rainfall evolution in many areas of globe, which show that climate change translates into wetter conditions (Dore, 2005; Alexander et al., 2006) as well as into a rainfall increase and repetition of extreme events (perceptible in the recent decades 1991–2010) (WMO, 2012 & 2010; Todd et al., 2001; Christensen et al., 2007; Planton et al., 2005). On a longer time-scale, the findings suggested that Ijebu-Ode has observed changes and irregular patterns of wet conditions and intense climate occurrences. This has implications for existing extreme flood risk and vulnerability, as well as predicted climate and its repercussions. Climate variability must be taken seriously in order to limit its influence in a sustainable manner.

Overall, Ijebu-Ode has had considerable inter-annual rainfall variability across months and years, with no discernible or statistically significant patterns in annual rainfall variability. A distinct seasonal variability is created, with a dominant rainy season typified by two high rainfall peaks (i.e., July and September) and a short dry season (i.e., August) and extended dry season falling between and after each peak. Maximum daily rainfall rates are generally observed in July; however, there is no trend in extreme rainfall or apparent change in frequency of extreme events over study periods, implying that any change in flood occurrence is a function of non-climatic factors in Ijebu-Ode. Decadal variability was discovered, but no long-term trends or patterns were discovered, with more variability during the wet season. The seasonal rainfall pattern is obvious and well-established, which is critical for revamping Ijebu-Ode's seasonal flood control. The established temporal rainfall and air temperature fluctuation and change in Ijebu-Ode is an indicator of the existence of local climate change. Flooding is predicted to continue due to the environment's precarity and high susceptibility. The study establishes the actual harm to human health and life, the environment, and economic activity caused by the flood occurrence. Flood risk is seen as a realistic threat and a real source of flood hazard to the affected communities in Ijebu-Ode in this context. Climate change, according to the IPCC (2014), will increase current risks while creating new ones for natural and human systems. As a result, climate change is anticipated to increase flood danger dramatically and gradually over time due to a lack of key infrastructure and services or for individuals living in Ijebu-Ode's exposed locations.

The results demonstrate that minimum and maximum temperatures in Ijebu-Ode have been generally high with low variability since 1989 (Figures 4.14 and 4.16; Tables 4.7 and 4.10), including decadal fluctuation (Figures 4.15 and 4.17; Tables 4.9 and 4.12). This shows that warming occurred over the 30-year study period, primarily during dry seasons with minimal rainfall (Figures 4.15 & 4.17; Figure 4.13). One of most commonly used parameters that indicate climate change is surface temperature (Amadi et al., 2014). Audu (2012), pointed out that temperature is one of the climate variables mostly affected by global warming, climate variability and climate change. As the temperature is increasing, evapotranspiration is also increasing (Figure 4.19). Ashaolu and Iroye, (2018), opined that evapotranspiration is used in the assessment of water surplus and deficit among many other components of water balance. Surplus, recharge, utilisation, and deficiency are the four major soil moisture seasons recorded in Ijebu-Ode (see Section 4.7 and Figure 4.19). Both surplus season and recharging happened in months with extraordinarily heavy rainfall (Figures 4.11, 4.12), corresponding with months of flood disaster and large flood events (Section 5.2.3; Figure 5.5). Both utilisation and deficit seasons are times when there is a water deficit in the soil, which has serious repercussions for plant cover and may worsen flood risk (Section 4.7 and Figure 4.19).

According to (Perrajkta et al., 2010), seasonal moisture changes are mainly attributable to seasonal changes in evapotranspiration, leading to soil moisture depletion in summer and rise in winter and spring. The wet soil may itself be result of a number of above-average but not necessarily extreme precipitation events, or of enhanced snowmelt associated with the temperature anomalies in a given season (IPCC, 2012). According to Neid et al., (2016), floods are initiated by the overall high moisture content, whereas in summer the flood-initiating soil moisture patterns are diverse and less stable in time whilst flash flood could be attributable to high intensity of rainfall (Merz & Bloschl, 2003). The flood favouring hydro-meteorological patterns vary between seasons and can be linked to flood types (Neid et al., 2014). The study of Neid et al., (2013) highlights that flood magnitude and extent arise from different flood generation processes and concludes that soil moisture pattern as well as weather patterns are not only beneficial to inform on possible flood occurrence but also on the involved flood processes and resulting flood characteristics. Neid et al., (2016) opined that in summer the flood-initiating soil moisture patterns are diverse and less stable in time. However, as observed by Omotosho (1988) and Adejuwon and Odekunle (2006), the dry season in this situation does not imply completely rainless conditions as in period of November to February but rather a decline in both the frequency and amount of rainfall.

Climate change is one of most important issues of twenty-first century: increasing extremes of temperature, precipitation and evaporation have been identified in recent decades (Mc Michael et al., 2013). Precipitation and temperature are two of the most important variables in the field of climate sciences and hydrology frequently used to trace extent and magnitude of climate change and variability (IPCC, 2007). Variability indicates the degree of fluctuation and uncertainty of the climate change process (Pelletier and Turcotte, 1999). Several studies have been conducted in different part of the globe in relation to climatic variations (Eludoyin, 2009; Ayansina & Ogunbo, 2009; Hasanean, 2001; Turkes et al., 2002). The most studies have reported and projected possible increase in frequency and intensity of extreme weather events (IPCC 2007; Niang et al. 2014).

Variability in rainfall varies from one region to another (IPCC 2007). The intensity and frequency of heavy precipitation events have increased in the last 50 years and the spatial pattern of the rainfall is likely to change, with rise in the number and intensity of extreme rainfall events which adversely impact the natural resources on which majority of the population is dependent (Thakural et al., 2018). Some researchers have pointed out the increasing trends of extreme rainfall in more than 8326 weather stations worldwide (Westra et al., 2013). Setiawan (2014) and Dhari (2017) asserted one of impacts of climate change is the unpredictable shifting of seasons and rainfall patterns which caused flooding in one place, yet drought in another area.

Overall, the recent decade (2009-2018) saw the greatest mean minimum temperature in Ijebu-Ode, indicating that minimum temperatures are rising. The findings demonstrated decadal variability, with warming across the 30-year study period and an increase in average minimum temperatures of $0.34^{0}$C. Maximum temperatures are highest between January-April and November-December; February is the warmest, while August is the coldest, with little change and dispersion. The mean maximum temperature climbed within each decade, while the standard deviation decreased, and the monthly maximum temperature increased by $0.28^{0}$ degrees Celsius throughout the 30-year period (1989-2018). Findings show that when the temperature rises, so does evapotranspiration. This implies that as the temperature warms, the possibility for more extreme precipitation in Ijebu-Ode increases. Over Ijebu-Ode, four major soil moisture seasons (surplus, recharge, utilisation, and deficiency) were recorded. July-October is the surplus season; June is the recharge season; November-February and August are the utilisation seasons; and March-May is the deficit season. Seasonal soil moisture changes, primarily attributable to seasonal changes in evapotranspiration, cause soil moisture to rise in the rainy season and deplete in the dry season, affecting various runoff generation mechanisms as well as runoff generation in Ijebu-Ode city. During the rainy season in Ijebu-Ode, the collection of excess water in the insufficient surface water drainage system has a significant tendency for inundation. The findings of this study will help to inform potential flood occurrences, flood processes, and flood features in Ijebu-Ode. In predicting flood risk, soil moisture and weather patterns are crucial sources of information in Ijebu-Ode.

## **8.3** Addressing floods from a risk perspective

Understanding the risk perception of flood-affected communities in Ijebu-Ode was discovered to be crucial in understanding the causes of inhabitant vulnerability, potential impacts, and coping methods adopted at the household and community levels to live with the flood risk in my research. Floods are defined in my research by their effects on the society, economy, and environment, and they are addressed from a risk perspective, combining hazard, exposure, and vulnerability. In context of flood risk management, risk perception is currently acknowledged as essential aspect of the subjective risk analysis (Schanze, 2007). Mileti (1980) defined risk perception as “cognition or belief in seriousness of the threat of an environmental extreme as well as subjective probability of experiencing a damaging environmental extreme”. Risk perception is important in understanding and anticipating the public responses to hazards, and setting priorities, and effectively channelling resources and communicating risk information on side of lay persons and experts (Ittelson, 1978; Lave and Lave, 1991; Slovic et al., 1982; Samuels and Gouldby, 2009). An understanding of the risk perception of the citizens in flood-affected areas is important for policy and decision-making, and implementation of flood mitigation systems (Botzen et al., 2009; Bruen and Gebre, 2001; De Wit, 2008; Heitz et al., 2009; Kellens et al., 2011; Miceli et al., 2008; Tranet al., 2008). In my research, flood risk perception is key to sustainable flood risk management, result is usable for advancement of a robust mitigation approach to reduce exposure and susceptibility. Overall narratives is focused on exposure to climate change, sensitivity to climate change and adaptive capacity.

Initiator event coupled with exacerbating conditions (sections 5.2.5, 5.3.1, 5.3.3, 5.3.4, 5.3.5, 5.3.7 and Appendix P) increases the inhabitants' risk (s) of being exposed and vulnerable to perennial pluvial flooding (Appendix P and section 5.3.1, 5.3.3), and description of the state of flood risk posed on them and their surroundings (sections 5.3.1, 5.3.3, 5.3.4, 5.3.7) is clear, indicating the inhabitants have a measure of risk perception. IPCC (2014) relates recent impact from the climate change to extreme events such as floods and significant vulnerability and exposure of many human systems to current climate vulnerability. Endogenous capacities that households and communities are using to cope with lingering flood problems including government efforts are clear (section 5.2.4, 5.2.6, 5.3.4, 5.3.5, Figure 5.6). The source (i.e., the source of the danger), the pathway (i.e., the path the hazard takes to reach the receptor), the recipient (i.e., the entity that is injured), and the negative consequences (i.e., effects) are all clearly defined. Given all of the flood mechanisms and problems, hazard risk (s) is unavoidable in Ijebu-Ode. The socioeconomic, physical, and environmental systems are all vulnerable to climate change. Exposure refers to assets, activities, livelihoods and people in an area in which hazard events may occur (UN-ISDR 2004), whilst vulnerability refers to propensity of exposed elements to suffer adverse effects when impacted by hazard events (IPCC 2012). The more an element at risk is exposed to a hazard and the more it is susceptible to forces and impacts of hazard, more vulnerable it is (Messner and Meyer 2006).

Communities in Ijebu-Ode are facing flood threats and negative consequences, which has raised flood risk awareness among residents. The expression of their fears and concerns (visually presented - Figure 6.4) demonstrates the inhabitants' hazard/exposure; however, the lack of an emergency flood response plan, poor flood information, a lack of material and social resources to assist in reducing or moderating harms, and a lack of government attention clearly indicated the inhabitants' low preparedness, low adaptive capacity, and high vulnerability; however no discernible differences can be attributed to gender. The lack of information about vulnerability risk factors and how to deal remains insufficient and difficult for the residents. It is critical to take a focused strategy to channelling preparedness and post-disaster intervention in Ijebu-Ode City. To a considerable extent, developing suitable risk communication activities to address this gap will increase residents' capacities and encourage their resilience to manage and adapt to changing climate and associated dangers more effectively. Negative consequences cannot be established until level of vulnerability and exposure of the people are known (Alexander, 2000; White et al., 2005).

Causes of vulnerability of people in Ijebu-Ode are clearly established (section 5.2.5, 5.3.1, 5.3.3, 5.3.4, 5.3.5 and Appendix O; section 4.3.2). Nigerian cities are characterized by poor infrastructure which impacts liveability and sustainability (Echendu, 2020). While climate change has led to more rains than in the past which has increased the incidence of flooding, Nigeria’s flooding is mostly human induced and exacerbated by the human-nature interactions (Aderogba 2012). (Section 4.3.2):

> *Residents attributed incessant flooding to persistent rainfall; ineffective drainages; poor waste collection and disposal and poor town and urban planning.* (Section 4.3.2). *News Agency of Nigeria (NAN, 2015).*

*Local observation of exposure to climate change*

The study's findings revealed that the rainy season (>100mm) falls between April and October, with substantial variability in the middle quartile (Table 4.4), with maximum daily rainfall rates often reported in July. The average monthly rainfall recorded in July and June contributed 16.62% and 16.33% to the annual total, respectively (section 4.4.1.2). The months of July and June overlap with the months when the majority of respondents said that floods occur most frequently (Figure 5.5a), including the surplus and recharge seasons (Figure 4.19). Findings revealed that flood-triggering physical (pre-) event conditions are exacerbated by seasonal soil moisture changes, which are primarily due to seasonal changes in evapotranspiration, resulting in soil moisture increase in the rainy season and depletion in the dry season, affecting various runoff generation mechanisms as well as runoff generation in Ijebu-Ode city (Figure 4.19). The duration of flood impacts varied; with most respondents reporting being affected for up to 5 days (Figure 5.5c). The month with the most damaging flood episodes in Ijebu-Ode, on the other hand, is poorly characterised (Figure 5.5b). While not statistically significant, a pattern of increased daily maximum precipitation may corroborate perceptions of increased flooding in Ijebu-Ode (subsection 4.4.1.3 & Figure 4.12). Climate change which manifests in changing patterns of rainfall increases storms frequency and hence leads to flooding (Douglas et al., 2008). Adeaga, (2008) opined flood occurs as a result of combination of meteorological and hydrological extremes as well as activities of man on drainage basins. Climate and meteorological events, poor urban planning, urbanization and anthropogenic activities are identified as four key components of urban flooding (Nkwunonwo et al., (2016).

The risk perception conducted on 8 interviewees reveals main source of water to the surface:

> *Flooding is only experienced when the rain starts (see section 5.3.1, 5.3.2), flood is regularly experienced due to the heavy rainfall (see subsection 5.3.1, 5.3.2, 5.3.4), heavy rainfall for about 30 mins – 1hr*

*usually causes heavy floods, regular flooded roads and compounds (see section 5.3.1, 5.3.4, 5.3.5).*

Flood risk problems have become a yearly occurrence in Ijebu-Ode in recent years, particularly during rainy seasons (section 4.3). Flooding is the most common disaster in Nigeria (Echendu, 2020). This has been identified as a potential hazard, danger, and risk for residents of Ijebu-Ode (sections 5.3.1, 5.3.2, 5.3.3, 5.3.4, 5.3.5, 5.3.7, and 8.3). Majority of Nigeria's states are increasingly suffering from annual flooding during the rainy seasons caused by increased precipitation linked to climate change (Aja and Olaore 2014). Abiodun et al., (2011) asserted that flooding is clearly partly driven by climate-related factors, and projections are that urban flooding will worsen as Nigeria's climate is likely to see growing shifts in temperature, rainfall, storms and sea levels rise throughout the twenty-first century.

*"Residents of Ijebu-Ode and it's environ cried out that the whole area has been flooded due to persistent rainfall. Each time it rained, situation was very critical, as water flooded the roads leaving no space on either part of roads". (Daily Trust Newspaper, 10th August, 2008).*

*"Many areas in Ijebu-Ode, Ogun State were recently flooded after a sudden downpour or the first rain in the year which lasted for more than one hour devastating many areas like Talbot, Osinubi, Igbeba, Molipa, Ondo-Road etc. flooding and making roads impassable due to the level of water on them and damaging properties". (Tribune Newspaper on Monday February, 2012)*

Flooding is clearly only experienced when rain begins; flood events are typical during rainy seasons (i.e., seasonal in nature), and surface water drainage systems are in disrepair. Pluvial (rain-related) flooding is well established in Ijebu-Ode as a distinct sort of flooding that ravages the people of Ijebu-Ode and their surroundings. Fluvial, coastal and pluvial were acknowledged as a major cause of concern for rural areas and cities within the country (Bashir et al., 2012; Douglas et al., 2008). However, in recent year's pluvial flooding events (rainfall-related), have arguably been the more widespread (Oladujoye et al., 2012). Houston et al., (2011) describe 'pluvial' (rain-related) flood as less well known by the general public, and less well understood, which occur following short intense downpours that cannot be quickly enough evacuated by drainage system or infiltrated to ground. Pluvial floods often occur with little warning in areas not obviously prone to flooding – hence the term 'invisible hazard (Houston et al., 2011)'. Pluvial floods have recently been identified as the type most likely to increase in severity as a result of the climate change (Houston et al., 2011), and also most difficult to manage because they are difficult to predict and it is challenging to provide adequate warning times.

*'Informality' and poor physical planning*

According to the findings, settlement consists primarily of privately owned homes and residential land use (section 5.2.2; Figures 5.2a). Based on a walking survey of the region and responses to the questions, the majority of dwellings appear to be 'self-build,' which is generally practised by poorer households and middle-income citizens. The findings indicate that the government has little control over physical development in Ijebu-Ode towns, and as a result, people develop their land to the disadvantage of broader community. Slums are created in the lack of effective planning and governance, and urban informal settlements are made more vulnerable to all types of natural hazards. This refers to a residential area where the majority of residents merely live and where there are little job prospects. The planning implications of this is that, per capital income of people will be low, investors will not be attracted and the government presence will be minimal (Michael et el., 2013).

According to (UN-HABITAT, 2009a), informal urban development does not comply with one or another requirement. Abunyewa et al., (2017) define informal settlements as places built outside land-use scheme and without planning permission and are composed mainly of makeshift houses that deviate from the standard building regulations. Informal settlements are residential areas (UN-Habitat, 2015b; Brown, 2015) where:

- inhabitants often have no security of tenure for land or dwellings they inhabit – for example, they may squat or rent informally;
- neighbourhoods usually lack basic services and city infrastructures;
- housing may noy comply with planning and building regulations and is often situated in geographically and environmentally sensitive areas.

Doberstein & Heather (2013) suggests that increased vulnerability among residents in informal communities is a major facilitator to rising devastating impacts

*Poor surface water drainage systems*

Poor surface water drainage systems were highlighted as the major concern in Ijebu-Ode by the Governor of the state (Ogun State) Dapo Abiodun during one of his inspection tours to various portions of Ijebu-Ode town destroyed by flood in 2019 (section 4.3.2; Figure 5.5c). In Ijebu-Ode, it is obvious that an inadequate surface water drainage system is a primary exacerbating cause of pluvial floods (seasonal rainfall pattern, high inter-annual rainfall variability over months and years, and insufficient drainages). In Nigeria's cities, commonest cause of flooding after excessive rains is poor drainage systems that can't cope (Andrew and Nelson, 2017). Sam (2009) explain that the existing drains are often blocked and choked with refuse or silted up acting as obstruction to the free flow of water. Inadequate storm drains, dumping of refuse in drainage lines and construction of houses close to and even on natural water channels have been shown to be responsible in that order for the increasing cases of flood in the urban centres (Lanrewaju, 2012). Lack of provision for drainage is one of the main causes of urban flooding in Nigeria (Echendu, 2020). There is a pressing need to construct sufficient drainage systems to tackle flooding problem (Etuonovbe 2011). Pluvial floods can occur on a regular basis in some metropolitan locations, particularly in tropical climates, emptying swiftly but reoccurring frequently, perhaps on a daily basis, throughout the rainy season. In my analysis, the interaction of hazards and vulnerability translates into a significant catastrophe risk in Ijebu-Ode.

*Poor waste management*

Flood problems in Ijebu-Ode is summarized by participants and Environmental Officer in the Water Supply and Environmental Sanitation Department of the LGA (section 5.2.3; 5.2.4; 5.2.5; 5.3.1, 5.3.2; 5.3.4; 5.3.6, 5.3.7; 7.4.2; 7.4.3) and publications in National Dailies (section 4.3.2.1). Poor waste management is one of anthropogenic factors contributing to, and worsening already difficult flooding problem in Nigeria (Ojo and Adejugbagbe 2017). Behaviours of the dwellers to use the available storm drains as refuse areas (Pelling, 2003), exacerbate their vulnerability and impacts of environmental hazards. Poor attitude of Nigerians to waste disposal has been widely discussed in various studies (Eneji et al. 2016; Ojo and Adejugbagbe 2017; Olukanni, Adebayo, and Tenebe 2014; Sridhar and Ojediran 1983). Drainage blockages linked to poor sanitation practices are common in Nigeria's highly populated urban areas (Echendu, 2020), roadside dumping, canal dumping, and dumping in rains is commonly practiced among a large proportion of population. In most cities in Nigeria, solid waste is routinely dumped into the drainage channels where it creates resistance to flow of water in the channel and may become trapped at bridges and culverts, causing overspilling of flood waters (Egbinola et al., 2017, p. 551). This causes blockage and hence results in flooding during the rainy season (Onwuemele 2012). One of observable impacts of the rapidly growing urbanization and economic emerging cities is witnessed in the form of heaps of the municipal solid waste (MSW) in inappropriate location (Olukanmi and Akinyinka, 2012). According to Jha et al., (2012, p. 350) and Lamond et al., (2012), the inadequate solid waste management systems are a widespread contributor to flood risk in cities across Africa, Asia, and Latin America as the solid waste is frequently responsible for the blocking drainage channels and filling floodwater retention ponds

## **8.4** Society, Vulnerability and Precarity

The concept of precarity provides an ontological basis for understanding climate change adaptation. In this study, precarity was defined as a tool for, as well as a result of, unequal growth and class inequality, as well as a mode of governance. Climate change exposure, sensitivity, and resilience were used to assess the vulnerabilities of flood-prone communities in Ijebu-Ode. Because of the unequal distribution of flood relief channels/infrastructure facilities, some communities are more vulnerable than others, establishing environmental precarity and disproportionate climate impact in Ijebu-0de, according to the findings of this study.

The developed section of the Ijebu-Ode community, where the elites and wealthy live, has less experience with the perennial flood risk than others who are marginalised and denied access to basic amenities, city facilities, security, protection, and decent urban administration. The idea of precarity is useful in this research to understand how the most vulnerable persons/groups of people lack crucial materials and social resources to modify or minimise harm caused by marginalisation and social inequality caused by political influence and poor governance. According to the findings of this study, underprivileged populations are more vulnerable to climate change and have a worse ability to cope with and recover from damage.

> *"The poor economic situation (i.e., poverty) makes people to live in places prone to hazard and disasters". (Respondent 1).*

> *"The need for a shelter at expense of the environmental consequences is responsible for the population (people) poor habits towards environment. Most of people who have bad habits live within slum & poor communities with less developments, they just find themselves settling down within the floodplains, due to cheap land. People are so poor, and what they need is food rather than sanitation, they see sanitation as secondary on the list of priorities. Problem is more of poverty." (Respondent 3)*

> *"Some places where problems were not felt before are now experiencing erosion problems due to increase in the population which leads to erection of more unplanned and unapproved buildings by appropriate authority." (Respondent 2)*

Inadequate infrastructure, poor institutional capacity, weak government policy, a lack of cooperation and integration among Ministries, Departments, and Agencies, poor environmental laws and implementation, corruption, poor monitoring and supervision by personnel in charge of waste collection and disposal, a lack of official dumpsites, a nonchalant attitude on the part of the government, a lack of political will, and poor information and communication systems were among the findings. The findings suggested that present flood risk management measures at the local government level are ineffective in minimising flood impacts due to inadequate money, a lack of autonomy, a lack of leadership, and the government's inability to lead by example. According to the findings, no official academic practises, programmes, or activities are now in existence in Ijebu-Ode local government, and environmental policies are inadequately executed.

> *"If we don't plan properly, persistent and reoccurrence of flood hazard is inevitable. Poor planning is affecting poor waste disposal and*

*negatively promoting erection of unplanned building. There is need for good physical planning of Nigerian cities and towns." (Respondent 4)***.**

*"Current revenue giving to local government is too meagre compared to revenue that goes to state and federal. Poor funding is major problem militating against proper functioning at local government, severely affecting sensitization and creating adequate awareness. Academic programmes to reduce flood risk and quick recovery is currently not in place at local government level, however, the Ministry of Environment through the sanitation practice is doing a lot indirectly to create awareness on the flood management. Though things are improving but federal government needs to do more in terms of funding local governments". (Respondent 1, 2 & 4)*

*"Inadequate/poor attention is given to environmental management by the government. You will hardly see any state in Nigeria who allocated up to 2% of their monthly budget to environmental management, implying the value for safe environment is low. Environmental issues are not main issues of discussion during plenary sessions. People campaign for election right in dump/refuse on roads and nobody queries and show concerns. I have never seen a debate where environmental issues come up, this tells us our value as a people and nation." (Respondent 3)*

*"The current flood risk management approaches are inadequate at local government, not enough effort yet, hence needs for more concerted and to study environment properly and come up with more robust strategies to combat prevailing environmental issues" (Respondent 2)*

Kyenge (2013) sees Local Government as a political authority with right to exercise political power, which means, right to take the decisions which are binding on people and to obtain compliance. In effect, local government is a creation of central government and subordinate to central authority (Alao et al., 2016). The Local government in Nigeria are not optimally performing as is expected partly due to insufficient funds, corruption and lack of autonomy (Alao et al., 2016).

> *"The people are saying if certain things are not put in place, the flood will continue to wreak havoc, especially now that we are in rain season. We can still manage to control the flood if some of the challenges are given appropriate attention". (Respondent 1).*

The overall findings of Alao et al. (2016) from research conducted in EDE North and EDE South Local Governments in Osun State from 1999 to 2014 revealed influence of colonialism, Godfatherism, corruption, excessive societal pressure, poor financing and undue interference from state government, lack of political will by political class to make the local government work as major factors militating against good performance at the local government levels. it is imperative to note that for public good to have a significant effect on people especially at grassroots level, the invaluable role of local government is indispensable. In this sense, Local Government is expected to be closer to people by facilitating effective and efficient service delivery and encourage political participation and involvement of the locals in management of the affairs (Alao et al., 2016).

In this study, the term 'precarity' is preferred over 'vulnerability' because the former implies that such precarity is reinforced by a larger political economy. This study recognises the problem and risk of the existential dimension of precariousness in order to provide adequate perspectives, in-depth comprehension, and to provide the best capability to overcome vulnerability. The study identified vulnerability as the fundamental cause of flood disasters in Ijebu-Ode, requiring immediate and long-term care to establish sustainable DRR. While it is legitimate to argue that improving capacities will help to reducing disaster risk, as previously discussed and indicated, this does not imply that individuals will be less vulnerable. As a result, decreasing vulnerability is a large undertaking that necessitates substantial restructuring of social institutions to address the underlying causes of unequal income and power distribution within society that are beyond the control of people who are most vulnerable. This is acknowledged to be outside the scope of the study.

## **8.5** Adaptive capacity

This reveals households', communities', and governments' abilities to build resilience and adapt to climate hazards. The IPCC defines adaptation as an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects that mitigates harm or capitalises on beneficial opportunities, whereas adaptive capacity is a system's ability to adjust to climate change (including climate variability and extremes) to mitigate potential damages, capitalise on opportunities, or cope with consequences. While adaptation improves a population's coping ability and may guard against present and future climate instability, adaptive capacity includes both current coping ability and strategies that boost future coping ability.

*Low resilience*

Based on observation and results, empirical results from this study identified Ijebu-Ode as an "unplanned settlement" to a great extent (Chapter 5, section 5.2.2; Figure 5.2a) and (section 5.2.5, 5.3.4, 5.3.5, and Appendix O). It is established that socioeconomic facilities are distributed disproportionally. As a result, social vulnerability is most widespread and concentrated in hazard-prone locations, with social exclusion, marginalisation, and growing inadequacy of urban infrastructure, all of which are markers of low urban resilience. Low resilience has been established on the part of both the inhabitants and the LGA's environmental department (sections 5.3.6, 5.3.7). Many communities lack rescue and emergency flood response plans, which is a key indicator of insufficient readiness, including a lack of awareness of flood problems (section 5.2.2). The majority of flood victims do not receive government, family and friends, or charitable organisation attention or benefits to mitigate the effects and speed recovery (section 5.2.4). Lack of relevant legal and policy frameworks is another indication of low importance given to controlling and managing flooding in Nigeria at all three levels of federal, state and local governments and to date, little to no effort is shown by government to solve this problem (Cirella and Iyalomhe 2018; Okoye 2019).

External assistance, such as a relief programme, has a significant impact on a household’s capacity to respond to shock and timing of relief can play an important role in determining effectiveness of coping strategies (Corbett, 1988). External assistance, such as bulk relief at proper time and appropriate distribution, can play a pivotal role in determining effectiveness of coping strategies. Haque and Zaman (1993) and Paul (1997) have made a similar argument that the external support and assistance along with the social capital at community level significantly contribute to swift recovery from a flood. It is critical to secure aid from governmental and non-governmental groups during and after a flood to reduce the challenges that victims face—though complete elimination is not possible—and to assist them in regaining their pre-disaster status. External assistance combined with social capital can considerably improve people's capacity and minimise their vulnerability to floods.

According to the findings of this study, the majority of residents do not have access to flood insurance due to a lack of awareness, accessibility, low income, and weak governance (section 5.2.4). This means that Ijebu-Ode residents have a limited capacity for renewal and reorganisation, as well as a slower recovery from existing climate sensitivity and exposure. Hence, there is a vicious cycle of flooding, poverty and deprivation (Adelekan, 2010; Douglas et al., 2008). There is considerable evidence from several studies that disadvantaged groups indeed experience slower recoveries from adverse impacts of climate change (Verner, 2010; Carter, et al, 2007; Kraay and McKenzi, 2014; Ravallion and Jalan, 2001). Insurance can be effective adaptation strategy, with potential to reduce impact of climate change on insurance policy holders (Elum and Simonyan, 2016; Federal Ministry of Environment, 2014). The absence of social security and inability of urban poor in Nigeria to recover from impact of flooding leave them to be more vulnerable (Salami, von Meding, and Giggins 2017).

According to the findings of this study, institutional capacity is also insufficient; both senior officers at the Ministry of Environment and Local Government confirmed that the Local Emergency Management Agency (LEMA) exists, but it is not vibrant enough and does not function at the local level. In the same vein, senior officers stated that both the National Emergency Management Agency (NEMA) and the State Emergency Management Agency (SEMA) are not meeting their objectives, that they are simply responding and not being proactive, and that they are not functioning well overall. When there are calamities, they do come to people's aid, but the percentage of victims taken care of is quite little. For example, if someone lost One Hundred Million Naira (100m) and is given One Million Naira (1m), it means that the victim's rehabilitation will be slow and may not have a meaningful effect. So, there is a need to dig into it further and get as many individuals to benefit as possible in order to improve their recovery rate. This implies a lack of coordination and absence of relevant structures and agencies in the Ijebu-Ode Local Government Authority (ILGA).

> *"The local governments are doing absolutely nothing; all they do is wait for disaster to happen and commensurate with people." (Respondent 3)*

> *"To my best of knowledge, I have not seen their much positive impact to the extent I would have loved to see it. So, LEMA may need to do more, if they are in existence, it maybe they are sleeping or lack of focus to get to a level noticeable by all or lack of adequate funding, which I don't think Local Government have enough money". (Respondent 4)*

Senior officer for Local Government mentioned some of the challenges amongst others confronting the aforementioned Agencies to include:

> *"Poor funding, poor management of available funds, lack of focus, lack of technical expertise, poor physical planning and lack of passion etc. We need to plan ahead and be preventive, it is not after disaster you go about and be compensating victims, if we have good plan, hazard will reduce drastically". (Respondent 4)*

The government is not lacking research institutions and agencies with skills to design an FRM strategy, but there is still no effective national early warning system in place for floods at all levels of the federal, state, and local governments, while National Meteorological Agency (i.e., NIMET) provides the seasonal rainfall predictions, but communication remains a problem (FGN. 2013).

The senior officer for Local Government in his opinion unequivocally stated that:

> *"Practices and activities to reduce flood risk and quick recovery at the local government level and optimizing flood risk management at both local and state level are not duty of Ministry of Local Government but solely the duty of Ministry of Environment".*

The findings of this study support the view that integration and coordination are lacking among existing government bodies, which sometimes carry out flood control projects without liaison with one another, resulting in ineffective control projects (Oladokun and Proverbs 2016). Absence of a national Flood Risk Management (FRM) strategy or the comprehensive flood risk maps, for example, are indicators of lack of attention paid to the Nigeria's flooding problem (Oladokun and Proverbs 2016).

Adefisoye (2015, p. 37) in his study which investigated the "assessment of Nigeria's institutional capacity in disaster management" concluded that:

> *'The vision of Nigeria to become one of top twenty nations of the world in no distant time, would be a mirage if relevant stakeholders do not wake up to their responsibilities and rise to the occasion to ensure realization of a viable, dynamic, efficient and effective disaster management system. The study advocates imperative of mainstreaming disaster management education into curriculum of secondary schools, as well as proper funding as viable strategies of overcoming these challenges.'*

According to the findings of this study, low institutional capability and bad urban administration have contributed to the suffering of Ijebu-Ode residents as a result of the perennial flood threat. The inevitability of dangers and tragedies as truths offered a strong necessity to find solutions to the ongoing flood problems, so safeguarding the human species from extinction. The findings imply that the government does not care about the welfare of its citizens, especially poor preparedness. A senior environmental officer in the ILGA's Water Supply and Environmental Sanitation Department confirmed issues such as insufficient manpower and inadequate facilities (section 5.3.6).

According to Adefisoye, (2015, p. 38), government should take the lead in management of disasters by establishing institutions and agencies that would be saddled with responsibilities of mitigating, preparing for, responding to and recovery from the disaster occurrences. It is important that Ijebu-Ode Local Government Authority should take the lead in implementing of preventive actions both directly, by allocating efficiently public resources, and indirectly, by showing people how to protect themselves against disaster occurrences. Importance of local communities being aware of the flooding and actively participating in discussions and decisions which might increase their resilience and adaptability to hazard are highlighted in the roles of NOA, which re-orientates and keeps Nigerians informed about the ways of taking part in the issue that affects them (Nkwunonwo et al., 2015). Hence, urgent need to channel flood-risk awareness and preparedness through both the formal and informal education to strengthening the community-based adaptation (CBA). Community-based adaptation (CBA), helps to define solutions for managing the risks while considering climate change (Cutter et al., 2012).

Disaster management is the coordination and integration of all activities necessary to build, sustain, and improve the capability to prepare for, protect against, respond to, and recover from threatening or actual natural or human-induced disasters (NDMF, 2010:2). Resilience and building of resilience should therefore be seen as an integral part of the disaster risk reduction activities (USAID, 2011). Resilience of a community in respect of potential hazard events is determined by the degree to which community has the necessary resources and is capable of organising itself both prior to and during times of need (UNISDR, 2009). It is obvious that residents in Ijebu-Ode are extremely exposed and sensitive to flood risk; nevertheless, the adaptive capacity required to absorb climate stress, consequences, and recover after flood events is found to be inadequate, signifying an incapacity to "spring back from" a shock (sections 8.3 & 8.5). It is critical to lower the susceptibility and exposure levels of the people of Ijebu-Ode.

*Poor coping strategies*

The findings of this study revealed that residents at the household and community levels were pooling their resources to cope with the long-term repercussions of flood catastrophes, which proved useful. The coping techniques may be inextricably linked to the residents' previous experience with comparable situations, reflecting the interwoven character of capacities that integrate local knowledge, current skills, and available resources. The findings in (section 5.2.4) suggest that inhabitants focus primarily on clearing drainage channels in their localities to reduce flood risk; nonetheless, interviewees in flood-prone areas surveyed in Ijebu-Ode found the drainages inadequate (section 4.3.2). The findings revealed that residents, particularly during rainy seasons, consistently abuse drainages (section 4.3.2, 7.4.2 & 7.4.3), resulting in considerable flood risk and vulnerability in the city. Inadequate access to storm drains, as well as a lack of maintenance of available storm drains, along with poor waste management, lowers run-off water's ability to travel quickly (Abunyewa et al., 2017).

According to the findings of this study, there is a lack of access to and allocation of coping resources in Ijebu-Ode to meet immediate demands while also ensuring the long-term viability of assets and livelihoods. The coping capacity in Ijebu-Ode is mostly reactive strategies used in the immediate aftermath of flood events. According to findings, the aggregate of resources available to Ijebu-Ode residents to combat the negative consequences of flood hazards is grossly inadequate, and the practises used to deploy them are segmented. Ijebu-Ode residents have limited capacity only to cope with short-term hazard impacts and a severe lack of capacity to adapt to long-term hazard consequences. For decades, residents of Ijebu-Ode have used many traditional ways to cope with floods and shocks at the family and communal levels (sections 5.3.4 & 5.3.5). Traditional tactics have been found to offer a minimum good contribution to strengthening people's adaptability to a flood threat; nonetheless, this is insufficient. Participants made significant contributions to communicating their difficulties (Subsection 5.3.5). Every locality might have some established or traditional coping strategies, but type of response adopted by people and its effectiveness may vary over time (Corbett, 1988).

The findings of this study revealed that the informality of Ijebu-Ode settlement is a major source of separation between residents, relevant official mediums/agencies, and the government, and that this undermines any actions (relief and compensation) made during a disaster. For a long period, the Ijebu-Ode people have been marginalised, highly exposed, and less protected by formal institutions, such as those providing mitigation. It is apparent that rehabilitation for victims who cannot afford the expense of repairs, reconstruction, or relocation to recover from even moderately damaging effects in Ijebu-Ode may take longer than projected. In light of 'environmental precarity,' the findings suggested that Ijebu-Ode citizens' ability to acquire flood relief infrastructure help is dependent on power relations, social ties, and flood relief social arrangements that are beyond the grasp of the impoverished and marginalised community. Preparation, mitigation, and the capacity to flee are all lacking. The study's findings revealed that residents are completely reliant on current poor drainage systems, which are constantly exploited and mistreated by residents due to a lack of flood knowledge and awareness. This section focuses on the individual, community, and the ability of supporting mechanisms for the individual and community at large. The findings in this research are corroborated by submission of Oladokun and Proverbs, (2016) who said flooding has become a major hazard in Nigeria in recent years. Increased flood events coupled with lack of coping capacity and the high levels of vulnerability of people have continued to put many lives and properties at risk (Komolafe et al., 2015). The findings of this study revealed that reactive coping strategy's reaction (s) referred to as perpetual cycles of response to the impact of flood disasters failed and proved ineffective, indicating the necessity to build a proactive and long-term flood risk reduction and adaptation measure in Ijebu Ode.

*Poor urban governance*

The findings of this study suggested poor urban government in Ijebu-Ode (sections 5.3.5 and 5.3.6). Local Government Area lacks proper planning and management. The government's reaction was fragmented in some sections or parts of Ijebu-Ode, exacerbating the flood threat and making it difficult for already marginalised individuals to acquire access to necessary facilities and services, increasing the susceptibility of many communities to the impact of risks. The findings suggested that, due to a lack of political will, the most vulnerable people are frequently disregarded during flood disasters, increasing their exposure to climate hazards, susceptibility to damage caused by climate hazards, and ability to cope with and recover from harm. All of those interviewed said they have experienced flooding in the past or in the present. This was validated by a senior environmental officer in the Water Supply and Environmental Sanitation Department for Ijebu-Ode LGA, who stated flood risk is a long-standing issue affecting numerous communities, with certain places recording flood damage on a yearly basis (sections 5.3.2 and 5.3.3).

According to the findings, local governments have insufficient capacity in areas such as planning and regulatory control, financing, human and administrative capacity, and service delivery. A senior environmental officer at the ILGA Water Supply and Environmental Sanitation Department mentioned and confirmed a similar problem (section 5.3.6). Poor service levels, disruptions, and inadequate coverage are among the issues that undermine quality of life and diminish faith in local government (Jones et al., 2014a). According to Avis (2016), the effectiveness of municipal government depends on the locally available resources, skills, structures and management processes. Sorensen and Okata, (2011) opined that strong and capable local government is considered a key lever to ensuring inclusive and sustainable urban development, facilitating governance systems accountable and promoting balanced multi-stakeholders' involvement. The UN-Habitat (2016) comment that urban governance requires greater capacity at all levels of the government (local, state and national) and for all involved in process and note capacity building for urban governance must take into account institutional capacities, technical and professional skills of individuals and the local leadership skills.

## **8.6** Flood risk mitigation and management in Ijebu-Ode

This research focuses on pluvial (rain-related) floods (or surface water floods that occur when rainfall exceeds the capacity of surface water drainage systems). In light of the present environmental disaster management, socioeconomic, and institutional issues in Ijebu-Ode, high rainfall variability, high current climate sensibility/exposure, little adaptation capacity, and overall high vulnerability are major concerns. The findings revealed that residents' inadequate adaptation capacity has adversely harmed sustainable flood risk management in Ijebu-Ode. Due to the community's high pre-existing sensitivities and the unsustainable flood risk management (FRM) in Ijebu-Ode, the social system is highly susceptible to/and unable to cope with the adverse effects of climate change, including climate variability and the perennial flood hazard. The primary focus of disaster management has been on drainage infrastructure, which is insufficient for lowering flood risk, considering the size of the risk now and in the future. Flood mitigation, preparation, and recovery treatments are all in jeopardy, meaning that coping mechanisms are insufficient.

The implementation of one-time resilience measures or temporary measures to address Ijebu-Ode's high susceptibility poses a whole future tragedy. Lack of resilience and capacity to anticipate, cope with, and adapt to extremes and change are important causal factors of vulnerability (Cardona et al., 2012). The extreme and non-extreme weather and climate events also affect vulnerability to future extreme events, by modifying resilience, coping, and adaptive capacity of the communities, societies, or social-ecological systems affected by such events (Cardona et al., 2012). The poor governance and the high level of corruption have impacted economic efficiency of resilient measures and the effective allocation of funding. Fatile (2012) asserted the fact that Nigeria is still grappling with problems of bad governance goes to show the level of non-accountability and ever-present manifestation of crude corruption that is open, naked, undisguised and yet legally untameable because of the system.

This research has brought a valuable insight into the prevailing situation of local climate and disaster risk management in Ijebu-Ode. According to the findings of this study, individuals and their environments are vulnerable to flooding as a result of their vulnerability and sensitivity to local climate change, which manifests in heavy and prolonged rainfall, and hence flooding. Flooding in Ijebu-Ode is exacerbated by increased surface runoff water after rainfall, as well as inadequate drainage systems/illegal channelization of drainage channels, poor waste management, poor physical planning, a lack of flood awareness, a lack of environmental education, weak government policies and programmes, a lack of political will, regular flooding, unplanned and unregulated urban development, and a lack of government attention. Poor waste management is one of the anthropogenic factors contributing to, and worsening already difficult flooding problem in Nigeria (Ojo and Adejugbagbe 2017). Poor attitude of Nigerians to waste disposal has been widely discussed in various studies (Eneji et al. 2016; Ojo and Adejugbagbe 2017; Olukanni, Adebayo, and Tenebe 2014; Sridhar and Ojediran 1983). Echendu (2020) opined that drainage blockages linked to the poor sanitation practices are common in Nigeria's highly populated urban areas. The roadside dumping, canal dumping, and dumping in rains is commonly practiced among a large proportion of the population (Echendu, 2020). This causes blockage and results in flooding during rainy season (Onwuemele 2012).

Section 8.3 examine informality and urbanisation, physical planning practises, drainage systems, waste management, and urban administration. Ijebu-Ode, being the Local Government Headquarter and the headquarters of major government ministries, offices, and banks, attracts a significant level of rural-urban migration, population, and urbanisation. Informality has emerged as a result of a number of interconnected causes, including population increase, rural-urban migration, a shortage of cheap housing, poor urban governance, economic fragility, and marginalisation. The influx of people into such an appealing area without guided planning, population density increases, distorting existing poor physical planning systems, and mounting pressures on existing insufficient drainage and waste management systems, exposing inhabitants to high levels of vulnerability with very limited coping capacity.

According to the findings of this study, most residents have focused on drainage clearance, confirming drainage system deficiencies as a primary contributor increasing pluvial floods in Ijebu-Ode Local Government. Inadequate and poorly maintained drainage networks have been identified as a major contributory factor to the increased frequency of urban flooding in Nigeria (Dalil et al., 2015; Ocheri and Okele, 2012). Oladokun and Proverbs (2016) opined fragile and inadequate sewage systems become overburdened and collapse, refuse and solid waste management facilities become overstretched to extent that drainage networks get blocked and flooding becomes inevitable. For instance, several flood canals and drainages have turned into refuse dumps few years after commissioning (Nkwunonwo et al., 2015; Agboola et al., 2012; Kolawole et al., 2011; Adewole et al., 2014). Deducing from aforementioned, poor sustainable spatial planning and poor urban governance are the major driver of vulnerability in Ijebu-Ode. For example, urban planning in Nigeria is poor and this is compounded by numerous compliance problems; this poor planning is a primary cause of flooding being experienced in Nigeria. According to Omoboye and Festus (2014), Nigeria's flooding is inextricably linked to the poor urban development practices. Urban planning in Nigeria is poor and this is compounded by numerous compliance problems; this poor planning is a primary cause of the flooding being experienced in Nigeria (Echendu, 2020).

According to the findings of this study, poor collaboration among relevant institutions in flood governance, unclear responsibilities among different Agencies involved, influencing powers in governance, lack of political will, poor discretions and exclusion of participation of local stakeholders, unskilled personnel and poor innovative techniques, and a lack of funds have all contributed significantly to the impact of climate change and the vulnerability of inhabitants. Poor physical planning implementation in practise remains difficult due to uncertainties about future dangers and institutional relationships. The shortcomings and activities stated above point to the effects of present institutional and governance flaws, such as existing maladaptive policies, inert agencies, weak political conditions, and inadequate planning. The Nigeria's current planning laws are standard but their development and implementation are poorly controlled (Nnaemeka-Okeke 2016). Political interference in planning work, understaffing and a lack of working equipment are factors that negatively impact effective planning and the execution of duties by planners (Nnaemeka-Okeke 2016; Oluwaseyi 2019). Cardona et al., (2012) opined that the high vulnerability and exposure are generally outcome of skewed development processes, associated with the environmental mismanagement, demographic changes, rapid and unplanned urbanization in the hazardous areas, failed governance, and scarcity of livelihood options for poor.

Environmental intervention agencies and institutions often function under serious resource constraints, in most cases leading to limited response toward environmental complaints. Or where it occurs, the response suffers from inadequacy and or slowness (Jackson, 2013). Being unfamiliar with environmental education information, legislation and environmental impacts of human activities, most people in Nigeria are unlikely to show spontaneous efforts or demand for environmental protection and enhancement (Jackson, 2013). In Nigeria where poverty rate is on the increase the desire to satisfy basic social needs could very well override environmental consideration (Jackson, 2013). Two statements by the influential Brundtland Commission reflect most clearly relationship between poverty and environment thus:

> *‘’poverty is a major cause and effect of global environmental problems: many parts of world are caught in vicious downward spiral: poor people are forced to overuse environmental resources to survive from day to day, and the impoverishment of the environment further impoverishes them, making their survival difficult and uncertain’’ (WCED, 1987)*

Thus, level and pace of socio-economic development has significant implication and influence on political will and the efficacy with which institutional regime and developed and applied to environment protection and conservation (Sani, 1998)

## **8.7** Reflection on future flood risk education, Nigeria

To summarise, the policy implementers (sections 7.4 and 7.4.1) all believe that climate change is real and poses a major threat to people and the environment. Rainfall durations and intensities have increased, resulting in major runoffs and flooding in several parts of Nigeria (Enete IC, 2014). According to the findings of this study, pluvial (rain-related) flooding is a serious and prevalent environmental hazard affecting people's lives, properties, and the environment in Ijebu-Ode. We can infer from the findings of this study that inadequate information regarding the threat posed by floods increases communities' susceptibility (harm) to flooding and may be to blame for residents of Ijebu-Ode's lack of risk awareness and preparedness. Strongest replies acknowledged the value of education in raising awareness of flood risk. The result of this research indicated that reasons for inefficiency waste management in Nigeria were attributed to inadequate awareness. Consequently, the heaps of wastes are still placed along road divider for days with minimal efforts at getting rid of them.

> *The participants in this study had poor knowledge about flooding and the environment and weak perceptions of risks posed by flooding and climate change. This combined with the poor communication of risk is believed to exacerbate flooding issues and vulnerabilities in Nigerian cities and towns.*

Hence promoting incidences of floods and vulnerabilities in Nigerian cities and towns (Figures 7.1c & 7.1d; Appendix T and Appendix U). According to the findings, insufficient public understanding of proper waste management procedures, combined with institutional deficiencies, are primary drivers of unsustainable habits and poor waste generation and disposal practises in Nigeria. This study recognised that reducing people's vulnerability is a long-term challenge that necessitates social, economic, and political reforms that are beyond the power of local people who confront risks and disasters, as well as the research. However, policymakers recognised that educating people about climate change and flood risk will reduce vulnerability to flooding, and they noted that pupils/students' awareness on environmental issues and problems is currently poor and weak, and they are not receiving desired awareness, new patterns in value, habits, and capacity building capable of reducing flood risks. Good governance, effective institutional capacity (e.g., LEMA and NIMET), and local cooperation can help develop proactive response to domestic waste and flood risk management.

According to the findings of this study, enhancing people's environmental protection literacy will aid in attaining desired behavioural changes and long-term flood risk management (FRM) in Nigerian communities. Policymakers claim that having enough knowledge about climate change adaptation and flood disaster risk management (FRM) can assist raise awareness and instil protective practises in people. According to the findings, environmental education is not taught as a required topic in Nigerian schools. This flaw highlights many undergraduate students' lack of environmental awareness and responsibility (Jackson, 2013). As a result, a more organised and comprehensive plan must be established in order to strengthen the environmental element of the syllabus through the incorporation of ethics and values. As Nigeria's future decision-makers, undergraduates may help conserve the environment through policies and actions; consequently, environmental courses should be successfully integrated into the mainstream curriculum. According to the findings, the current Nigeria curriculum programme in several relevant courses such as geography, social studies, and civic education has less thorough and poorly explained themes on climate change and flood risk that are capable of appropriately fulfilling growing demand on environmental issues. Environmental education is regarded as a positive idea in the system, and if correctly implemented, will aid in the resolution of the majority of the nation's environmental issues. Policymakers believe that incorporating environmental education into teacher education programmes and developing a robust climate and flood risk education programme will help increase household awareness of the environmental implications of poor domestic waste management, improve flood knowledge, foster better environmental habits, and raise awareness of climate change and its effects on humans and the environment.

The poor perception of flooding among general public hinders flood risk reduction in Nigeria (Nkwunonwo, Whitworth and Baily, 2015). Jackson (2013), opined several factors account for the low public awareness and poor civic consciousness of environmental issues in Nigeria. Among them are the poor understanding and education on environmental issues and lack of information. Although they may feel vaguely uneasy, most people do not care unless directly affected by the hazards. Jackson (2013) furthermore noted there is a dearth of information on environmental problems in the country. Studies done are unavailable to public; and very little effort is undertaken to make easily available the full facts of our environment. This is because it involves sometimes costly measures and controversial political decisions (Adelagan, 2006). Poor perception of flooding among local communities is a major issue which underscores the current activities of NOA within Nigerian institutional framework (Ologunorisa & Adeyemo, 2005; Ajibade, McBean & Bezner-Kerr, 2013). Evidence base for flood impacts, risks, and mitigation efforts at the city level in Nigeria is limited, and much of information available is low quality, inconsistent, or outdated (Brian, 2021). There is no consistent set of statistics at a national or subnational level that can be used to compare impacts of flooding across cities, and reports that focus on particular flood events are often incomplete (Lamond, Adekola, Adelekan, Eze, & Ujoh, 2019, p. 2).

The government, through the Ministry of Education, has not given 'much' attention to 'problems' of environmental education. School administration rarely conducts seminars and workshops on environmental issues since they do not perceive the necessity or consider it an essential portion of their schedule of activities, thus it is not emphasised. Due to the lack of integration in existing curriculum and programmes, student teachers (would-be teachers) do not currently offer environmental education as an obligatory subject/general course. The majority of currently practising teachers in Nigeria can only impart climate change and flood risk education to the extent of their limited personal experiences, exposure, and sensitization, thus the need for formal in-service training to acquire sufficient content and pedagogical knowledge and skills on subject matter. With increasing complexity of the environmental issues, education in Nigeria should focus on instilling environmental responsibility and accountability, beginning from the primary, to secondary and tertiary level (Jackson, 2013). Jackson, (2013) asserted environmental education is an effective instrument for creating consciousness of ecological balance that the development need not necessarily degrade natural environment. Terungwa & Torkwase, (2013) posited need for science and technology to embrace the environmental education in Nigeria. It aims at creating a future society where people are aware of their civic responsibilities and are ready to play useful roles as producers and the citizen's conscious of their environmental impact (ICSE, 2000). Generally, these objectives if attained will produce the following output:

- Awareness and sensibility to the environment, its importance and challenges
- Knowledge and understanding of the environment and its challenges
- Values and attitude of concern for environment and motivation to improve and maintain environmental quality for the purpose of survival.
- Skills to identify and help resolve environment issues (usually survival issues)
- Participation in activities that lead to resolution of environmental problems

Overall, the high community's pre-existing sensitivities and low coping and adaptive capacity (i.e., human, institutional, and system) are established as the main factor that continued to expose human systems to current climate vulnerability and multiple stresses in Ijebu-Ode, implying mitigation measures should consider links between'human capital development' and climate change - increasing the inhabitants' capacities will help in reducing system sensitivity to climate change. Participants strongly advocated for incorporating climate change into educational planning, with schools serving as the primary source of knowledge and awareness, and students serving as the target audience. The main focus here is to increase the resilience of Ijebu-Ode residents to climate risk through education. Finally, environmental education and training are required to promote knowledge of the long-term negative climate impact, environmental deterioration, and unchecked development, as well as to stimulate behaviour change in residents to better appreciate, use, manage, and conserve the environment. As a result, boosting residents' climate and flood knowledge, skills, and resources will help to expand the capacity to which they can resort.

There is a need to develop a future society in which individuals are aware of their civic responsibilities as citizens and are concerned about the preservation of their environment. Environmental education should consider the entire environment - natural/man-made, ecological, political, economic, technological, social, legislative, cultural, and aesthetic, among other things - and be a constant, lifelong process both in and out of school. Building resilient infrastructures will aid in reducing exposure to climate risk by supplementing environmental education. Environmental specialists must design a solid flood risk curriculum and programmes, as well as offer appropriate funding, formulate a new educational policy (i.e., provide direction for educational activities), adequate planning, and proper implementation.

## **8.8** Contribution and novelty of this research

My research makes important contributions to knowledge, these are:

- There is currently a dearth of literature and research exploring flood risk in mixed formal-informal settlements, this thesis provides a significant contribution to this research gap.

- This research contributes significantly to knowledge by recognising environmental precarity throughout my research, and the value of using the term ''disaster'' in my thesis is multifaceted. Environmental hazards, social and human vulnerability, and development shortcomings reveal the vulnerability of Ijebu-Ode's vulnerable residents to disaster risk, allowing for the development of limitless socially responsive policy responses that are poorly acknowledged by existing researchers.

- This research emphasized the incorporation of behavioural dimensions (i.e., a society strategy that uses awareness and human-capital development to promote changes to individual or community attitudes, perceptions and behaviour) into actions that fosters a future flood-risk resilient population and society, which has to date received less attention in how it will adjust to climate risk adaptation.

- This research makes an important contribution to knowledge on how inclusion of environmental education into the National Curriculum in tropical African communities could generate opportunities with respect to flood-risk communication and enhance understanding of contemporary environmental challenges.

- This research makes an important contribution to knowledge on how injecting gender focused communication and perspective into the public policy formulation on flooding in tropical African communities could generate opportunities with respect to achieve effective flood disaster risk reduction and also fostering resilience, however, within the context of Ijebu-Ode, we find that the significance of gender and other socio-economic factors is dwarfed by the challenges presented by precarity.

- This study uncovers critical areas in geophysical processes, vulnerability risk factors and societal capacities in mixed formal-informal settlements that are poorly acknowledged by existing researcher.

## 8.9 Summary

A shift in the frequency of floods in Ijebu-Ode is likely due to non-climatic factors since there are no identifiable trends or patterns in the excessive rainfall or frequency of extreme occurrences across the research period. Ijebu-Ode may see rising floods as a result of the pattern of increasing daily maximum precipitation, even though this is not statistically significant. Rainfall changes on an annual and intra-annual scale have been identified over Ijebu-Ode. The annual rainfall regime in Ijebu-Ode has been reasonably stable over the past three decades (1989-2018), but it is prone to seasonal variations in precipitation. The minimum and maximum temperatures for the studied period (1989–

2018), generally demonstrated a rising tendency across the research period. The results showed that potential evapotranspiration (PET) and actual evapotranspiration (ET) are both rising as the temperature rises. The majority of the rainfall occurs between April and October (which corresponds to the observed and established rainy seasons in Ijebu-Ode), and rainfall in Nigeria and at Ijebu-Ode has a significant 'wet' seasonal distribution. The seasonal variations in evapotranspiration rate's effect on the soil moisture pattern will have an effect on the varied runoff generation processes and concentrations. This could then result in an excess of water accumulating in the drainage systems. Flooding in Ijebu-Ode is a result of both high rainfall that occurs during the rainy seasons and human activity that makes it worse.

A strong link is clearly established between source, pathway, receptor and consequences (Figures 1.9, 1.10 & 1.11). The pluvial (rain-related) flooding regarded as the 'invincible hazard' has also been convincingly demonstrated in Ijebu-Ode. Pluvial (rain-related) flooding is acknowledged as the most prevalent type of flooding in Ijebu-Ode because rainfall and a stressed urban drainage system are the main cause and pathway of flood events in the research location. In the past and more recently, flooding has been an issue for homes and communities, most notably during the rainy seasons. Both human activities and considerable rainfall that happens throughout the rainy seasons contribute to the flooding in Ijebu-Ode. In Ijebu-Ode, residents' susceptibility to urban pluvial (rain-related) flooding is proven. According to studies, pluvial flooding is a greater threat than fluvial and coastal floods combined. It is obvious that the people of Ijebu-Ode are regularly at danger of disaster and are made vulnerable by natural hazards, informality, marginalisation, and unequal distribution of flood relief resources, among other things. Vulnerability is seen as the root cause of flood disasters in Ijebu-Ode areas. Severity of impacts of extreme and non-extreme weather and climate events depends strongly on level of vulnerability and exposure to these events (Cardona et al., 2012). This research acknowledges the abilities and resources that individuals and groups (i.e., a larger "community") have available to them in coping with recurring risks and disasters in the past and present, as well as their contribution to local development. There is a great need for empowerment because the population's capacity for surviving in a harsh environment and their capacity to prevent, prepare for, cope with, and recover from disasters is very low. Respondents acknowledge the difficulties flooding causes for their community, but they also acknowledge that these difficulties are likely more than what they can personally handle and call for a larger regional strategy and solution. The results suggest that precarity, may be a critical challenge in Ijebu-Ode.

It is clear from studying flood risk in Ijebu-Ode that a variety of issues and worries are found. For instance, the potential ramifications of such a significant variation in estimated (in)formal housing raise intriguing questions about how such variations may affect risk perception, readiness, and behaviour.

'Unplanned community' is found to be a strong factor exacerbating the exposure to flood risk in Ijebu-Ode, which could be linked to the poor urban governance, low coping capacity, poor flood risk perception and low resilience for addressing climate change-related hazardous risk.

The high probability of occurrences of hazardous events and inhabitants' low capability to cope and adapt connotes a high risk and severe consequences for the inhabitant, assets and total environment and imply that social system of Ijebu-Ode is more susceptible to the flood risk impacts, therefore have an overall high vulnerability (Figures 1.10 & 1.11). The poor interaction between physical, social, and engineering factors has increased susceptibility of individuals, households and communities to impact of hazards in Ijebu-Ode. Identification of these factors provides basis for prioritisation of initiatives that will help contribute to flood risk reduction. Exploring measures that will prompt high level of flood risk awareness and formulation of policies needed to improve in flood resilience in overall is fundamentally crucial. Specifically, flood-risk education program focuses on the flood risk communication, improving the students' current climate literacy, water knowledge, strengthening their risk perception, encouraging positive attitudinal changes, develop the students' skills on flood disaster risk management and to train futures' flood-risk resilient population and society. Reduction of physical vulnerability of people is closely related to people's knowledge of flood risk and familiarity with the emergency response to incoming floods. Flood risk management seeks to reduce risk from flood events to people who are located in flood prone areas. As indicated in earlier sections/chapters, different level of risk occurs within exposed locations. Environmental education and infrastructural resilience will help to bridge the gap between reduction of flood risk vulnerabilities and climate change adaptation. Enhancing inhabitant capacities through human capital development (HCD)/improve capacity of human resources will help to manage flood risk and reduce vulnerability.

There is a curriculum gap, which hinders the school's role in raising students' knowledge of and awareness of school risk, as well as, by extension, the resilience of households and communities. The curriculum is at the centre of any educational process because it gives meaning to and transforms concepts, aims, goals, objectives, and expectations into concrete reality. There is a rising demand for flood risk perception knowledge, as it is critical for knowing how to establish effective flood risk management that is inclusive of all. Environmental education is a part of Sustainable Development Goals (SDGs), as a strategy for more effective environmental management has long been part of the global discourse on sustainability and have gained global agreement. Relentless efforts are required to address current environmental problems and steer Nigeria towards sustainable development. Since development and environment are intertwined, they must be integrated into educational activities to ensure the educational system produce environmentally responsible citizens to enhance sustainable development. It is argued that environmental education is relevant to all aspects of flood risk reduction and most realistic and easy to achieve than the identified exogenous factors. Vulnerability to climate change, capacity for adaptation and mitigation responses are underpinned and strongly influenced by sustainable livelihoods, behavioural and lifestyle choices whilst the social acceptability and/or effectiveness of climate policies are influenced by extent to which they incentivize (sections 8.3; 8.5 & 8.6).

With the use of Ijebu-Ode in South West Nigeria as a case study, this study was able to generate an in-depth understanding of the "challenges and potential solution(s) to pluvial flood risk in urban tropical African communities."

# Chapter 9

# CONCLUSION

***This chapter summarizes the thesis findings.***

The aim of this research was to develop an in-depth understanding of 'challenges and potential solution(s) to pluvial flood risk in urban tropical African communities, a case study using Ijebu-Ode, in Southwest Nigeria'. The prime objective of the research is to establish vulnerability of inhabitants to urban pluvial (rain-related) flooding (in Ijebu-Ode) and consider how flood impacts can be mitigated using non-structural measures. It examines the current meteorological and hydrological conditions in Ijebu-Ode to develop an understanding of the hazard and mechanisms responsible for flooding. It examines and identifies current vulnerability, existing flood mitigation measures and determines the extent of climate exposure and susceptibility of the local community. This research engaged with the local community to understand their concerns, aspirations and understanding of flood risk, but also mechanisms to overcome the risks deployed at the local, settlement scale, using local knowledge. Inhabitant (individual and community) capacities have proven invaluable in coping with past disasters, though recovery is hindered by poor infrastructural and governmental capacities. This research acknowledges and highlights the problem and dangers presented by the existential dimension of precariousness (socio-economic and political domains).

## 9.1. KEY SUMMARY

Rainfall pattern across Africa vary, with considerable uncertainties in extremes exhibited different scales of temporal and spatial variability. Flood risks in African cities have been largely exacerbated by anthropogenic influences. Africa one of the most vulnerable continents to climate change due to its low adaptive capacity. Ijebu-Ode city is a microcosm of many fast-growing urban areas such as, Istanbul, Cairo, Mumbai, Nepal, Caribbean, Latin America, Cape Town including many African urban areas etc., witnessing similar environmental issues, implying the flood issues are global phenomenon.

Singling out the driving forces and cau’salities that link climate variability and vulnerability is challenging, however, this research has tried to identify some of the driving forces with a major emphasis on environmental precarity. The precarity of individuals in dealing with disaster risk and climate change is a fundamental problem. For example, flood risk in Ijebu-Ode has been found to be exacerbated as a result of anthropogenic influence risks. Ijebu-Ode city inhabitants are currently experiencing increasing flood impacts and high vulnerability from identified climate change-related hazards due to high community exposure, high community sensitivity and flood impact and low adaptive capacity**.** The inhabitant’s poor preparedness for a disaster is potentially dangerous and increases their vulnerability, hence the urgent need for ‘human capital development’ to increase inhabitants’ adaptive capacity and foster the communities flood resilience.

A lack of sustainable reduction in flood risk and vulnerability in Ijebu-Ode could be attributable to the deliberate attempt by local and state governments to ignore the poor urban dwellers due to their informal/ ‘illegal’ status and poor risk knowledge, communication and inadequate data to demonstrate the extent of problem, including lack of relevant equipment and qualified personnel and pollical will. The socially marginalized inhabitants of Ijebu-Ode living in formal-informal settlements lack adequate town and urban planning, social security, urban governance and resilient infrastructures that will help reduce their exposure to pluvial flood risk, attributable to politically induced conditions. As a result, their experience of the flooding often involves material losses, greater damage to and destruction of homes, disruption of economic activities, damage road infrastructures, dirtiness of surroundings, loss of lives, displacement and homelessness, with impacted health, less protection and limited capacity to recover from recurring pluvial flooding, leaving them vulnerable and impoverished.

In spite of the inhabitant’s high vulnerability level and limited access to exogenous and structural factors, an aspect of response has engaged a wide range of endogenous capacities individually and collectively (though a passive prevention) geared towards reducing the risk and impact of disasters. Severe impacts on inhabitants of Ijebu-Ode city reflect the non-crucial role played by urban stakeholders in developing adaptation and mitigation strategies in ameliorating the flood hazard. Inhabitants of Ijebu-Ode are found to be coping with observed climate hazards in a detrimental manner that does not guarantee future adaptive and growth capacity, implying that critical disaster risks rest ahead in future. Inequality aggravates position of disadvantaged communities in Ijebu-Ode vis-à-vis climate change impact by increasing the inhabitant's exposure to climate hazards, susceptibility to damage caused by climate hazards, and decrease their ability to cope with and recover from the damage. Well-established areas within Ijebu-Ode communities with little threat of flooding for many decades are now increasingly at risk.

Understanding social impacts of flooding is important for decision makers in preparing for the future risks. Assessment of flood risk and climate change vulnerability helps to define the indicators and measures to improve resilience of Ijebu-Ode communities towards actual and expected climate risks.

