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IMPACT OF FLOODS ON THE ENVIRONMENT, NATURAL ECOSYSTEM AND DEVELOPMENT STRATEGIES FOR MINIMIZING THIS IMPACT IN IBAJI LGA OF KOGI STATE

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ABSTRACT

This study investigated the impact of Floods on The Environment, Natural Ecosystem and Development Strategies for Minimizing this Impact in Ibaji LGA of Kogi State. The objectives of the study are to identify the impact of floods on the environment and natural ecosystem, identify how floods affect the ecosystem, and state the strategic ways of minimizing the impact of flood in the study area. It is used purposive sampling technique and population of the study are 11,400. The findings of the study revealed that destruction of crops and damage of vital infrastructure and preventing access to essential public services are the major impacts in the study area, and also the major livelihood affected in the study area is agricultural system (farming). The study continues revealing that tackling climate change, forecasting early warning, monitoring, and preparation of contingency plans are the best strategies to minimize the impact of flood in the study area.

The study recommends government to promote natural flood management techniques and enhance forecasting and warning system to improve preparedness and response, encourage the adoption of resilient infrastructure designs that can withstand and adapt to flooding, promote community-based initiative for flood preparedness, and as well as to conduct public awareness campaign to educate individuals about the importance of minimizing the impact of floods on the environment and ecosystem.

Keywords: Floods; Environment; Natural Ecosystem; Development Strategies; Ibaji LGA; Kogi State

1 INTRODUCTION

A flood is described as an accumulation of water that covers typically dry ground. Floods are the most common natural disasters to hit nations, regardless of their degree of development. Floods are becoming a more serious threat on a global scale. Floods have a negative impact on both essential assets and way of life. Moreover, the relationship between flooding and food security grew to dominate worldwide environmental and socioeconomic debates.

The most significant and lethal natural disasters that cause fatalities on a global scale are floods. According to Doocy et al. (2013), there is a sizable chance that a flood may result in catastrophic losses, because of unmanaged deforestation and unapproved human activities close to lake, river, and coastal environments. The effect of floods on the human population is assessed using fatality rates, injury rates, displaced populations, malnutrition, and other material losses (Pingali, 2005). Also, once a sizable amount of time has gone since a flood occurrence, there may be an increase in infectious illness mortality. Several tightly entwined, complex factors and circumstances contribute to flooding.

The environment and humans are two of these. When it comes to weather, human factors such as structural and infrastructural failures of levees and dams, modification of the landscape that negatively prevents run-offs with waterproof surfaces, as well as subpar drain structures, outweigh natural phenomena such as torrential rain, strong hurricanes, and whirlwinds. Researchers have cautioned that areas with high water levels are more vulnerable to storms and other severe weather that produce strong winds. Oceans have risen as a result of climate change, along with intense monsoons and devastating storms. People's lives and property are now at risk from flooding due to the population's fast rise as well as changes in agricultural and other land-use patterns. The negative effects of a flood include death and incapacitation, indirect extensive drowned cropland, and loss of priceless infrastructure. Human and geophysical factors are both responsible for floods. Geo-physical characteristics of river-bed zones make them more vulnerable to flood disaster than people living in the hinterland. In the past three decades, billions of people have direct or indirectly suffered floods with several million rendered homeless, thousands of deaths and injuries, as well as the enormous victims that remained undocumented (UNISDR, 2015).

As a result, recent studies have revealed that flooding is a persistent issue in most of Nigeria. Nigeria is home to a variety of climate zones, from the tropical maritime climate that is unique to the rainforest, coastal regions, and other southern geographical zones to the Sahel and tropical hinterlands in the northern parts of the country. Due to prolonged periods of heavy rain, many Nigerian villages, farming communities, cities, and towns have at some point faced a flood calamity. The most recent national flood disaster occurred in Kogi State in September 2017.

This study will add to the body of knowledge by investigating the impact of floods on the environment and natural ecosystem as well as to develop some strategies in order to minimize the impacts in Ibaji Local Government Area of Kogi State.

1.1 Statement of the Problem

Natural catastrophes like the flood that hit Ibaji Local Government. Several interventions have been drawn to these problems as part of risk mitigation initiatives. Investigations on the effects of the floods on the environment, the natural ecosystem, and any minimum strategic effects are anticipated.

Due to the massive influx of people from rural to urban regions and the fact that many of these urban areas are located close to fault lines and coastlines, the population worldwide is now at risk (Intergovernmental Panel on Climate Change IPCC, 2007). According to Adeagbo et al. (2016), windstorms and floods frequently occur in Nigeria. In October 2012, floods in 14 States of Nigeria, including Kogi, wreaked havoc. More than 500,000 people were displaced in Kogi State alone, and the flood devastated nine out of the state's 21 local government areas. Lokoja and Ibaji Local Government Areas were included. The worst hit was Ibaji which was completely submerged (National Emergency Management Agency NEMA, 2012).

As a result, the floods didn't just threaten food storage; several hectares of farmland were also submerged. Particularly when the impacted towns' preparedness and response were weak and subpar, the secondary consequences lasted far longer. In fact, until November 2012, waters were still present in houses and fields in Niger Delta villages (NEMA Report, 2012).

1.2 Objectives of the Study

The objectives of the study are to:

- identify the impact of floods on the environment and natural ecosystem in the Ibaji Local Government Area.
- identify how floods affect the ecosystem in the Ibaji Local Government Area.
- states the strategic ways of minimizing the impact of flood.

1.3 Research Question

- What is the impact of floods on the environment and natural ecosystem in the Ibaji Local Government Area?
- How do floods affect the ecosystem in the Ibaji Local Government Area?
- What are the strategies of minimizing the impact of flood?

1.4 Significance of the Study

The research will give a clear insight into the impact and development strategies for minimizing the flooding in Ibaji Local Government Area. The research will help to identify the impact on the environment and the natural ecosystem are prone to flood. It will also help to know the ways to mitigate the effect of flooding.

1.5 Scope of the Study

In order to establish the strategies for limiting their impact in the Ibaji Local Government Area of Kogi State, the study's spatial focus is on floods. It also links floods to their impact on the environment and natural ecosystems.

The respondents' responses on examining the effects of floods on the environment and the natural ecosystem, how the floods affect the ecosystem, and ultimately, the strategically sound approaches to minimize the damage are all included in the content scope. Respondents will be questioned about both their past and present experiences prior to the flood.

1.6 Study Area

The Ibaji Local Government Area (LGA) lies in Kogi state's southern region. There are approximately 1,377 square kilometers of land in the region. It is located between the equator's 06°52'00"N and 06°87'00"N latitudes and the Greenwich meridian's 06°48'00"E and 06°80'00"E longitudes (Kosema, 2007). The tropical climate of the Ibaji LGA has two seasons: the wet season and the dry season. The dry season begins in November and lasts until March, whereas the wet season begins in April and lasts until October. The soils are characterized by a sandy texture overlying a weakly structured clay accumulation (Atoyebi, 2013). The flood plains (of the Rivers Niger and Benue valleys) in Ibaji are made up of hydromorphic soils that contain mixture of coarse alluvial and colluvial deposits (Oriola, 1994).

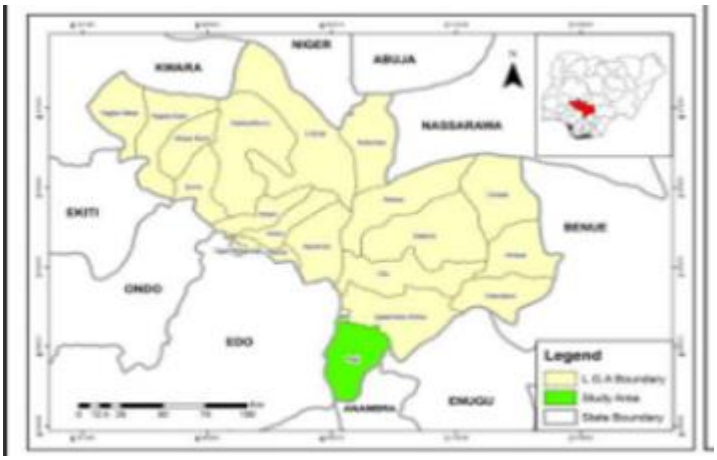
1.7 Operational Definition of Terms

- ***Flood:*** Mathur, et al (2010) defined flood as a rising and overflowing of a water body onto a normally dryland. It is an overflow of an expanse of water that submerges land which is normally not submerged. It usually occurs when volume of water exceeds in a water body, such as river, or lake, and results in water flow. The occurrence (which) takes places in the aftermath of meteorological events.
- ***Impact of Floods:*** The adverse effects of flooding include: Loss of human life. Property and infrastructure damage. Road closures, erosion, and landslide risks.
- ***Environment:*** According to a Goudie "environment is the representative of physical components of the earth where man is an important factor affecting the environment. Douglas and Holland: 'The term environment is used to describe, in the aggregate, all the external forces, influences and conditions, which affect the life, nature, behaviour and the growth, development and maturity of living organisms.'
- ***Natural Ecosystem:*** A natural ecosystem is a community of living and non-living entities and occurs freely in nature. Every component interacts together as a combined unit through physical, chemical and biological processes. The discriminating factor of natural ecosystems from other ecosystems is that they are completely natural.
- ***Developing Strategies:*** is the process of researching and identifying strategic options, selecting the most promising and deciding how resources will be allocated across the organisation to achieve objectives.
- ***Investigation:*** An investigation is a systematic, minute, and thorough attempt to learn the facts about something complex or hidden; it is often formal and official.

2 REVIEW OF RELATED LITERATURE

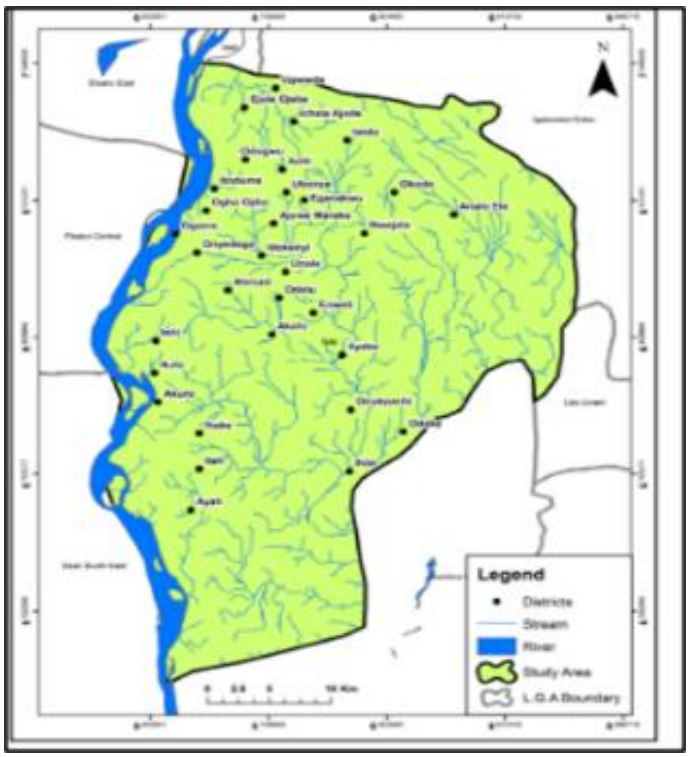
2.1 Introduction

This section gave the conceptual framework and pertinent material that served as the study's direction. Floods are one of the most frequent natural disasters that affect the world (UN-Habitat, 2003). The idea of a flood raises complex issues. This is due to the possibility that flooding could be both natural and artificial, given that it is possible for human activity on streams to create floods. Yet, experts on floods claim that the phenomena kills more than 20,000 people every year and adversely affects over 75 million people worldwide (Smith, 1996; UN-Habitat, 2003).



Source: Ministry of Environment Kogi State

Figure 1: Map of Kogi State showing Ibaji LGA



Source: Ministry of Environment Kogi State

Figure 2: Map showing Drainage Pattern in Ibaji

According to Sordlin's argument from 2007, flooding is characterized by the buildup of enormous amounts of water in an area without flow. Although it is referred to as a flood in the literature, flooding is frequently used instead. The former is a noun that later serves as a verb, yet both refer to the same thing. As a result, flooding is a type of natural disaster whose occurrence is linked to the natural world through its pattern, which is also influenced by human behavior. Height, peak overflow, areas submerged, and amount of flow are characteristics of floods. The aforementioned traits are crucial for choosing the best use of land, designing and building bridges, building dams, predicting flood events, and managing and controlling floods.

Flooding is a frequent environmental risk and a major global contributor to natural catastrophe fatalities and economic losses (Smith, 2013; Miller, Muir-Wood, & Boissonnade, 2008; Jonkman, 2005; Kousky, 2014). According to estimates, floods killed 6.8 million people in the 20th century and more than 500,000 people between 1980 and 2009. (Kousky, 2014; Doocy et al., 2013). The frequency and financial damages associated with flooding occurrences have likewise steadily increased over the past few decades (Tanoue, Hirabayashi, & Ikeuchi, 2016; Do, Westra, & Leonard, 2017). This begs the question of what causes the changes in flood impacts, with potential reasons including growth in the exogenous flood hazard (such as excessive precipitation or high streamflow events) or greater exposure of populations and assets to flood dangers (IPCC, 2012; Do, Westra, & Leonard, 2017).

By examining the variables that affect national or regional disaster losses, as measured by either fatalities or monetary losses, a growing body of research has examined adaptation to natural disasters (e.g., Kahn, 2005; Toya & Skidmore, 2007; Rashky, 2008; Anbarci, Escaleras, & Register, 2005; Fankhauser & McDermott, 2014; Keefer, Neumayer, & Plumper, 2011; Schumacher & Strobl, 2011; Hsiang and Narita; 2012). The fundamental theory is that populations with higher degrees of exposure to natural hazards would probably spend more in risk mitigation measures (as a rational choice), making them better suited to the danger than other populations with lesser exposure.

Flood types are categorized depending on their nature since floods can be classified based on the causal agents. River flooding is the term used to describe when rivers overrun their banks. The issue of capacity affects every component of the emergency management system, both locally and nationally. The systemic level is concerned with creating an environment that allows people and organizations to function and should include the regulatory, general policy, accountability, and financial frameworks. The institutional level focuses on organizational performance and management capabilities generally and includes an organization with the responsibility for managing floods (Akanbi, 2015). Additionally, Olowu (2010) and Adedeji et al. (2012) emphasized that many Third World countries, particularly those in Africa, are more vulnerable to the violent effects of major disasters because of failing state infrastructures, a lack of appropriate legal and policy frameworks, and a lack of funding.

