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**Effects of Flood on Environmental Quality in Ringim, Jigawa State,
Northern Nigeria**

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ABSTRACT

The aim of the study was to determine the level of flood risk and its effects on environmental quality in Ringim Local Government Area. Dabi, Kyarama, Ringim, Sintilmawa and Yandutse were purposively selected being the most flood prone in which 400 questionnaires were administered. Observation method was also adopted in the study. Flood risk map was developed through simulation method using GIS spatial analyst. Descriptive statistics particularly percentage was employed in SPSS software. Result indicated that flood used to occur every year according to 85.5% of the respondent. The worst scenarios of flood in the area occurred in 2012, 2015 and 2018 according to 384, 287 and 400 respondents respectively. Simulation result categorised the area into high risk 354.1km² (33.1%), medium risk 507.4km² (48.0%) and low risk 195.5 km² (18.5%). Larger part of the respondents (93%) indicated that flood disaster has serious negative effects on environmental quality in the area. Over 50% of the respondents in the whole areas indicated that the major form of land damage due to flooding is through erosion and land degradation. In all the areas flood effect on quality of the water is less. Majority of the respondent in the areas (63.75%) indicated that effect of flooding on vegetation is less to moderate. Most of the areas studied are affected by moderate to high risk of flooding that causes serious damage to environmental resources such as land, water and vegetation which need to be restored through flood control and mitigation strategies for effective environmental quality.

Keywords: Environmental Quality, Flood Disaster, Mitigation, Strategies, Ringim

1.0 INTRODUCTION

It is obvious that societies and communities are often faced with certain disaster, either naturally or artificially induced that can cause serious damages. A disaster is any potentially damaging phenomena induced by physical or human activity that may cause the loss of life, injury, property damage, socio-economic disruption, and/or environmental degradation (Hickey and Salas, 1995 and Rose, 2014). Flood is one of the oldest and most devastating catastrophes that causes enormous damage and loss of life worldwide. It could also be seen as the inundation of an area not normally covered with water, through a temporary rise in level of stream, river, lake or sea (Emodi, 2012). The nature of flood disasters and their impacts depend on the natural and man-made conditions on floodplains, economic development and the installation of flood protection measures which has political, economic and social

dimension as well as engineering aspects. Thus, flood disaster can be described by various parameters including flood extent, water depth, flow velocity, duration, preparedness and vulnerability among others (Nigerian Hydrological Services Agency, 2013). The environment is Nature's life support system, consisting of air, land and water systems. In the natural state, each form of a system has a fixed composition, which is altered when a foreign matter is introduced into it as a result of anthropogenic activities or natural disasters (e.g. hurricanes). This leads to environmental degradation (Eneh, 2015). Environmental quality is measured in terms of the total contaminants and pollutants in the environmental systems, as compared with the natural composition and established quality standards of the systems (Lui & Liptak, 2000). The release of foreign substance into the environment (water, air and land) affect the quality of the environment. Flood distorted

environmental quality because it introduces water in excess into the environment beyond its carrying capacity, capable of causing a lot of damages. Good quality environment is needed in any society for an effective life, for that environmental quality need to be maintain at all course for effective development. Looking at the value of environment to man it is crucial for everyone to be aware of his/her dependence on a healthy environment as healthy environment maintain good environmental quality for sustainable development (Rahman, Shi and Chongfa, 2014 and Saleh, 2014). Effect of flood on environmental quality is becoming a global issue of concern. Flood causes more property and environmental damage in the United State and other parts of the globe than any other form of natural disaster (Bartosova, Clark, Novotny and Taylor, 2000). Flood may cause destruction of the entire environment. Flood causes destruction of homes, grains stores, social and economic infrastructural facilities, it may result into destruction of farmlands together with crops and animals, it may also amounted to accumulation of massive quantities of silt on important environmental structure like water supply systems, sewage treatments and ecosystem services in an area. One of the major effect of flood is the destruction of the environment, leading to a decrease in environmental quality (Abam, 2006 and Armah, *et al*, 2010).

Flood disaster is not a new phenomenon in Ringim and its environs because it is located in flood prone zone for decades. The area experienced floods for more than five (5) consecutive hydrological years; 2001, 2005, 2012, 2018 and 2019. Many a times in Ringim flood submerged houses, schools, clinics and roads among others causing serious to the entire environment (Umar, 2016). Some of the recent flood disasters in Ringim LGA that were highly devastating in nature include the floods of 2012, 2013, 2014, 2015, 2018 and 2019. Despite the expected increase in frequency and magnitude of flood in the Nigeria and invariably Ringim, few impact studies on the environmental quality have been undertaken so far. In addition to that there is no reliable and comprehensive data on effect of flooding on environmental quality in the area for effective measures to be taken.