It is clear the four domains of sustainability explored in this research:

i) socio-cultural domain (i.e., enhancement and improvement of lives of inhabitants);

ii) economic domain (i.e., finance);

iii) political domain (i.e., policy); and,

iv) ecosystem/environment domain (i.e., the good environmental plan which protect and restore critical natural ecosystems)

Have together exacerbated risk in Ijebu-Ode. This is an indicator of human-ecosystem dis-equilibrium and absence of a holistic approach and temporal processes that could lead to sustainability in the city.

There was an upward trend in rainfall and minimum and maximum temperatures over the course of the study period, but there were no discernible trends in annual rainfall, patterns of severe rainfall, or frequency of extreme occurrences, suggesting that any change in the frequency of floods in Ijebu-Ode was caused by non-climatic factors. Flooding is common and usually experienced during the raining seasons in Ijebu-Ode with heavy rainfall, poor drainage systems usually resulting in severe floods. When rain is very heavy, most of the drainage channels overflow thereby severely affecting the people. Recent floods in Ijebu-Ode have highlighted the threat that climate change presents to the people and communities; however, there is little evidence of any change in the frequency of intense precipitation events in Ijebu-Ode, as such changes in flood risk may be a function of changing landcover and use. The lack of waste infrastructure within the settlements means that waste is often placed into the public environment or streets, exacerbating the threat presented by flooding. No discernible difference is identified based on gender, suggesting the issues of flooding in Ijebu Ode are more complex and multifaceted that to be simply defined by gender alone. This study concludes that a better understanding of gender (in)equality in society to climate change impacts is crucial for effective policy responses, developing community capacities and critical for achieving a more comprehensive flood risk reduction, that builds on current communities and networks, however, it fails to identify particular differences in gender understanding or responses to pluvial flood risk in Ijebu-Ode, potentially reflecting wider deeper-routed complex issues.

Inhabitants of Ijebu-Ode have a poor knowledge flooding, with no clear source of flood information. Flood risk communication have not yet worked well as flood damage reduction tool as a result of limited opportunities and personal capacities. The school (i.e., formal education) have no yet to played vital role in flood risk management, however this is considered a key opportunity internationally in awareness improvement (e.g., Galliard, 2010). The curriculum and knowledge-gap of practising teachers and would-be-teachers (i.e., undergoing training in teacher training schools), has continued to impact negatively on teacher's responsibility to educate citizens about the hazards. Government is yet to make this a priority and provide necessary attention and focus in engaging formal education in risk communication. This research offers a long-term mitigation and adaptation measure to develop and enhance resilience of communities by increasing their pluvial flood risk awareness and preparedness through incorporation of environmental education - flood disaster risk education (i.e., resilience measures related to all activities that improves capacity building of human resources – information and education about the hazards which has implications for appropriate actions) into the education curriculum. Inclusion of environmental education in the national curriculum including the need for existing curriculum review and to include a compulsory element at all levels could help achieve desired behavioural change in society more widely and improve sustainable development. The transformative behavioural and a systematic change is required to achieve a sustainable flood risk management. However, this research acknowledges that further research is required to study operational and financial implications surrounding the new environmental education curriculum design. The complex interdisciplinary nature of the course would demand changes in current teacher education programmes and create challenges to the implementation and effectiveness of the programme due to current shortage of trained teachers in the field of study.

Both environmental education and infrastructural resilience will help to bridge the gap between the reduction of flood risk vulnerabilities and climate change adaptation. There is need for corporate interactions and collaborations among the prominent institutions, agencies, and departments in charge of environmental matters, protection, preservation and management. The results of this research unfold reliable feedback on meteorological and hydrological events condition and how the communities respond in the past to climate variability and change, which is applicable for governmental planning in water resources, climate adaptation, also flood prevention and its associated negative impacts. Therefore, this work is highly useful and thereby recommended for the Federal government of Nigeria.

# REFERENCES


**A**

Abagissa, J (2019): Informal Settlements in Addis Ababa: Extent, Challenges and Measures Taken. Jou of Pub Admin, Fin. and Law; Issue 15.

Abaje, I.B., Ogoh, A.O., Amos, B.B. & Abashiya, M. (2015): Climate change, flood disaster assessment and human security in Katsina State, Nigeria. American Journal of Human Ecology, 4(4), pp. 47–56.

Abam, T.S. 2006. Development Policy Framework for Erosion and Flood Control in Nigeria. *EARTHWATCH – Magazine for Environment and Development Experts in Nigeria* 5(1). 25-32.

Abatan, A.A., Osayomi, T., Akande, S.O., Abiodun, B.J. and Gutowski, W.J. (2018). Trends in mean and extreme temperatures over Ibadan, Southwest Nigeria. Theoretical and Applied Climatology, 131(3-4), 1261-1272.

Abayomi, F., Dedeke, G. A. (2006). Ethnozoological trade and practices among the Ijebu people of South-Western Nigeria and the impact on some mammalian species. Indilinga African Journal of Indigenous Knowledge Systems: Indigenous Knowledge and Community: Two Sides of the Same Coin, 5, 175-187.

Abatan, A.A., Abayomi, T., Akande, S.O., Abiodun, B.J. and Gutowski, W.J. (2018): 'Trends in mean and extreme temperatures over Ibadan, Southwest Nigeria', Theoretical and Applied Climatology, Vol. 131, Nos 3-4, pp. 1261-1272.

Abbas, F., Ahmed, A., Safeeq, M., Ali, S., Saleem, F., Hammed, H.M., Farhad, W (2014) Changes in precipitation extremes over arid to semiarid and subhumid Punjab, Pakistan. Appl. Climatol. m116: 671-6803

Abd' Razack., Nelson, Yusuf, J.A., Agbu, E.U., Jonathan, Z and Jonathan, Z (2013): An appraisal of solid waste generation and management in Jalingo City, Nigeria. J. Environ Earth Sci, Vol. 3 no. 9

AbdulGafar O.F (2015): Ijebu Ode's Ojude Oba Festival: Cultural and Spiritual Significance. Available at: https://journals.sagepub.com/doi/full/10.1177/2158244015574640. (Accessed on July 25,2019).

Abdullah F.A & Lalit. K (2017). An assessment of the impact of urbanization and land use changes in the fast-growing cities of Saudi Arabia. Jou. Of Geocart. Inter. Vol 34(1). Pp. 78-97.

Abdulhamid, O.S., & Chima, P (2016): Local government administration in Nigeria: the search for relevance. Commonwealth Journal of Local Governance. DOI: 10:5130/cjlg.v0i18.4850

Abdul-Rahman, T.A., & Adebanjo, R.A (2019): The Role of Community Leaders in Actualization of Community Road Development Project. *Sustainable development* 15 (2): 237-247

Abere, J.O and Opara, J.A. (2012) "Deforestation and Sustainable in the Tropics: Causes and Effects" Journal of Educational and Social Research, vol. 2, No.

Abimbola, A. (2011): Ife Origin Influence in the History of Ijebu People of South-Western Nigeria. *Africa Research Review*, 5(5), 13-24.

Abiodun B.J., Salami A.T., Tadros m., (2011). Climate Change Scenarios for Nigeria: understanding biophysical impacts. Climate Systems Analysis Group, Cape Town, for building Nigeria's response to climate change project, Ibadan, Nigeria. Nigerian Environmental Study/Action Team (NEST), Ibadan.

Abolade, O., Muili, A.B., and Ikotun, S.A (2013): "Impact of flood disaster in Agege Local Government area of Lagos State, Nigeria", International Journal of Development and Sustainability, Vol 2 No. 4, pp 2354-2367

Abraham, E.M., P. Drechsel and O. Cofie. (2002): "The Challenge of Urban Flood Control: The Case of Accra's Korle Lagoon."

Abraham, T. W. and Fonta, W. M. (2018): Climate change and financing adaptation by farmers in Northern Nigeria. Financial Innovation, 4(11) Abubakar, A.N., & Abubakar, T (2014): "Counting" The Cost of Policy Inconsistency in Nigeria: The Case of Privatization Policy. Public Policy and Administration Research V 3 (4).

Abunyewah, M., Gajendran, T., & Maund, K (2018): Profiling Informal Settlements for Disaster Risks. 7th International Conference on Building Resilience; Using scientific knowledge to inform policy and practice in disaster risk reduction, ICBR 2017, 27-29 November 2017, Bangkok, Thailand.

Action Aid, Climate change, urban flooding and the rights of the urban poor in Africa Key findings from six African cities. 2006, Actionaid.

Action Aid (2006): Climate change, urban flooding and the rights of the urban poor in Africa. A report by Action Aid International.

Adeaga, O. (2006). Multidecadal Variability of Rainfall and Water Resources in Nigeria. Fifth FRIEND World Conf., Havana, 2006.

Adeaga O. (2008): Flood Hazard Mapping and Risk Management in Parts of Lagos N.E., Department of Geography, Faculty of Environmental Sciences, University of Lagos, Akoka, Lagos, Nigeria.

Adeaga. O. (2008): "Adoption of Global Navigation Satellite System (GNSS) Technology in Flood Disaster Management and Response; A case study of Lagos Mega City". A paper delivered at International Symposium on GNSS.

Adebayo, W.A (2014): Environmental law and flood disaster in Nigeria: The imperative of legal control. Intn. Jou. of Educ. & Res. Vol 2 (7).

Adebo G, Ajewole O 2012. Gender and the urban environment: Analysis of willingness to pay for waste management disposal in Ekiti-State, Nigeria. American International Journal of Contemporary Research, 2(5): 228-236.

Adebote DA, Oniye SJ, Muhammed YA. Studies on mosquitoes breeding in rock pools in Inselbergs around Zaria, Northern Nigeria. J Vector Borne Dis. 2008;45(1):21–28.

Adedeji, O.H., Odufuwa, B.O. & Adebayo, O.H., (2012): Building capabilities for flood disaster and hazard preparedness and risk reduction in Nigeria: need for spatial planning and management. Journal of Sustainable Development in Africa, 14(1), pp. 45–58.

Adedokun, J.A (1978): West African Precipitation and Dominant Atmospheric Mechanisms. *Arch Meteo Geoph Biokl*. Seria A, 27:289-310

Adedoyin: J. A. (1989). Global-scale sea-surface temperature anomalies and rainfall characteristics in Northern Nigeria. International Journal of Climatology, 9: 131-144.

Adefisoye, T (2015): An Assessment of Nigeria's Institutional Capacity in Disaster Management. *Scientific Research Journal (SCIRJ)* 3, 37-48

Adefisan (2018): Climate Change Impact on Rainfall and Temperature Distributions Over West Africa From Three IPCC Scenarios. J Earth Sci Clim Change, Vol 9 (6). DOI; 10:4172/2157-7617.100476

Adefisoye, T (2015): An assessment of Nigeria's Institutional capacity in disaster management. Sci. Res. Rou. (SCIRJ), V III (1).

Adefolalu, D. O (1972): On the equivalent potential temperature of the tropical atmosphere and the "Little Dry Season" of West Africa. *Niger. Meteor. Mag.*, **2,** 15–40.

Adefolalu, D. O. (1986). Further aspects of Sahelian drought as evident from rainfall regime of Nigeria. *Journal Meteorology and Atmospheric Physics, 36*(3–4), 277–295.

Adefolalu, D.O. (1986). Rainfall Trends in Nigeria. Theor. Appl. Climatol. 37:205-219.

Adefolalu, D.O. 2010. Climate Change, Impact and Adaptation: Role of Seasonal Climate prediction. In: *Climate Change Impacts and Adaptation*: Developmental Issues. Nigerian Meteorological Society (2010) pp 53-87.

Adejobi O, Olorunnimbe R 2012. Challenges of waste management and climate change in Nigeria: Lagos State metropolis experience. African Journal of Scientific Research, 7(1): 346-362.

Adejuwon, S.A (1988): An assessment of the patterns of rainfall fluctuations between 1922 and 1985 in Nigeria. Unpublished PhD thesis, Obafemi Awolowo University, Ile-Ife.

Adejuwon, J.O., Balogun, E.E., Adejuwon, S.A (1990): On the Annual and Seasonal Patterns of Rainfall Fluctuations in Sub-Sahara West Africa. *International Journal of Climatology*, 10: 839-848

Adejuwon, S.A. (2004). Impact of climate variability and climate change on crop yield in Nigeria, Contributed paper to Stakeholders workshop on Assessment of Impact & Adaptation to Climate Change, pp. 2-8

Adejuwon, J.O., & Agundiminegha, Y.G. (2019). Impact of climate variability on cassava yield in the humid forest agroecological zone of Nigeria. *Journal of Applied Sciences and Environmental Management*, 23(5), 903-908

Adekola, O (2013): The Inconsistency of the Flood Narrative in Nigeria. International Relations. Available online: evr.info/2013/02/04/the-inconsistency-of-flood-narrative-in-nigeria/

Adekola, P.O., Allen, A.A and Akintunde, E.A. (2014). Environmental factors affecting infant mortality in Ibadan North LGA of Nigeria. *African journal of Social Sciences*, 4(4), 53-67.

Adekola, O., and Lamond, J (2018): "A Media Framing Analysis of Urban Flooding in Nigeria: Current Narratives and Implications for Policy." *Regional Environmental Change* 18 (4): 1145–1159. doi:10.1007/s10113-017-1253-y.

Adekoya, J. O (1979): Little Dry Season in West Africa. M.S. thesis, Dept. of Meteorology, The Florida State University, 158 pp.

Adelakun K. (2003). Information and communication technology: Implication for advancing environmental education in Nigeria. Environmental Watch. 1(1).

Adelagan, J. A. (2006). The History of Environmental Policy and Pollution of Water Sources in Nigeria (1960-2004): The Way Forward, Research Report N0. 72, Development Policy Center Ibadan. Archive.epa.gov/oswer/international/web/html/200610-education-fact-sheet.html

Adelekan, I.O., (2010): Vulnerability of poor urban coastal communities to flooding in Lagos, Nigeria. Environment and Urbanization, 22(2), pp. 433–450, 2010.http://dx.doi.org/10.1177/0956247810380141

Adelekan, I. O. (2011). Vulnerability assessment of an urban flood in Nigeria: Abeokuta flood 2007 Journal Natural Hazards. 56: 215-231.

Adelekan, I.O. [2012]. Qualitative Studies of Recent Floods and Sustainability Growth and Development of Cities and Towns in Nigeria Int. J. Basic Applied Sci., 1:200-216.

Adelekan I.O. (2013) Private sector investment decisions in building and construction: increasing, managing and transferring risks: case study of Lagos, Nigeria. Background paper prepared for the Global Assessment Report on Disaster Risk Reduction, 1-9, 2013. Available from: http://www.preventionweb.net/english/hyogo/gar/2013/en/bgdocs/Adelekan,%202012.pdf

Adelekan IO (2015a) Integrated global change research in West Africa: flood vulnerability studies. In: Werlen B (ed) Global sustainability: cultural perspectives and challenges for transdisciplinary integrated research. Springer, Zurich, pp 163–184

Adelekan, I. O. (2016): "Flood Risk Management in the Coastal City of Lagos, Nigeria." *Journal of Flood Risk Management* 9 (3): 255–264. doi:10.1111/jfr3.12179.

Adeleke, B.O. (1978). "Urban and Rural Development in Nigeria" Lagos, Nigeria. Heineman Press.

Adeleke, M.L., Al-Kenawy, D., Nasr-Allah, A.M., Murphy, S., El-Naggar, G.O., Dickson, M., (2018): Fish farmers' perceptions, impacts and adaptation on/of/to climate change in Africa (the case of Egypt and Nigeria). In: Theory and Practice of Climate Adaptation. Springer, Cham, pp. 269–295

Adeleye, A and R. Rustum, (2011). Lagos (Nigeria) flooding and influence of urban planning. J. Urban and Planning (ICE), 164 (3): 175-187. ISSN: 755-0793, E-ISSN-0807.

Adelore, O., & Majaro-Majesty, H (2008): Literacy teaching and peace building in multi-ethnic communities in Nigeria. Australian Journal of Adult Learning V 48 (1). PP 164 & 165

Adeloye AJ, Rustum R (2011) Lagos (Nigeria) flooding and influence of urban planning. Urban Design and Planning 164 (DP3): 175-187. 15

Adeloye, A. J., and R. Rustum. (2011): "Lagos (Nigeria) Flooding and Influence of Urban Planning." *Proceedings of the Institution of Civil Engineers-Urban Design and Planning* 164 (3): 175–187.

Adenekan, S (2003): Environmental News Reporting in Nigeria. The Critical Challenges in Soola, E.O (ed.). Communication for Development Purposes. Ibadan: Kraft Books Limited, P. 142-156Adeniyi, P. (2013): “Improving land sector governance in Nigeria- Implementation of the land governance assessment framework”. Synthesis Report, Lagos, Nigeria. http://siteresources.worldbank.org/INTLGA/Resources/LGAF_Nigeria_Final_Report -November2011.pdf .

Adenodi, R.A (2018): A centurial analysis of rainfall variability in Nigeria. Nig. Jou. of Tech. (NIJOTECH), Vol 37 (2) pp 543-547.

Adeoti, A., Olayide, O., & Coster, A. (2010). Flooding and welfare of Fisher’s household in Lagos State, Nigeria. Journal of Human Ecology, 32(3), 161-167.Adepitan, J.O., Falayi, E.O., Ogunsanwo, F.O (2017): Confirmation of Climate Change in Southwestern Nigeria through Analysis of Rainfall and Temperature Variations Over the Region. Con. Jou of Phy and Life Sci (CJPL) Vol. 5. No 1

Adeoye N.O., Ayanlade A. & Babatimehin O (2009): Climate change and menace of floods in Nigerian cities: socio-economic implications. Adv Nat and Appl Sci, 3, (3), 369– 377.

Adeniyi and Omole, (2015): Disaster risk management: An assessment of urban flood in Nigeria. Published by the Department of Geography and Envrionmental Management, Tai Solarin University of Education, Ijagun, Ijebu-Ode, Ogun State, Nigeria.Adeoti, A., Olayide, O., & Coster, A. (2010). Flooding and welfare of Fisher’s household in Lagos State, Nigeria. Journal of Human Ecology, 32(3), 161-167.

Aderogba, K.A (2012). Substantive causes and effects of Flood in South Western Nigeria and Sustainable Development of the Cities and Towns, Journal of Emerging Trends in Educational Research and Policy Studies (JETERAPS) 3 (4): 551-560.

Aderogba, K. A. (2012a). “Qualitative Studies of Recent Floods and Sustainable Growth and Development of Cities and Towns in Nigeria.” *International Journal of Academic Research in Economics and Management Sciences* 1 (3): 1. 1–25

Aderogba, K.A (2012b): Global warming and challenges of floods in Lagos metropolis, Nigeria. Academic Research International 2: 448-468

Aderogba, K.C., Martin, O.M., Oderinde, S., Afelumo, T (2012): Challenges of poor drainange systems and floods in Lagos Metropolis, Nigeria. International Joutnal of Social Science and Education 2: 412-427

Adesina AO. (2003). Legibility and the Nigerian urban environment: Experiences from Ilorin: In: Adekunle V, et al (Eds.) Proceedings of the conference on the challenges of environmental sustainability in a democratic governance, Environment and Behaviour Association of Nigeria. Lagos, Nigeria.

Adewole, A. O. (2012). Effects of overpopulation on economic development in Nigeria: A qualitative assessment. International Journal of Physical and Social Science. 2(5).

Adewole, I.F., Agbola, S.B. & Kasim, O.F., (2014): Building resilience to climate change impacts after the 2011 flood disaster at the University of Ibadan, Nigeria. Environment and Urbanization, 27(1), pp. 199–216.

Adeyemi O. Adenusi Rotimi D, Osunsanmi Temidayo O.B (2015). State of infrastructureprocurement in Lagos State, Nigeria: the PPP approach. Glob J Manag Bus Res 15:7-17. 10. 17406/GJMBR.

Adeyemi, O. (2012). "Corruption and Local Government Administration in Nigeria: A Discourse of Core Issues." European Journal of Sustainable Development, Vol.1, (2), 183-198.

Adeyemi, O.O (2019): Local Government Administration in Nigeria: A Historical Perspective. Journal of Public Administration and Governance ISSN 2161-7104 2019, Vol. 9, No. 2

Adger WN (1999): Social vulnerability to climate change and extremes in coastal Vietnam. World Dev 27(2):249–269

Adger, N., Brooks, N., Bentham, G., Agnew, M. and Eriksen, S. (2004): New indicators of vulnerability and adaptive capacity, Technical Report 7, Tyndall Centre for Climate Change Research.

Adigun, F., Abolade, O., and Yusuf, A. A.: Incidence of flood and its impacts: empirical evidence from Ajeromi-Ifeledun, Lagos State, Nigeria, *International Journal of Innovative Research and Science*, 2, 239–254, 2013.

Agamben, G (1998): *Homo Sacer: Sovereign Power and Bare Life*. Translated by Daniel Heller-Roazen. Stanford, CA: Stanford University Press.

Ageena I, Macdonald N., Morse A. (2014): Temporal and spatial variation of maximum and climatic temperature across Libya (1945-2009), *Theoretical and Applied Climatology,* 117: 549-563, DOI 10.1007/s00704-013-1012-z

Agba, M. S., Akwara, A. F. & Idu, A. Y. 2013. "Local Government and Social Service Delivery in Nigeria: A Content Analysis." Academic Journal of Interdisciplinary Studies, Vol. 2 (2), Agbola B.S., Ajayi O., Taiwo O.J. & Wahab B.W., (2012).'The August 2011 flood in Ibadan, Nigeria: Anthropogenic causes and consequences', International Journal of Disaster Risk Science 3, 207-217. https://doi.org/10.1007/s13753-012-0021-3

Agbonkhese, O., Yisa, G. L., Daudu P.I. Vol 3, No 10 (2013). Bad Drainage and its Effects on Road Pavement Conditions in Nigeria.

Agbonkhese, O., E. Agbonkhese, E. Aka, J. Joe-Abaya, M. Ocholi, & A.Adekunle .(2014): "Flood Menace in Nigeria: Impacts, Remedial and Management Strategies." *Civil and Environmental Research* 6 (4): 32–40.

Ahadzie, D. K. and D. G. Proverbs. (2011): "Emerging Issues in the Management of Floods in Ghana. *"International Journal of Safety and Security Engineering".* Vol.1, No. 2: 182-192.

Ahadzie, D.K., & Proverbs, D.D (2010): Flooding and Post Flooding Response Strategies in Ghana. *WIT Transactions on Ecological Environment*, 33: pp. 281-291

Ahadzie, D.K., Dinya, I., Dinya, R.D., Proverbs, D.G (2016): Flood Risk Perception, Coping and Management In Two Vulnerable Communities in Kumasi, Ghana. DOI: 10.2495/SAFE-V6-N3-538-549/009. Available Online: researchgate.net/publication/312635336_FLOOD_RISK_PERCEPTION_COPING_AND_MANAGEMENT_IN_TWO_VULNERABLE_COMMUNITIES_IN_KUMASI_GHANA.

Ahmed, F, V Moodley & R Sookrajh 2008. The Environmental Impacts of Beach Sport Tourism Events: A Case Study of the Mr Price Pro Surfing Event, Durban, South Africa. Africa Insight 383: 73-85.

Ahmed, I., Tang, D., Wang, T.F., Wang, M., Wagan, B (2015): Precipitation trends over time using Mann-Kendall and Spearman's rho tests in Swat river basin, Pakistan. Adv. Meteorol. 2015: Article ID 431860

Ahrens, C.D (2006): Meteorology Today: An Introduction to Weather, Climate and the Environment 8th Edition. Published by Brooks Cole. Canada.

Aiyelokun, O., and Odekoya. O (2016): Analysis of trend and variability of atmosphere in Ijebu-Ode, Southwest Nigeria. Inter. Res. Jou. of Agricul. Sci and Soil Sci, Vol 6 (2). Pp. 025-031

Aina, E. O., and S. A. Adejuwon. (1995): "Regional Climate Change: Implication on Energy Production in the Tropical Environment." In *Proceedings of the International Workshop on Global Change Impact on Energy Development*, edited by J. C. Umolu. Lagos, Nigeria: Damtech Nigeria Limited.

Aina, T. (1990): Petty landlords and poor tenants in a low-income settlement in Metropolitan Lagos, Nigeria, Amis, P. and Lloyd, P.C. (eds.), Housing Africa‟s Urban Poor, International African Institute, pp87-102.

Aina, D. A (2006). State and Local Government in Nigeria: The Changing Scene. From Native Administration, Divisional Administration to Council Managership and |Local Government" in Aborissade, O.and Aransi, I. O (2006) eds. Pp 279-303.

Aiyelokun, O., AND Odekoya, O (2016): Analysis of trend and variability of atmospheric temperature in Ijebu-Ode, Southwest Nigeria. Inter. Res. Jou. of Agricul. Sci. and Soil Sci. (ISSN: 2251 – 0044) Vol 6 (2). Pp. 025-031

Aja, G. N., and A. Y. Olaore. (2014): "The Impact of Flooding on the Social Determinants of Health in Nigeria: A Case for North-South Institutional Collaboration to Address Climate Issues." *Developing Country Studies* 4 (22): 6–12.

Ajaero, I., & Anorue, L. (2018). Newspaper framing and climate change mitigation in Nigeria and Ghana. African Population Studies, 32(2), 4228-4238. https://doi.org/10.11564/32-2-1195

Ajakaiye, D.O., & Adeleye, V.A (1999): Concepts, Measurement and Causes of Poverty. CBN Economic and Financial Review, Vol. 39 No.4

Ajao, I.O.; O.S. Obafemi, and T.O. Ewumi. (2011). Household sanitation and mortality rate in Nigeria: an expository analysis. Journal of Applied Sciences in Environmental Sanitation, 6(3): 333-342

Ajayi, O., Agbola, S.B., Olokesusi, B.F., Wahab, B., Taiwo, O.J., Gbadegesin, M., Taiwo, D.O., Kolawole, O., Muili, A., Adeola, M.A., Olutade, O.G., Shiji, F. & Abiola, N.A., (2012): Flood management in an urban setting: a case study of ibadan metropolis. Special Publication of the Nigerian Association of Hydrological Sciences, pp. 65–81.

Ajibade, I., McBean, G. & Bezner-Kerr, R., (2013): Urban flooding in Lagos, Nigeria parterns of vulnerability & resilience among women. Global Environment Change, 23(6), pp. 1714–1725.

Ajibade, I., Armah, F. A., Kuuire, V. Z., Luginaah, I., McBean, G., and Tenkorang, E. Y.: Assessing the bio-psychosocial correlates of flood impacts in coastal areas of Lagos, Nigeria, J. Environ. Plann. Man., 58, 445–463, doi: 10.1080/09640568.2013.861811, 2014

Ajibola M.O. Adewale B.A and Ijasan K.C (2012). Effects of Urbanization on Lagos Wetlands. Inter Jou of Bus. And Soc. Sci. Vol 3 (17).

Akande, A. et al., (2017). Geospatial Analysis of Extreme Weather Events in Nigeria (1985–2015) Using Self-Organizing Maps. Advances in Meteorology. https://doi.org/10.1155/2017/8576150

Akanni, O. and Bilesanmi, L. 2011. Flood: Lagos residents forced to relocate …. Drowning teenager rescued" in Vanguard: Towards a Better Life for the People. Lagos: Vanguard Media Limited. (Friday, July10), p. 20.

Aketoyon, I.S., Ogundele, F.O. and Soladoye, O. (2010). Characterization by Factor Analysis of Chemical Faces of Groundwater inthe Coastal Plain Sands Aquifer of Lagos, South Western Nigeria. Int'l J. of Academic Research. Vol. 2. No. 5, Sept., 2010.

Akinluyi ML, Adedokun A. (2014). Urbanization, environment and homelessness in the developing world: The sustainable housing development. Mediterranean Journal of Social Sciences. 5(2):261-271.

Akinsola, A.A., Ogunjobi, K.O (2014): Analysis of rainfall and temperature variability over Nigeria. Global Jou. of Human-Social Science: B Geography. Geo-Sciences, Environmental Disaster Management V 14 (3)

Akintola, E.O (1994): Flooding phenomenon, Ibadan Region. Ibadan: Rex Charles Publication, pp. 244-255

Akintola F.O., and G.O Ikwuyatum (2012). Issues in Sustainable Flood Management in Nigeria. *In Sustainable Environment Management in Nigeria,* edited by F.A Ivbijaro and F.O Akintola, 197-207. Ibadan: Book Builders.

Akintola, F.O., Ikwuyatum, G.O (2012): Issues in sustainable flood management in Nigeria in ivbijaro FA, Akintola FO Editors: Sustainable Environmental Management in Nigeria. Ibadan, Oxford University Publishers

Akinyemi, O., Ayeni, O.A., Faweya, O., Ibraheem, A.G (2013): Statistical Study of Annual and Monthly Rainfall Patterns in Ekiti State, Nigeria. Int. Jour of Pure and Appl. Sci and Technol, 15 (2), pp 1-7

Akinyemi, T. (1990): Stemming the Tide of Lagos Flood in: The Guradian, Friday, July 20, pp. 7

Akolokwu, S.A. (2012): *Overview of the flooding in Nigeria: A Situation Analysis*. Paper presented at the Ministry of Water Resources, Abuja. 10th December 2012.

Akpati, B (1996): Media Reporting of Environmental Population in Nigeria. A Critique Paper Presented at National Workshop on Environmental Reporting, Otta, Nigeria. P. 1-10

Akukwe, T.I (2014): *Determinants of Flooding in Port Harcourt Metropolis, Nigeria*. IOSR J. Humanit. Soc. Sci., 19 (2014), pp. 64-72

Akukwe, T.I., Ogbodo, C. (2015). Spatial Analysis of Vulnerability to Flooding in Port Harcourt Metropolis, Nigeria. Sage Open March 1, 2015. 5:2158244015575558, 1-19.

Akinyemi, T. (1990): Stemming the Tide of Lagos Flood in: The Guradian, Friday, July 20, pp. 7

Alao, D.O, Osakede, K.O., and Owolabi, T.Y (2015): Challenges of local government administration in Nigeria: lessons from comparative analysis. International Journal of Development and Economic Sustainability Vol.3, No.4, pp.61-79.

Alao. D.O., Ajike, C.A., & Ibrahim, M.N (2016): Environmental Factors and Local Gov Administration in Nigeria: A Study of EDE North & EDE South Local Gov, Osun State, Nigeria (199-2014). *Kuwait Chapter of Arabian Journal of Business and Management Review. Vol 5. No 7.*

Alabaster, "Waste Minimization Strategies for Developing Countries", SIEP/UNCHS, Ittigen Workshop UMP/SDC. Collaborative Program on Municipal Solid Waste in Low Incomes Countries, 1995.

Alayande, A. W. and Agunwamba, J. C. (2010). "The impacts of urbanization on Kaduna River flooding," *Journal of American Science*, 2010; 6(5) pp 28 – 35.

Alayande, W.A., Mohammed, G., Caleb, I. & Deimode, M.I., (2012): Assessment of urban flood disaster: a case study of 2011 Ibadan floods. Hydrology for Disaster Management: Special Publication of the Nigerian Association of Hydrological Sciences, pp. 13–23.

Alberti .M, Marzluff.M. J, Shulenberger. E, Bradley. G, Ryan .C, Zumbrunnen .C (2003). Integrating humans into ecology: Opportunities and challenges for studying urban ecosystems. AIBS Bulletin, 53 (12), pp. 1169-1179

Alayande, A. W. and Agunwamba, J. C. (2010). "The impacts of urbanization on Kaduna River flooding," *Journal of American Science*, 2010; 6(5) pp 28 – 35.

Alayande, W.A., Mohammed, G., Caleb, I. & Deimode, M.I., (2012): Assessment of urban flood disaster: a case study of 2011 Ibadan floods. Hydrology for Disaster Management: Special Publication of the Nigerian Association of Hydrological Sciences, pp. 13–23.

Alexander D (1993) Natural disasters. Kluwer Academic Publishers, London, p 650

Alexander, D., (2000). Confronting Catastrophe: New Perspectives on Natural Disasters. 1st Edn. Oxford University Press, New York, ISBN-10: 0195216962, pp: 282.

Alexander, L. V., and Co-authors, (2006): Global observed changes in daily climate extremes of temperature and precipitation. *J. Geophys. Res.*, 111

Alexander, M. A., Blade, I., Newman, M., Lanzante, J. R., Lau, N.-C., and Scott, J. D. (2002): The atmospheric bridge: the influence of ENSO teleconnections on air-sea interaction over the global oceans, J. Climate, 15(16), 2205–2231.

Alexander, M., (2005): 'Vulnerability to landslides. In T. Glade, M. Anderson and M. Crozier (eds.) Landslide Hazard and Risk. John Wiley & Sons Ltd., Chichester. pp. 175 – 198

Alexander, L.V., Zhang, X., Peterson, T.C et al., (2006): "Global observed changes in daily climate extremes of temperature and precipitation," Journal of Geophysical Research Atmospheres, vol. 111, no. 5, Article ID D05109, pp. 1–22, 2006.

Alfred O (2013): Flood in Kenya. Department of Meteorology, University of Nairobi, Nairobi Kenya (Chapter 21). AlfredOpere.pdf. Available at: erepository.uonbi.ac.uk

Ali AMS (2007) September 2004 flood event in South-western Bangladesh: a study of its nature, causes, human perception and adjustments to a new hazard. Nat Hazards 40:89–111

Ali, P.I.O. (2005). Flood damage assessment in Markurdi town, Unpublished M.Sc. Thesis, Department of Geography, Benue State University, Markurdi, Nigeria

Aliyu, B.N., & Adamu, M (2014): A Systematic Approach to Disaster Vulnerability Assessment in Kano Region, Nigeria. Jou. of Environ. V (1), No. 1, 15-20

Allan, R. P. & Soden, B. J. (2008): Atmospheric warming and the amplification of precipitation extremes. *Science* 321, 1481–1484.

Allen, M. R. & Ingram, W. J. (2002): Constraints on future changes in climate and the hydrologic cycle. *Nature* 419, 224–232.

Allen, J, W O'Toole, I McDonnel & R Harris 2002. Festival and Event Management (2nd ed). New York: John Wiley and Sons.

Allen, J., O'Toole W., McDonnel, I., & Harris R. (2002). Festival and special event management. Milton: Wiley.

Allo, N (2020): Disaggregating the Nigerian Postcode: A Step to Creating an Environment dor Geomarketting in Nigeria. GISRUK, 2010; Session 4 A. Geodemographics. Available online: https://www.researchgate.net/publication/275890750_Disaggregating_the_Nigerian_Postcode_A_Step_to_Creating_an_Environment_for_Geomarketing_in_Nigeria

Aluko, O. (2000). Development Control in Nigeria's new civil rule programme. Journal of the institute of Town planners (JNITP) 13, 78-88.

Aluko, B.T. and Amidu, A. (2006). "Urban Low-Income Settlements, Land Deregulation and Sustainable Development in Nigeria", Paper presented at the 5th FIG Regional

Conference, Promoting Land Administration and Good Governance, Accra, Ghana, March 8-11, 2006.

Aluko, O. (2011). Development control in Lagos State: an assessment of public compliance to space standards for urban renewal. *African Research Review,* 5(5), 169-184. Retrived from http://www.afrrevjo.com/php?/11ajol

Aluko, J. O (2006). Corruption in the Local Government System in Nigeria. Ibadan: Oluben Printers

Alvaro, C., Tingju, Z., Katrin, R.., Richard, S.J. & Claudia, R. (2009). Economy-wide impact of climate change on Agriculture in Sub-Saharan Africa, International food policy research Institute (IFPRI) discussion paper, No 00873, p. 1.

Amadi, S.O., Udo, S.O., and Ewona, I.O (2014): Trends and variation of monthly mean minimum and maximum temperature over Nigeria for the period 1950-2012. Int'l J Pure and Appl. Phys, 2 (4) 1-27.

Amadi, S.O. and Udo, S.O. (2015). Climate change in contemporary Nigeria: An empirical analysis of trends, impacts, challenges and coping strategies. IOSR Journal of Applied Physics, 7(2), 1-9. Amanchukwu, R. N. et al. (2015): Climate change education in Nigeria: The role of curriculum review. Education, 5(3): 71-79.

Amao, F.L (2012): Housing in informal settlements and urban upgrading in Ibadan, Nigeria. Developing Country Studies ISSN 2224-607X (Paper) ISSN 2225-0565 (Online) Vol 2 (10)

Amit, K.D. (2016). Drainage system highways. Term paper in transportation engineering. Lovely professional University, Puniab-India. https//www.scribed.com/doc/4/42527504/Drainage-System-in-Highways

Amujo, O.C., & Otubanjo, O (2012): The Saliency of Second Level Agenda – Setting Theory Effects of the Corporate Reputation of Business Organization in Nigeria. International Journal of Marketing Studies 4 (5).

Anabaraonye, B. et al. (2019): Educating farmers and fishermen in rural areas in Nigeria on climate change mitigation and adaptation for global sustainability. International Journal of 35 Scientific & Engineering Research, 10(4),1391-1398

Ande T (1994). Strategies for Domestic Refuse Storage and Collection, Sewage and Refuse Disposal and Environmental Sanitation in the Local Government Areas of Ogun State. Paper Presented at the Workshop on Healthy Physical Environment and Solid Waste Management in Ogun State, August 30-31

Andersson, T. D. & Lundberg, E. (2013). Commensurability and sustainability: Triple impact assessments of a tourism event. Tourism Management, 37, 99109. http://dx.doi.org/10.1016/j.tourman.2012.12.015.

Andjelkovic, I. (2001), International Hydrological Programme: Guidelines on Non-structural Measures in Urban Flood Management, UNESCO, Paris.

Andersson, E. (2006). Urban landscapes and sustainable cities. Ecology and Society 11 (1): retrieve 18th April, 2017 from 〈http://www.ecologyandsociety.org/vol11/iss1/art34〉

Anabaraonye, B. et al. (2019). Educating farmers and fishermen in rural areas in Nigeria on climate change mitigation and adaptation for global sustainability. International Journal of 35 Scientific & Engineering Research, 10(4),1391-1398

Andrew, S., and Nelson, O (2017): Why flooding in Nigeria is an increasingly serious problem. Available Online: theconversation.com.cdu.amproject.org.

Aniah, E.J (2001): The Role of secondary cities in regional economic development in Nigeria. Journal of environmental sciences 4(2), pp112-119.

Anusionwu, E., & Diejomoah (1981): "The structure of income inequality in Nigeria: A macro analysis". In: H. Bienen and V. Diejomoah, eds., The Political Economy of Income Distribution in Nigeria. New York: Holmes and Meier Publishers Inc.

Anyanwu, U.I., Agbede, R.I.S., Ajanusi, O.J & Umoh J.U. 1999. A Survey OF Culsiness (Mosquitoes) in a Northern Guinea Savannah town of Zaria, Kaduna State. Nig. J. Parasitol, 20:137-148.

Apata, T.G. (2006). Income and Livelihood Diversification among Farming Households in Crude-oil Polluted Areas of Ondo State, Nigeria. PhD. Thesis, Department of Agricultural Economics, University of Ibadan, Ibadan, Nigeria.

Apata, T.G. (2011). Effects of Global Climate Change on Nigerian Agriculture: An Empirical analysis, Central Bank of Nigeria (CBN), Journal of Applied Statistics, Vol 2 (1), pp. 31-50. 10

Apata TG, Samuel KD, Adeola AO (2009): Analysis of climate change perception and adaptation among Arable Food Crop Farmers in South Western Nigeria. Paper Presented at the conference of international association of agricultural economics, pp 2–9

Apata, T.G., Agboola, T.O., Kehinde, A.S.L., and Sanusi, R.A. (2011b). Economic Impacts of Climate Change on Nigerian Agriculture and Adaptation Strategies Response among Farming Households in Nigeria, Journal of Agricultural Science and Technology, Vol.

5, No.2 (Serial No. 33), pp. 203-214. ARAÚJO LE, MORAES NETO JM, SOUSA FAS (2009): Classificação da precipitação anual e da quadra chuvosa da bacia do rio paraíba utilizando índice de anomalia de chuva (IAC). Rev. Ambient. Água. 4(3): 93-110.

ARD Inc. (2002). Nigeria environmental analysis final report, under USAID contract No LAG-1-00-9900013-00. Biodiversity and sustainable forestry (BIOFOR) Indefinite Quantity Contract.

Arigbola, A. (2008). Improving usban land use and management in Nigeria. The Case of Akure. Theoretical and Empherical Researches in Urban Management, Year 3, Number 7.

Armitage, D. (2005): Adaptive Capacity and Community-Based Natural Resource Management. Environmental Management, 35 (6): 703-715.

Arrese. C. (2001). Malaria: Its Human Impact, Challenges, and Control Strategieds in Nigeria. Fall 2001; Volume 2, Number 2. Retrieved from; https://www.hcs.harvard.edu/~ephic/currentissue/Fall2001/carrington.html

Arthurton R (1998): Marine-related physical natural hazards affecting coastal megacities of the Asia-Pacific region-awareness and mitigation. Ocean Coast Manage 40:65–85.

Ary, D., Jacobs, L.C., Sorensen, I., Christine, K. & Walker, D. (2013): Introduction to Research in Education. 9th ed. Cengage Learning.

Ashaolu, E.D., & Iroye, K.A (2018): Rainfall and potential evapotranspiration patterns and their effects on climatic water balance in the Western Lithoral Hydrological Zone of Nigeria. RUHUNA Jou. of Sci. Vol 9 (2): 92-116

Ashengrau, A., Seage. G.R., III (2008) Essentials of epidemiology in public health. U.K. Jones and Bartlett Publishers, Inc. Available at http://books.google.co.tz/books?id=bp86bTK1D38C&pg=PA34&dq in June, 03, 2013.

Ashley, R., Blanksby, J., Chapman, J., & Zhou, J., (2007): Towards integrated approaches to reduce flood risk in urban areas. Advances in Urban Flood Management, pp. 415-432, 2007

Ashley R.M., Blanksby J., Chapman J. & Zhou J (2007): “Towards integrated approaches to increase resilience and robustness for the prevention and mitigation of flood risk in urban areas”. In: R. Ashley, S. Garvin, E. Pasche, A. Vassilopoulos & C. Zevenbergen, eds. Advances in urban flood management. London: Taylor and Francis, 2007, ISBN: 978 0 415 43662 5.

Ashley, S. T., and W. S. Ashley. 2008. Flood Fatalities in the United States. Journal of Applied Meteorology and Climatology 47 (3): 805– 18.

Asimakopoulos DN, Assimakopoulos VD, Chrisomallidou N, Klitsikas N, Mangold D, Michel P, Santamouris M, Tsangrassoulis A (2001). Energy and Climate in the Urban Built Environment, M. Santamouris (Ed.) London, James and James Publication.

Assembly of People's Deputies, "Act N" 005/97/ADP on Environmental Code in Burkinafaso." French, 1997

Assessment of Nigeria Agricultural Policy (2005). Agriculture in Nigeria: Identifying Opportunities for Increased Commercialization and Investment, IITA press, IITA Ibadan.

Association of British Insurers (2005): The social value of general insurance. Association of British Insurers, London

Asmusson, E.M (1985): El Nino and Variations in Climate. *American Scientist*, 73: 168-177

Asoegwu, R, N (20098): Enforcing Environmental Laws and Regulations: Levels of Responsibilities. Jou of Envr Mgt. and Safety, 26-31

Asumadu et al (2015): Impact analysis of flood in Accra, Ghana. Published in Journal of applied science research, October 2015.https://www.researchgate.net/publication/282662976

Asumadu-sarkodie, S., Owusu, P.A., and Rufangura, P. (2015): "Impact Analysis of Flood in Accra, Ghana."Vol.6, No. 9: 53-78.

Attiah, A (1999): Planning for Sustainable Tourism Development: An Investigation into Implementing Tourism Policy In the North West Coast Region of Egypt (PhD). University of London, London.

Atta-ur-Rahman (2003) Effectiveness of flood hazard reduction policies: a case study of Kabul-Swat floodplain, Peshawar Vale. An unpublished M. Phil thesis submitted to the Department of Geography, Urban and Regional Planning, University of Peshawar, Pakistan.

Atufu, C., & Holt, C.P (2018): Evaluating the impacts of flooding on the residents of Lagos, Nigeria. Urban Water System & Floods II. WIT Transaction on The Built Environment, Vol 184

Audu, E.B (2012): An Analytical View of Temperature in Lokoja, Kogi State Nigeria. Int'l. J. Sci. Tech, 2(2): 856-859

Auyero J (2012) Patients of the State. The Politics of Waiting in Argentina. Durham and London: Duke University Press.

Avis, W.R. (2016): Urban Governance (Topic Guide). Birmingham, UK: GSDRC, University of Birmingham

Awa, O., & Akinkenwa, G (Sunday Magazine, 18 July, 2021): A nation in search of lasting solution to perennial flooding. Available online: guardian.ng/Saturday-magazine/cover/a-nation-in-search-0f-lasting-solution-to-perrenial-flooding/

Awe, O. O. (2009). Population, familyplanning and HIV/AIDS in Sub-saharan Africa. African Journal of Sociology, psychology and Anthropology in practice. 1(3); 134-144

Awofeso, Pelu (2010): One Out of Every Two Nigerians Now Lives in a City: There Are Many Problems but Just One Solution. World Policy Journal, 27, 4, 67-73.

Awojobi, O.N., & TETTEH, J (2017): The Impacts of Climate Change in Africa: A Review of the Scientific Literature Jou of Inter Acad Res for MultDiscp. Impact Factor 4; 483, ISSN: 2320-5083, V 5 (11).

Awosusi OO, Jegede AO. (2013). Challenges of sustainability and urban development: A case of Ado-Ekiti, Ekiti State, Nigeria. International Education Research. 1(1):22-29.

Awuh M.E, Japhets P.O, Officha M.C, Okolie A.O, Enete I.C (2019): A correlation Analysis of the Relationship between Land Use and Land Cover/Land Surface Temperature in Abuja Municipal, FCT, Nigeria. JGIS Vol 11(1) pp. 44-55.

Awuor, C.B, Orindi, V.A, and Adwera, A.O (2008): "Climate change and coastal cities: the case of Mombasa, Kenya," Environment and Urbanization, vol. 20, no. 1, pp. 231–242.

Ayanda, O.I (2009) Relative Abundance of Adult Female Anopheles Mosquitoes in Ugi, Nasarawa State. Journal of Parasitology and Vector Biology 1 (1) 004-009.

Aiyelokun, O., & Odekoya, O (2016): Analysis of trend and variability of atmospheric temperature in Ijebu-Ode, Southwest Nigeria. African Journal of Geo-Science Research, 4 (2): 09-12

Aiyelokun, O., and Odekoya. O (2016): Analysis of trend and variability of atmosphere in Ijebu-Ode, Southwest Nigeria. Inter. Res. Jou. of Agricul. Sci and Soil Sci, Vol 6 (2). Pp. 025-031

Ay Lett, A (2015): Institutionalizing the Urban Governance of Climate Change Adaptation: Results of an International Survey. *Urban Climb, 14*, 4-16

Ayandele, E. A. (1992). The Ijebus of the Yorubaland, 1850-1950: Politics, economy and society. Ibadan, Nigeria: Heinemann Educational Books.

Ayanlade, A., Odekunle, T.O., Orinmogunje, O.I and Adeoye, N.O (2009): Inter-Annual Climate Variability and Crop Yields Anomalies in Middle Belt of Nigeria. Advance in Natural and Applied Sciences, 3 (3): 452-465

Ayanlade, A. et al. (2017). Comparing smallholder farmers' perception of climate change with meteorological data: A case study from southwestern Nigeria. Weather and Climate Extremes 15, 24–33Ayansina, A; Ogunbo, S (2009). GIS Approach in Assessing Seasonal Rainfall Variability in Guinea Savanna Part of Nigeria. *7th FIG Regional Conference, Vietnam.* 164

Ayinde, O.E., Ajewole, O.O., Ogunlade, I., and Adewumi, M.O. (2010). Empirical analysis of agricultural production and climate change: A case study of Nigeria, Journal of Sustainable Development in Africa, 12 (6), pp. 275-283.

Ayoade, J. O. (1970): "The Seasonal Incidence of Rainfall in Nigeria." *Weather* 25: 414–18.

Ayoade J.O (1973): "Trends and Periodicities in Annual Rainfall in Nigeria." *Nigeria Geography Journal* 16 (2): 167–76.

Ayoade, J.O and Akinlola, F.O. (1980) "Public Perception of Flood Hazard in Two Nigeria Cities "Environmental Integration Pergamon Press. Volume 4, no, "pp. 8-10.

Ayoade J.O. & Akintola F.O (1980): Public perception of flood hazard in two Nigerian cities. *Environ Int*, **4**, 277– 280.

Ayoade, J.O. (1988). Tropical Hydrology and Water Resources, Macmillan Publisher, Ibadan.

Ayoade, J.O (1988): Introduction of Climatology for the Tropics. Ibadan: Abi Print and Pak Publishers

Ayres, L (2007b): Qualitative research proposals – part II: conceptual models and methodological options. *J. Wound. Ostomy. Continence Nurs*. 34: 131-133

**B**

Babatunde, S.A., Owolabi, A., Olalekan, J.T., Bolanle, W.W (2012): The August 2011 Flood in Ibadan, Nigeria: Anthropogenic Causes and Consequences. Int. J. Disaster Risk Sci, 3 (4); 207-217

Babalola, A., Ishaku, H.T., Busu, I., and Rafee, M.M (2010): The practice and challenges of solid waste management in Damaturu Yobe State.

Babbie E. (1992): The Practice of Social Research. 6th edn. Belmont: Wadsworth Publishing

Babanyara J.O., and Dauda K.T (2009). Evaluation of Solid Waste Generation, Categories and Disposal options in Developing Countries. A Case Study of Nigeria, J. Appl. Sci. Environ. Manage. Vol. 13 (3) 83-88.

Babanyara y.y, Usman H.A, Saleh U.F (2010). An overview of urban poverty and environmental problems in Nigeria. J Human Ecol 31: 135-143 SSRN: http: ssm.com/abstract=1876746.

Babatunde, S.A., Owolabi, A., Olalekan, J.J., Bolanle, W.W (2012): The August 2011 Flood in Ibadan, Nigeria: Anthropogenic Causes and Consequences. Int. J. Disaster Risk Sci. 2012, 3 (4): 207-217 doi:

Babsal and Co. Limited (1998): Katsina State Environmental Action Plan. Final Report FEPA Under World Bank Assisted programme. Babsal and Co. Limited, Ikeja-Lagos.

Badiger, S. (2010). "Integrated Modeling Framework for Assessing Impacts of Changes in Land-use and Climate on Hydrologic Regimes and Water Distribution", presentation made at SANDEE, MSE and MSSRF Workshop on Economics of Climate Change Adaptation, during 12-13 February, Madras School of Economics, Chennai.

Baerwald, T. 2010 ): Prospects for geography as an interdisciplinary discipline , Ann. Assoc. Am. Geogr. , 100 , 493 – 501 .

Baiye, E. (1988): Numan in the Throes of Floods, in: The Guardian, Thursday, October 8, pp. 9

Bakare, W (2016): Solid Waste Management in Nigeria. Published by BioEnergy Consult online.

Baker, J. L. (2012): *Climate change, disaster risk, and the urban poor: Cities building resilience for a changing world*. Washington, DC: World Bank Publications.

Baker, V. R., Webb, R. H. & House, P. K. (2002): The scientific and societal value of paleo flood hydrology. In: Ancient Floods, Modern Hazards: Principles and Applications of Paleo flood Hydrology (ed. by P. K. House, R. H. Webb, V. R. Baker & D. R. Levish), 127–146. Water Science and Application Series, vol. 5, American Geophysical Union, Washington DC, USA.

Baker, R., (2012): Blue space thinking. In Flood Hazards: Impacts & Responses for the Built Environment, eds. J. Lamond, C. Booth, F. Hammond & D. Proverbs, Taylor & Francis: New York, pp. 191–205.

Balbi, S., Glupponni, C., Mojtahed, V, Gallina, V (2012): A Conceptual Framework for Comprehensive Assessment of Risk Prevention Measures: The KULTURISK Framework (KR-FWK). Available at SSRN 2184193.

Balica S, Wright NG (2010) Reducing the complexity of the flood vulnerability index. Environ Hazards 9:321–339

Balsiger, P.W., (2004): Supra disciplinary research practices: history, objectives and rationale. Futures, 36(4), pp. 407-421.

Balzerek, H.; Fricke, W.; Heinrich, J.; Moldenhauer, K.; and Rosenberger, M. (2003). "Man-made flood disaster in the savanna town of Gombe / NE Nigeria; the natural hazard of gully erosion caused by urbanization dynamics and their peri-urban footprints", *Erdkunde*, pp 94 – 109

Banacos, P.C (2011): Eastern Region Technical Attachment Box and Whisker Plots for Local Climate Datasets: Interpretation and Creation using Excel 2007 / 2010 Interpretation A Journal of Bible and Theology Vol.1 pp. 2–20

Banacos, T.C (2011): Box and Whiskers plots for local climate datasets: Interpretation and creation using Excel 2007/2010. Eastern Region Technical Attachment No 2011-01

Bandura, A (1963): *Social learning and personality development*. New York Holt, Rinehart, and Wiaton.

Bandura, A (1971): *Behaviour therapy from a social learning perspective.* Proceedings of the XIXth International Congress of Psychology. London. England

Banerjee, S, G and Morella, E (2011): Africa's Water and Sanitation Infrastructure: Access, Affordability and Alternatives. The International Bank for Reconstruction and Development/World Bank, Washington DC, USA.

Banfoff G (2001): Rendering the world unsafe: 'vulnerability' as Western discourse. Disasters 25: 19-35.

Baqersad, M., et al. ( 2016): Comparison of coupled and uncoupled consolidation equations using finite element method in plane-strain condition. Civil Engineering Journal, 2 (8), 375–388.

Baqersad, M., et al., (2017): Asphalt mixture segregation detection: digital image processing approach. Advances in Materials Science and Engineering, 2017, 1–6. Article ID 9493408

Barbier, E (2019): *The water paradox: Overcoming the Global Crisis in Water Management.* (Yale University Press)

Bariweni, P.A., Tawari, C.C and Abowei, j.f.n (2012). Some Environmental Effects of Flooding in the Niger Delta Region of Nigeria, International Journal of Fisheries and Aquatic Science 1 (1): 35-46, 2012 ISSN: 2049-8411: e-ISSN: 2049-842X.

Barnett, T.P (1988): Long-termTrends in Surface Temperature Over the Oceans. Monthly Weather Review, 112: 303-312

Bashir O.O., Oludare A.H., Johnson O.O., Aloysius B. (2012). Floods of Fury in Nigerian Cities. J Sustain Dev 5 (7): 69-79, https://doi.org/10.553a/jsd.v5n7p69.

Basic F. (2009): Geographic Visualisation Tools for Communicating Flood Risks to The Public. Melbourne, Australia: RMIT University. 230 p.

Bate, R., 2004. Climate change and mosquito-borne disease, causal link or green alarmism? Am. Enterprise Inst. Public Policy Res.

Bates, P.D. and A.P.J. De Roo, (2000). A simple raster-based model for flood inundation simulation. J. Hydrol., 236: 54-77. DOI: 10.1016/S0022-1694(00)00278-X

Bath & North East Somerset Council (2016). Highways Drainage. Retrieved from; http;//www.bathnes.gov.uk/services/streets-and-highway-maintenance/drains

Batica, J. (2015): Methodology for Flood Resilience Assessment in Urban Environments and Mitigation Strategy Development, (September), 229.

Baumgartner, H., & Steenkamp, J.B.E (2001); Response styles in marketing research: A cross-national investigation. *Journal of Marketing Research, 38, 143-156*

Baxter PJ, Moller I, Spencer T, Tapsell S. Health effects of climate change in the UK: an expert review for comment. London: Department of Health; 2001. Coastal flooding and climate change; pp. 177–87.

BBC News (5 September 2009). "UN warns on West Africa floods"**.** Archived from the original on 5 September 2009**.**

BBC (27/09/2018): Why does Nigeria keep flooding? Available online: bbc.co.uk/news/world-africa-45599262

BBC (27 Sep, 2018): Why does Nigeria keep flooding? Are Nigeria's rains causing the floods? Available online: from bbc.om-delivered

Beall, J, (2007): *Cities, terrorism and urban wars of the 21st century* (Crisis states working paper). London: LSE

Beg, N., J. Corfee Morlot, O. Davidson, Y. Afrane-Okesse, L. Tyani, F. Denton, Y. Sokona, J.P. Thomas and Co-authors, (2002): Linkages between climate change and sustainable development. Clim. Policy, 2, 129-144

Beguería, S., M. Angulo-Martínez, S. M.Vicente-Serrano, J. I.López-Moreno, and A. El-Kenawy, (2011): Assessing trends in extreme precipitation events intensity and magnitude using non-stationary peaks-over-threshold analysis: A case study in northeast Spain from 1930 to 2006. *Int. J. Climatol.*,31, 2102–2114

Begun S., Stive M.J. & Hall J.W., (2007). *Flood risk management in Europe: Innovation in policy and practice*, Springer Science & Business Media, London.

Bello, O.B., Ganitu, O.T., Wlab M.K.A., Afolabi, M.S., Oluleye, E. Ig S.A., Mahmud, J., Azeez, M.A., and Abdulmaliq, S.Y., (2012). Evidence of Climate Change Impacts on Agriculture and Food Security in Nigeria. International Journal of Agriculture and Forestry 2012, 2 (2): 49-55 DOI: 10.5923/j.ijaf.20120202.08.

Benestad, R., Hanssen-Bauer, I., Chen, D. (2008): Empirical-Statistical Downscaling, World Scientific Publishing Company, Singapore, 228 pages.

Benjamin, M.A (2007): “Analysing Urban Flood Risk in Low-Cost Settlements of George, Western Cape, South Africa: Investigating Physical and Social Dimensions” A thesis submitted to the University of Cape Town in fulfilment of the requirements for the degree of Masters in Social Science Department of Environmental and Geographical Science University of Cape Town.

Benito, G., Grodek, T. & Enzel, Y: (1998) The geomorphic and hydrologic impacts of the catastrophic failure of flood control-dams during the 1996-Biescas flood (central Pyrennees, Spain). Z. Geomorphol. 42(4), 417–437.

Benito, G: (2003) Palaeoflood hydrology in Europe. In: Palaeofloods, Historical Data and Climatic Variability: Applications in Flood Risk Assessment (ed. by V. R. Thorndycraft, G. Benito, M. Barriendos & M. C. Llasat), 19–24. Centro de Ciencias Medioambientales, Madrid, Spain.

Benito, G., Lan, M., Barriendos, M., Llasat, M. C., Francés, F., Ouarda, T., Thorndycraft, V., Enzel, Y., Bardossy, A., Coeur, D. & Bobée, B: (2004a) Systematic, palaeoflood and historical data for the improvement of flood risk estimation. Natural Hazards 31, 623–643

Benson D, Lorenzoni I, Cook H (2016): Evaluating social learning in England flood risk management: an ‘individual-community interaction’ perspective. Environ Sci Policy 55:326–334. https://doi.org/10.1016/j.envsci.2015.05.013

Berda Y (2017) Living Emergency, Israel’s Permit Regime in the Occupied Territories. Stanford, CA: Stanford University Press.

Berg P., Mosely C., and Haerter J.O (2013): Strong increase in convective precipitation in response to higher temperatures, Nature Geosci., doi:10.1038/ngeo 1731

Berghuijs, W.R., Woods, R.A., Hutton, C.J., Sivapalan, M (2016): *Dominant flood generating mechanisms across the United States*. Geo-phys. Res. Lett., 43 (2016), pp. 4382-4390, 10.1002/2016GL068070

Betts, A. K., Chen, F., Mitchell, K. E. & JanJic, Z. I. (1997): Assessment of the land surface and boundary layer models in two operational versions of the NCEP Eta Model using FIFE data. *Mon. Wea. Rev.* 125(11), 2896–2916.

Bhagat. R. B, (2011). Emerging pattern of urbanisation in India Economic and Political Weekly, 46 (34), pp. 10-12

Bhandari, P (2020): Variability/Calculating Range, IQR, Variance, Standard Deviation. Available online: scribbr.com/statistics/variability/.

Bhandari, P (2022): Questionnaire Design| Methods, Question Types & Examples. Published online: scribbr.com/methodology/questionnaire/

Bhattacharya, N., & Lamond, J (2011): A Review of Urban Flood Risk Situation in African Growing Economies. Conference: International Symposium on Urban Flood Risk Mnagement: At: Graz, Australia

Biasutti, M. (2019): Rainfall trends in the African Sahel: Characteristics, processes, and causes. Wiley Interdiscip. Rev. Clim. Chang. 10, e591.

Bill, G., & Katie, P (2013): Design for Climate Change. A Book Published by RIBA Publishing. 15 Bonhill Street, London EC2P2EA ISBN 978185946 4489; Stock code 77532

Birkmann, J., (2013). Measuring Vulnerability to Promote Disaster-Resilient Societies and Enhance Adaptation: Discussion of Conceptual Frameworks and Definitions. In: Measuring Vulnerability to Natural Hazards: Towards Disaster Resilient Societies,

Birkmann, J. (Ed.), New York, United Nations University Press, ISBN-13: 9789280812022, pp: 9-54.

Birner, R., and A. Okumo. (2011): Challenges of Land Governance in Nigeria: Insights from a Case Study in Ondo State. Nigeria Strategy Support Program (NSSP) Working Paper 22. Abuja: International Food Policy Research Institute.

Bjerkenes, J (1966): Survey of El Nino 1957-1958 in its Relation to Tropical Pacific Meteorology. *Inter-America Tropical Tuna Bulletin*, 12: 1-62

Bjerkenes, J (1969): Atmospheric Telecommunication from the Equatorial Pacific. *Monthly Weather Review*, 97: 163-172

Blackmoore, C. (1994): Taking responsibility. Environmental agenda, Science and technology p. 2

Blaikie, P., Cannon, T., Davis, I. & Wisner, B. (1994): At risk: natural hazards, people's vulnerability, and disasters. London: Routledge. 284 p.

Blake J (1999) Overcoming the 'value-action gap' in environmental policy: tensions between national policy and local experience. Local Environ 4(3):257–278

Blong, R. (1996): Volcanic hazards risk assessment. In Monitoring and Mitigation of Volcano Hazards; Scarpa, R., Tilling, R.I., Eds.; Springer: Berlin/Heidelberg, Germany; New York, NY, USA, 1996; p. 23.

Blöschl, G.; Hall, J.; Parajka, J.; Perdigão, R.A.P.; Merz, B.; Arheimer, B.; Aronica, G.T.; Bilibashi, A.; Bonacci, O.; Borga, M.; et al. (2013): Changing climate shifts timing of European floods. Science 2017, 357, 588–590.

BNRCC (Building Nigeria's Response to Climate Change). (2011): *National Adaptation Strategy and Plan of Action on Climate Change for Nigeria* (NASPA-CCN). http:// nigeriaclimatechange.org/docs/naspaAug2012.

BNRCC (Building Nigeria's Response to Climate Change). (2011): National adaptation strategy and plan of action on climate change for Nigeria (NASPA-CCN). Prepared for the Federal Ministry of Environment Special Climate Change Unit. http://csdevnet.org/wpcontent/uploads/NATIONAL-ADAPTATION-STRATEGY-AND-PLAN-OF-ACTION.pdf

Board, R.J., O'Connor & Fisher (1998): Public perceptions of global warming: United States and International Perspectives. *Climate Research* 11 (1): 75-84

Boé, J., Terray, L., Habets, F., Martin, E. (2006): A simple statistical-dynamical downscaling scheme based on weather types and conditional resampling. Journal of Geophysical Research, D23106, doi:10.1029/2005JD006889

Boé, J.; Terray, L.; Habets, F.; Martin, E. (2007): Statistical and dynamical downscaling of the Seine basin climate for hydro-meteorological studies. Int. J. Clim. 2007, 27, 1643–1655.

Boholm A. (2008): New perspectives on risk communication: uncertainty in a complex society. Journal of Risk Research, 11 (1-2):1-3.

Boko, M., Niang, I., Nyong, A., & Vogel, C., et al (2007): Africa. In M.L. Parry, O.F. Canziani, J.P. Paluticof et al (Eds.), *Climate change 2007: Impacts, adaptation and vulnerability*. Contribution of Working Group II to the Fourth Assesment Report of the Intergovernmental Panel on Climate Change (pp. 433-467). Cambridge: Cambridge University Press.

Boko, M., I. Niang, A. Nyong, C. Vogel, A. Githeko, M. Medany, B. Osman-Elasha, R. Tabo, and P. Yanda, (2007): Africa. In: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Parry, M.L., O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 433-467

Bokwa, A. (2013): Natural Hazard. In P. T. Bobrowsky (Ed.), Encyclopedia of Natural Hazards (pp. 711–718). Springer. https://doi.org/10.1007/978-1-4020-4399-4_248

Bolanle, A.O., Odufuwa, B.O., Oriola, S (2012): Household participation in waste disposal and management in Ijebu-Ode, Nigeria. J. HumEcol, 40 (3): 247-254

Bolanle Wahab, (2015): Community Consultation and Sensitization in Risk Management. Published by the Department of Geography and Environmental Management, Tai Solarin University of Education, Ijagun, Ijebu-Ode, Ogun State, Nigeria.

Bolatito, S. & Ibrahim, B. S. (2014). “Challenges of Local Government Administration in Nigeria; An Appraisal of Nigerian Experience.” International Journal of Science and Research (IJSR) Vol. 3 (7), 562-568

Bonan G (2002). Ecological Climatology, Cambridge University Press.

Boo, K. (2006): Beyond the Beautiful Forevers. Life, Death, and Hope in a Mumbai Undercity.

Boone, H.N., and Boone, D.A (2012): Analyzing Likert Data. Journal of Extension V 50 (2).