Although there was an early attempt to manage disasters in Nigeria through the establishment of the Police Fire Brigade, now known as the Federal Fire Services, in 1906, with a variety of roles ranging from fighting fires to protecting people's lives and property, as well as offering humanitarian aid in disaster situations, disaster or crisis management in Nigeria is still in its infancy (Adedeji et al., 2012). The National Emergency Management Agency (NEMA) was established in 1999 by Act 12 as amended by Act 50, with the duty of managing disasters throughout the nation (Adedeji et al., 2012). The organization has implemented initiatives to increase public awareness and decrease the effects of dangers on the nation through educating the populace.

2.2 Floods and the Causes of Floods

Flooding is a temporary condition of widespread submergence of dry lands from runoff of inland or tidal waters or from unusual and rapid accumulation of runoff (Jeb and Aggarwal, 2008). Flooding is characterized by the accumulation of excess water which rises to overflow land which is not normally inundated (Mukhopadhyay, 2010). Flood is defined as the flow of water above a channel's carrying capacity (Olajuyigbe et al., 2012).

Figure 3: 2022 Flood in Ibaji Community, Ibaji LGA, Kogi State.

Every year, floods are a serious tragedy that afflict many nations of the world, particularly in the majority of flood plain areas. Floods not only cause property destruction and put human and animal lives in danger, but they also have additional unintended consequences including the spread of illnesses like cholera and malaria. Flooding is frequently brought on by torrential rainfall over flat terrain, reservoir failure, volcanic eruptions, melting snow and/or glaciers,

etc. Flood risk is dependent on a number of variables, including rainfall, riverflow and tidal-surge data, terrain, flood control systems, and changes brought on by building on flood plains.

Several causes contribute to flooding, which is always preceded by a lot of rain. Other factors that contribute to flooding include strong winds over water, unusually high tides, tsunamis brought on by undersea earthquakes, and cracks or failures in levees, dams, retention ponds or lakes, and other water-retention infrastructure. Impervious surfaces, as well as other natural and man-made hazards that obliterate soil and vegetation that might soak up rain, can exacerbate flooding. Although flooding is a natural occurrence, alterations to the soil caused by humans may also have a role. Flooding is not caused by development, but it can get worse. Pavement and rooftops in cities and suburbs prevent some rain from reaching the soil. Consequently, the volume of runoff into low-lying areas or the storm drainage system may increase.

When the land, stream courses, and artificial reservoirs are unable to absorb or contain all the water, floods happen. A flash flood is a quick flood that happens with little or no warning and is caused by heavy rain over a very small region. Flash floods are unavoidable consequences of the natural rainfall runoff process. It is a natural phenomenon and its magnitude is periodic. The periodicity of flood implies that every year some area surrounding the river (on both sides) is flooded.

The management of flood disasters, like the management of other disasters, can be divided into three stages: the preparedness stage, where activities like prediction, rusk zone identification, or vulnerable mapping are undertaken long before the event occurs; the prevention stage, where activities like forecasting early warning, monitoring, and preparation of contingency plans are made before or during the event; and the response and mitigation stage, where activities are carried out after the event (Van Western et al., 1993).

Figure 4: 2022 Floods in Ibaji LGA, Kogi State.

Adetunji & Oyeleye (2013) quoting Kates (1985), similarly defined floods as an overflow of an expanse of water that submerges land. Flooding happens when rivers, streams, ponds, and dams overflow their natural banks and engulf floodplains as well as places that extend outside of them. Inundation of land by water causes floods, which are often transient in nature but may recur because many places and regions experience periodic and even annual flooding (the Niger Delta Region, for example). Floodplains, low-lying areas, coastal regions, and other places like cities where human activities amplify flooding occurrences are the locations most at risk from flooding.

According to Professor Daniel Oladele Adefolalu (2013), necessary conditions for floods to occur include the following:

- Where infiltration rate is equal to zero. The soil is said to be at field capacity or saturated and any run-off could constitute a hazard.
- Intensity of rainfall, where heavy rainfall occurs within a short duration of time.
- Where water stored in dams or reservoirs is released at the wrong time. For example, excess water from the Ladgo Dam in Cameroon was released in 2012 which caused severe flooding in many parts of northwestern Nigeria.

2.2.1 Causes of Flood

When there is regularly heavy rainfall, natural forces are the main cause of floods. Floods typically occur in Nigeria between the months of July and October when the rains are at their heaviest due to the country's two catastrophic weather systems. Floods can also be caused by anthropogenic factors (human-induced activities). Flooding occurs downstream when rivers are dammed and surplus water is released, as occurs, for instance, at the Ladgo Dam in Cameroon or the Oyan Dam in Ogun. People (mainly the poor) are increasingly living on floodplains and in other flood-prone locations as a result of growing urbanization, especially in developing nations. This makes them extremely vulnerable to the consequences of floods. The main source of floods in urban areas is other human activities like building along (and across) drainage systems and drainage channel blockage due to careless trash disposal. Aderogba (2012), Adetunji & Oyeleye (2013), Ojeh & Ugboma (2013), Olajiyigbe et al (2012), and other empirical research attest to the influence of man on flooding.

Olajiyegbe, et al (2012) quoting Odemerho (2004) and Nwafor (2006) have noted that floods are worse in third world cities with the prevalence of unplanned and uncoordinated development. Odemerho (2004) also identified three factors accentuating flood problems in Benin City viz: land and physical development problems; gaps in basic hydrological data; design and implementation problems and cultural factors. We shall return to this later when we examine the impacts of flood in human settlements.

Floods in coastal locations can also be caused by ocean surges when there are strong winds and big waves in the vicinity. The main sources of floods in coastal areas include tropical weather systems including typhoons, cyclones, and tsunamis caused by earthquakes or volcanic eruptions in high seas.

2.3 Floods Impact on Natural Ecosystem

An ecosystem naturally occurs when species living there interact with their surroundings. It occurs naturally in the world and doesn't need human intervention to work. Natural ecosystems contain things like ponds, forests, and rivers. Floods happen when low-lying, normally dry areas temporarily become submerged with water outside of their regular boundaries (Rojas et al. 2013). Flooding makes up about one-third of all natural catastrophes and is the sort that affects the most people (Sivakumar 2011). Flood-related impacts are expected to worsen due to global environmental change with flood risk increasing by 187% from increasing temperature in the HadCM3 climate model (Arnell and Gosling 2016). Flood magnitude is also expected to increase due to intensified water cycling resulting from as little as a 1.5°C global average temperature increase (Alfieri et al. 2017). However, all floods are not created equal and the causes and consequences of individual floods are often unique. Floods can occur randomly as a result of a number of different factors, including ice jams, storm surges, and excessive precipitation, or they can be seasonal, as in the case of spring snowmelt or monsoon rains. Heavy precipitation accounts for about 65% of river floods (Douben 2006), but northern latitude areas with snow cover are also vulnerable to flooding caused by snowmelt and sometimes exacerbated by rain events (Kundzewicz et al. 2014). Flood events have been further characterized based on magnitude, frequency, duration, and volume (Burn and Whitfield 2016). The effects of floods on both natural ecosystems and the people who benefit from them can be predicted in part by these features. For instance, flood intensity can impact how much groundwater recharges or how much infrastructure and homes are damaged by flooding. Predicting flood impacts on natural ecosystems and ecosystem services involves many factors in addition to flood volume.

Prior ecosystem circumstances may be just as important as flood characteristics in deciding how an ecosystem will react to a flood occurrence. Floods are necessary for rivers to produce a special habitat, enhance biological productivity, and promote biodiversity. The Flood Pulse Concept states that predictable seasonal floods are beneficial for riverine systems and can influence biotic composition, nutrient transport, and sediment distribution but unpredictable floods may be disruptive for natural organisms (Junk et al. 1989). Additionally, many natural ecosystems have reduced resilience to future extreme events such as flooding due to human activities that include urban development and farming on floodplains, river flow disruptions, and pollution (Woodward et al. 2016). These activities increase the likelihood that floods become catastrophic events especially from the perspective of “benefits” obtained from ecosystems. The specific effects of flooding on natural ecosystems and their services are not well understood, but the importance of flooding for maintaining ecological functions in rivers has been recognized (Peters et al. 2016). Most of the research on flooding takes advantage of fortuitous events and thus often lacks pre-flood reference data (Poff and Zimmerman 2010). This relatively sparse evidence on how flooding and changes in hydrology impact natural ecosystems drives a large amount of environmental flow management (Acreman et al. 2014) and flood-related research.

Our understanding of the effects of flooding on natural ecosystems and how future changes in flood size may affect the accessibility of natural ecosystem services can be improved by using an ecosystem service approach. People have taken advantage of various ecosystem services for over 10,000 years (Fisher et al. 2008), making them integral to society. In fact, the estimated global value of all ecosystem services in 2011 was $125 trillion/year (Costanza et al. 2014). There are many studies that evaluate the effects of disturbances on ecosystem services, but most of these studies focus on terrestrial systems and there are few that look at natural ecosystem services (Grizzetti et al. 2016).

The ecosystem services provide a comprehensive assessment of the ecosystem's reaction to floods by representing a range of service kinds (such as provisioning, sustaining, cultural, and regulating) from the Millennium Ecosystem Assessment framework (MA 2005). In order to differentiate between common (typically seasonal) flooding and uncommon extreme storms that may have a different impact on natural ecosystems, we also examined the effects of minor versus extreme magnitude floods on each of the 10 ecosystem services. In contrast to massive floods, which we predicted would have greater detrimental effects on ecosystem services, we projected that small floods would improve the providing of ecosystem services.

In the end, our research can help develop efficient flood protection techniques that can lessen the negative effects of floods while maintaining natural ecosystem services. Decision-makers can better manage variable flows, including small and sporadic extreme floods, by taking into account the relevance of small vs extreme floods for ecosystem services. Managing ecosystem services may benefit both people and natural ecosystems because ecosystem services are produced from healthy ecosystems.

2.4 Strategies for Minimizing the Impact of flood

Public and private actions impacting floodplains must explicitly take the risks to life and property into account at a time when the country is particularly conscious of allocating limited resources among conflicting economic, environmental, and social needs. The technical, financial, and legal capacity of all parties impacted to carry out their duties must be taken into consideration while evaluating proposed solutions to flood hazard situations.

To lessen the risks that flooding poses to life and property, three fundamental measures can be used either separately or in tandem. These are:

2.4.1 Modify the Susceptibility to Flood Damage and Disruption

Actions to prevent risky, wasteful, unpleasant, or foolish use of the floodplain are part of the strategy to reduce vulnerability to flood damage and disruption. The non-federal sector is primarily responsible for carrying out such initiatives. These measures include limitations on the way and time of day and/or season of occupancy, the ways and means of access, the pattern, density, and elevation of structures, and the character of their materials (structural strength, absorptiveness, solubility, and corrodibility). They also include restrictions on the type of buildings and their contents, as well as the ancillary facilities and landscaping of the grounds. Changes to the interdependencies between floodplains and the nearby, non-flooding areas may also be required by the plan, particularly in the interdependencies involving utilities and trade. Land use restrictions, development and redevelopment strategies, floodproofing, disaster preparedness and response plans, and flood forecasting and warning systems are some of the implementation "tools" for these efforts. Although they are covered later in the "Modify Flooding" method, land management measures can also reduce a region's susceptibility to flood damage. For established or undeveloped floodplains, whether for more urban or rural locations, different tools may be more appropriate.

2.4.2 Modify the Adverse Impacts of Floods on The Individual and the Community

A second strategy for mitigating flood losses consists of actions designed to assist individuals and communities in their preparatory, survival, and recovery responses to floods. Tools include dissemination of information and education, arrangements for spreading the costs of the loss over time, and purposeful transfer of some of the individual’s loss to the community. The distinction between a reasonable and unreasonable transfer of costs from the individual to the community, as described under the preceding section on regulations, is a key element.

2.4.3 Modify Floods

The traditional strategy of modifying floods relies upon the construction of dams, dikes, levees, floodwalls; channel alterations; high-flow diversions and spillways; and land treatment measures. These tools permit changes in the volume of runoff; in the peak stage of the flood; in the time of rise and duration; in the extent of the area flooded; in the velocity and depth of floodwaters; and consequently in the amount of debris, sediment, and pollutants that floods carry. While the effectiveness of these tools in protecting property and saving lives has been demonstrated repeatedly, sole reliance upon a flood modification strategy is neither practical nor desirable.

Flood modification (structural) measures acting alone leave a residual flood loss potential within the remaining floodplain and add the risk of rare but potentially devastating damages from structural failure or from uncontrolled flows of major storms. Unless accompanied by appropriate nonstructural measures, the structural measures could lead to a false sense of security and encourage floodplain landowners to develop inappropriate uses of their lands. For this reason, some form of land use regulations and other appropriate nonstructural measures should accompany the implementation of structural measures.

To accomplish the intended management objectives, some combination of strategies and instruments is needed in practically every community. Although public and private decision makers may be guided by these floodplain management tactics and related technologies, there is a precondition and perhaps less visible challenge: recognizing the area's overall needs and goals. Making assumptions about how the area and region will grow in the future and being sensitive to effects that go beyond the immediate results of an action are necessary to meet this issue. For instance, despite the fact that both reflect expenses that are passed on to the general public, flood-modifying operations in the past sometimes neglected to account for indirect social costs (like displacement) and lost environmental resources. In order to combat flood losses, there has been a trend in recent decades toward a greater dependence on nonstructural solutions and a lesser emphasis on structural measures. Nonetheless, it must be understood that no matter how well floodplain management plans are created, some possibility for flood loss still exists.

3 METHODOLOGY

3.1 Research Design

The research employs a mixed-method approach of data collection through in-depth interview and survey methods. These methods are selected because it will provide a better and deeper understanding, by providing a fuller picture that can enhance description and understanding of the phenomena.

3.2 Population of the Study

The population development of Ibaji as well as related information and services.

Table 1: Population Size

Name	Status	Population Projection 2022-03-21		
Ibaji	Local Government	171,900		
Ibaji				
Population (2022) – Project: 171,900 Area: 1,373 km^2 Population Density (2022): 125.2/km^2 Annual Population Change (2006-2022): 1.9%				
Nigeria	Federal Republic	88,992,220	140,431,790	216,783,400

Source: 2022 - National Population Commission of Nigeria (web), National Bureau of Statistics (web).

The population projection assumes the same rate of growth within the local government area. All population figures for Nigeria show high error rates; census results are disputed. Area figures are computed using geospatial data.

3.3 Sample and Sampling Techniques

The research employed purposive sampling technique, key informant interview (KII) and Focus Group Discussion (FGD) which will be an open- ended questionnaire with Stakeholders, Ministry of Water Resources and indeed some CSOs and INGOs in the local government area.