From previous studies De Moel, *et al*, (2013) Evaluated effect of flood damage reducing measures in part of Rotterdam using multiple layer safety (MLS) frame work based on land use type and realised that almost 60% of flood risk in the area is associated with industrial land use and to make buildings wet prove by 89% flood effect on environment will be reduced significantly at least by 40%. Thus the study utilizes model, it centered more on land use type and neglected other aspects of environmental quality. Dahri, Atoui, and Abida (2014) evaluated water and sediment quality in the southern branch of a flood control channel in Sfax city, as well as its neighboring sites. The study investigated level of water contamination due do flood disaster through mapping and realised that most of the water is affected by contaminants as a result of flood event. This study is more on water quality rather than environmental quality elements. Marcellinus and Joseph (2015) conducted a study on the assessment of the impact of flood events in Makurdi, Nigeria. The study uses information sourced from questionnaire and personal observation among others. The results of the analyses show that floods in Makurdi occur at the event of high rainfall intensity. Apart from rainfall, other factors that influence flooding in the area include lack of good drainage networks, dumping of wastes/refuse in drainage and water channels, and degree of built up areas leading to and increased runoffs. Although, personal properties and public infrastructure suffer all forms of flood damages and that residents in the flood prone areas have remained on the basis of having no alternative, cultural ethnic affinity, family home where parent were buried and cheaper houses to rent.

Commitments are often limited to distribution of relief materials by the government agencies such as the National Emergency Management Agency (NEMA), State Emergency Management Agencies (SEMAs) among others, and other Non-governmental Organizations (NGOs). The scope of most of the existing studies is limited to causes and extent of flood, its effects on infrastructures. That is why the objectives of the study were to determine frequency and extent of flood events in the area, level of risk and effects of flood on environmental quality in the area for effective development.

2.0 MATERIALS AND METHODS

2.1 The Study Area

Ringim Local Government Area belongs to Hadejia-Jama'are River Basin (HJRB) which is part of the Lake Chad Basin Hydrological Area identified as HA-VIII by the Nigeria Hydrological Services Agency (NIHSA), situated in the Sudano-Sahelian zone of Northern Nigeria. The study area is located between latitude 12°N and 12.20°N of the equator and between longitude 8.53°E and 9.20°E. The aerial coverage of Ringim is approximately

1,057km². The area is bordered to the west by Kano State, Garki Local Government Area to the north, Dutse Local Government Area to the south-East, and Taura and Jahun Local Government Areas to the east (figure 1). The population is projected to be 257,100 as at 2016. Majority of the population are Hausa and Fulani. The people of Ringim local government area are mostly farmers, livestock/poultry farmers, marketers and other administrative civil servants.