Braun, V., & Clark, V (2006: p. 79): Using thematic analysis in psychology. *Qual Res, Psych; 3*: 77-101

Bosschaart, A., Joop van der Schee., Kuiper, W (2016): Designing a flood-risk education program in the Netherlands. Jou. of Envr. Edu. V47 (4)

Botes, L., & van Rensburg, D. (2000). Community participation in development: nine plagues and twelve commandments. *Community Development,35*(1), 41–58.

Botzen WJW, Aerts JCJH, van den Bergh JCJM. (2009): Dependence of flood risk perceptions on socioeconomic and objective risk factors. Water Resources Research, 2009; 45 (10):15.

Botzen WJW, Aerts JCJH, van den Bergh JCJM (2009) Dependence of flood risk perceptions on socioeconomic and objective risk factors. Water Resources Research doi:10.1029/2009WR007743

Boynton, P.M (2004): Administering, analysing and reporting your questionnaire. BMJ 328 (7452); 1372-1375

Bradford RA et al (2012) Risk perception—issues for flood management in Europe. Nat Hazards Earth Syst Sci 12(7):2299–2309

Braun, V. & Clarke, V. (2006): Using thematic analysis in psychology. Qualitative Research in Psychology. 3(2), 77-101.

Braun, B, Aßheuer, T (2011): Floods in megacity environments: vulnerability and coping strategies of slum dwellers in Dhaka/Bangladesh Nat. Hazard., 58 (2) (2011), pp. 771-787

Brázdil, R., Pfister, C., Wanner, H., von Storch, H. & Luterbacher, J. (2005b): Historical climatology in Europe – the state of the art. Climatic Change 70(3), 363–430.

Brázdil, R. & Kotyza, O: (1999): History of Weather and Climate in the Czech Lands III. Daily Weather Records in the Czech Lands in the Sixteenth Century II. Masaryk University, Brno, Czech Republic.Brázdil, R., Pfister, C., Wanner, H., von Storch, H. & Luterbacher, J: (2005b) Historical climatology in Europe – the state of the art. Climate Change 70(3), 363–430.

Brian. O (2009): The Economic Impacts of Climate Change in Kenya: Riparian Flood Impacts and Cost of Adaptation. Available At: https://www.weadapt.org/sites/weadapt.org/files/legacy-new/knowledge-base/files/4e25a4b8c8bf61c-kenya-riparian-floods-case-study.pdf

Briceno, S. & Pitt, D. (1988): New ideas in EE. P.37

Brilly M, Polic M (2005): Public perception of flood risks, flood forecasting and mitigation. Nat Hazards Earth Syst Sci 5:345-355

Brinkmann, S. (2014): Interview. in T Teo (ed.), Encyclopedia of Critical Psychology. Springer, Berlin, pp. 1008-1010. https://doi.org/10.1007/978-1- 4614-5583-7_161.

Bryant, E.A (1991): *National hazards*, Cambridge University Press, New York

Brooks, N (2004*): Drought in he African Sahel; Long-term perspectives and future prospects. Working Paper No. 61, Tyndall centre for climate change research*. Norwich: University of East Anglia. Available www.tyndall.ac.uk

Broto, V.C., Osuteye, E., & Westman, L (2022): A billion of the world's most climate – vulnerable people live in informal settlements – Here's what they face. Published online: preventionweb.net/news/billions-worlds-most-climate-vulnerable-people-live-informal-settlements-heres-what-they-face.

Brown, A (2015): *Planning for sustainable and inclusive cities in global south* (Topic Guide). Evidence on demand.

Brown JD, Damery SL (2002): Managing flood risk in the UK: towards an integration of social and technical perspectives. Trans Inst Br Geogr 27:412–426

Brown, J.D (2000): What issues affect Likert-Scale questionnaire formats? Shiken: JALT Testing & Evaluation sig Newsletter, 4 (1), p. 27-30

Brown S., and Dawson R.J., (2016). Building Network-Level Resillience to Resource Disruption from Flooding. Case studies from Shetland Island and Huricane Sandy. Floodrisk, Lyon, 17-21st October 2016

Brown, E., Lumbroso, D., & Wade, S. (2014). Science for Humanitar-ian Emergencies and Resilience (SHEAR) scoping study: Annex1–Results of a stakeholder questionnaire. Retrieved fromhttps://www.gov.uk/dfid-research-outputs/final-report-science-for-humanitarian-emergencies-and-resilience-shear-scoping-study

Brunland C. (1987): Our common future: Report of the 1987 world commission on environment and development. Oxford; Oxford University Press.

Bubeck, P., H. De Moel, L.M. Bouwer and J.C.J.H. Aerts, (2011). How reliable are projections of future flood damage? Nat. Hazards Earth Syst. Sci., 11: 3293-3306. DOI: 10.5194/nhess-11-3293-2011

Bubeck, P., H. Kreibich, E. C. Penning-Rowsell, W. Botzen, H.de Moel, and F. Klijn. (2017): "Explaining Differences in Flood Management Approaches in Europe and in the USA– a Comparative Analysis." *Journal of Flood Risk Management* 10 (4): 436–445. doi:10.1111/jfr3.12151.

Buckle and Smith (2000). "Solid Waste Handling in Metropolitan". United States of America Public Health Service (USPHS) publications. Washington D.C, February.

Bulkeley, H., Betsell. M.M (2003): *Cities and Climate Change: Urban. Sustainability and Global Environmental Governance*. Routledge: London, UK.

Bulkley, H (2010): Cities and the Governing of Climate Change *Annu. Rev, Environ Resour*, 35, 229-253

Bulkley, H (2013): *Cities and Climate Change*; Routledge: New York, NY, USA

Bunting, A. H., Dennett, M. D., Eliston, J., & Milford, J. R. (1976). Rainfall trends in the West Africa Sahel. Q.J.R. Meteorological Society, 102:56– 64 8.

Burrouphs, W.J (1992): *Weather Cycle Real or Imaginary*. London: Cambridge University Press.

Burton I, Kates RW, White GF (1978): The environment as hazard. Oxford University Press, New York, p 240

Butler, R. A. (2005). *World Deforestation Rates and Forest Cover Statistics, 2000 – 2005* [Online]. Available: http://news.mongabay.com/2005/1115-forests.html#.

Butler, J (2009): *Frames of War: When is Life Grievable?* London: Verso

Butler C, Pidgeon N (2011): From 'flood Defence' to 'flood risk management': exploring governance, responsibility, and blame. Environ Plan C Gov Policy 29:533–547. https://doi.org/10.1068/c09181j

Byg A, Salick J. (2009): Local perspectives on a global phenomenon-Climate change in Eastern Tibetan villages. *Global Environmental Change-Human and Policy Dimensions.*19:156–166.

**C**

Callistus, T and Clinton, H.A. (2016): Addressing flood challenges in Ghana: A Case of the Accra Metropolis. Inter. Conf. on Infrastructure Dev. In Africa. Available at: https://www.academia.edu/2688013/ADDRESSING_FLOOD_CHALLENGES_IN_GHANA_A_CASE_OF_THE_ACRRA_METROPOLIS.

Cannarozzo, M., Noto, L.V, Viola, F. (2006): Spatial distribution of rainfall trends in Sicily (1921–2002). Physics and Chemistry of the Earth 31:1201–1211.

Cao. Q, Yu. D, Georgescu .M, Han. Z, Wu. J (2015). Impacts of land use and land cover change on regional climate: A case study in the agro-pastoral transitional zone of China. Environmental Research Letters, 10 (12), p. 124025

Cappello, M. (2005): Photo interviews: Eliciting data through conversations with children. Field methods. 17(2), 170-182.

Cardona, O.., Aalst, M. K. van, Birkmann, J., Fordham, M., McGregor, G., Perez, R., Pulwarty, R. S., Schipper, E. L. F., & Sinh, B. T. (2012): Determinants of risk: exposure and vulnerability. In C. B. Field, V. Barros, T. F. Stocker, D. Qin, D. J. Dokken, K. L. Ebi, M. D. Mastrandrea, K. J. Mach, G.-K. Plattner, S. K. Allen, M. Tignor, & P. M. Midgley (Eds.), Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. Cambridge University Press. https://www.ipcc.ch/site/assets/uploads/2018/03/SREX-Chap2_FINAL-1.pdf

Cardona, O.D., Van, M.K., Aalst, J., Birkmann, M., Fordham, G., McGregor. Perez, R., Pulwarty, R.S., Schipper, E.L.F., and Sinh, B.T (2012): Determinants of risk. Exposure and Vulnerability. In *Managing the risk of extreme events and disasters to advance climate change adaptation. A special report of the Working Group I and II of the Intergovernmental Panel on Climate Change,* ed. CB. Field, V. Barros, T.F. Stocker, D. Qin, D.J Dokken, K.L. Ebi, M.D. Mastrandirea, et al., 65-108. Cambridge and New York, Cambridge University Press.

Carmin J, Tierney K, Chu E, Hunter L, Roberts T, Shi L (2015): Adaptation to climate change. In: Dunlap RE, Brulle R (eds) Sociological perspectives on climate change. Oxford University Press, Oxford. https://doi.org/10.1093/acprof:oso/9780199356102.003.0006

Carr DL. Tropical deforestation. In: Janell D, Hansen K, editors. Geographical Perspectives on 100 Problems. London: Kluwer Acad; 2004. pp. 293–99

Carrington, D., (2015): *World population to hit 11bn in 2100 – with 70% chance of continuous rise*, viewed 27 November 2015, from http://www.geohive.com/earth/population_now.aspx

Castillo-Rodríguez J.T., Escuder-Bueno I., Altarejos-García L. & Serrano-Lombillo A. (2014): The value of integrating information from multiple hazards for flood risk analysis and management. Nat Hazards Earth Syst Sci 2014, 14, 379–400.

Carter, Michael, Peter D. Little, Tewodaj Mogues and Workneh Negatu (2007): Poverty Traps and Natural Disasters in Ethiopia and Honduras. World Development, vol. 35, no. 5, p. 835-856.

Caves, R.W (2004): Encyclopaedia of the City. Routledge pp.556, ISBN 9780415252256.

Ceccato, P. and T. Ghebremeskel, M. Jaiteh, P.M. Graves and M. Levy *et al*., 2007. Malaria stratification, climate and epidemic early warning in Eritrea. Am. J. Trop. Med. Hyg., 77: 61-68.

Celestino, L. J. L.; A.O. Mohammed, and L. Xiwu. (2012). Solid waste management and its Environmental impacts on human health in Juba Town - South Sudan. Scholarly Journals of Biotechnology. 1(2): 28-38.

Celik, A. P., Zyman, R. and Mahdi, R. (eds.), (2009): Sustainable Urbanization in the Information Age ST/ESA/ PAD/SER.E/137, Department of Economic and Social Affairs Division for Public Administration and Development Management United Nations New York, New York.

Cèline, L., Jean, D.C., Isabelle, R., Sylvie, D., Sandrine, A., Mario, B (2018): Exposure to Flash Floods: The Conflicts Between Human Mobility and Water Mobility. Available online: https://doi.org/1016/8979-178548-289-2.50008-2.

Central Bank of Nigeria (CBN). Statistical Bulletin, 2008

Chambers, J.M., Cleveland, W.S., Kleiner, B., and Turkey, P.A (1983): *Graphyical Methods for Data Analysis*, Belmont, CA: Wadsworth

Chandola, V., Banerjee, A., and Kumar, V (2007): Outlier Detection A Survey. University of Minnesota. Pp: 36-45

Chang, P (2002): The Coupled Ocean – Atmosphere System. *A paper presented at workshop and conference on El Nino and Tropical Ocean Atmosphere Interactions*. Abdus Salam International Centre for Theoretical Physics. Italy, 3rd – 14th June 2002

Chang, G., Wang, L., Meng, L. & Zhang, W. (2016): Farmers' attitudes toward mandatory water-saving policies: A case study in two basins in northwest China. Journal of Environmental Management. 181, 455-464.

Changnon. S.A (1992). Inadvertent weather modification in urban areas: Lessons for global climate change. Bulletin of the American Meteorological Society, 73 (5) (1992), pp. 619-627

Changnon SA (2005): The 1993 flood's aftermath: risks, root causes and lessons for the future. J Contemp Water Res Educ 130:70–74

Chaudhary P, Bawa KS. (2011): Local perceptions of climate change validated by scientific evidence in the Himalayas. *Biology Letters.* 7:767–770.

Cheng, Y., Nie, J., Li, G., Zhang, C. & Wang, W. (2008). Study on land use and land cover change with the integration of RS, GIS and GPS technologies-the case of Baotou City in the ecotone of agriculture-animal husbandry, China. *Geoscience and Remote Sensing Symposium* Presented in IGARSS 2008 International IEEE, pp. IV.

Chhabra, D., Sills. E., & Cubbage, F.W (2003). The Significance of Festivals to Rural Economies: Estimating the Economic Impacts of Scottish Highland Games in North Carolina. Journal of Travel Research, 41 (4), 421-427

Chiang, J. C. H. and Sobel, A. H. (2002): Tropical tropospheric temperature variations caused by ENSO and their influence on remote tropical climate, J. Climate, 15, 2616–2631.

Chizoba, I (2020): Full List of Radio Station in Nigeria & Frequencies. Available Online: nigerianinfomedia.com.ng

Chow, V.T (1957): Report of the Committee on Runoff, 1955-1956. *Trans. Am. Geophys. Union,* 38, 378-384.

Chow Ven Te (1966). Handbook of Applied Hydrology, Mc Graw Hill Civil Engineering Series, Mc Graw-Hill Book Company, New York.

Christensen, J.H., Hewitson, B., Busuioc, A., et al., (2007): "Regional climate projections," in Climate Change 2007: The Physical Sciences Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, S. Solomon, D. Qin, M. Manning et al., Eds., chapter 11, pp. 847–940, Cambridge University Press, Cambridge, UK, 2007, https://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4- wg1-chapter11.pdf

Christiana, N.E & Amanambu, C.A (2013): Climate Variation Assessment Based on Rainfall and Temperature in Ibadan, South-Western, Nigeria. Jou of Environ and Earth Sci, Vol 3 (11)

Christoperson, R.W. (1997). Geosystems: An Introduction to physical Geography. London: Prentice – Hall (Third Edition). Pp. 423.

Christopherson, R.W, (1995): Elemental Geosystems, Macmillan, New York. Pp. 230-239.

Chukwuemeka E, Osisioma B, Onwuka E, Ugwu J 2012. The challenges of waste management to Nigeria sustainable development: A study of Enugu State. International Journal of Research Studies in Management, 1(2): 79-87.

Chukwuemeka, E., Ugwuanyi, B. I., Ndubuisi-Okolo, P. & Onuoha, C. E. (2014). "Nigeria Local Government: A Discourse on the Theoretical Imperatives in a Governmental System." An International Multidisciplinary Journal, Ethiopia, Vol. 8 (2), 305-324.

Church, C.A and Keller, J (1989): Can mass media affect behaviour? Development Communication Report 1990/4 No 71, p.5

Churchill, C (2006): Protecting the poor: a microinsurance compendium International Labour Office/Munich Re, Geneva.

Cirella, G. T., and Iyalomhe, F.O (2018): "Flooding Conceptual Review: Sustainability-focalized Best Practices in Nigeria." *Applied Sciences* 8 (9): 1558. doi:10.3390/app8091558.

CITY ALLIANCE. (2014): About slum upgrading. [Online]. Available at: <http://www.citiesalliance.org/About-slum-upgrading

Ciullo, A.; Viglione, A.; Castellarin, A.; Crisci, M.; Di Baldassarre, G. (2017): Socio-hydrological modelling of flood-risk dynamics: Comparing the resilience of green and technological systems. Hydrol. Sci. J. 2017, 62, 880–891. Claire, C.S., Muaed, J.A.O (2014): Critical analysis of Learning Thesis and Ideologies and Their Impact on Learning: "Review Article": Published online: Jou. of Counselling and Education 3(2), 62-77

Clackson, J.R (1960): The Seasonal Movement of Boundary of Northern Air in Nigeria. *Meteorological Service Technical Note*. Number 5, p.6.

Claire, C.S., Muaed, J.A.O (2014): Critical analysis of Learning Thesis and Ideologies and Their Impact on Learning: "Review Article": Published online: Jou. of Counselling and Education 3(2), 62-77

Clements, R. (2009): economic-cost-of-climate-change-in-Africa.

Climate Change (IPCC, 2007): Impacts, Adaptation and Vulnerability. Cambridge University Press, Cambridge, United Kingdom and New York, USA (2007)

Cline WR (2007) Global Warming and Agriculture. Centre for Global Development, Peterson Institute for International Economics, Washington, DC, USA. 16.

Cloete, F., (1995): *Local government transformation in South Africa*, J.L. Van Schaik Publishers, Pretoria.

Cochran P, Huntington OH, Pungowiyi C, Tom S, Chapin FS, III, Huntington HP, Maynard NG, Trainor SF. (2013): Indigenous frameworks for observing and responding to climate change in Alaska. *Climatic Change.* 120:557–567.

Cohen, B. (2006): Urbanization in Developing Countries: Current Trends, Future Projections, And Key Challenges For Sustainability Technology, Society, 28, pp63–80.

Collins, E. and Simpson, L. (2007): *The Impact of Climate Change on insuring flood risk*. Institute of Actuaries of Australia, New Zealand, Pp. 1-38.

Collins, A, C Jones & M Munday (2009): Assessing the Environmental Impacts of Mega Sporting Events: Two Options? Tourism Management 30: 828 - 837.

Commission for Africa (2005), Action for a Strong and Prosperous Africa, London, page 51.

Commission for Africa (2005), Action for a Strong and Prosperous Africa, London, page 249.

"Communication". The office of superintendent of Public Instruction. Washington. https://en.wikipedia.org/wiki/Communication

Conway, D (2005), "From headwater tributaries to international river: observing and adapting to climate variability and change in the Nile basin", Global Environmental Change Vol 15, pages 99–114.

Corbett, J. (1988): 'Famine and household coping strategies. World Development. 16(9). pp. 1099–1112.

Cornwall, W. (2021). Europe's deadly floods leave scientists stunned despite improvements, flood forecasts sometimes failed to flag risks along smaller streams. *Science*, *373*(6553), 372–373. https://doi.org/10.1126/SCIENCE.373.6553.372/ASSET/FF38E2C6-8279-4A40-82B4-54D1B7E4725B/ASSETS/GRAPHIC/373_372_F1.JPEG

Couzin J. (2007): Opening doors to native knowledge. *Science.*315:1518–1519.

Covello VT, von Winterfeldt D, Slovic P. (1986): Risk communication: a review of literature. Risk Abstracts, 3:171-182.

CRED (2018): Diasaster 2018: Year in Review. Available at: https://cred.be/default/files/CredCrunch.pdf

Crichton, D. (1999): The risk triangle. In Natural Disaster Management; Ingleton, J., Ed.; Tudor Rose: London, UK, 1999; p. 2.

Cubash U, Dai XJ, Ding Y, Griggs DJ, Hewtson B, Houghton JT, Isaksen I, Karl T, Mcfarlaid M, Meleshko VP, Mitchell JFB, Noguer M, Nyenzi BS, Oppenheimer M, Penner JE, Pollonais S, Stocker T., Trenberth, T.E. (2001): Technical Summary Report by Working Group I of the IPCC, Pg. 68

Cubasch, U., D. Wuebbles, D. Chen, M.C. Facchini, D. Frame, N. Mahowald, and J.-G. Winther, (2013): Introduction. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M.

Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Cui. L, Shi. J (2012). Urbanization and its environmental effects in Shanghai, China. Urban Climate, 2, pp. 1-15

Curtis, R.V. & Watson, T.F. (2014): Dental biomaterials: imaging, testing and modelling. Washington DC, CRC Press.

Cutter, S.L., Bornff, B.J., Shirley, W.L (2003): Social vulnerability to environmental hazards. Soc. Sci. @ 84: 242-261

Cutter SL, Emrich CT, Webb JJ, Morath D (2009) Social vulnerability to climate variability hazards: a review of the literature. Final report to Oxfam America. Columbia, South Carolina: Hazards and Vulnerability Research Institute, University of South Carolina.

Cutter, S., B. Osman-Elasha, J. Campbell, S.-M. Cheong, S. McCormick, R. Pulwarty, S. Supratid, and G. Ziervogel, (2012): Managing the risks from climate extremes at the local level. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 291-338

CRED Crunch (November, 2019): Disasters in Africa: 20-year Review (2000-2019). Issue no. 56. Available online: C:/users/ccuk/Downloads/CredCrunch56.pdf. (1) Constitution of the Federal Republic of Nigeria (1999): Published online: publicofficialsfinancialdisclosure.worldbank/sites/fdl/files/assets-law-library-files/Nigeria_Constitution_1999_en.pdf

**D**

Dabanlı, I et al. (2016): Trend assessment by the innovative-Şen method Water Resour. Manag.

Dabi, D.D., A.O. Nyong, A.A. Adepetu, V. Ihemegbulem and J. Agaye (2007). "Determinants of adaptive strategies and opportunities of rural households in northern Nigeria". In N. Leary, J. Adejuwon, V. Barros, I. Burton and R. Lasco (eds)", Adaptation to Climate Change, Earthscan, London, U.K. 20

Dada A. (2011): Flooding: Lagos advises Mile 12 residents, others to relocate. Sunday Punch, 29 May 2011.

Daily Sun, (2011a): Get ready for more rains. Daily Sun, 24 August 2011.

Daily Sun, (2011b): Group blames Lagos flood on bad leadership at LGAs. Daily Sun, 15 July 2011.

Daily Times, (1947): Rain causes considerable damage to roads and buildings. Daily Times, 15 July 1947.

Dalil, M., Mohammad, N.H., Yamman, U.M., Husaini, A. & Mohammed, S.L., (2015): An assessment of flood vulnerability on physical development along drainage channels in Minna, Niger State, Nigeria. African Journal of Environment Science and Technology, 9(1), pp. 38–46.

Daniels, M. (2004). Beyond Input-Output Analysis: Using Occupation-Based Modelling to Estimate Wages Generated by a Sport Tourism Event. Journal of Travel Research, 43 (1), 75-82.

Daniel Lirebo (2006): An Assessment of the Development and Implementation of Regulations on Informal Settlements, The Case of Addis Ababa City, Ethiopia. Addis Ababa University.

Daniel, I.O.A. (2013): Communication as socio-cultural meaning exchange. The example of Richard Wright's Black Boy. International Journal of Applied Linguistics and English Literature, 2,5:173-177

Dan-Jumbo, N., M. Metzger, and A. Clark (2018): "Urban Land-use Dynamics in the Niger Delta: The Case of Greater Port Harcourt Watershed." *Urban Science* 2 (4): 108. doi:10.3390/urbansci2040108.

Danladi, S.S 92013): Language Policy: Nigeria and The Role of English Language in the 21st Century. European Scientific Journal V 9 (170)

Daramola A, Ibem EO. (2010). Urban environmental problems in Nigeria: Implications for sustainable development. Journal of Sustainable Development in Africa. 12(1):124-145.

Darnton, A., (2008b) Practical Guide: An overview of behaviour changes models and their uses, in: Government Social Research Unit, GSR behaviour change practice guide 2. Available at: www.gsr.gov.uk

Das, A. A (2017): City of Two Tales: Shelter and Migrants in Surabaya. Environ. Urban. ASIA 2017, 8, 1–21.

DA SILVA DF, SOUSA FAS, KAYANO MT, GALVÍNCIO JD (2009): Influência da variabilidade climática global e de suas escalas temporais sobre a precipitação no Alto Mundaú (PE). Rev. Bras. Geogr. Fís. 2, (3): 64-82

Davis J.A & Froend R. (1999): Loss and degradation of wetlands in southwestern Australia: underlying causes, consequences and solutions. Wetland Ecology and Management 7: 13-23

Dawodu, O.A., Egbrevba, O.J (2021): Patters of inequality in Nigeria: A social psychological perspective. Int. Soc. Assoc. DOI: 10.13140/RG.2.2.36004.81254

Dawson TP, Lees DC. (2006): Model-based uncertainty in species range prediction. *Journal of Biogeography.*33:1704–1711.

Dawson RJ, Hall JW, Barr SL, Batty M, Bristow AL, Carney S, Dagoumas A, Evans S, Ford A, Harwatt H, Köhler J, Tight MR, Walsh CL, Zanni AM. (2009). A blueprint for the integrated assessment of climate change in cities. Tyndall working paper. 129:26.

Day B A, Monroe M C 2000. Environmental Education Communication for a Sustainable World, Handbook for International Practitioners. Academy for Educational Development, Washington, DC.

Debios, S (2022): 10 Advantages and Disadvantages of Questionnaires. Available online: surveyanyplace.com/blog/questionnaire-pros-and-cons/

DE BRUIJN, K. M. (2005): Resilience and flood risk management: a systems approach applied to lowland rivers. PhD Thesis, TU Delft.

de Chazal, J., Quètièr, F., Lavorel, S., Van Doorn, A (2008): Including multiple differing stakeholder values into vulnerability assessment of socio-ecological systems. Glo Environ Chang. 18 (3): 508-20

de Moel H, van Alphen J, Aerts JCJH (2009): Flood maps in Europe—methods, availability and use. Nat Hazards Earth Syst Sci 9:289–301. https://doi.org/10.5194/nhess-9-289-2009

De Risi, R.; Jalayer, F.; de Paola, F.; Iervolino, I.; Giugni, M.; Topa, M.E.; Mbuya, E.; Kyessi, A.; Dahiya, B. (2014): Southeast Asia and Sustainable Urbanization. Glob. Asia, 9, 84–91.

De Satge, R., Holloway, A., Mullins, D., Nchabaleng, L., and Ward, P (2002): *Learning about livelihoods: Insights from Southern Africa.* Cape Town: Peri-Peri and Oxfam.

Desatis, L., & Noel, U.D (2000): The concept of theme as used in qualitative nursing research. *West. J. Nurs. Res; 22*: 351-372

De Wit, MS, van der Most H, Gutteling JM, Bočkarjova M (2008) Governance of flood risks in The Netherlands: interdisciplinary research into the role and meaning of risk perception.

DEFRA (Department for Environment Food and Rural Affairs) (2013): Desktop review of 2D hydraulic modelling packages. Environmental Agency. Bristol.

Defra/Environment Agency. 2003. Available online: www.defra.gov.uk/environ/fcd/research Kron, W. (2003): Flood Risk = Hazard X exposure X vulnerability. J. Lake Sci. 2003, 15, 185–204.

Delamere, T.A., Wankel, L.M., & Hinch, T.D. (2001). Development of a scale to measure resident's attitudes toward the social impacts of community festivals, part II: Item generation and purification of the measure. Event Management, 7 (1), 11–24.

Department of Environment (DOE) (1994). Sustainable Development: The UK Strategy HMSO, London.

Department of Environmental Food and Rural Affairs (DEFRA) (2002). Achieving aBetter Quality of Life: Review of Progress Towards Sustainable Development, London.

Desanker, P., C. Magdaza, A. Allalli, C. Basalirwa, M. Boko, G. Dieudonne, T.E. Downing, P.O.

Devas, N., with Amis, P., Beall, J., Grant, U., Mitlin, D., Nunan, F and Rakodi, C (2004):. *Urban governance, voice and poverty in the developing world*. London: Earthscan

Dessler, A.E. and Parson, E.A. (2019): The Science and Politics of Global Climate Change: A Guide to the Debate, Cambridge University Press, New York, USA.

Dewar, R.E and Wallis, J.R (1999): Geographical patterning of interannual rainfall variability in the tropics and near tropics: An L-moments approach, American Meteorology Society pp: 3457-3466.

Dewey, J., (1938): Logic: The Theory of Inquiry. New York: Holt and Co.

Dewulf, A., Meijerinks, S., Runhaar, H (2015): Editorial: The Governance of Adaptation to Climate Change as a Multi-Level, Multi-Sector and Multi-Actor Challenge: A European Comparative Perspective. *Water Clim. Chang, 6*, 1-8

Dhari, L (2017): The use of rainfall variability in flood countermeasure. Planning. Jou. of the Civil Egnr. Vol (3): 157 DO:10.22146/jcef.27579.

Dhonneur, G., (1974): *Nouvelle Approche des Réalités Météorologiques de l'Afrique Occidentale et Centrale*. Vol. I. Agence pour la Sécurité de la Navigation Aérienne en Afrique et à Madagascar, Dakar, Senegal, 358 pp., [www.sist.sn/gsdl/collect/butravau/index/assoc/HASH01c8/4dd229d8.dir/THS-607.pdf](www.sist.sn/gsdl/collect/butravau/index/assoc/HASH01c8/4dd229d8.dir/THS-607.pdf).

Di Baldassarre, G., Montanari, A., Lins, H., Koutsoyiannis, D.,Brandimarte, L., & Blöschl, G. (2010). Flood fatalities in Africa:From diagnosis to mitigation.Geophysical Research Letters,37(L22402). https://doi.org/10.1029/2010GL045467

Di Baldassarre G., Uhlenbrook, S (2012): is the current flood of data enough? A treatise on research needs for the improvement of flood modelling. Hydrological Processes 26: 153-158

Di Baldassarre, G., Mutanari, N., Lins, H., Koutsoyiannis, D and Brandimarte, L (2010): Flood fatalities in Africa: From diagnosis to mitigation. Geophysical Research Letter 37 (22). DOI:10-1029/2010GL045467

DiCicco-Bloom, B. & Crabtree, B.F. (2006): The qualitative research interview. Medical Education. 40(4), 314-321.

Dilley, M., Chen, Dimmock, K., & Tiyce, M. (2001). Festivals and Events: Celebrating Special Interest Tourism. In N. Douglas, N. Douglas, & R. Derret (Eds.), *Special Interest Tourism. Context and cases* (355-383). Singapore: John Wiley.

Dinpashoh, Jhajharia, D., Fakheri-Fard, A., Singh, V.P., Kahya, E (2011): Trends in reference crop evapotranspiration over Iran J. Hydrol., 399, pp. 422-433

Dioha, M. O. and Emodi, N. V. (2018): Energy-climate dilemma in Nigeria: Options for the future. IAEE Energy Forum.

Dixon, J., Gulliver, A. & Gibbon, D. (2001). Farming systems and poverty: improving farmers' livelihoods in a changing world, Rome and Washington, D.C.: FAO and World Bank.

Dlugolecki, A, *et al. (2009):* Coping with Climate Change: Risks and Opportunities for Insurers Chartered Insurance Institute, London.

DMCN (2004): "Coping with floods in Kenya: vulnerability, impacts and adaptation options for the flood prone areas of western Kenya," DMCN-UNEPDMCN-UNEP Project Report, Nairobi, Kenya.

Doberstein, Brent. (2009): "Post-disaster assessment of hazard mitigation for small and medium-magnitude debris flow disasters in Bali, Indonesia and Jimani, Dominican Republic." Natural hazards 50, no. 2: 361-377.

Doberstein, Brent, and Heather Stager. (2013): "Towards guidelines for post- disaster vulnerability reduction in informal settlements." Disasters 37, no. 1: 28-47

Dobson, J., Bright, E., Coleman, P., Durfee, R., & Worley, B. (2000). LandScan: A global population database for estimating populations at risk. Photogrammetric Engineering and Remote Sensing, 66(7), 849-857.

Dogulu, N., Bhattacharya, B., Solomatine, D.P., Bernhofer, C., Bateman, A., Brilly, M (2015): An educational perspective on flood risk management. Conf: 36th | AHR World Congress. At: Den Haag, The Netherlands. Available online: researchgate.net/publication/281238370_An_educational_perspective_on_flood_risk_management

Dolmans, D.H. & Ginns, P. (2005): A short questionnaire to evaluate the effectiveness of tutors in PBL: validity and reliability. Medical Teacher. 27(6), 534-538.

Donald. H., Alam. W., Davied. B., Alistair. G., Andrew. H., and Marion. (2011). Pluvial (rain-related) flooding in urban areas: the invincible hazard. Available at: eprints.gla.ac.uk/162145/7/162145.pdf (Accessed on: July 12, 2019).

Dong Y, Wang Z, Chen Z, Yin D (2009) Centennial fluctuations of flood-season discharge of Upper and Middle Yangtze River Basin, China (1865–1988): cause and impact. Front Earth Sci China China 3(4):471–479

Douglas, I., Alan, K., Magbende, M., MicDonell, Y., Mclean, L., AND Campbell, J., 2008, “Unjust Waters, Climate Change Flooding and the Urban Poor in Africa”. *Environmental and Urbanization* 20 [1], 187-205. http://dx.doi.org/10.117/0956247808089156.

Douglas, I., (2017): Flooding in African cities, scales of causes, teleconnections, risks, vulnerability and impacts. International Journal of Disaster Risk Reduction, 26, pp. 34–42.

Dow, K. and Dowing, T. E. (2006): The Atlas of Climate Change: Mapping the World’s Greatest Change. Brighton: Earthscan, pp. 64 – 77.

Downing, T., Watts, B., and Bohle, H (1999): *Climate change and food security: Toward a geography of vulnerability. Climate change and world food security. NATO ASI Series No. 37. Heidelberg*: Springer-Verlag. Earthwatch (1999) ‘Island, 1, 1996.

Doxiadis, C. A. (1968): Ekistics: an introduction to the science of human settlements. New York: Oxford University Press

Ducrot, R., Bueno, A.K., Barban, V and Reydon, B.P. (2000): Integrating land tenure infrastructure and water catchment management in SăO Paulo’s periphery: Lessons from a gaming approach. Environment and Urbanization, 22 (2): 543-60

Dube, A. Githeko, M. Githendu, P. Gonzalez, D. Gwary, B. Jallow, J. Nwafa, and R. Scholes, (2001): Africa. In: Climate Change 2001: Impacts, Adaptation, and Vulnerability.

Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change [McCarthy, J.J., O.F. Canziani, N.A. Leary, and D.J. Dokken (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 487-531.

Dung-Gwom, J. Y., Hirse, S. O. and Pwat, S. P. (2008): Four Year Strategic Plan For Urban Development And Housing In Plateau State (2008-2011) Submitted To The Plateau State Strategic Plan Committee.

Dung-Gwom. J.Y. & Oladosu, R.O. (2004), „Characteristics and physical panning implications of slums in Jos‟, Jrl. of Envron. Sciences Vol 8(2), 118-127.

Duru, N. P. and Emetumah, C. F. (2016): Evaluating the effects of information literacy on climate change awareness among students in Imo State University. Archives of Current Research International, 4(3), 1-10.

Du W, FitzGerald GJ, Clark M, Hou XY. Health impact of floods. Prehosp Disaster Med. 2010; 25:265–72.

Dwyer L., Forsyth, P., & Spurr, R. (2005). Estimating the impacts of special events on an economy. Journal of Travel Research, 43 (4), 351–359.

Dwyer, L., Mellor, R., Mistilis, N. & Mules, T. (2000a). *A framework for assessing "tangible" and "intangible"* impacts of events and conventions. Event Management, 6 (3), 175-189

Dyson, L.L (2012): *The Heavy Rainfall and Flood of February 2000: AA Synoptic Overview of Southern Africa Floods of February 2000*. Department of Civil Engineering, Pretoria: University of Pretoria.

Dzurec LC, Abraham IL (1993): The nature of inquiry: Linking quantitative and qualitative research. Adv Nurs Sci. 16:73–90.

**E**

East coast pavement services (August 24, 2017): Water's Effect on Asphalt Pavement Deterioration. https://eastcoatpavement.com/blog/2017/08/24/waters-effect-asphalt-pavement-deterioration.

Easterling D.R., Meehl G.A., Parmesan C., Changnon S.A., Karl T.R., Mearns L.O (2000): Climate extremes: observations, modeling, and impacts. Science 289:2068–2074

Ebele, N. E. and Emodi, N. V. (2016): Climate change and its impact in Nigerian economy. Journal of Scientific Research & Reports, 10(6), 1-13Ebhuoma, E. (2018). Why trivializing people's culture can be catastrophic for the effective communication of extreme weather warnings: Lessons from the Delta State of Nigeria. In *Proceedings* *of the international crisis and risk communication conference* (pp. 38–41).EC (European Commission) (2004): Flood risk management – Flood prevention, protection and mitigation, Communication from the Commission to the Council, the Europeans Parliament the European Economic and Social Committee and the Committee of the Regions

Ebhuoma, E & Leonard, L (2020): An operation framework for communicating flood warnings to indigeneous farmers in Southern Nigeria: a system thinking analysis. *GeoJournal.*

Eboh, E. & Diejomaoh, I. (2010). "Local Governments in Nigeria: Relevance and Effectiveness in Poverty Reduction and Economic Development." Journal of Economic and Sustainable Development, Vol.1, (1), 12-28

Ebhuoma, E., & Leonard, L (2021): An operational framework for community flood warnings to indigenous farmers in southern Nigeria: a system thinking. GeoJournal 86 (4). Available online: https://www.researchgate.net/publication/341450577_An_operational_framework_for_communicating_flood_warnings_to_indigenous_farmers_in_southern_Nigeria_a_systems_thinking_analysis

EC (European Commission) (2004): Flood risk management – Flood prevention, protection and mitigation. Communiucation from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee to the Regions.

Echendu, A.J (2020): The impact of flooding on Nigeria's sustainable development goals (SDGs), Ecosystem Health and Sustainability, 6:1, DOI: 10.1080/20964129.2020.1791735.

Economic Section, United States Embassy in Nigeria (2011): Nigeria Malaria Fact Sheet: http://nigeria.usembassy.gov.

Edith O.A & Vincent N.O (2016). Concequences of rural-urban migration on the source region of Ughievwen clan Delta State Nigeria. Eur. Jou. of Geogr. Vol 7(3). Pp. 42-57

Edward – Adebiyi, R. (1997). "The Story of Ogunpa". The Guardian, Saturday, May 17, pp.5.

Edwards, P.J., Roberts, I., Clarke, M.J., DiGuiseppi, C., Wentz, R., Kwan, I., Cooper, R., Felix, L.M. & Pratap, S. (2009): Methods to increase response to postal and electronic questionnaires. Cochrane Database of Systematic Reviews, [online]. Issue 3. Art. No.: MR000008. Available at: https://researchonline.lshtm.ac.uk/5119/1/Edwards_et_al-2009-_The_Cochrane_library.pdf.

Egbenta, I.R., Udo, G.O. & Otegbulu, A.C., (2015): Using hedonic price model to estaimate effects of flood on real property value in Lokoja Nigeria. Ethiopian Journal of Environmental Studies and Management, 8(5), pp. 507–516, 2015.http://dx.doi.org/10.4314/ejesm.v8i5.4

Egbinola, C.N & Amobichukwu, A.C (2013): Climate Variation Assessment Based on Rainfall and Temperature in Ibadan, South-Western, Nigeria. Jon of Env. And arth Sci. Vol 3 (11)

Egbinola, C. N., Olaniran, H. D., & Amanambu, A. C. (2017): Flood management in cities of developing countries: the example of Ibadan, Nigeria. Journal of Flood Risk Management, 10(4), 546–554. https://doi.org/10.1111/jfr3.12157

Eguaroje O., Alaga T., Ogbole J., Omolere S., Alwadood J., Kolawole I. etr al., (2015).'Flood vulnerability assessment of Ibadan City, Oyo state, Nigeria', *World Environment* 5, 149-159.

Egunjobi, L. (2002): Planning the Nigerian Cities for Better Quality of Life, in Onakomaiya S.O. & Oyesiku O.O. (eds), Environment, Physical Planning and Development in Nigeria, Department of Geography and Regional Planning, Olabisi Onabanjo University, Ago-Iwoye, Nigeria, pp. 89-107.

Ehrlich, P. R. (1968). Population control or race to oblivion? The population Bomb. New York: Ballantine Books.

EITEL, B. & OCHOLA, O. 2006. Integrated flood hazard, risk and vulnerability assessment in Nyando Basin, Kenya: options for land use planning. [Web:] http://www2.geog.uni-heidelberg.de/ physio/forschung/nyandobasin.htm [Date of access: 4 Jan. 2010].

Ejaz, N., Akhtar, N., Nissar, H., & Ali Naeen, U (2010): Environmental impacts of improper solid waste management in developing countries: a case study of Rawalpindi City. WIJ Transactions on Ecology and the Environment. Vol 142.

Ejieji CJ. 2011. Performance of Three Empirical Reference Evapotranspiration Models under Three Sky Conditions using two Solar Radiation Estimation Methods at Ilorin, Nigeria. Agricultural Engineering International: CIGR Journal 13(3): 1-21

Ejike, E. (2014). Leadership. "Nigeria Ranks 136th Most Corrupt Country In Latest Global Corruption Index" Cited in http://leadership.ng/news/392876/nigeria-ranks-136thcorrupt-country-latest-global-corruption-index. retrieved 14/07/15

Ekoko, A. E. (1990): The historical and socio-political environment of Nigerian defence policy. In A. E. Ekoko, & M. A. Vogt. (Eds.). Nigerian defence policy: Issues and problems. Lagos: Malthouse press.

Ekpo, K (2018): School plant maintenance culture and utilization in book (chapter 10): Handbook on educational planning and policy analysis. Available online: researchgate.net/publication/332803969_School_Plant_Maintenance_Culture_and_Utilization

Ekwe, M.C., Joshua, J.K., Igwe, J.E & Osinowo, A.Y (2014): Mathematical study of monthly and annual rainfall trends in Nasarawa State, Nigeria. IOSR Journal of Mathematics (IOSR-JM) V 10 (1) PP 56-62.

Elisha, A.A and Abiodun, D.O (2017): Statistical Analysis of Rainfall Trend in Akure, Ondo State, Nigeria. Analele Universităţii din Oradea, Seria Geografie, Year XXVII, no.

Elisha, I. et al. (2017): Evidence of climate change and adaptation strategies among grain farmers in Sokoto State, Nigeria. IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT), 11(3), 1-7

Elmqvist. T, Fragkias .M, Goodness. J, Güneralp. B, Marcotullio. P.J, McDonald. R.I, Parnell. S, Schewenius .M, Seto.M. S, Wilkinson.K.C (Eds.) (2013). Urbanization, biodiversity, and ecosystem services: challenges and opportunities, Springer, New York

Eludoyin, A. O. Akinbode, M. O. and Okuku, E. (2007). “Combating flood crisis with geographical information system: An Example from Akure, Southwestern Nigeria”, *International Symposium on New Directions in Urban Water Management*, UNESCO Paris.

Eludoyin, O (2009): Monthly variation in the 1985-1994 and 1995-2004 rainfall distribution over five selected synoptic stations in Western Nigeria. Nigeria Journal of Meteorology and Climate Science, 7: 11-22

Eludoyin, O.M & Adelekan. I.O (2012): The physiologic climate of Nigeria. Int J Biometeorol 52 (2). Available Online: researchgate.net/publication/225049504_The_Physiologic_Climate_of_Nigeria

Eludoyin, A.O., Nevo, A.O., Abuloye, A.P., Eludoyin, O.M. and Awotoye, O.O. (2017): ‘Climate events and impact on cropping activities in a part of southwest Nigeria’, Weather, Climate and Society, Vol. 9, No. 2, pp. 235-253.

Elum, Z. A. and Simonyan. J. B. (2016). Analysis of Nigerian insurers’ perceptions of climate change, SAJEMS NS, 19(4), 549-561. http://dx.doi.org/10.17159/2222-3436/2016/v19n4a6

Elum, Z. A. and Momodu, A. S. (2017). Climate change mitigation and renewable energy for sustainable development in Nigeria: A discourse approach. Renewable and Sustainable Energy Reviews 76, 72–80Emmanuel el. I., Giulia, D., Katia, F.I., Chiara, B., Federica, C (2020): Operational framework for flood risk communication. Inter. Jour, of Disaster Risk Reduction v 46

Emmanuel MR (2005). An Urban Approach to Climate-Sensitive Design; Strategies for the Tropics, London, Spon Press.

EM-DAT, (2012). The OFDA/CRED International Disaster Database Université Catholique de Louvain, Brussels (Belgium)

EM-DAT (2015): *The human cost of weather-related disasters, 1995-2015*, Centre for Research on the Epidemiology of Disasters, UN Office for Disaster Risk Reduction (UNODRR), Brussels, pp. 1-25.

EM-DAT: The OFDA/CRED I nternational Disaster Database, www.emdat.be-Université Catholique de Louvain-Brussels-Belgium.

EM-DAT Database (1900-2019). Available at: https://www.emdat.be/emdat_db/ (Accessed on: Nov 25th , 2019).

EM-DAT (2015): *The human cost of weather-related disasters, 1995-2015*, Centre for Research on the Epidemiology of Disasters, UN Office for Disaster Risk Reduction (UNODRR), Brussels, pp. 1-25.

EMDAT (CRED) (2016): Annual Disaster Statistical Review 2016. Debarati, G., Philippe, H., Pascaline, W., Regina, B (2016). Available at: https://www.emdat.be/sites/default/files/adsr_2016.pdf

Emeka, N, Eric E, Nweze N.J. (2015) "Status and Trends of deforestation: An Insight and Lessons from Enugu State, Nigeria" Net Journal of Agricultural Science, Vol 3, No 1: 23-31.

Emodi, E.E.)2012). The Menace of Flood in Nigeria: Impacts and Rehabilitation Strategies. *Journal of Environmental Management and Safety*. Centre for Environment and Population Activities. www.cepajourna.com.

Emrish, C.T., & Cutter, S.L (2011): Social vulnerability to climate-sensitive hazards in the Southern United States. Weather Clim. Soc. 3: 193-208

Eneji, C.V. O., Eneji, J.E.O, V.Ngoka, and Abang, M . (2016): "Attitude Towards Waste Management and Disposal Methods and the Health Status of Cross River State, Nigeria." *SCIREA Journal of Agriculture* 1 (2): 231-247.

Enete IC (2014): Impacts of climate change on agricultural production in Enugu State, Nigeria. Journal of Earth Science & Climatic Change, 5(9), 234

Engelbrecht. R., Geissbuhler, A and Lovis, C. (Eds) (2005) Connecting medical informatics & bioinformatics: Proceedings of MIE 2005: the X1Xth International Congress of the European Federation for Medical Informatics. England. IOS Press. Available at http://books.co.tz/books?id=mJT1hoe6t4wC&printsec on June, 03, 2013.

Environment Agency (2011): National flood and coastal erosion risk management strategy for England. https://www.gov.uk/government/publications/national-flood-and-coastal-erosion-risk-management-strategy-for-england.

EPA (2011): Understanding the Risks, Empowering Communities, Building Resilience: The National Flood and Coastal Erosion Risk Management Strategy for Erosion Risk Management

Epstein, P.R., 2002. Climate change and infectious disease: Stormy weather ahead? Epidemiology, 13: 373-375.

Erhun, M.O (2015): The Relevance of Culture to the Socio-Economic Growth and Development in Nigeria: A Legal Perspective. Journal of Culture, Society and Development. An international peer review Journal Vol 9

ESCAP/UNDP. (1991): Manual and guidelines for comprehensive flood loss prevention and management. UN-ESCAP, Bangkok, Thailand;92p.

Etannibi, E.O.A. (2002): Tracking Corruption and Abuse of office in a Democratic Society. Equal Justice: A Quarterly Publication of Human Rights Monitor. 2(7), July.

Ettlinger N (2007) Precarity unbound. Alternatives: Global, Local, Political 32(3): 319–340.

Etuonovbe, A. K. (2011). "The Devastating Effect of Flooding in Nigeria." Paper presented at the FIG working week, Maputo.

Etuonovbe, A.K. (2011). *The devastating effect of flooding in Nigeria. Hydrography and Environment Innocent Chirisa, Zimbabwe Inclusive Cities and Housing: Analysis of stewardship instruments in Epworth, Zimbabwe FIG Working Week*. Bridging the Gap between Cultures Marrakech, Morocco, 18-22 May 2011.

European Parliament Council (2007): Directive 2007/60/Ec of the European Parliament and of the council of 23 October 2007 on the assessment and management of flood risks.

Evengard, B. and R. Sauerborn, 2009. Climate change influences infectious diseases both in the Arctic and the tropics: Joining the dots. Global Health Action, 10.3402/gha.v2i0.2106

Evan, A (2018).'History stories: The World's Most Catastrophic Flood in Photos.' https://www.history.com/news/worlds-most-catastrophic-floods-in-photos. (Accessed on: June 4, 2019).

Ezeaku, C. (October 4 2017). “Flooding: Causes, Prevention And Solutions.” *The Tide*. http://www.thetidenewsonline.com/2017/10/04/flooding-cause-prevention-and-solution/Ezekiela, A.A., Ajibefunb, I.A., Akinnirana, T.N., & Ogunwole-Olapadea, F. (2016): EconomicValue of Crop Productivity Biodiversity in Ijebu Ode Agricultural Zone of Ogun State, Nigeria. Sociology, 6(2), 111-123.

**F**

Fabiyi, Y.L. (1984) “Land administration in Nigeria: Case studies of the implementation of the land use decree (Act) in Ogun, Ondo and Oyo States of Nigeria.” Agricultural Administration 17(1): 21-31.

Fadairo, G., & Ganiya, S.A (2010): Effects of flooding on the built environmrnt in Akure Nigeria. In West Africa built environment research (water) conference pp. 281

Falade, J.B. (2001). Amenity and Open Spaces Contents of Nigerian Planning Legislation. A Paper Presented at the Policy Seminal in Environmental Issues and Management in Nigerian Development Held at the Department of Geography University of Benin 4th-7th April 2001.

Fahm, A.O. (2015): Ijebu Ode’s Ojude Oba Festival: Cultural and Spiritual Significance. SAGE Open, 5(1), 1-11. DOI: 10.1177/2158244015574640

Famakinwa, M., Adisa, B.O., & Alabi, D.L (2019): Factors influencing role of performance of community leaders in rural development activities in Southwestern Nigeria. Acta Universitasis Agriculturae et Silviculturae Mendehanae Brunensis 67 (20.

Fan, L., Liu, G., Wang, F., Geissen, V. & Ritsema, C. (2013): Factors Affecting Domestic Water Consumption in Rural Households upon Access to Improved Water Supply: Insights from the Wei River Basin, China. PloS One. 8. e71977.

Fan, Z., Thomas, A., (2012): Spatiotemporal variability of reference evapotranspiration and its contributing climatic factors in Yunnan province, SW China, 1961–2004. Climatic Change, DOI 10.1007/s10584-012-0479-4.

FAO/UNEP. (1997). Negotiating a sustainable future for land. Structural and institutional guidelines for land resources management in the 21st century. FAO/UNEP, Rome.

Faurata, B.K., Idrisa, Y.L., Egbule, C.L., and Agu, V.C., (2011): Climate Change and Adaptation Measures in Northern Nigeria: Empherical Situation and Policy Implications. *African Technology Policy Studies Network*. Working Paper Series: No. 62 (pdf).

Farrell, K. (2018). “An Inquiry into the Nature and Causes of Nigeria’s Rapid Urban Transition.” *Urban Forum 29*: 277-298.

Fatile, J.0 (2012): Corruption and the challenges of good governance in the Nigerian public sector. Africa's public service delivery and performance review 1 (3): 46

Farmer G. and Wigley. T.M.L. (1985). Climatic Trends for Tropical Africa. A research report for the Overseas Development Administration. 136 pp.

Fasakin, J.O., (2009): Physical Development Strategies for Ondo State, A Paper Presented at the Stakeholders Forum, Organized by, the Ondo State Ministry of Physical Planning and Urban Development, 2-7, Akure, Nigeria

Fayemi, J.A. (2020): Effects of Climate Change and Global Warming on Sustainable Development and Socio-Economic Life of Ijebu-Ode Indigenes of Nigeria. *Journal of Sustainable Development in Africa*, 22(1), 95-103

Fazey, I., Fazey, J., Fischer, J., Sherren, K., Warren, J., Noss, R. and Dovers, S. (2007): Adaptive capacity and learning to learn as leverage for social-ecological resilience. Frontiers in Ecology and the Environment, 5 (7): 375-380

Fazey I, Wise RM, Lyon C, Câmpeanu C, Moug P, Davies TE (2016): Past and future adaptation pathways. Clim Dev 8(1):26–44. https://doi.org/10.1080/17565529.2014.989192

Federal Government of Nigeria. (2013): Nigeria Post-Disaster Needs Assessment – 2012 Floods.

Federal Government of Nigeria (1997). Drought Management in Nigeria; What can people do to minimize its impact? Abuja: Federal Ministry of Environment

Federal Ministry of Information (1999): Nigerian handbook. Ikoyi, Lagos. FMI.

Federal Ministry of Environment (2014). United Nations Climate Change Nigeria. National Communication (NC). NC 2. 2014. https://unfccc.int/sites/default/files/resource/nganc2.pdf

Federal Republic of Nigeria (June, 2013): Final Report: State and Local Governance Reform. Retrieved from: documents.worldbank.org/curated/en242881146809683997 1/E42560EAOP113300 00PUBLICOOBOX3797948.pdf.

Federal Government of Nigeria. (2013). Nigeria Post-Disaster Needs Assessment – 2012 Floods. https://www.gfdrr.org/sites/gfdrr/files/NIGERIA_PDNA_PRINT_05_29_2013_WEB.pdf

Federal Ministry of Environment (2014). United Nations Climate Change Nigeria. National Communication (NC). NC 2. 2014.

https://unfccc.int/sites/default/files/resource/nganc2.pdfFederal Republic of Nigeria Budget (2013): www.fgnbudget.com.ng

Federal Republic of Nigeria. (2007). Official gazette on the breakdown of the national and state provisional totals of 2006 census, S.I No. 23 of 2007; 94(24). Lagos.

Federal Research Division (2008): *Country Profile: Nigeria*. Library of Congress- Federal Research division, July 2008. Pp. 7-8.

Fekade, W. (2000). Deficits of formal urban land management and informal responses under rapid urban growth, an international perspective. Habitat International, 24(2), 127-150

Felsenstein, D. (2003): Local festivals and tourism promotion: The role of public assistance and visitor expenditure. Journal of Travel Research, 41 (4), 385-392

Fendler R (2008): Floods and safety of establishments and installations containing hazardous substances conclusions on a research project of the German Umweltbundesamt. Nat Hazards 46:257–263

Feng X., Porporato A., Rodriguez-Iturbe I (2013): Changes in rainfall seasonality in the tropics. Nat Clim Chang 3:811–815

Fernandez M, Hamilton H, Kueppers LM. (2013): Characterizing uncertainty in species distribution models derived from interpolated weather station data. *Ecosphere.*4

Fernández-Llamazares Á, Méndez-López E, Díaz-Reviriego I, McBride M, Pyhälä A, Rosell-Melé A, Reyes-García V. (2015): Links between media communication and local perceptions of climate change in an indigenous society. *Climatic Change.* 131:307–320.

Fetter, C.W. (1988). Applied Hydrogeology. Prentice Hall, Upper Saddle River, New Jersey.

Few R, (2003).'Flooding, vulnerability and coping strategies: Local responses to a global threat', *Progress in Development Studies* 3, 43-58.

Few R, Ahern M, Matthies F, Kovats RS. Floods, health and climate change: a strategic review. Tyndall Centre Working Paper 63. Norwich: University of East Anglia; 2004.

Few, R. and Matthies, F., (2006): Flood hazards and health: responding to present and future risks, Earthscan: London

FEW, R., AHERN, M., MATTHIES, F. & KOVATS, S. 2005. Health and flood risk: A strategic assessment of adaptation processes and policies. Tyndall Centre for Climatic Change Research; Technical report 17; project T3.31. University of East Anglia (UEA). [Web:] http://ceh.resourcehub.ssrc.org/ health-and-flood-risk-a-strategic-assessment-of-adaptation-processes-and-policies/resource_view [Date of access: 26 Mar. 2010].

Few, R., H. Osbahr, L.M. Bouwer, D. Viner and F. Sperling (2006): "Linking climate change adaptation and disaster management for sustainable poverty reduction". Synthesis Report for Vulnerability and Adaptation Resource Group (VARG). Available at: ec.europa.eu/development/icenter/.../env_cc_varg_adaptation_en.pdf

FGN. (2013). "Nigeria Post-disaster Needs Assessment." *A Report by the Federal Government of Nigeria, with Technical Support from the European Union, United Nation, World Bank, and other Partners, Nigeria Post-Disaster Need Assessment 2012*, 154.

Fielding, J.L (2012): Inequalities in exposure and awareness of flood risk in England and Wales Disasters, 36 (3) (2012), pp. 477-494.

Figueiredo E, Valente S, Coelho C, Pinho L. (2009): Coping with risk: analysis on the importance of integrating social perceptions on flood risk into management mechanisms - the case of the municipality of Agueda, Portugal. Journal of Risk Research, 2009; 12 (5):581-602.

Filatova T, Mulde JPM, van der Veen A (2011) Coastal risk management: how to motivate individual economic decisions to lower flood risk. Ocean Coast Manag 54(2):164–172

Fisher, J.B., Whittaker, R.J., Malhi, Y., (2011) ET come home: Potential evapotranspiration in Geographical Ecology. Global Ecological Biogeography 20: 1–18.

Fitzgerald.G, W Du, Jamal. A, Clark. M, Hou X.Y. (2010). Flood fatalities in contemporary Australia (1977-2008). Emerg. Med. Austral., Volume 22. Pp.180-186.

Flemming G. (2002). How can we learn to live with rivers? The findings of The Institutions of Civil Engineers Presidential Commission on flood risk management. Philos Trans Ser A Math Phys Eng Sci 360 (1766): 1527-1530. http://doi.org/ 10.1098/rsta.2002.1014.

Flohn, H (1971): Tropical Circulation Pattern. Bonn: Bonnerk, Meteorology, Abah Publishers.

Floods and Rainstorms Impacts, Responses and Coping Among ... - MCSER. https://www.mcser.org/journal/index.php/jesr/article/download/435/452

Floodsite (2006): Guidelines for socio-economic flood damage evaluation. T9-06-1.

Floodlist (2016): West Africa – Deadly floods in Mali and Burkina Faso. Available at: floodlist.com/Africa/west-africa-nigeria-mali-burkina-faso-august-2016.

Floodlist (2019): 8 killed in Burkina Faso Floods. Available at: floodlist.com/Africa/8-killed-burkina-faso-floods.

FME (Federal Ministry of Environment) (2012): Bulletin on Ecological Disasters, Abuja, Nigeria. FME

Folland, C. K., Palmer, T. N., Parker, D. E. (1986). Sahel rainfall and worldwide sea temperatures 1901- 85: observational, modelling and simulation studies. Nature, 320:602–607 9

Folorunsho, R. and Awosika, L. (2001): *Flood Mitigation in Lagos, Nigeria through wise management of Solid Waste: a case of Ikoyi Victoria Islands; Nigeria*. Paper Presented at the UNESCO-CSI workshop, Maputo 19-23 November 2001.

Folorunsho R., & Awosika L. (2001, November): Flood Mitigation in Lagos, Nigeria through Wise Management of Solid Waste: a case of Ikoyi and Victoria Islands; Nigerian. UNESCO-CSI workshop, Maputo.

Fominyen, George (4 September 2009). "West Africa's seasonal floods in 2009". ReliefWeb. Archived from the original on 8 September 2009.

Food and Agriculture Organization of the United Nations (FAO) (1995). *Planning for Sustainable Use of Land Resources.* FAO Land and Water Bulletin 2. 472 pp. Rome: Food and Agricultural Organization of the United Nations [This contribution presents a framework for sustainable development that applies to areas where agriculture is the dominanat activity]

Food and Agriculture Organization of the United Nations (2016): National Policy on the Environmental (Revised 2016). Available online: leap.unep.org/countries/ng/national-legislation/national-policy-environment-revised-2016

Ford, J.D., & Smith, B (2004): A framework for assessing the vulnerability of communities in the Canadian artic to risks associated with climate change. Arctic. 57: 389-400

Fordham M (1998) Participatory planning for flood mitigation: models and approaches. Aust J Emerg Manag 99: 27-34

Fowe, T, Abdoulaye, D, Rodrigue, F.W.K, Boubacar, I, Maimouna, B.T, Karim T, Harouna K (2018): Trends in flood events and their relationship to extreme rainfall in an urban area of Sahelian West Africa: The Case Study of Ouagadougou, Burkina Faso, Jou. of Flood Risk MGT/ V (12) Issue S1. Available at: https://doi.org/10.1111/jfr3.12507

Fox, S. (2014): The Political Economy of Slums: Theory and Evidence from Sub-Saharan Africa. World Dev. 54, 191–203.

Fox, S and Goodfellow, T. (2012): *Cities and development*. 2nd ed. Abingelon: Routeledge.

Francés, F: (2004) Flood frequency analysis using systematic and non-systematic information. In: Systematic, Palaeoflood and Historical Data for the Improvement of

Flood Risk Estimation. Methodological Guidelines (ed. by G. Benito & V. R. Thorndycraft), 55–70. Centro de Ciencias Medioambientales, Madrid, Spain.

Fredrick O.K. and Beneah D.O.O (2018): Relationship between Flooding and Outbrek of Infectious Disease in Kenya: A Review of the Literature. Jou. of Environ. And Pub. Health V (2018) 8 pages. https://dio.org/10.1155/2018/5452938

Frei C, Schär C, Lüthi D, Davies HC (1998) Heavy precipitation processes in a warmer climate. Geophys Res Lett 25: 1431-4434.

FREITAS MAS (2005): Um sistema de suporte à decisão para o monitoramento de secas meteorológicas em regiões semiáridas. Rev. Tecnol. (suppl 19): p. 84-95.

Frhd Nwanolue, B.o.g., & Iwuoha, V (2012): From Monopolism to Competitionism: A Market Analysis of The Performance of The Nigeria Postal Service, 1985-2011. European Journal of Business and nManagement V 4 (7).

FRN (2021): Nigeria's Adaptation Communication to the United Nations Framework Convention on Climate Change. Available online: unfcc.int/sites/default/file/resource/Nigeria%20Final%20ADCOM%%20Report.pdf

Frost, J (2018): Measures of variability, Range, Interquartile Range, Variance and Standard Deviation. Available online: statiticsbyjim.com/basics/variability-range-interquartile-variance-standard-deviation (Accessed December 10, 2022)

Fu .P, Weng .Q (2016). A time series analysis of urbanization induced land use and land cover change and its impact on land surface temperature with Landsat imagery**.** Remote Sensing of Environment, 175 (2016), pp. 205-214

Fuentes, U., and Heimann, D. (1999): An improved statistical-dynamical downscaling scheme and its application to the alpine precipitation climatology. Theoretical and Applied 610 Climatology, pp.119-135

Funk, T. (2006). Heavy Convective Rainfall Forecasting: A Look at Elevated Convection, Propagation and Precipitation Efficiency. In Proceedings of the 10th Severe Storm and Doppler Radar Conference. Des Moines, IA: National Weather Association.

**G**

Gagné, R.M., (1968): Contributions of Learning to Human Development. Psychological Review, 75(3), 177-191.

Gagné, R. M., (1970): The conditions of learning. 2nd ed. Oxford, England: Holt, Rinehart & Winston.

Gailard, J.C (2010): Vulnerability, capacity and resilience: Perspectives for climate and development policy. Jou of Int. Dev V 22 (2), pages 218-232.

Gailard, J.C., Cadag, J.R.D., Rampengan, M.M.F (2019): People's capacities in facing hazards and disasters: an overview. National Hazards (2019) 95:863-876https://doi.org/10.1007/s11069-018-3519-1

Gallopin, G. C. (2006). Linkages between vulnerability, resilience and adaptive capacity. Journal of Global Environmental Change. 16: 293-303.

Garcia RA, Cabeza M, Rahbek C, Araujo MB. (2014): Multiple Dimensions of Climate Change and Their Implications for Biodiversity. *Science.*;344:486

Gboyega, A. (2001). Local Autonomy in Federal politics: The Nigerian Local Government System in Historical Perspective", Being a paper presented at an International Conference on New Directions" Federalism in African, Abuja Nigeria.

Gebremedhin, K., Shetty, A., Nandagiri, L (2016): Analysis of variability and trends in rainfall over northern Ethiopia Arab J Geosci, 9 (451) https://doi.org/10.1007/s12517-016-2471-1

Gebremedhin, E.T, Basco-Carrera, L., Jonoski, A., Iliffe, M., & Winsemius, H. (2020). Crowdsourcing and interactive modelling for urban flood management. Journal of Flood Risk Management,13(2), e12602. https://doi.org/10.1111/jfr3.12602

Geisen, E (2018): How to Ask Sensitive Survey Questions. Available online: Qualtrics.com/blog/how-to-get-the-truth-when-asking-survey-questions-about-sensitive-topics/

Getachew K.W., Tamene A.D (2015). Assessment of the Effects of Urban Road Surface Drainage. A case Study of GinjoGuduruKebele of Jimma Town. International Journal of Science, Technology and Safety. Vol 3 (4). Pp. 164-173.

Getis, A., Getis, A. and Fellman, J.D. (1998), Introduction to Geography. WCB Mc Graw Hill.

Ghana UNCT. Ghana-Floods Sanitation Report. 2015. Retrieved from https://www.humanitarianresponse.info/en/system/files/documents/files/unct_sitrep-accra_floods_08062015.pdf

Ghauri, P., & Gron hang, K (2005): Research Methods in Business Studies Harlow, FT/Prentice Hall

Ghebru, H., H. Edeh, D. Ali, K. Deininger, A. Okumo, and S. Woldeyohannes. (2014): Tenure Security and Demand for Land Tenure Regularization in Nigeria. Nigeria Strategy Support Program (NSSP) Working Paper 25. Abuja: International Food Policy Research Institute.

Giddings, S. W., (2007): *Housing challenges and opportunities in Sub Saharan Africa*, International housing coalition, Washington, DC.

Giffin, K. & B. R. Patten. (1976): Basic Readings in Interpersonal Communication: Theory and application. New York: Harper & Row.