3.3.1 Sample Size

To determine the sample size, the study used the Krejcie and Morgan formula as expressed:

$$n = \frac{x^2 NP(1-P)}{e^2(N-1) + x^2 P(1-P)}$$

Where: 1 = small sample techniques

n = required sample size
X^2 = the table of value of chi-square for 1 degree of freedom at 95% level of confidence= 3.841
N= Population Size = 171,900
P = the population proportion (assumed to be 50 since this would provide the maximum sample size) 50/100= 0.5
e = margin of error at 95% level of confidence is 0.05

$$n = \frac{3.841 \times 171{,}900 \times 0.5(1-0.5)}{0.05^2(171{,}900-1) + 3.481 \times 3.481 \times 0.5(1-0.5)}$$

$$n = \frac{3.841 \times 171{,}900 \times 0.5 \times 0.5}{0.0025 \times 171{,}899 + 12.117361 \times 0.5 \times 0.5}$$

$$n = \frac{4933764.5}{429.7475 + 3.02934025}$$

$$n = \frac{4933764.5}{432.77684025}$$

$$n = 11400.25075544694$$

$$n = 11400\ (Approximately)$$

$$n = 11400$$

3.4 Research Instruments

The research instruments are interview transcript, phone recorder, questionnaire, notebook and pen for note taking, laptop to store data obtained.

- *Objective 1: Identify the impact of floods on the environment and natural ecosystem in the Ibaji Local Government Area.* This will be achieved through direct interviews with some stakeholders.
- *Objective 2: Identify how floods affect ecosystems in the Ibaji Local Government Area.* This will be followed by a direct interview with the communities.
- *Objective 3: States the strategic ways of minimizing the impact of flood.* This was obtained from field observation and questionnaires at the wards.

3.5 Procedure for Data Collection

Data will be collected using both qualitative and quantitative methods. The procedure will be in accordance with the research objectives.

3.6 Method Analysis

In accordance with the study's objectives, transcribed information from the interviews and discussions was acquired, compiled, and organized into themes. After that, the results of the questionnaire were subjected to straightforward statistical techniques, such as tables and bar charts, before being content-analyzed and thematically interpreted in narrative and descriptive styles. Simple percentages, frequency tables, and charts were used to analyze data gathered through questionnaires. The purpose of the questionnaire-based data obtained for this study is to confirm or deny claims made during focus group discussions and interviews.

4 RESULT

This chapter presents the result of investigating the impact of floods on the environment and natural ecosystems and developing strategies for minimizing this impact in Ibaji LGA of Kogi State.

4.1 Socio-Economic and Demographic Data of the Respondents

This section discusses the result of the respondents by their age ranges, gender, the highest level of school attended and their occupation shown in the table below respectively.

Table 2 Distribution of the Respondents by Age, Marital Status, Highest level of School Attended and the Types of Occupation

		Frequency n = 200	Percentage (%)
Age	20 – 30 years	47	23.5
	31 – 40 years	78	39.0
	41 – 50 years	62	31.0
	51 and above	13	6.5
Gender	Female	58	29.0
	Male	142	71.0
Highest Level of School Attended	Non-Formal Education	13	6.5
	Primary Education	30	15.0
	Secondary Education	45	22.5
	Tertiary Education	112	56.0
Types of Occupation	Civil Servant	42	21.0
	Farmer	56	28.0
	Private Sector Employee	21	10.5
	Trader	53	26.5
	Unemployed	28	14.09

Table. 4.2.1: reveals the socio-economic and demographic data of the respondents;***Source:*** *Fieldwork 2023*

The major age range of the respondents participating were 39% which ranged 31-40 of age range. 23.5% of the other respondent's age range are 20-31 years, 31% range 41-50 and 6.5% range 51 and above years of age. The age group of the respondents used in this study is 20 years and above, this is because the age bracket is considered in demographic studies to be reasonable to answer questions based on their experience with day-to-day flood impacts.

Of the genders of the respondents 29.0% were female respondents, while 71.0% of the other respondents were male. This shows that male respondents participated more than the female respondents in the study area.

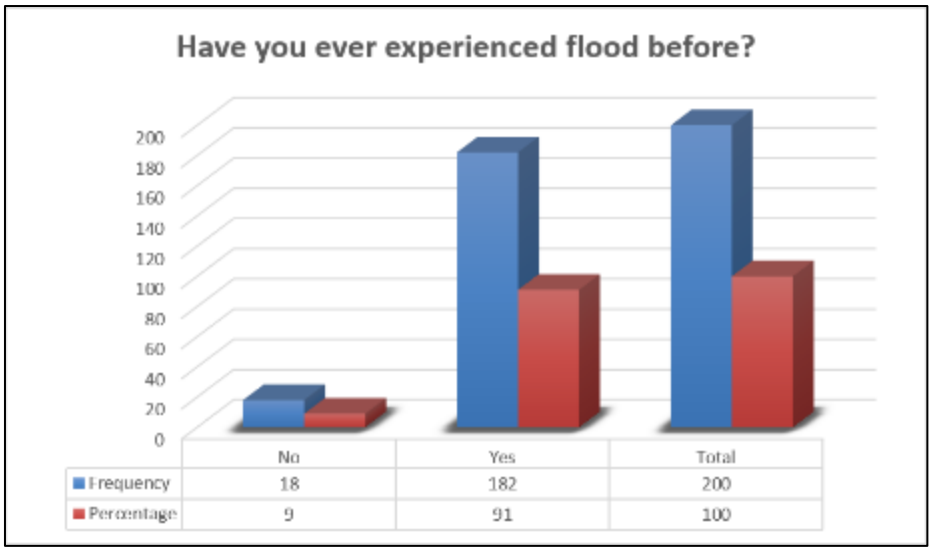
It reveals that most of the sampled respondents in the study area (Ibaji Local Government Area of Kogi State) 56.0% have attained tertiary education. This is closely followed by those that have attained secondary education with 22.5%, primary education with 15.0% and non-formal education 6.5% respectively. A significantly high proportion of respondents have acquired tertiary education, secondary education. It is expected that educated persons will have better and improved knowledge of the impact of floods on the environmental and natural ecosystems and development strategies for minimizing the impact. Education is critical to the future of the individual beneficiary and the society (Country) concerned. The results show that the respondents in the study area are educated.

In Ibaji local government area of Kogi state 21.0% are civil servants, some are farmers with 28.0%, 10.5% engaged in private sector employees, while 26.5% engaged in trading (traders), and 14.0% of the other respondents are unemployed respectively.

One of the most widely used indices of socio-economic status in the demographic analysis is occupational level, as it is expected to play a significant role in the research. Occupation is a regular activity performed for payment that occupies one's time. It can be referred to as the activity to which one regularly devotes oneself, especially one's regular work, or means of getting a living. The results in the study area shows that the majority of the respondents are farmers.

4.2 The Impact of Floods on the Environment and Natural Ecosystem in the Ibaji Local Government Area

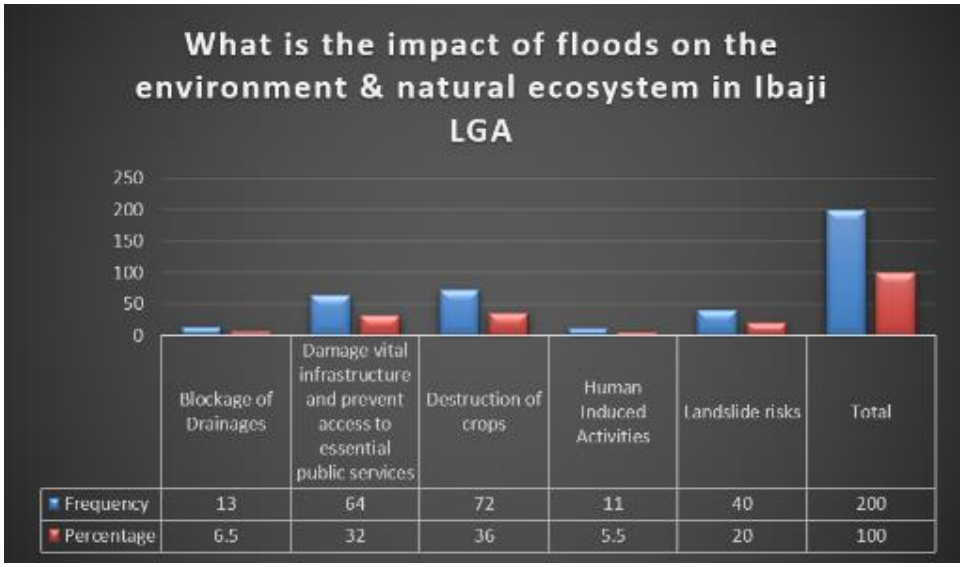
Based on the objectives of this research, one of the key finding is to identify the impact of floods on the environment and natural ecosystem in the study area i.e. Ibaji Local Government Area of Kogi State. However, the figures reveal the impacts in the study area as shown below.



Source: Fieldwork 2023

Figure 5: Have you ever experienced flooding before?

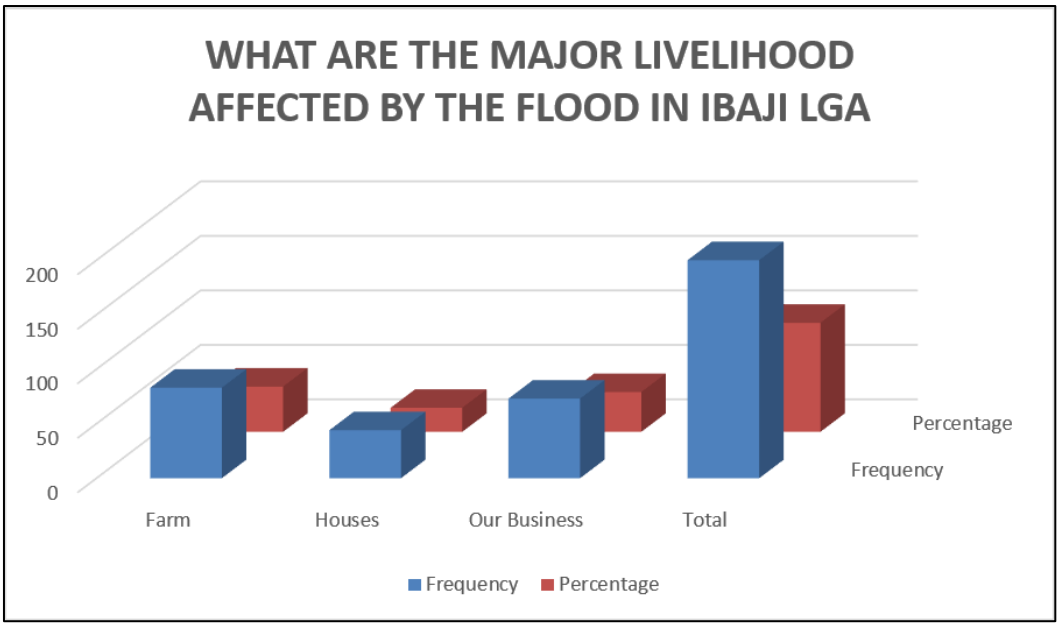
Fig. 4.1 shows if the respondents have ever experienced flood; according to 9.0% of the respondents there have never experienced flood before, while 91.0% of the other respondents says that they have experienced flood in their area. This showed from the result that the majority of the respondents in the study area have experienced flood according to 91.0% of the respondents. This results is in line with the finding of the Kogi State Emergency Management Agency (KOSEMA) (2007) who worked on the report on the flood disaster in Ibaji Local Government, Kogi State.



Source: Fieldwork 2023

Figure 6: What is the impact of floods on the environment and natural ecosystem in the Ibaji LGA?

According to the above fig. 4.1, the impact of floods on the environment and natural ecosystem in the study area are; blockage of drainages says 6.5% of the respondents, 32.0% of the other respondents says damage vital infrastructure and prevent access to essential public services, while 36.0% says that the impact resulted of destruction of crops, 5.5% claims human induced activities, and 20.0% of the respondents says its impacted landslide risks. This result shows that the major impact of floods on the environment and natural ecosystem in Ibaji local government area are destruction of crops and damage of vital infrastructure and prevent access to essential public services. This is the same with the finding of Adebayo, W.O & Jegeda, O.A, (2010) who works on the environmental impact of flooding in Benin City, Nigeria and also in line with the findings of Arnell NW & Gosling SN (2016) who worked on the impacts of climate change on river flood risk at the global scale.



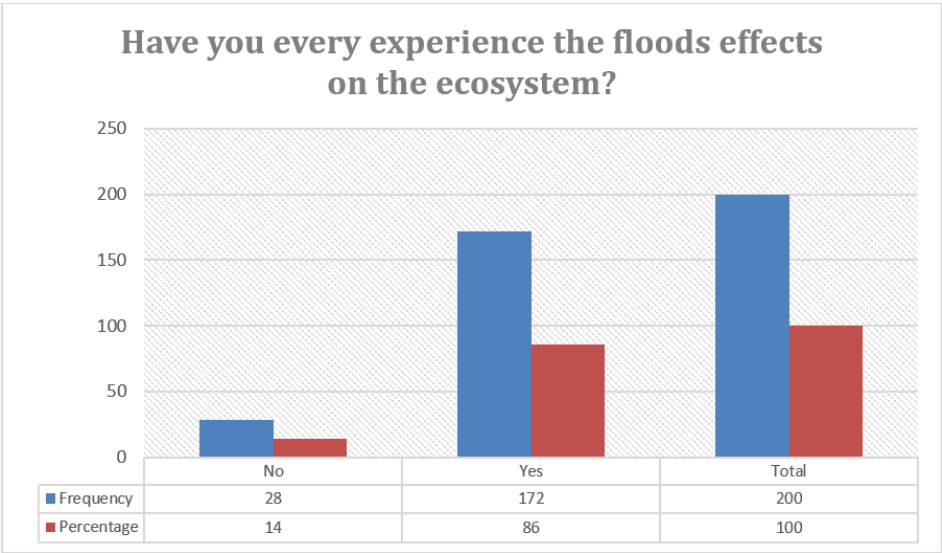
Source: Fieldwork 2023

Figure 7: What are the major livelihoods affected by the flood in Ibaji LGA?

According to the result in fig. 4.3 above the major livelihood that was affected by the flood in the study area are farms, says 41.5% respondents, while 22.0% of the other respondents responded that it is houses that are affected, and according 36.5% of the respondents the major livelihood affected according to their responses is their businesses. It clearly shows that the major livelihood affected by the flood in Ibaji local government area of Kogi state is farm (agricultural activities). This finding is in line with the findings of Kousky, C. (2014) that work on informing climate adaptation: A review of the economic costs of natural disasters.