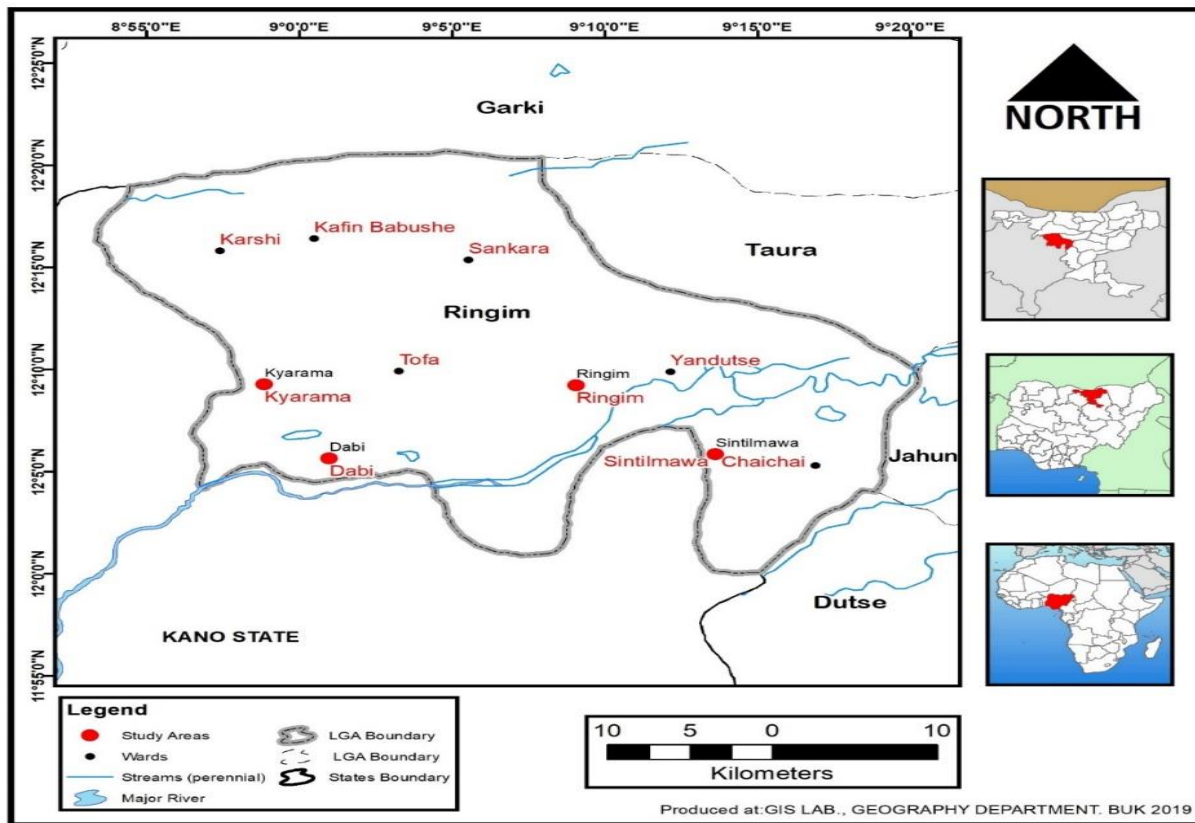


Figure 1. Ringim Local Government Area in Jigawa State from Google Earth, 2020

2.2 Materials Used

Materials used in the study include Global Positioning System (GPS) for taking coordinates, Camera for taking pictures, Topo sheets, DEM and maps for data analysis.

2.3 Sampling Procedures

The study adopted the methodology of Armah, *et al* (2010) in selecting sample sites. Thus, 5 wards were

purposively chosen out of the existing 10 wards to form the sample, based on their location in flood prone and flood events. The selected areas are Dabi, Karama, Ringim, Sintilmawa and Yandutse. These areas are considered the most flood prone in the study area. A total of 400 respondents were determined as a sample based on Taro Yamane's formula given as:

$$n = \frac{N}{1+N(e)^2} \dots\dots\dots (i)$$

Where: n= sample size required
N = number of households (28,210)

e = allowable error (%)

Substitute numbers in formula:

$$n = 28,210 \div 1 + 28,210 (0.05)^2$$

$$n = 400(\text{Rounded})$$

2.4 Data Collection

A total of 400 questionnaire were administered, field observation, interview and household (HH) questionnaire were utilised in collecting data. Coordinates of the selected areas were collected using GPS. Digital Elevation Model (DEM) of the area was developed. Data on flood occurrences from 2012 to 2018 was collected from hydro-metrological agencies through questionnaire. Landsat ETM-2018 with 28.5m resolution was downloaded from Glovis USGE.

2.5 Data Analysis

The study used statistical techniques in analysing the data obtained from the research respondents. The statistical techniques involved the use of descriptive statistics. The data collected from the research respondents were represented statistically, using frequency distribution, tables, percentage and figures. The statistical analyses were carried out using the Statistical Package for Social Sciences

3.0 RESULTS AND DISCUSSION

3.1 Frequency of Occurrence of Flood Disaster

From the analysis, 85.5% of the respondent indicated that flood occurs annually while 14.5% indicated that the flood occurrence is rarely or sporadically (table 1). From the analysis, majority of the respondents identified the flood as an environmental disaster that occurs regularly. 85.5 percent of the responses indicated that, the flood occur annually and the areas

(SPSS) and Microsoft Excel soft wares. Interview data was reported.

The extent of flood disaster in the study area, was handled by calculating the return interval of flood and level of risk of flood disaster in the study area.