Giles, W.F., & Field, H.S (1978): Effects of amount, format, and location of demographic information on questionnaire return rate and response bias of sensitive and non-sensitive items. Personell Psychology, 31, 544-559

Gilissen, H. K., Alexander, M., Matczak, P., Pettersson, M. & Bruzzone, S. (2016). A framework for evaluating the effectiveness of flood emergency management systems in Europe. www.ecologyandsociety.org/vol21/iss4/art27/

Giorgi, A (1992): Description versus interpretation: competing alternative strategies for qualitative research. *J. Phenomenon. Psych. 23*: 119-135

Giorgi, F., Hewitson, B.C., Christensen, J., Hulme, M., von Storch, H., Whetton, P., Jones, R., Mearns, L., Fu, C. (2001): Regional climate information – evaluation and projections. In Climate Change 2001: The Scientific Basis. Contribution of Working Group i to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Houghton, J.T., Ding, Y., Griggs, D.J., Noguer, M., van der Linden, P.J. (eds). Cambridge University Press: Cambridge, New York, USA; 881.

Giorgio, C., Romeo, B., Maarco, C., (1994): Survey of Aedes alboctus (Skuse) (Diptera: Culicidae) infestation in Desenzano Del Garda Brescia Province, Italy). Institute of Entomology "G. Grandi", University of Bologna Journal, 48: 211-217.

GITHIRA, D.N. (2016): Growth and eviction of informal settlements in Nairobi. Unpublished Master's thesis. Faculty of Geo-Information and Earth Observation, University of Twente, Enschede, The Netherlands.

Glaser, R., Riemann, D., Schönbein, J., Barriendos, M., Brázdil, M., Bertolin, C., Camuffo, D., Deutsch, M., Dobrovolný, P., van Engelen, A., Enzi, S., Halíčková, M., Koenig, S.J., Kotyza, O., Limanówka, D., Macková, J., Sghedoni, M., Martin, B., Himmelsbach, I (2010): *The variability of European floods since AD 1500*. Clim. Change, 101 (2010), pp. 235-256, 10.1007/s10584-010-9816-7

Glenwick, D.S. (2016): Handbook of Methodological Approaches to Community based Research: Qualitative, Quantitative, and Mixed Methods. Oxford, Oxford University Press.

Global Facility for Disaster Reduction and Recovery (GFDRR) (2011b): *Ghana Country Program for Disaster Risk Management and Climate Adaptation*, World Bank/ GFDRR and UNDP, Accra.

GNF. (2002). Wetland Restoration and Degradation, Global Nature Fund, International. Available at: http://www.globalnature.org/34235/Wetland.Restoration/Degradation/02_vorlage.asp.

Gomez, K.A and Gomez, A.A (1984): Statistical procedure for agricultural research. 2nd ed. John Wiley and Sons, New York, NY.

Gossling, SG (2002). Global Environmental Consequences of Tourism. Global Environmental Change 12: 283-302.

Goswami U.D (2000): a study on some features of surface air temperature over Assam, M. Ph. Dissertation, Gauhati University

Goudie, A. (1997). The Human Impact Reader: Readings and Case Studies. Blackwell Publishers.

Goula, B.T.A, Soro, E.G, Kouassi, W, & Srohourou, B (2012): Tendences et ruptures aunivendes pluies journaliẽmes extrẽmes en Cote D' ivoire (Afrique de I' Quest). *Hydrological Science Journal*, 57 (6), 1067-1080

Gouldby B. & Samuels P. (2005) Language of risk: project definitions, FLOOD site project, report: T32- 04-01, HR Wallingford, UK.

Grace U.M, Sawa B.A, Jaiyeola I.A (2015). Multi-Temporal Remote Sensing of Land Dynamics in Zaria, Nigeria. Jou. of Enviro. And Earth Sci. Vol 5 (9).

Granger, K.; Jones, T.; Leiba, M.; Scott, G. (1999): Community Risk in Cairns: A Multi-Hazard Risk Assessment; AGSO (Australian Geological Survey Organisation): Canberra, Australia, 1999.

Graphiconline.com. Flood disaster profile of Ghana since 1968. Retrieved fromhttp://www.graphic.com.gh/news/general-news/flood-disaster-profile-of-ghana.htmlOn 13th June 2016.

Green D, Raygorodetsky G. (2010): Indigenous knowledge of a changing climate. *Climatic Change.*;100:239–242.

Griffith, C. (2009): Introduction to the Issue UGEC Viewpoints | No. 2 | September 2009

Groisman PYA (1999) Changes in the probability of heavy precipitation: Important indicators of climatic change. Clim Change 42: 243-283.

Grothmann T, Patt A (2005) Adaptive capacity and human cognition: the process of individual adaptation to climate change. Glob Environ Change 15:199–213

Grubbs FE. (1996): Procedures for detecting outlying observations in samples. Techno metrics 11: pp 1–21.

Guha-Sapir, D., P. Hoyois and R. Below, 2013. Annual disaster review 2012: The numbers and trends. Centre for Research on the Epidemiology of Disasters (CRED), Institute of Health and Society (IRSS), Universite catholique de louvain-Brussels, Belgium.

Guisan, A., & Thuiller, W. (2005). Predicting species distribution: offering more than simple habitat models. Ecology Letters, 8(9), 993-1009. doi: 10.1111/j.1461-0248.2005.00792.x

Gupta, A., and Ahmed R (1999): Geomorphology and the Urban Tropics: Building an Interface between Research and Usage. *Geomorphology*. 31 (1-4): 133-49

Guttman, N.B., (1991): 'January Singularities in the Northeast from a Statistical Viewpoint', Journal of Applied Meteorology, 30, 358-367

Gyau-Boakye, P (1997): Flood Control Measures: Hazard Mapping, Water Research Institute of CSIR, Accra.

Gwary, D. (2008). Climate change, food security and Nigeria Agriculture. Paper presented at the Workshop on the challenges of climate change for Nigeria. NISER 19th -20th May 2008.

**H**

Haan, C.T (2002): Statistical Methods in Hydrology lowaState Press.

Habitat, U. N. (2016): "Slums Almanac 2015-16." Tracking Improvement in the Lives of Slum Dwellers. Nairobi

Haerter, J. O., Berg, P. & Hagemann, S. (2010): Heavy rain intensity distributions on varying timescales and at different temperatures. *J. Geophys. Res.* 115, D17102.

Hagemeier-Klose M, Wagner K (2009): Evaluation of flood hazard maps in print and web mapping services as information tools in flood risk communication. Nat Hazards Earth System sciences, 9:563–574.

Hagen-Zanker, Jessica & Rebecca Holmes (2012): Social Protection in Nigeria: Synthesis Report ODA, London.

Hair, J.F., Hult, G.T.M, Ringle, C.M., and Sarstedt, M (2017): A Premier on Partial Least Squares Structural Equation Modelling (PLS-SEM). 2nd Ed. Thousand Oaks, CA: Sage

Halder, H (2019): Climate change in Nigeria: Impacts and responses. Available Online: assets.publishing.service.gov.UK/media/5dcd7a1aed915d0719bf452/675_Climate_Change_in_Nigeria.pdf

Halgamuga, M.N., & Nirmalathas, A (2017): 'Analysis of large flood events. Based on flood data during 1985-2016 in Australia and India'. *International Journal of Disaster Risk Reduction 24*

Hall J.W., Meadowcroft I.C., Sayers P.B. et al. Integrated flood risk management in England and Wales. Nat Hazards Rev 2003, 4, 126–135

Haider, H. (2014): *Conflict sensitivity*. (Topic Guide). Birmingham. University of Birmingham

Hall, J.W et al., (2014): Water security, coping with the course of freshwater variability. *Science* 346, 429-430.

Hallegatte S., Green C., Nicholls R.J. & Corfee-Morlot., (2013).'Future flood losses in major coastal cities', *Nature Climate Change* 3, 802-806.

Hallegatte S., Colin G., Nicholls R.J. & Corfee-Morlot J. (2013): Future flood losses in major coastal cities. Nat Clim Change, 3, (9), 802–806.

Hameed, S and Mixon, K. (2013): *Private-sector development in fragile, conflict-affected, and violent countries*. Washington, DC: Centre for Strategic and International Studies.

Hamilton, R. A., and J. M. Archibold (1945): Meteorology of Nigeria and adjacent territory. *Quart. J. Roy. Meteor. Soc.*, **71,** 231–265.

Hangnon, H., De Longueville, F., & Ozer, P. (*2015*). Précipitations extrêmes et inondations à Ouagadougou: Quand le développement urbain est mal maîtrisé …. In *XXVIIIe Colloque de l'Association Internationale de Climatologie* (pp. 497–502).

Hardoy J.E, Caincross and Satterth Waite D. (1990). The poor die young. Earthscan publication, London.

Harkness, J.A., Edwards, B., Hansen, S.E., Miller, D.R. & Villar, A. (2010): Designing questionnaires for multipopulation research. In: Harkness, J.A., Edwards, B, Johnson, T.T, Lyberg, P., Mohler, P., Penell, E (eds). Survey methods in multinational, multiregional, and multicultural contexts. Hoboken, John Wiley & Sons, pp.31-57.

Hardwick Jones, R., Westra, S. & Sharma, A. (2010): Observed relationship between extreme sub-daily precipitation, surface temperature and relative humidity. *Geophys. Res. Lett.* 37, L22805.

Harvatt J, Petts J, Chilvers J (2011) Understanding householder responses to natural hazards: flooding and sea-level rise comparisons. J Risk Res 14(1):63–83

Hasanean, H. M. (2001). Fluctuations of surface air temperature in the east Mediterranean. Theoret Appl Climatol, 68(1–2):75–87 5.

Hasanain K. A. A (2017): Analysis of Rainfall Seasonality Index in Iraq 191 Vol: 13 No:1, January 2017 DOI: http://dx.doi.org/10.24237/djps.1301.158A P-ISSN: 2222-8373 EISSN: 2518-9255

Hawkins E, Sutton R. (2009): The potential to narrow undertainty in regional climate predictions. *Bulletin of the American Meteorological Society.*90:1095

Haque, C.E. and M.Q. Zaman (1993) 'Human responses to riverine hazards in Bangladesh: A proposal for sustainable floodplain development'. World Development. 21(1). pp. 93–107.

Hartmann DJ, Klein Tank AMG, Rusticucci M, Alexander LV, Brönnimann S, Charabi YA-R, Dentener FJ, Dlugokencky EJ, Easterling DR, Kaplan A, Soden BJ, Thorne PW, Wild M, Zhai P (2013): Observations: atmosphere and surface. In: Stocker TF, Qin D, Plattner G-K, Tignor M, Allen SK, Boschung J, Nauels A, Xia Y, Bex V, Midgley PM (eds) Climate change 2013: the physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, pp 159–254. doi:10.1017/CBO9781107415324.008

Heerwegh, D. & Loosveldt, G. (2008): Face-to-face versus web surveying in a highinternet-coverage population differences in response quality. Public Opinion Quarterly. 72(5), 836-846.

Heitz C, Spaeter S, Auzet AV, Glatron S (2009): Local stakeholders' perception of muddy flood risk and implications for management approaches: a case study in Alsace (France). Land Use Policy 26(2):443–451

Helen Briassoulis. Factors Influencing Land-Use and Land Cover Change. Available at: www.eolss.net/Sample-Chapters/C19E1-05-03.pdf (Accessed on: July 11, 2019) Holdgate M.W (1993). The sustainable use of tourism: A key conservation issue. Ambio, 22 (1993), pp. 481-482

Hellmuth, M. E., Moorhead, A., Thomas, M. C., & Williams, J. (2007): *Climate risk management in Africa: Learning from practice*. New York: International Research Institute for Climate and Society

Helm, P. (1996): Integrated Risk Management for Natural and Technological Disasters. Tephra 1996, 9, 15.

Helsel, D.R., Hirsch, R.M (2002): Statistical Methods in Water resources. Techniques of Water Resources Investigations Description. Book 4. Chapter A3. US. Geological Survey. 522pp.

Henderson, L.J (2004): "Emergency and Disaster: Pervasive Risk and Public Bureaucracy in Developing Nations". Public Organization Review: A Global Journal Vol. 4 pp 103-119

Hesselink, A. W: (2002) History Makes a River. Morphological Changes and Human Interference in the River Rhine, The Netherlands. University of Utrecht, Utrecht, The Netherlands.

Henah, and V. N. Ojeh. (2013) "Geospatial Techniques for the Assessment and Analysis of Flood Risk along the Niger-Benue Basin in Nigeria." *Journal of Geographic Information System* 5 (2): 123.

Henry, U (Vanguard Newspaper, 15th APRIL, 2009): Nigeria: Stunted Growth Blamed on Lack of Continuity

Hewitt, K., (1980). Book review: The environment as hazard. Annals Assoc. Am. Geographers, 70: 306-311.

Hill Strategies (2003). Economic impacts of 97 festivals and events funded by the Ontario Trillium Foundation, the Ontario Arts Council and the Ontario Cultural Attractions Fund. Ontario Trillium Foundation. www.hillstrategies.com

Hirsch, R.M., J.R. Slack, and R.A. Smith (1982): Techniques of trend analysis for monthly water quality data , Water Resources Research 18(1):107-121.

Hollis, G.E. 1992. The causes of wetland loss and degradation in the Mediterranean. In: Finlayson, C.M., Hollis, G.E. and Davis, T.D. (eds), Managing Mediterranean Wetlands and Their Birds. IWRB Special Publication No. 20, pp. 83–90. Slimbridge, UK.

Holloway, I., & Todres, L (2005): The status of method: flexibility, consistency and coherence. In: I Holloway (ed). *Qualitative Research in Health Care (1st edn)*. Berkshire: Open University Press; 90-102

HÖPPNER, C., BUCHECKER, M. AND BRÜNDL, M., 2010. *Risk communication and natural hazards*. CapHaz-Net WP5 report. Birmensdorf, Switzerland: Swiss Federal Research Institute.

Houghton, J.T (2015): Global Warming: The Complete Briefing; Fifth Edition

Houghton, J.T., Meira Filho, L.G., Gallander, B.A., Harris, N., Kattenberg, A., Maskell, K (1996): Climate Change. The IPCC Second Assessment Report. Cambridge University Press, New York (1996) 522 pp.

Houghton, H.W., Colin, C., (1987): Wind-Drive Meridonal Eddy Heat Flux in the Gulf of Guinea. Journal of Geophysical Research. 92: 10777-10786.

Houston, D., Werritty, A., Bassett, D., Geddes, A., Hoolachan, A., and McMillan, M.: Pluvial (Rain-Related). (2011): Flooding in Urban Areas: The Invincible Hazard, Joseph Rowntree Foundation, York, UK, 2011.

Horch, N. (2009): Management control of global supply chains. Berlin, BoD–Books on Demand.

Hosain, M.S and Davis C, G. (2007) "AGIS TO REDUCE Flood Impact on Road Transportation Systems. Bangladesh University Press.

Hsieh, H.F., & Shannon, S.E (2005): Three Approaches to Qualitative Content Analysis. Qualitative Health Research 15 (9): 1277-88

https://www.art.man.ac.uk/planning/care

https://public.wmo.int/en/media/news/updated-30-year-reference-period-reflects-changing-climate

https://data.worldbank.org/country/nigeria?view=charthttps://data.worldbank.org/country/nigeria?view=chart

https://link.springer.com/article/10.1007/s11027-014-9622-z

https://public.wmo.int/en/media/news/updated-30-year-reference-period-reflects

changing-climate

https://www.legit.ing/1114394-flood-nigeria-latest-disaster-happen.html.

https://www.ranked.com/top-10-biggest-and-worst-floos-ever-in-history.

https://answersdrive.com/why-is-the-population-density-important-2984465

https://en.wikipedia/wiki/2007_African_floods # info_from_African_Sources.

https://en-wikipedia.org/wiki/2009_West_Africa_floods

https://www.theguardian.com/global-development/2015/aug/11/burkina-faso-calls-aid-floods-worsen.

https://openknowledge.worldbank.org/bitstream/handle/10986/15811/782620PUB0REVI0C00PUBDATE0603020130.txt?sequence=2

https://www.unicef.org/infobycountry/burkinafaso_51086.html

http://www.e-ir.info/2013/02/04/the-inconsistency-of-the-flood-narrative-in-nigeria/

Huang, J. Z., Li, M. & Cai, L. (2010). A model of community-based festival image. International Journal of Hospitality Management, 29, 254-260.

Hubert, H., (1926): *Nouvelles Études sur la Météorologie de l'Afrique Occidentale Française*. Publications du Gouverneur Général de l'Afrique-Occidentale Française.

Huho, J.M, and Kosnei, R.C (2014): "Understanding extreme climatic events for economic development in Kenya," Journal of Environmental Science, Toxicology and Food Technology, vol. 8, no. 2, pp. 14–24, 2014.

Hulme. M (1996a). Climate change within the period of meteorological records. In W.M. Adams, A.S. Goudie, & A.R. Orme (Eds.). The physical geography of Africa (pp. 88-102) Oxford: University Press.

Hulme, M., Doherty, R., Ngara, T., & New, M. (2005): Global warming and Africa climate change. In A. Low (Ed.), *climate change and Africa* (pp.29-40). Cambridge: Cambridge University Press.

Hunter NM, Horritt MS, Bates PD, Wilson MD, Werner MGF (2005) An adaptive time step solution for raster-based storage cell modelling of floodplain inundation. Adv Water Resour 28:975–991.

Huntington HP, Callaghan T, Fox S, Krupnik I. (2004): Matching traditional and scientific observations to detect environmental change: A discussion on Arctic terrestrial ecosystems. *Ambio.* (suppl. 13):18–23.

Huntington HP. (2011): The local perspective. *Nature.*478:182–183.

Huong, HTL., Pathirina, A (2011): Urbanization and climate change impacts on future urban flood risk in Can Tho city, Vietnam, Hydrology and Earth System Sciences Discussions 8: 10781-10824.

Huq, S. (2011). Improving information for community-based adaptation. London: International Institute for Environment and Development

**I**

IAC (Inter Academy Council) Report (2004). Realizing the promise and potential of African agriculture, Royal Netherlands Academy of Arts and Sciences, NL-1000 GC Amsterdam, The Netherlands.

Ibem, Eziyi Offia (2011): The Contribution of Public-Private Partnerships (PPS) to Improving Accessibility of Low-Income Earners to Housing in Southern Nigeria. Journal of Housing and the Built Environment, 26, 2, 201-217.

Ibitoye, M (2007): The need for planning of peri-urban growth in south western Nigeria: the surveyors' perspective. Symposium organized by the Nigerian Institution of Surveyors (NIS). University of Lagos, Lagos.

Ibok, E. E. (2014). "Local Governance and Service Delivery in Nigeria." Caribbean Journal of Science and Technology, Vol.2, 536-541.

Ibrahim, A, Iheanacho, A.C and Bila, Y. (2015) "Economic Analysis of Causes and Impact of Deforestation in Nigeria" Journal of Agricultural Economics and Social Sciences, vol 1, no 1: 142-150.

Ibukun, W.O., & Aboluwodi (2010): Nigeria National Policy on Education and the University Curriculum in History. Implication for nation building. *Jou of Educ. And Prac. 1, 2.* www.iiiste.org

ICSE (2000). International Council for Science and the Environment: Recommendations for Improving the Scientific Basis for Environmental Decision Making. December 2000

Idowu OA, Adeleke MA, Aina TM. Assessment of indoor breeding activities of mosquitoes during the dry season in Abeokuta, Southwestern/ Nigeria. J Environ Health Res. 2012;12(1):25–30.

Ignatowski JA, Rosales J. (2013): Identifying the exposure of two subsistence villages in Alaska to climate change using traditional ecological knowledge. *Climatic Change.*121:285–299.

Ifeanyi-obi, C.C. and Nnadi, F.N. (2014). Climate change adaptation measures used by farmers in Southsouth Nigeria. Journal of Environmental Science, Toxicology and Food Technology, 8(4)

Ifeka, A., Akinbobola, A., (2015a): Trend analysis of precipitation in some selected stations in Anambra state. Atmos. Clim. Sci. 5, 1–12.

IFRC 2003. World disasters report 2003: focus on ethics in aid international Federation of Red Cross AND Red Crescent Societies, Geneva pp 1 – 11.

IFRC. (2004). World Disasters Report: Focus on community resilience. Bloomfield and London. International Federation of Red Cross and Red Crescent Societies.

IFRC (2008): *West and Central Africa: Flood alert confirmed, International Federation of the Red Cross and Red Crescent Societies, July 31.* Retrieved from http://www.ifrc.org/fr/nouvelles/nouvelles/common/west-and-central-africa-flood-alert-confirmed/

IFRC (International Federation of Red Cross and Red Crescent): Nigeria: Floods – July, available at: http://reliefweb.int/disaster/ fl-2012-000138-nga (last access: 10 March 2015), 2012.

IFRC (2019): Nigeria: Flood Emergency Plan of Action (E.P.A) DREF n$^{0}$ MDRNG028. Originally Published: 7$^{th}$ October, 2019.

Ijeoma, S., (2012): Nigeria & Climate Change Adaptation. International *Society of Sustainability Professionals*. ISSP Insights, May 2011. Accessed 3$^{rd}$ of March 2019.

Ike, P.C. & Uzokwe, U.N., (2015): Estimation of poverty among rural farming households in Delta State. Journal of Poverty, Investment and Development, 11, pp. 86–93.

Ikelegbe, O., & Onwuemele, A (2012): Planning the Nigerian Environment: Laws and Problems of Implementation. Available Online: https:www.researchgate-net (Accessed on 23$^{rd}$ July, 2021).

Ilallah, M (2012): “Transformation Agenda Of Disaster Management In Nigeria: www.google.com/emergency+management+in+nigeria:http://saharareporters.com /article/transformation-agenda-disaster-management-nigeriamusa-ilallah

Illeris, K., (2002): The Three Dimensions of Learning: Contemporary Learning Theory in the Tension Field between the Cognitive, the Emotional and the Social. Denmark: Roskilde University Press.

Illeris, K (2007): How we learn. Learning and non-learning in school and beyond. New York, NY: Routledge.

Ilesanmi, O. O. (1972). An empirical formulation of the onset, advance and retreat of rainfall in Nigeria. *Journal of Tropical Geography, 34*, 17–24.

Ilesanmi, O. O (1972): Aspects of the precipitation climatology of the July–August rainfall minimum of Southern Nigeria. *J. Trop. Geogr.*, **35,** 51–59.

Ilesanmi, O. (1981). Aspect of the precipitation climatology of the July-August rainfall minimum of southern Nigeria. Urban and regional planning problems in Nigeria. University of Ile-Ife Geographical Associations Regional Planning Committee.

Ilesanmi, T. M. (2004). Yoruba orature and literature: A cultural analysis. Ile-Ife, Nigeria: Obafemi Awolowo University Press.

Iloeje, N. P. (1981). *A new geography of Nigeria*. Great Britain: Longman.

Iloeje, N.P (2004): A new Geography of Nigeria, Lagos, Longman publishers.

IMF and World Bank (2006), "Clean energy and development: towards an investment framework. DC2006–0002", Environmentally and Socially Sustainable Development Vice-Presidency and Infrastructure Vice-presidency, The World Bank, Washington, DC, page viii.

Imteaz, M.A., & Hossain, I (2023): Climate Change Impacts on 'Seasonality Index' and its Potential Implications of Raineater Savings. Water Resources Mnagement, 37, 2593=2606.

Ingol-Blanco, E., (2008): Climate Impacts on the Water Resources: An overview of Global Impacts and Technique to Assess at Local Scale. University of Texas at Austin.

IPCC (1998): The Regional Impacts of Climate Change: An Assessment of Vulnerability. A Special Report of IPCC Working Group II. Available online: ipcc.ch/site/assets/uploads/2020/II/The-Regional-Impact.pdf

Intergovernmental Panel on Climate Change. Climate change 2001: impacts, adaptation, and vulnerability. Cambridge: Cambridge University Press; 2001.

Intergovernmental Panel on Climate Change (IPCC) (2001) Climate change 2001: Synthesis report. A contribution of working groups I, II, and III to the third assessment report of the intergovernmental panel on climate change. Geneva: Intergovernmental Panel on Climate Change.

Intergovernmental Panel on Climate Change (2007). Climate Change 2007: Impacts, Adaptation, and Vulnerability: M.L. Parry, O.F. Canziani, J.P. Palutikof, van der Linden, J. Paul, C.E. Hanson (Eds.), Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom, pp. 1000.

IPCC (2007) In: Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M, Miller HL (eds) Climate change 2007: the physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, p 996

IPCC, (2007a): Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K. and A. Reisinger (eds.)]. IPCC, Geneva, Switzerland, 104 pp.

IPPC (2007): Climate change 2007: Working Group II: Impacts, Adaptation and Variability: IPCC Fourth Assessment Report: Climate Change 2007. Published online: archive.ipcc.ch/publications_and_data/ar4/wg2/en/ch3s3-4.html

Intergovernmental Panel on Climate Change (IPCC) (2007), Climate change 2007: climate change impacts, adaptation and vulnerability. Working Group II; contribution to the Intergovernmental Panel on Climate Change Fourth Assessment Report. Summary for Policymakers, 23

IPCC, 2007: Summary for Policymakers. In: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 7-22

Intergovernmental Panel on Climate Change (IPCC). (2011): Special report: Managing the risks of extreme events and disasters to advance climate change adoptions (SREX). Summery for Policymakers.

Intergovernmental Panel on Climate Change, IPCC (2012): ‘Summary for Policymakers’ in Field, C.B, et al., (eds) *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change,* Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 1-19.

IPCC, (2012): Summary for Policymakers. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker,

D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 1-19.

IPCC (2012). *Managing the risks of extreme events and disasters to advance climate change adaptation: summary for policy makers*. Cambridge: Cambridge University Press pp 4 – 15.

IPCC, 2012: Glossary of terms. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D.

IPCC. (2012): Managing the risks of extreme events and disasters to advance climate change adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. Cambridge, UK, and New York, NY, USA: Cambridge University Press, 2012, 582 pp

IPCC (2013): (Intergovernmental Panel on Climate Change) GIEC, Changements climatiques en 2013, Les éléments scientifiques, résumé à l'intention des décideurs, service d'appui technique du groupe de travail I GTI, 2013, action while others do not. Nat Hazards 38:101–120

IPCC (2013): (Intergovernmental Panel on Climate Change) GIEC, Changements climatiques en (2013): Les el ´ ements scientifiques, ´ resum ´ e´ a l'intention des d ` ecideurs, service d'appui technique ´ du groupe de travail I GTI, 2013, https://www.ipcc.ch/pdf/ assessment-report/ar5/wg1/WG1AR5 SummaryVolume FINAL FRENCH.pdf.

IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

IPCC (2014) Climate change 2014: Impacts, adaptation, and vulnerability. Part A: global and sectoral aspects. In Field CB et al (eds) Contribution of working group 11 to the fifth assessment report of the intergovernmental panel on climate change. Cambridge, United Kingdom and New York, NY, USA, 1123 pp

IPCC, (2014): Summary for Policymakers. In: Field CB, Barros VR, Dokken DJ, Mach KJ, Mastrandrea MD, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, et al., editors. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge, United Kingdom, and New York, NY, USA: Cambridge University Press; pp. 1–32.

IPCC, 2014: Summary for Policymakers. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

IPCC (2014) Climate change 2014: impacts, adaptation, and vulnerability. Part A: global and sectoral aspects. In: Field CB et al (eds) Contribution of working group II to the fifth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1132 pp.

IPCC (2014d). Livelihoods and poverty. In C. B. Field, V. R. Barros, & D. J. Dokken (Eds.), Climate change 2014: Impacts, adaptation, and vulnerability. Part A: Global and sectoral aspects. Contribution of working group II to the fifth assessment report of the intergovernmental panel on climate change (pp. 793–832). Cambridge, UK: Cambridge University Press

International Federation of Red Cross and Red Crescent Societies (2013). Emergency appeal operation update Nigeria. Floods Vol 2. Available at http://www.ifrc.org/docs/Appeals/12/MDRNGO1402.pdf,http://reliefweb.int/sites/reliefweb.int/files/resource/Nigeria%20flood.pdf.

International Federation of Red Cross and Red Crescent Societies (2010): Burkina Faso: Floods. Available at: https://www.ifrc.orgdocs/appeals/10/MDRBF 010do.pdf

International Federation of Red Cross and Red Crescent Societies (IFRC, 2019).

International Institute for Environment and Development. Available online: https://www.iied.org/ introduction-urban-poverty (accessed on 1 June 2018).

International Institute for Environment and Development (2018). Available online: https://citiesipcc.org/wpcontent/uploads/2018/03/Informality-background-paper-for-IPCC-Cities.pdf (accessed on 21 January 2021)

International Institute for Environment and Development. Available online: https://www.iied.org/ introduction-urban-poverty (accessed on 21 January 2021).

International Labour Organization (2017): World Social Protection Report (2017-2019), Geneva

International Strategy for Disaster Reduction (ISDRC). 2004. A global review of disaster reduction initiatives. Living with risk. Volume 1. United Nations. New York

International Strategy for Disaster Reduction (ISDR), (2008): "Disaster Risk Reduction Strategies and Risk Management Practices: Critical Elements for Adaptation to Climate Change" Submission to the UNFCCC Adhoc Working Group on Long Term Cooperative Action. Accessed at: www.unisdr.org/.../risk-reduction/climate-change/.../IASCISDR_paper_cc_and_DDR.pdf

Inyang, M.P., and Esohe, K.P., 2014. Deforestations, Environmental Sustainability And Health Implications In Nigeria: A Review; International Journal of Science, Environment and Technology 3(2), 502 – 517

ISDR (2008): Disaster risk reduction strategies and risk management practices: Critical elements for adaptation to climate change; www.unisdr.org/.../risk-reduction/climate/.../IASC-ISDR_paper_cc_and_DRR.pdf

Ishaq Khalid (BBC Africa, 30 July, 2017): How can Nigerians be protected from the annual floods? Available online: bbc.co.uk/news/world-africa-40720985

ITDG-Bangladesh (Intermediate Technology Development Group-Bangladesh). 2003. An attempt on application of alternative strategies for community-based flood preparedness in South-Asia (Bangladesh) [Web:] http://www.unisdr.org/eng/public_aware/world_camp/2003/english/Others/Bangladesh.pdf [Date of access: 30 May 2009].

Ittelson WH (1978) Environmental perception and urban experience. Environ Behav 10(2):193–213

IUCN. (2006). The Future of Sustainability: Re-thinking Environment and Development in the Twenty-first Century. Report of the IUCN Renowned Thinkers Meeting, 29-31 January 2006. www.iucn.org

IUCN 2006. Ecosystem Livelihood natural Disaster, IUCN Pub. 57. In: *Climate Impacts and Adaptation: Developmental Issues*. NmetS, 2010 pp 53-61.

Iyanda, I. A., (2003). *River Niger Flood and Flood Management for sustainable Hydroelectric Power Generation at Kainji Dam*. Unpublished MSc Research. Federal University of Technology, Minna). McFeeters, S. K., (1996). The use of the normalized difference water index (NDWI) in the delineation of open water features. *International journal of remote sensing*, 17 (7), 1425-1432.

## J


Jackson, I. J (1977): Climate, water and agriculture in the tropics. Longmans, London

Jackson, J., Houghton, M., Russel, R., & Triandos, P. (2005). Innovations in measuring economic impacts of regional festivals: A Do-It-Yourself Kit. Journal of Travel Research, 43 (4), 360-375.

Jackson, O.B (2013): Environmental Education and Sustainable Development in Nigeria: Breaking the Missing Link. *International Journal of Education and Research Vol. 1 No. 5*

Jacobsen M., Webster M. & Vairavamoorthy K., (2012). *The future of water in African cities: Why waste water?* World Bank, Washington, DC.

Jago, L., & Dwyer, L. (2006). Economic evaluation of special events. A Practitioner's Guide. Altona: Common Ground.

Jago, L, L Dwyer, G Lipman, D van Lill & S Vorster 2010. Tourism, Sport and Mega-Events Sustainability: Contributing to the Roadmap for Recovery. International Colloquium on Mega-event Sustainability, Sandton, Johannesburg.

Jegillos, S. (1999): Fundamentals of disaster risk management: How are southeast Asian countries addressing this? (In Holloway, A. Risk, sustainable development and disasters: southern perspectives. Cape Town: Periperi Publications.)

Jerry C.T., Jason V.M., Thayoparan G (2018): Ghana must move from coping with floods, to adapting for them (Online Pup). Available at: httpr://theconversation.com/Ghana-must-move-from-coping-with-flood-to-a-adating-for-them

Jha, A. K., Bloch, R., and Lamond, J.: Cities and flooding: A Guide to integrated urban flood risk management for the 21st century, World Bank Publications, Washington, D.C., 2012.

Jha, A. K., Bloch, R., & Lamond, J. (2011): Cities and Flooding: A Guide to Integrated Urban Flood Risk Management for the 21st Century. https://doi.org/10.1596/978-0-8213-8866-2

Jha, K.A, Lamond, J, Bloch, R, Bhattacharya, et al., (2011b). *Five Feet High and Rising: Cities and Flooding in the 21st Century,* Policy Research Working Paper, 5648, The World Bank, Transport, Energy & Urban Sustainable Development Unit, East Asia and Pacific Region. Available at: http://econ.world bank.org

Jha, A.K., Bloch, R., & Lamond, J (2012): Cities and Flooding: *A guide to integrated urban flood risk management for the 21st century*, World Bank Publications, Washington, DC

Jibrillah, A.M., Ja'afar, M., & Choy, L.K (2019): Monitoring vegetation change in the dryland ecosystem of Sokoto, northwestern Nigeria using geoinformatics Indones. J. Geogr., 51 (1), pp. 9-17Jimoh, H.I., (2008). Drainage Problems in a Tropical Environment: Perspectives on Urban Quality Management: Journal of human ecology, International Interdisciplinary Journal of man-environment relationship. 23 (4) pp 275-283.

Jimoh, H.O., Omole, F.K. and Omosulu, S.B. (2013). An examination of urban renewal exercice of Badia East of Lagos State, *Nigeria. International Journal of Education and Research,*1(5): 1-14

Jinag L, O'Neil BC (2017). Global urbanization projections for the shared socioeconomic pathways. Glob Environ Change 42:193-199.https://doi.org/10.1016/j.gloenvcha.2015.03.008.

Johnson, C., Penning-Rowsell, E. & Parker, D., (2007): Natural and imposed injustices: the challenges in implementing 'fair' flood risk management policy in England. The Geographical Journal, 173(4), pp. 374–390.

John-Nsa, C (2021): Understanding the factors influencing the spatial dynamics of informal settlements: The case of Enugu City, Nigeria. Available online: Town reg. plan. Vol 79 Bloemfontein http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S2415-04952021000200006

Joel, B.B (2018): Policy Somersault and Accountability in Nigerian Education. Being a paper delivered at the 2918 Nigerian Academy of Education Annual Summit at the National Commission for College of Education, Abuja, Nigeria. Available Online: Babalola-NAE-Final-07-Feb-2018-POLICY-SOMERSAULT-AND-ACCOUNTABILITY-IN-NIGERIAN-EDUCATION (Accessed 26th July, 2021)

Jones, P (2017): Formalizing the Informal: Understanding the position of Informal Settlements and Slums in Sustainable Urbanization Policies and Strategies in Bandung, Indonesia. Food and *Sustainability* **2017**, *9*(8), 1436; **https://doi.org/10.3390/su9081436**: agris.fao.org/agris-search.do?recordID=CH2018116871.

Jonkman S.N. and Kelman I. (2005): An analysis of the causes and circumstances of flood disaster deaths. *Disasters* 29:75-97.

Jonkman SN. (2005). Global perspectives on loss of human life caused by floods. Natural Hazards, 2005; 34(2):151-175

Jonkman SN (2005): Global perspectives of loss of human life caused by floods. Nat Hazards 34:151-175

Joronen M (2017) Spaces of waiting: politics of precarious recognition in the occupied West Bank. Environment and Planning D: Society and Space 35: 994–1011.

Joshi, A., Kale, S., Chandel, S., & Pal, D.K (2015): Likert Scale: Explored and Explained. Current Journal of Applied Science and Technology 7 (4): 396-403.

Joshua, I.A., Makama, J.G., Joshua, W.I., Audu, O. & Nmadu, A.G., (2014): Disasters in Nigeria: a public health perspective. Journal of Community Medicine and Primary Health Care, 26(1), pp. 59–75Julius H.K., (2011). Climate change variability in Sub-Saharan Africa: a review of current and future trends and impacts on agriculture and food security. Environ Dev Sustain. 13: 587-605 DOI 10.1007/s10668-010-9278-0

Juliana Alcântara Costa e Gláuber Pontes Rodrigues (2017): Space-time distribution of rainfall anomaly index (RAI) for the Salgado Basin, Ceará State – Brazil. Ciência e Natura, Santa Maria v.39 n.3, Set - Dez, p. 627 – 634 Revista do Centro de Ciências Naturais e Exatas - UFSM ISSN impressa: 0100-8307 ISSN on-line: 2179-460X

Juma, K.S., (2015): Impact of Climate Variability and Change on Rain-Fed Farming System in Selected Semi-arid Areas of Tanzania. Retrieved from. http://suaire.suanet.ac.tz:8080/xmlui/bitstream/handle/123456789/818/JUMA%20KABOTE%20SAMWEL.pdf?sequence¼1&isAllowed¼y

Jun, S., and FuQing, Z (2017): Daily extreme precipitation and trends over China, Sci. China Earth Sci. Vol. 60 (12), 2190-2203

Jun, E.R., & Melda, S (2020): 1.47 billion people face flood risk worldwide: for over a third, it could be devastating. Available online: (blogs.worldbank.org/climatechange/147-billion-people-face-flood-risk-worldwide-over-third-it-could-be-devastating (Accessed January 22, 2023)

Jun, R., & Melda, S (2020): People in Harm's Way: Flood Exposure and Poverty in 189 countries. Climate Change Group, The World Bank, Washington DC, USA. Centre for Advanced Spatial Analysis, University College London, London, UK

Jun, R., Melda, S. (2020): People in Harm's Way: Flood Exposure and Poverty in 189 Countries. https://elibrary.worldbank.org/doi/abs/10.1596/1813-9450-9447

**K**

Kalejaye, O.J. Atofojomo, O.A. and Odunlami, A.T. (2006): History of Nigerian Mass Media, Lagos: African Resource Communication.

Kalnay E, Cai M (2003) Impact of urbanization and land-use change on climate. Nature 423: 528-531.

Kamara AJ 2006. Household Participation in Domestic Waste Disposal and Recycling in the Tshwane Metropolitan Area: An Environmental Education Perspective. Thesis in Environmental Education, Unpublished. University of South Africa.

Kane, R.P (2000): Some Characteristics and Precipitation Effects of the El Nino of 1997-1988. *Journal of Atmosphere and Solar-Terrestrial Physical*, 61: 1325-1346

Kanellopoulou, E. A. (2002). Spatial distribution of rainfall seasonality in Greece. Weather, 57, 215–219. http://dx.doi.org/10.1256/004316502760053576

Kantakuma. L.N, Kumar. S, Schneider. K (2016). Spatiotemporal urban expansion in Pune metropolis, India using remote sensing. Habitat International, 51, pp. 11-22 Kar NP, Kumar A., Singh OP, Carlton JM, Nanda N (2014). A review of malaria transmission dynamics in forest ecosystems. Parasite Vectors, 7:265. doi:10.1186/1756-3305-7-265.

Kaur, M., (2016): Application of mixed method approach in public health research. Indian J. Community Med. Off. Publ. Indian Assoc. Prev. Soc. Med. 41 (2), 93

Kay, B.H., Ryan, P.A., Russel, B.M., Holt, J.S., Lyons, S.A., Foley, P.N., (2000): The importance of subterranean mosquito habitat to arbovirus vector control strageties in North Queensland, Australia. Journal Medical Entomology, 37: 846-853.

Ke, Q., S.N. Jonkman, T. Rijcken and P.V. Gelder, (2012). Flood damage estimate for downtown shanghai city-sensitivity analysis. Proceedings of the Poster Presentation, the 3rd Conference of the International Society for Integrated Disaster Risk Management, Sept. 7-9, Beijing, China

Keddy, P.A. (1983) Freshwater Wetlands Human-induced Changes: Indirect Effects must also be considered. Environmental Management 7(4): 299-302.

Kendall, M.G., (1975): Rank Correlation Methods, 4th edition, Charles Griffin, London.

Kellens W, Zaalberg R, Neutens T, Vanneuville W, De Maeyer P (2011): An analysis of the public perception of flood risk on the Belgian coast. Risk Anal 31:1055–1068

Kellens W, Terpstra T, De Maeyer P (2013): Perception and communication of flood risks: a systematic review of empirical research. Risk Anal 33 (1): 24-49

Kelly, P.M., Adger, W.N (2000): Theory and Practice in Assessing Vulnerability to Climate Change and Facilitating Adaptation. Climatic Change 47 (4), 325-352.

Kershi, J. and Simon, R. (2005): *The essentials of the Environment*. London: Holder Arnold; Pp. 30-39.

Keskitalo, E.C.H (2010): *Developing Adaptation Policy and Practice in Europe: Multi-Level Governance of Climate Change*; Springer: Dordrecht, The Netherlands

Khan AN (1996) Planning for reduction of flood hazard. In: Proceedings of 6th all Pakistan Geographical Association, the Islamia University Bahawalpur, Pakistan. pp 182–230

Kharim VV, Zwiers FW (2000) Changes in the extremes in an ensemble of transient climate simulations with a coupled atmosphere-ocean GCM. J Clim 13: 3760-3788.

Kharol. S.K, Kaskaoutis .D.G, Badarinath .K.V.S, Sharma .A.R, Singh .R.P (2013). Influence of land use/land cover (LULC) changes on atmospheric dynamics over the arid region of Rajasthan state, India. Journal of Arid Environments, 88 pp. 90-101.

Kidson, R. & Richards, K. S: (2005) Flood frequency analysis: assumptions and alternatives. Progr. Phys. Geogr. 29(3), 392–410.

Kikegawa Y, Genchi Y, Kondo H, Hanaki K (2006). Impacts of Cityblock Scale Countermeasures against Urban Heat Island Phenomena upon a Building's Energy Consumption for Airconditioning, Appl. Energy, 83: 649-668.

Kiktev D, Sexton DMH, Alexander L, Folland CK (2003) Comparison of modelled and observed trends in indices of daily climate extremes. J clim 16: 3560-3571.

King D (2000): You're on our own: community vulnerability and the need for awareness and education for predictable natural disasters. J Conting Crisis Manage 8:223–228

Kjeldsen T.R., **Macdonald N.**, Lang M., Mediero L., Albuquerque T., Bogdanowicz E., Brazdil R., Castellarin A., David V., Fleig A., Gül G.O., Kriauciuniene J., Kohnova S., Merz B., Nicholson O., Roald L.A., Salinas J.L., Sarauskiene D., Sraj M., Strupczewski W., Szolgay J., Toumazis A., Vanneuville W., Veijalainen N., Wilson D. (2014), Documentary evidence of past floods in Europe and their utility in flood frequency estimation, *Journal of Hydrology*, 517: 963-973 DOI: 10.1016/j.jhydrol.2014.06.038

Klein JA, Hopping KA, Yeh ET, Nyima Y, Boone RB, Galvin KA. (2014): Unexpected climate impacts on the Tibetan Plateau: Local and scientific knowledge in findings of delayed summer. *Global Environmental Change-Human and Policy Dimensions.* 28:141–152.

Klein, J.T., (201): A taxonomy of interdisciplinarity. The Oxford handbook of interdisciplinarity, 15.

Klein R. J.T., Nicholls, R. J., & Thomalla, F. (2003). Resilience to natural hazards: how useful is this concept? Journal of Environmental Hazards. 5: 35-45.

Klijn F., Samuels P. & van Os D. Towards flood risk management in the EU: state of affairs with examples from various European countries. Int J River Basin Management 2008, 6, 307–321.

Knighton, J.; Steinschneider, S.; Walter, T. A (2017): Vulnerability-Based, Bottom-up Assessment of Future Riverine Flood Risk Using a Modified Peaks-Over-Threshold Approach and a Physically Based Hydrologic Model. Water Resour. Res. 2017, 53, 10043–10064.

Knoema (2008): Nigeria-Population density. Available at:https://Knoema.com/atlas/Nigeria/Population-density.Kobina, O. A.; G.K. Nyarko, and A. M. Koomson. (2002). Malaria in the sub Saharan Africa. Revista VacciMonitor (Vacunología y Temas Afines), 11(4): 1-6.

Koenig, S & B Leopkey 2009. Canadian Sporting Events: An Analysis of Legacy and Sports Development. Proceedings of the Administrative Sciences Association of Canada 2009 Conference. Niagara Falls, Ontario.

Kolawole, O.M., Olayemi, A.B. & Ajayi, K.T., (2011): Managing flood in Nigerian cities: risk analysis and adaptation options – Ilorin city as a case study. Archives of Applied Science Research, 3(1), pp. 17–24.

Kollmuss A, Agyeman J (2010) Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior? Environ Educ Res 8(3):239–260

Komolafe, A.A., Adegboyega, S.A. & Akinluyi, F.O., (2015): A review of flood risk analysis in Nigeria. American Journal of Environmental Sciences, 11(3), pp. 157–166, 2015.http://dx.doi.org/10.3844/ajessp.2015.157.166

Kometa S.S, AkohN.R (2012): The Hydro-geomorphological implications of urbanisation in Bamenda, Cameroon. Journal of Sustainable Development, 5 (6) (2012), p. 64

Kothari, C.R. (2004): Research Methodology: Methods and Techniques. New Delhi, New Age International.

Kraay, Aart and David McKenzie (2014): Do Poverty Traps Exist? Assessing the Evidence. Journal of Economic Perspectives, vol. 28, no. 3, p. 127-148.

Kraus NN, Slovic P (1988) Taxonomic analysis of perceived risk: modeling individual and group perceptions within homogeneous hazard domains. Risk Anal 8(3):435–455

Krausmann E, Mushtaq F (2008): A qualitative Natech damage scale for the impact of floods on selected industrial facilities. Nat Hazards 46:179–197

Krefting L. (1991): Rigour in qualitative research: The assessment of trustworthiness. Am J Occup Ther. 145:214–22.

Kreibich, H., et al., (2009). Is flow velocity a significant parameter in flood damage modelling? Natural Hazards and Earth System Science, 9 (5), 1679–1692.

Kreibich H, Thieken AH, Petrow T, Mu¨ller M, Merz B (2005) Flood loss reduction of private householdsdue to building precautionary measures—lessons learned from the Elbe flood in August 2002. NatHazards Earth Syst Sci 5:117–126

Kripalani, R.H., Kul Karni, A (1997): Climatic Impact of El Nino/La Nina on the India Monsoon. A new perspective. *Weather*, 52 (2): 39-46

Krnegar, A.F., Winston, J.S (1975): Large Scale Circulation Anomalies Over the Tropics During1971-1972. Monthly Weather Review, 103: 465-473

Kron, Wolfgang. (2002): "Keynote lecture: Flood risk= hazard x exposure x vulnerability." Flood defence: 82-97.

Kron, W.; Eichner, J.; Kundzewicz, Z. (2019): Reduction of flood risk in Europe—Reflections from a reinsurance perspective. J. Hydrol. 2019, 576, 197–209.

Kubiat, U (2018). Causes and Impacts/Effects of Poor Drainage Systems and Floods in Nigeria. Online Publications. Available at: https://researchcyber.com/flooding-in-nigeria-4-causes-9-and-way-out/ (Accessed on: 5 February, 2020).

Kuhlicke, C, Scolobig, A, Tapsell, S, Steinführer, A, De Marchi, B (2011): Contextualizing social vulnerability: findings from case studies across Europe Nat. Hazard., 58 (2) (2011), pp. 789-810

Kumwenda, S., Niang, E., Orondo, P. W., William, P., Oyinlola, L.,Bongo, G. N., & Chiwona, B. (2017): Challenges facing young African scientists in their research careers: A qualitative exploratory study. Malawi Medical Journal: The Journal of Medical Association of Malawi,29(1), 1–4. https://doi.org/10.4314/mmj.v29i1.1Kundzewicz, Z. W., Hirabayashi, Y., and Kanae, S.: River floods in the changing climate – observations and projections, Water Resour. Manag. 24, 2633–2646, 2010.

Kundzewicz, Z. W., Kanae, S., Seneviratne, S. I., Handmer, J., Nicholls, N., Peduzzi, P., Mechler, R., Bouwer, L.M., Arnell, N., Mach, K., Muir-Wood, R., Brakenridge, G. R., Kron, W., Benito, G., Honda, Y., Takahashi, K., and Sherstyukov, B.: Flood risk and climate change: global and regional perspectives, Hydrolog. Sci. J., 59, 1–28, 2014.

Kyenge, J. (2013) listed indiscipline, misplaced priority, unskilled staff, financial challenges and Autonomy.

Kyenge, J (2013): The Challenges of Local Government Administration in Nigeria. *Journal of Management and Corporate Governance. Vol. 5 (1) Pp. 70-76*

Kyesi, A and Mwakalunga, V. (2009). GIS Application in coordinating solid waste collection. The Case of Sinza Neighbourhood in Kirundomi Municipality, Dares Salaam City, Tanzania. Unpublished Paper Presented to Surveyors. Key Roles in Accelerated Development, Eilat, Israel, 3-8 May 2009.

L

La Cruz-Reyna, S.D. (1996): Long-term probabilistic analysis of future explosive Eruptions. In Monitoring and Mitigation of Volcano Hazards; Scarpa, R., Tilling, R.I., Eds.; Springer: Berlin/Heidelberg, Germany; New York, NY, USA, 1996.

Lagos State Government (LSG): Abstract of Local Government Statistics, Lagos: Lagos Bureau of Statistics, Ministry of Economic Planning and Budget Secretariat, Alausa, Ikeja, 2012.

LaMarca, N (2011): The Likert Scale: Advantages and Disadvantages. Available online: psy450.wordpress.com/2011/12/05/the-likert-scale-advantages-and-disadvantages/

Lamb, H.H. (1968). The changing climate, Methuen, London.

Lambu, I.B (2017, p. 12): An assessment and mapping of street Hawking in Kano State Nigeria. Available online: researchgate.net/puplication/327040585_An_assessment_and_mapping_of_street_Hawking

Lame, S.M. & Yusoff, W.F.W., (2015): Poverty reduction in Nigeria: the role of entrepreneur-ship education. Journal of Educational and Literature, 3(2), pp. 63–71.

Lamidi, T. B. (2009). Distribution and seasonal abundance of anopheline mosquito species in Nguru, Yobe State, North-Eastern Nigeria. Animal Research International, 6(1): 949 –952.

Lamidi, T.B., Alo, E.B., and Naphtali, R.S. (2017a). Mosquito Species Diversity and Distribution in Three riverine communities in Taraba state, North-eastern Nigeria.IOSR journal of pharmacy and Biological science, Volume12, Issue 2, Ver. III (March -April, 2017) pp 21-28, doi 10.9790/3008-1202032128

Lamond, J., Bhattacharya, N., and Bloch, R.: The role of solid waste management as a response to urban flood risk in developing countries, a case study analysis, in: Flood Recovery Innovation and Response, edited by: Proverbs, D., Mambretti, S., Brebbia, C., and de Wrachien, D., WIT Press, Southampton, 193–205, 2012.

Lamond, J., Bhattacharya, N., & Bloch, R. (2012): The role of solid waste management as a response to urban flood risk in developing countries, a case study analysis. 193–204. https://doi.org/10.2495/FRIAR120161

Lamond, J., Penning – Rowsell (2014): The robustness of flood insurance regimes given changing risk resulting from climate change. Climate Risk Management, V (2), pp 1-10

Lamond, J., Adekola, O., Adelekan, I., Eze, B., & Ujoh, F. (2019): Information for Adaptation and Response to Flooding, Multi-Stakeholder Perspectives in Nigeria. Climate, 7(4), 46. https://doi.org/10.3390/cli7040046

Landsberg EH (1981). The Urban Climate, Maryland, Academic Press.

Landsberg. H.E. (1975). Sahel drought: change of climate or part of climate? Archieves for Meteorology, Geophysics and Bioclimatology, Ser. B. 23:193 – 200

Lange, P.A.M.V., Kruglanski, A.W., Higgins, E.T (2011): *Handbook of Thesis of Social Psychology: Collection: Volumes 1 & 2*. SAGE. ISBN9781473971370.

Lanihun, A. (2002): Communicating for Development Purposes: Gender

Lanrewaju AF. (2012). Urbanization, housing quality and environmental degeneration in Nigeria. Journal of Geography and Regional Planning. 5(16):422-429.

Lautze, S., Aklilu, Y., Raven-Roberts. A., Young H., Kebede G. & Learning J. (2003). Risk and Vulnerability in Ethiopia: Learning from the Past, responding to the Present, preparing for the future. Report for the U.S. Agency for International Development, Addis Ababa, Ethiopia.

Lave TR, Lave LB (1991) Public perception of the risks of floods: implications for communication. Risk Anal 11:255–267

Lavell A, Oppenheimer M, Diop C, Hess J, Lempert R, Li J, Muir-Wood R and Myeong S (2012) Climate change: new dimensions in disaster risk, exposure, vulnerability, and resilience. In: Field CB et al (eds) Managing the risks of extreme events and disasters to advance climate change adaptation. A special report of working groups I and II of the intergovernmental panel on climate change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp 25–64

Lawanson, T. O. (2005): Challenges of Sustainability and Urban Development in Nigeria: Reviewing the Millennium Development Goals. In Fadare W. et al. (eds), Globalization, Culture and the Nigerian Built Environment, 2, Obafemi Awolowo University, Ile-Ife, Nigeria.

Lawrence J, Reisinger A, Mullan B, Jackson B (2013): Exploring climate change uncertainties to support adaptive management of changing flood-risk. Environ Sci Policy 33:133-142.

Lawson, E., Thorne, C., Ahilian, S., Allen, D., Arthut, S., Everett, G., Fenner, R., Glenis, V., Guan, D., Hoang, L., Kilsby, C., Lamond, J., Mant, J., Maskrey, S., Mount, N., Sleigh, A., Smith, L., & Wright, N (2014): Delivering and evaluating the multiple flood risk benefits in BLUE-GREEN Cities; an interdisciplinary approach. Conference paper in

MIT TRANSACTIONS ON ECOLOGY AND THE ENVIRONMENT. DOI: 10.2495/FRAIR140101.

Lebel T, Ali A (2009): Recent trends in the Central and Western Sahel rainfall regime (1990–2007). J Hydrol. doi: 10.1016/j.jhydrol.2008.11.030.

Lechowska, E (2018): What determines flood risk perception? A review of factors of flood risk perception and relations between its basic elements. *Nat Hazards* 94**,** 1341–1366 (2018). https://doi.org/10.1007/s11069-018-3480-z

Lee, D., & Jung, J (2014): The growth of low-income popuklations in floodplains: a case study of Austin, TX.KSCEJ Civ Eng 18: 683-693

Lee, E. H., Lee, Y. S., Joo, J. G., Jung, D., & Kim, J. H. (2016): Flood reduction in urban drainage systems: Cooperative operation of centralized and decentralized reservoirs. Water (Switzerland), 8(10). https://doi.org/10.3390/w8100469

Leeds, MA (2008). Do Good Olympics Make Good Neighbors? Contemporary Economic Policy 26,3: 460–467.

Lehner B, Ll PD, Alcamo J, Henrichs T, Frank K (2006) Estimating the impact of global change on flood and drought risks in Europe: a continental, integrated analysis. Clim Change 75:273–299.

Lemos, Maria Carmen and Emma L Tompkins (2008): “Responding to the risks from climate related Disasters” *highlights climate change*. UK: IDS, page 1-4

Lenderink, G. & van Meijgaard, E. (2008): Increase in hourly precipitation extremes beyond expectations from temperature changes. *Nature Geosci.* 1, 511–514.

Lenderink, G., van Meijgaard, E. & Selten, F. (2009): Intense coastal rainfall in the Netherlands in response to high sea surface temperatures: Analysis of the event of August 2006 from the perspective of a changing climate. *Clim. Dynam.* 32, 19–33.

Lenderink, G., Mok, H. Y., Lee, T. C. & van Oldenborgh, G. J. (2011): Scaling and trends of hourly precipitation extremes in two different climate zones—Hong Kong and the Netherlands. *Hydrol. Earth Syst. Sci.* 15, 3033–3041.

Leng, Z., et al. ( 2008). Interface bonding between Hot-Mix asphalt and var- ious portland cement concrete surfaces. Transportation Research Record: Journal of the Transportation Research Board, 2057, 46–53

Li, Y, Wang (2009): Impacts of urbanization on surface runoff of the daidenne creek watershed, St. Charles County, Missouri, Physical Geography 30: 556-573

Lienert, J., Schnetzer, F., Ingold, K (2013): Stakeholder Analysis Combined with Social Network Analysis Provides Fine-Grained Insight into Water Infrastructural Planning Processes. *J. Environ.Mang., 125*, 134-148

Little, D. N., et al., (2003). Chemical and mechanical processes of moisture damage in Hot-mix asphalt pavements. In: Moisture sensitivity of asphalt pavements. CD-ROM. Washington, DC: Transportation Research Board of the National Academies, 37–74.

Little, D. N., et al., (2003). “Chemical and mechanical processes of moisture damage in Hot-mix asphalt pavements.” Transportation Research Board National Seminar in Diego Califonia, pp. 37-70

Littlejohn, S. W. (1983): *Theories of human communication* (2nd ed.). Belmont, CA: Wadsworth.

Liu XP, Zhang JQ et al (2011): Grid-based multi-attribute risk assessment of snow disasters in the Grasslands of Xilingol, Inner Mongolia. Hum Ecol Risk Assess 17(3SI):712—731 Parsons, M., Nalau, J., Fisher, K., Brown, C (2019): Disrupting Path Dependency: Making Room For Indigenous Knowledge in River Management. *Glob. Environ. Chang*., 56, 95-113

Livada, I., Asimakopoulos (2005): Individual seasonality index of rainfall regimes in Greece. Chm. Res. 28 (2): 155-161

Lock, S., Rubin, G.J., Murray, V., Rogers, M.B., Amlôt, R. and Williams, R., (2012): Secondary stressors and extreme events and disasters: a systematic review of primary research from 2010–2011. PLoS currents, 4.

Lougeay R, Brazel A, Hubble M (1996). “Monitoring Intra-Urban Temperature Patterns and Associated Land Cover in Phoenix; Arizona Using Landsat Thermal Data”, Geocarto Int., 11: 79-89.

Lois M.V & Ralph B.T (1980). Consequences of Population Density and Size. Available at: https://journals.sagepub.com/doi/abs/10.1177/107808748001600202. (Accessed on: July 29, 2019)

Loots I., Smithers J.C. & Kjeldsen T.R. (2022). Quantifying the influence of urban development on runoff in South Africa, Urban Water Journal, DOI: 10.1080/1573062X.2022.2027472

Lowe, P. & Phillipson, J., (2006): Reflexive interdisciplinary research: the making of a research programme on the rural economy and land use. Journal of Agricultural Economics, 57(2), pp. 165-184, 2006.

Lucas, R.E., & Prescott, E.C (1967): Investment under uncertainty. Econometric a, 39, 315-335

Lucas O.A and Gilles H.M. (2006). A Short Textbook of Public Health Medicine fot the Tropics. New York.

Lucia, S., Herrmann, L. & Killias, M. (2007): How important are interview methods and questionnaire designs in research on self-reported juvenile delinquency? An experimental comparison of Internet vs paper-and-pencil questionnaires and different definitions of the reference period. Journal of Experimental Criminology. 3(1), 39-64.

Ludwig, F., C. T. Van Scheltinga, J. Verhagen, B. Kruijt, E.van Ierland, R. Dellink, … P. Kabat. (2007): *Climate Change Impacts on Developing countries-EU Accountability*. Wageningen University and Research Centre.

Ludwig, R., R. Roson, C. Zografos, and G. Kallis (2011): Towards an inter-disciplinary research agenda on climate change, water and security in southern Europe and neighbouring countries, Environ. Sci. Policy, 14, 794 – 803.

Lumbroso, D., Ramsbottom, D., & Spaliveiro, M. (2008): Sustain-able flood risk management strategies to reduce rural communities' vulnerability to flooding in Mozambique. Journal of Flood Risk Management,1(1), 34–42

Lumbroso, D., Rance, J., Pearce, G., & Wade, S. (2014): Science for Humanitarian Emergencies and Resilience (SHEAR) scoping study: Final report. Retrieved from https://www.gov.uk/dfid-research-outputs/final-report-science-for-humanitarian-emergencies-and-resilience-shear-scoping-study

Lumbroso, D., Brown, E., & Ranger, N. (2016): Stakeholders' perceptions of the overall effectiveness of early warning systems and risk assessments for weather-related hazards in Africa, the Caribbean and South Asia. Natural Hazards,1–24.

Lumbroso, D. (2018): How can policy makers in sub-Saharan Africa make early warning systems more effective? The case of Uganda. International Journal of Disaster Risk Reduction,27, 530–540

Lumbroso, D (2020): Flood risk management in Africa. Jou. of Flood Risk Mgt. 13 (L22402). DOI:10.1111/jfr3.12612

Lundholm. J.T, Richardson. P.J (2010). MINI-REVIEW: Habitat analogues for reconciliation ecology in urban and industrial environments. Journal of Applied Ecology, 47 (5) (2010), pp. 966-975

Luthy, R. et al. (1992): ''Future concerns in environmental engineering graduate education.'' J. Prof. Issues Eng. Educ. Pract., 118 (4), 361– 380.

Lwasa, S. (2009): Managing City Growth and Development in the Context of Environmental Changes within Sub-Saharan Africa. UGEC Viewpoints | No. 2 | September 2009.

**M**

Ma Wen Jie (2017): Sciencing: Why Are Green Plants Important to the Environment? Available at: https://sciencing.com/green

Mabogunje A. (1985). Towards an urban policy in Nigeria. In: Onobokun, P (Ed.), Housing in Nigeria. A book of readings. Ibadan, Nigeria. NISER

Mabogunje, A.I., (2001). Lesson of Experience in Housing Low-Income Groups on Sub-Saharan Africa, Paper Presented at International Conference on Housing and Urban Development for low Income Group in Sub-Saharan Africa, held in Accra, Ghana, 22-26 July 2002.

Mabogunje A. (2002). Re-constructing the Nigerian city: The new policy on urban development and housing, paper presented at a national conference on the city in Nigeria, Ile Ife.

Mabogunje, A. L., Kates, R. W. (2004). Sustainable development in Ijebu-Ode, Nigeria: The role of social capital, participation, and science and technology (CID Working Paper No. 102). Cambridge, MA: Sustainable Development Program, Center for International Development, Harvard University.

Mac Sweeney, N. (2008): *Private-sector development in post-conflict countries*, Cambridge: DCED

Madu, I. A. (2012). Spatial vulnerability of rural households to climate change in Nigeria: Implications for internal security. Robert S. Strauss Center for International Security and Law at The University of Texas at Austin. https://www.strausscenter.org/researchreports?download=105:spatial-vulnerability-of-rural-household-to-climate-change-in-nigeria

Madu, I. A. (2016). Rurality and climate change vulnerability in Nigeria: Assessment towards evidence based even rural development policy. Paper presented at the 2016 Berlin Conference on Global Environmental Change, 23-24 May 2016 at Freie Universität Berlin.

Madukwe, M.C., (2015): Application of t-test in agricultural extension research. In: Madukwe, M.C. (Ed.), A Guide to Research in Agricultural Extension.AESON: Nigeria, third ed., pp. 203–217

Magdi M.E. Zumrawi (2016). Investgating Surface Drainage Problem of Roads in Kharttoun State. International Journal of Civil Engineering and Technology (IJCIET), 7 (3) 91-103.

Maguire, Brigit, and Patrick Hagan. (2007): "Disasters and communities: understanding social resilience." Australian Journal of Emergency Management, the 22, no. 2: 16.

Mann, H.B., (1945): Non-parametric tests against trend, Econometrica 13:163-171.

Marja, J.F., & Ann, L.C (1997): Broadening horizons: Integrating quantitative and qualitative research. Can J Infect Dis 8 (2): 65-66

Malfas, M, E Theodoraki & B Houlihan 2004. Impacts of the Olympic Games as Mega Events. Municipal Engineer 157(ME3): 209-220.

Malone, K., Truong, S., Gray, T (2017): Reimagining Sustainability in Precarious Times. Available online: link.springer.com/content/pdf/bfm%3A978-981-2550-1%2F1.pdfMaltby, E. (2000): Ecosystem Approach: From Principle to Practice. Ecosystem Service and Sustainable Watershed Management in North China, International Conference, Beijing, P.R. China, August 23-25, 2000.

Malpass, P., (1990): *The housing crisis*, Routledge, London.

Manaye, T.S., Allu, R.D (2020): A review of recent studies on urban stormwater drainage system for urban flood management. doi:10.20944/preprints202010.0295.vi

Manfredi, G.; Gasparini, P. (2013): Flood risk assessment for informal settlements. Nat. Hazards, 69, 1003–1032.

Maraun, D., Wetterhall, F., Ireson, A. M., Chandler, R. E., Kendon, E. J., Widmann, M., Rust, H. W., Sauter, T., Themeβl, M., Venema, V. K. C., Chun, K. P., Goodess, C. M., Jones, R. G., Onof, C., Vrac, M., and Thiele-Eich, I. (2010). Precipitation downscaling under climate change:recent developments to bridge the gap between dynamical models and the end user. Reviews of Geophysics, 48, RG3003, 34, DOI: 10. 1029 /2009RG000314

Marfin, A.A, Bleed, D.M., Lofgne, J.P., Olin, A.C., Savage, H.M., Smith, G.C., Moore, P.S., Karabatsos, N., Tgai, T.P., (1993): Epidemiologic aspects of St Louis encephalitis epidemic in Jefferson County Arkansa 1991. American Journal Tropical Medicine and Hygiene, 49: 30-37.

Maria A., Esther E., Agness P.O (2014): Effect of High Population Density on Rural Land Use in FEDERAL Capital Territory, Abuja-Nigeria. Journal of Emerging Trend in Education Research and Policy Studies (JETERAPS) 5 (4): 392-395.

Marin A. (2010): Riders under storms: Contributions of nomadic herders' observations to analysing climate change in Mongolia. *Global Environmental Change-Human and Policy Dimensions.* 20:162–176.