4.3 How Floods Affect the Ecosystem in the Ibaji Local Government Area

Another key finding of this research is to identify how floods affect the ecosystem in the Ibaji Local Government Area of Kogi State. Below is the result and the discussion presented in the figures.

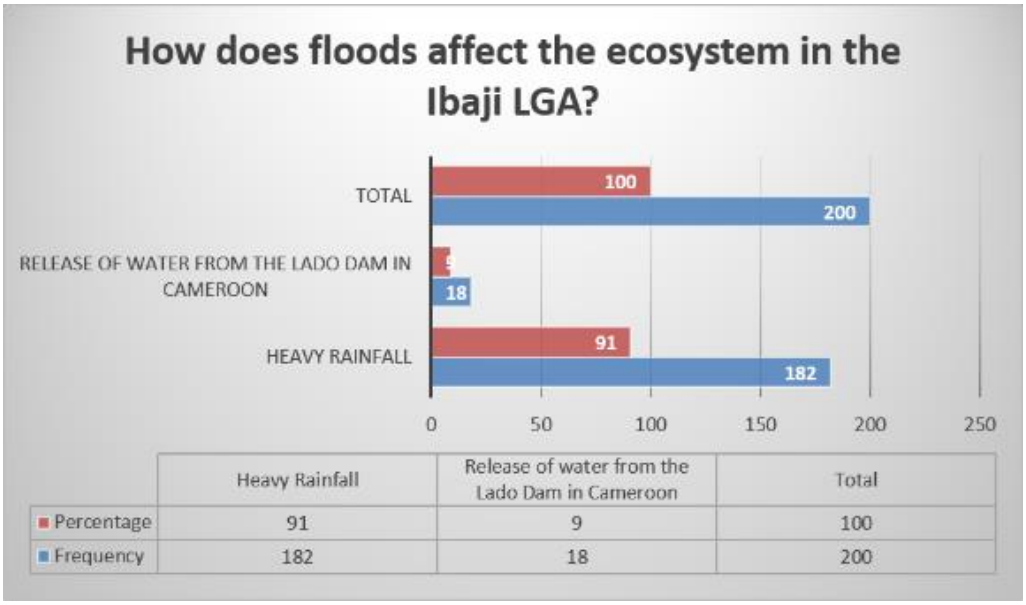


Source: Fieldwork 2023

Figure 8: Have you ever experienced the effects of floods on the ecosystem?

The above fig. 4.4 reveals the experience of the respondents on floods effects on the ecosystem in the study area; where 14.0% of the respondents responded "No" that they have never experienced the floods effects on the ecosystem, while 86.0% of the other respondents from the study area says that they have experienced the floods effects on the ecosystem. This reveals that the majority of the respondents in the study area have experienced the flood's effects on the ecosystem. This result is in line the findings of Grizzetti B, Lanzanova D, Liquete C, Reynaud A, Cardoso AC (2016) who worked on

assessing water ecosystem services for water resource management and also the findings of Doocy, S., Daniels, A., Murray, S., and Kirsch, T.D., (2013) who worked on the human impact of floods.



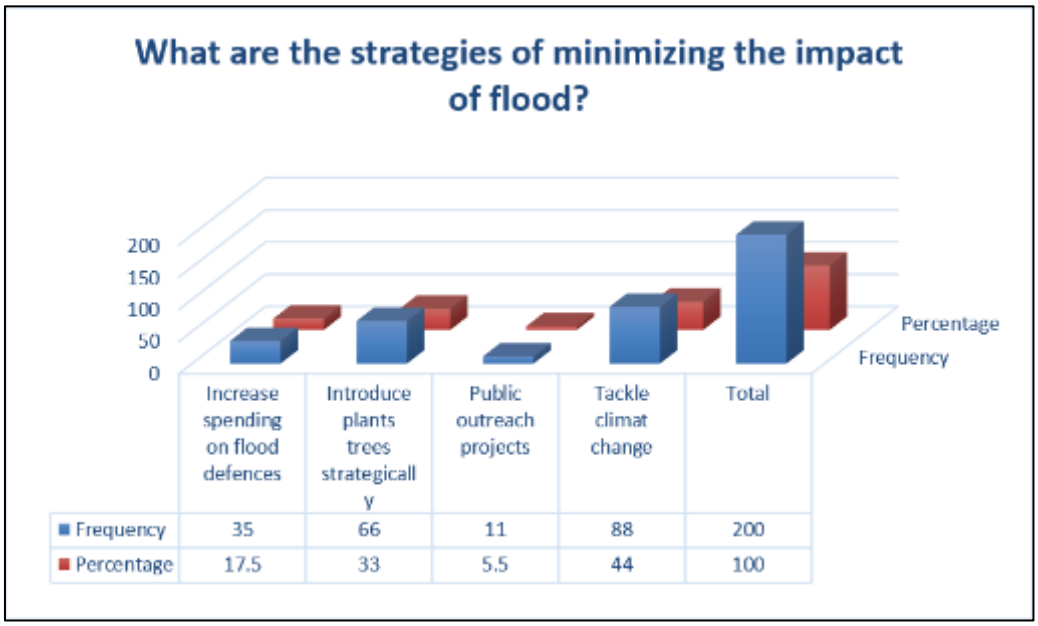
Source: Fieldwork 2023

Figure 9: How does floods affect the ecosystem in the Ibaji Local Government Area?

91.0% of the respondents responded that heavy rainfall is one of the floods that affect the ecosystem in the Ibaji local government area of Kogi state, and 9.0% of the other respondents claims that it's as the result of the release of water from the Lado Dam in Cameroon that affected the ecosystem in the local government area (Ibaji) of Kogi state. This result is the same with the findings of Millennium Ecosystem Assessment (2005) that works on the Millennium ecosystem assessment – Island Press, Washington, DC, and that of Grizzetti B, Lanzanova D, Liquete C, Reynaud A, Cardoso AC (2016) that worked on assessing water ecosystem services for water resource management.

4.4 Strategically Ways of Minimizing the Impact of Flood.

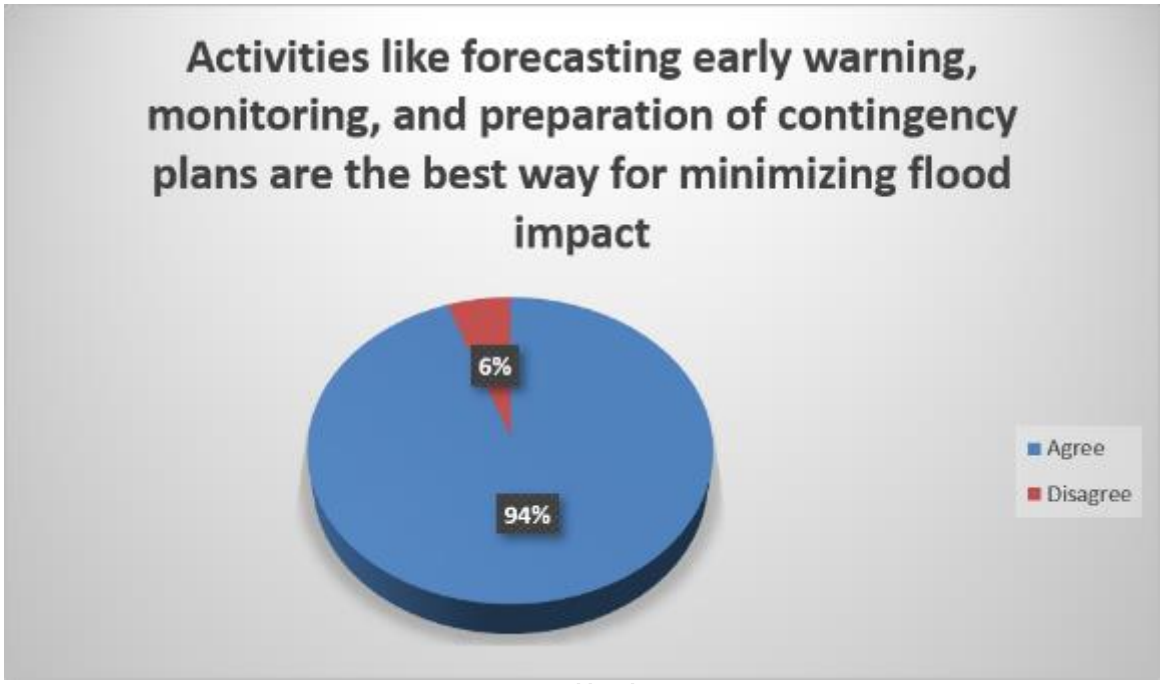
This section identifies the strategic ways of minimizing the impact of flood in the Ibaji Local Government Area of Kogi State. The result is being presented in the figures below.



Source: Fieldwork 2023

Figure 10: What are the strategies of minimizing the impact of flood?

Increase spending on flood defences according to 17.5% of the respondents is one of the best strategies for minimizing the impact of floods in the study area, 33.0% of the respondents responded that its by introducing plants trees strategically that can minimize the impact of the flood in the study area, while 5.5% of the other respondents claims that public outreach projects can help in minimizing the flood impact in the study area, and lastly, 44.0% of the respondents says that tackle climate change is the best strategies of minimizing the impact. The result concluded that tackling climate change is the major and best strategy to minimize the impact of flood in Ibaji local government area of Kogi state according to the majority of the respondents 44.0%. This result is the same as the finding of Oriola, E. O. (1994) who worked on the Strategies for combating urban flooding in a developing nation in Ondo, Nigeria.



Source: Fieldwork 2023

Figure 11: Activities like forecasting early warning, monitoring, and preparation of contingency plans are the best way for minimizing flood impact.

The fig. 4.7 above reveals that 94% of the respondents agreed that activities like forecasting early warning, monitoring, and preparation of contingency plans are the best way for minimizing flood impact in the study area, while 6% of the other respondents from the study area disagreed that activities like forecasting early warning, monitoring, and preparation of contingency plans are NOT the best way for minimizing the flood impact. The fig. clearly shows that forecasting early earning, monitoring, and preparation of contingency plans are the best way that can be adapted for minimizing the flood impact in the Ibaji local government area of Kogi state. This is in line with the findings of Oriola, E. O. (1994) who worked on the Strategies for combating urban flooding in a developing nation in Ondo, Nigeria.

5 DISCUSSION

Investigating the impact of floods on the environment and natural ecosystems and developing strategies for minimizing the impact in Ibaji local government area of Kogi state was conducted using field observation and questionnaires administered to study areas, with direct interview with the stakeholders.

The research has attempted to examine the socio-economic and demographic characteristics of the respondents, the impact of floods on the environment and natural ecosystem, how floods affect the ecosystem and to state the strategic ways of minimizing the impact of flood in the study area.

The demographic characteristics of the respondents revealed that the majority of the respondents are within the age group of 31-40 years, male, tertiary education holders and farmers in terms of occupation.

The analysis revealed the impact of floods on the environment and natural ecosystems in the study area which includes destruction of crops and damage to vital infrastructure and prevent access to essential public services, and also the major livelihood affected by the flood in the study area is farm (agricultural activities).

The analysis revealed that the respondents had experienced the flood effects on the ecosystem. It also revealed how floods affect the ecosystem in the study area which is as a result of heavy rainfall.

According to the analysis, the best strategic ways to minimize the impact of flood are by tackling climate change, forecasting early warning, monitoring, and preparation of contingency plans in the study area.

6 CONCLUSION

The study has instigated the impact of floods on the environment and natural ecosystems and developing strategies for minimizing the impact in Ibaji local government area of Kogi state , it was found that majority of the respondents are of middle age class, male, educated and farmers.

The study concluded that destruction of crops and damage to vital infrastructure and preventing access to essential public services are the impact of floods on the environment and natural ecosystem. How floods affect the ecosystem is through the heavy rainfall, and the strategic ways to minimize the impact of flood is through tackling climate change, forecasting early warning, monitoring, and preparation of contingency plans in the study area.

Recommendations

The following are the recommendation:

- The government should promote natural flood management techniques and enhance flood forecasting and warning systems to improve preparedness and response.
- Encourage the adoption of resilient infrastructure designs that can withstand and adapt to flooding.
- Promote community-based initiatives for flood preparedness, including early warning systems and evacuation plans.
- Conduct public awareness campaigns to educate individuals about the importance of minimizing the impact of floods on the environment and ecosystem.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

Acknowledgments

The author expresses profound gratitude to the Centre for Disaster Risk Management and Development Studies, University of Maiduguri.

REFERENCES

[1] Acreman M, Arthington AH, Colloff MJ, Couch C, Crossman ND, Dyer F, Overton I, Pollino CA, Stewardson MJ, Young W (2014*). Environmental flows for natural, hybrid, and novel riverine ecosystems in a changing world*. Front Ecol Environ 12:466–473.

[2] Adeagbo, A., Daramola, A., Carim-Sanni, A., Akujobi, C. and Ukpong, C. (2016). Effects of natural disasters on social and economic wellbeing: A study in Nigeria. *International Journal of Disaster Risk Reduction*, [online] 17, pp.1–12. Available at: https://www.sciencedirect.com/science/article/pii/S2212420915301370?casa_token=_-vTv6Bz5bYAAAAA:36cpigQU-R7U2_POsuvaJO3zJXhq2lUnlHgtJ0CP9mIguh0YQK6rGWIqid8HFZedOiWmELlcpQ#s0150 [Accessed 26 Mar. 2021].

[3] Adebayo, W.O & Jegeda, O.A, ((2010). The Environmental Impact of Flooding on Transportation Land Use in Benin City, Nigeria, *An International Multi-Disciplinary Journal, Ethiopia Vol. 4 (1), 390-400*. www.ajol.info

[4] Adedejil, 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 Land Management, Journal of Sustainable Development in Africa (Volume 14 (1),* 45-58.

[5] Aderogba, K.A. (2012), 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* Vol. 1 (3) 1-25.

[6] Adetunji, M., & Oyeleye, O. (2013, Evaluation of the causes and effects of floods in Apete, Ido LGA, Oyo State, Nigeria, *Civil and Environmental Research Vol 3(7), 19-* (www.iiste.org).

[7] Alfieri L, Bisselink B, Dottori F, Naumann G, Wyser K, Feyen L, de Roo A (2017) *Global projections of river flood risk in a warmer world.* Earth's Future 5:171–182.

[8] Anbarci, N., Escaleras, M., and Register C.A. (2005). Earthquake fatalities: *The interaction of nature and political economy.* Journal of Public Economics, 89, 1907-33.

[9] Arnell NW, Gosling SN (2016). The impacts of climate change on river flood risk at the global scale. *Climatic Change 134:387–401*

[10] Atoyebi, T.R. (2013). Frequency Analysis of Maximum Daily Rainfall for Selected Towns in North-Central Nigeria. *Hydrology and Water Resource,* 9(3), 45.