The Return Interval (R.I) of flood in the last seven years was calculated using the weibull’s formula as adopted from Umar (2016). As follows:

$$R.I. = \frac{M+1}{N} \dots\dots\dots (ii)$$

Where

R.I = Return Interval

M = Number of years to be studied

N = Number of flood events within those years

$$R.I. \frac{7+1}{5} \dots\dots\dots (iii)$$

$$= \frac{8}{5}$$

$$= 1.6$$

The level of risk of flood disaster was also simulated using the Digital Elevation Model (DEM), drainage pattern and other remotely sensed dataset were developed to determine the flood potentialities in terms of magnitude, severity and area coverage. The area was classified into flood risk classes based on DEM using ArcGIS 10.4.1 spatial analyst software in GIS environment.

at high risks of flood have not experience any year without flooding. “The effect of floods in the study area has been on the increase especially in the last decades”. “It has become a life-threatening concern to the people of and the number of damages caused by this perennial disaster are alarming”. This finding however, is in line with that of Emodi (2012) that the effect of floods and its damage in Nigeria has increase especially in the last three decades.

Table 1. Frequency of Flood Occurrence

Frequency	No. of Response	Percentage (%)
Annually/Regularly	342	85.5
Sporadically/Rarely	58	14.5
Total	400	100.0

From the results it is obvious that significant number of the respondents indicated that flood disaster has occurred over the years. The trend line shows that the highest incidence was in 2018 and 2012, followed by 2015, 2013, 2017, 2014, and 2016 (figure 2). Collectively, findings from the results revealed that

flood disaster occur almost every year. From the responses (figure 2) it is also cleared that the worst scenario is in 2018 (400), 2012 (384) and 2015 (287). It was also complained by some people during the interview “that 2018 and 2012 are the worst flood scenario they have ever experience in their lives”.

This finding is in line with the finding Konwea (2012) who described the 2012 flood as the worst flood Nigeria has ever seen in half a century (during the last five decades), which led to the death of

hundreds of people, displaced over 2 million people, and destroy several thousands of hectares of farmlands.

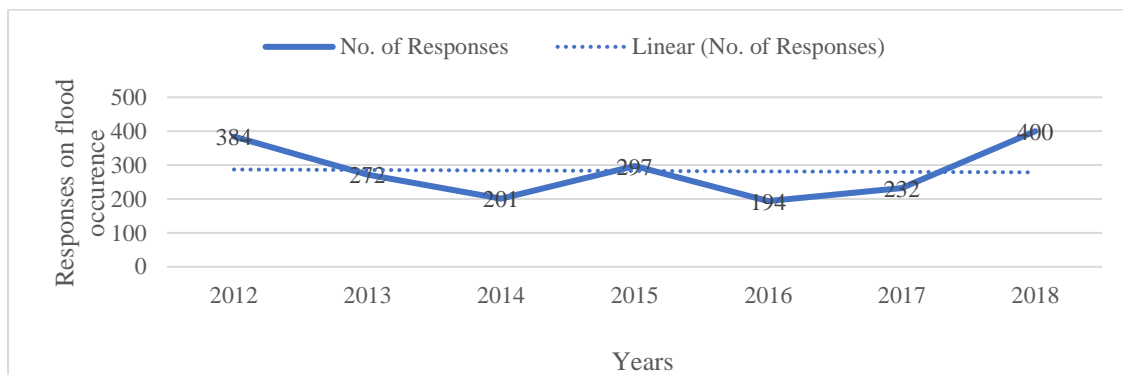


Figure 2 Flood occurrences in seven years

This finding therefore indicated that the frequency of flood occurrence is high. This finding correspond the finding of Jigawa State Emergency Management Agency (2019), that flood disaster has the highest frequency of occurrence, wider coverage and highest impacts when compared with other form of disaster. Results for flood reoccurrence interval shows that the widest interval between one flood event and another in the study area is 1.6 years. These findings therefore revealed that the frequency of flood occurrence is very high and alarming over the years. The findings are in line with the assertion of Rose, (2014) that among all other natural environmental disasters, flood has the highest frequency of occurrence, wider coverage and highest impacts.

3.2 Severity of Flood Risk in the Study Area

The simulation in figure 3 shows that the areas liable to annual flood are Yandutse, Ringim, Sintilmawa, Dabi, and Kyarama among others. But the community with the highest risk is Yandutse, Dabi, Sintilmawa and Ringim. The findings in table 8 shows 85.5 percent of the responses indicated that, the flood occur annually and the areas at high risks of flood have not experience any year without flooding. As for the Socio-economic activities of the people of the study area, findings from field studies (observation, and interview and questionnaire administration) shows that, agriculture is the predominant livelihood strategy for people in this area and the most important activity in terms of spatial extent. More than 80% of the population of the

region is engaged in farming and depends mainly on natural soil fertility with limited external inputs such as inorganic fertilizers. Notwithstanding the most common constraints to agricultural development are frequent flood, low soil fertility, and inadequate irrigation facilities. The findings also revealed that, annual flooding has implications for the variety of crops cultivated as the arable crops such as maize, corn, millet and potatoes among others cannot withstand prolonged submergence. These crop types are highly susceptible to stagnant water as the roots of the crops rot easily. From the field observation, it is obvious that the study areas suffered the same level of damage.