Marin A, Berkes F. (2013): Local people's accounts of climate change: to what extent are they influenced by the media? *Wiley Interdisciplinary Reviews-Climate Change.* 4:1–8.

Markham, C.G (1970): Seasonality of precipitation in the United States. Am Assoc Am Geogr 60:593– 597.

Martens Pim. “How will climate change affect human health?” American Scientist; Research Triangle Park; (Nov/Dec1999)

Mary Zsamboky, Amalia Fernández-Bilbao, David Smith, Knight, J, Allan, J (2011): Impacts of Climate Change on Disadvantaged UK Coastal Communities Joseph Rowntree Foundation

Mashi, S.A., Inkani, A.I., Obaro, O., Asanarimam, A.S (2020): Community perception response and adaptation strategies towards flood risk in a traditional African city. *National Hazards*, 103, 1727-1759

Mason, S and A Joubert (1997), “Simulated changes in extreme rainfall over southern Africa”, International Journal of Climatology Vol 17, pages 291–301.

Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. (2012): A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 555-564

Matemilola, S. (2019). Mainstreaming climate change into the EIA process in Nigeria: Perspectives from projects in the Niger Delta Region. Climate, 7(2), 29.

Mazmanian, D.A., & Sabatier, P.A (1989): Implementation and Public Policy. Glenview, III: Scott Fresman

Mays N, Pope C. (1995): Rigour and qualitative research. BMJ. 311:109–12.

Mba HC, Ude BC, Ume LC, Uchegbu B. (eds) (2004). Management of Environmental Problems and Hazards in Nigeria, Hants: Ashgate Publishing Ltd.

McBain W [Main author], Wilkes D, Retter M, (2010): Construction Industry Research and Information Association. Flood resilience and resistance for critical infrastructure. CIRIA, London

McCarthy, J.J., Canziani, O., Leary, N.A., Dokken, D.J., White, K.S (eds.) (2001): Climate Change 2001: Impacts, Adaptation and Vulnerability. IPCC Workin Group II Cambridge University Press, Cambridge.

McDonald, J.F, McMillen, D.P., (2010). Urban economics and real estate: Theory and policy. John Wiley and Sons. (Retrieved March 2, 2013, from <http://books.google.co.tz/books?id=yZ_mH-P6OYQC&pg=PA121&dq=definition+of+population+density>)

McGranahan G, Balk D, Anderson B (2007): The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones. Environ Urban 19(1):17–37

McMichael, A., Githeko, A., Akhtar, R., Carcavallo, R., Gubler, D., Haines, A., Kovats, R., Martens, P., Patz, J. and Sasaki, A. 2001. *Human health, in Climate change* (2001): *impacts, adaptation, and vulnerability* (eds, McCarthy, J., Canziani, O., Leary, N., Dokken, D. and White, K.). Cambridge University Press, Cambridge pp 22-39.

Mc Robert, J., Robinson, P., and Giummara, G. (2000). Environmental Best Practice for Out Back Roads-Guidelines Only. Transport SARC 90165-4. (Online), http://www.transport.sa.gov.au/pdfs.environmental/env_outback_roads.pdf (March 3rd, 2019)

Meehl G A, Stocker T F, Collins W D, Friedlingstein P, Gaye A T, Gregory J M, Kitoh A, Knutti R, Murphy J M, Noda A, Raper S C B, Watterson I G, Weaver A J and Zhao Z-C. (2007). Global Climate Projections. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt K B, Tignor M and Miller H L (eds)]. Cambridge University Press. Cambridge, United Kingdom and New York, NY, USA.Menamparampil, T. (1996). The challenge of cultures: Cross-cultural relationships, conflicts, inculturation. Bombay, India: St. Pauls.

Menoni S, Pergalani F (1996) An attempt to link risk assessment with land use planning: a recent experience in Italy. Disaster Prev Manage 5:5–6

Mertz, O., Mbow, C., Reenberg, A., Diouf, A (2009): Farmers' Perceptions of Climate Change and Agricultural Adaptation Strategies in Rural Sahe. Environmental Management 43, 804-816.

Merz B., Hall J., Disse M., & Schumann A. Fluvial flood risk management in a changing world. Nat Hazards Earth Syst Sci 2010, 10, (3), 509–527

Merz B, Kreibich H, Schwarze R, Thieken A (2010) Assessment of economic flood damage. Nat Hazards Earth Syst Sci 10:1697–1724

Merz B., Thieken A. & Gocht M., (2007).'Flood risk mapping at the local scale: Concepts and challenges', in Begum S., Stive M.J.F. & Hall J.W. (eds.), *Flood risk management in Europe*, 25, pp. 231-251, Springer, Dordrecht, London.

Metoffice.gov.uk/weather/climatechange/what-is-climate-change

Metz H.C. (1991). Nigeria a country study. Federal Research Division of the Library of Congress. Washington.

Metzger, M., Lee mans, R., Schroter, D.A (2005): Multidisciplinary multi-scale framework for assessing vulnerabilities to global change. Int J Appl Earths Obs Geo inform. 7:253-67

Meyer W.B. and Turner B.L II (eds.) (1994). *Changes in Land Use and Land Cover. A Global Perspective*. 713 pp. Cambridge: Cambridge University Press [This is an important contribution that examines methodological and data issues and reports on the human driving forces and consequences of major land-use and land-cover changes] Meijerink S. & Willemijn D. (2008): Shifts in the public–private divide in flood management. Int J Water Resour Dev, 24, (4), 499–512.

Messner F. and Meyer V. (2005): Flood damage, vulnerability and risk perception – challenges for flood damage research. (this issue).

Miceli R, Sotgiu I, Settanni M (2008) Disaster preparedness and perception of flood risk: a study in an alpine valley in Italy. J Environ Psychol 28(2008):164–173

Michie, S., Johnston, M., Francis, J., Hardeman, W., Eccles, M., (2008) From Theory to Intervention: Mapping Theoretically Derived Behavioural Determinants to Behaviour Change Techniques. Applied Psychology 57, 660-680.

Middleton, N., (2003). An Introduction to Environmental Issues: The Global Casino. New York. pp 366-372. Oyebande, L., Obot, E. O. and Bdiliya, H. H. (2003). *An inventory of wetlands in Nigeria*. Report prepared for World Conservation Union–IUCN, West African Regional Office, Ouagadougou, Burkina Faso.

Midgley, G F, R A Chapman, B Hewitson, P Johnston, M De Wit, G Ziervogel, P Mukheibir, L Van Niekerk, M Tadross, B W Van Wilgen, B Kgope, P Morant, A Theron, R J Scholes and G G Forsyth (2005): "A status quo, vulnerability and adaptation assessment of the physical and socioeconomic effects of climate change in the Western Cape", Report No ENV-S-C 2005-073 to the Western Cape Government, Cape Town, CSIR, Stellenbosch.

Mikhaylov A., Moiseev N., Aleshin K., Burkhardt., T (2020): Global climate change and greenhouse effect. Entrepreneurship Sustain Issues 7:2897

Mileti DS (1980) Human adjustment to the risk of environmental extremes. Sociol Soc Res 64(3):327–347

Millennium Ecosystem Assessment (MEA) (2005). Ecosystems and Human Wellbeing: Synthesis. Island Press, Washington DC. Retrieved June 8, 2013 from http://www.millenniumassessment.org/documents/document.356.aspx.pdf

Miller, M. (2007:) "Adapting to Climate Change: Water Management for Urban Resilience" Environ Urban, 19, 99-113

Milly P.C.D., Wetherald R.T., Dunne K.A. & Delworth T.L. (2002): Increasing risk of great floods in a changing climate. Nature, 415 2002, 687, (1), 514–517.

Miltin, D., & Satterhwaite, D. (2012): *Urban poverty in the global south: scale and nature*. Abingelon: Routledge.

Min, S.-K.; Zhang, X.; Zwiers, F.W.; Hegerl, G.C. (2011): Human contribution to more-intense precipitation extremes. Nature, 470, 378–381.

Minnery, J.; Argo, T.; Winarso, H.; Hau, D.; Veneracion, C.; Forbes, D.; Childs, I. (2013): Slum upgrading and urban governance: Case studies in three South East Asian cities. Habitat Int. 39, 162–169.

Minzhong, Z., Jun, N., Shaozhong, K., Xiaolin, L., Hongna, L (2017): The contribution of human activities to increasing evapotranspiration is significantly greater than climate change effect over Heihe agricultural region. Online Publication: C:Users/ccuk/Downloads/s41598-017-08952-5.pdf.

Mirza, M.M.Q., (2003): Climate change and extreme weather events: Can developing countries adapt? Climate Policy, 3(3), pp. 233–248.

Mitchell J (2003): European river floods in a changing world. Risk Anal 23:567–574

Mohammed, A, (2004)."Domestic Energy Crisis And Deforestation Challenges in Nigeria" Journal of Environmental and Earth Science, Centre for Energy and Environment, Nigeria Defense Academy Kaduna,Nigeria, Vol. 4, No. 2, p 94.

Mohan .M, Pathan. S.K, Narendrareddy. K, Kandya. K.A, Pandey. S (2011). Dynamics ofurbanization and its impact on land-use/land-cover: A case study of megacity Delhi. Journal of Environmental Protection, 2 (09), p. 1274

Mohanty, U.C. and Dube, S.K., (1981): 'Statistical Structure of the meterological parameters over the Bay of Bangal during Monsoon-77 experiment' Mausam, 32, 1, 51-54.

Mokoro (2005): The Impact of the Environment on Nigeria's Public Administration Kamla-Raj.J. Human.Ecology; 17 (2): 117-122

Moll R. (2005): Co-operation within Europe on flood management and spatial planning. In: Szöllösi-Nagy, A. and Zevenbergen, C. [Eds.]. Urban Flood Management. A.A. Balkema publishers

Molles M.C. Jr (2008). *Ecology: Concepts and Applications* ($4^{th}$ ed.). New York: McGraw-Hill. P.291. ISBN 0-70-330976-1. Available at: http://en.wikipedia.org/wiki/Riparian_fores. (Accessed on: July 12, 2019).

Montz BE, Gruntfest E (2002) Flash flood mitigation: recommendations for research and applications. Environ Hazards 4:15–22

Morgan M.G. (1997): Public Perception, Understanding and Values. Implication for Environmental Design and Management: The Industrial Green Game. Washington DC: National Academy Pre. Pp. 200-211.

Mortimore, M.J., Adams, W.M. (2001): Farmer Adaptation, Change and Crisis in the Sahel. Global Environmental Change. Human and Policy Dimensions II, 49-57

Mosger, S.C (2007): *Communicating climate change and facilitating social change*. University of Colorado, Boulder: Lisa Dilling

Mthethora, R.M (2012): Critical dimensions for policy implementation. African Journal of Public Affairs, 5 (2).

Mowlana, H (2018): On human communication. Jou. of the European Institute for Communication and Culture V25 (1-2)

Mubareka, S., Ehrlich, D., Bonn, F., & Kayitakire, F. (2008). Settlement location and population density estimation in rugged terrain using information derived from Landsat ETM and SRTM data. International Journal of Remote Sensing, 29(8), 2339-2357. doi: 10.1080/01431160701422247

Muggah, R. (2012): Researching the Urban Dilemma: Urbanization, Poverty and Violence, IDRC, Ottawa.

Muhamed B.B. (2014). Highway drainage system. Retrieved at: https://linkedin/pulse/2014125045254-112545392-highway-drainage-system

Muhammed, S. (2013): Corruption in Nigeria: A Challenge to Sustainable Development in the Fourth Republic. European Scientific Journal. 9(4): 118-137

Mujumdar PP (2001) Flood wave propagation: The St. Venant equations. Resonance 6: 66-73. 33.

Mundy, P., & Lloyd-Laney, L. (1992): Indigenous communication. *Appropriate Technology,19*(2), 1–7.

Mundy, P. (1993). *Indigenous knowledge and communication.*

Munich Re (2010) Extreme weather events—signs of climate change? Geo Risk Res, NatCatSERVICE. Access on 24 Aug 2010. http://www.munichre.com/en/media_relations/company_news/default.aspx?foid=2010-08-05

Murawski, A., Bürger, G., Vorogushyn, S., & Merz, B (2016): Can local climate variability be explained by weather patterns? A multi-system evaluation for the Rhine basin. Hydrol. Earth Syst. Sci., 20, 4283-4306

Mwayangi JM, Mbogo CM, Muturi EJ, Nwosu JG, Kabiru EW, Githore JI, et al. et al. Influence of biological and physico-chemical characteristics of larval habitats on the body size of Anopheles gambiae mosquitoes (Diptera: Culicidae) along the Kenya Coast. J Vector Borne Dis. 2007; 44:122–127.

**N**

NAAEE (2000): Nonformal Environmental Education Programs: Guidelines for excellence. Available online: naaee.org/sites/default/files/nonformalgl.pdf

Nabegu, A. B. (2014): "Analysis of Vulnerability to Food Disaster in Kano State, Nigeria." *Greener Journal of Physical Sciences* 4 (2): 22–29.

Naess LO. (2013): The role of local knowledge in adaptation to climate change. *Wiley Interdisciplinary Reviews-Climate Change.*;4:99–106.

Nagendra H, Sudhira.H. S, Katt. Mi, Schewenius .M (2013). Sub-regional assessment of India: Effects of urbanization on land use, biodiversity and ecosystem services.

NALAS (2011): Challenges of regularization of informal settlement in South East Europe. Overview of the relevant urban planning and legalization laws and practice. Available at: http://www.pur.rs/materials/publication/403%20Challenges%20of%Regularization %20EGKekn.pdf.

Napoleon, S., Momodu, K.O., Joan, E.D (2011): Mitigating the impact of solid wastes in urban centres in Nigeria. J Hum Ecol 34 (2): 125-133

Natarajan, N., Brickell, K., Parsons, L (2019): Climate change adaptation and precarity across the rural-urban divide in Cambodia: Towards a "climate precarity" approach. Jou. of Nature and Space, Vol 2 (4), pp 889-921

National Emergency Agency [NEMA], 2012], Ibadan, Oyo State, Nigeria.

National Emergency Management Agency (NEMA) (1999): Establishment Act.

National Population Commission (NPC). (1991). Final results of River State.

National Population Commission. (1998). 1991 Population Census of the Federal Republic of Nigeria: Analytical report at the national level, Abuja: National Population Commission.

National Population Commission 2009, *Nigeria Demographic and Health Survey, 2018*, National Population Commission, Abuja, Federal Republic of Nigeria, Maryland, USA. ICF Macro Calverton

National Research Council (2007). Tools and Methods for Estimating Population at Risk from Natural Disasters and Complex Humanitarian Crises. Washington, D.C.: The National Academies Press.

National Water Resources Institute. 2011. Report of Assessment of the 26th August 2011 Ibadan Flood Disaster, Oyo State, Nigeria. Kaduna: NWRI

NCA [2014]. Global Change. Retrieved March 3rd, 2019, from http://nca 2014. Globalchange.gov/report/response-strategies/mitigation.

Ndaruzaniye V., Lipper L., Fiott D., Flavell A., & Clover J., (2010).'Climate change and security in Africa: Vulnerability discussion paper', *Africa Climate Change Environment and Security (ACCES)*, 3-9

Ndujihe C (2018): Rain of Fury: Nigeria loses 141 lives to rainstorm, flood in 2018. https://www.vanguardngr.com/2018/08/rains-of-fury-nigeria-loses-141-lives-to-rainstorm-flood-in-2018

Neal P, Palmer J 1990. Environmental Education in the Primary School. Blackwell: Oxford.

Nebugu, A.B (2010): An analysis of municipal solid waste in Kano Metropolis, Nigeria. J Hum Ecol 31 (2); 113-116

Nelson, O (2018): Why Nigeria is not prepared to deal with flooding. Available Online: theconversation.com, Funded by: National Research Foundation, Water Research Commission, Rhodes University

NEMA (2013): Report on Flood Disaster in Nigeria. Abuja: Government Press

Neuwirth, R. (2005): Shadow Cities: A Billion Squatters—A New Urban World; Routledge: New York, NY, USA.

NEST (Nigerian Environmental Study/Action Team). 1991. Nigeria's Threatened Environment: A National Profile. Ibadan: NEST.

NEST (2011). Gender and climate change adaptation: Tools for community-level action in Nigeria. Ibadan, Nigeria: Nigerian Environmental Study/Action Team (NEST) – BNRCC. https://genderinsite.net/sites/default/files/BNRCC-Gender-Toolkit.pdf

New, M., Todd, M., Hulme, M., and Jones, P (2001): "Precipitation measurements and trends in the twentieth century," International Journal of Climatology, vol. 21, no. 15, pp. 1899–1922, 2001.

News.bbc.co@uk/1world/africa/6996584

Nguluma, Huba. (2003): "Housing themselves: Transformations, modernisation and spatial qualities in informal settlements in Dar es Salaam, Tanzania." PhD diss., Infrastruktur

Niang I, Ruppel OC, Abdrabo MA, Essel A, Lennard C, Padgham J, Urquhart P (2014): Africa. In: Barros VR, Field CB, Dokken DJ, Mastrandrea MD, Mach KJ, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea PR, White LL (eds) Climate change 2014: impacts, adaptation, and vulnerability. Part B: regional aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, pp 1199–1265

Niang, I, et al., (2014): Africa. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. (eds Barros, V.R. et al.). 1199-1265 (Cambridge Univ. Press 2014)

Niang, I., O.C. Ruppel, M.A. Abdrabo, A. Essel, C. Lennard, J. Padgham, and P. Urquhart, (2014): Africa. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1199-1265.

Nicholls, N. (1984): A system for predicting the onset of the north Australian wet season. *J. Climatol*, 4, pp. 425-435

Nicholls, R., Hanson, J.S., Herweijerc, C., Patmore, N., Hallegatee, S, et al (2008): Ranking of Port Cities with high exposure and vulnerabilities to climate extremes. OECD Environment Working Papers, No. 1. University of Southhampton, United Kingdom: OECD publishers.

Nicholson, S. E., (2011): *Dryland Climatology.* Cambridge University Press, 516 pp. Nicholson, S.E (2018): The ITCZ and the Seasonal Cycle Over *Equatorial Africa.* Vol 99 (2). Pages 337-348. DOI: https//doi.org/10.1175/BAMS-D-16-0287.1

Nieuwolt S (1974): Seasonal rainfall distribution in Tanzania and its cartographic representation. Erdkunde 28:186–194

Niewolt, S (1977): Tropical climatology. Wiley, London.

Nigerian Environmental Study Team (2004) Regional climate modelling and climate scenarios development in support of vulnerability and adaptation studies: outcome of regional climate modelling efforts over Nigeria. NEST, Ibadan, Nigeria, 12–20

Nigeria Tribune (2021): Ogun Will Experience Flooding, July, September, Govt Advises Residents to Vacate Flood Plain Areas: Available Online: tribuneonlineng.comogun-will-experience-flooding-july-september-gov-advises-residents-to-vacate-flood-plain-areas

NIGERIAN TRIBUNE (September 28, 2021): How weak implementation of environmental laws, poor waste disposal worsens flooding in Nigeria.

https://tribuneonlineng.com/how-weak-implementation-of-environmental-laws-poor-waste-disposal-worsen-flooding-in-nigeria/

Nigerian Tribune (January 20, 2022): FG moves to Strengthen Implementation of 6-3-3-4 Education System. Available online: https://tribuneonlineng.com/fg-moves-to-strengthen-implementation-of-6-3-3-4-education-system/

Nigussie, H. (2017: Indigenous communication forms and their potential to convey food security messages in rural Ethiopia. *Indian Journal of Human Development,10*(3), 414–427.

NiMet. (2010): Nigeria Climate Change Review Bulletin, Nigeria Meteorological Agency. Retrieved from: http://www.nimetng.org.

NIMET 2013. 2013 Seasonal Rainfall Prediction. Available at nimet.gov.ng/seasonal-rainfall-prediction. Pp 1-20.

Nkechi, N.E (2016): Policy Somersault and the Challenge of Educational Development in Nigeria: Charting a course for the future. Int Jou of Educ. And Res. V 4 Nkechi, O. et al. (2016). Mitigating climate change in Nigeria: African traditional religious values in focus. Mediterranean Journal of Social Sciences, 7(6), 299-308Nkeki, F. N., P. J

Nkote, N., Nichodemu, R., Will, Kaberuka., and John, C.M (2018): Policy Implementation: Conceptual Foundations, Accumulated Wisdom and New Directions. Jou of Public Administrstion and Governance Vol 8 (3)

Nkwunonwo, U. C.: Land use/land cover mapping of the Lagos metropolis of Nigeria using (2012) SLC-off Landsat ETM+ Satellite Images, International Journal of Scientific and Engineering Research, 4, 1217–1223, 2013.

Nkwunonwo, U. C., Whitworth, M., and Baily, B. (2015): Relevance of social vulnerability assessment to flood risk reduction in the Lagos metropolis of Nigeria, British Journal of Applied Science & Technology, 8, 366–382, 2015.

Nkwunonwo, U., W. Malcolm, and B. Brian. (2015) "Flooding and Flood Risk Reduction in Nigeria: Cardinal Gaps." *Journal of Geography & Natural Disasters* 5: 136.

Nkwunonwo, U.C., Whitworth, M. & Baily, B., (2015): Review article: a review & critical analysis of the efforts towards urban flood reduction in the Lagos region of Nigeria. Natural Hazards and Earth System Science Discussion, 3, pp. 3897–3923, 2015.http://dx.doi.org/10.5194/nhessd-3-3897-2015

Nkwunonwo, U. C., Whitworth, M., and Baily, B. (2016): Review article: A Review and Critical Analysis of the Efforts Towards Urban Flood Risk Management in Lagos Region of Nigeria. *Nat. Hazards Earth Syst. Sci.* 2016, *16*, 349-369

Nkwunonwo, U.C, Whitworth, M and Baily, B. (2016): "A Review and Critical Analysis of the Efforts Towards Urban Flood Risk Management in the Lagos Region of Nigeria." *Natural Hazards and Earth System Sciences* 16 (2): 349–369. doi:10.5194/nhess-16-349-2016

Nnadi, O. I. et al. (2019): Impacts of variability and change in rainfall on gender of farmers in Anambra, Southeast Nigeria. Heliyon 5.

Nnadi, O.I., Liwenga, E.T., Lyimo, J.G., Madukwe, M.C (2019): Impacts of variability and change in rainfall on gender of farmers in Anambra Southeast Nigeria. Available Online: cell.com/Heliyon/pdf/S2405-8440 (19).

Nnaemeka-Okeke, R. (2016): "Urban Sprawl and Sustainable City Development in Nigeria." *Journal of Ecological Engineering* 17 (2): 1-11

NOAA (2013): Types of Floods. National Flood Safety Awareness Week, March 18-22, 2013. US National Oceanic and Atmospheric Administration (NOAA).

NOAA, National Climatic Data Center, State of the Climate, Global Analysis for Annual 2014, 2015, http://www.ncdc.noaa .gov/sotc/global/2014/13.

Noble, I.R., S. Huq, Y.A. Anokhin, J. Carmin, D. Goudou, F.P. Lansigan, B. Osman-Elasha, and A. Villamizar, (2014): Adaptation needs and options. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 833-868.

Noji EK. Natural disasters. Crit Care Clin. 1991; 14:271–92.

Norman, G., (2010): Likert scales, levels of measurement and the "laws" of statistics. Advances in Health Sciences Education. 15(5), 625-632.

Norris, I.F., & Juliet, U.D (2016): Impact of Environmental Education on the knowledge and Attitude of Students Towards the Environment. Int Jour of Envr. And Sci Educ. V II (12), 5367-5375

Norwegian Refugee Council (NRC, 2015). Urban Displacement. Retrieved from: http://www.nrc.no.?=9188162#.VikPwVJIyNI.

Nott., J. (2006). Extreme Events: A Physical Reconstruction and Risk Assessment. Cambridge University Press.

Nouri A. Elfarnouk (2015): Squatter Settlements in Tripoli, Libya: Assessing, Monitoring, and Analysing the Incidence and Prevalence of Urban Squatter Areas in the Peri-Urban Fringe. Thesis submitted to the graduate degree program in Geography and the Graduate Faculty of the University of Kansas in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

NPC (2006) National Population Commission, Nigeria. Census Figure.

Nunnally JC, Bernstein LH (1994): Psychometric theory, 3rd ed. New York, NY: McGraw-Hill.

NRC (National Research Council). 1989. Improving Risk Communication. Washington, DC: National Academy Press.

Nwafor, J.C. (2006). Environmental Impact Assessment for Sustainable Development: The Nigeria Perspective". Enugu EL DEMAK Pubs pp 359-394.

Nwaka, G.I (2015): The urban informed sector in Nigeria: towards economic development, environmental health and social harmony. Glob Urban Dev Mag 1 (1).

Nwigwe, C., and T. Emberga. (2014): "An Assessment of Causes and Effects of Flood in Nigeria." *Standard Scientific Research and Essays* 2 (7): 307–315.

Nwoko A.U (2013): Flooding in Nigerian Cities: Problem and Prospects. *A case study of Aba Urban, Abia State, Nigeria.* Geography and Planning Department, Abia State University Uturu, Nigeria. E-mail: alexyrhema99@mail.com. Available at: https://www.academia.edu/3669614/FLOODING_IN_NIGERIAN_CITIES_PROBLEMS_AND_PROSPECTS_A_Case_Study_of_Aba-Urban_Abia_State_State_Nigeria (Accessed on: July 22, 2019)

Nyakundi, H., Mogere, S., Mwanzo, I., Yitambe, A (2010): Coummunity perceptions and response to flood risk in Nyando District, Western Kenya. JAMBA, Jou. of Disaster Risk Studies Vol 3 (1).

Nye M, Tapsell S, Twigger-Ross C (2011) New social directions in UK flood risk management: moving towards flood risk citizenship? J Flood Risk Management 4:288–297.

Nzeadibe, T. C. (2011). Climate change awareness and adaptation in the Niger Delta Region of Nigeria. African Technology Policy Studies Network. Working paper, no. 57. Nairobi: Published by the African Technology Policy Studies Network. https://atpsnet.org/wpcontent/uploads/2017/05/wps57.pdf

**O**

O‟Brien Karen, Linda Sygna, Robin Leichenko, W. N. Adger, Jon Barnett, Tom Mitchell, Lisa Schipper, Thomas Tanner, Coleen Vogel and Colette Mortreux (2008): Disaster Risk Reduction, Climate Change Adaptation and Human Security. Report prepared for the Royal Norwegian Ministry of Foreign Affairs by the Global Environmental Change and Human Security (GECHS) Project, GECHS Report 2008:3.

Obata, M.C (2010): Extreme River flood events in Nigeria: A geographical perspective of Nigerian. Journal of Geography and the Environment 1:170-179

Obermayr, C. (2017): Sustainable City Management: Informal Settlements in Surakarta, Indonesia; The Urban Book Series; Springer: Cham, Switzerland, 2017. Available online: http://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&source=web&cd=8&ved=0ahUKEwi1rT5hJfUAhXFj5QKHSMgDyMQFghDMAc&url=http%3A%2F%2Fjournaldl.com%2Fdownloadpdf%2F5910882e3fbb6e13743eb6d7&usg=AFQjCNHG4foAlucZVjlYZZbwTj2oRxhSw

Obeta CM (2014) Institutional Approach to Flood Disaster Management in Nigeria: Need for a Preparedness Plan. British Journal of Applied Science and Technology 4: 4575-4590

Obioha, E. (2008). Climate Change, Population Drift & Violent Conflict over land resources in North Eastern Nigeria, Journal of Human Ecology, 23 (4), pp. 311-324.

OCHA [11 Sep. 2013]: Heavy rains. Retrieved March 3rd, 2019 from https://www.onocha.org/

OCHA (28 September 2009). "West Africa - Flood Affected Population - June to September 2009 (as of 24 Sep 2009)

OCHA (2012): *"Nigeria: Floods Situation Report No. 2"*. *Nigeria*. https://reliefweb.int/sites/reliefweb.int/files/resources/Full%20Report_1141.pdf

OCHA, (2013): Nigeria: Floods – Sep 2013. Available online: https://reliefweb.int/disaster/fl-2013-000116-nga

OCHA, (2015): Nigeria: Floods – Aug 2015. Available online: https://reliefweb.int/disaster/fl-2015-000155-nga

Ocheri, M. & Okele, E., (2012): Social impact and people's perception of flooding in Makurdi town, Nigeria. Hydrology for Disaster Management, pp. 97–105. Priest S.J, M.J. Clark, E.J. Treby (2005): Flood insurance: the challenge of the uninsured Area, 37, pp. 295-302

Odeh, J. (2007, November 22): How Media Can Enhance Democracy. The Guardian, p. 65. Lagos.

Odekunle, T. (2001). The magnitude frequency characteristic of rainfall in Ondo, Southwestern, Nigeria. Ife Research Publications in Geography, 8:36–41

Odekunle TO. and SO. Gbuyiro (2003): Rain days predictability in south western Nigeria. J. Nigerian Meteorol. Soc. 4:1–17.

Odekunle, T.O (2004): Rainfall and the length of the growing season in Nigeria. Int J Climatol 24: 467–479

Odemerho, F.O., (1993). Flood Control Failures in a Third World City: Benin City Nigeria, some Environmental Factors and Policy Issues. *Geo Journal* 29 (4) 371-376.

Odermerho F.O., (2004). Benin City: A Case Study of Urban Flood Problems" In Sada P.O and Odemerho F.O (eds) Environmental Issues and Management in Nigeria Development. Evan BROTHER Nig. Publisher Ltd.

Odjugo, P. A. O.(2006): An analysis of rainfall pattern in Nigeria, Global Journal of Environmental Sciences, 4, 139–145, 2006.

Odjugo, P.A.O (2009): THE IMPACT OF CLIMATE CHANGE ON WATER RESOURCES: GLOBAL AND NIGERIAN ANALYSIS. FUTY Journal of the Environment, Vol. 4, No. 1, 2009 © School of Environmental Sciences, Federal University of Technology, Yola-Nigeria. ISSN 1597-8826 © School of Environmental Sciences, Federal University of Technology, Yola-Nigeria. ISSN 1597-8826 59

Odjugo, P.A.O., 2010. General Overview of Climate Change Impacts in Nigeria; J Hum Ecol, 29(1): 45 – 55

Odjugo, P.A.O and Uriri (2011). Changing rainfall and anthropogenic induced flooding in Benin-City, Nigeria. Journal of Geography and Regional Planning. 4 (1) pp. 42-49

Odufuwa, B.O., Adedeji, O.H., Oladesu, J.O. & Bongwa, A., (2012): Floods of fury in Nigerian cities. Journal of Sustainable Development, 5(7), pp. 69–79.

Odume, N., & Slaughter, A. (2018): How we manage extreme water conditions is the next big challenge for African countries, QuartzAfric. Retrieved from https://qz.com/africa/1205679/climate-change-africas-challenge-with-both-floods-and-droughts/

Odunuga, S.: Urban Land Use Change and the Flooding in Ashimowu Watershed, Lagos, 20 Nigeria, PhD thesis, University of Lagos, Nigeria, 2008.

Odunuga S.S. (2008): *Urban Land Use Change and the Flooding Patterns in Ashimowu Watershed, Lagos, Nigeria* (Doctoral dissertation, School of Postgraduate Studies, University of Lagos, Lagos).

Offiong, R.A., Atu, J.E., Njar, G.N., AND Amuyou, V.A (2008). Problems and prospects of poor drainage system and urban sustainability in Calabar, Nigeria. Global Journal of Social Science. 7 (2). Pp 121-127.

Offiong, R.a., Atu, J.E., Njar, G.N., & Iwara, A, I (2009): Effects of Land Use Change on Soil Physico-Chemical Properties in a South-Southern Nigeria. African Journal of Environment, Pollution and Health, 7 (2), 47-51.

Offiong, R.A., Atu, J.E., Njar, G.N., & Iwara, A.I (2009): Effects of Land Use Change on Soil Physico-Chemical Properties in a South-Southern Nigeria. African Jou. od Envr. Pollution and Health, 7 (2), 47-51

Ofoezie, I.E., and Asaolu, S.O. (1997). Water Level Regulation and Control of Schistosomiasis Transmission: A Case Study in Oyan Reservoir, Ogun State, Nigeria. Bulletin of the World Health Organization, 1997, 75(5), 435-441. World Health Organization

Ogbuabor, J. E. and Egwuchukwu, E. I. (2017). The impact of climate change on the Nigerian economy. International Journal of Energy Economics and Policy, 7(2), 217-223

Ogu, V.I., (2000). Private sector participation in municipal waste management in Benin City, Nigeria. Environment and Urbanization V.12, No.2, pp 103-116.DOI.

Ogu V.I (2009). Urban Infrastructure development and sustainability in Nigeria. Human Settlement Dev 111:109 http://www.cotss.net/sample-chapters/c14/el-18-05-05.pdf

Ogunbodede, E.F., & Summonla, R.A (2014): Flooding and traffic management. International Jounal of Innovation and Scientific Research 7: 121-130

Ogundebi, A.O (2004). Socio-economic impacts of Flooding in Lagos State. *Environ. Impact Anal*. 12 (1), 16-30.

Ogundele, J., and A. O. Jegede. (2011): "Environmental Influences of Flooding on Urban Growth and Development of Ado-Ekiti, Nigeria." *Studies in Sociology of Science* 2 (2): 89.

Ogundele, O.M., Rapheal, O.M., Abiodun, A.M (2018): Effects of Municipal Wastes Disposal Methods on Community Health in Ibadan-Nigeria. *Polytechnica* 1, 61-72

Ogundiya, I.S. (2010): Corruption: The Bane of Democratic Stability in Nigeria. Current Research Journal of Social Sciences. 2(4): 233-241.

Ogunnowo, C.O, (2004): A Concise Geography of Ijebu-Ode Region. Fotak Publisher, Ijebu-Ode.

Oguntade, P.G., Friesen, J., van de Giesen, N., Savenije, H.H.G (2006): Hydroclimatological of the Volta River Basin in West Africa: trends and variability from 1901 to 2002. Phys. Chem. Earth, 31 (2006), pp, 1180-1188

Oguntade, P.G., Abiodun, B.J., Gunnar L (2012): Spatial and temporal temperature trends in Nigeria, 1901-2000. Meteorology and Atmospheric Physics. 118:95-105

Ogunwale, A.O. (2015). "Deforestation and Greening the Nigerian Environment" Nigeria Institute of Social and Economic Research, Ibadan Nigeria.

Ohl CA, Tapsel S. Flooding and human health – the dangers posed are not always obvious. BMJ. 2000; 321:1167–8.

Ohakwe J, Nnorom I, Iwueze I 2011. Survey of attitude of residents towards environmental deterioration in Nigeria and factors influencing their willingness to participate in reducing the trend: A case study of waste management. Trends in Applied Sciences Research, 6(2): 154-164.

Ojima T (1991). "Changing Tokyo Metropolitan Area and its Heat Island Model". Energy Building, 15-16: 191-203.

Ojinnaka, O.: Hydrography in Nigeria and Research Challenges, FIG Working Week 2013, Environment for Sustainability, TS05E – Hydrographic Education and Standards – 6439 (1-11), Abuja, available at: http://www.fig.net/pub/fig2013/papers/ts05e/TS05E_ojinnaka_6439.pdf (last access: 10 March 2015), 2013.

Ojo, A.O (2007): *The Climatic Dilemma*: Lagos State University: Ojo, Nigeria

Ojo, O. O., and Adejugbagbe, J.A. (2017): "Solid Waste Disposal Attitude in Sango Ota, Ogun State: Implication for Sustainable City Development in Nigeria." *Journal of Environment and Waste Management* 4 (3): 253–260.

Okayo, J, Odera, P, and Omuterema, S (2015) "Socio-economic characteristics of the community that determine ability to uptake precautionary measures to mitigate flood disaster in Kano Plains, Kisumu County, Kenya," Geo-environment Disasters, vol. 2, no. 1.

Oke TR (1981). "Canyon Geometry and the Nocturnal Urban Heat Island: Comparison of Scale Model and Field Observations", J. Climatol., 1: 237-254.

Oke TR (1982). "The Energetic Basis of the Urban Heat Island", Quarterly J. Royal Meteorol. Soc., 108(455): 1-24.

Oke TR (1987). Boundary Layer Climates (2nd Ed.), New York, Methuen and Co. Ltd.

Oke, J.R. (1987), Boundary Layer Climate, 2nd Edition, Routledge.

Oke TR, Johnson GT, Steyn DG, Watson ID (1991). Simulation of Surface Urban Heat Islands Under Ideal Conditions at Night- Part 2: Diagnosis and Causation, Boundary Layer Meteorol. 56: 339-358.

Okebukola P.O (2001). Perspectives on waste and waste management In P.O. Okebukola and B.B. Akpan (eds). Strategies for teaching waste management. Ibadan: STAN 268-273.

Okechukwu C.A (2008). “Consequences of Unplanned and Uncontrolled Environmental Physical Development in Nigeria Cities”.

Olajuyigbe, A. E., Rotowa, O. O., and Durojaye, E. (2012): An assessment of flood hazard in Nigeria: the case of mile 12, Lagos, Mediterranean Journal of Social Sciences, 3, 367–375, 2012.

Okereke, R.A. 920070. “Incidence of Flooding in Southern Nigeria”. International Journal of Environmental Issues, Vol. 5. NO. 1-2, PP.20-28.

Okoye, C. (2019): “Perennial Flooding and Integrated Flood Risk Management Strategy in Nigeria.” *International Journal of Economics, Commerce and Management*, VII (9): 364-375.

Okpara, D.O., Kharlamova, M., & Gracher, V (2021): Poliferation of household waste irregular dumpsites in Niger Delta region (Nigeria): unsustainable public health monitoring and future restitution. *Sustainable Environment Research* 31, Article Number:4

Okunlola, P (1996): Reporting Environment: The Nigerian Print Media Experience. Paper Presented at National Workshop on Environmental Reporting, Otta, Nigeria, P. 1-10

Okyere, Charles Y., Yira Yacouba and Dominik Gilgenbach (2012): "The Problem of Annual Occurrences of Floods in Accra: An Integration of Hydrological, Economic and Political Perspectives. Interdisciplinary Term Paper, Zentrum für EntwicklungsforschunOlabode, E A and Adeleke, A D “Statistical Analysis of Rainfall Trend in Akure, Ondo State, Nigeria” Analele Universităţii din Oradea, Seria Geografie, pp 114 – 121, 2017.

Oladokun, V., and Proverbs D. (2016): “Flood Risk Management in Nigeria: A Review of the Challenges and Opportunities.” *Flood Risk Management and Response* 6(3): 485-497.

Oladunjoye, M.: Nigeria: July 10 Flooding – Lagos Gives Relief Materials to Victims, Daily Champion Newspaper, available at: http://allafrica.com/stories/201109080792.html (last access: 8 February 2015), 2011.

Olajide OA, Agunbiade ME, Bishi HB (2018): The realities of Lagos urban development vision on livelihoods of the urban poor. *Journal of Urban Management* 7: 21–31.

Olajire, B (2018): Causes and Effects of Poor Waste Management. Available Online: servantboy.com

Olajuyigbe, A. E., Rotowa, O. O., and Durojaye, E. (2012): An assessment of flood hazard in Nigeria: the case of mile 12, Lagos, Mediterranean Journal of Social Sciences, 3, 367–375, 2012.

OLAJUYIGBE, A.E., POPOOLA, O.O., ADEGBOYEGA, S.A. & OBASANMI, T. (2015): Application of geographic information systems to assess the dynamics of slum and land use changes in urban core of Akure, Nigeria. *Journal of Sustainable Development,* 8(6), pp. 311-325. DOI: 10.5539/jsd.v8n6p311

Olamiju, I.O., (2012). Micromanagement Issues in Approved Private Residential Layouts in Akure, Nigeria. A PhD Proposal Seminar Paper, Department of Urban and Regional Planning, School of Environmental Technology, Federal University of Technology, Akure, Nigeria.

Olaniran, O.J. (1983): Flood Generating Mechanism at Ilorin, Nigeria. *Geojournal* 7(3):271-279.

Olaniran, OJ (1983): The onset of the rains and the start of the growing season in Nigeria. Nigerian Geographical Journal 26: 81–88.

Olaniran O.J, (1991a). Rainfall anomaly patterns in dry and wet years over Nigeria. Int. J. Climatol. 11: 177-204.

Olaniran O.J, (1991b). Evidence of Climate Change in Nigeria based on annual series of rainfall of different daily amounts. 1911-1998. Clim. Change 19: 319-341.

Olaniran, O.J (2002): Rainfall anomalies in Nigeria: The contemporary understanding. 4$^{th}$ Inaugural lecture delivered at the University of Ilorin, Nigeria

Olaniyi, O. A. et al. (2013): Review of climate change and its effect on Nigeria ecosystem. International Journal of African and Asian Studies, 1, 57.

Olanipekun J.A, Oyeniyi P. and Konwea P.E. (2007). Assessment of Solid Waste Management Techniques in Ekiti State Urban Area. Nigerian School Health Journal 19 (2) 75-82.

Olanrewaju, D.O. (2004): Town planning: A veritable means for poverty reduction, Inugural Lecture Seris 38, delivered at The Federal University of Technology, Akure on 26th October, 2004.

Olanrewaju R.M (2009). The Effect of Urbanization in a City of Developing Country. The Case Study of Ilorin, Kwara State, Nigeria. Ethiopian JOU. of Environ. Stud. And Mgt. Vol 2.

Olapido, E. (2010): Towards enhancing the adaptive capacity of Nigeria: a review of the country's state of preparedness for climate change adaptation. Heinrich Böll Foundation Nigeria.

Olaseha, I. O., and M. K. C. Sridhar. 2004. Community Mobilization for Drainage Improvement: Experience from Three Communities in Ibadan, Nigeria. International Quarterly of Community Health Education 22 (10): 77–85.

Olayiwola, A & Salau, W (2022): Evaluation of Land Cover Dynamics and Landscape Fragmentation in Ijebu-Ode, Nigeria. Published Online: https://doi.org/10:38094/jgier30249 Vol 3 (2).

Onah, E.I (2014): Nigeria: A Country Profile. Journal of International Studies Vol. 10, 151-162

Ologunorisa, E.T. (2001). An assessment of flood risk in the Niger Delta, Nigeria. Ph.D Thesis, Department of Geography and Environmental Management, University of Port -Harcourt, Port Harcourt.

Ologunnorisa, E.T. (2004): *Rainfall Flood Prediction in the Niger Delta*, *Nigeria* (Abstract), International Conference in Hydrology: Science and Practice for the 21st Century, London, UK.

Ologunorisa, T.E, and A. Adejumo. (2005). Public Perception of Flood Hazard in the Niger Delta Nigeria. The Environmentalist 25: 39-45.

Ologunorisa, E.T; Diagi, P.N (2005): Extreme Rainfall and its Implication for Flood Frequency in the Western Niger Delta. A Case Study of Warri. *Nigerian Journal of Tropical Geography* 1:57-62.

Ologunorisa, E.T. and Tersoo, T (2006). The changing rainfall pattern and its implication for flood frequency in Markurdi, Northern Nigeria, Journal of Applied Science and Environmental Management, Vol 10 (3) 97-102.

Oloke, O. C., Ijasan, K. C., Ogunde, A. O., Amusan, L. M., and Tunji-Olayeni, P. F.: Improving urban residents' awareness of the impact of household activities on climate change in Lagos State, Nigeria, Journal of Sustainable Development, 6, 56–64, 2013.

Olokor C.O. (2001). Harzadous Wastes: Its production, effects, disposal and control in Nigeria Industries; Oyo: JONAPHER ~ SD 2(2) 258-267.

Olotuah, A.O. (2005): Urbanisation, Urban Poverty, and Housing Inadequacy, Proceedings of Africa Union of Architects Congress, 23-28 May, Abuja, Nigeria, pg. 185-199.

Oludare Hakeem A., Barshir Olufemi O., and Olusegun Hezekiel A. (2012). "Building Capabilities for Disaster and Hazard Preparedness and Risk reduction in Nigeria: Need for Spatial Planning and Land Management", Journal of Sustainable Development in Africa, Vol. 14, No. 1, pp.

Oluduro, C. (1988): Grappling with the Problem of Flood, in Daily Times, Tuesday July 5, p. 11.

Olukanmi, D.O and Akinyinka, M.O (2012). Environment, Health AND Wealth: Towards an analysis of municipal solid waste management in Ota, Ogun State, Nigeria, Proc. ICCEM (2012) 138-145.

Olukanmi, D.O (2013a): Assessment of WASH Program in Public Secondary Schools in South-Western Nigeria. APRN Journal of Engineering and Applied Sciences Vol. 8 (3).

Olukanmi, D.O and Akinyinka, O.M (2014). Environment, Health and Wealth: Towards an analysis of municipal solid waste management in Ota, Ogun State, Nigeria. Presented at the International Conference in Clean Technology and Engineering Management, Covenant University Ota, Nigeria, ICCEM (2012) 51-71.

Olukanni, D. O., R. A. Adebayo, and I. T. Tenebe. (2014): "Assessment of Urban Drainage and Sanitation Challenges in Nigeria." *International Journal of Emerging Technology and Advanced Engineering* 4 (12): 100–105.

Olorunfemi F.B (2008): "Disaster Incidence and Management in Nigeria". Research Review. Vol.24 No. 2, pp 1-23

Olorunfemi, F.B (2010): "Climate Change and Flood Risk in the Informal Settlements of Cape Town: Understanding Vulnerability and Adaptation Options" Final Technical Report of The African Climate Change Fellowship Programme, Submitted to Global Change Systems for Analysis, Research and Training (START), Washington DC, USA.

Olorunfemi, F.B (2011): Managing flood disasters under a changing climate: lessons from Nigeria and South Africa, NISER Research Seminar Series NISER, Ibadan.

Oluseyi, A.B (2017): Plant Genetic Resources (PGR) in Nigeria and the Reality of Climate Change. A review. *Asian J. Environ.Ecol*, 2, 1-24.

Olotuah, A. O. and Bobadoye, S. A. (2009): Sustainable Housing Provision for the Urban Poor: A Review of Public Sector Intervention in Nigeria, The Built and Human Environment Review, 2, pp51- 63.

Olthusi, K.; Benni, J.; Eichwede, K.; Zevenbergen, C. (2015): Slum Upgrading: Assessing the importance of location and a plea for a spatial approach. Habitat Int, 50, 270–288.

Olowa, O.W (2012): Concept, Measurement and Causes of Poverty I Perspective. American Journal of Economics 2 (1): 25-36

Olowoopejo M (2016): Lagos blames residents for persistent flooding. Vanguard 27 June [online]. Available at https://www.vanguardngr.com/2016/06/lagos-blames-residents-persistent-flooding/

Oluwande, P.A (2002) "An overview of urban solid waste management in Nigeria". A paper presented at the workshop on waste disposal, environmental pollution and community health, industrial unit and technology. University of Ibadan 13-16th June.

Oluwaseun A.A & Taiwo O.A (2019). Challenges of Deforestation in Nigeria: An Ethical Perspective. Nnamdi Azikiwe Journal of Philosophy, Vol II (1). Available at: Journals.ezenwahaetorc.org/index.php/NAJP/article/view/2019-11-1-0006/504 (Accessed on July 12, 2019)

Oluwaseyi, O. B. (2019). "Assessment of Physical Planning Administration in Nigeria."

Oluwatayo, I.B. (2011). Climate change and adaptation strategies of small-scale arable crop Farmers in rural Nigeria, International Journal of Agriculture and Food Science, 1, pp. 12-27.

Omar, M (2013): Governing Nigerian Urban Centres. Public Policy and Administration Research www.iiste.org ISSN 2224-5731(Paper) ISSN 2225-0972(Online) Vol.3, No.1, 2013

Omer AM (2008). Energy, Environment and Sustainable Development, Renewable Sustainable Energy Rev., 12: 2265-2300. Peterson JT (1973). The Climate of Cities: A Survey of Recent Literature, IN: McBoyle G. (ed.), Climate Rev., 264-285.

Omer, L.A (2017): Outlier Detection in Extreme Value Series. Jou. of Multidisciplinary Eng. Sci. & Tech. Vol 4 (5)

Omoboye, I. F., and Festus I.A (2014). "Environmental Challenges in Nigeria: Typology, Spatial Distribution, Repercussions and Way Forward."

Omofonmwan SI, Osa-Edoh GI. (2008). The challenges of environmental problems in Nigeria. J. Hum. Ecol. 23(1):53-57.

Omogbai, B. E. (2010): An Empirical Prediction of Seasonal Rainfall in Nigeria. Journal of Human Ecology. 32(1), 23-27

Omotosho, J.B (1988): Spatial variation of rainfall in Nigeria during the little dry season. Atmos Res22:137–147

Omotosho, J. (2007). Pre-rainy season moisture build-up and storm precipitation delivery in the West Africa Sahel. International Journal of Climatology, 28:937– 946

Omran, A., Mahmood, A., and Aziz, H.A (2007): Current practice of Waste Management in Malaysia and its Disposal

Onanuga, M.Y., Eludoyin, A.O., & Ofoezie, I.E. (2022): Urbanization and its effects on land and water resources in Ijebuland, southwestern Nigeria. *Environment, Development and Sustainability*, 24(1), 592-616.

O'Neill, B. C., Ren, X., Jiang, L., Dalton, M. (2012): The effect of urbanization on energy use in India and China in the iPETS model Energy Economics xxx xxx–xxx.

ONGWENYI, G.S., DENGA, F.G.O., ABWAO, P. & KITHEKA, J.U. (1993): Impacts of floods and drought on the development of water resources of Kenya: case studies of Nyando and Tana catchments. (In Gladwell, J.S., ed. Hydrology of warm humid regions: proceedings of the Yokohama symposium 13- 15 July 1993, Yokohama, Japan. Tokyo: The Foundation of River and Basin Integrated Communications p. 117-123.)

Onibokun, A. G., and A. J. Kumuyi. 1999. Ibadan. In Managing the Monster: Urban Waste and Governance in Africa, edited by A. G. Onibokun, 1–10. Ottawa: International Development Research Centre.

Onwabiko, E (2012): Head, Human Rights Writers Association of Nigeria www.huriwa.Blogspot.com

Onwuemele, A. (2012): "Chapter 11 Cities in the Flood: Vulnerability and Disaster Risk Management: Evidence from Ibadan, Nigeria." In *Urban Areas and Global Climate Change*, edited by W. G. Holt, 277–299. Emerald Group Publishing Limited.

Onwutuebe, C. J. (2019). Patriarchy and Women Vulnerability to Adverse Climate Change in Nigeria. https://doi.org/10.1177/2158244019825914SAGEOnyekwere, I. A. (2012). Demography and population dynamics for Nigeria. Owerri: Cel-bez Publisher

Opere, A (2017): "Floods in Kenya 2013," 2017, https://www.researchgate.net/publication/289351003-Flood-in, Kenya.

Opondo, D.O (2013): Erosive coping after the 2011 flood in Kenya. Int. Jou. of Global Warming. 5 (4): 452-466. DOI: 10.1504/IJGW.2013.057285

Organization for Economic Co-operation and Development OECD, 2001. Available at: www.oecd.org/publications/pol_brief/ (Accessed on: June 20, 2019)

Organisation Météorologique Mondiale. Déclaration de l'OMM sur L'état du Climat Mondial en 2016; World Meteorological Organization (WMO): Geneva, Switzerland, 2016; Volume 1189, p. 44. Available online: https://library.wmo.int/doc_num.php?explnum_id=3500.

Oriola, S (1989): Strategies for combating urban flooding in developing nation. A case study from Ondo, Nigeria Assessed at:

https//www.researchgate.net/publication/226782992_strategies_for_combating_flooding_in_a_developing_nation_A_Case_Study_of_Ondo_Nigeria.

Oriola, E (1994): Strategies for combating urban flooding in a developing nation: a case study of Ondo, Nigeria. *The Environmentalist*, 4: 57-72

Orlove B, Chiang J, Cane M. (2000): Forecasting Andean rainfall and crop yield from the influence of El Ni¤o on Pleiades visibility. *Nature*.403:68–71.

Orunboloye 10 (1995). The demographic situation in Nigeria and prospects for fertility transition. J Int Dev 7 (1): 135-144.https://doi.org/10.1002/jid.3380070109.

Osaghae, E. E. (1998): Crippled giant: Nigeria since independence. Bloomington: Indiana University Press

Osuafor, A. M. and Nnorom, N.R. (2014). Impact of Climate Change on Food Security in Nigeria. AFRREV STECH, 3(1). https://www.ajol.info/index.php/stech/article/view/103132

O'Toole (200): Research on Policy Implementation: Assessment and Prospects. Journal of Public Administration, Research and Theory, 10 (2), 263

Otitoju. M.A. and Enete, A.A. (2016). Climate change adaptation: Uncovering constraints to the use of adaptation strategies among food crop farmers in South-west, Nigeria using principal component analysis (PCA). Cogent Food & Agriculture, 2. http://dx.doi.org/10.1080/23311932.2016.117869

Ozor, N. et al. (2012). A framework for agricultural adaption to climate change in Southern Nigeria. International Journal of Agriculture Sciences, 4(5), 243-251

Otubu, T. (2010): "Land reforms and the future of the land Use Act in Nigeria." Nigerian Current Law Review (NIALS) 2007-2010.

Ouikotan, R., J. V. Der Kwast, A. Mynett, and A. Afouda (2017): "Gaps and Challenges of Flood Risk Management in West African Coastal Cities." Paper presented at the Proceedings of the XVI World Water Congress, Cancun Quintana Roo.

Ouwuka, S.U., Ikekpeazu, F.O., Muo, A (2015): Evaluating the Causes of Flooding in Six Communities in Akwa Anambra State. Jou. of Nat. Sci. Res. V (5), No. 4

Owolabi, T.O.S & Ekechi, C.O (2014): Communication as critical factor in Disaster Management and Sustainable Development in Nigeria. Inter. Jou. of Devp. And Eco. Sust. Vol 2 (3), pp. 58-72

Owusu-Frempong, Y. (2005). Afrocentricity, the Adae festival of the Akan, African American festivals, and intergenerational communication. Journal of Black Studies, 35, 730-750.

Oyaigbevwen, V.O (1988). A conceptual framework for an environmental management policy. In P.O. Sada and F.O. Odemorho (eds) Environmental issues and management in Nigeria Development. I badan: Evans Brothers

Oyebande, L.: Drainage protection to urban lands: an environmental challenge, Nigerian Geographical Association Conference, 16– 21 December 1974, University of Nigeria, Nsukka, Enugu, 1–7, 1974.

Oyebanji, L. (1990) 'Aspect of Urban Hydrology and the Challenge of African Urban Environment African Urban Quarterly. Vol.5 Nos. 1 & 2 pp. 39-63

Oyegbile, O. (2008): 'Battling a Global Threat' in Tell Magazine. Lagos: Tell Communications Limited, Ikeja. (August, 11); pp, 20 - 25.

Oyegoke, S.O. and Oyebande, L. (2008). A New Technique for Analysis of Extreme Rainfall for Nigeria. Environmental Research Journal 2 (1): 7-14, 2008 20) The News (2010). Sacked by Flood.

Oyesiku, O.O. (2002): From Womb to Tomb, 24th Inaugural Lecture, Olabisi Onabanjo University, Ago-Iwoye, 27th August.

Oyinloye, M., Olamiju, I., & Adekemi, O (2013): Environmental impact of flooding on Kosofe Local Government Area of Lagos State, Nigeria: A GIS Perspective. Jou. of Envr. And Earth Science. Vol 3 (5)

Oyinloye, et al (2013): Combating Flood Crisis Using GIS: Empirical Evidence from Ala River Floodplain, Isikan Area, Akure, Ondo State, Nigeria. Communications in Information Science and Management Engineering, Sept. 2013, Vol. 3 Iss. 9, pp. 439-447.

Oyegoke S.O., Sojobi A.O. (2012): Developing Appropriate Techniques to Alleviate the Ogun River Network Annual Flooding. Inter. Jou. of Sci. & Engr. Res. Vol 3 (2), pp. 10-16.

Ozor N (2009a) Implications of climate change for national development: the way forward. Debating policy options for National Dev., Enugu Forum Policy paper 10; African Institute for Applied economics (AIAE) Enugu, Nigeria, pp 19–32

Ozor N (2009b) Understanding climate change. Implications for Nigerian agriculture, policy and extension. Paper presented at the National conference on climate change and the Nigeria environment. Organized by the Department of Geography, University of Nigeria, Nsukka, 29 June–2nd July

**P**

Pack k. (2007). Park's Textbook of Preventive and Social Medicine India; Barnasida Bhanot Publishers.

Padgham, J., Devisscher, T., Chuluun, T., Mtilatila, L., Kaimila, E., Mansingh, I., et al. (2013): Building shared understanding and capacity for action: Insights on climate risk communication from India, Ghana, Malawi, and Mongolia. *International Journal of Communication,7,* 970–983.

Pahl-Wostl C. (2006): Framework for adaptive water management regimes and for the transition between regimes. NeWater project, Report Series No. 12, 2006.

Palmer TN, Räisänen J (2002) Quantifying the risk of extreme seasonal precipitation events in a changing climate. Nature 415: 512-514.

Pareek A, Trivedi PC. (2011): Cultural values and indigenous knowledge of climate change and disaster prediction in Rajasthan, India. *Indian Journal of Traditional Knowledge.*10:183–189.

Patel, K. (2013): *Provision and improvement of housing for the poor*. (Topic Guide). Evidence on Demand

Patil. A & Partil. J. (2011). Effects of Bad Drainage on Roads. Civil and Environmental Research, 1 (1), 1-7

Patricia, K., Bila, G.S., Jean, F, N., Jean, K (2013): Environmental Impacts of Wastes Mnagement Deficiencies and Health Issues: A case study in the city of Kaya, Burkina Faso. Jou of Envr Protection V 4 (10), Artcle ID: 37557, 8 pagesPatil M. K. (2015): Change in Seasonality Index of Rainfall in Sangli District. Indian Streams Research Journal ISSN 2230-7850 Impact Factor: 3.1560(UIF) Volume-5 | Issue-1 | Feb-2015 Available online at www.isrj. Indian Streams Research Journal | Volume-5 | Issue-1 | Feb-2015| Online & Print 1

Patrick Kirkby, Casey Williams & Saleemul Huq (2017): Community-based adaptation (CBA): adding conceptual clarity to the approach, and establishing its principles and challenges, Climate and Development, DOI: 10.1080/17565529.2017.1372265 To link to this article: http://dx.doi.org/10.1080/17565529.2017.1372265Patwardhan, A., Downing, T., Leary, N., & Wilbanks, T. (2009). Towards an integrated agenda for adaptation research: Theory, practice and policy. Current Opinion in Environmental Sustainability, 1, 219–225. doi: 10.1016/j.cosust.2009.10.010

Patz, J., 2000. Climate, ecosystems, infectious diseases and health. Proceeding of the Comments to Conference of National Academies, April 10, http://www4.nas.edu/.

Paul BK (1984) Perception and agricultural adjustment to floods: Jamuna floodplain, Bangladesh. J Human Ecol 12(1):3–19

Paul, I.P., Caroline, M.W., Bo Dong., Ross, I.M., Kevin, G.W., Nicola, G., Jonathan, E.H., Nina, M., Sonja, S.F., Gamel, A., Richard, P.A., Emily, C.L.B., Liang, F., Maslin, G., Keith, H., Chris, H., Mary, F.L., Ahmed, S., & Andrew, G.T (2023): Drivers and Impacts of Eastern African Variability. *Nature Reviews Earth and Environment*. Available Online: nature.com/articles/s43017-023-00397

Pavlov, I. P., (1927): Conditioned Reflexes: An Investigation of the Physiological Activity of the Cerebral Cortex. Ed. Anrep., G. V., London: Oxford University Press.

Payne, G. and Majale, M. (2004): The Urban Housing Manual Publisher: Earth scan Publications Ltd, 168 pages. So A.T.P and Leung A.Y.T (2004): Survey of attitudes towards buildings in three Chinese cities: Hong Kong, Shanghai and Taipei. Facilities 22(3/4): 100-108.

Peduzi, P., Dao, H., Herold, C., Mounting, F (2009): Assessing global exposure and vulnerabilities towards natural hazards: The disaster risk index, Natural Hazards Earth System Science 9:1149-1159

Peixoto JMA, Nelson BW, Wittmann F (2009) Spatial and temporal dynamics of river channel migration and vegetation in central Amazonian white-water floodplains by remote-sensing techniques. Remote Sens Environ 113:2258–2266

Pelletier, J. D. & Turcotte, D. L. Self-affine time series: II. Applications and models. *Advances in Geophysics* **40**, 91–166 (1999).

Pelling, M. (2003). The Vulnerability of Cities: social resilience and natural disaster. London: Earthscan, 212

Pelling M et al (2004) Reducing disaster risk a challenge for development. United Nations Development Programme — Bureau for Crisis Prevention and Recovery. doi:10.1007/s003450050172.

Pelling M, Blackburn S (2012): Megacities and the coast: risk, resilience and transformation. 1st edn. Earthscan from Routledge, Oxford

Pendagrass, A.G., Knutti, R., Lehner, F., Deser, C., Saderson, B.M (2017): Precipitation variability increases in a warmer climate. *Sci. Rep. 7* 17966

Penning-Rowsell, E.C.; Priest, S.; Johnson, C (2014): The evolution of UK flood insurance: Incremental change over six decades. Int. J. Water Resour. Dev. 30, 694–713

Penning-Rowsell, Edmund C. and Priest, Sally J. (2015): Sharing the burden of adapting to increasing flood risk: who pays for flood insurance and flood risk management investment in the United Kingdom. Mitigation and Adaptation Strategies for Global Change, 20 (6). pp. 991-1009. ISSN 1381-2386 [Article] (doi:10.1007/s11027-014-9622-

Perry RW, Lindell MK (1990) Predicting long term adjustment to volcano hazard. Int J Mass Emergencies Disasters 8(2):117–136.

Petit, C. C., & Lambin, E. F. (2002). Impact of data integration technique on historical land-use/land-cover change: Comparing historical maps with remote sensing data in the Belgian Ardennes. *Landscape Ecology*, 17(2), 117-132.

Petschel-Held G, R Lasco R, E Bohensky, T Domingoes, A Guhl, J Lundberg & M Zurek 2006. Drivers of Ecosystem Change. In Ecosystems and Human Well-Being Volume 4: Multi-scale Assessments. Washington D.C.: Island Press.

Piaget, J., (1964): Part I: Cognitive development in children: Piaget development and learning. Journal of Research in Science Teaching, 2, 3, 176–186.

Pilgram, A. (1788) Untersuchungen über das Wahrscheinliche der Wetterkunde durch vieljährige Beobachtungen. Joseph Edlen von Kurzbeck, Wien, Austria

Planton, S., Dequ ´ e, M., Douville, H., and Spagnoli, B (2005): “Impact du ´ rechauffement climatique sur le cycle hydrologique,” ´ Comptes Rendus Geoscience, vol. 337, no. 1, pp. 193–202, 2005.

Poku-Boansi, M., Amoako, C., Owusi-Ansah J., Cobbinah, P.B (2020): What the state does but fails: Exploring smart options for urban flood risk management in informal Accra, Ghana City and Environment Interactions 5 (1): 100038

Poortinga W, Pidgeon N (2003) Public perceptions of risk, science and governance: main findings of a British survey of five risk cases. University of East Anglia and MORI, Norwich

Popoola, K.O., Eludoyin, A.O., Oladehinde, G.J., Ajayi, S.A. and Popoola, O.S. (2020): ‘Rainfall and temperature variability across selected ecological regions in Nigeria’, Interdisciplinary Environmental Review, Vol. 20, Nos. ¾, pp. 311-323.

Population Reference Bureau (PRB, 2015). World Population Data Sheet, with a Special Focus on Women’s Empowerment (2015). Geneva: PRB

Porson. A, Clark. P.A, Harman .I.N, Best .M.J, Belcher .S.E (2010). Implementation of a new urban energy budget scheme in the MetUM. Part I: Description and idealized simulations**.** Quarterly Journal of the Royal Meteorological Society, 136 (651) , pp. 1514-1529

Potchin, M. (2009). Land use and the state of the environment. Land use policy, 265, 170-177. http://dx.doiu.org/10.1026/J.landusepol.2009.08.008.

Potts, D. (2012): Whatever Happened to Africa’s Rapid Urbanisation? Africa Research Institute.

Prager, K (2012): Understand behaviour change: How to apply theories of behaviour change to SEWeb and related public engagement activities: James Hutton Institute: Katrin.prager@hutton.ac.uk

Premium Times & Opinion (January 10, 2017): Key Drivers of Change (II): Education Reform, By Tunji Olaopa. Available online: https://opinion.premiumtimesng.com/2017/01/10/key-drivers-of-change-ii-education-reform-by-tunji-olaopa/

Preston, B. and Stafford-Smith, M. (2009): Framing vulnerability and adaptive capacity assessment: Discussion Paper. CSIRO Climate Adaptation Flagship Working paper No. 2. Pearson RG, Thuiller W, Araujo MB, Martinez-Meyer E, Brotons L, McClean C, Miles L, Segurado P,

Pressman, J., & Widavsky, A (1973): Implementation: How Great Expectations in Washington are Dashed in Oakland or *Why it's Amazing that Federal Programs Work at All*. Berkeley: University of California Press

Prestone-Jones, A (2020): The importance of Climate Change Education in Urban Planning. A Review of Planning Courses at UK Universities, In: Leal Filho W., Nagy G., Borga M., Chaávez Muňoz P., Magnuszewski A. (eds) Climate Change, Hazards and Adaptation Options. Climate Change Management.

Punch Newspaper, (2017): Early morning rainfall; Roads, homes flooded in Lagos. Punch Mobile App, July 22, 2017.