[11] Burn DH, Whitfield PH (2016) Changes in floods and flood regimes in Canada. *Can Water Resour* J 41:139–150

[12] Costanza R, de Groot R, Sutton P, van der Ploeg S, Anderson SJ, Kubiszewski I, Turner RK (2014) Changes in the global value of ecosystem services. *Glob Environ Change* 26:152–158.

[13] Daniels T. & Daniels, C. (2003), *The Environmental Planning Handbook for Sustainable Communities and Regions*, Planners Press, APA, Chicago, Illinois Washington DC. (see Chapter12 Planning for Natural Hazards and Natural Disasters, 257-276).

[14] Do, H.X., Westra, S. and Leonard, M., 2017. *A global-scale investigation of trends in annual maximum streamflow.* Journal of Hydrology, 552, pp. 28- 43.

[15] Doocy, S., Daniels, A., Murray, S., and Kirsch, T.D., (2013). The human impact of floods: *a historical review of events 1980-2009 and systematic review.* PLoS Curr. doi: 10.1371/currents.dis.f4deb457904936b07c09daa98ee8171a.

[16] Douben K (2006) Characteristics of river floods and flooding: *a global overview*, 1985–2003. Irrig Drain 55:S9–S21

[17] Fisher B, Turner RK, Morling P (2008). *Defining and classifying ecosystem services for decision making*. Ecol Econ 68:643–653.

[18] Grizzetti B, Lanzanova D, Liquete C, Reynaud A, Cardoso AC (2016) *Assessing water ecosystem services for water resource management*. Environ Sci Policy 61:194–203.

[19] https://training.fema.gov/hiedu/docs/fmc/chapter%207%20-%20flood%20damage%20reduction%20strategies%20and%20tools.pdf

[20] IPCC (2012). 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.

[21] IPCC. (2007). Climate Change 2007 - the physical science basis. *Contribution of Working Group I to the Fourth Assessment Report of IPCC.* Cambridge. UK. Cambridge University Press.

[22] Jeb, D. N., & Aggarwal, S. P. (2008). Flood inundation hazard modeling of the River Kaduna using remote sensing and geographic information systems. *Journal of Applied Sciences Research*, 4(12), 1822-1833.

[23] Junk WJ, Bayley PB, Sparks RE (1989). The flood pulse concept in river-floodplain systems. *Can Spec Publ Fish Aquat Sci* 106:110–127.

[24] Kahn, M. (2005). The death toll from natural disasters: The role of income, geography and institutions. *The Review of Economics and Statistics,* 87(2), 271-84.

[25] Kogi State Emergency Management Agency (KOSEMA) (2007). *Report on the Flood Disaster in Ibaji Local Government, Kogi State, Lokoja*: Office of the Secretary KOSEMA.

[26] Kousky, C. (2014). Informing climate adaptation: *A review of the economic costs of natural disasters.* Energy Economics, 46, 576-592.

[27] Kundzewicz ZW, Kanae S, Seneviratne SI, Handmer J, Nicholls N, Peduzzi P, Mechler R, Bouwer LM, Arnell N, Mach K, Muir-Wood R, Brakenridge GR, Kron W, Benito G, Honda Y, Takahashi K, Sherstyukov B (2014) *Flood risk and climate change*: global and regional perspectives. Hydrol Sci J 59:1–28.

[28] Mathur, S. K, Singh. K.K, Sharma, A. Chowdharry (2010). *Floods and their Management with Special Reference to India, in Natural Disasters.* (ed) by KK. Singh, A. Lotfi, W. Singh & M. Singh, A.P.H Publishing Corporation, New Delhi, 99-123,

[29] Millennium Ecosystem Assessment (2005). *Millennium ecosystem assessment. Ecosystems and human wellbeing:* a framework for assessment. Island Press, Washington, DC.

[30] Mukhopadhyay, S. (2010). A geo-environmental assessment of flood dynamics in lower Ajoy River inducing sand splay problem in Eastern India. *Ethiopian Journal of Environmental Studies and Management,* 3(2).

[31] National Population Commission of Nigeria (web), *National Bureau of Statistics* – (2022); (web).

[32] National Emergency Management Agency (NEMA) (2012). Flood: more than 25,000 displaced in Benue as many communities remain adamant, Accessed online on the 10th of December 2015 via *http://www.nema.gov.ng/emergency-zones/floods.aspx*

[33] Ojeh, V.N & Ugboma, (2012). *Flood hazards in Urban Niger Delta*: A Case Study of Abraka Town, International Journal of Environmental Engineering Research, Volume 1(1), 23-29.

[34] Olajiyigbe, A.E, Rotowa, O.O & Durojaye, E. (2012). *An Assessment of Flood Hazard in Nigeria:* The Case of Mile 12 Lagos, Mediterranean Journal of Social Sciences Vol. 3 (2), 367-375.

[35] Oriola, E. O. (1994). *Strategies for combating urban flooding in a developing nation:* A case study from Ondo, Nigeria. Environmentalist, 14(1), 57-62.

[36] Peters DL, Caissie D, Monk WA, Rood SB, St-Hilaire A (2016). *An ecological perspective on floods in Canada.* Can Water Resour J 41:292–310.

[37] Pingali, P., Alinovi, L., & Sutton, J. (2005). *Food Security in complex emergencies:* enhancing food system resilience. Disasters, Volume 29, June.

[38] Poff NL, Zimmerman JKH (2010). Ecological responses to altered flow regimes: *a literature review to inform the science and management of environmental flows.* Freshw Biol 55:194–205.

[39] Rashky, P. (2008). *Institutions and the losses from natural disasters.* Natural Hazards and Earth System Sciences, 8, 627-34.

[40] Sivakumar B (2011). *Global climate change and its impacts on water resources planning and management:* assessment and challenges. Stoch Environ Res Risk Assess 25:583–600.

[41] Smith, K. (2013). *Environmental Hazards Assessing Risks and Reducing Disasters, 6th Edition*. Routledge, New York, NY.

[42] Smith, S.K. and McCarty, C. (1996). Demographic Effects of Natural Disasters: A Case Study of Hurricane Andrew. Demography, [online] 33(2), p.265. *Available at:https://link.springer.com/article/10.2307/2061876* [Accessed 26 Mar. 2021].

[43] Tanoue, M., Hirabayashi, Y., and Ikeuchi, H., (2016). *Global-scale river flood vulnerability in the last 50 years.* Scientific Reports, 6, No. 36021.

[44] Toya, H., and Skidmore, M. (2007). *Economic development and the impact of natural disasters.* Economics Letters, 94, 20-25.

[45] UNISDR. (2015). *UN Secretary-General*: World threatened by dangerous & unacceptable levels.

[46] United Nation, UN (2003). *Guidelines on participatory planning and management for flood mitigation and preparedness, 9(129)*: ill., Water resources series, 0082-8130, No. 82, United Nations: New York.

[47] Van Western, C.J.I., Van Duren, H.M.G. Kruse and M.T.J. Terlien (1993). GIZZI: Training package for Geographic Information Systems in Slope Instability Zonation. *International Institute for Aerospace Survey and Earth Science (ITC),* 15(1): 245 pp. Enschede, The Netherlands.

[48] Woodward G, Bonada N, Brown LE, Death RG, Durance I, Gray C, Hladyz S, Ledger ME, Milner AM, Ormerod SJ, Thompson RM, Pawar S (2016). *The effects of climatic fluctuations and extreme events on running water ecosystems.* Philos Trans Royal Soc Lond B 371:20150274.

APPENDIX I

University of Maiduguri,

School of Postgraduate Studies,

Centre for Disaster Risk Management and Development Studies

18th May 2023

Dear Respondent,

QUESTIONNAIRE

The researcher is a M.Sc. student at the University of Maiduguri, Centre for Disaster Risk Management and Development Studies. The goal of this questionnaire is to gather data for his project on the "Impact of Floods on the Environment, Natural Ecosystem and Development Strategies for Minimizing this Impact in Ibaji LGA of Kogi State'.

Please do your best to respond to these questions. Your response will be handled as such and used only for academic research purposes in compliance with current privacy laws and informal consent ethics.

I appreciate your help and kindness very lot.

Yours Sincerely

INSTRUCTIONS

i. Tick the appropriate boxes where applicable.

ii. Leave out any questions where answers are not sure.

SECTION A: SOCIO-ECONOMIC AND DEMOGRAPHIC DATA

1. Age? (b) 20-30 [ ] (c) 31-40 [ ] (d) 41-50 [ ]
   (e) 51 and above [ ]

2. Gender? (a) Male [ ] (b) Female [ ]

3. Marital status? (a) Single [ ] (b) Married [ ] (c) Divorced [ ] (d) Widowed [ ]

4. What is the highest level of school you attended? (a) Tertiary [ ] (b) Secondary [ ]
   (c) Primary [ ] (d) None-Formal [ ]

5. Type of Occupation? (a) Civil Servant [ ] (b) Farmer [ ] (c) Trader [ ]
   (d) Unemployed [ ] (e) Private Sector Employee [ ]
   (f) Others ……..

SECTION B: THE IMPACT OF FLOODS ON THE ENVIRONMENT AND NATURAL ECOSYSTEM IN THE IBAJI LOCAL GOVERNMENT AREA.

6. Have you ever experienced flooding before? a. Yes b. No

7. Do floods affect the environment and natural ecosystem of Ibaji LGA? a. Yes b. No

8. If "Yes" what are the main impacts of the floods on Ibaji local government area of Kogi State? _____

9. What is the impact of floods on the environment and natural ecosystem in the Ibaji Local Government Area? a. Human induced activities b. Blockage of drainages c. Damage vital infrastructure and prevent access to essential public services d. Destruction of crops e. Landslide risks

10. How would you describe the severity of the impact on these elements? A. Mild b. Moderate c. Severe

11. Are there any specific examples or incidents that highlight the impact of floods on the environment and natural ecosystems in Ibaji LGA? a. Yes b. No

12. Does the floods affect the livelihood activities of the community in Ibaji LGA? a. Yes b. No

13. Does the flood effects especially affect agricultural activities in Ibaji LGA? a. Yes b. No

14. What are the major activities in the study area? a. Farming b. Trading

15. What are the major livelihoods affected by the flood in Ibaji LGA? _____

SECTION C: HOW FLOODS AFFECT THE ECOSYSTEM IN THE IBAJI LOCAL GOVERNMENT AREA.

16. Have you ever experienced the floods on the ecosystem? a. Yes b. No
17. How does floods affect the ecosystem in the Ibaji Local Government Area? a. Heavy rainfall b. Release of water from the Lado dam in Cameroon c. Other (Specify) _____
18. Are there positive ecological effects to controlling flooding? a. Yes b. No
19. The effects of floods are not always negative? a. Agree b. Disagree
20. Do floods cause sedimentation and erosion in Ibaji LGA? a. Yes b. No
21. Do floods carry contamination with pollutants such as agricultural pesticides and industrial chemicals? a. Yes b. No
22. An ecosystem naturally occurs when species living there interact with their surroundings. a. Agree b. Disagree
23. Floods happen when low-lying, normally dry areas temporarily become submerged with water outside of their regular boundaries. a. Yes b. No

SECTION D: STATES THE STRATEGICALLY WAYS OF MINIMIZING THE IMPACT OF FLOOD.

24. What are the strategies of minimizing the impact of flood? a. Tackle climate change b. Increase spending on flood defenses c. Introduce plants trees strategically d. Public outreach projects e. Other (specify) _____

25. Activities like forecasting early warning, monitoring, and preparation of contingency plans are the best way for minimizing flood impact. a. Agree b. Disagree

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APPENDIX II

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FREQUENCIES VARIABLES=ONE TWO THREE FOUR FIVE SIX SEVEN EIGHT NINE TEN ELEVEN TWELVE
  THIRTEEN FOURTEEN FIFTEEN SIXTEEN SEVENTEEN EIGHTEEN NINETEEN TWENTY TWENTYONE
  TWENTYTWO TWENTYTHREE TWENTYFOUR TWENTYFIVE

  /STATISTICS=SKEWNESS SESKEW

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Frequency

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		TWENTYONE TWENTYTWO
		TWENTYTHREE TWENTYFOUR
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	Missing	0	0

Frequency Table

ONE

	Frequency	Percent	Valid Percent	Cumulative percent
Valid 20-30	47	23.5	23.5	23.5
31-40	78	39.0	39.0	62.5
41-50	62	31.0	31.0	93.5
51 and above	13	6.5	6.5	100.0
Total	200	100.0	100.0	

TWO

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Female	58	29.0	29.0	29.0
Male	142	71.0	71.0	100.0

Total	200	100.0	100.0	

THREE

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Divorced	13	6.5	6.5	6.5
Married	98	49.0	49.0	55.5
Single	42	21.0	21.0	76.5
Widowed	47	23.5	23.5	100.0
Total	200	100.0	100.0	

FOUR

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Non-Formal	13	6.5	6.5	6.5
Primary	30	15.0	15.0	21.5
Secondary	45	22.5	22.5	44.0
Tertiary	112	56.0	56.0	100.0
Total	200	100.0	100.0	

FIVE

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Civil Servant	42	21.0	21.0	21.0
Farmer	56	28.0	28.0	49.0
Private Sector Employee	21	10.5	10.5	59.5
Trader	53	26.5	26.5	86.0
Unemployed	28	14.0	14.0	100.0
Total	200	100.0	100.0	

SIX

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid No	18	9.0	9.0	9.0
Yes	182	91.0	91.0	100.0
Total	200	100.0	100.0	

SEVEN

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid No	19	9.5	9.5	9.5
Yes	181	90.5	90.5	100.0
Total	200	100.0	100.0	

EIGHT

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Damage of Agriculture and livelihoods	57	28.5	28.5	28.5
Displacement of people	13	6.5	6.5	35.0
Economic consequences	13	6.5	6.5	41.5
Environmental impact	39	19.5	19.5	61.0
Infrastructure damage	65	32.5	32.5	93.5
Water contamination and health risk	13	6.5	6.5	100.0
Total	200	100.0	100.0	

NINE

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Blockage of drainages	13	6.5	6.5	6.5
Damage vital				
infrastructure and prevent access to essential	64	32.0	32.0	38.5
public services				
Destruction of crops	72	36.0	36.0	74.5
Human induced activities	11	5.5	5.5	80.0
Landslide risks	40	20.0	20.0	100.0
Total	200	100.0	100.0	

TEN

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Mild	25	12.5	12.5	12.5
Moderate	50	25.0	25.0	37.5
Severe	125	62.5	62.5	100.0
Total	200	100.0	100.0	

ELEVEN

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Yes	200	100.0	100.0	100.0

TWELVE

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid No	5	2.5	2.5	2.5
Yes	195	97.5	97.5	100.0
Total	200	100.0	100.0	