The simulation indicated that 354.1km² (33.1%) of the total area of the Ringim is exposed to high risk of flood disasters, 507.4km² (48.0%) medium risk, and only 195.5 km² (18.5%) is exposed to low risk of flood disasters (table 2). This simply revealed that the community within the local government area are affected by the flood disaster be it high, medium or low and has a serious negative impact to the socio-economic activities and the environmental quality in the area.

Based on the modelling, the severity and frequency if occurrences of flood disaster in Ringim Local Government Area, Jigawa state was considered to be high. This finding is in line with that of Umar (2016), who stated that Ringim and Jahun Local Government

Areas of Jigawa State are exposed to high risk of flood disasters.

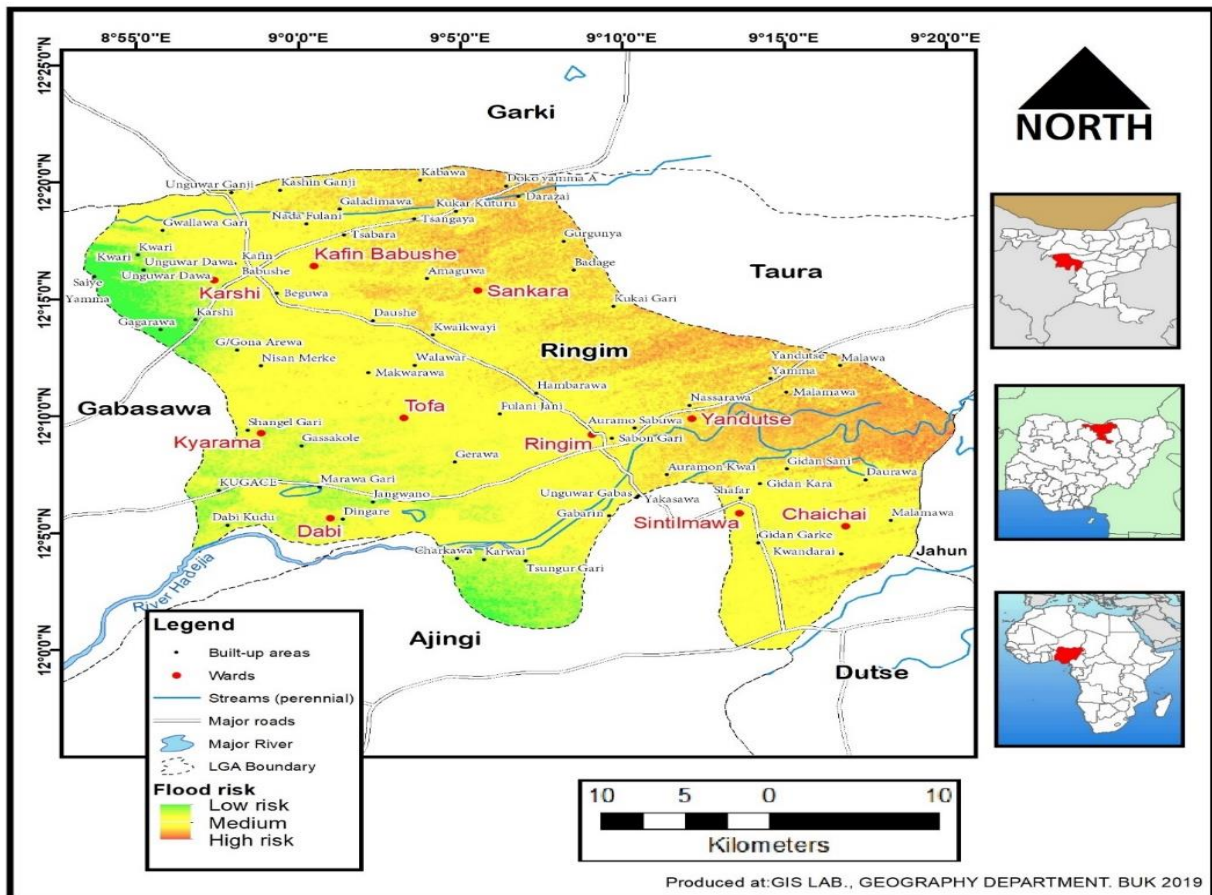


Figure 3 Flood Risk Map of Ringim LGA

Table 2. Area extent of flood risk classes

S/N	Risk Classes	Area in km ²	Percentage (%)
1	High Risk Areas	354.1	33.5
2	Medium Risk Areas	507.4	48
3	Low Risk Areas	195.5	18.5
Total		1,057km²	100%