Punch Metro (AltAfrica September 12, 2018): Nigeria: Residents Flee Community as Gully 'Swallows' 50 Houses inIjebu-Ode, Ogun State. Available at: https://alternative.com/2018/09/12/nigeria-residents-flee-community-as-gully-swallow-50-houses-in-Ijebu-ode-ogun-state/

Pupovac, V., Petrovecki, M (2011): Summarizing and preventing numerical data. Published Online: biochemia-medical.com/assets/images/upload/xml_bm-21-106.pdf

**Q**

Qiang, Y (2019): Disparities of population exposed to flood hazards in the United States. J. Environ. Manag. 232: 295-304

Quattrochi DA, Luvall JC, Rickman DL, Estes Jr MG, Laymon CA, Howell BF (2000). "A Decision Support Information System for Urban Landscape Management Using Thermal Infrared Data", Photogrammetric Eng. Remote Sensing, 66: 1195-1207.

Quikotan, R.B., van der Kwast, J., Mynett, A., Afouda, A (2017): Gaps and challenges of flood risk management in West Africa coastal cities. Inter. Water Res. Assc (WRA).

Available online: iwra.org/member/congress/resource/ABSID329_ABSID329_full_paper.pdf

Quintero, A.J., Segal, L.S., King, T.S. & Black, K.P. (2009): The personal interview: assessing the potential for personality similarity to bias the selection of orthopaedic residents. Academic Medicine. 84(10), 1364-1372

**R**

Raaijmakers, R., Krywkow, J., van der Veen, A (2008): Flood risk perceptions and spatial multi-criteria analysis: exploratory research for hazard mitigation. Natural hazards 46: 307-322.

Rachel, O.A., Komine, H., Yasuhara, K., Murakami, S (2009): Municipal solid waste management in developed and developing countries – Japan and Nigeria as a case study. Available at: http://www.geo.civil.ibaraki.ac.jp/komine/mypapers/JGSPapers/2009/jas2009(973)Rachel.pdf

Raffaello, C., Richardo, V., and Monica, S (2013): Toward Climate Resilient Development in Nigeria. International Bank for Reconstruction and Development/The World Bank 1818 H Street NW, Washington, DC 20433

Rain, D., Engstrom, R., Ludlow, C. and Antos S. (2011) Accra Ghana: A city vulnerable to flood and drought-induced migration. Case study prepared for cities and climate change: Global Report on human Settlement pp 1-21

Ramachandra, T.V., & Aithal, B.H. (2013): Understanding urban sprawl dynamics of Gulbarga-Tier II city in Karnataka through spatio-temporal data and spatial metrics. *International Journal of Geomatics and Geosciences,* 3(3), 388-404

Ramage, C.S (1971): Monsoon meteorology. Academic Press, New York

Ramos C, Reis E (2002) Floods in southern Portugal: their physical and human causes, impacts and human response. Mitig Adapt Strat Glob Change 7:267–284

Random House: New York, NY, USA, 37. Davis, M. Planet of Slums; Verso: London, UK.

RAMSAR, Handbook's 4th edition. Handbook 1. (2010). Wise use of wetlands. Available at: http://www.ramsar.org/pdf/lib/hbk4.01.pdf.

Ranger N., and Fisher S., (2012): The Challenges of Climate Change and Exposure Growth for Disaster Risk Management in Developing Countries. Produced for the Government Office of Science, Foresight project 'Reducing Risks of Future Disasters: Priorities for Decision Makers'

Ranjan, S., Ramanathan, A.L. and Singh, V.B. (2019): 'Extreme climate event footprint at Delhi, India: a comparison of last one-decade meteorological conditions', Journal of Climate Change, Vol. 5, No. 1, pp. 33-40.

Rasmusson, E.M., (1985): El Niño and variations in climate. Am. Sci., 73: 168-177.

Ratnayake, U & Herath, S. [2005]. Changing Rainfall and its Impacts on Landslide in Sri Lanka. *Journal of Mountain Science*. 2. [3], 218-224.

Ravallion M and J Jalan (2001): Household Income Dynamics In Rural China. World Bank Policy Research Working Paper. Washington, D.C.: World Bank

Reacher M, McKenzie K, Lane C, Nichols T, Kedge I, Iversen A, et al. Health impacts of flooding in Lewes: a comparison of reported gastrointestinal and other illness and mental health in flooded and non-flooded households. Commun Dis Public Health. 2004; 7:39–46.

Rebelo LM, Finlayson CM, Nagabhatle N (2009): remote sensing and GIS for wetland inventory, mapping and change analysis. Journal of Environmental Management. 2144-2151.

Reerink, G.; van Gelder, J. (2010): Land tilting, perceived security, and housing consolidation in the kampongs of Bandung, Indonesia. Habitat Int. 34, 78–85.

Reid, H. (2015, September). Personal communicationReiter, P., 2001. Climate change and mosquito-borne disease. Environ. Health Perspect. 109: 141-161. Reja, U., Manfreda, K.L., Hlebec, V. & Vehovar, V. (2003): Open-ended vs. closeended questions in web questionnaires. Developments in Applied Statistics. 19(1), 159-177.

Reliefweb, (2012): "Kenya: floods-Apr 2012," http://reliefweb.int/disaster/ff-2012-000062-ken.

Reliefweb (2019): Kenya Flash Update No. 2: Floodds|5 November 2019. Available At: https://reliefweb.int/report/kenya/kenya-flash-update-no-2-floods-5-november-2019

Removȧ, M., & Cislerovȧ (2010): Analysis of climate change effects on Evaporation in the Watershed Uhliřskȧ in the Jizera, Mountains. Soil & Water Res., 5 (1): 28-38

Renn O (1992) Concepts of risk: a classification. In: Krimsky S, Golding D (eds) Social theories of risk. Praeger, Wesport, CT, pp 53–79.

Renn O (1995) Individual and social perception of risk. In: Fuhrer U (ed) Ökologisches Handeln als sozialerProzess. Birkhäuser, Basel, pp 27–50

Renn O (2005): White paper on risk governance. Towards an integrative approach. The International Risk Governance Council, (IRGC) Geneva.

Republic of Kenya, National Policy on Disaster Management, Ministry of Special Programmes, Nairobi, Kenya, 2007.

Reutschler, J., and Melda, S (World Bank Group, October 2020): People in Harm's way: Flood Exposure and Poverty in 189 Countries

Reyes-Garcia, V., Fernàndez-Llamazares, A.F., Guèze, M., Garcès, A., Mallo, M., Vila-Gomèz, M., Vilaseca, M (2016): Local indicator of climate change: The potential contribution of localknowledge to climate research. Wiley Interdiscip. Rev. Clim. Change 7 (1): 109-124.

Reynolds, B., Seeger M.W (2005): Crisis and emergency risk communication as an integrative model J. Health Commun., 10 (1), pp. 43-55

Richard Samans, J. B., G. Corrigan, and A. M. D. Hanouz. (2017): "The Inclusive Growth and Development Report 2017." World Economic Forum.

Richard, D (2021): Nigeria – Hundreds of Homes Damaged by Floods in Taraba State. Available Online: floodlits.com/Africa/Nigeria-floods-taraba-july-2021 (Accessed: October 25th 2021)

Richards J.A. (2022): Supervised Classification Techniques. In: *Remote Sensing Digital Image Analysis*. Berlin Heidelberg: Springer, Cham (263-367). Https://doi.org/10.1007/978-3-030-82327-6_8.

Rogolf, K (1987): Repulation, Coordination and Monetary Policy, in Barro, R.J (ed.) Handbook of Modern Business Cycle Theory. New York: John Wiley Press

Rohde, P., Lewinsohn, P.M. & Seeley, J.R. (1997): Comparability of telephone and face-to-face interviews in assessing axis I and II disorders. American journal of Psychiatry. 154(11), 1593-1598.

Rolse, M.I., Pit, S.W., Mckenzce, J.W (2020): Social vulnerability in a high-risk flood affected rural region of NSW Australia Nat Hazards https://doi.org/10.1007/s11069-020-038876

Rolland, E., Bracken, L.J., Hardy, R.J., Large, A.R.G: Rethinking flood risk communication. *Natural Hazards,* 92, 1665-1686.

Rollanson, E., Bracken, L.J., Hardy, R.J., Large, A.R.G (2018): Rethinking flood risk communication. *Natural Hazards* 92, 1665-1686

Rosenfeld. D (2000**).** Suppression of rain and snow by urban and industrial air pollution**.** Science, 287 (5459), pp. 1793-1796

Rosenzweig C, Neofotis P. (2013): Detection and attribution of anthropogenic climate change impacts. *Wiley Interdisciplinary Reviews-Climate Change.* 4:121–150

Roth M, Oke TR, Emery WJ (1989). Satellite-derived Urban Heat Islands from Three Coastal Cities and the Utilization of Such Data in Urban Climatology, Int. J. Remote Sensing, 10(11): 1699-1720.

Rotimi M. A. (2003): Trends In Industrial And Residential Development In Nigeria: Implications For Health And Safety. An Invited Paper Presented At The 39th National Conference/Scientific Workshop Of The Environmental Health Officer Assoociation Of Nigeria (EHOAN), October, 2003

Rowell, D.P., Folland, C.K., Maskell, K., Owen, J.A and Ward, M.N. (1992): Modelling the influence of sea surface temperature on the variability and predictability of seasonal Sahel rainfall. *Georg. Res. Lett*, 19, pp. 905-908.

Roy, N., Pandey, W (2016): Concepts and Practices of Disaster Management Concepts and Practices of Disaster Management. Available online: researchgate.net/publication/320126456_Concepts_and_Practices_of_Disaster_Management_Concept_and _Practices_of_Disaster_Management

ROOY MP. Van (1965): A Rainfall Anomaly Index Independent of Time and Space. Notos. 14, 43p

Rubinto, M., Nichola, A., Peng, Y., Zhang, Jian-min., Lash ford, C., Cai, Yang-peng., Lin, Peng-zhi (2019): Urban and river flooding: Comparison of flood risk management approaches in the UK and China and an assessment of future knowledge needs. Water Science and Engineering Volume 12 (4), pages 274-283.

Rudolf, B., Zbigniew, W., Kundzewicz & Gerado, B (2006): Historical hydrology for studying flood risk in Europe. Hydro-Sci-Jour-des Sci Hydrologiques, 51 (5)

Rufat, S., Tate, E., Burton, C.G., Maroof, A.S (2015): Social Vulnerability to Floods: Review of Case Studies and Implications for Measurement. Int. Jou. of Disaster Risk Reduction. V 14 (4), PP. 470-486

Ryan, R.L, R. Kaplan, and R. Grese. (2001). Predicting volunteer commitment in environmental stewardship programme. Journal of Environmental Planning and Management 44:629-648.

Ryle, G., (2002): The concept of mind. Chicago: University of Chicago Press.

**S**

Saaroni H, Ben-Dor E, Bitan A, Potchter O (2000). Spatial Distribution and Microscale Characteristics of the Urban Heat Island in Tel-Aviv, Israel, Landscape Urban Plann., 48: 1-18.

Sadiq, A.A (2020): An estimation of rainfall seasonality index of Yola South LGA and its effects on Agriculture and environment. African Journal of Environment and Natural Science Research V 3 (3) (pp. 57-72).

Sailor DJ (1994). Sensitivity of Coastal Meteorology and Air Quality to Urban Surface Characteristics, Preprints of the Eighth Joint Conference on the Applications of Air Pollution Meteorology, Am. Meteorol. Soc. Boston, MA, 8: 286-293.

Sakijege, T.; Sartohadi, J.; Marfai, M.A.; Kassenga, G.R.; Kasala, S.E. (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. Jàmbá J. Dis. Risk Stud, 6, 1–10.

Salami, A.W., Raji, M.O., Sule, B.F., Abdulkareem, Y.A., Bilewu, S.O., (2010): Impacts of climate change on the water resources of Jebba Hydropower Reservoir, 2nd Annual Civil Engineering Conference, University of Ilorin, Nigeria. 26–28 July, 2010, International conference on sustainable urban water supply in developing countries: 298-312.

Sam, P. (2009). Flooding in Accra Research Report. http://www.modernghana.com/news/223780/1/flooding-in-accra-research-report.html (ASSESSED March 3RD, 32019).

Sam, P.A (2009): Are the Municipal Solid Waste Management Practices Causing Flooding During the Rainy Season in Accra, Ghana, West Africa, online (accessed 29 March, 2019), Modern Ghana

Samarajiva, R., Malathy, K., Anderson, P.S., Ayesha, Z. (2005): National Early Warning System: Sri Lanka. A Participatory Concept Paper for the Design of an Effective All-Hazard Warning System. http://www.lirneasia.net/2005/03national-early-warningsystem

Samera K.M. (2015). 'Choked drains cause of rise in no. of mosquito breeding sites'. Retrived from: https;//timesofindia.indiatimes.com/City/Navi-Mumbai/choked-drains-cause-of-rise-in-no-of-mosquito-breeding-sites/articleshow/50249586.cms

Samuels, P. G.: An overview of flood estimation and flood prevention. In invited paper presented at the first international symposium on flood defense, Kassel Reports of Hydraulic Engineering, 9, G1–G11, 2000.

Samuels P, Gouldby B (2009): Language of risk-project definitions, 2nd edn. Floodsite project report T32-04-01.

Samuels, P., Klijn, F., and Dijkman, J.: An analysis of the current practice of policies on river flood risk management in different countries, Irrig. Drain., 55, S141–S150, 2006. Resources.hwb.wales.gov.uk/VTC/settlement_wales/NucleatedSettle/default.html

Samuel, R, Evic, T, Christopher, G.B, Abu. S.M (2015): Social vulnerability to floods: Review of case studies and implications for measurement.

Samuel S, Allan H, Huamei Y, Fareeza K and Muhammad A (2003): Statistical Analysis of Drought Indices and Alberta Drought Monitoring. Alberta Agriculture, Food and Rural Development. Conservation and Development Research. Pp 1-45

Sanderson EW, Jaiteh M, Levy MA, Redford KH, Wannebo AV, Wolmer G. (2002). The human footprint and the last of the wild. BioScience. 52:891–904.

Sangster, H., Jones C., **Macdonald N.** (2018): The co-evolution of historical source materials

in the geophysical, hydrological and meteorological sciences: Learning from the past moving forward, *Progress in Physical Geography*, 42(1): 61-82 https://doi.org/10.1177/0309133317744738

Climate-change impact on the 20th-century relationship between the Southern Annular Mode and global mean temperature | Scientific Reports (nature.com)

Sani, Sham (1998). Environmental Management Issues and Challenges in the Next Millennium, Public Lecture organized by the Center for Graduate Studies, University Kebangsam Malaysia (UKM) 5th March 1998.Baugi

Santos, P.P. (2020): A comprehensive approach to understanding flood risk drivers at the municipal level. J. Environ. Manag. 2020, 260, 110127.

Sarr, B (2011): Return of heavy downpours and floods in a context of changing climate. Climate change in the Sahel. A challenge for sustainable development (special isse). *AGRHYMET Monthly Bulletin*, 9-11. Retrieved from from hhtp://www.cilss.bf/fondsitalic/download/down/specialchpdf.

Sasidharana, V, E Sirakayab & E Kerstettera 2002. Developing Countries and Tourism Eco-labels. Tourism Management 23: 161-174.

Satterthwaite David, Saleemul Huq, Mark Pelling, Hannah Reid and Patricia Romero Lankao (2007): "Adapting to Climate Change in Urban Areas The possibilities and constraints in low- and middle-income nations" Human Settlements Discussion Paper Series.

Satterthwaite, D. (2007): *Climate change and urbanization: Effects and implications for urban governance*. New York: UNDESA

Satterthwaite, D. (2008): Understanding Asia Cities: A Synthesis of the Findings from Eight City Case Studies. Glob. Urban Dev. 4, 1–28.

Satterthwaite, D (2011): How urban societies can adapt to resource shortage and climate change. Philos Trans R Soc A 369:1762–1783

Satterthwaite, D (2015): Urban Poverty. *Urban Pollution and Environmental Management: Topic Guide.* Evidence on Demand.

Satterthwaite, D. (2017): "The Impact of Urban Development on Risk in sub-Saharan Africa's Cities with a Focus on Small and Intermediate Urban Centres." *International Journal of Disaster Risk Reduction* 26: 16–23.

Saxena, V. (2008)."Communicating Effectively: Five Impediments to Communication." http://voices.yahoo.com/communicating-effectively.

Sayers, P., Li, Y., Galloway, G., Penning-Rowsell, E., Shen, F., Wen, K., Chen, Y., and Le Quesne, T (2013): Flood Risk Management: a Strategic Approach, UNESCO, Paris, 2013.

Sayers, P.B.; Gouldby, B.P.; Simm, J.D.; Meadowcroft, I.; Hall, J. (2003): Risk, Performance and Uncertainty in Flood and Coastal Defence—A Review R&D Technical Report FD2302/TR1.

Sayne, A. (2011). Climate change adaptation and conflict in Nigeria. Washington, DC: USIP. https://www.usip.org/sites/default/files/Climate_Change_Nigeria.pdfSchanze, J. (2006) "Flood Risk Management–a Basic Framework." In *Flood Risk Management: Hazards, Vulnerability and Mitigation Measures*, 1–20. Netherlands: Springer.Schanze J (2007) A conceptual framework for flood risk management research. In: Schanze J (ed) Flood risk management research—from extreme events to citizens involvement. Proceedings of European symposium on flood risk management (EFRM 2007), Dresden, pp 1–10

Schipper, E.L.F., Tanner, T., Dube, O.P., Adams, K. and Huq, S. (2020): 'The debate: is global development adapting to climate change?', World Development Perspectives [online] http://eprints.soas.ac.uk/32627/ (accessed 10 January 2020).

Schlein, Lisa (5 September 2009). "West Africa Hit by Devastating Floods". Voice of America. Archived from the original on 6 September 2009.

Schmied, M, C Hochfeld, H Stahl, R Roth, F Armbruster, S Türk & C Friedl 2007. Green Champions in Sport and Environment: Guide to Environmentally-sound Large Sporting Events. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), Berlin and German Olympic Sports Confederation (DOSB), Division Development of Sports, Frankfurt.

Schweitzer, K (2019): Curriculum Design: Definition, Purpose and Types. Avalable online: thoughtco.com/curriculum-design-definition-4154176

Science in Africa (SIA) 2003. Waste: Is the Developing World Ready? July-August 2003. Africa's First online Science Magazine No. 13: 16-18.

Secretariat of the Convention on Biological Diversity (2010), *Global Biodiversity Outlook 3*, May, 2010, p.56

Security, C. O. H. (2013): "Building a Coordinated Approach to Flood Disasters in Nigeria." *Nigeria*. http://www.aapeaceworks.org.ng/documents/1412092739flood_coordination_workshop_rep_july_22,_2013.pdf

Semadeni-Davies, A., Hernebring, C., Svensson, G., L.-G. Gustafsson, L.G (2008a): *The impacts of climate change and urbanisation on drainage in Helsingborg, Sweden: combined sewer system*. J. Hydrol., 350, pp. 100-113, 10.1016/j.jhydrol.2007.05.028

Semadeni-Davies, A., Hernebring, C., Svensson, G., L.-G. Gustafsson, L.G (2008b): *The impacts of climate change and urbanisation on drainage in Helsingborg, Sweden: suburban stormwater*. J. Hydrol., 350 (2008), pp. 114-125, 10.1016/j.jhydrol.2007.11.006

Semeniuk, C.A. 1987. Wetlands of the Darling System – a geo- morphic approach to habitat classification. J. Royal Soc. Western Austr. 69: 95–112.

Semenov VA, Bengtsson L (2002) Secular trend in daily precipitation characteristics: Greenhouse gas simulation with a coupled AOGCM. Clim Dyn 19: 123-140.

SERA PROJECT (Strengthening emergency response abilities). (2000): Vulnerability Profile: Darra Woreda (district), North Shewa Zone, Oromiya Region. Disaster Prevention and Preparedness Commission (DPPC); United States Agency for International Development (USAID). [Web:] http://www.dppc.gov.et/downloadable/Sera%20project/Darra%20Woreda%20VP.pdf [Date of access: 13 Dec. 2009]

Service, M.W., (2000): Medical Entomology for Students. Liverpool Cambridge University Press, London, pp. 224 -245.

Setiawan, H (2014): ilmuhutan.com. [Online]. Available at: http:ilmuhutan.com/efekglobal.warmingKhususnyaterhadapperubah.anniklim [Accessed 13 Nov, 2019].

Seto K.C., Shepherd JM (2009) Global urban land-use trends and climate impacts. Current Opinion in Environmental Sustainability 1: 89-95

SEN, Z. (2012): Innovative trend analysis methodology. **Journal of Hydrologic *Engineering***, v. 17, n. 9, p. 1042-1046.

SEN, Z. (2014): Trend identification simulation and application. **Journal of Hydrologic *Engineering***, v. 19, n. 3, p. 635-642.

Seneviratne SI et al., (2012): Changes in Climate Extremes and their Impacts on the Natural Physical Environment. In Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, Special Report on Extremes (SREX) by the Intergovernmental Panel on Climate Change

Shanze, J et al., (eds) (2006): Flood Risk Management: A Basic Framework. Hazards, Vulnerability and Mitigation Measures, 1-20.

SHARMA, D. (2002): Coping strategies and early warning systems of tribal people in India in the face of natural disasters: case studies in Maurbhanj, Orissa and Dungarpur, Rajastan, India. New Delhi: International Labour Office. 54 p.

Sharma, J., Ravindranath, N.H (2019): Applying IPCC 2014 framework for hazard-specific vulnerability assessment underclimate change. *Environ. Res. Commun*. 1 051004

Shen X (2010) Flood risk perception and communication within risk management in different cultural contexts. United Nations University Institute for Environment and Human Security (UNU-EHS), Bonn, Germany

Sherwood, S. C., Webb, M. J., Annan, J. D., Armour, K. C., Forster, P. M., Hargreaves, J. C., et al. (2020): An assessment of Earth's climate sensitivity using multiple lines of evidence. Reviews of Geophysics, 58, e2019RG000678. https://doi.org/ 10.1029/2019RG000678

SHUAIB, Y. A. (2012). *Flood: NEMA Receives N104m Relief Materials from Japan* [Online]. Abuja: National Emergency Management Agency, Available: http://www.nema.gov.ng/media-room/press-release.aspx?viewpr=84.

Shukia, J. and Fennessy, Y.M.J. (1988): Prediction of time-mean atmospheric circulation and rainfall: Influence of pacific sea surface temperature anomaly. *J. Atmos. Sci*., 45, pp. 9-28

Shuster WD, Bonta J, Thurston H, Warnemuende E, Smith DR (2005) Impacts of impervious surface on watershed hydrology: a review. Urban Water Journal 2: 263-275. 34. Kalnay E, Cai M (2003) Impact of urbanization and land-use change on climate. Nature 423: 528-531. 35.

Sighomnou, D, Descroix, L, Genthon, P, Mahẽ, G, Moussa, I.B, Gautier, E, Hiernaux, P (2013): La crue de 2012 ã Niamey: Un paroxysme du Sahel? Sẽcheresse, 24, 3-13.

Silveira, A.L.L., Goldenfun, J.A., and Fendrich, R (2001): Urban drainage control measures, in: Urban Drainage in Humid Tropics, C.E.M. Tucci (ed), Urban Drainage in Specific Climates. C. Maksimovic Hydrology. No. 40. Vol 1. 125-154

Silvestre, G (2009): The Social Impacts of Mega-Events: Towards a Framework. Unpublished Master thesis in Tourism Management at the University of Westminster, London.

Simamjuntak, L., Frantzeskaki, N., Enserink, B., Ravesteijn, W (2012): Evaluating Jakarta's Flood Defence Governance: The Impact of Political and Institutional Reforms. *Water Policy, 14*, 561-580.

Simmons IG 1999. Environmental thought: The last 25 years. International Journal of Environmental Studies, 29: 163-170.

Simmons, B. (2000). ''Towards excellence in environmental education: A view from the United States.'' Water, Air, Soil Pollut., 123, 517–524

Skinner, B. F., (1938): The Behavior of Organisms: An Experimental Analysis. Oxford, England: Appleton-Century.

Slack, E., & Cótè, A (2014): *Comparative urban governance* (Future of cities: working paper). London: Foresight, Government Office for Science.

Slovic P, Fischhoff B, Lichtenstein S (1982) Why study risk perception. Risk Anal 2(2):83–93

Slovic P (1987): Perception of risk. Science 236:280–285Slovic P, Fischhoff B, Lichtenstein S (1984): Behavioral decision theory perspectives on risk and safety. Acta Psychol 56:183–203

Slovic P (2000): The perception of risk, 1st edn. Earthscan publications Ltd., London

Slovic, P., & Peters, E (2006): Risk Perception and Affect. Volume 15, Issue 6. Journal.sagepub/doi/10.1111/j.1467-8721.2006. 00461.x

Smit, B., Pilifosova, O. (2001): Adaptation to Climate Change in Context of Sustainable Development and Equity. Chapter 18 in McCarthy, J.J., Canziani, O., Leary, N.A., Dokken, D.J., White, K.S. (eds.), Climate Chang 2001: Impacts, Adaptation and Vulnerability – Contributions of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. Cambridge, UK.

Smit BA (2006) Adaptation, adaptive capacity and vulnerability. Global Environ Change 16:282–292

Smith, B., Burton, I., Klein, R., Wandel, J. (2000): An Anatomy of Adaptation to Climate Change and Variability. Climate Change 45, 223-251.

Smith K (1992) Environmental hazards: assessing and reducing disasters. Rutledge, London, p 325

Smith, K. (1996): Environmental Hazards: Assessing Risk and Reducing Disaster; Routledge: London, UK, 1996.

Smith, K.: Environmental hazards: assessing risk and reducing disaster, Routledge, London, 2013.

Snyder, P.K., Delire, C and Foley, J.A (2004): Evaluating the influence of different vegetation biomes on the global climate. Clim. Dyn 23:279-302

Snyder, R.L., Moratiel, R., Song, Z., Jomaa, I., Swelam, a., Shapland, T (2011): Evapotranspiration response to climate change. Acta Horticulture 922 (922): 91-98. December 2011 Available online: https://www.researchgate.net/publication/279540223_Evapotranspiration_response_to_climate_change

Sobowale, A., Sajo, S.O., Ayodele, O.E (2016): Analysis of Onset and Cessation of Rainfall in Southwest Nigeria: Food Security Impact of Variability in the Length of Growing Season. Hungarian Agric Engr: Published Online at: http://hae-journals.org/HUISSN 0864-7410 (PRINT)/HU ISSN 24115-9571 (Online) DOI:10. 17676/HAE.

Social action (2012): *The 2012 Floods*: Social Action Briefing, No. 5 December 2012, pp. 2-14.

Sokona, Y. and F. Denton, 2001: Climate change impacts: can Africa cope with the challenges? Clim. Policy, 1, 117-123.

Solomon, E. and Edet, O. G. (2018) Determinants of climate change adaptation strategies among farm households in Delta State, Nigeria. Current Investigations in Agriculture and Current Research, 5(3). https://lupinepublishers.com/agriculture-journal/fulltext/determinants-of-climatechange-adaptation-strategies-among-farm-households-in-delta-state-nigeria.ID.000213.php

Song, Y (2016): High Temporal Resolution Rainfall Information Retrieval from Tipping-Bucket Rain Gauge Measurements Procedia Engineering 1193-1200.

Sorensen, A., & Okata, J. (eds.) (2011): *Megacities: Urban Form, Governance and Sustainability*. New York: Springer

Sote, A. (2003). Ojude Oba festival of Ijebu-Ode. Ibadan, Nigeria: African Book Builders.

Southerton, S., McMeekin, A., Evans, D., (2011) International review of behaviour change initiatives: climate change behaviours research programme, Government Social Research Unit, London.

Spurr, R. (2006). Assessing the economic impacts of events: A computable general equilibrium approach Journal of Travel Research, 45 (1), 59-66

Sridhar M. K. C.; I.O. Olaseha, G. O. Adeoye, T. Tajudeen, and B.C. Ogunwolere. (2007). Sustainable Waste Management through Integrated Waste Recycling. The International Journal of Environment, Cultural, Economic and Social Sustainability, 3(3): 103-112.

Stapp WB, WALS AEJ, Stankorb SL (1996) Environmental education for empowerment: action research and community problem solving. Kenda//Hunt Publishing Company, Iowa

Stead, W.E & Stead, J.G (1996) Management for a small planet. Sage publications: London, New Delhi. P. 176.

Steckler A, McLeroy KR, Goodman RM, Bird ST, McGormick L. (1992): Toward integrating qualitative and quantitative methods, An introduction. Health Educ Q. 19:1–18.

Stenchion P (1997) Development and disaster management. Aust J Emerg Manag 12(3):40–44

Stiftung, F.E (2018): Social participation in Nigeria. ISBN: 978-978-56481-7-1. Available online: library.fes.de/pdf/bueros/Nigeria/15963.pdf

Stige, L.C., Stave, J. and Chan, K. 2006. The effect of climate variation on agro-pastoral production in Africa. *Proceedings of the National Academy of Sciences* 103: 3049-3053.

Stigter CJ, Zheng DW, Onyewotu LOZ, Mei XR. (2005): Using traditional methods and indigenous technologies for coping with climate variability. *Climatic Change.* 70:255–271.

Storbjörk, S., (2007): Governing climate adaptation in the local arena: challenges of risk man-agement and planning in Sweden. Local Environment: The International Journal of Jus-tice and Sustainability, 12(5), pp. 457–469, 2007.http://dx.doi.org/10.1080/13549830701656960

Sridhar, M. , and O.Ojediran . (1983): "The Problems and Prospects of Refuse Disposal in Ibadan City, Nigeria." *Journal of Environmental Health* 46(1): 28–31.

Storbjörk, S., (2007): Governing climate adaptation in the local arena: challenges of risk man-agement and planning in Sweden. Local: The International Journal of Jus-tice and Sustainability, 12(5), pp. 457–469, 2007.http://dx.doi.org/10.1080/13549830701656960

Stow. D.A, Chen. D.M (2002). Sensitivity of multitemporal NOAA AVHRR data of an urbanizing region to land-use/land-cover changes and misregistration. Remote Sensing of Environment, 80 (2), pp. 297-307

Strauss, K. (2018). Labour geography 1: Towards a geography of precarity? Progress in Human Geography 42(4), 622–630.

Su, T., Webb, J.B., Meyer, R.P., Mulla, M.S., (2003): Spatial and temporal distribution of mosquito in underground storm drain systems in Orange County, California. Journal of Vector Ecology, 28(1): 79-89.

Suman P, Satiprassad S, Pulak M, Subbash C.M (2018). Impacts of urbanization on land use/cover changes and its probable implication on local climate and groundwater level. Jou of Urban Mgt, Vol 7 (2). Pp. 70-84. Available at: https://doi.org/10.1016/j.jum.2018.04.006

Svoboda, J., Chladova, Z., Pop, L., Hosek, J. (2012): Statistical-dynamical downscaling of wind roses over the Czech Republic. Theoretical and Applied Climatology, doi: 10.1007/s00704-012-0759-y

Swan, A (2010): *How increased urbanisation has induced flooding problems in the UK: A lesson for African cities?* Phys. Chem. Earth, 35 (2010), pp. 643-647, 10.1016/j.pce.2010.07.007

Swapan, M.S (2008): Socio-economic aspect of solid waste recovery and recycling in Bangladesh: a case study of Khulna City. Department of Urban and Regional Planning. In: Curtin University of Technology

Swart, R., Robinson, J., Cohen, S. (2003): Climate Change and Sustainable Development: Expanding the Option. Climate Policy 3 (1) SI9-S40

Swiss Re, (2010a): Making Flood Insurable for Canadian Homeowners. Swiss Re/Institute for Catastrophic Loss Reduction.

Sz¨oll¨osi-Nagy A. & Zevenbergen C., (2005): Urban Flood Management. Rotterdam: A.A. Balkema Publishers, 2005.

**T**

Tabari, H., Meron, T.T., Willems, P (2015): Statistical assessment of precipitation trends in the upper Blue Nile River basin Stoch. Environ. Res. Risk Assess, 10.1007/s00477-015-1046-0

Taha H (1997). Urban Climates and Heat Islands: Albedo, Evapotranspiration and Anthropogenic Heat, Energy Buildings, 25: 99-103.

Tanner, T., Mitchell, T., Polack, E., & Guenther, B (2009): *Urban governance for adaptation. Assessing climate change resilience in ten Asian cities*. Brighton: IDS

Tashakkori, A. & Teddlie, C. (2010). SAGE handbook of mixed methods in social & behavioral research. 2nd ed., SAGE Publications, Inc.

Taiwo, A.M., Olujimi, O.B., Arowolo, T.A (2012): Surface Water Quality Monitoring in Nigeria: Situational analysis and Future Management Strategy. Published Online: researchgate.net/publication/224829944_Surface_Water_Quality_Monitoring_in_Nigeria_Situational_Analysis_and_Future_Management_Strategy. DOI:10.5772/33720 (Assessed July 26, 2023)

Tata, E., Decker, V., Just, C (2018): Evaluating collaborative readiness for interdisciplinary flood research. Published online: onlinelibrary.wiley.com/doi/full/10.111/risa.13249.https://doi.org/10.111/risa.13249.

Taylor RW. (2000). Urban development policies in Nigeria: Planning, housing and land policy. New Jersey: Centre for Economic Research in Africa, Montclair State University.

Tazen, F., Diarra, A., Kabore, R. F. W., Ibrahim, B., Bologo/Traoré, M., Traoré, K., & Karambiri, H. (2018). Trends in flood events and their relationship to extreme rainfall in an urban area of Sahelian West Africa: The case study of Ouagadougou. *Burkina Faso, Journal of Flood Risk Management*, e12507.

Tchobanoglous, G.; T. Hilary, E. Rolf. (1977). Solid Wastes Engineering Principles and Management issues. Mcgraw-Hill Book Company, 7- 73.

Teng W, Hsu M, Wu C, Chen AS (2006) Impact of flood disasters on Taiwan in the last quarter century. Nat Hazards 37:191–207

Terpstra T, Gutteling JM. (2008): Households' perceived responsibilities in flood risk management in the Netherlands. International Journal of Water Resources Development, 2008; 24 (4):555-565.

Terungira, U., & Torkwase, I.C (2013): Current issues in flood disaster: challenges and implication for science and technology to enhance environmental education. Academic Journal of Interdisciplinary Studies 2: 61-65

Terry, A.J. (2011). Clinical research for the Doctor of Nursing practice. 3rd ed. Mississauga, Canada, Jones & Bartlett Publishers.

Thakur, P. K., S. Maiti, N. C. Kingma, V. H. Prasad, S. P. Aggarwal, and A. Bhardwaj. 2011. Estimation of Structural Vulnerability for Flood Using Geospatial Tools in the Rural Area of Orissa, India. Natural Hazards 61 (2): 501–20.

Thakural, L.N., Kumar, S., Jain, S.K., Ahmad, T., (2018): The impact of climate change on rainfall variability: a study in central himalayas. In: Singh, V.P., Yadav, S., Yadava, R.N. (Eds.), Climate Change Impacts. Springer Singapore, pp. 181–192.

Tharenou, P., Donohue, R. & Cooper, B. (2007): Management research methods. New York, NY, Cambridge University Press. p.338.

The BBC (27 Sept 2018): Why does Nigeria keep flooding? Available online: bbc.co.uk/news/world-africa-45599262

The Glossary of Environment Statistics, Studies in Methods, Series F. No. 67 United Nations, New York, 1997. Available at: https://stats.oecd.org/glossary/detail.asp?ID=2819. (Accessed on July 19,2019).

The guardian (Thur. 15 Dec, 2011): How will climate change affect rainfall? Found at: the guardian.com/environment/2011/dec/15/climate-change-rainfall.

The Land Scan Global Population Distribution Project: Current State of the Art and Prospective Innovation, Corresponding Author: Computational Sciences and Engineering Division, Oak Ridge National Laboratory, 1 Bethel Vallkey Road, Oak Ridge, TN 37831-6017: Email: rosean@ornl.gov. Available at: https://www.academic.edu.33722938/The_Landscan_Global_Population_Distribution_Project_Current_State_of_the_Art_and_Prospective_Innovation (Accessed on: July 26, 2019)

The Nation Newspaper, July 11th 2011.

The Nation Newspaper, July 12th 2011.

The Nation Newspaper, August 31th 2011

The Nation Newspaper, September 3rd 2011.

The New Humanitarian (2003): Record of rainfall recorded in Burkina Faso and Mali. Available at: www.thenewhumanitarian.org/news/2003/08/19/record-rainfall-recorded-burkina-faso-and-mali.

The Punch Newspaper, July 12th, 2011.

The Punch Newspaper, September 19th, 2011.

The Punch Newspaper, July 18th, 2011.

The Punch Newspaper, 24th 2011

The STATISTICA electronic manual: Plots: Box/Whisker

The World Bank (2016) Data. Nigeria [Online]. Available at http://data.worldbank.org/country/nigeria. Accessed on March 4th, 2019.

The World Bank (2010) World Development Report 2010: Development and Climate Change. Washington, DC: The World Bank.

Theis, T. (1996a): ‘‘Too many equations?’’ J. Environ. Eng., 122(6), 451.

THISDATS Newspaper (23rd September, 2022): Nimet Records 95% Accurate Weather

Precision in 15 years. Available online: https://www.thisdaylive.com/index.php/2022/07/29/nimet-records-95-accurate-weather-precision-in-15-years/

Thomas S. (2008): Urbanization as a driver of change The Arup Journal 1/2008 pp58-67

Thompson, C (2009): “Floods and droughts: how climate change is impacting Africa,” in Proceedings of COP 15: Climate Change Conference, Copenhagen, Denmark, December 2009.

Thorndike, E., (1913): Educational Psychology: The Psychology of Learning. New York: Teachers College Press.

Thorndycraft, V. R., Barriendos, M., Benito, G., Rico, M. & Casas, A: (2006) The catastrophic floods of AD 1617 in Catalonia (northeast Spain) and their climatic context. Hydrol. Sci. J. 51(5), 899–912 (this issue).

Thornthwaite, C. W. (1948), An approach towards a rational classification of climate, Geogr. Rev., 38, 55–94.

Tian, Y., Yue, T., Zhu, L., & Clinton, N. (2005). Modeling population density using land cover data. Ecological Modelling, 189(1-2), 72-88. doi: 10.1016/j.ecolmodel.2005.03.012

Tian, J., Liu, J., Wang, J., Li, C., Nie, H., Yu, F (2016): Trend analysis of temperature and precipitation extremes in major grain-producing area of China Int. J. Climatol, pp. 1-16

Tiepolo M, (2014)., Flood risk reduction and climate change in large cities south of the sahara’, in Macchi S. & Tiepolo M. (eds.), *Climate change vulnerability in southern African cities*, pp. 19-36, Springer, Switzerland.

Tiffen, M., (2003): Transition in sub-Saharan Africa: agriculture, urbanization and income growth. World Dev., 31, 1343-1366

Tilbury D1992. Environmental education within preservice teacher education: The priority of priorities. International Journal of Environmental Education and Information, II: 267-280.

Tingsanchali T. (2011): Flood disaster and risk management, Invited Paper, Proceedings, 1st EIT International conference on water resources engineering, Petchaburi, Thailand, August, p. 15-24.

Tingsanchali, T (2012): Urban flood disaster management. Procedia Engineering 32: 25-37 DOI: 10.1016/j.proeng.2012.01.1233

Tiza, M.T., Iorver, V.T., Iortyom, E.T., (2016). The effects of Poor drainage system on roads pavement. A review. Inter. Jou for Inno. Res, in Multi. Field. Vol 2 (8)

Tompkins, E.L., W.N. Adger, E. Boyd, S. Nicholson-Cole, K. Weatherhead, and N. Arnell, (2010): Observed adaptation to climate change: UK evidence of transition to a well-adapting society. Global Environmental Change, 20(4), 627-635.

Toure, D. (2014)): "Resident/Humanitarian Coordinator Report On The Use Of Cerf Funds Nigeria Rapid Response Floods." https://www.unocha.org/cerf/sites/default/files/CERF/RCHC%20Report%2013-NGA-001.pdf

Toyosi, O.S.O., & Chioma, O.E (2014): Communication as critical factor in disaster management and sustainable development in Nigeria. Int Jour of Dev and Eco. Sustainability. Vol 2 (3), pp. 58-72

Tran P, Marincioni F, Shaw R, Sarti M, van An L (2008) Flood risk management in Central Viet Nam: challenges and potentials. Nat Hazards 46:119–138

Tran, P., Shaw, R., Chantry, G. & Norton, J., (2009): GIS and local knowledge in disaster management: a case study of flood risk mapping in Vietnam. Disasters, 33(1), pp. 152–169.

Tremearne, A.J.N (1910): Notes on some other British West African peoples. J R Soc Arts 58:839–847 http://www.jstor.org/stable/41339263

Trenberth, K.E. 2011. Changes in precipitation with climate change. *Climate Research* 47: 123-138.

Trenberth KE (2006) The impact of climate change and variability on heavy precipitation, floods, and droughts: encyclopedia of hydrological sciences. Wiley, New York

Trenberth, K. E., Dai, A., Rasmussen, R. M. & Parsons, D. B. (2003): The changing character of precipitation. *Bull. Am. Meteorol. Soc.* 84, 1205–1217.

Trivedi, J. K., Sareen, H. and Dhyani, M. (2008): Rapid urbanization - Its impact on mental health: A South Asian perspective, Indian Journal of Psychiatry, 50(3) pp161–165

Tschakert, T, Sagoe, R, Ofori-Darko, G & Coejoe, N.S (2010).'Floods in the Sahel: an analysis of anomalies memory and anticipatory learning', *climate change* DOI 10.1007/s10584-009-9776-y

Tso CP (1994). "The Impact of Urban Development on the Thermal Environment of Singapore". Report of the Technical Conference on Tropical Urban Climates. World Meteorological Organization, Dhaka.

Tucci C.E.M and Villannueva, A 1997. Controle de enchentes das cidades de Porto Uniᾶo da Victὁria e Porto Uniᾶo. CORPRERI, 117p

Tucci, C.E.M (2001): Urban drainage issues in developing countries, in: Urban Drainage in Humid Tropics, C.E.M. Tucci (ed), Urban Drainage in Specific Climates, C. Maksimovic (ch, ed), UNESCO Technical Documents in Hydrology, Vol. 1 (40): 23-40

Tukey, J. W., (1977): Exploratory Data Analysis. Addison-Wesley, 688 pp.

Turkes M, Sumer UM, Demir I (2002) Re-evaluation of trends and changes in mean, maximum and minimum temperatures of Turkey for the period 1929–1999. Int J Climatol, 22:947–977

Turner BL II, Clark WC, Kates RW, Richards JF, Mathews JT, Meyer WB, editors (1990). The Earth as Transformed by Human Action: Global and Regional Changes in the Biosphere over the Past 300 Years. Cambridge, NY: Cambridge Univ. Press/Clark Univ.

Turner B.L II. Skole D., Sanderson S., Fisher G, Fresco L., and Leemans R. (1995). *Land-Use and Land. Cover Change: Science/Research plan.* IGBP (International Geosphere/Biosphere Programme)

Trettin L, Musham C. (2000): Is trust a realistic goal of environmental risk communication? Environment and Behavior, 32 (3):410-426.

Twigg, J. (2007). Characteristics of a disaster-resilient community: A guidance note. London. University College London Press.

Twigger-Ross C, Coates T, Orr P et al (2011): Community resilience research: final report on theoretical research and analysis of case studies report to the Cabinet Office and Defence Science and Technology Laboratory. Collingwood Environmental Planning Ltd, London

Twigger-Ross C, Kashefi E, Weldon S et al (2014): Flood resilience community pathfinder evaluation rapid evidence assessment. Defra, London.

**U**

Uchegbu, A. (1988): "A Legal framework for environmental protection and enforcement in Sada, P. O. and Odemerho, T. O. (eds)Environmental Issues and Management in Nigerian Development. Evans Brothers Limited, Ibadan
U

gochukwu, S.C. & Onyekwena, T. (2014): Participation of indigenous contractors in Nigerian public sector construction projects and their challenges in managing working capi-tal. International Journal of Civil Engineering, Construction and Estate Management, 1(1), pp. 1–21.

Udensi, L.O., Udoh, O.S., Daasi, G.L.K., & Igbara, F.N (2012): Community leadership and the challenges of community development in Nigeria: The case of Boki local government area, Cross River State. International Journal of Development and Sustainability V 1 (3): Pages 912-923

Ufoegbune, G.C; Yusuf, H.O., Eniola, A.O. and Awomeso, J.A. (2011). Estimation of Water Balance of Oyan Lake in the North West Region of Abeokuta, Nigeria. British Journal of Environment and Climate Change, 1(1): 13-27, 2011.

Ugochukwu, S.C. & Onyekwena, T., (2014): Participation of indigenous contractors in Nigerian public sector construction projects and their challenges in managing working capital. International Journal of Civil Engineering, Construction and Estate Management, 1(1), pp. 1–21.

Ugonna l. (2016). A review of flooding and flood risk reduction in Nigeria. Glob J Human Soc Sci Res 16:23-42. https://socialscienceresearch.org/index.php/GJHSS/ARTICLE/VIEW/1717.

Ugwu, L. I. and Ugwu, D. I.: Gender, floods and mental health: the way forward, International Journal of Asian Social Science, 3, 1030–1042, 2013.

*U*kaegbu C.O, Nnachi A.U, Mawak J.D, Igwe C.C. (2014). Incidence of Concurrent Malaria and Typhoid Fever Infections in Febrile Patients in Jos, Plateau State Nigeria. *International Journal of Scientific and Technology Research. 3(4)*: 157-161.

Ukhurebor, K.E & Uzuazo, S.I (2020): Temperature and Rainfall Varaibilty Studies Within South-South Region of Nigeria. eJournal of Interdiscplinary Research (AU-Ejir): Vol 5 (2)

Umejei, E (2007): *Climate Change: Nigerian media sleeping on duty*. Daily Independent, December 10, p. 9

Umoh, G.S. 2008. Programming Risks in Wetlands Farming: Evidence from Nigerian Floodplains. *Journal Human Ecology* 24 (2): 85-92

UN (2007): World Population Prospects: the 2006 revision-executive summary. Department of Economic and Social Affairs, population division, United Nations. New York.

UN (2020): Climate Change Is an Increasing Threat to Africa. Available at: unfcc.int/nens/climate-change-is-an-increasing-threat-to-africa#

UNCED (1992). Agenda 21 (Chapter 36): Promoting education, public awareness and training. (Report). United Nations Conference on Environment and Development, 314 June, 1992. Rio de Janeiro.

UNCHA, (2012): Floods Situation Report, UN Office for the Coordination of Humanitarian Affairs, v.2.

UNDHA. (1992): Internationally Agreed Glossary of Basic Terms Related to Disaster Management; United Nations Department of Humanitarian Affairs: Geneva, Switzerland, 1992.

UNDP (United National Development Programme). (1992): An overview of disaster management. Geneva: UNDP-DMTP. 125 p.

UNEP (2012) 21 Issues for the 21st century: result of the UNEP foresight process on emerging environmental issues. United Nations Environment Programme (UNEP), Nairobi, Kenya, 56 pp

UNECE (2009): Self-made cities. In search of sustainable solutions for informal settlement in the United Nations Economic Commission for Europe region. UNECE (Online). Available at: www,unece.org/publications/oes/SelfMadeCities.pdf.

UNECE (2015a): Formalizing the Informal Challenges and Opportunities of Informal Settlements in South-East Europe. UNECE (Online). Available at: https://www.unece.org/fileadmin/DAM/hlm/wpla/workshops/informal settlement2015/advanced formalizing informal.pdf.

UNEP (United Nations Environment Program) (2001). State of the environment, India 2001. Retrieved from 〈http://www.envfor.nic.in/sites/default/files/soer/2001/ind_land.pdf〉. (Accessed 26 January 2016).

UNESCO/UNEP (1978) Intergovernmental conference on environmental education – Tbilisi (USSR) 14–26 Oct 1977. ED/MD/49, Paris

UNESCO. (1995): Fighting floods in cities; Project training material for disaster reduction; Report, Delft, Holland

UNESCO (2019): Climate change education and awareness. Available online: n.unesco.org/themes/addressing-climate-change/climate-change-education-and-awareness

UNESCO Institute of Education (2003): Towards a multilingual culture of education. Hamburg: UNESCO Institute of Education.

UNFCCC (2007). Climate Change Impact, Vulnerabilities and Adaptation in Developing Countries. *United Nations Framework Convention on Climate Change, Information Services of UNFCCC Secretariat, Germany.*

UNISDR (2012): Unplanned urbanization increasing flood impacts. Available online: preventionweb.net/news/view/27968

UN-Habitat (2003): The Challenge of Slums: Global Report on Human Settlements 2003; Earthscan Publications: London, UK. Available online: http://www.google.com.au/url?sa=t&rct=j&q=&esrc=s& source=web&cd=1&ved=0ahUKEwjJv8XvhpfUAhWBzpQKHRrBDg4QFgghMAA&url= http%3A% 2F%2Fmirror.unhabitat.org%2Fpmss%2FgetElectronicVersion.aspx%3Fnr%3D1156 %26alt%3D1&usg= AFQjCNF35f0K3vXL3mvZTAbJLcEDFzR2Uw

UN-Habitat (2006): State of World's Cities 206/07: The Millennium Development Goals and Urban Sustainability; 30 Years of Shaping the Habitat Agenda, Earthscan, London.

UN-Habitat. (2009): Global report on human settlements: *Planning sustainability cities, Policy directions*. Nairobi: UN-HABITAT

UN-HABITAT. (2009a): Planning sustainable cities: global report on human settlements 2009. Nairobi.

UN-HABITAT (2010). *Regional Updates: Arica at a glance*. State of the World's Cities 2008/2009: Harmonious Cities. UN HABITAT.

UN Habitat, The State of African Cities 2010: Governance, Inequality and Urban Land Markets. 2010, UN Habitat: Nairobi.

UN Habitat (2011): *Global Report on Human Settlements 2011: cities and climate change,* United Nations Human Settlements Programme (UN Habitat) Earthscan, London UNISDR, 2012.

UN-HABITAT (2012b): *Going green. A Handbook of Sustainable Housing Practices in Developing Countries*. Available at: http//www.lavoutnubienne.org/sites/default/files/stock/documents/marketing promotion/12-09-25 Going green UNHabitat.pdf

UN-Habitat. (2013b): *Streets as public spaces and drivers of urban prosperity.* Nairobi: UN-Habitat

UN-Habitat. (2014) 'The Evolution of National Urban Policies: A Global Overview; UN-Habitat: Nairobi, Kenya.

UN-Habitat. (2015b): *Informal settlement*. (Habitat III Issue Paper 22). Nairobi: UN-Habitat

UN-Habitat. (2015f): *Global report 2015: Increasing synergy for greater natural ownership*. Nairobi: UN-Habitat

UN-Habitat. (2016): Urbanization and Development: Emerging Futures. World Cities Report. Nairobi, Africa, 2016. Available online: https://unhabitat.org/wp-content/uploads/2014/03/WCR-%20Full-Report-2016.pdf

United Nations Department of Economic Social Affairs Population Division (2014): *Population Facts*. No. 2014/3. Available at: https://www.un.org/en/develpoment/desa/population/publications/pdf/popfacts_2014-3.pdf. (Accessed on: July 19, 2019)

United Nations Department of Economic and Social Affairs: 2018 Revision of World Urbanization Prospects. Available at: https://www.un.org/development/desa/publications/2018-revision-of-world-urbanization-prospects.html (Accessed on: July 19,2019)

United Nations Development Programme (2004): Kenya National Disaster Profile. available at: kenya://meteorological.uonbi.ac.uk

United Nations Development Programme (UNDP) (1992): *An overview of disaster management*, 2nd ed. Washington, D, C: UNDP

United Nation Education Scientific and Cultural Organization 1978. Final Report Intergovernmental Conference on Environmental Education. August, 3rd USSR, pp.14-26

United Nations Population Division, World Organization Prospects: The 2007 Revision Population Database, accessed online at http://esq.un.org/unup/index.asp, on July. 19., 2019

United Nations (2015) formalizing the Informal: Challenges and Opportunities of informal Settlements in South-East Europe. United Nations FIG Publication.

United Nations University. 13 June 2004, via EurekAlert! NASA's Earth Observatory. Available at: http://radio-weblogs.com/0105910/2004/06/15.html.

United Nations. (2007a). World urbanization prospects: The 2007 revision, Population Division of the Department of Economic and Social Affairs. 244.

United Nations. (2007b). State of the world population: Unleashing the potential of urban growth, United Nations Population Fund. 108.

UN (11, Nov 2008): Disaster Strategies and Risk Management Practices: Critical Elements for Adaptation to Climate Change.

United Nations (2009): Water in a changing world, 318 pages, UNESCO publishing, ISBN: 978-1-84407-840-0

United Nations (2012): World Urbanization Prospects the 2011 Revision Highlights ESA/P/WP/224 Department of Economic and Social Affairs Population Division United Nations New York

United Nations (2015): Transforming Our World: The 2030 *Agenda for Sustainability Development*: United Nations: New York, NY, USA

UN/OCHA (2010): More than 1.8 million people in West and Central Africa affected by floods – UN: Available at: https://news.un.ord/en/story/2010/10/357152-more-18-million-people-west-an-central-africa-affected-floods-un

UN/0CHA (2017): West and Central Africa: 2017 flood impact (as of 18 Oct 2017). Available at: https://reliefweb.int/report/niger/west-and-central-africa-2017-flood-impact-18-0ct-2017

UN Office for the Coordination of Humanitarian Affairs (2008a): *13,000 flood-affected West Africans need continued support.* Retrieved from http://reliefweb.int/report/burkina-faso/130000-flood-west-africans-need-continued-support

UN Office for the Coordination of Humanitarian Affairs (2008b): Recent floods in West Africa (as of 02 Sep 2008). Retrieved from http://reliefweb.int/map/senegal/recent-floods-west-africa-02-sep-2008

UN Office for the Coordination of Humanitarian Affairs (2009): 600000 people affected by floods in West Africa. Retriueved from http: reliefweb.int/report/Burkina-faso/600000-people-affected-floods-west-africa

UN Office for the Coordination of Humanitarian Affairs (OCHA). 2010. Inondations 2010. Bulletin d'information # 2. 19 octobre 2010. Reliefweb.

United Nation and Economic Commission for Europe (UN/ECE) (2003): Best Pratices on Flood Prevention, Protection and Mitigation. *Guidelines on Sustainable Flood Prevention.* Available at: ec. europa. en/environment/water/flood_risk/pdf/flooding_best_practices (Accessed on April 20, 2019).

UNISDR (United Nations International Strategy for Disaster Reduction). (2002): ISDR background paper for WSSD. Geneva: UN.

UNISDR: United Nations International Strategy for Disaster Reduction (2004): Living with Risks: a global Review of Disaster Reduction Initiatives, 2004 Version Volume 1, available at: http:// www.unisdr.org/files/657_lwr1.pdf.

UNISDR (2004): *Living With Risk: A Global Review of Disaster Reduction Initiatives* (UNISDR, 2004; pg. 17).

UNISDR (2005). Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters. Available at: http://www.unisdr.org/2005/wcdr/intergover/official-doc/Ldocs/Hyogo-framework-for-action-english.pdf (downloaded on: 12.09.2015).

UNISDR (United Nations International Strategy for Disaster Reduction). (2009): UNISDR terminology on disaster risk reduction. Geneva: UNISDR. 30 p. http://www.preventionweb.net/files/7817_UNISDRTerminologyEnglish.pdf Date of access: 8 Sep. 2011.

UNISDR, (2009a). Risk and Power in a Changing Climate: Invest today for a safer tomorrow. United Nations International Strategy for Disaster Reduction (UNIDR).

UNISDR, (2009b). Terminology on Disaster Risk Reduction (DRR). Geneva, Switzerland. UNISDR.

UNISDR, (2013a). Global assessment report on disaster risk reduction: From shared risk to shared value: the business case for disaster risk reduction. United Nations office of Disaster Risk Reduction (UNISDR).

UNISDR, (2013b). Loss Data and Extensive/Intensive Risk Analysis. United Nations Office of Disaster Risk Reduction (NUIDR).

UNSTTPUNDA (United Nations System Task Team on the Post-2015 UN Development Agenda). (2012) Disaster and Resilience. United Nations. New York.

USGCRP [2014]. Hatfied, J.G., Tackle, R. Grotjahn, P. Holden, R.C. Izanrrable, T. Mader, E. Marshall and D. Liverman, 2014: Ch.6: Agriculture Climate Change Impacts in the United States: The Third National Climate Assessment. J.M. Melillo, Terere [T.C], Richmond and G.W. Yohe, Eds, U.S. global change research program, 150-174.

USGCRP (2016): The impacts of climate change on human health in the United States: A scientific assessment. Available online: health2016.globalchange.gov

United Nations General Assembly (1987): *Report of the World Commission on Environment and Development: Our Common Future*. Transmitted to the General Assembly as an Annex to document A/42/427- Development and International Co-operation: Environment. Retrieved on 13 December 2019

United Nations General Assembly (1987): *Report of the World Commission on Environment and Development: Our Common Future*. Transmitted to the General Assembly as an Annex to document A/42/427- Development and International Co-operation: Environment. Chapter 2: Towards Sustainable Development: Paragraph 1 United Nations General Assembly. Retrieved on 13 December 2019.

University of Gälve (2018): What is sustainable development at HIG. Available online; hig.se/Ext/En/Eu/University-of-Galve/About-the-University/Environmental-Work/what-is-sustainable-development-at-HIG/Ecological-sustainability.html

Ujor, M.F., Isa, D., Olanrewaju, O (2009): Understandin urban sprawl in the Federal Capital City Abuja: Towards sustainable urbanization in Nigeria. *Journal of Geography and Regional Planning 3: 106-113*

USAID, (2011): Introduction to disaster risk reduction. Available online: preventionweb.net/files/26081_Kp1concep-disasterrisk1.pdf

USAID, (2011): Introduction to disaster risk reduction. Available online: preventionweb.net/files/26081_Kp1concep-disasterrisk1.pdf

USAID (2018): The State of Climate of Africa in 2018. Available Online: the-state-of-climate-in-Africa-2018-Report-March=2019_Final.pdf

Usamah, Muhibuddin, John Handmer, David Mitchell, and Iftekhar Ahmed. (2014): "Can the vulnerable be resilient? Co-existence of vulnerability and disaster resilience: informal settlements in the Philippines." International journal of disaster risk reduction 10: 178-189.

Utsumi, N., Seto, S., Kanae, S., Maeda, E. E. & Oki, T. (2011): Does higher surface temperature intensify extreme precipitation? *Geophys. Res. Lett.* 38, L16708. Katz RW, Acero JG (1994) Sensitivity analysis of extreme precipitation events. Int J Climatol 14: 985-999.

**V**

Van Alphen J, Martini F, Loat R et al (2009): Flood risk mapping in Europe, experiences and best practices. J Flood Risk Manag 2:285–292.

Van Alphen J, Martini F, Loat R et al (2009): Flood risk mapping in Europe, experiences and best practices. J Flood Risk Manag 2:285–292.

Van der Veen A, Logtmeijer CJJ (2005): Economic hotspots: visualising vulnerability to flooding. Nat Hazards 36(1–2):65–80

Vanguard newspaper (2010). “the many colours of ojude oba”. Available at: https://www.vanguardngr.com/2010/11/the -many-colurs-of-ojude-oba/ (Retrieved on: July 25,2019)

Vanguard. (2012): *2012 year of flood fury: A disaster foretold, but ignored?* from http://www.vanguardngr.com/2012/10/2012-year-of-flood-fury-a-disaster-foretold-but-ignored/

Vanguard Newspaper, (2018): Rains of Fury: Nigeria loses 141 to rainstorm, flood in 2018. Available online: https://www.vanguardngr.com/2018/08/rains-of-fury-nigeria-loses-141-lives-to-rainstorm-flood-in-2018/

Van Ogtrop, F. F., Hoekstra, A. Y., and van der Meulen, F.: Flood management in the lower Incomati River Basin, Mozambique: two alternatives, J. Am Water Resour. As., 41, 607–619, 2005.

Victor K. Rono. (2010). An Investigation into the Adequacy of The Drainage System on Narok Mai Mahim Road (Bachlor's thesis, University of Nairobi, Kenya). Retrieved from: http://realestates.uonbi.ac.ke/sites/default/files/cae/artsdesign/realestates/final%20project.pdf

Vincent, K (2007): "Uncertainty in adaptive capacity and the importance of scale" *Global Environmental Change* 17 (1): 12-24

Vogel, C., (2000): Usable science: an assessment of long-term seasonal forecasts amongst farmers in rural areas of South Africa, South African Geographical Journal, 82, 107-116.

Vogel, C. (2002): A preliminary assessment of environmental vulnerability in Southern Africa. Save the Children UK, South Africa scenario planning paper. 29pp.

Vojinović Z., (2015). *Flood risk: The holistic perspective: From integrated to interactive planning for flood resilience,* IWA Publishing, London.

Vold, T. and D.A.Buffett (eds.). (2008). Ecological Concepts, Principles and Applications to Conservation, B.C. 36 PP. Available at: www.biodiversitybc.org

Voogt .J.A, Oke .T.R (2003). Thermal remote sensing of urban climates**.** Remote sensing of environment, 86 (3) (2003), pp. 370-384

Vuong, B, (1992). Influence of density and moisture content on dynamic stress-strain behaviour of a low plasticity crushed rock. Road and Transport Research, 1 (2), 88–100.

Vuren SV, Vried HJD, Ouwerkerk S, Kok M (2005) Stochastic modelling of the impact of flood protection measures along the River Waal in the Netherlands. Nat Hazards 36:81–102

Vygotsky, L.S., (1978): Interaction between learning and development (M. Lopez-Morillas, Trans.). In Cole, M., Steiner, V. J., Scribner, S. & Souberman, E. Eds., Minds in society: The development of higher psychological processes. Cambridge, MA: Harvard University Press

**W**

WAHAB, B. & AGBOLA, B. (2017): The place of informality and illegality in planning education in Nigeria. *Planning Practice & Research,* 32(2), pp. 212-225. https://doi.org/10.1080/02697459.2016.1198565

Walesh, S.G (1989): *Urban Surface Water Management*; John Wiley and Sons: Haboken, NJ, USA, ISBN G780470172810

Walker, B., Holling, C.S., Carpenter, S. and Kinzig, A. (2004): Resilience, Adaptability and Transformability in Social-ecological Systems. Ecology and Society, 9 (2): 5 [online] URL: http://www.ecologyandsociety.org/vol9/iss2/art5.

Walker, G, Burningham, K, Fielding, J, Smith, G, Thrust, D (2006): Addressing environmental inequalities: Flood risk, Environmental Agency, Bristol

Walker, G., Lin, T. & Kobayashi Yoshiaki (2009): Is flood insurance feasible? Experiences from the People's Republic of China. ADB sustainable development working paper series Philippines Asian Development Bank.

Wallace J.M., Gutzler D.S (1989): Teleconnections in the geo-potential height field during the northern Hemisphere winter Mon. Weather Rev., 109, pp. 784-812.

Walsh, R. P. D., & Lawler, D. M. (1981). Rainfall seasonality: Description, spatial patterns and change through time. *Weather, 36*, 201–204.

Walter, S., Lörcher, I. and Brüggemann, M. (2019): 'Scientific networks on Twitter: analyzing scientists' interactions in the climate change debate', Public Understanding of Science, Vol. 28, No. 6, pp. 696-712.

Wamsler, C (2016): From Risk Governance to City-Citizen Collaboration: Capitalizing on Individual Adaptation to Climate Change. *Environ. Policy Gov. 26*, 184-204

Wandemberg, J.C (2015): Sustainable by design. Amazon. P. 122 ISBN 978-1516901784. Retrieved on 13 December 2019.

Wang X, Yau MK, Nagarajan B, Fillion L (2010) The Impact of assimilating radar-estimated rain rates on simulation of precipitation in the 17–18 July 1996 Chicago floods. Adv Atmospheric Sci 27(2):195–210

Wang, K (2013): Engineering Hydrology 4th Edition Mc Graw Hill

Wanner, H., Beck, C., Brázdil, R., Casty, C., Deutsch, M., Glaser, R., Jacobeit, J., Luterbacher, J., Pfister, C., Pohl, S., Sturm, K., Werner, P. C. & Xoplaki, E: (2004) Dynamic and socioeconomic aspects of historical floods in Central Europe. Erdkunde 58(1), 1–16.

Ward, (1978). Floods: A Geological Perspective, London: Macmillian Press Ltd.

Ward, M.N., Folland, C.K., Maskell, K., Colma, A.W., Rowell, D.P., and Lane, K.B. (1993): Experimental seasonal forecasting of tropical rainfall at the U.K. Meteorological

Office. In: Shukia, J. (ED.) *NATO ASI Series*, Vol. 16, Prediction of international climate variation, pp. 197-216.

Warrick, O. (2011) Local voices, local choices? Vulnerability to climate change and community-based adaptation in rural Vanuatu (Dissertation). University of Waikato.

Watson, C. (1993): Trends in World Urbanisation Proceedings of the First International Conference on Urban Pests.

Watson, J. B., (1928). Psychological care of infant and child. New York: W. W. Norton Company, Inc

Watterson IG, Dix MR (2003) Simulated changes due to global warming in daily precipitation means and extremes and their interpretation using the gamma distribution. J Geophys Res 108: 4379.

WCED (1987). Our Common Future World Commission on Environment and Development. Oxford University Press

WeADAPT. (2017). Retrieved from http://www.weadapt.org/ knowledge-base/global-initiative-on-community-basedadaptation-gicbaWegehenkel, M., Jochheim, H. & Kersebaum, K. C (2005): The application of simple methods using remote sensing data for the regional validation of a semi distributed hydrological catchment model. *Phys. Chem. Earth* 30(8), 575–587.

Wehner MF (2004) Predicted twenty-first century changes in seasonal extreme precipitation events in the parallel climate model. J Clim 17: 4281-4290.

Weichselgartner, J. (2000): Hochwasser als soziales Ereignis. Gesellschaftliche Faktoren einer Naturgefahr. Hydrologie und Wasserbewirtschaftung 44(3), 122–131.