THIRTEEN

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid No	2	1.0	1.0	1.0
Yes	198	99.0	99.0	100.0
Total	200	100.0	100.0	

FOURTEEN

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Farming	160	80.0	80.0	80.0
Trading	40	20.0	20.0	100.0
Total	200	100.0	100.0	

FIFTEEN

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Farm Houses	83 44	41.5 22.0	41.5 22.0	41.5 63.5
Our Business	73	36.5	36.5	100.0
Total	200	100.0	100.0	

SIXTEEN

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid No	28	14.0	14.0	14.0
Yes	172	86.0	86.0	100.0
Total	200	100.0	100.0	

SEVENTEEN

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Heavy rainfall	182	91.0	91.0	91.0
Release of water from the Lado Dam in Cameroon	18	9.0	9.0	100.0
Total	200	100.0	100.0	

EIGHTEEN

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid No	154	77.0	77.0	77.0
Yes	46	23.0	23.0	100.0
Total	200	100.0	100.0	

NINETEEN

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Agree	14	7.0	7.0	7.0
Disagree	186	93.0	93.0	100.0
Total	200	100.0	100.0	

TWENTY

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid No	56	28.0	28.0	28.0
Yes	144	72.0	72.0	100.0
Total	200	100.0	100.0	

TWENTYONE

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid No	39	19.5	19.5	19.5
Yes	161	80.5	80.5	100.0
Total	200	100.0	100.0	

TWENTYTWO

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Agree	102	51.0	51.0	51.0
Disagree	98	49.0	49.0	100.0

Total	200	100.0	100.0	

TWENTYTHREE

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid No	86	43.0	43.0	43.0
Yes	114	57.0	57.0	100.0
Total	200	100.0	100.0	

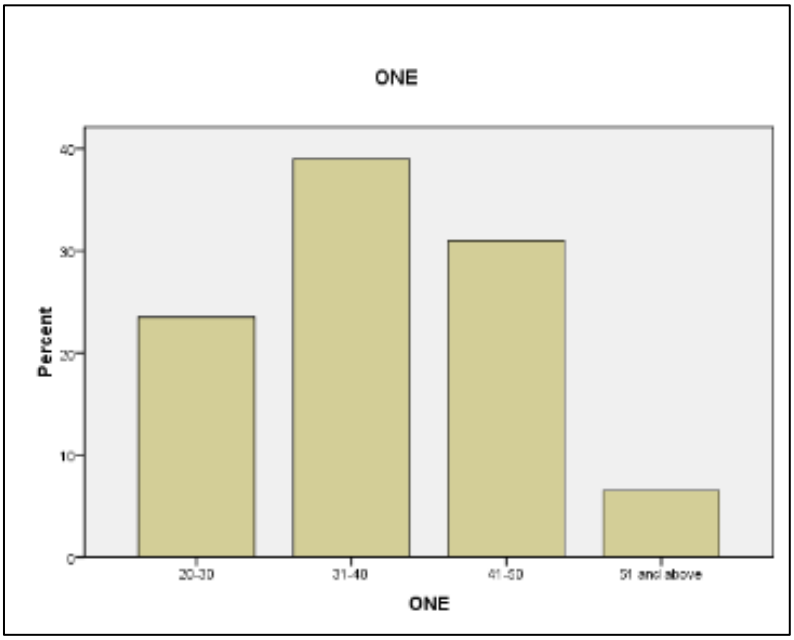
TWENTYFOUR

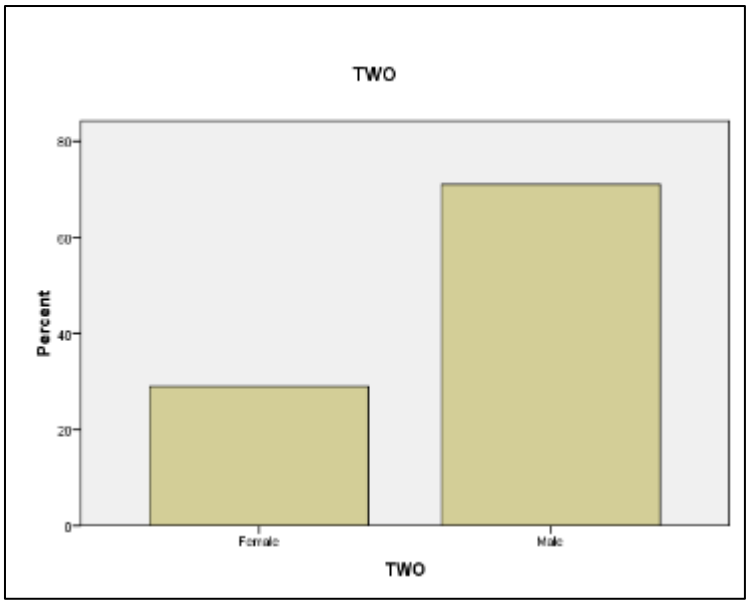
	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Increase spending on flood defences	35	17.5	17.5	17.5
Introduce plants trees strategically	66	33.0	33.0	50.5
Public outreach projects	11	5.5	5.5	56.0
Tackle climate change	88	44.0	44.0	100.0
Total	200	100.0	100.0	

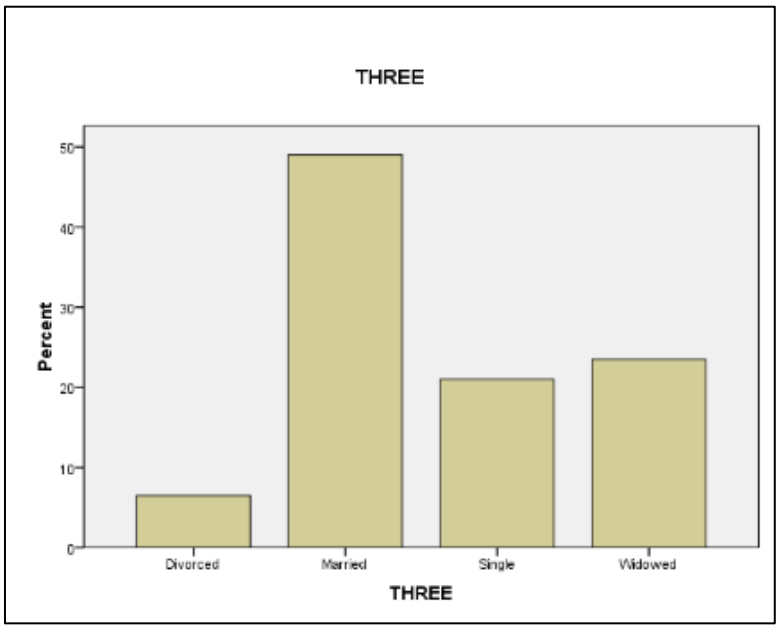
TWENTYFIVE

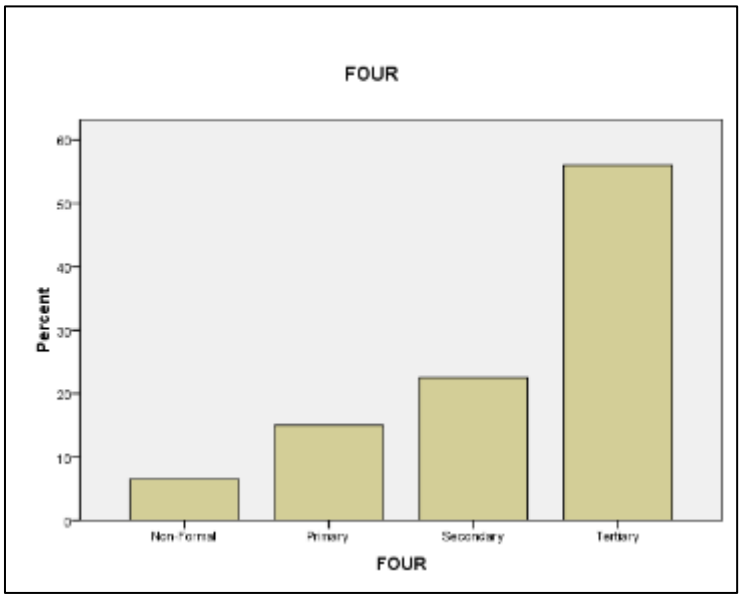
	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Agree	189	94.5	94.5	94.5
Disagree	11	5.5	5.5	100.0
Total	200	100.0	100.0	