3.3 Effects of Flood on Environmental Quality

From the analysis, almost all the respondent (93%) indicated that flood disaster has effects on environmental quality, while 7% indicated that flood does not have any negative effects on environmental quality (table 3). Flood can have a variety of impact

on the environment within a flooded area. From the field study, it was observed that annual flooding affect environmental quality through land damage by (river erosion, degradation, degeneration and pollution); results in loss of biodiversity; and affects the quality of water of the study area.

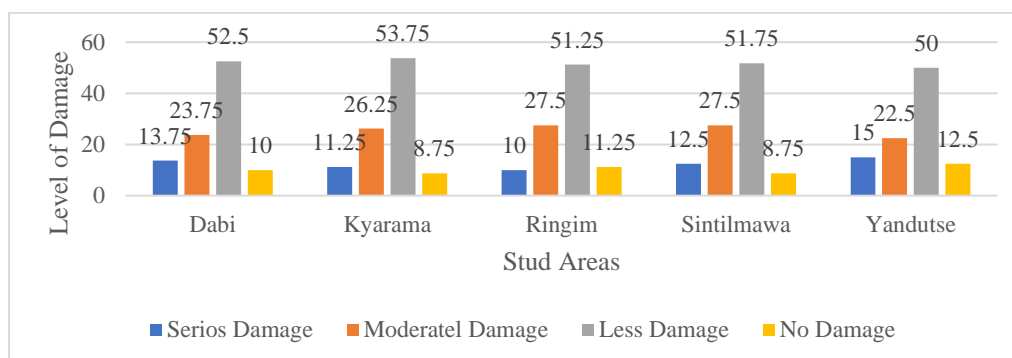
Table 3. Effects of flood on environment

Level of Damage	Respondents	Percentage (%)
Serious effects	372	93.0%
No effects	28	7.0%
Total	400	100

3.4 Effects of Flood Land

It can be seen from figure 4 that the finding in Dabi area shows that, majority of the households (52.50%) indicated that the effects flood disaster has on land is less, 23.75% indicated moderate damage, 13.75% indicated serious damage and 10% indicated no damage. The finding in Kyarama area shows that, 52.50% of the households indicated that, flood disaster has less effects on land, 26.25% indicated moderate damage, 11.25% indicated serious damage and 8.75% indicated no damage. The finding in Ringim area shows that, majority of the households (51.25%) indicated that the effects flood disaster has on land is less, 27.50% indicated moderate damage, 11.25% indicated no damage and 10% indicated serious damage. The finding in Sintilmawa area shows that, 51.25% of the households indicated that, flood disaster has less effects on land, 27.50% indicated moderate damage, 12.50% indicated serious damage and 8.75% indicated no damage. The finding in Yandutse area shows that, majority of the households (50%) indicated that the effects flood disaster has on land is less, 22.50% indicated moderate damage, 15% indicated serious damage and 12.50% indicated no damage (Figure 4).

Finding from the analysis revealed that whenever there is flood disaster, it usually causes damage to the lands of the affected area, more especially in the form of erosion, land degradation, degeneration, and pollution. Even though majority of the respondent believed that the level of damage is less, but some significant percentages of the research respondents indicated that the damage is moderate while some indicated serious damage. This findings however, is not in line with the findings of Rahman, *et al* (2014), who according to his finding whenever there is flood it usually causes serious damages to the lands of the affected areas, more especially in the form of erosion, land degradation, degeneration, and land pollution. However, according to the interview “damage to environmental quality such as land degradation, degeneration, erosion and pollution will hinder movement of people from one place to another which will affect their farming activities, trading and other socio-economic and political activities in causing accident and other problems among others” Also land and water pollution might contribute negatively in the spread of diseases. On the other hand, damage to environmental quality will leads to damage to the residence of the communities leading to loss of lives and properties.

**Figure 4 Level of damage on land**

From the transit visit of the study area, it was observed that land degradation, pollution and erosion

are the major secondary impacts after any flood (plate 1). Flood disaster fervent the free movement of

people through inundation, degeneration and land pollution which will affect their farming activities, trading and other socio-economic and political activities among other problems. It was complained

during the interview with some respondents that “farming activities and other businesses were ceased away due to sudden flood last year. A severe economic crisis was occurred during and after flood”.