Weissman Jerry, (2003): “Presenting to Win: The Art of Telling Your Story”, Prentice Hall, New Jersey 2003. Pg. 157

Weksea, B.; Steyn, G.; Otieno, F. A (2011): review of physical and socioeconomic characteristics and intervention approaches of informal settlements. Habitat Int.35, 238–245.

West, Darrell M., and Marion Orr. (2007): "Race, gender, and communications in natural disasters." Policy Studies Journal 35, no. 4 : 569-586

Westin, D. (2012): “Types and Levels of Communication”. http://www.ehow.com/info_8064650.

Westra, S.; Alexander, L.; Zwiers, F.W. (2013): Global Increasing Trends in Annual Maximum Daily Precipitation. J. Clim. 2013, 26, 3904–3918

Wheater, H.S (2006): Flood hazard and management: A UK perspective. Philos. Trans. A Math. Phys. Eng. Sci., 364 (1845), pp.

White GF (1974) Natural hazard: local, national, global. Oxford University press, New York Vietnam News Agency. 23/05/2008 – 11:17 AM

White, P., M. Pelling, K. Sen, D. Seddon and S. Russell et al., (2005). Disaster risk reduction. A Development Concern. DFID.

White paper on housing, (1994): *A new housing policy and strategy for South Africa*, Government Printers, Pretoria, pp. 1–55.

WHO (2002): *Floods: Climate Change and Adaptation Strategies for Human Health*. Report on a WHO meeting. 30 June – 2 July 2002, London, United Kingdom, World Health Organisation Regional Office for Europe, Denmark 9 pp.

WHO/UNEP (1997). Water Pollution Control - A Guide to the Use of Water Quality

WHO/UNICEF (2012): Progress on Drinking Water and Sanitation. Joint Monitoring Programme for water supply and sanitation. ISBN:978-92-806-4632-0

WHO (2013): *Floods in the WHO European Region: health effects and their prevention.* WHO Regional Office for Europe, Cpenhagen. Pp.6-38.

WHO. World Malaria Report (2015). Geneva: World Health Organisation; 2015. Citation

Wilbanks T, Kates RW. (1999): Global change in local places: How scale matters. *Climatic Change.*43:601–628.

Wilby, R.L., Charles, S.P., Zorita, E., Timbal, B., Whetton, P., Mearns, L.O. (2004): Guidelines for use of climate scenarios developed from statistical downscaling methods, Supporting material of the Intergovernmental Panel on Climate Change, available from the DDC of IPCC TGCIA, 27

Wilhelm B., Ballesteros Canovas JA, **Macdonald N**, Toonen W, Baker V, Barriendos M, Benito

G, Brauer A, Corella JP, Denniston R, Glaser R, Ionita M, Kahle M, Liu T., Luestcher M., Macklin M, Mudelsee M, Munoz S, Schulte L, St George S, Stoffel M, Wetter O., (2019): Interpreting historical, botanical, and geological evidence to aid preparations for future floods, *WIRES Water*, 6:1, 2019;e1318, https://doi.org/10.1002/wat2.1318

Williams, Donald C. (2012): Global urban growth: A reference handbook. ABC-CLIO.

Willis KF, Natalier K, Revie M (2011): Understanding risk, choice and amenity in an urban area at risk of flooding. Hous Stud 26:225–239. https://doi.org/10.1080/02673037.2011.549215

Wilson, D. (1997): Communication and Social Action, Port-Harcourt: Footstep Publications

Wilson, D.C., Adebisi, O.A., Kaine, C., Cheeseman, C.R (2009): Building recycles rates through the informal sector. Wast Mang 29 (2).

Wilson, J.M., Dwivedi, O.M., Gȧmez-Fernȧndez, C.M (2020): Planetary precarity and the pandemic. Journal of Postcolonial Writing, V 56 (4): PP 439-446

Winayanti, L., and Lang, H. C., (2004): Provision of urban services in an informal settlement: a case study of Kampung Penas Tanggul, Jakarta. Habitat International, 28 no. 1: 41-65

Winship, C. (2011): Sociological Methods & Research 40th Anniversary. Sociological Methods & Research. 40(1), 3-5.

Wisher, C; Brater, E. (1995). Hydrogeography. Second Edition. John Willy and Sons Inc. Japan.

WMO/GWP (2008): Urban flood risk management, a tool for integrated flood management, Associated Programme on Flood Management, World Meteorological Organization.

WMO (World Meteorological Organization), (2016): “Hotter, drier, wetter. Face the future,” *Bulletin*, vol. 65, no. 1, p. 64, 2016.

WMO (2017): World Guidelines on the Calculation of Climate Normals. WMO – No. 1203.

WMO (2017): Integrated flood management tools series: community-based flood management. Availabe Online: floodmanagement.info/publications/tools/APFM_Tool_4_e.pdf (Accessed: 27th October, 2021)

WMO (2019): State of the Climate in Africa – 2019 Report. Available at: library.wmo.int/doc_num.php?explnum_id=10421

WMO (2020): WMO confirms 2019 as second hottest year on record. Available Online: public.wmo.int/en/media/press-release/wmo-confirms-2019-second-hottest-year-record.

Wogalter, M.S., DeJoy, D, M., Laughery K.R (Eds.),(1999): Warnings and Risk Communication, 9780748402663, Taylor & Francis, Philadelphia (1999), p. 365

Wogu, J. O. (2006): The Relevance of Information and Communication Technology to National Development: the Nigerian Experience. International Journal of Communication No. 4 Nsukka: Communication Studies Forum.

Wood, EH 2005. Measuring the Economic and Social Impacts of Local Authority Events. International Journal of Public Sector Management 18,1: 37-53.

Woodruff, R.E., C.S. Guest, M.G. Garner, N. Becker, J. Lindesay, T. Carvan and K. Ebi, 2002. Predicting ross river virus epidemics from regional weather data. Epidemiology, 13: 384-393.

WOODS, M.M., MILETI, D.S., KANO, M., KELLEY, M.M., REGAN, R. AND BOURQUES, L.B., 2012. Communicating actionable risk for terrorism and other hazards. *Risk Analysis*, 32 (4), 601-615.

World Bank (1996a): "Taking Actions for Poverty Alleviation in Sub-Saharan Africa". Report of an African Task Force, May 1, World Bank, Washington D.C

World Bank (1996b): "Poverty in the Midst of Plenty". The Challenge of Growth with inclusion". A World Bank Poverty Assessment, May 31. World Bank, Washington D.C

World Bank (2010) World development report 2010: development and climate change. World Development Report. World Bank, Washington

World Bank (2014): Ibadan Urban Flood Management Project: Environmental and Social Management. Framework Final Report. Oyo state Government of Nigeria.

World Bank. (2019b): Researchers in R&D (per million people). Retrieved from https://data.worldbank.org/indicator/SP.POP.SCIE.RD.P6EDITORIAL5of5

World Health Organization (1975): Ecology and Control of Vector of Public Health Importance WHO Technical Report Series, Geneva, 56: 5-70.

World Health Organization (2016). World Malaria Report 2016.World Health Organization, Geneva.Pages1-186.

World Development Indicators, July 2000

World Health Organization. Climate change and human health: impact and adaptation. 2000. Available from: http://whqlibdoc.who.int/hq/2000/WHO_SDE_OEH_00.4.pdf.

World Meteorological Organization (2006a): Legal and Institutional Aspects of Integrated Flood Management Associated Programme on Flood Management (APPM) Technical Document No.3 Flood Management Policy Series, (WMO-NO 997), Geneva. Available at: http://www.apfm.info/pdf/ifm_legal_aspects.pdf

World Meteorological Organization (WMO), Statement on the Status of Global Climate in (2012, 2013) M. H. I. Dore, "Climate change and changes in global precipitation patterns: what do we know?" Environment International, vol. 31, no. 8, pp. 1167–1181, 2005.

World Meteorological Organization (WMO), *Statement on the Status of Global Climate in 2012*, 2013. Organisation Météorologique Mondiale. Le Climat Dans le Monde 2001–2010, Une Décennie D'Extrêmes Climatiques, Rapport de Synthèse; World Meteorological Organization (WMO): Geneva, Switzerland, 2013; Volume 1119, p. 15

World Meteorological Organization (WMO), (2017): Frequently asked questions: what is climate? Retrieved from. http://www.wmo.int/pages/prog/wcp/ccl/faqs.php assessed on. (Accessed 2 May 2018)

World Meteorological Organization, 2017. http;//public.wmo. Retrieved from: Int/en/resources/meteoterm (Accessed on June 10, 2019).

World Resources Institute / United Nation Environment Program, United Nations Development Program, the World Bank (1996). World Resources 1996-97. The Urban Environment, Oxford University Press, Oxford

Worldwide Fund For Nature. (2006): Climate change impacts on East Africa. Worldwide Fund For Nature. Retrieved from https://repositories.tdl.org/tamug-ir/bitstream/handle/1969.3/28826/east_africa_climate_change_impacts_final[1].pdf?sequence=1

Wright, T. 2011. Waterlogged: Pakistani Children push a motorbike through flooded streets after rain in Lahorerin". The Wall Street Journal. London.

Wright, T. (2011): *Waterlogged: Pakistani Children push a motorbike through flooded streets after rain in Lahorerin*, The Wall Street Journal. London.

www.infoo@climatechange.org.

**X**

Xiuzhen Li, Richard B, Christopher C, Sarah E. W (2018): Coastal wetland loss, consequences and challenges for restoration. Jou, Anthropocene Coasts Vol 1 (1): 1-15. Available at: http://doi.org/10.1139/anc-2017-0001

**Y**

Yang, M., Ding, X. & Dong, B. (2014): The measurement of disability in the elderly: a systematic review of self-reported questionnaires. Journal of the American Medical Directors Association. 15(2), 150.e1-151.e9.

Yazdanpanah, M., Forouzani, M., Abdeshahi, A. & Jafari, A. (2016): Investigating the effect of moral norm and self-identity on the intention toward water conservation among Iranian young adults. Water Policy. 18(1), 73-90.

Yodmani, S. and Hollister, D. (2001): Disasters and Communication Technology: Perspectives from Asia. Paper Presented at the Second Tampere Conference on Disaster Communication.

Yue, S., Pilon, P., Cavadias, G (2002): Power of the Mann-Kendall test and the Spearman's rho test for detecting monotonic trends in hydrological time series J. Hydrol., 259, pp. 254-271

**Z**

Zahari, R. K., and Ariffin, R. N. R., (2013): Risk communications: flood-prone communities of Kuala Lumpur. ProcediaJournal of advanced transportation, 45 no. 2: 117-128

Zbigniew, W.K., Malgorzata, S., Iwona, P (2019): Climate variability and floods: A global review. Water 11 (7): 1399

Zemba, A.A (2012). Impact of Urbanization of Land Use-Land Cover Dynamics in Jalingo City, Nigeria. Available at: https://researchgate.net/publication/305357042_The_impact_of _urbanization_on_land_cover_change_in_jalingo_city_Nigeria. (Accessed on: July 17,2019)

Zhang, C., Wong, P.M., Selinus, O (1999): "A Comparison of Outlier Detection Methods: Exemplified with an Environmental Geochemical Dataset". 6th International Conference on Neural Information Processing, Proceedings ICONIP '99.

Zhang, Q., Gu, X., Singh, V.P., Xiao, M (2014): *Flood frequency analysis with consideration of hydrological alterations: changing properties, causes and implications.* J. Hydrol., 519 (2014), pp. 803-813, 10.1016/j.jhydrol.2014.08.011

Zhang Q, Xu CY, Zhang ZX, Chen YD, Liu CL, Lin H (2008) Spatial and temporal variability of precipitation maxima during 1960–2005 in the Yangtze River basin and possible association with large-scale circulation. J Hydrol 353:215–227

Zhang, X.B., Alexander, L., Hegerl, G.C., Jones, P., Tank, A.K., Peterson, T.C., Trewin, B., and Zwiers, F.W (2011): Indices for monitoring changes in extremes based on daily temperature and precipitation data. Wires Clim. Change, 2. 851-870

Zhao .S, Da .L, Tang .Z, Fang .H, Song .K, Fang .J (2006). Ecological consequences of rapid urban expansion: Shanghai, China. Frontiers in Ecology and the Environment, 4 (7) (2006), pp. 341-346

Zhou L, Dickinson RE, Tian Y, Fang J, Li Q, Kaufmann RK. (2004). Evidence for significant urbanization effect on climate in China. PNAS. 101:9540–9544.

Zhu, D., Zhou, N., Jiang, S (2011): Research overview of runoff model for urban rainwater, Journal of Water Resources and Water Engineering 22: 132-137 (in Chinese).

Zhu, J. (2010): Symmetric Development of Informal Settlements and Gated Communities: Capacity of the State—The case Study of Jakarta, Indonesia; Asia Research Institute Working Paper Series No. 135; National University of Singapore: Singapore. Available online: http://www.ari.nus.edu.sg/wps/wps10_135.pdf.

Zhunda, N.G., Munishi, P.K.K., Soka, G.E., and Monjare, J.F (2013). Influence of Socio-Economic Factors on Land Use and Vegetation Cover Changes In and Around Kagoma Forest Reserve in Tanzania. Ethiopian Jou. of Environ. Stud.Mgt. Vol 6(5)

Zoleta-Nantes D (2002) Differential impacts of flood hazards among the street children, the urban poor and residents of wealthy neighbourhoods in metro Manila, Philippines. Mitig Adapt Strat Glob Change 7:239–266

Zorn, M. (2018): "Natural Disasters and Less Developed Countries." In *Nature, Tourism and Ethnicity as Drivers of (De) Marginalization*, edited by S. Pelc, and M. Koderman, 59–78. Springer international publishing.

Zhou, L. and Robert, D. (2004), "Research News and Publications", Greenhouse Bulletin, No. 125. htt://en.wikipedia org/wiki/urbanization http://www.arch.hku.hk/cmhui/teach/65156-7f.htm.

Zinyowera, M.C., B.P. Jallow, R.S. Maya, H.W.O. Okoth-Ogando, L.F. Awosika, E.S. Diop, T.E. Downing, M. El-Raey, D. Le Sueur, C.H.D. Magadza, S. Toure, and C. Vogel, (1997): Africa. In: The Regional Impacts of Climate Change: AnAssessment of Vulnerability.A Special Report ofWorking Group II of the Intergovernmental Panel on Climate Change [Watson, R.T., M.C. Zinyowera, R.H. Moss, and D.J. Dokken (eds.)]. Cambridge University Press, Cambridge, UK, pp. 29-84

Zurbrug. C. (2002). Solid waste management in Developing Countries. SANDEC/EAWAG. http://wiow.sandec.ch/solid waste/Document/04-sw-management/Basic-of-swm.pdf. Acdcessed on March 5th, 2019.

# APPENDICES

## Appendix A

PhD thesis research ethics committee approval letter

Faculty of Science and Engineering Research Ethics Committee

26 March 2020

Dear Dr Macdonald

I am pleased to inform you that your application for research ethics approval has been approved. Application details and conditions of approval can be found below. Appendix A contains a list of documents approved by the Committee. **Application Details**

Reference: 6422
Project Title: Nigeria flood risk assessment
Principal Investigator/Supervisor: Dr Neil Macdonald
Co-Investigator(s): Mr Temitope Aiyewunmi
Lead Student Investigator: -
Department: Geography and Planning
Approval Date: 26/03/2020
Approval Expiry Date: Five years from the approval date listed above

The application was **APPROVED** subject to the following conditions:

**Conditions of approval**

**Please note:** this approval is subject to the restrictions laid out in the Policy on research involving human participants in response to COVID19. Therefore all face-to-face contact with human participants for the purpose of research should be halted until further notice; unless the study qualifies as one of the exceptions specified in the Policy and has been discussed with Research Ethics and Integrity team.

- All serious adverse events must be reported to the Committee (ethics@liverpool.ac.uk) in accordance with the procedure for reporting adverse events.
- If you wish to extend the duration of the study beyond the research ethics approval expiry date listed above, a new application should be submitted.
- If you wish to make an amendment to the study, please create and submit an
- amendment form using the research ethics system. If the named Principal Investigator or Supervisor changes, or leaves the employment of the University during the course of this approval, the approval will lapse. Therefore it will be

necessary to create and submit an amendment form within the research ethics system.

- It is the responsibility of the Principal Investigator/Supervisor to inform all the investigators of the terms of the approval.

Kind regards,

Faculty of Science and Engineering Research
Ethics Committee foseeth@liverpool.ac.uk
0151 795 0649



**Appendix - Approved Documents**

(Relevant only to amendments involving changes to the study documentation)

The final document set reviewed and approved by the committee is listed below:

| Document Type | File Name | Date | Version |
|---|---|---|---|
| Fieldwork Risk Assessment | Risk Assessment_06-02-2020 | 06/02/2020 | v1 |
| Interview Schedule | ORAL INTERVIEW QUESTIONS | 06/02/2020 | v2 |
| Participant Information Sheet | PARTICIPANT INFORMATION SHEET I | 07/02/2020 | v2 |
| Participant Consent Form | Consent Form FINAv2L | 07/02/2020 | v2 |
| Questionnaire | Questionnaire v2 | 07/02/2020 | v2 |
| Participant Information Sheet | PARTICIPANT INFORMATION SHEET Q | 07/02/2020 | v2 |
| Participant Consent Form | Consent Form FINAv2L | 07/02/2020 | v2 |
| Participant Information Sheet | PARTICIPANT INFORMATION SHEET Iv3 | 23/03/2020 | v3 |

**Appendix B**

First field survey questionnaire

**Residents Questionnaire in Ijedu-Ode**

**Introduction**

Dear participants,

This questionnaire has been built as a part of my PhD research, I am currently studying a Doctor of Philosophy (PhD) in the Faculty of Science and Engineering, School of Environmental Sciences and Department of Geography and Planning at University of Liverpool, United Kingdom. The PhD aims to determine the mechanisms, causes and potential solutions to pluvial flood risk in urban tropical African communities, using a case study of Ijebu-Ode, in Southern Nigeria. The research is solely for an academic purpose and the principal outcome is intended to be a better understanding of how best to proffer a long-term sustainable mitigation approach to the apparent flooding confronting the Ijebu-Ode city.

This questionnaire has been designed to be complete individually. Information obtained in this survey will be kept strictly confidential for this study. For any query related to the survey or the study you are welcome to contact me on Temitope.Aiyewunmi@liverpool.ac.uk.

I will be grateful if you can complete this survey ASAP so that will help to achieve my target in a short period of time. I would like to express my appreciation for your kind support.

Best regards

Temitope Aiyewunmi

Please place a cross over your home. This will permit the anonymous results of this survey to be mapped, it will not however be possible to identify individual properties.


Image from Google Earth ©

***Please be precise by ticking the right box □ when answering the questions.***

**Section 1: Participant Information**

(1) Gender? A. Male □ B. Female □

(2) What is your age?
A. 18-25 □ B. 26-35 □ C. 36-45 □ D. 46-55 □ E. 56-65 □ F. 66 and above □

(3) What is your occupation?
A. Student □ B. Trader □ C. Business executive □ D. Public servant □ E. Others □

(4) What is your level of education?
A. Primary □ B. Secondary □ C. Tertiary □ D. No formal □ E. Others □

**Section 2: Home area information**

(5) What is the predominant home ownership type in your area?
A. Public □ B. Private □ C. Government □

(6) What is the predominant land use in your area?
A. Residential □ B. Commercial □ C. Industrial □ D. Education □ E. Farming □

(7) What is the predominant building structure in your area?
A. Wood frame □ B. Mud □ C. Concrete □ D. Brick or block □ E. Other □

(8) What is the predominant house type in your area?
A. Bungalow □ B. A story building □ C. 2-storey building □ D. More than 2-storey building □ E Other □

(9) How long have you been living in Ijebu-Ode (years)?
A. 0-1 □ B. 2-5 □ C. 6-15 □ D. 16-25 □ E. 25 and above □

(10) What is your residential status?
A. Permanent □ B. Temporary □ C. Visiting □

(11) Do you have a rescue or emergency flood response plan in your area?
A. Yes □ B. No □

(12) Do you have information on flood problems in your area (Ijebu-Ode)?
A. Yes □ B. No □

(13) If yes, what is the source?
A. Nigeria Meteorological Agency (NiMet) report □ B. Radio news □
C. Newspaper □ D Television news □ E. Personal observation □

## Section 3: Flood risk indicators

(14) Do you have a river in your area?
A. Yes □ B. No □

(15) If yes, do you live near or close to a river?
A. Yes □ B. No □

(16) If yes, what is the distance usually covered (km)?
A. Less than 1 □ B. 1 □ C. 2 □ D. 3 □ E. 4 and above □

(17) Do you often experience flood near or around where you live?
A. Yes □ B. No □

(18) If yes, could you please mention causes of the flood in your area:

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……………………………………………………………………………………………………………………………
………………………………

(19) Did you imagine or expect that this area would be affected by flood?
A. Yes □ B. No □

(20) If yes, could you please explain:

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……………………………………………………………………………………………………………………………
………………………………

(21) If no, kindly state your reasons:

……………………………………………………………………………………………………………………………
……………………………………………………………………………………………………………………………
………………………………

(22) During which months of the year do you usually experience the flood disasters/erosion?
A. Jan □ B. Feb □ C. Mar □ D. Apr □ E. May □ F. Jun □ G. Jul □
H. Aug □ I. Sep □ J. Oct □ K. Nov □ L. Dec □

(23) Please indicate the months that major floods events usually occur in your area
A. Jan □ B. Feb □ C. Mar □ D. Apr □ E. May □ F. Jun □ G. Jul □
H. Aug □ I. Sep □ J. Oct □ K. Nov □ L. Dec □

(24) How long do you feel the effects of the flood (days)?
A. 1-5 □ B. 6-10 □ C. 11-15 □ D. 16-20 □ E. 21 and above □

## Section 4: Resilience indicators

(25) What coping measures have you used to reduce the flood disasters in your area?
A. Sand filling □ B. Clearance of drainage □ C. Digging holes around your building □ D. Construction of concrete barriers □ E. Relocation □

(26) Do you get government attention/benefits at any time for the flood disasters in your area? A. Yes □ B. No □

(27) Do you receive aid in form of shelter and financial assistance from family and friends?

A. Yes □ B. No □

(28) Do you receive donations from religious bodies/charity organizations?

A. Yes □ B. No □

(29) Do you have flood insurance?

A. Yes □ B. No □ If No, why not..................................................................

(30) Do you think you and your household are prepared for future flood event?

A. Yes □ B. No □

(31) If No, why not and what action could you take?

……………………………………………………………………………………………………………………………………
……………………………………………………………………………………………………………………………………
……………………………

**Table 1:** Respondents' awareness of the effects of flood disasters in Ijebu Ode.
**VS**: Very severe; **S**: Severe; **NTS**: Not too severe; **NT**: Not severe; **NSA**: Not so severe.

| S/N | Severity of effects of flood disasters | Ratings | | | | |
|---|---|---|---|---|---|---|
| | | VS | S | N TS | NS | NSA |
| | | 5 | 4 | 3 | 2 | 1 |
| 1 | Flooded/restricted access to premises by flood | | | | | |
| 2 | Flooded street/restricted passage | | | | | |
| 3 | Loss of lives/injury | | | | | |
| 4 | Often infected with malaria fever | | | | | |
| 5 | Destruction of road asphalt/road cutting and degradation/potholes | | | | | |
| 6 | Contamination of drinking water source | | | | | |
| 7 | Damaged properties/homes | | | | | |
| 8 | Loss of farmland | | | | | |
| 9 | Erosion of building foundation/collapse of building | | | | | |
| 10 | Increase of cost of living | | | | | |
| 11 | Rendered homeless/displaced | | | | | |
| 12 | Affected business | | | | | |
| 13 | Drowning in the flood/washing away of people by the runoff water | | | | | |
| 14 | Dirtiness/poor aesthetics of the environment | | | | | |
| 15 | Others (Specified) | | | | | |

**Table 2:** Residents' perceived causes of flood vulnerability.
**SA**: Strongly Agree; **A**: Agree; **I**: Indifferent; **D**: Disagree; **SD**: Strongly disagree.

| S/N | Substantive causes of flooding | Ratings | | | | |
|---|---|---|---|---|---|---|
| | | SA | A | I | D | SD |
| | | 5 | 4 | 3 | 2 | 1 |
| 1 | Heavy/prolonged rainfall | | | | | |
| 2 | Increased surface runoff water after rainfall due to blocked drainages | | | | | |
| 3 | Blockage of/or waste disposal into drainage channels | | | | | |
| 4 | Inadequate drainage channels | | | | | |
| 5 | Poor waste management | | | | | |
| 6 | Poor physical planning | | | | | |
| 7 | None compliance/violation to environmental laws | | | | | |
| 8 | High urbanization/high population growth | | | | | |
| 9 | Flood from river | | | | | |
| 10 | Building along water channels | | | | | |
| 11 | None compliance/violation of planning regulations | | | | | |
| 12 | Construction and reconstruction | | | | | |
| 13 | Slope/nature of terrain | | | | | |
| 14 | Poor weather forecast/non-heading to weather forecast | | | | | |
| 15 | Absence of trees/exposure of soil surface to direct rainfall | | | | | |
| 16 | Lack of environmental education/awareness | | | | | |
| 17 | Illegal channelization of drainage channels | | | | | |
| 18 | Weak govt. policies and programmes/poor political will | | | | | |
| 19 | Social and cultural activities | | | | | |
| 20 | Regular flooding | | | | | |

**Table 3:** Respondents' perspective of the effectiveness of flood control.
**HE**: Highly effective; **E**: Effective; **ME**: Minimally effective; **NE**: Not effective; **NEA**: Not effective at all

| S/N | Effectiveness of flood control | Ratings | | | | |
|---|---|---|---|---|---|---|
| | | **HE** | **E** | **ME** | **NE** | **NEA** |
| | | **5** | **4** | **3** | **2** | **1** |
| 1 | Proper use of drainage | | | | | |
| 2 | Constant opening and evacuation of solid waste and silt from the drainages | | | | | |
| 3 | Proper refuse disposal | | | | | |
| 4 | Construction of drainage where there is none | | | | | |
| 5 | Properly channelled and well connected drainages | | | | | |
| 6 | Proper land use planning | | | | | |
| 7 | Adequate provisions of waste disposal facilities | | | | | |
| 8 | Creating environmental education and awareness on the danger of flood | | | | | |
| 9 | Sorting of wastes before disposal | | | | | |
| 10 | Use of sand bags and other flood barriers | | | | | |
| 11 | Raising of building foundation | | | | | |
| 12 | Regular planting of trees in open/exposed spaces | | | | | |
| 13 | Construction of bridge | | | | | |
| 14 | Regular environmental check by relevant agencies | | | | | |
| 15 | Adequate rainfall forecast and prompt alert to the residents' | | | | | |
| **Education** | | | | | | |
| 16 | Schools play a significant role for increased awareness of flood risk education for students. | | | | | |
| 17 | Students have enough awareness of flood risk in Nigeria. | | | | | |
| 18 | Students have enough awareness in terms of practicing good flood risk practice (e.g. keeping drainage channels clear of rubbish) in Nigeria. | | | | | |
| 19 | Student's awareness of flood risk has an impact on flood risk family awareness. | | | | | |
| 20 | Do you feel teachers are sufficiently aware of flood risk problems in Nigeria? | | | | | |

## Section 4: Mitigation

### Mitigation approach for the flood risk reduction

(1) Do you think flood risk management is achievable in Ijebu-Ode?
A. Yes □ B. No □ If No, why not.................................................................

(2) Which of the following sustainable measures do you consider necessary for effective flood risk management in Ijebu-Ode?

i. Proper land use and planning through regulated development

A. Yes □ B. No □

ii. Concentration on construction of sufficient drainages, maintenance and regular desilting existing drains/gutters

A. Yes □ B. No □

iii. Frequently evacuating the solid waste to improve hydraulic performance of drains and increase their carrying capacities

A. Yes □ B. No □

iv. Effective weather forecast and flood warning alert systems (i.e. radio, phones etc.)

A. Yes □ B. No □

v. Introduction of flood-risk education in the school curricula at all levels and also extensively use effective community awareness to increase the people's flood risk perception and preparedness.

A. Yes □ B. No □

vi. Conscious allocation of financial resources (adequate funding) by central government towards flood control

A. Yes □ B. No □

vii. Consequences of rapid urbanization and poor urban planning need to be addressed □

viii. Improvements in the institutional capacities

A. Yes □ B. No □

ix. Prevention of further erection of building and further developments in the identified flood prone areas

A. Yes □ B. No □

Please use the space below if you have any further comments relevant

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**THANK YOU VERY MUCH FOR YOUR ANSWERS AND YOUR VALUABLE SUPPORT**

**Appendix C**

First field survey oral interview questions

***To determine the mechanisms, causes and potential solutions to pluvial flood risk in urban tropical African communities, using a case study of Ijebu-Ode, in Southern Nigeria***

The interviews will begin with ten leading questions which are all open-ended. They are followed by supplementary questions which are made up at that time, based on the responses of the leading questions. The main aim is to keep the objectives of the research constantly in focus so that all the aspects of the study can be covered. Below are the ten leading questions:

(1) How long have you lived in Ijebu-Ode or moved/relocated into this area? Would you be willing to mark n the map the area/neighbourhood you reside in?
(2) Have you experienced flooding in this area in the past or presently or both past and present? If yes, please kindly explain the common causes of flooding in this area?
(3) Did you imagine or expect that this area would be affected by flood before considering building a house or living here?
(4) What are the challenges/effects of flooding that are unique/special to your area or surroundings?
(5) What are your experiences of flooding and how have you responded?
(6) What are your collective efforts in this area or surroundings to reduce and manage the flood problems?
(7) What are the effort (s) made so far by Government (Local or State) in solving the flood problems in your area or surroundings?
(8) Have you made any personal decisions to reduce future flood risk of disaster (s) in your area?
(9) How will you describe the problem of flood in Ijebu-Ode?
(10) What measure (s) or step (s) do you personally consider as best or necessary that will provide a long-lasting solution to the problem of flooding in your area in particular and Ijebu-Ode in general?

**Appendix D**

Second field survey questionnaire

**Questionnaires for academic staff of Tai Solarin University of Education in Ijebu-Ode**

**Introduction**

Dear participants,

This questionnaire has been built as part of my PhD research, I am currently studying a Doctor of Philosophy (PhD) in the Faculty of Science and Engineering, School of Environmental Sciences and Department of Geography and Planning at University of Liverpool, United Kingdom. The PhD aims to determine the mechanisms, causes and potential solutions to pluvial flood risk in urban tropical African communities, using a case study of Ijebu-Ode, in Southern Nigeria. The research is solely for an academic purpose and the principal outcome is intended to be a better understanding of how best to proffer a long-term sustainable mitigation approach to the apparent flooding confronting the Ijebu-Ode city.

This questionnaire has been designed to be complete individually. Information obtained in this survey will be kept strictly confidential for this study. For any query related to the survey or the study you are welcome to contact me on Temitope.Aiyewunmi@liverpool.ac.uk.

I will be grateful if you can complete this survey ASAP so that will help to achieve my target in a short period of time. I would like to express my appreciation for your kind support.

Best regards

Temitope Aiyewunmi

***Please be precise by ticking the right box □ when answering the questions.***

**Section A:** Participant Information

(5) Gender? A. Male □ B. Female □

(6) What is your age?
A. 18-25 □ B. 26-35 □ C. 36-45 □ D. 46-55 □ E. 56-65 □ F. 66 and above □

(7) What is your department?
A. Geography and Planning□ B. Social Studies □ C. Primary Education Studies □

(8) What is your level of qualification?
A. B.Ed. □ B. B.Sc. (Ed.) □ C. M.Ed.□ D. M.Sc. □ E. PhD. □

(5) What is your position/rank?
A. Lecturer Grade 2 □ B. Lecturer Grade 1 □ C. Senior Lecturer □ D. Principal Lecturer/Associate Professor/Reader □ E. Senior Principal Lecturer/Professor □

(6) What is your number of years in service? A. 1-5 □ B. 6-10 □ C. 11-15 □ D. 16-20 □ E. 21 and above □

**Section B:** Climate information

(7) Climate change is real and posing serious threat, harming people and environment. A. Strongly agree □ B. Agree □ C. Don't know □ D. Disagree □ E. Strongly disagree □.

(8) There is insufficient knowledge about the hazard posed by floods, which increase vulnerability of communities to flood. A. Strongly agree B. Agree □ C. Don't know □ D. Disagree E. Strongly disagree □.

(9) Educating young people on climate change and flood risk will decrease vulnerability to flooding. A. Strongly agree B. Agree □ C. Don't know □ D. Disagree E. Strongly disagree □.

(10)Unsustainable living habits of the people is a confirmation of insufficient flood and environmental knowledge, risk perception and risk communication. A. Strongly agree B. Agree □ C. Don't know □ D. Disagree E. Strongly disagree □.
Please explain the reasons why you agree or disagree
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(11) Sufficient knowledge on climate change and flood disaster risk management will help raise awareness and impart preventive habits in the people. A. Strongly agree B. Agree □ C. Don't know □ D. Disagree E. Strongly disagree □.

(12) Including climate change and flood risk education in teacher education programmes could help raise peoples' flood knowledge and better habits towards environment. . A. Strongly agree B. Agree □ C. Don't know □ D. Disagree E. Strongly disagree □.
Please explain the reasons why you agree or disagree
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**Section C:** Flood information

(13) Flooding is a major and the prevailing environmental hazard impacting the people's lives, properties and environment in Nigeria. A. Strongly agree B. Agree □ C. Don't know □ D. Disagree E. Strongly disagree □.
Please explain the reasons why you agree or disagree
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(14) Unsustainable living habits of people are major factors exacerbating incidences of floods and vulnerabilities in Nigerian cities and towns. A. Strongly agree B. Agree □ C. Don't know □ D. Disagree E. Strongly disagree □.
Please explain the reasons why you agree or disagree
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(15) Insufficient flood knowledge could impair peoples risk perception and preparedness intentions. A. Strongly agree B. Agree □ C. Don't know □ D. Disagree E. Strongly disagree □.

(16) Increasing the peoples' environmental protection literacy, could help in achieving desirable behavioural changes and sustainable flood risk management (FRM) in Nigeria communities. A. Strongly agree B. Agree □ C. Don't know □ D. Disagree E. Strongly disagree □.

Please explain the reasons why you agree or disagree

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(17) Designing a robust climate and flood risk education (curriculum) will help raise awareness of climate change and the impacts of humans on the environment. A. Strongly agree B. Agree □ C. Don't know □ D. Disagree E. Strongly disagree □.

**Section D:** Waste management information

(18) Solid wastes are indiscriminately disposed and poorly collected in Nigerian cities and towns. A. Strongly agree B. Agree □ C. Don't know □ D. Disagree E. Strongly disagree □.

Please explain the reasons why you agree

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(19) Lack of public perception and awareness on proper waste management approach couple with institutional weaknesses are key drivers of unsustainable habit and poor practices in waste generation and disposal in Nigeria. A. Strongly agree B. Agree □ C. Don't know □ D. Disagree E. Strongly disagree □.

Please explain the reasons why you disagree

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(20) When it is about to rain or raining, people are in habit of emptying and disposing off their domestic wastes and rubbish in drainage channels and surface runoff. A. Strongly agree B. Agree □ C. Don't know □ D. Disagree E. Strongly disagree □.

Please explain the reasons why you agree

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(21) Large chunk of the uncollected municipal solid wastes ends up blocking the drainage channels, obstructing free flow of water, forcing the excess water to spill on the roads and surroundings, causing panic and severe havoc on lives and properties. A. Strongly agree B. Agree □ C. Don't know □ D. Disagree E. Strongly disagree □.

Please explain the reasons why you disagree

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(22) Including environment education (EE) in teacher education curriculum will increase household level of awareness on environmental implications of poor domestic waste disposal and management. A. Strongly agree B. Agree □ C. Don't know □ D. Disagree E. Strongly disagree □.

Please explain the reasons why you disagree

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(23) Good governance and effective institutional capacity and coordination at the local government level (i.e., LEMA & NIMET) could foster proactive response towards domestic waste and flood risk management. A. Strongly agree B. Agree □ C. Don't know □ D. Disagree E. Strongly disagree □.

Please explain the reasons why you agree or disagree

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**Section E:** School information

(24) Does government through the Ministry of Education give 'much' concerns to 'issues' of environmental education? A. Yes □ B. No □.

If no, why?

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(25) Is environmental education taught as a compulsory subject in Nigerian schools? A. Yes □ B. No □.

If yes, how successful is it?

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If no, why and should it be a subject at all levels?

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(26) Mention some of the environmental issues and problems that is common in your environment/surroundings.

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(27) Do you think that pupils/students are aware of environmental issues and problems? A. Yes □ B. No □.

If yes, to what extent?

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If no, what could be responsible?

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(28) Do you think pupils/students are getting the desired awareness and perception, new patterns in value, habits and capacity building capable of reducing flood risk? A. Yes □ B. No □.

If yes, to what extent?

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If no, why?

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(29) Do you think current Nigeria curriculum programme in areas of some related subject such as geography, social studies and civic education comprises of subject matter on climate change and flood risk management? A. Yes □ B. No □

If yes, to what extent?

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If no, should environment education be included in the teacher education curriculum and be taught as a subject or course as to meet the 'new demands' of environmental literacy on climate change adaptation and flood risk management?

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(30) Do the student teachers offer environmental education as a compulsory subject or course? A. Yes □ B. No □.

If yes, do student teachers have adequate environmental education knowledge and awareness?

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If no, why?

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(31) Do you think current practising classroom teacher are qualified to impart climate change and flood risk education in Nigeria? A. Yes □ B. No □.

If yes, to what extent?

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If no, do you think that the in-service training of teachers for sufficient content and pedagogical knowledge in environmental education is crucially important to the improvement of expertise for teaching and learning of climate change Adaptation and flood risk management?

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(32) Do school management often conduct seminars and workshops on environmental issues? A. Yes □ B. No □.

If yes, how often?
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If no, why?
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**Section F:** Educational needs

(33) Would the teachers be happy to teach the students about environment and climate change to achieve improvement in environmental and disaster management? A. Yes □ B. No □

(34) What will teachers need to provide for module or content in teaching and learning of climate change and flood risk management?
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(35) Any other comments
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**Thank you for your time and effort in completing this survey, your input will help to achieve improvement in future environmental management.**

**Appendix E**

Second field survey oral interview questions

**General question**

(1) Could you please say what your role is? and how is this related to environmental education?

(2) In your opinion do you think environmental education is visible and achievable? If yes, how? If no, what are the challenges and way out?

(3) Could you please mention the major environmental hazard severely affecting people's lives, properties and destroying the environment in Nigerian cities and towns? **Please could you recount your personal experience (s)?**

(4) In your opinion please what are the factors responsible for flood hazards and disaster risks in Nigeria cities and towns? **How and why?**

(5) What do you think is responsible for population (people) poor habit towards environment?

(6) What do you think is responsible for indiscriminate domestic waste disposal and collection?

(7) In your opinion, do you think adequate attention is giving to environmental management by government?

(8) Do you think the current flood risk management approaches at the local government level are effectively reducing flood and Impacts? **If yes, how and to what extent? If no, what could be responsible?**

(9) Do you think the role media could be valuable in communication of climate change and flood risk awareness?

**Ministry of Education**

(10) In your opinion please what has been academic practices, programmes and activities in place at the local government level to reduce flood risk and quick recovery?

(11) Do you think desirable habitual change about environmental management will help flood risk reduction in Nigeria? **If yes, how? If no, why?**

(12) In your opinion how do you think desirable and sustainable flood preventive behaviour could be achieved? **If yes, how? and if no, why?**

(13) Do you think current general Goals and Philosophy of Nigeria Education addresses climate change adaptation and flood disaster risk management? **If yes, how? If no, why?**

(14) What aspect of flooding problem do you think should be included in the teacher education programmes curriculum and syllabus?

(15) In your opinion how best could climate and flood education be imparted and inculcated into the pupils/students in schools?

**Ministry of Environment/Ministry of Local Government Administration**

(16) In your opinion, do you think the Local Emergency Management Agency (LEMA) exist? **If yes, could you please explain? And if no, why?**

(17) In your opinion, do you think National Emergency Management Agency (i.e., NEMA), State Emergency Management Agency (i.e., SEMA) and Local Emergency Management Agency (i.e., LEMA) are performing their objectives? **If yes, to what extent? If no, what are the challenges?**

(18) In your opinion, what has been practices and activities put in place by your ministry at the local government level to reduce flood risk and quick recovery?

(19) What are the challenges hindering your ministry to optimize flood risk management both at local and state level?

(20) In your opinion please how best could awareness on climate change adaptation and flood risk management be communicated at the local level?

## Appendix F

Major conclusions from previous IPCC assessments (Niang et al., 2014).

| Report | Major conclusions | References |
|---|---|---|
| Special Report on Regional Impacts of Climate Chang | • Sensitivity of water resources and coastal zones to climatic parameters<br>• Identification of climate change as an additional burden on an already stressful situation<br>• Major challenges for Africa: lack of data on energy sources; uncertainties linked to climate change scenarios (mainly for precipitation); need for integrated studies; and the necessary links between science and decision makers | Zinyowera et al. (1997 |
| Third Assessment Report | • Impacts of climate change on and vulnerability of six sectors: water resources; food security; natural resources and biodiversity management; health; human settlements and infrastructure; desertification<br>•Adaptation strategies for each of the sectors<br>• Threats of desertification and droughts to the economy of the continent<br>• Suggestion of adaptation options: mainly linked with better resource management<br>• Identification of research gaps and needs: capacity building; data needs; development of integrated analysis; consideration of literature in other languages | Desanker et al. (2001) |
| Fourth Assessment Report | • Vulnerability of Africa due mainly to its low adaptive capacity<br>• Sources of vulnerability mainly socioeconomic causes (demographic growth, governance, conflicts, etc.)<br>• Impacts of climate change on various sectors: energy, tourism, and coastal zones considered separately<br>• Potential impacts of extreme weather events (droughts and floods)<br>• Adaptation costs<br>• Need for mainstreaming climate change adaptation into national development policies<br><br>Two case studies:<br>Food security: Climate change could affect three main components of food security.<br>Traditional knowledge: African communities have prior experience with climate variability, although this knowledge will not be sufficient to face climate change impacts.<br>• Research needs: better knowledge of climate variability; more studies on the impacts of climate change on water resources, energy, biodiversity, tourism, and health; the links between different sectors (e.g., between agriculture, land availability, and biofuels); developing links with the disaster reduction community; increasing interdisciplinary analysis of climate change; and strengthening institutional capacities | Boko et al. (2007) |

**Appendix G**

Record of flood disaster in some countries in Africa (1900-2019)

| Countries | Disaster Type | Event Count | Total Death | Total Affected | Damage |
|---|---|---|---|---|---|
| **Nigeria** | - | 17 | 386 | 2076354 | 276900 |
| | Flash flood | 6 | 330 | 109165 | 7805 |
| | Riverine flood | 28 | 1110 | 10275064 | 636717 |
| **Ghana** | - | 6 | 97 | 1135159 | 86700 |
| | Flash flood | 1 | 13 | 0 | 0 |
| | Riverine flood | 16 | 409 | 385990 | 33500 |
| **Niger** | - | 9 | 256 | 785398 | 11000 |
| | Flash flood | 4 | 29 | 73867 | 0 |
| | Riverine flood | 16 | 271 | 154040 | 261039 |
| **Burkina Faso** | - | 5 | 24 | 76354 | 0 |
| | Flash flood | 3 | 6 | 17730 | 0 |
| | Riverine flood | 12 | 142 | 561873 | 181176 |
| **Sudan** | - | 9 | 67 | 568420 | 25000 |
| | Flash flood | 6 | 272 | 843364 | 0 |
| | Riverine flood | 24 | 872 | 6164507 | 533200 |
| **Ethiopia** | - | 14 | 136 | 405840 | 920 |
| | Flash flood | 9 | 863 | 1129358 | 9400 |
| | Riverine flood | 32 | 1105 | 1809978 | 8900 |
| **Kenya** | - | 11 | 401 | 1182388 | 371850 |
| | Flash flood | 8 | 134 | 51500 | 500 |
| | Riverine flood | 37 | 1150 | 2232222 | 136038 |
| **Liberia** | - | 1 | 0 | 15431 | 0 |
| | Riverine flood | 5 | 14 | 38410 | 0 |
| **Senegal** | - | 10 | 11 | 360114 | 3406 |
| | Coastal flood | 1 | 0 | 2000 | 50 |
| | Flash flood | 1 | 1 | 23600 | 0 |
| | Riverine flood | 10 | 79 | 834111 | 50979 |
| **Chad** | - | 4 | 2 | 82609 | 0 |
| | Flash flood | 2 | 100 | 349269 | 1000 |
| | Riverine flood | 12 | 199 | 1006087 | 10000 |
| **Rwanda** | - | 4 | 101 | 1900360 | 22000 |
| | Flash flood | 2 | 34 | 26051 | 0 |
| | Riverine flood | 10 | 170 | 85739 | 9 |
| **Togo** | - | 4 | 0 | 59965 | 0 |
| | Riverine flood | 8 | 72 | 547695 | 0 |

**Source:** EM-DAT Database (CRED) (1900-2019)

**Available At:** https://www.emdat.be/emdat_db/

**Appendix H**

Tragedies of flood disaster and associated impacts in selected African urban areas

| Country | Places affected | Disaster | Natural cause | Human cause | Effects | Month/ Year |
|---|---|---|---|---|---|---|
| **Togo** | Northern Togo | Flooding | Heavy rainfall | - | 60,000 + people are affected, over 30,000 houses destroyed and 6 dams, 20 people died, cultivate lands washed away, damaged infrastructure and many people were displaced | - |
| **Ghana** | Upper East Region | Flood | Heavy rainfall | - | 75,000 people affected, school, building and roads submerged | Aug, 2007 |
| **Niger** | - | Flood | Heavy rains | - | 4,500 + people affected | Aug, 2007 |
| **Mali** | - | Flood | Heavy rains | - | 15,000 + people affected | Aug, 2007 |
| **Uganda** | Teso, Lango & Busisu Region | Flood | Heavy rainfall | - | 300,000 people affected, submerged the land and damaged crops and displaced many people | July, Aug, Oct, 2007 |
| **Sudan** | Eastern and Southern Sudan-Blue Nile, Gezira, Red Sea, Upper Nile etc. | Flash flood | Torrenti al rain | - | 500,000 + people affected, at least 200 are homeless, 113 died, an estimated 42,000 hectares of crops lost, at least 12,000 head of livestock. Acute water diarrhoea (AWD) which killed 57 people | July 2007 |
| **Kenya** | Western Kenya-Buldalangi | Flood, Nzoia River Overflow | Heavy rains | - | Displaced 1,700 families, submerged houses and farmland | Oct, Nov, 2006; Aug, 2007 |
| **Angola** | Benguela Province | Flooding | Heavy rain | - | 16 people reportedly died, 86 houses damaged | 2019, March; 2015, March and 2016, Jan |
| **South Africa** | Mozambiqu e and Malawi | ,, | Heavy rain | Poor up-keep and planning | Over 500,000 people were affected with at least 40 fatalities, 3 people reportedly died and houses and bridges were damaged | 2019, March |
| **Zimbabw e** | Chiredzi District in Masvingo Province | ,, | 203 mm rainfall in 24 hours | - | 50 homes damaged and 300 people affected | 2019, Feb; 1977 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Malawi** | Southern and Central Region | ,, | Heavy rain | - | 1,000 people displaced, 15 people injured, 260 houses damaged | 2019, Feb |
| **Rwanda** | Goma to Kigali, Gisenyi district- North Western Rwanda | Flood | Heavy rainfall | - | 10 villages were flooded, damaged houses, rendered 7,000 people homeless, 15 people died | Aug, 2007 |
| **Ethiopia** | Northern, Wester and Southern Ethiopia | Flood | Heavy rainfall | - | 183, 000 people affected, 42,000 people displaced, 17 people died, 4,000 head of livestock drowned and washed away, 34,000 hectares of land damaged. | Aug, 2007 |
| **Nigeria** | Oyo | Perennial flood | 6 hours downpour; torrential rain; water channels overflow their banks | Narrow drainage channels; Building houses and shops on water channels; Non-compliance with environmental laws; attitude of the people; Pressure on drainage channels; Indiscriminate dumping of refuse and growing of bushes on most drainages which block free flow of water; Lack of tangible masterpl | Submerged general part of the State; The University of Ibadan axis of the city were submerged; A bulldozer was swept away; farm lands were submerged | 2017, June; other years of flood experience include: 2011, 2012,2013, 2016,Aug; 1960, 1961, 1963, 1969, 1978, 1980 (1980 & Aug 2011 were very critical for the |

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| | an for the city. | |

**Source:** Office for the Coordination of Humanitarian Affairs (OCHA, 2007)/ and Flodlist.com/America/floods-paraguay-peru-ecuador-bolivia-2019

**Appendix I**

National newspapers; National news; Government agencies flood report in Nigeria

| Geo zones | State | Area/ City | National Newspapers/ <u>News:Months</u> reported | Disaster | Natural Causes | Human Causes | Effects ( Life lost and damages ) | Years and months that the disaster struck |
|---|---|---|---|---|---|---|---|---|
| **Eastern-Central Region** | Niger, Kogi, Anambra, Delta | - | BBC News (Sept 26, 2018) | Flash flood | Heavy rainfall, Over spilling of River Benue and Niger due to heavy rain, Climate Change | Rapidly expanding population, Lack of proper town planning, unregulated development, Building on flood plains, poor waste disposal, and few/lack of drainage systems, deforestation and rapid urbanization. | Over 2.4 million people affected, 2.192,000 people displaced, 45 people died; extensive damage of farmland | 2012’ 2015, 2016, 2017; July, Sept and Oct |
| **North Central** | Nasarawa and Niger | Maraba, Kar Local Government Area | News Agency of Nigeria (NAN, August 31, 2018) | Flood | Heavy rain, high flow of Niger Basin | - | 15 people reportedly killed; severe damage of houses, properties, bridge, culverts and road damage; In 2017, 7000 houses are destroyed | 2012, 2017, 2018; July and August |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| „ | Benue | 21 Local Government were affected | World Humanitarian Data & Trends (OCHA Aug 11, 2017) | Flash flood; River Overflow | Heavy Rainfall | - | 350,000 reportedly affected | 2012, 2017 Sept & OCT |
| „ | Benue | Guma Local Government Area | Vanguard Newspaper (Sept 2, 2017) | Flood | 7 hours rain downpour | - | Washed away 8 bridges, submerge close to 50 huts and houses, rendering about 200 persons homeless, destroy farmlands | 2017, Sept: worst to be recorded after 2012 flood |
| „ | Plateau, Benue, Nasarawa, Niger, Kogi | Lau, Karim and Damper Local Government Area | News Express (Sept 28, 2015) | Flood | Rainfall | Release of Lagdo Dam Water in Cameroun | 363 people killed, houses, bridges, roads, livestock and farms were washed away | 2012 |
| **North West** | Kano | 8 local government areas affected -Kiru Local Government as worst | News Agency of Nigeria (NAN, August 31,2018) | Flood | Heavy rain | - | Houses were destroyed; 3 people died | 2017, Aug |
| „ | Sokoto; Kaduna | Gwadabawa Local Government Area of Sokoto | Channels Television (Aug 5, 2015-up-dated) | Flood | Heavy Rainfall | - | 159+houses were destroyed, over 30 houses submerged in Sokoto while in | 2013, Aug |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Kaduna over 500 houses were affected. Properties worth millions of Naira were destroyed. No life was lost | |
| „ | Katsina; Kaduna | 29 Local Governments Area are affected | The Guardian Newspaper (Sept 14, 2018) | Flood | Heavy rainfall | Blocked drainages, construction of structure along water channel, illegal mining along river banks | 53 lives lost and 30 missing | 2018, May & Sept |
| „ | Sokoto | - | Daily Times (Aug 26, 2011) | Flood | Rainfall | - | 6,000 residents affected | 2011, Aug |
| „ | Kaisina | - | Punch Newspaper (Jun 24, 2011) | Flood | Rainfall | - | 100 families rendered homeless | 2011, Jun |
| **North East Region** | Borno Local Government-Gwoza, Ngala, Kaga etc. | Rann | World Humanitarian Data & Trends (OCHA, Aug 11, 2017) | Flood | Rainfall | - | Cut off roads; 43 people displaced | 2017, Aug |
| **South South Region** | Edo | Esan South East Local Government Area | National Television Authority (NTA Sept 18, 2018; This Days Newspaper (Sept 28, 2018) & Punc Newspaper (Sept | Flood | Heavy rainfall; Overflow of River Niger | - | 30,000 persons displaced; 42 communities submerged; 8,000 houses and thousands of hectares of farmland | 2017, Sept |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 15, 30, 2018) | | | | were affected; 6 people died | |
| „ | Edo | Edo North/ Edo Central | Vanguard Newspaper (Oct 12, 2018) | Flood | Rainfall | - | Destruction of thousands of hectares of Rice farmlands | 2018, Oct |
| „ | Cross River | Calabar; Ebito; Murray; Efioter; Target Duke | News Agency of Nigeria (NAN Sept 14, 2018); The Nation Newspaper (Sept 14, 2018) | Massive flood | Heavy rainfall | Dumping of refuse on drainage, Building on water channels | 175 houses destroyed; 3,000 people displaced; farming activities affected | 2018, July & sept |
| „ | Balyesa | Ovom community in Yenagoa Local Government Area | Punch Newspaper (Sept 30, 2018) | Flood | Rainfall | - | Submerged more than 70 houses, Schools and Churches | 2018, Sept |
| **South East** | Imo | Federal Housing Estate, Egbu, Owerri North and World Bank Area of Owerri West | Premium Times (Mar 22, 2019) | Flood | Heavy rain downpour | Building of houses along waterways | Many houses were submerged; Over #50-million-naira worth of properties destroyed; 3,200+ people were affected | 2017, Sept |
| **South West** | Lagos | Ikoyi; Victoria; Island | The Punch Newspaper (Jul 3, 2011) | Flood | Rainfall | - | Schools were flooded | 2011, Jul |
| „ | Lagos | - | The Nation Newspap | Flood | Rainfall | - | 10 people died | 2011, July |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | er (Jul 12, 2011) | | | | | |
| „ | Lagos | - | The Punch Newspaper (Jul 18, 2011) | Flood | Rainfall | - | 52 lives lost; Over 170 houses and other properties destroyed | 2011, Jul |
| „ | Lagos | Oshodi; Ladipo Bus Stop | Vanguard Newspaper (Aug 28, 2016) | Flood | 21 hours heavy downpour | - | Flooded roads | 2016, Jul |
| „ | Lagos | Lekki; Banana Island; Ikoyi; VI | Punch Newspaper (July 9, 2017) | Flood | 12 hours heavy rain; Climate change | Lack of proper planning; Rapid urbanization & population increase; Poor drainage systems/blocked drainage with solid waste; Land reclamation/Sand filling; Poor Sanitation | Houses and roads were flooded; Traffic jam; Swallowed houses and cars; 25 people died. | 2011, July; 2017, July. |
| „ | Lagos | - | Enviro News (Jan 20, 2019) | Heavy flash flood | First rain in 2019 which lasted for about 1hr:30 mins | Blocked drains/gutters | Affected businesses and blocked roads | 2019, Jan |
| „ | Oyo | Ibadan-Orogun | Vanguard Newspaper (June 23, 2017) | Perennial flood | 6 hours downpour; torrential rain; water channels overflo | Narrow drainage channels; Building houses and shops on water channels; Non- | Submerged general part of the State; The University of | 2017, June; other years of flood experience include: 2011, |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | w their banks | compliance with environmental laws; attitude of the people; Pressure on drainage channels; Indiscriminate dumping of refuse and growing of bushes on most drainages which block free flow of water; Lack of tangible masterplan for the city. | Ibadan axis of the city were submerged; A bulldozer was swept away; farm lands were submerged | 2012,2013, 2016,Aug; 1960, 1961, 1963, 1969, 1978, 1980 (1980 & Aug 2011 were very critical for the State) |
| „ | Oyo | Ibadan | The Punch Newspaper (June 24, 2011) | Flood | 5 hours rain downpour | - | 1 person died; Washed away 2,105 buildings | 2011, June |
| „ | Ondo | Akure-Ondo State Capital | Vanguard Newspaper (Nov 8, 2018) | Flood | Heavy downpour | - | 2 people were swept away | 2018, Aug |
| „ | Ondo | Ilaje-Ese Odo LGA of Ondo State | Today Nig News (March 22, 2019); The Guardian Newspaper (Mar 23, 2019) | Flood | Wind Storm & Ocean Surge | - | Affected 7 Local Government Area; 745 people were affected | 2018 |
| „ | Ondo | Ikare headquarters of Akoko North LGA Ondo State; Hospital | The Nation Newspaper (Aug 25, 2018 | Flood | 4 days torrential rainfall | Blocked gutters; Indiscriminate dumping of refuse; Poor water channelization | Flood roads making it impassable for vehicles to ply | 2018, Aug |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Junction; First Bank Area & Dan Road | | | | | | |
| „ | Ogun | Abeokuta-State Capital; Ijaye, Kuto; Lafenwa; Okelantoro Areas etc. | Vanguard Newspaper (July 20, 2018) | Flood | 3 hours Heavy torrential rain | Indiscriminate building of houses; Dumping of refuse particularly along waterways and drainages | 11 people died; Property worth of billions of naira were lost; Shops submerged. | 2018, July |
| „ | Ogun | Abeokuta; Ota; Atan; Ijebu-Ode; Ijebu-Igbo; Ago-Iwoye Cities etc. | New Flakes News, Nigeria (Jul 14, 2018) | Flood | Heavy rainfall | - | Properties worth millions of naira were destroyed; many people were rendered homeless and hopeless; several vehicles and houses were trapped and submerged | 2018, July |
| „ | Ogun | Ijebu-Ode LGA, Ogun State-Oyingbo, Obalende, Italapo junction, Ejinrin road, Talbot road, Imowo road, | P.M.News (Oct 5, 2011) | Flood | Heavy rain | Lack of drainage channels; Dumping of refuse in the gutters; Narrow and shallow gutters | Flooded roads; Many were trapped in the flood for 7hrs +; Traffic Gridlock, Roads with big and wide potholes and severe damage | 2011, Oct |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Omo-Owo road, Ondo road by Epe motor parks etc. | | | | | of the town. | |
| „ | Ogun | Ijebu-Ode-mostly Igbebe road | Hot News (Feb 10, 2012) | Flood | Many hours of rainfall; High volume of water flowing from Ibadan garage and Bonojo road | Culverts under construction | Submerged houses and shops, flooded roads; Loss of properties. | 2012, Feb |
| „ | Ogun | Ijebu-Ode-Talbot, Osinubi, Igbeba road, Molipa, Ondo road Areas etc. | Tribune Newspaper (Feb 27, 2012) | Flood | A sudden downpour, which lasted for more than one hour. | - | Flooded the roads making it impassable; Damaged properties | 2012, Feb |
| „ | Ogun | Ijebu-Ode | Vanguard Newspaper (July 15, 2018) | Massive flood | Multi-hour downpour | - | Swept away 2 mothers, 3 children and many valuables in Abeokuta the State Capital while the thunderstorm killed a young man in Ijebu-Ode | 2018, July |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| „ | Ogun | Ijebu-Ode | Vanguard Newsper (July 4, 2017) | High flood | Little rain | Blocked drainage | - | 2017, July |
| „ | Ogun | Ijebu-Ode-Irewon, Molipa, Igbeba, Obalende, Owakurudu, Epe garage, Serico | Sundiata post (july 24, 2015); News Agency of Nigeria (NAN 24, 2015) | Flood | Whenever it rained | Poor drainage | Usually trapped at homes; Impassable roads; submerged homes, Devastated roads, Closed business, Closed schools, Increased cost of living, forced migration and other pandemic risks associated with flooding | 2015, July |
| „ | Ogun | Ijebu-Ode | Daily Trust Newspaper (Aug 10, 2008) | Flood | Persistent rainfall/ Each time it rained | - | Flooded roads | 2008, Aug |
| „ | Ogun | Ijebu-Ode-Igbeba road affected most | Ogun State Today News (2012) | Flood | Many hours of rainfall | Construction of culverts which started 3 days before the rain, prevented free flow of water | Flooded major roads and submerged houses and shops | 2012 |
| „ | Ogun | Ijebu-Ode-Owakurudu, MayoMayo, Logun | Sunday Punch Newspaper (Sept 23, 2018) | Flood, erosion | Rainfall | Poor/Abandoned water Channelization | Abandoned channelization turned to gully of death, swallowe | 2018, Sept |

| | |
|---|---|
| communities | d houses and farms; leave owners of houses distraught |

**Appendix J**

Participant Information from community questionnaire (Appendix B).

| Section 1 | Participant Information | Frequency (n = 300) | Percentage (%) |
|---|---|---|---|
| **1** | **Gender** | | |
| | Male | 141 | 47.16% |
| | Female | 157 | 52.50% |
| | **Total** | 298 | 99.33% |
| **2** | **Age** | | |
| | 18-25 | 75 | 25.86% |
| | 26-35 | 61 | 21.03% |
| | 36-45 | 71 | 24.48% |
| | 46-55 | 50 | 17.24% |
| | 56-65 | 27 | 9.31% |
| | 66 and above | 6 | 0.69% |
| | **Total** | 290 | 96.66% |
| **3** | **Occupation** | | |
| | Student | 78 | 26.08% |
| | Trader | 62 | 20.73% |
| | Business executive | 43 | 14.38% |
| | Public servant | 81 | 27.09% |
| | Others | 35 | 11.70% |
| | **Total** | 299 | 99.67% |
| **4** | **Education** | | |
| | Primary | 11 | 3.71% |
| | Secondary | 77 | 26.01% |
| | Tertiary | 186 | 62.83% |
| | No formal | 5 | 1.69% |
| | Others | 17 | 5.74% |
| | **Total** | 296 | 98.99% |

**Appendix K**

Home Area Information from community questionnaire (Appendix B).

| **Section 2** | **Home area information** | **Frequency (n = 300)** | **Percentage (%)** |
|---|---|---|---|
| **5** | **Predominant home ownership** | | |
| | Public | 71 | 23.74% |
| | Private | 205 | 68.58% |
| | Government | 23 | 7.69% |
| | **Total** | 299 | 99.67% |
| **6** | **Predominant land use** | | |
| | Residential | 199 | 66.56% |
| | Commercial | 66 | 22.07% |
| | Industrial | 19 | 6.39% |
| | Education | 6 | 2.01% |
| | Farming | 9 | 3.01% |
| | **Total** | 299 | 99.67% |
| **7** | **Predominant building structure** | | |
| | Wood frame | 8 | 2.69%% |
| | Mud | 16 | 5.39% |
| | Concrete | 73 | 24 58% |
| | Brick or block | 197 | 66.34% |
| | Others | 3 | 1.01% |
| | **Total** | 297 | 99.33% |
| **8** | **Predominant house type** | | |
| | Bungalow | 128 | 42.81% |
| | A storey building | 132 | 44.155 |
| | 2 – storey building | 27 | 9.03% |
| | More than 2 – storey building | 9 | 3.01% |
| | Others | 3 | 1.00% |
| | Total | 299 | 99.67% |
| **9** | **Number of years participants have lived in Ijebu-Ode** | | |
| | 0-1 | 10 | 3.34% |
| | 2-5 | 41 | 13.71% |
| | 6-15 | 79 | 26.42% |
| | 16-25 | 99 | 33.11% |
| | 25 and above | 7 | 23.41% |
| | Total | 299 | 99.67% |

| | | | |
|---|---|---|---|
| **10** | **Residential status** | | |
| | Permanent | 158 | 53.38% |
| | Temporary | 122 | 41.22% |
| | Visiting | 16 | 5.41% |
| | Total | 296 | 98.67% |
| **11** | **Have a rescue or emergency flood response plan in your area** | | |
| | Yes | 43 | 14.33% |
| | No | 238 | 81.23% |
| | Total | 281 | 93.66% |
| **12** | **Have information on flood problems in your area** | | |
| | Yes | 135 | 46.39% |
| | No | 156 | 53.60% |
| | Total | 291 | 97% |
| **13** | **If yes indicate source (s) of information of flood problems** | | |
| | Nigerian Meteorological Agency (NiMeT) report | 9 | 4.71% |
| | Radio news | 26 | 13.61% |
| | Newspaper | 15 | 7.85% |
| | Television news | 42 | 21.99% |
| | Personal observation | 99 | 51.83% |
| | Total | 191 | 63.67% |

**Appendix L**

Flood risk indicators from community questionnaire (Appendix B).

| Section 3 | Flood risk indicators | Frequency (n = 300) | Percentage (%) |
|---|---|---|---|
| **14** | **Have river in your area** | | |
| | Yes | 50 | 16.95% |
| | No | 245 | 83.05% |
| | Total | 295 | 98.33% |
| **15** | **Live near or close to a river** | | |
| | Yes | 36 | 15.13% |
| | No | 202 | 84.87% |
| | Total | 238 | 79.33% |
| **16** | **If yes, indicate distance usually covered to a river (km)** | | |
| | Less than 1 | 33 | 29.46% |
| | 1 | 10 | 8.93% |
| | 2 | 25 | 22.32% |
| | 3 | 18 | 16.07% |
| | 4 and above | 26 | 23.21 |
| | Total | 112 | 37.33% |
| **17** | **Often experience flood near or around where you live** | | |
| | Yes | 168 | 53.73% |
| | No | 123 | 42.27% |
| | Total | 291 | 97% |
| **18** | **If yes, could please mention the cause (s) of the flood in your area** | | |

Overall, as indicated and expunged in the questionnaire, the respondents mentioned the following as the main causes of flood in their areas:

- Heavy rainfall/large volume of water on the surface.
- Inadequate drainage systems and poor drainage channelization.
- Dumping of wastes in the drainages/poor waste management.
- Bad roads devoid of drainages.
- Lack of proper preparation prior or during the rainy season.
- Nonchalant attitude of inhabitants towards environmental issues.
- Bad governance/inability of government to cater for the grassroot people.
- Sloppy topography.
- Poor town planning/poor building plan.
- Non-compliance/violation of environmental laws by the inhabitants.
- Construction over drainage pathway.
- Poverty/lack of funds.
- **Overflow of rivers (only 6 participants mentioned it…. will investigate)

Inadequate environmental routine checks by the relevant authorities.

| | | | |
|---|---|---|---|
| **19** | **Imagine or expect that this area would be affected by flood** | | |
| | Yes | 145 | 50.52% |

<table>
<tr><td></td><td>No</td><td>142</td><td>49.48%</td></tr>
<tr><td></td><td>Total</td><td>287</td><td>95.67%</td></tr>
<tr><td>20</td><td colspan="3">If yes, could you please explain</td></tr>
<tr><td colspan="4">Overall, as indicated and expunged in the questionnaire, the respondents imagine or expect that their area will be flooded due to the following:
<ul>
<li>Whenever there is heavy rainfall, the whole area is usually flooded because large volume of water from the rain do not have enough and proper drainage channels to convey it/poor drainage pattern.</li>
<li>Environmental services are not really effective/negligence on the part of the environmental agencies.</li>
<li>People are fund of and keep dumping refuse in the gutters/in-appropriate dumping of refuse.</li>
<li>Poor/improper town planning.</li>
<li>Some houses and shops were built on the drainage channels which disturbs free flow of water.</li>
<li>Bad governance/not attending to our plights.</li>
<li>Poor environmental inspection by relevant authorities and officials e.g. Environmental Inspection Agency and Sanitary Inspectors.</li>
<li>Some of the building foundations are not solid and not well raised up to withstand the flood.</li>
<li>Untarred roads/bad roads/roads are constructed without drainages.</li>
</ul></td></tr>
<tr><td>21</td><td colspan="3">If no, kindly state your reason (s)</td></tr>
<tr><td colspan="4">Overall, as indicated and expunged in the questionnaire, the respondents did not imagine or expect that their area will be flooded due to the following reason (s):
<ul>
<li>A very big and efficient drainage system is available but are constantly abused.</li>
<li>Regularly carrying out environmental sanitation and making some stagnant water in gutters to flow.</li>
<li>High building foundation with strong concrete barriers.</li>
<li>No river is close or around</li>
<li>High elevated areas/topography is properly defined.</li>
</ul>
Roads are tarred with well-constructed drainages.</td></tr>
<tr><td>22</td><td colspan="3">Months in the year that respondents usually experience the flood disasters/erosion</td></tr>
<tr><td></td><td>Jan</td><td>11</td><td>4.07%</td></tr>
<tr><td></td><td>Feb</td><td>8</td><td>2.96%</td></tr>
<tr><td></td><td>Mar</td><td>8</td><td>2.96%</td></tr>
<tr><td></td><td>Apr</td><td>21</td><td>7.78%</td></tr>
<tr><td></td><td>May</td><td>37</td><td>13.70%</td></tr>
<tr><td></td><td>Jun</td><td>65</td><td>24.07%</td></tr>
<tr><td></td><td>Jul</td><td>86</td><td>31.85%</td></tr>
<tr><td></td><td>Aug</td><td>11</td><td>4.07%</td></tr>
<tr><td></td><td>Sep</td><td>13</td><td>4.81%</td></tr>
<tr><td></td><td>Oct</td><td>7</td><td>2.59%</td></tr>
<tr><td></td><td>Nov</td><td>2</td><td>0.74%</td></tr>
<tr><td></td><td>Dec</td><td>1</td><td>0.37%</td></tr>
<tr><td></td><td>Total</td><td>270</td><td>90%</td></tr>
<tr><td>23</td><td colspan="3">Months in the year that major flood events usually occur</td></tr>
<tr><td></td><td>Jan</td><td>8</td><td>2.92%</td></tr>
<tr><td></td><td>Feb</td><td>8</td><td>2.92%</td></tr>
</table>

| | | | |
|---|---|---|---|
| | Mar | 9 | 3.29% |
| | Apr | 12 | 4.38% |
| | May | 21 | 7.66% |
| | Jun | 67 | 24.45% |
| | Jul | 103 | 37.59% |
| | Aug | 20 | 7.30% |
| | Sep | 15 | 5.47% |
| | Oct | 7 | 2.56% |
| | Nov | 4 | 1.46% |
| | Dec | 0 | 0% |
| | Total | 274 | 91.33% |
| **24** | **Numbers of day (s) the flood effect (s) is felt** | | |
| | 1-5 | 116 | 43.45% |
| | 6-10 | 67 | 25.09% |
| | 11-15 | 32 | 11.99% |
| | 16-20 | 28 | 10.49% |
| | 21 and above | 24 | 8.99% |
| | Total | 267 | 89% |

**Appendix M**

Resilience indicators from community questionnaire (Appendix B).

| **Section 4** | **Resilience indicators** | **Frequency (n = 300)** | **Percentage (%)** |
|---|---|---|---|
| **25** | **Coping measures used to reduce the flood disaster (s)** | | |
| | Sand filling | 89 | 30.38% |
| | Clearance of drainage | 131 | 44.71% |
| | Digging holes around the building | 31 | 10.58% |
| | Construction of concrete barriers | 30 | 10.24% |
| | Relocation | 12 | 4.10% |
| | Total | 293 | 97.67% |
| **26** | **Get government attention/benefits at any time for the flood disasters** | | |
| | Yes | 64 | 22.22% |
| | No | 224 | 77.77% |
| | **Total** | 288 | 96% |
| **27** | **Receive aid in form of shelter and financial assistance from family and friends** | | |
| | Yes | 96 | 33.21% |
| | No | 193 | 66.78% |
| | Total | 289 | 96.33% |
| **28** | **Receive donations from religious bodies and charity organizations** | | |
| | Yes | 67 | 23.26% |
| | No | 221 | 76.74% |
| | **Total** | 288 | 96% |
| **29** | **Have flood insurance** | | |
| | Yes | 48 | 16.72% |
| | No | 243 | 83.28% |
| | Total | 287 | 95.67% |
| | **If no, why not?** | | |
| Overall, the respondents stated the following as the reason (s) why they do not have flood insurance: • Lack of information/awareness not in place. • No idea/have not come across one. • Not available/not existing in Nigeria. • No scheme for it/government did not make provision. • Ignorance/flooding does not occur in my area/I don't think I need it. • Costly and unaffordable/no stable income. • Not easily accessible and process is complicated. Most insurance company do not cover flood/not common to hear about. | | | |
| **30** | **Do you think you and your household are prepared for future flood?** | | |
| | Yes | 151 | 58.75% |

| | | | |
|---|---|---|---|
| | No | 106 | 41.25% |
| | Total | 257 | 85.675 |
| **31** | **If no, why not and what action could you take?** | | |

Overall, the respondents stated the following as the reason (s) why they are not prepared for future flood event (s):

- Did not find it necessary/ignorance.
- Lack of basic amenities.
- Inadequate drainage systems/no drainages in many areas.
- The force or effect of the flood are too much for a private resident to control.
- Cannot construct drainage systems as individuals
- Lack of government attention.
- Lack of fund.