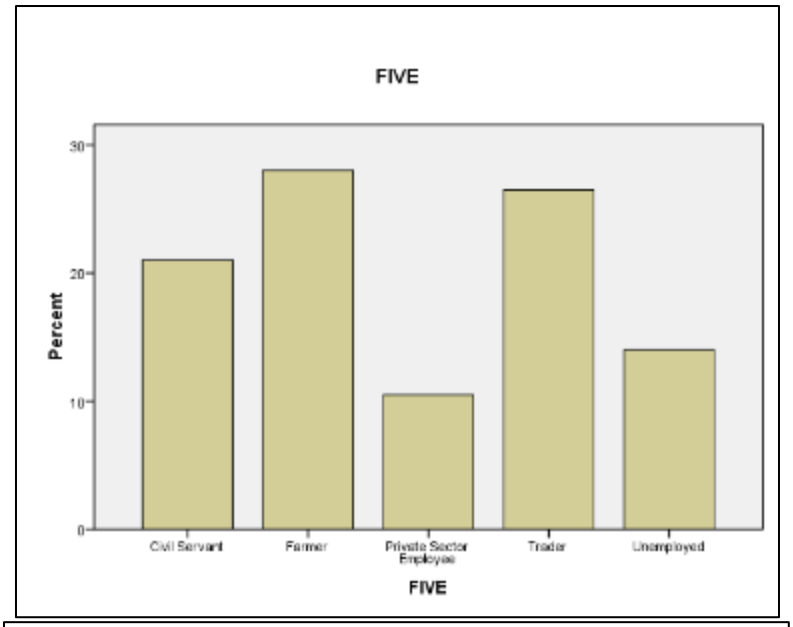
APPENDIX III

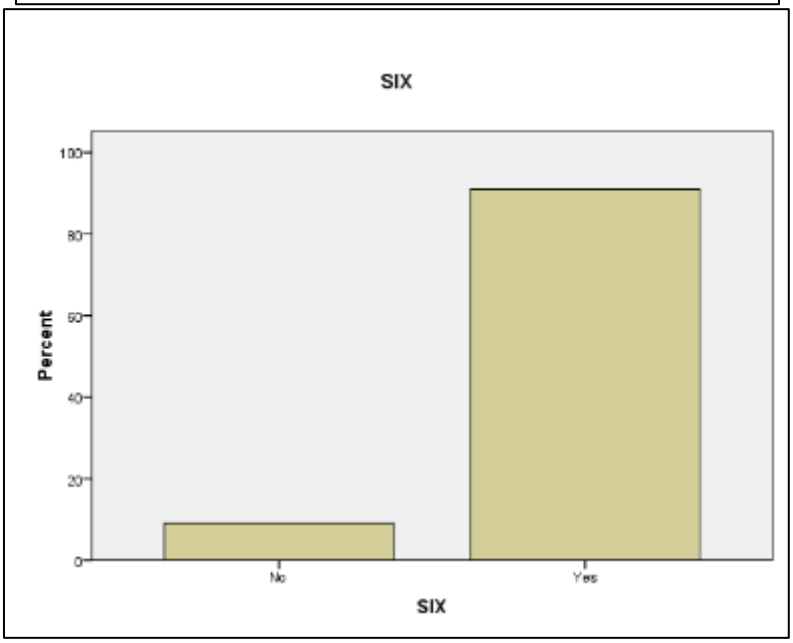


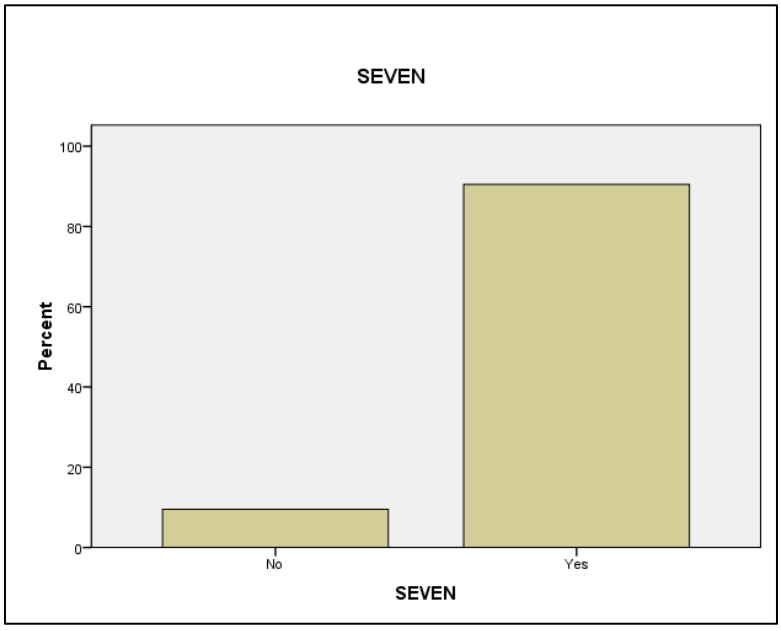

TWO
Percent
80
60
40
20
0
Female
Male
TWO

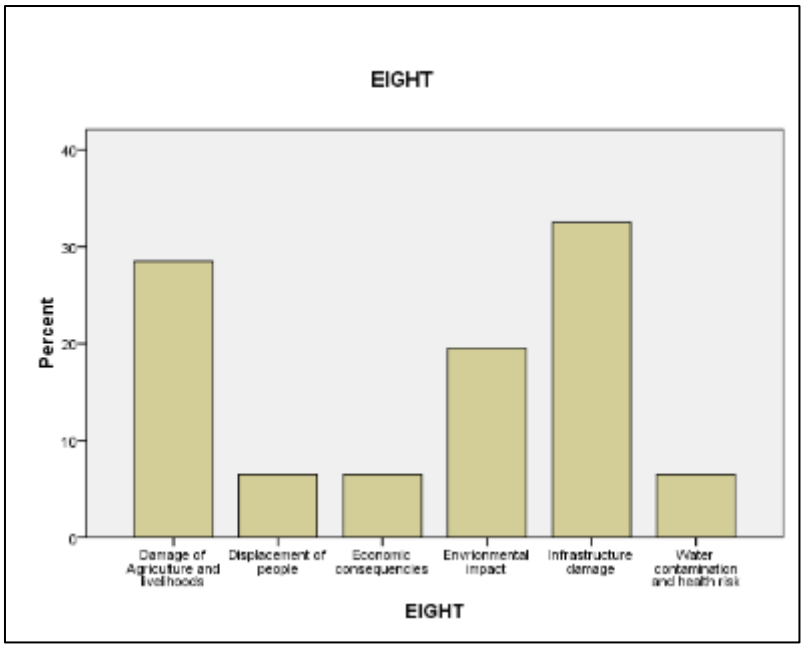

THREE
Percent
50
40
30
20
10
0
Divorced
Married
Single
Widowed
THREE

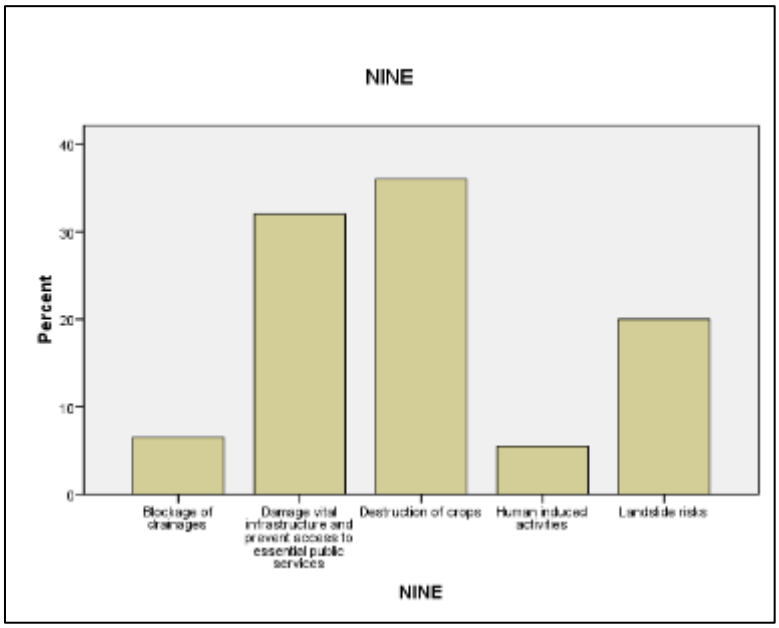

FOUR
Percent
60
50
40
30
20
10
0
Non-Formal
Primary
Secondary
Tertiary
FOUR

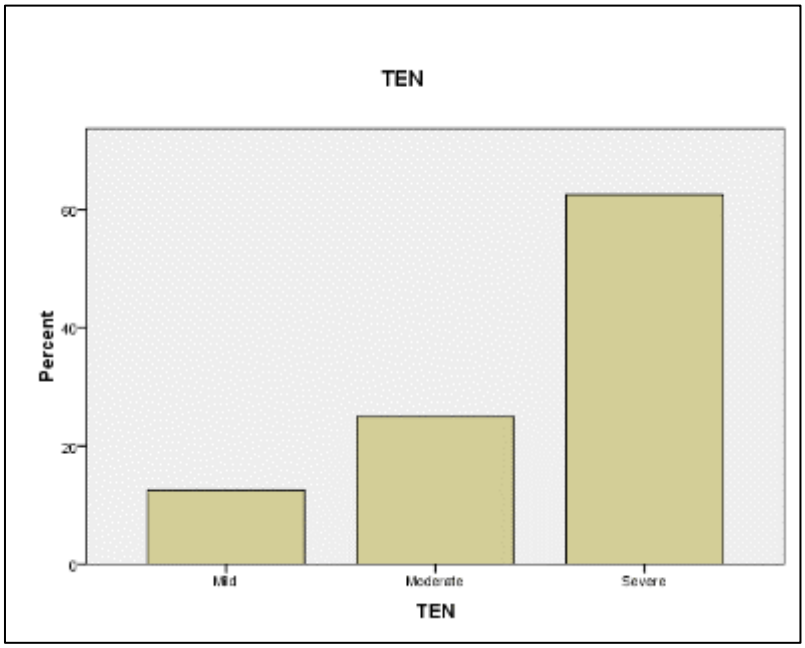

FIVE
Percent
30
20
10
0
Civil Servant
Farmer
Private Sector Employee
Trader
Unemployed
FIVE

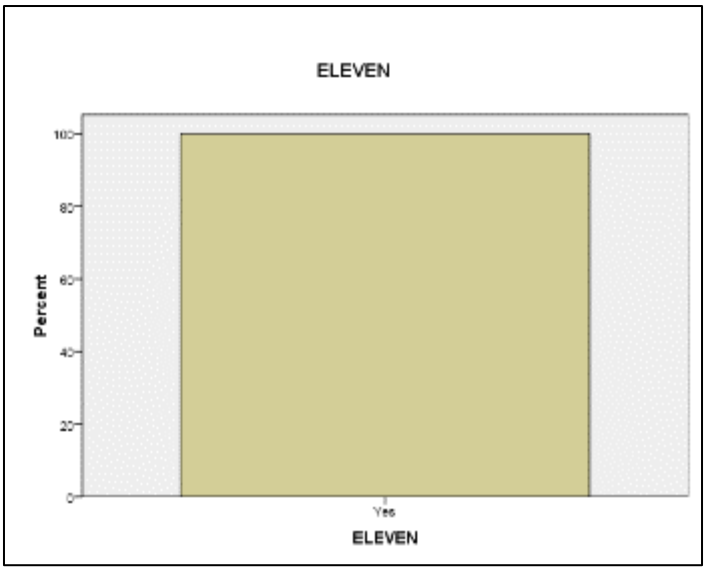

SIX
Percent
100
80
60
40
20
0
No
Yes
SIX

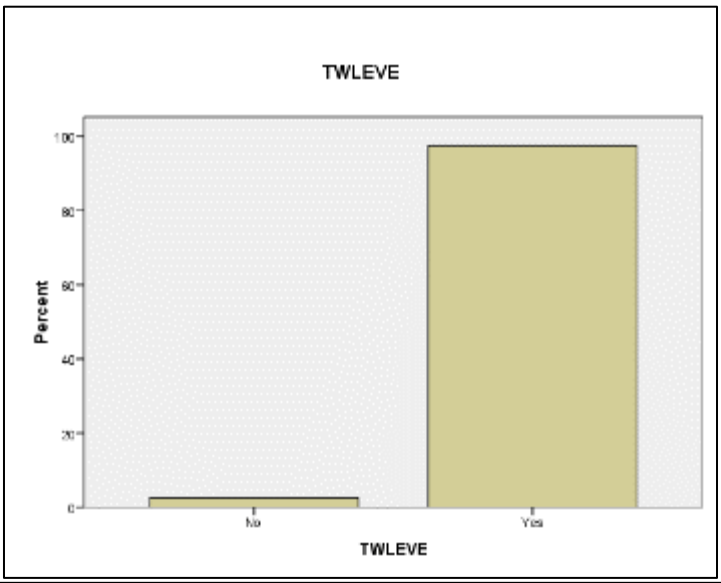

SEVEN
Percent
100
80
60
40
20
0
No
Yes
SEVEN

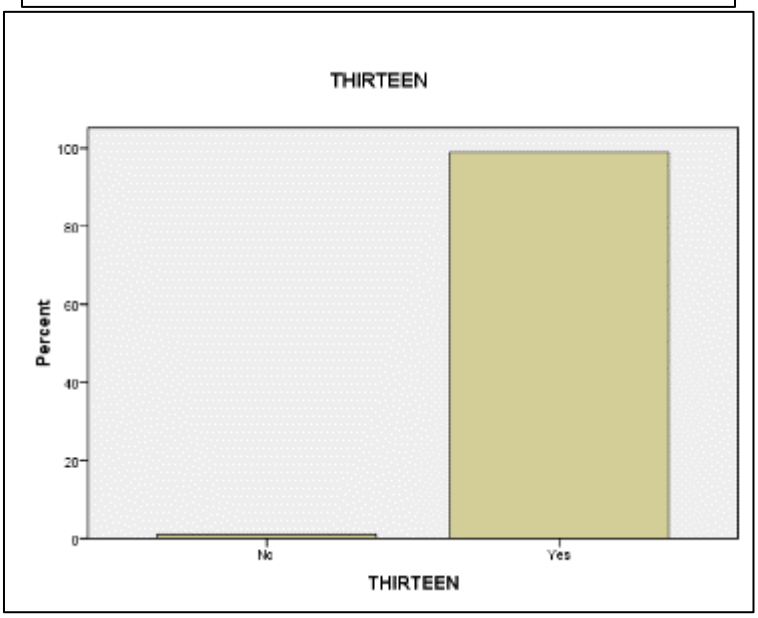

EIGHT
Percent
40
30
20
10
0
Damage of Agriculture and livelihoods
Displacement of people
Economic consequencies
Environmental impact
Infrastructure damage
Water contamination and health risk
EIGHT

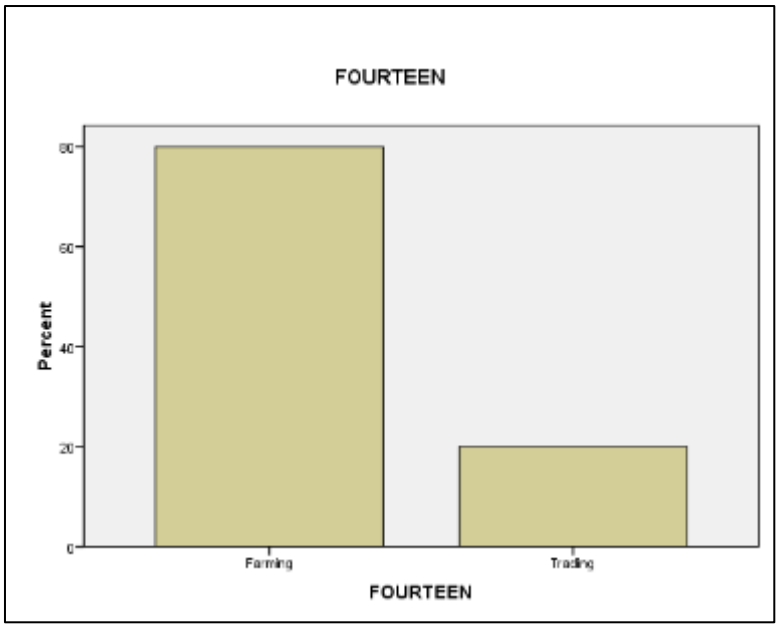

NINE
Percent
40
30
20
10
0
Blockage of drainages
Damage vital infrastructure and prevent access to essential public services
Destruction of crops
Human induced activities
Landslide risks
NINE