Plate 1. Degeneration, Pollution and Erosion by Flood in Dabi and Ringim Areas

3.5 Effects of Flood on Water Quality Physical properties

The finding in Dabi area shows that, 32.50% of the households indicated that, flood disaster has less effects on the Physical quality of water (taste, odour and colour), 30% indicated moderate damage, 28.75% indicated serious damage and 8.75% indicated no damage. In Kyarama area, the finding shows that, 37.50% of the households indicated that, flood disaster has less effects on the quality of water, 25% indicated moderate damage, 22.50% indicated serious damage and 15% indicated no damage. In Ringim area, majority of the households (40%) indicated that the effects flood disaster has on the quality of water is less, 18.75% indicated serious damage, 18.75% indicated moderate damage while 22.50% of the households believed that flood has no damage on the quality of water. The finding in Sintilmawa area shows that, 28.75% of the households indicated that, flood disaster has moderate damage on water quality, 26.25% indicated

less damage, 25% indicated serious damage and 20% indicated no damage. The finding in Yandutse area, 33.75% of the households indicated that the effects flood disaster has on water quality is less, 27.50% indicated serious damage, 26.25% indicated moderate damage and 12.50% indicated no damage (figure 5).

Findings revealed that whenever flood disaster occurs, it usually contaminates the existing resources of water of the affected area. More especially those areas that sources the water from wells and the flowing water of the river since the flood carries along so many contaminants that pollute water. This finding is in line with that of Umar (2016), who according to his finding whenever flood occurs, it usually contaminates the existing water resources of the affected areas since it carries along so many contaminants that pollutes water. Flood create health hazard by way of way of damaging the water supply system thereby creating insufficient drinking water.

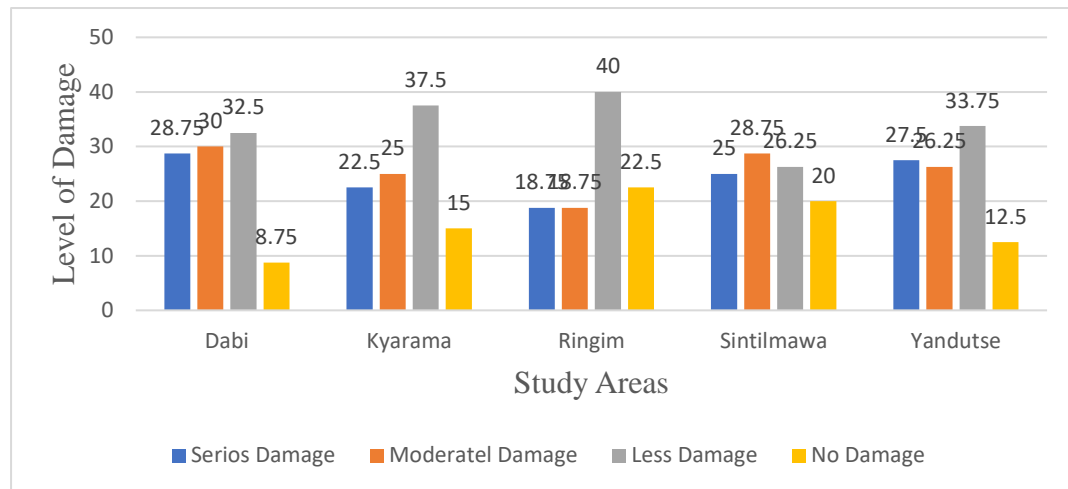


Figure 5 Level of damage on water

3.6 Effects of Flood on Vegetation:

The finding in Dabi area revealed that 51.25% of the households indicated that, flood causes moderate damage to vegetation, 32.50% indicated less damage, 6.25% indicated serious damage while 10% of the household indicated that flood has no damage on vegetation resource in the area. The result in Kyarama shows that, 43.75% of the households indicated that, flood has less effects on vegetation, 40% indicated moderately damage, 2.50% indicated less damage and 10% of the households indicated no damage. The finding Ringim area shows that, majority (63.75%) of the households indicated that, flood disaster causes moderate damage to vegetation, 21.25% indicated that the level of damage is less, 6.25% of the respondent indicated that the level of damage cause by flood disaster on vegetation is serious while 8.75% of the households believed that flood causes no damage on vegetation. The result in Sintilmawa shows that, 61.25% of the households indicated that, flood causes moderate damage on vegetation, 21% indicated less damage, 6.250% indicated serious damage and 11.25% of the households indicated no damage. The findings in

Yandutse shows that, half (50%) of the households indicated that, flood causes moderate damage on vegetation, 32.50% indicated less damage, 5% indicated serious damage and 12.50% of the households indicated no damage (figure 6).