Overall, the respondents advanced the following as the action they could take as preparation (s) towards future flood event (s):

- Regular cleaning of the available drainages.
- By educating people around not to dump or throw wastes in the drainages/gutters.
- Collaborative efforts by willing landlords to construct drainages.
- Seek the cooperation of the people in the neighbourhood to join hands and efforts in enforcing compliance to environment laws.
- Relocation could have been the ideal thing but due to heavy financial burden/cost, it is most times overlooked.
- Proper construction of roads.
- Contact non-governmental organizations.
- Seek government intervention by crying out.
- Pray to God for help.

**Appendix N**

Mitigation measures from community questionnaire (Appendix B).

<table>
<tr><th>Section 5</th><th>Mitigation</th><th>Frequency (n = 300)</th><th>Percentage (%)</th></tr>
<tr><td>1</td><td colspan="3">Do you think flood risk management is achievable in Ijebu-Ode?</td></tr>
<tr><td></td><td>Yes</td><td>211</td><td>74.30%</td></tr>
<tr><td></td><td>No</td><td>73</td><td>25.70%</td></tr>
<tr><td></td><td>Total</td><td>284</td><td>94.67%</td></tr>
<tr><td></td><td colspan="3">If no, why not?</td></tr>
<tr><td colspan="4">Overall, the respondents stated the following as the reasons why they think flood risk management is not achievable in Ijebu-Ode:<br>• Always flood anytime rain falls.<br>• Poor drainage systems for flood/water passage.<br>• Inadequate enlightenment on waste disposal/poor waste and environmental management.<br>• Improper conduction of environmental sanitation.<br>• No one cares because the impact of the risk management so far is neither seen nor felt.<br>• Ignorance/people are adamant, not ready to change their unsustainable attitude towards the environment.<br>• Because nothing was done in the previous rain and flood episodes.<br>• It appears people are paranoid towards teaching issues related to flooding.<br>• No proper flood awareness programmes.<br>• Bad and insensitive government/lack of political will.<br>Lack of conscious allocation of funds by the central government to manage the flood menace.</td></tr>
<tr><td>2</td><td colspan="3">Sustainable measures that are considered necessary for effective flood risk management in Ijebu-Ode</td></tr>
<tr><td>I</td><td colspan="3">Proper land use and planning through regulated development</td></tr>
<tr><td></td><td>Yes</td><td>244</td><td>88.09%</td></tr>
<tr><td></td><td>No</td><td>33</td><td>11.99%</td></tr>
<tr><td></td><td>Total</td><td>277</td><td>92.33%</td></tr>
<tr><td>Ii</td><td colspan="3">Concentration on construction of enough drainages, including maintenance and regular desilting existing drains/gutters</td></tr>
<tr><td></td><td>Yes</td><td>245</td><td>86.88%</td></tr>
<tr><td></td><td>No</td><td>37</td><td>13.12%</td></tr>
<tr><td></td><td>Total</td><td>282</td><td>94%</td></tr>
<tr><td>Iii</td><td colspan="3">Frequently evacuating the solid waste to improve hydraulic performance of drains and increase their carrying capacity</td></tr>
<tr><td></td><td>Yes</td><td>239</td><td>84.15%</td></tr>
<tr><td></td><td>No</td><td>45</td><td>15.85%</td></tr>
<tr><td></td><td>Total</td><td>284</td><td>94.67%</td></tr>
<tr><td>Iv</td><td colspan="3">Effective weather forecast and flood warning alert systems (i.e. radio, phones etc.)</td></tr>
<tr><td></td><td>Yes</td><td>220</td><td>78.85%</td></tr>
</table>

| | | | |
|---|---|---|---|
| | No | 59 | 21.15% |
| | Total | 279 | 93% |
| **V** | **Introduction of flood risk education in the school curricula at all levels, also extensively use effective community awareness to increase the people's flood risk perception and preparedness** | | |
| | Yes | 228 | 80.28% |
| | No | 56 | 19.72% |
| | **Total** | 284 | 94.67% |
| **Vi** | **Conscious allocation of financial resources (adequate funding) by central government towards flood control** | | |
| | Yes | 240 | 85.41% |
| | No | 41 | 14.59% |
| | Total | 281 | 93.67% |
| **Vii** | **Consequence of rapid urbanization and poor urban planning need to be addressed** | | |
| | Yes | 229 | 82.37% |
| | No | 49 | 17.63% |
| | Total | 278 | 92.67% |
| **Viii** | **Improvements in the institutional capacities** | | |
| | Yes | 216 | 77.98% |
| | No | 61 | 22.02% |
| | Total | 277 | 92.33% |
| **Ix** | **Prevention of further erection of building and further developments in the identified flood prone areas** | | |
| | Yes | 227 | 80.78% |
| | No | 54 | 19.22% |
| | Total | 281 | 93.67% |

**Appendix O**

What are the substantive causes of flood vulnerability of people to the flood disasters in Ijebu-Ode Local Government Area? From community questionnaire (Appendix B).

| S/N | Item | N t/n = 300 | SA (5) (%) | A (4) (%) | I (3) (%) | D (2) (%) | SD (1) (%) | Mean score |
|---|---|---|---|---|---|---|---|---|
| 1 | Heavy/prolonged rainfall | 292 (97.3%) | 53.4 | 35.6 | 5.14 | 1.37 | 4.54 | 4.32 |
| 2 | Increased surface runoff water after rainfall due to blocked drainages | 290 (96.7%) | 51.0 | 34.1 | 9.67 | 3.10 | 2.07 | 4.30 |
| 3 | Blockage of/or waste disposal into drainage channels | 286 (95.3%) | 53.5 | 29.7 | 6.99 | 7.34 | 2.45 | 4.25 |
| 4 | Inadequate drainage channels | 291 (97%) | 54.6 | 28.2 | 6.87 | 7.56 | 2.75 | 4.24 |
| 5 | Poor waste disposal | 291 (97%) | 47.8 | 34.4 | 10.2 | 4.47 | 3.09 | 4.19 |
| 6 | Poor physical planning | 290 (96.7%) | 44.8 | 31.7 | 12.4 | 6.21 | 4.83 | 4.06 |
| 7 | None compliance/violation of environmental laws | 289 (96.3%) | 41.9 | 26.0 | 17.7 | 1.07 | 3.46 | 3.92 |
| 8 | High urbanization/high population growth | 289 (96.3%) | 28.4 | 21.8 | 19.7 | 21.8 | 8.30 | 3.40 |
| 9 | Flood from rivers | 299 (99.7%) | 16.7 | 26.1 | 13.7 | 24.4 | 19.0 | 2.97 |
| 10 | Building along water channels | 290 (96.7%) | 31.7 | 25.5 | 13.8 | 15.9 | 13.1 | 3.47 |
| 11 | None compliance/violation of planning regulations | 288 (96%) | 24.3 | 38.5 | 16.7 | 13.9 | 6.60 | 3.60 |
| 12 | Construction and reconstruction | 286 (95.3%) | 20.6 | 29.4 | 21.7 | 18.2 | 10.1 | 3.32 |
| 13 | Slope/nature of terrain | 283 (94.3%) | 22.6 | 28.6 | 25.1 | 12.7 | 11.0 | 2.71 |
| 14 | Poor weather forecast/non-heeding to weather forecast | 288 (96%) | 17.7 | 22.6 | 22.6 | 22.2 | 14.9 | 3.06 |
| 15 | Absence of trees/exposure of soil surface to direct rainfall | 290 (96.7%) | 28.3 | 25.5 | 20% | 13.8 | 12.4 | 3.44 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **16** | Lack of environmental education/awareness | 290 (96.7%) | 32.1 | 27.2 | 15.5 | 12.8 | 12.4 | 3.54 |
| **17** | Illegal channelization of drainage channels | 282 (94%) | 29.4 | 30.5 | 16.3 | 17.4 | 6.38 | 3.59 |
| **18** | Weak government policies and programmes/poor political will | 288 (96%) | 43.4 | 29.2 | 14.2 | 9.72 | 3.47 | 3.99 |
| **19** | Social and cultural activities | 285 (95%) | 15.8 | 18.6 | 24.6 | 27.4 | 13.7 | 2.95 |
| **20** | Regular flooding | 288 (96%) | 36.5 | 32.3 | 13.9 | 10.4 | 6.94 | 3.81 |

**Appendix P**

What are people's perceptions of the severity of flood disasters in Ijebu-Ode Local Government? From community questionnaire (Appendix B).

| S/N | Items | N f/n=300 | VS: 5 (%) | S: 4 (%) | NTS: 3 (%) | NS: 2 (%) | NSA: 1 (%) | Mean Score |
|---|---|---|---|---|---|---|---|---|
| **1** | Flooded/restricted access to premises by flood | 289 (96.3%) | 34.9 | 38.4 | 13.8 | 7.61 | 5.19 | 3.90 |
| **2** | Flooded street/restricted passage | 281 (93.7%) | 34.5 | 35.2 | 18.2 | 11.0 | 4.63 | 3.95 |
| **3** | Loss of lives/injury | 290 (96.7%) | 17.2 | 27.2 | 17.9 | 16.6 | 21.0 | 3.03 |
| **4** | Often infected with malaria fever | 288 (96%) | 31.3 | 33.7 | 11.5 | 14.6 | 9.03 | 3.63 |
| **5** | Destruction of road asphalt/road cutting and degradation/potholes | 290 (96.7%) | 46.9 | 27.6 | 11.0 | 7.24 | 7.24 | 3.99 |
| **6** | Contamination of drinking water source | 297 (99%) | 28.3 | 17.5 | 22.2 | 12.8 | 19.2 | 3.23 |
| **7** | Damage properties/homes | 289 (96.3%) | 40.5 | 19.7 | 16.6 | 12.1 | 11.1 | 3.66 |
| **8** | Loss of farmland | 289 (96.3%) | 28.0 | 30.5 | 14.9 | 12.8 | 13.8 | 3.46 |
| **9** | Erosion of building foundation/collapse of building | 290 (96.7%) | 26.2 | 25.2 | 18.3 | 16.9 | 13.5 | 3.16 |
| **10** | Increase of cost of living | 290 (96.7%) | 19.7 | 27.6 | 22.1 | 16.2 | 14.5 | 3.22 |
| **11** | Rendered homeless/displaced | 292 (97.3%) | 20.2 | 27.1 | 25.7 | 12.7 | 14.4 | 3.26 |
| **12** | Affected business | 288 (96%) | 23.3 | 31.3 | 17.7 | 19.1 | 8.68 | 3.41 |
| **13** | Drowning in the flood/washing away of people by the runoff | 291 (97%) | 19.6 | 27.2 | 18.6 | 19.6 | 15.1 | 3.17 |
| **14** | Dirtiness/poor aesthetics of the environment | 293 (97.7%) | 38.9 | 27.3 | 13.3 | 12.6 | 7.85 | 3.77 |
| **15** | Others (Specified) | 157 (52.3%) | 19.8 | 25.5 | 21.0 | 13.4 | 20.4 | 3.11 |

**Appendix Q**

What is the people's perception about the effectiveness of flood control in Ijebu-Ode Local Government? From community questionnaire (Appendix B).

| S/N | Items | N f/n=300 | HE: 5 (%) | E: 4 (%) | ME: 3 (%) | NE: 2 (%) | NEA: 1 (%) | Mean score |
|---|---|---|---|---|---|---|---|---|
| 1 | Proper use of drainage | 282 (94%) | 47.2 | 26.6 | 7.80 | 11.4 | 7.09 | 4.32 |
| 2 | Constant opening and evacuation of solid waste and silt from the drainages | 286 (95.3%) | 43.7 | 24.8 | 11.2 | 10.8 | 9.44 | 4.30 |
| 3 | Proper refuse disposal | 282 (94%) | 42.9 | 26.2 | 12.0 | 10.6 | 8.16 | 4.25 |
| 4 | Construction of drainage where there is none | 283 (94.3%) | 46.6 | 21.9 | 10.6 | 8.48 | 12.4 | 4.24 |
| 5 | Properly channelled and well-connected drainages | 282 94% | 45.0 | 20.9 | 14.9 | 9.93 | 9.23 | 4.19 |
| 6 | Proper land use planning | 285 (95%) | 37.5 | 29.1 | 15.1 | 10.5 | 7.72 | 4.06 |
| 7 | Adequate provision of waste disposal facilities | 283 (94.3%) | 33.6 | 29.7 | 15.9 | 9.17 | 11.7 | 3.92 |
| 8 | Creating environmental education and awareness on the danger of flood | 286 (95.3%) | 35.0 | 23.8 | 17.5 | 11.5 | 12.2 | 3.40 |
| 9 | Sorting of wastes before disposal | (97.3% | 26.0 | 23.0 | 21.2 | 17.1 | 12.7 | 2.97 |
| 10 | Use of sand bags and other flood barriers | 286 (95.3%) | 21.0 | 28.7 | 24.8 | 13.3 | 12.2 | 3.47 |
| 11 | Raising of building foundation | 284 (94.7%) | 25 | 23.6 | 27.5 | 17.6 | 6.34 | 3.60 |
| 12 | Regular planting of trees in open/exposed spaces | 286 (95.3%) | 19.6 | 21.3 | 23.4 | 21.0 | 14.7 | 3.32 |
| 13 | Construction of bridge | 282 (94%) | 24.8 | 20.9 | 21.3 | 18.4 | 14.5 | 2.71 |
| 14 | Regular environmental check by relevant agencies | 286 (95.3%) | 30.1 | 25.9 | 13.6 | 14.3 | 16.1 | 3.06 |
| 15 | Adequate rainfall forecast and prompt alert to the residents | 281 (93.7%) | 21.0 | 22.8 | 19.6 | 23.1 | 9.96 | 3.43 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **EDUCATION** | | | | | | | |
| **16** | Schools play a significant role for increased awareness of flood risk education for students | 282 (94%) | 33.7 | 29.0 | 18.7 | 10.6 | 7.80 | 3.54 |
| **17** | Students have enough awareness of flood risk in Nigeria | 279 (93%) | 26.5 | 25.8 | 25.1 | 13.3 | 9.32 | 3.59 |
| **18** | Students have enough awareness in terms of practising good flood risk practices (e.g., keeping drainage channels clear of rubbish) in Nigeria | 275 (91.7%) | 21.5 | 25.1 | 27.6 | 20.4 | 5.46 | 3.99 |
| **19** | Student's awareness of flood risk has an impact on flood risk family awareness | 93.3% | 22.9 | 23.9 | 25 | 22.5 | 5.71 | 2.95 |
| **20** | Do you feel teachers are sufficiently aware of flood risk problems in Nigeria? | 281 (93.7%) | 24.2 | 25.3 | 22.4 | 17.1 | 11.0 | 3.81 |

**Appendix R**

Participant Information from educator questionnaire (Appendix D).

| Section A | Participant Information | Frequency (n = 25) | Percentage (%) |
|---|---|---|---|
| **1** | **Gender** | | |
| | Male | 17 | 77% |
| | Female | 5 | 23% |
| | **Total** | 22 | 100% |
| **2** | **Age** | | |
| | 18-25 | 0 | 0% |
| | 26-35 | 4 | 17% |
| | 36-45 | 2 | 9% |
| | 46-55 | 12 | 52% |
| | 56-65 | 5 | 22% |
| | 66 and above | 0 | 0% |
| | **Total** | 23 | 100% |
| **3** | **Department** | | |
| | Geography | 5 | 23% |
| | Social Studies | 11 | 50% |
| | Primary Education Studies (PES) | 6 | 27% |
| | **Total** | 22 | 100% |
| **4** | **Qualification** | | |
| | B.Ed. | 2 | 9% |
| | B.Sc. | 3 | 14% |
| | M.Ed. | 5 | 23% |
| | M.Sc. | 6 | 27% |
| | Ph.D. | 6 | 27% |
| | **Total** | 22 | 100% |
| **5** | **Position/ Rank** | | |
| | **Lecturer Grade 2** | 9 | 45% |
| | **Lecturer Grade 1** | 3 | 15% |
| | **Senior Lecturer** | 4 | 20% |
| | **Principal Lecturer/Associate Professor/Reader** | 2 | 10% |

| | | | |
|---|---|---|---|
| | **Senior Principal Lecturer/Professor** | 2 | 10% |
| | **Total** | 20 | 100% |
| **6** | **Number of years in service** | | |
| | **1-5** | 4 | 19% |
| | **6-10** | 2 | 10% |
| | **11-15** | 7 | 33% |
| | **16-20** | 4 | 19% |
| | **21 and above** | 4 | 19% |
| | **Total** | 21 | 100% |

**Appendix S**

Climate information from educator questionnaire (Appendix D).

| S/N | Item | N t/n = 25 | SA (5) (%) | A (4) (%) | DK (3) (%) | D (2) (%) | SD (1) (%) | Mean score |
|---|---|---|---|---|---|---|---|---|
| **7** | Climate change is real and posing serious threat, harming people and environment. | 22 (88%) | 68% | 32% | 0% | 0% | 0% | 4.68 |
| **8** | There is insufficient knowledge about the hazard posed by floods, which increase vulnerability (harm) of communities to flood. | 23 (92%) | 35% | 52% | 8.7% | 4.3% | 0% | 4.17 |
| **9** | Educating young people on climate change and flood risk will decrease vulnerability (harm) to flooding. | 23 (92%) | 83% | 17% | 0% | 0% | 0% | 4.83 |
| **10** | Unsustainable living habit of the people is a confirmation of insufficient flood and environmental knowledge, risk perception and risk communication. | 22 (88%) | 46% | 32% | 17% | 4.3% | 0% | 4.18 |

Respondent 1: B. many factors such as pollution and blockage of drainage system accounts for this
Respondent 2: A. because if people are aware of the damages of flood, they will prevent it
Respondent 3: B. because there is no adequate information and orientation as regards environmental issues or problems
Respondent 4: A. there are laid down rules there are not followed by the people
Respondent 5: A. even in the cases where limited knowledge of climate change is obtainable, cost of living could push people to jettison risk of flood for survival
Respondent 6: A. because people lack the knowledge about the environmental behaviour
Respondent 7: the proper knowledge about the unsustainable living habits of people will enhance the people to adjust the habit
Respondent 8: C
Respondent 9: A. unsustainable living habits of the people is contributing to various environmental problems such as flooding
Respondent 10: A. level of literacy is very low; hence, most people are unable to read sign post erected to guide people on how issue of flooding
Respondent 11: B. because knowledge determines perception of people about the environmental behaviour
Respondent 12: B. the fact that people actually block drains carry out other activities that promote flooding are enough reasons and confirmation of insufficient knowledge on flood and environmental risk perception
Respondent 13: B. because if people are knowledgeable about flood and the risk they will not live in unsustainable environment
Respondent 14: C

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Respondent 15: A. people are ignorant of their actions or the effect of their actions on the environment during raining season, when they throw their garbage into drainages when it rains<br>Respondent 16: C<br>Respondent 17: B. the evidence of environmental knowledge leads to sustainable living habits. If not evident, it leads to unsustainable living habits of the people<br>Respondent 18: B. economic status of the people plays a significant role in the unsustainable living habits; irrespective of the risk factor, as long as it meets economic needs, living habits rank above environmental knowledge<br>Respondent 19: B. knowledge about consequences of unsustainable living culture of people will help them to adjust their habits of wastage; proper knowledge of this will encourage flood and other environmental risk/changes<br>Respondent 20: B. most of the topography of Ijebu-Ode; don't have adequate drainage, even the one with good drainage are been dump refuse into<br>Respondent 21: A. people don't have knowledge of the risk done by flood that is causing harm the environment<br>Respondent 22: C<br>Respondent 23: E. I disagree because unsustainable habit of people can lead to flooding i.e., disposing refuse wrongly could lead to flooding | | | | | | | |
| **11** | Sufficient knowledge on climate change adaptation and flood disaster risk management will help raise awareness and impart preventive habits in the people. | 22 (88%) | 86% | 14% | 0% | 0% | 0% | 4.86 |
| **12** | Including climate change and flood risk education in teacher education curriculum could help raise peoples' flood knowledge and better habits towards environment. | 23 (92%) | 87% | 13% | 0% | 0% | 0% | 4.87 |
| Respondent 1: B. to broaden their knowledge and preach awareness to prevent occurrence<br>Respondent 2: A. education is power so such education will empower people to prevent flood<br>Respondent 3: A. the reason is that environmental problems does not cause by the adult, both young and old are vulnerable, therefore environmental education is very important in teacher education.<br>Respondent 4: A. it becomes easy for the teachers to transfer knowledge to students whom will be expected to act accordingly<br>Respondent 5: A. providing information on climate change will enhance grassroot knowledge of climate change and possible ways of adaptation which in turn will enhance better understanding of people in the community<br>Respondent 6: A. yes, this is sure because it will change people's perception about climate change and flood<br>Respondent 7: B. because people will have more knowledge about the implications of flood and at early stage and how to prevent them | | | | | | | | |

Respondent 8: A. the inclusion of climate change and flood risk education would not only save lives but would also reduce expenditure in this area thereby allowing for better fund management
Respondent 9: A. there is the need for more environmental education to sensitize the people
Respondent 10: A. this will enable teachers to have in-depth knowledge of climate change
Respondent 11: A. it will go a long way changing orientation of people
Respondent 12: A. this would have been programmed in teachers while learning in school so when they leave school, they will be able to teach students primary and post-primary schools as well as they bringing it to practical and demonstrating it in their immediate environment
Respondent 13: A
Respondent 14: A. the flood risk education will assist in raising awareness of the danger of flooding and climate change among the people in the world over
Respondent 15: A. educating the people on climate change and flood risk will help shape their attitude and become more environmentally friendly especially during raining season by not throwing garbage into the drainage systems
Respondent 16: A.it help people to understand and address impacts of global warming increase climate literacy among young people, encourages changes in their attitudes, behaviour and adaptation to climate change in their environment for purpose of future occurrence
Respondent 17: A. teacher education serves as a means enlightenment; hence, including climate change in its programs will help maximize or eradicate flood
Respondent 18: A. climate change and flood risk education in school will serve as means of information dissemination on the effects of flood; however, such education should be extended to the informal setting/sector of the society
Respondent 19: A. the teachers are one of the primary sources of information in the society; including climate change and flood risk education I their programme will increase awareness of people of all environmental hazards, thereby preventing their consequences
Respondent 20: A. with the awareness and campaign against dumping of refuse can prevent people from blocking drainage and enforcement of law will really help
Respondent 21: A. i agree because people that have been educated on the risk of flood will have better habits towards their environment
Respondent 22: A. education was recognized for its ability to empower, inform and motivate those engaged, the wider community and government to take action on climate change
Respondent 23: A. because inclusion of knowledge of climate change in the curriculum helps to give insight on how to get prepared before experiencing the flood.

## Appendix T

Flood information from educator questionnaire (Appendix D).

| S/N | Item | N t/n = 300 | SA (5) (%) | A (4) (%) | DK (3) (%) | D (2) (%) | SD (1) (%) | Mean score |
|---|---|---|---|---|---|---|---|---|
| **13** | Flooding is a major and the prevailing environmental hazard impacting the people's lives, property and environment in Nigeria. | 23 (92%) | 78% | 13% | 0% | 0% | 8.7% | 4.52 |
| The free text responses for Q13 are provided in Table 7.1. | | | | | | | | |
| **14** | Unsustainable living habits of people are major factor exacerbating incidences of floods and vulnerabilities in Nigerian cities and towns. | 19 (76%) | 32% | 58% | 0% | 11% | 0% | 4.10 |
| Respondent 1: B. bad economy and lack of job<br>Respondent 2: A. for example some people dispose waste as the weather changes<br>Respondent 3: B. as a result of farmlands and products that have been destroyed by flooding e,g., recent flooding that occurred in Bauchi State, Nigeria<br>Respondent 4: B<br>Respondent 5:<br>Respondent 6: A. yes, because you can't give what you don't have<br>Respondent 7:<br>Respondent 8: C<br>Respondent 9: A. people block the water channels and river ways with different garbage's and waste materials<br>Respondent 10: this I because people incalcitrant<br>Respondent 11: A. because you only give what you have<br>Respondent 12: B. dumping of refuse in the public drains which prevent natural free flow of flood which eventually overflow the brim and spread across the road causing damages along its course<br>Respondent 13: A<br>Respondent 14: D. disagree because flooding is not the only factor causing unsustainable living habit of the people<br>Respondent 15: A. lack of education on flooding result in people not being friendly to the environment during raining season<br>Respondent 16: A. not even only that. I don't care attitude of our people due to deforestation can cause flooding; trees are excellent at intercepting and storing water.<br>Respondent 17: C. the attitude of the populace towards flood reduction is appalling and therefore causes more incidences of flood and vulnerabilities<br>Respondent 18: C. unsustainable living habits affect how people dispose their wastes; many disposes waste into river channels or canals because they cannot afford better or proper means of waste disposal<br>Respondent 19: A. ignorant culture of domestic wastage is one of factors for prevalence of flood; this is as a result of the unsustainable habits of living by people in society, mostly, those in rural areas<br>Respondent 20: B | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Respondent 21: D<br>Respondent 22: A<br>Respondent 23: A | | | | | | | | |
| **15** | Insufficient flood knowledge could impair peoples risk perception and preparedness intentions. | 23 (92%) | 57% | 26% | 8.7% | 0% | 8.7% | 4.23 |
| **16** | Increasing the peoples' environmental protection literacy could help in achieving desirable behavioural changes and sustainable flood risk management (FRM) in Nigeria communities. | 21 (84%) | 57% | 38% | 0% | 0% | 4.8% | 4.42 |
| Respondent 1: A. when people are knowledgeable about environmental protection, it becomes easy for changes and flood management will become effective<br>Respondent 2: once people are literate, they will adjust to do right things<br>Respondent 3: A. orientation and sensitization campaign is the solution to flood problems because most environmental problems are caused as a result of ignorance<br>Respondent 4: A. educating the people and reorientating them can help in changing the behaviour for a better society<br>Respondent 5: B. more knowledge of environmental protection will create awareness and the need for safety<br>Respondent 6: A. given new orientation will help a lot<br>Respondent 7: A. because people will know how and when to avoid the risk of flood<br>Respondent 8: E. protection of the basic features of human environment would reduce risk to human lives and properties thereby conserving human needs<br>Respondent 9: A. increase in the people's environmental protection knowledge will ensure the sustainability of human environment<br>Respondent 10: B. it will increase people environmental literacy because persistence will force people to adapt<br>Respondent 11: A. creation of more awareness is achieved<br>Respondent 12: B. once people have sufficient information on the danger of flooding and possible solution to such, they will adequately do the needful because everyone wants and desires the safety of his live and properly<br>Respondent 13: B<br>Respondent 14: B. environmental protection literacy will expose the Nigerian populace and communities to the dangers and remedies need to manage the hazards likely to be caused by flooding and other environmental risks<br>Respondent 15B. it will increase awareness about the danger of flooding<br>Respondent 16: A. I should agree to introduce the recycle of materials, this will reduce waste; as well as organize tree planting day at school for our children and awareness to the citizens<br>Respondent 17: B. I agree because information is power and literacy is about being informed about issues<br>Respondent 18: A. public awareness of the effects of flooding can be achieved when people are adequately informed or enlightened | | | | | | | | |

<table>
<tr><td colspan="9">Respondent 19: A. knowledge about a phenomenon is vital; the knowledge of it will reduce its risk, hence, the higher the level of literacy amongst the people, the lower the risks<br>Respondent 20: B. by changing attitude of people towards blocking drainage<br>Respondent 21: *<br>Respondent 22: *<br>Respondent 23: A. the enlightenment of people of how to control and prevent flood will definitely abstain the people from experiencing flooding</td></tr>
<tr><td>17</td><td>Designing robust climate and flood risk education (curriculum) will help raise awareness of climate change and the impacts of humans on the environment.</td><td>22 (88%)</td><td>59%</td><td>36%</td><td>0%</td><td>0%</td><td>4.6%</td><td>4.5</td></tr>
</table>

**Appendix U**

Waste Management Information from educator questionnaire (Appendix D).

| S/N | Item | N t/n = 300 | SA (5) (%) | A (4) (%) | DK (3) (%) | D (2) (%) | SD (1) (%) | Mean score |
|---|---|---|---|---|---|---|---|---|
| **18** | Solid wastes are indiscriminately disposed and poorly collected in Nigerian cities and towns. | 23 (92%) | 57% | 30% | 4.3% | 4.3% | 4.3% | 4.30 |

Respondent 1: A: Nigerian cities and towns are too congested, places allocated for disposing solid waste are close to areas inhabited by the people causing more harm than good
Respondent 2: A. Because most cities have no defined dump site
Respondent 3: A. there is insufficient orientation and sensitization on the proper method of disposing waste; also, incinerators were not provided for people to dispose their waste
Respondent 4: A. very evident in major towns and cities with many falling ill.
Respondent 5: B. the collection point of solid waste by the local government remains the walk-way dividing the dualized roads in Ijebu-Ode; this has indeed contributed to indiscriminate dumping of waste
Respondent 6: A. yes, this look like normal culture here; there is need to act now
Respondent 7: A. because people dispose solid wastes, they ought not to which block free flow of water
Respondent 8: A. because there is no superb administrative instrument to execute the laws in place
Respondent 9: A. solid wastes are nor properly management in Nigeria cities
Respondent 10: B. this is because of poor hygenic nature
Respondent 11: A. very common in Ijebu-Ode
Respondent 12: B. while some people may truly dispose their refuse in containers, quite a large number of people just drop their solid waste on the road and other places
Respondent 13: C
Respondent 14: E
Respondent 15: A. it is a common phenomenon in the cities and homes; people dispose waste anywhere and government agency that is responsible for collection is not responsive
Respondent 16: B. the method of solid waste disposal are poor as something else; imagine dumping inside canal, dumping in the street and into the sea etc.
Respondent 17: A. it is evident in Nigerian cities, solid wastes are indiscriminately disposed; the right technique for even collection is not put in place
Respondent 18: A. the rate and manner at which solid wastes litter Nigerian towns and cities is an indicator of poor waste disposal system/method
Respondent 19: B. many societies especially rural areas are fond of dropping/disposing their wastes in the drainages; due to no proper waste management system in those areas or communities
Respondent 20: A. most waste disposal agent doesn't have a place to deposit their waste, even individual also disposed the waste any how
Respondent 21: A. I agree because people dump refuse when there is flood and this causes havoc in the society
Respondent 22: A. *the continuous indiscriminate disposal of solid waste is increasing in Nigeria and is linked to: poverty; poor governance; urbanization; population growth; poor standard of living and non-challan attitude towards environmental cleanliness and sanitation

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Respondent 23: A. Nigerian government are corrupted to this extent of when the disposing of refuse is contract out to private firm, government fail to monitor this firms on how properly they dispose it; this has been causing a lot of havoc in the cities | | | | | | | | |
| **19** | Lack of public perception and awareness on proper waste management approach couple with institutional weaknesses are key drivers of unsustainable habit and poor practices in waste generation and disposal in Nigeria. | 23 (92%) | 57% | 26% | 8.7% | 0% | 8.7% | 4.22 |
| Respondent 1: A. the illiteracy level in Nigeria is still high especially as regards proper waste management which is the major problem in Nigeria<br>Respondent 2: A. because government do not have appropriate sanctions for offenders<br>Respondent 3: A. because government does not create enough sensitization and awareness; also, there is no formidable laws that prohibit people from indiscriminate waste disposal in Nigeria<br>Respondent 4: A. many do not know and are not aware of how to dispose refuse and how to manage waste, this accounts for the dirty environment we are<br>Respondent 5: B. heavy downpour sometimes wash these wastes into drainages thus creating pollution; this is a weakness on government part; while some individuals wait for rain before dumping their wastes into the drainages; a result of insufficient public knowledge<br>Respondent 6: A<br>Respondent 7: A. people lack the knowledge about the implication of poor waste management<br>Respondent 8: A<br>Respondent 9: A. the public perception and awareness are very poor<br>Respondent 10: B. this is because government has abandoned the role<br>Respondent 11: A<br>Respondent 12: B. inability of the relevant institutions to ensure proper waste management encourages unsustainable habitual poor waste disposal<br>Respondent 13: B<br>Respondent 14: A<br>Respondent 15: A<br>Respondent 16: C<br>Respondent 17: C<br>Respondent 18: E. there is no correlation between public perception and unsustainable habit; the correlation is between economic status and unsustainable habits<br>Respondent 19: A. majorly the states of Nigeria lack institutional framework for waste management; also, the populace themselves have a poor perception on waste management; these two factors has been a bane to Nigeria<br>Respondent 20: B<br>Respondent 21: A. the reason is that people don't know how to manage their waste in the society, any opportunity of flood, they dump their wastes<br>Respondent 22: A<br>Respondent 23: E. I strongly disagree due to the non-challan attitude by the government even when there is a parastatal including of sensitizing the people | | | | | | | | |

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| **20** | When it is about to rain or raining, people are in habit of emptying and disposing off their domestic wastes and rubbish in drainage channels and surface runoff. | 23 (92%) | 61% | 26% | 0% | 0% | 13% | 4.22 |

Respondent 1: A. people do so believe, the rain will take away their domestic waste afar off their environment, unknown to them, it causes more damage than good
Respondent 2: E. not in my environment
Respondent 3: A. lack of adequate knowledge about the effect of disposing waste in our drainages when it is raining; also, inability of government to make provisions for incinerators at strategic locations
Respondent 4: A. very common; drainages are blocked and roads and houses become flooded
Respondent 5: E. as earlier explained, this unhealthy habit is still being practised by some individuals
Respondent 6: A. almost everywhere
Respondent 7: A. they believe that the erosion will wash it away
Respondent 8: A. because most houses don't have waste disposal facilities
Respondent 9: A. with this habit, people believed that wastes will be flush away by the rain water
Respondent 10: A. this is because of poor hygienic nature of the people
Respondent 11: A. very common in the town
Respondent 12: B. apart from the fact that I see you people do these often, many drainage channels are always filled with refuse hence cause flood on the road
Respondent 13: B
Respondent 14: E
Respondent 15: A. after rainfall, you will see waste all over the places and many at times drainages are blocked by waste which in most cases affect the flow of flood
Respondent 16: B. people are fond of dumping waste inside the gutter anytime there is rainfall, even on the major streets at times
Respondent 17: A. people living mostly in the rural and developing areas are usually seen by disposing off their domestic wastes; hence, I agree with both the statement
Respondent 18: A. the poor waste disposal coupled with weak transportation system made water an alternative means of waste disposal
Respondent 19: B. the notion "the waste will erupt bad odour once it gets wet"; also, they believe as it rains the drainage water flow will take the waste to the river or sea" has been a recuring mentality to Nigerians
Respondent 20: B. people think that during rain is best time to dispose their refuse due to government insufficient place to deposit their refuse
Respondent 21: A. we are seeing this in our areas, people have the habit of dumping the wastes in drainage channels for the flood to carry it away
Respondent 22: A. lack of appropriate storage facilities; inadequate waste management and planning; wrong perceptions by residents and non-challan attitudes towards environmental cleaning and sanitation
Respondent 23: A. most of this happen among the illiterates due to lack of good orientation by (NOA) - National Orientation Agency

| | | | | | | | | |
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| **21** | Large chunk of the uncollected municipal wastes ends up blocking | 22 (88%) | 73% | 14% | 4.6% | 0% | 9.1% | 4.41 |

<table>
<tr><td></td><td>the drainage channels, obstructing free flow of water, forcing the excess water to spill on the roads and surroundings, causing panic and severe havoc on lives and properties.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="9">Respondent 1: A. the lives and properties, flood has killed and destroyed being witness<br>Respondent 2: E. because the drains are too small and the flood water is devoid of waste<br>Respondent 3: A. because once the drainage is blocked, as a result of uncollected solid waste, water will definitely find its ways thereby causing flooding which at times caused loss of lives<br>Respondent 4: B. this is evident in many areas; mountains of refuse are allowed even on the major streets<br>Respondent 5: E. this has also been captured in my earlier observation<br>Respondent 6: A. because there is no waste management department<br>Respondent 7: A<br>Respondent 8: A<br>Respondent 9: A. this is responsible for the perennial flood disaster in Nigeria<br>Respondent 10: A. this is because of lack of enlightenment programme by government<br>Respondent 11: A<br>Respondent 12: B. each time it rained, there was panic everywhere because of the fear of damage possibly caused by flood in pulling down many dilapidated building<br>Respondent 13: A<br>Respondent 14: A<br>Respondent 15: A<br>Respondent 16: C<br>Respondent 17: B<br>Respondent 18: A. the major cause of flooding in the country is blocked drains and water channels due to solid waste disposal; the more people dump waste in drains the more the effects of flooding<br>Respondent 19: B. flood which has cause a great havoc to life is as a result poor practices of waste management by people; disposed waste thrown into drainages blocks the channel, hence, water flow is hindered, hence, its reverberation effects is on the people<br>Respondent 20: A<br>Respondent 21: A. I agree to this as blockage has been causing havoc and death<br>Respondent 22: A<br>Respondent 23: A. sometimes this happens because there is no good drainage system constructed</td></tr>
<tr><td>22</td><td>Including environmental education (EE) in teacher education curriculum will increase household level of awareness on environmental implications of poor domestic waste disposal and management.</td><td>23 (92%)</td><td>83%</td><td>13%</td><td>0%</td><td>4.3%</td><td>0%</td><td>4.74</td></tr>
<tr><td colspan="9">Respondent 1: A. awareness on environmental education will increase knowledge and eliminate improper waste disposal<br>Respondent 2: A. education is key, curriculum will expand the knowledge</td></tr>
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<table>
<tr><td colspan="9">Respondent 3: B. because we start educating children from primary level, it will assist us at the long run in minimizing or put an end to the problem of waste disposal and management<br>Respondent 4: A. the type of environment and how it should be maintained can be taught<br>Respondent 5: A. the message on environmental protection will penetrate individual homes through their wards and enforcement will become easier<br>Respondent 6: A. people need more awareness<br>Respondent 7: A<br>Respondent 8: A<br>Respondent 9: A. environmental education should be included in the school curriculum at the various levels of education<br>Respondent 10: A. this is because teachers need to be well informed, so that they will be able to impact the correct knowledge to the student<br>Respondent 11: A. creation more awareness<br>Respondent 12: B. the inclusion of environmental education in teacher education curriculum will reinforce the teacher and student alertness on management of wastes<br>Respondent 13: A<br>Respondent 14: A<br>Respondent 15: A<br>Respondent 16: A<br>Respondent 17: B<br>Respondent 18: D. environmental education should not be limited to school; it should have a wider coverage; the percentage of enrolment in school is low, hence, the low level of awareness on environmental implication of poor waste disposal system<br>Respondent 19: A. every society needs an adequate knowledge on environmental education, hence, teachers play important role in impacting the society<br>Respondent 20: A<br>Respondent 21: A. It will make household know how to dispose their wastes when they have knowledgeable people in their midst<br>Respondent 22: A<br>Respondent 23: A. the enlighten of environmental education will surely give people insight on how to manage waste disposal management</td></tr>
<tr><td>23</td><td>Good governance and effective institutional capacity and coordination at the local government level (i.e., LEMA & NIMET) could foster proactive response towards domestic waste and flood risk management.</td><td>22 (88%)</td><td>68%</td><td>27%</td><td>4.6%</td><td>0%</td><td>0%</td><td>4.64</td></tr>
<tr><td colspan="9">Respondent 1: A. institutions would be able to enforce every laws regarding waste disposal at all levels<br>Respondent 2: A. flood policy and plan of action by government<br>Respondent 3: A. this is because if the problem of waste disposal is be minimized, the role of environmental agencies like NIMET, FEPA, LEMA cannot be overemphasized; so, these agencies must be empowered to perform their constitutional roles<br>Respondent 4: A<br>Respondent 5: A. despite the fact that there are waste collection vehicles, the the driving force and enforcement of effective usage remains the duty of the local government<br>Respondent 6: A. this is leadership problem</td></tr>
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| Respondent 7: A. the local government are closest to the people<br>Respondent 8: A<br>Respondent 9: B. there should be good government policy to curb various environmental problems<br>Respondent 10: A<br>Respondent 11: A. leadership by example<br>Respondent 12: B. effective institutional capacity will surely foster improved proactive response to domestic waste flood risk management<br>Respondent 13: B<br>Respondent 14: A. this is because local governments in Nigeria are closer to the grassroot and coordination of waste management is possible<br>Respondent 15: A<br>Respondent 16: C. our attitude as a citizen needs to be change towards this style of dumping refuse in the sea<br>Respondent 17: Respondent 17: B. I agree they are saddled with such responsibility, but its quite unfortunate that due to some factors they might not be up to the task<br>Respondent 18: A. local government is the closest to the people; an improvement on institutional capacity at the local government level would definitely positively on domestic waste and flood risk management<br>Respondent 19: A. government has the major work in fostering good living condition in the society, in the aspect of effective institution and proper law enforcement to ensure waste are disposed appropriately<br>Respondent 20: B<br>Respondent 21: A. if the people assigned to do this job are doing it religiously people will be educated on how to manage their wastes<br>Respondent 22: *<br>Respondent 23: B |

**Appendix V**

School Information from educator questionnaire (Appendix D).

| Section E | **School Information** | **Frequency (n = 25)** | **Percentage (%)** |
|---|---|---|---|
| 24 | Does government through the Ministry of education give 'much' concerns to 'issues' of environmental education? | | |
| | Yes | 9 | 41% |
| | No | 13 | 59% |
| | Total | 22 | 100% |
| Respondent 1: B. nothing has reflected in subject been taught in schools in environmental education<br>Respondent 2: A. environmental study is part of the curriculum<br>Respondent 3: B. most of our commissioner or ministers for education are not environmentalist<br>Respondent 4: A<br>Respondent 5: B. although the local government has provision for this, this aspect is not visible in the National Curriculum on Education<br>Respondent 6: B. no such evidence from anywhere<br>Respondent 7: A<br>Respondent 8: B. it's a result of policy somersault | | | |

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| Respondent 9: B. this is because environmental education is not separate subject been taught at the school level<br>Respondent 10: A<br>Respondent 11: B. no evidence of such<br>Respondent 12: B. it is borne out of their non-challan attitude towards the wellbeing of their constituents<br>Respondent 13: B<br>Respondent 14: A<br>Respondent 15: B. it is not a compulsory course at any level of education in Nigeria<br>Respondent 16: A<br>Respondent 17: A<br>Respondent 18: A. there is no synergy between Ministry of Education and that of Environment due to policy somersault.<br>Respondent 19: B. environmental education are just taught on a periphery; therefore, the issues of environment such as hazards of waste and its devastating consequences are not much discussed<br>Respondent 20: A<br>Respondent 21: B. we are not seeing the impact in our society, if this done<br>Respondent 22: A<br>Respondent 23: A | | | |
| 25 | Is environmental education taught as a compulsory subject in Nigerian schools? | | |
| | Yes | 3 | 14% |
| | No | 19 | 86% |
| | Total | 22 | 100% |
| Respondent 1: A. environmental education is been taught but not so effective<br>Respondent 2: B. environmental degradation is a serious issue<br>Respondent 3: B. because our education policy makers does not see environmental problem as a serious problem that cause serious setback in Nigeria<br>Respondent 4: B. as a subject, it will have as one of the objectives; "the maintenance of an ideal society"<br>Respondent 5: B. yes, this should be taught in all levels as it will enhance good health<br>Respondent 6: B. may be under Geography<br>Respondent 7: B. it has been a success because it has been able to let them know how dangerous environmental problem is<br>Respondent 8: B. it should be taught throughout foundation to the secondary school<br>Respondent 9: B. it is been taught as a required course in many schools<br>Respondent 10: B. it should be taught, so as to increase the necessary awareness to protect the environment<br>Respondent 11: Yes in TASUED, I don't know of other school<br>Respondent 12: B. it will give students opportunity of knowing much about the environment hence take proper adaptation where and when necessary<br>Respondent 13: B<br>Respondent 14: B. environmental education is not taught, particularly in secondary schools because there is no full-fledged curriculum<br>Respondent 15: B. it will enlighten people, especially students about the danger of flooding and the benefit of environmental sanitation<br>Respondent 16: B. this should be included in the school curriculum from the J.S.1 till the University level | | | |

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| Respondent 17: B. it should be a subject because the environment constitutes a major part of our lives; therefore, teaching it as a subject will be helpful in teaching environmental problems<br>Respondent 18: B. all human activities are carried out in the environment. There is need for all to know how to take care or protect the environment<br>Respondent 19: B. it remains a course or subject taught at just primary and junior secondary level, with just a tip of knowledge about the issues, whereas, it's a subject that is important to all at large<br>Respondent 20: B. adequate information need to be pass through our student by making or creating a subject that will comprises of clearly environment and proper waste management<br>Respondent 21: B. it has never have effect in the lives of the masses<br>Resoponden22: B. education is the only way to make best minds work productively; introducing environmental education will bring students closer to their communities, provide solutions to global, issues in real time; create and raise awareness of environmental<br>Respondent 23: B. it should be a subject at all levels because everyone should be concerned about environmental education | | | |
| 26 | Mention some of the environmental issues and problems that is common in your environment/surroundings:<br>• Drainage blockage; illegal refuse dumping on the roads; inadequate drainage system, late collection of wastes; indiscriminate dumping of wastes, poor drainage management.<br>• Flooding and erosion during rainfall, air pollution, oil spilage pollution, land reclamation and deforestation. | | |
| 27 | Do you think that pupils/students are aware of environmental issues and problems? | | |
| | Yes | 8 | 36% |
| | No | 14 | 64% |
| | Total | 22 | 100% |
| Respondent 1: A. they are aware but not effectively knowledgeable as to the cause<br>Respondent 2: B. not emphasized in the curriculum<br>Respondent 3: B. because there is no adequate orientation and education as regards environment<br>Respondent 4: B. students are not taught and schools and parents and guardians pay not much attention to environmental issues<br>Respondent 5: A. the monthly observation of environmental sanitation observed every last Saturday of the month when movement would be restricted between 7:00am and 10;00am.<br>Respondent 6: B. no orientation to those effects<br>Respondent 7: B. lack of government agencies concerned and the entire society<br>Respondent 8: B. the education sector is in shamble<br>Respondent 9: A. this awareness among the pupils and students are very weak; this is because it is not a compulsory subject in the curriculum and school time table<br>Respondent 10: B. it should be included in the school curriculum | | | |

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| Respondent 11: A. to some extent<br>Respondent 12: B. poor education and sensitization of the students on the subject matter<br>Respondent 13: B. this is due to the lack of including it as a core subject in their course of study<br>Respondent 14: A. pupils/students are aware of environmental issues and problems to a limited extent<br>Respondent 15: *<br>Respondent 16: B. government factor, the responsibility of the government is to make or let the citizens know about the hazards in it; on flood, the citizens as well be more aware of the negative side of it<br>Respondent 17: B. teachers are yet to see it as a necessity in creating awareness of environmental issues to pupils/students<br>Respondent 18: A. 30% of the rating<br>Respondent 19: B.**lack of proper education in their respective schools, government agencies concerned and the whole society<br>Respondent 20: B. government does not inculcate it into syllabus (scheme of work)<br>Respondent 21: A. yes, pupils and students are seeing these things in their surroundings<br>Respondent 22: B. it is not included in the curriculum<br>Respondent 23: A. some of them are aware because the government through the National Orientation Agency (NOA) is not reaching the people at large | | | |
| 28 | Do you think pupils/students are getting the desired awareness and perception, new patterns in value, habits and capacity building capable of reducing flood risk? | | |
| | Yes | 1 | 5% |
| | No | 19 | 95% |
| | Total | 20 | 100% |
| Respondent 1: B. flood risk are not been emphasized as a real issue or serious risk in schools<br>Respondent 2: B. not emphasized in the curriculum<br>Respondent 3: B. no sensitization as far as environment is concerned<br>Respondent 4: B. environmental issues are not taught in schools<br>Respondent 5: B. despite the aforementioned measures, indiscriminate dumping of wastes still strives; drainages are filled with wastes, flood occur whenever there is heavy downpour<br>Respondent 6: B. the school curriculum we run is not design for our development<br>Respondent 7: B. no proper structure is in place for defined knowledge in order to increase their awareness and perception<br>Respondent 8: B. there is a gap in the educational sector<br>Respondent 9: B. this is because of weak government policy<br>Respondent 10: *<br>Respondent 11: A. depending on the curriculum and teaching contents<br>Respondent 12: B. no one is interested in impacting this into the pupils<br>Respondent 13: B<br>Respondent 14: B. the reason being that they do not have adequate education<br>Respondent 15: * | | | |

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| Respondent 16: B. the awareness should be more pronounce to the citizen as to know the level of hazard cause by flood; students should be taught the day the start school; the awareness will be more pronounced<br>Respondent 17: B. there is no enabling environment for pupils/students to get the desired awareness and perception<br>Respondent 18: B. the curriculum failed to cover the environmental issue<br>Respondent 19: B. no proper structure is in place for adequate knowledge in order to increase their awareness for reducing flood risk<br>Respondent 20: B. not included in the scheme of work<br>Respondent 21: B. students don't get desired awareness because the government is not playing their role<br>Respondent 22: *<br>Respondent 22: B. the reason is that I think there should be awareness like billboards, posters etc. so that the people can see visible knowledge about the awareness | | | |
| 29 | Do you think current Nigeria curriculum programme in areas of some related subjects such as geography, social studies and civic education comprises of subject matter on climate change and risk management? | | |
| | Yes | 12 | 52% |
| | No | 11 | 48% |
| | Total | 23 | 100% |
| Respondent 1: A. these subjects only make reference to these problems but nothing more than this is been taught; there is a need for over emphasis to be laid as touching climate change and risk management<br>Respondent 2: A. is there in the curriculum<br>Respondent 3: B. yes<br>Respondent 4: A. only that it is not well stressed and not well emphasized<br>Respondent 5: A. very little and majorly theoretical<br>Respondent 6: A. this is a new idea in the system and if properly implemented it will solve most of our problems<br>Respondent 7: B. it should be included in teacher's curriculum and it should be taught as a subject on its own<br>Respondent 8: A. the curriculum is rich and encompassing, however, the government and private operators are not financing education to the desired level<br>Respondent 9: A. yes, but not adequately addressed; environmental education should be included in the teacher's education in Nigeria<br>Respondent 10: B. yes<br>Respondent 11: A. will go a long way to create more awareness<br>Respondent 12: B. it should be included in the teacher education curriculum<br>Respondent 13: B. yes<br>Respondent 14: A. yes, but quite limited coverage<br>Respondent 15: *<br>Respondent 16: A. yes<br>Respondent 17: A. to a large extent because issues on climate change and flood risk management are embedded in the Nigerian Curriculum Programme<br>Respondent 18: B. yes, environmental education should be included in the curriculum or teacher education | | | |

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| Respondent 19: B. certainly it should be included in the teacher's curriculum and as well taught as a subject<br>Respondent 20: B. yes<br>Respondent 21: A. well it is not as expected, yes it should be taught to make the masses dump their waste properly<br>Respondent 22: A. yes<br>Respondent 23: B. the curriculum is not detailed enough to cover the new demand of environmental literacy | | | |
| 30 | Do the student teachers offer environmental education as a compulsory subject or course? | | |
| | Yes | 3 | 14% |
| | No | 18 | 86% |
| | Total | 21 | 100% |
| Respondent 1: Environmental education is not seen as a compulsory subject course because it is not related to all disciplines<br>Respondent 2: B. I don't know<br>Respondent 3: B. because the curriculum/syllabus does not make provision for environmental education in Nigeria<br>Respondent 4: B. it is not part of their General Courses<br>Respondent 5: B. it is not enough prominence on the curriculum<br>Respondent 6: B<br>Respondent 7: B. non-inclusion in the curriculum is the reason<br>Respondent 8: *<br>Respondent 9: B. student teachers are not offering environmental education as a compulsory subject<br>Respondent 10: B. because there is no curriculum design for it<br>Respondent 11: A. yes<br>Respondent 12: B. it was not considered necessary particularly at the time of preparation of the curriculum<br>Respondent 13: B. because most of the teachers are not geography teachers<br>Respondent 14: B. this is because they are not adequately expose to it<br>Respondent 15: *<br>Respondent 16: B. have no idea<br>Respondent 17: A. yes, they are properly equipped<br>Respondent 18: B. curriculum somersault<br>Respondent 19: B<br>Respondent 20: B. just to be in the scheme<br>Respondent 21: B. student-teachers do not offer it as a compulsory course because they think it has no relevance<br>Respondent 22: B<br>Respondent 23: A. the students do not have adequate environmental knowledge due to the teacher focus on the theory aspect | | | |
| 31 | Do you think current practising classroom teacher are qualified to impart climate change and flood risk education in Nigeria? | | |
| | Yes | 11 | 50% |

| | | | |
|---|---|---|---|
| | No | 11 | 50% |
| | Total | 22 | 100% |

Respondent 1: A. emphasis could be placed on these problems by them and the students/pupils will see serious risk in them; these students/pupils believe their teachers ever more than their parents
Respondent 2: A. because they are aware of the problem
Respondent 3: B. yes need for in-service training of teachers
Respondent 4: A. while teaching social study or geography
Respondent 5: A. while there is information on climate change outside the curriculum, this educator can be subject to seminars on the topic
Respondent 6: B. yes, in-service training of teachers can assist in so many ways
Respondent 7: A. yes, because they stay in those areas where these issues are faced and all they need to know is better training and techniques
Respondent 8: A. if given the right facilities, incentives, and other needs
Respondent 9: B. because most teachers are not well knowledgeable on environmental issues
Respondent 10: B. yes
Respondent 11: A. because they have trained on the subject matter
Respondent 12: A. to the extent of the degree of training, orientation and sensitization given to them
Respondent 13: B. yes
Respondent 14: A yes. If trained and allowed to attend seminars and conferences
Respondent 15: *
Respondent 16: A. yes
Respondent 17: B. it is important; the place of in-service training cannot be ruled out
Respondent 18: B. yes, it is important for all teachers in training in environmental related education causes
Respondent 19: A. they live in the society where these issues are faced, all they need to know or learn is better training techniques
Respondent 20: B. yes
Respondent 21: B. in-service training of teachers can help in giving more knowledge to the masses
Respondent 22: B. yes
Respondent 23: B. there should be training on the respect of climate change also

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| 32 | Do school management often conduct seminars and workshops on environmental issues? | | |
| | Yes | 3 | 14% |
| | No | 19 | 86% |
| | Total | 22 | 100% |

Respondent 1: B. schools do not see the need or priority to do so
Respondent 2: B. I don't know
Respondent 3: B. lack of fund; lack of knowledge about the effect of environmental problems on economy, education, social and political systems
Respondent 4: B. they possibly see no reason for it and it may not be in their schedule of duties
Respondent 5: B. due to non-inclusion in the school curriculum
Respondent 6: B. no such programme
Respondent 7: B. non-inclusion in the curriculum is the reason

Respondent 8: maybe; because budgeting allocation to educational sector is meagre
Respondent 9: B. schools are nor conducting workshops and seminars on environmental issues
Respondent 10 B. lack of fund
Respondent 11: B. nothing of such at the management level
Respondent 12: B. even the management does really appreciate the need for such hence no workshop and seminar will be organized
Respondent 13: A. occasionally
Respondent 14: B. because most times they do not have the wherewithal
Respondent 15: *
Respondent 16: A. at least once in a month
Respondent 17: B. it is yet to be considered by the school management
Respondent 18: B. the interest of the management in most schools is about profit and loss in terms of turnover and not on environmental issues
Respondent 19: B. lack of awareness in one part and non-inclusion in curriculum on the other hand
Respondent 20: to create more awareness to the people
Respondent 21: B. the school management feel unconcerned about the environmental issues
Respondent 22: B
Respondent 23: B. when there is no programme set aside for this

**Appendix W**

Educational Needs from educator questionnaire (Appendix D).

| Section F | Educational Needs | Frequency (n = 25) | Percentage (%) |
|---|---|---|---|
| **33** | Would the teachers be happy to teach the students about environment climate change to achieve improvement in environmental and disaster management? | | |
| | Yes | 21 | 100% |
| | No | 0 | 0% |
| | **Total** | 21 | 100% |

**34: what will teachers need to provide for module or content in teaching and learning of climate change and flood risk management?**

Respondent 1: effects of climate change; what is flooding? how to manage flood? effects of flooding
Respondent 2: understanding the basis of environmental study and the danger of environmental degradation
Respondent 3: meaning of environment; meaning of environmental problems; importance of environment to human life; effect/consequences of damaging our environment on human life
Respondent 4: *
Respondent 5: approval from the Ministry of Education Science and Technology; seminar on the importance of environmental protection and hazard connected to flood and climate change
Respondent 6: yes, if all necessary teaching materials were provided
Respondent 7: relevant materials and recent knowledge of environmental happenings
Respondent 8: teaching material; removal of bureaucracy; given incentives to teachers and allocation of better financing of education
Respondent 9: teachers will need adequate knowledge and skills
Respondent 10: good instructional materials
Respondent 11: all necessary and related teaching aids
Respondent 12: thorough training with risk assessment facilities
Respondent 13: the teachers need basic knowledge and regular training on environmental risk management courses
Respondent 14: teachers will need curriculum/curricular adequately planned by environmental curriculum specialists encompassing basic ingredients
Respondent 15*
Respondent 16: to ensure effective learning and deep understanding of the subject matter; climate change should be integrated across school curricular; its severe impact and coping measures has to be adapted to address related target groups
Respondent 17: *
Respondent 18: the importance of technology in teaching cannot be overemphasized; provision of adequate teaching aid in terms of technology would assist teachers in putting together robust module or content on climate change
Respondent 19: proper relevant materials; recent knowledge on environmental issues
Respondent 20: *
Respondent 21: teachers will need in-service training to enhance their knowledge in environmental and disaster management
Respondent 22: *

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| Respondent 23: the teachers that want to disseminate the teaching must have knowledge of it; there should be availability of materials like posters for visual learning |
| **35: Any other comments**<br>Respondent 1: *<br>Respondent 2: *<br>Respondent 3: we should make our environment conducive because an healthy environment is an healthy living; so, our education policy makers should see environmental education as a subject to be included in our curriculum<br>Respondent 4: *<br>Respondent 5: *<br>Respondent 6: this is a generally acknowledged problem in Nigeria and there is need for urgent attention in other to solve this problem<br>Respondent 7: *<br>Respondent 8: *<br>Respondent 9: the teacher, students and general populace need to develop environmentally friendly attitude for the sustainability of the environment and survival of human race<br>Respondent 10: *<br>Respondent 11: Ijebu-Ode needs a very urgent attention on this subject matter<br>Respondent 12: *<br>Respondent 13: *<br>Respondent 14: *<br>Respondent 15: *<br>Respondent 16: *<br>Respondent 17: *<br>Respondent 18: the effects of climate change is real; most developing countries are not adequately equipped to manage these effects; developed countries should provide adequate assistance financially and technology<br>Respondent 19: *<br>Respondent 20: *<br>Respondent 21: the government should be up and doing by giving the masses assistance in waste disposal<br>Respondent 22*<br>Respondent 23: the government should implore the National Orientation Agency (NOA) in carrying out their duties |