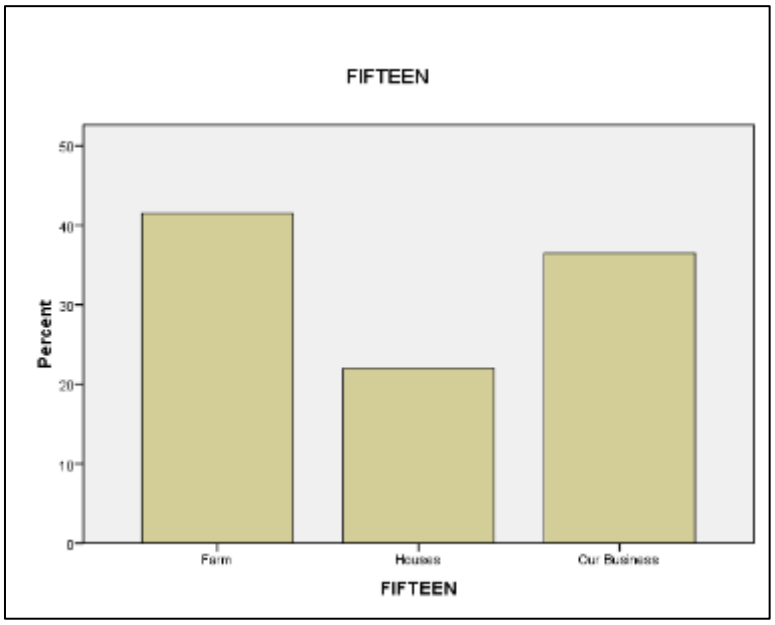

TEN
Percent
60
40
20
0
Mild
Moderate
Severe
TEN

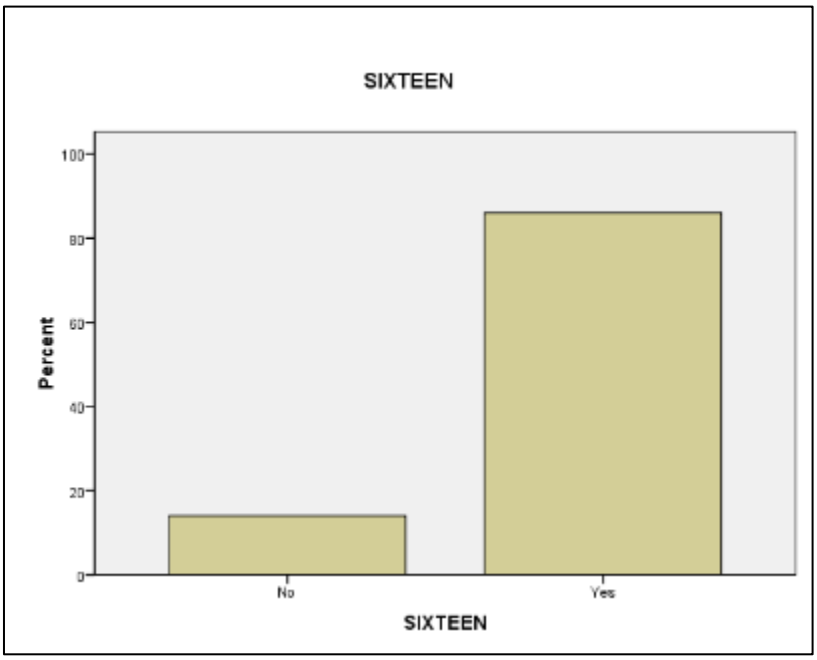

ELEVEN
Percent
100
80
60
40
20
0
Yes
ELEVEN

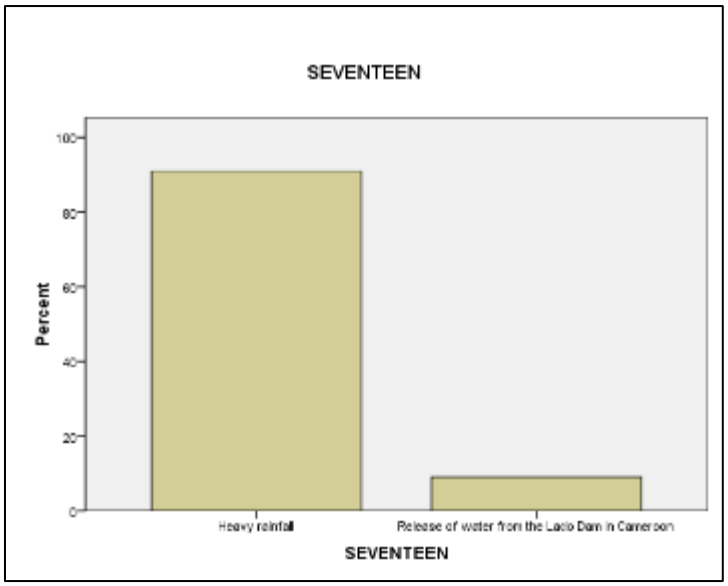

TWLEVE
Percent
100
80
60
40
20
0
No
Yes
TWLEVE

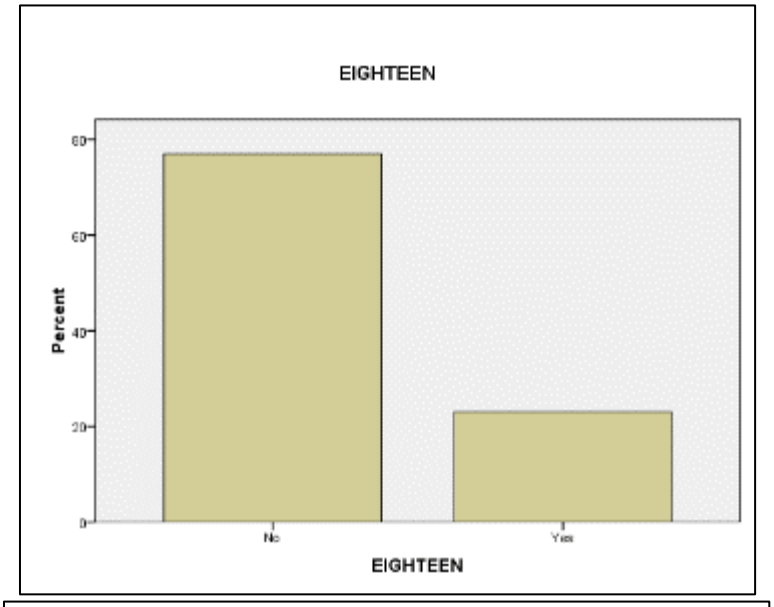

THIRTEEN
Percent
100
80
60
40
20
0
No
Yes
THIRTEEN

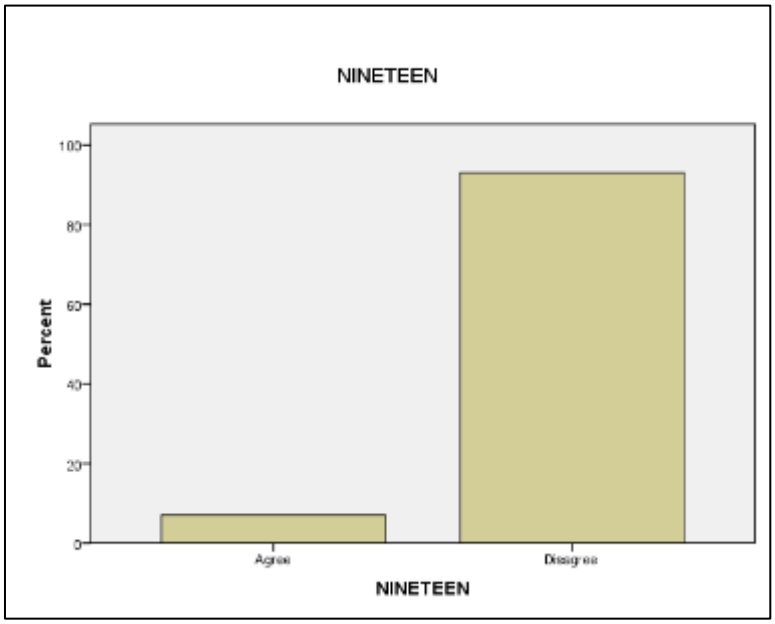

FOURTEEN
Percent
80
60
40
20
0
Farming
Trading
FOURTEEN

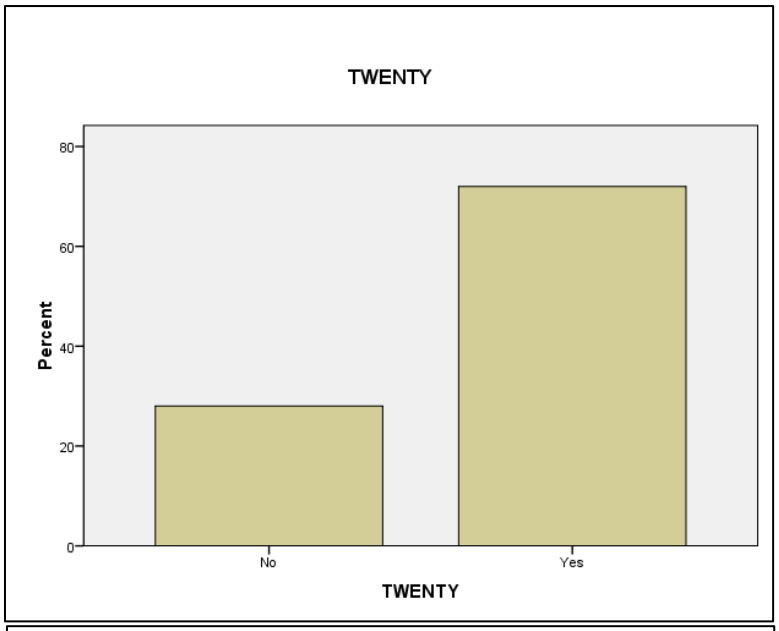

FIFTEEN
Percent
50
40
30
20
10
0
Farm
Houses
Our Business
FIFTEEN

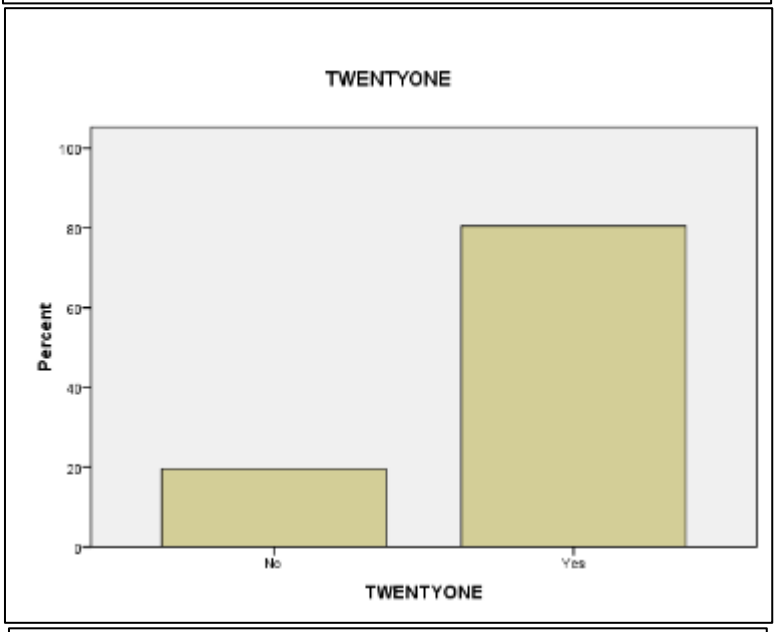

SIXTEEN
Percent
100
80
60
40
20
0
No
Yes
SIXTEEN

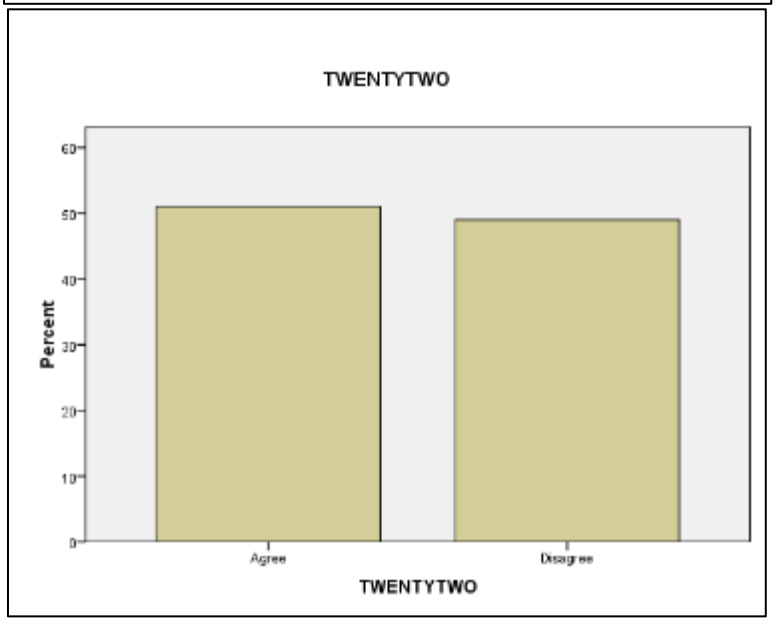

SEVENTEEN
Percent
100
80
60
40
20
0
Heavy rainfall
Release of water from the Lagdo Dam in Cameroon
SEVENTEEN

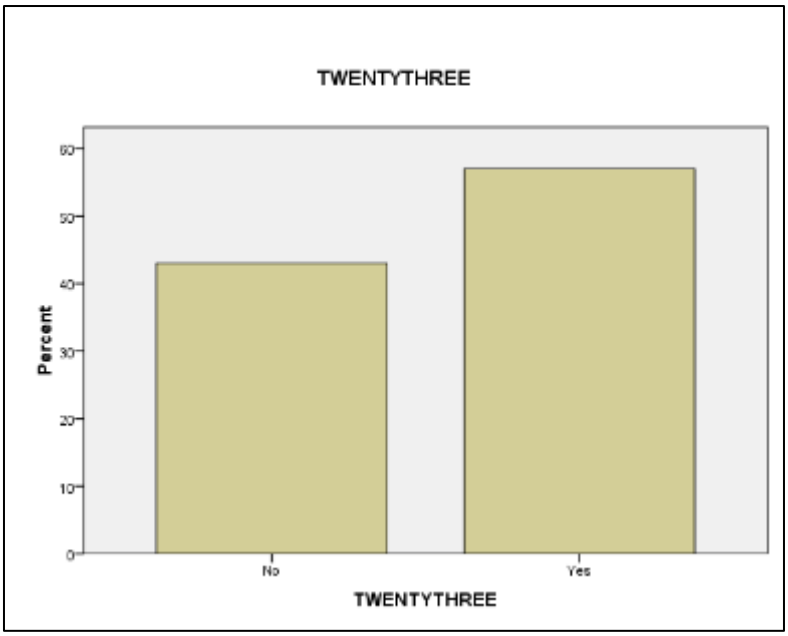

EIGHTEEN
Percent
60
40
20
0
No
Yes
EIGHTEEN

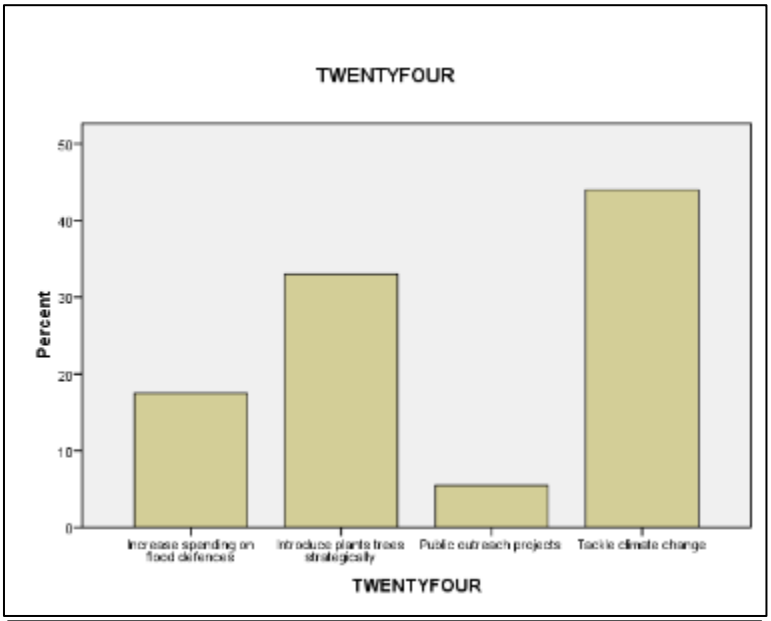

NINETEEN
Percent
100
80
60
40
20
0
Agree
Disagree
NINETEEN

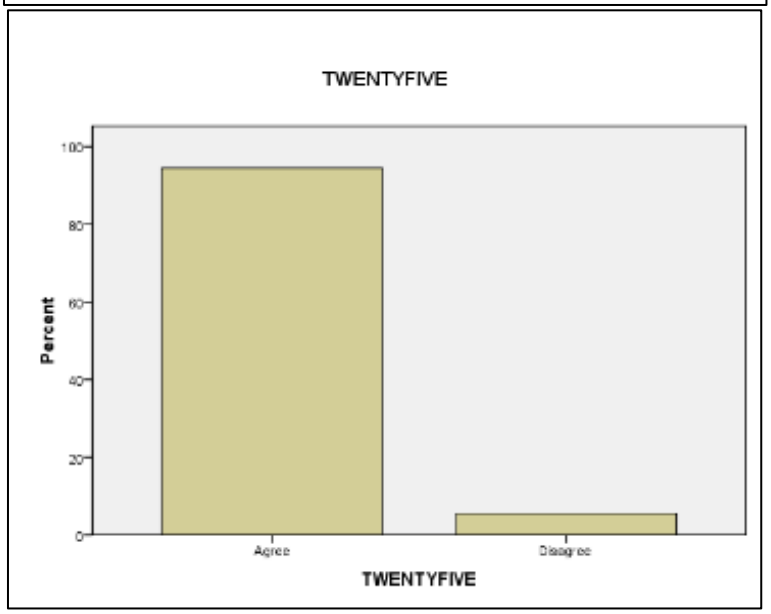

TWENTY
Percent
80
60
40
20
0
No
Yes
TWENTY


TWENTYONE
Percent
100
80
60
40
20
0
No
Yes
TWENTYONE


TWENTYTWO
Percent
60
50
40
30
20
10
0
Agree
Disagree
TWENTYTWO


TWENTYTHREE
Percent
60
50
40
30
20
10
0
No
Yes
TWENTYTHREE


TWENTYFOUR
Percent
50
40
30
20
10
0
Increase spending on flood defences
Introduce plants trees strategically
Public outreach projects
Tackle climate change
TWENTYFOUR


TWENTYFIVE
Percent
100
80
60
40
20
0
Agree
Disagree
TWENTYFIVE