This finding revealed that disaster causes damage to vegetation of the affected area. Even though majority of the research respondent indicated that the level of damage is moderate, it is significant in bringing about negative environmental effects like increasing rate of evaporation and surface run off which in turns increase the rate of soil erosion, desertification and drought. Flood may lead loss of biodiversity (vegetation) by inundating the grassland and off-rooting some tree plants (deforestation). Vegetation protect the soil from the adverse effects of rain drop and other agents of denudation and also increase the infiltration rate. Thus, loss of biodiversity (vegetation) amplifies floods. Loss of vegetation will result to the loss of habitat and food to other organisms which in turn will affect the soil quality and invariably agriculture.

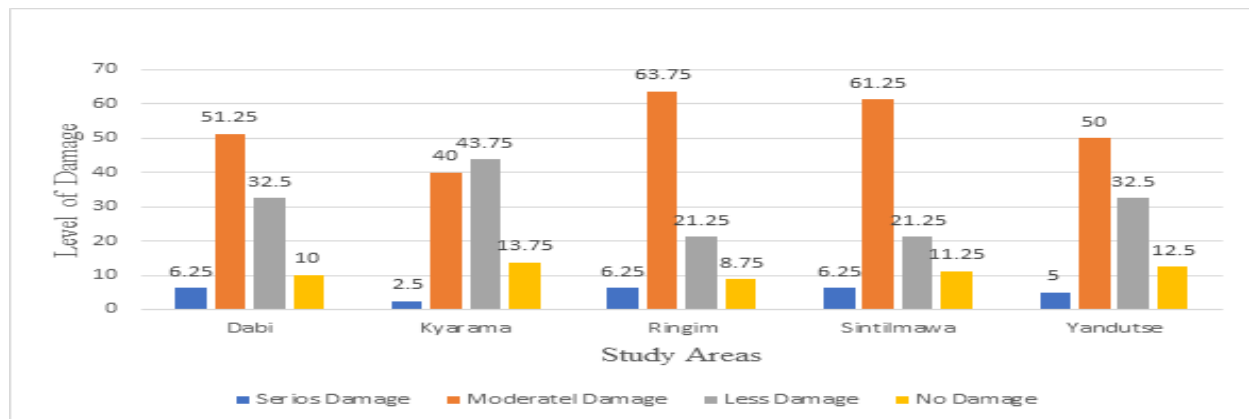


Figure 6. Level of damage on vegetation

4.0 CONCLUSION

It was deduced that flood occurs annually and the effect of floods in the study area has been on the increase especially in the last decades. The study established that highest incidence of flood in the areas was in 2018 and 2012 and it seriously affected environmental quality. Larger percentage of the study area is exposed to moderate and higher risk of flood. It was observed that annual flooding affect environmental quality through land damage by river erosion, degradation, degeneration and pollution that results in loss of biodiversity and affects the physical quality of water of the study area as well. The study concluded that effect of flood on land is less in most of the study locations. It was deduced that effect of flood on water quality physical properties like taste, odour and colour is less. It shows that effect of flood on vegetation is less even though it is significant to change biodiversity which is an important aspect of environmental quality.

5.0 RECOMMENDATIONS

Based on findings of the study it was recommended that there is need to strengthen coordination in forecasting, preventing and mitigating the impacts of

flood disasters through common initiatives, such as: creation of committees or organisations for responding to flood disasters; enhancing information and data sharing on flood disaster events; building capacity of stakeholders and local authorities for the assessment of impacts; and designing coping strategies and adaptation measures to avoid environmental damage. Areas that fall under high to moderate risk of environmental quality by flood need to be given serious attention in terms of flood control and mitigation for effective environmental quality. Government through the Ministry of Agriculture and Cooperatives should, through Extension Services encourage Communities to increase plantation on the upland in order to enhance food security and household level. Hadejia Jama'are River Basin Authority, Non-Governmental and community members should strengthen effort towards dredging exercises in the river channels to get rid of the silt and aquatic weeds. Likewise further studies should be carried out across other flood prone areas of Ringim Local Government Area and the entire Hadejia-Jama'are River Basin, to validate the findings of this study and enable generalization.

6.0 ACKNOWLEDGEMENTS

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