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A Study on Anthropogenic Activities Influencing Flood Vulnerability in Ala Riverfront Residential Areas of Akure, Nigeria

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ABSTRACT

This research investigates anthropogenic activities influencing flood vulnerability in Ala riverfront residential areas of Akure, Nigeria with a view to identifying area susceptible to flood hazard in the river basin and to suggest possible mitigation measures. With respect to data gathering for the study, 265 questionnaires which amounted to 1% of the research population were administered using simple random sampling. Findings from the survey revealed erection of buildings on riparian land and indiscriminate dumping of wastes into river bodies as factors responsible for the blockage of river channels and waterways. It also exposed resident's poor dispositions to flood forecasts and non-adherence to other management measures. The study concludes by recommending public enlightenment campaign to reducing denizen's vulnerability to flood disaster. There is the need for provision of waste management and drainage facilities as well as regular dredging of the watercourse to stimulate its absorptive capacity in the event of heavy downpour. It further suggests creation of artificial lake as natural basin to collect huge volume of water discharged from all watersheds leading to the river. Ultimately, stringent efforts of environmental and town planning officers are needed to enforce total compliance to all intended management regulations to check the menace.

1. Introduction

The term flood is pictured as a body of water which overflow swathes of land not normally inundated^[1]. It is apropos to assert that incidence of flooding is as old as humanity. Documental evidence showed that it all started with the Noachian deluge when the surface of the earth was submerged by water orchestrated by unabated torrential rainfall which led to the extermination

of mankind with the sole exclusion of Noah's household^[2]. The forgoing narrative thus suggest the necessity on the part of man to mitigate the effects of flooding in his environment by ensuring that all vulnerable landscape is identified and precautionary measures are put in place to tackle the impending challenge headlong.

Flooding is a global phenomenon ravaging both the developed and developing nations with its deleterious effects sparking serious attention; which has become sub-

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ject of research interest among climatologist, hydrologist, economist, urban planner and other professionals in the built environment. This is not unconnected to the fact that it is the most common and destructive of all natural hazards with wide reaching effects, wrecking havocs to the built and natural environments, as well as, endangering human health and material possessions^[3]. Natural catalytic factors influencing flood disasters had been attributed to meteorological and hydrological phenomenon which include prolonged rainfall, storm surge, glacial melt among others^[4]. It is imperative to emphasize that the degree of susceptibility of man and his environment to this natural catastrophe is tending towards socio-natural inclinations. The bottom-line of this discourse rested on the fact that flood hazard is chiefly of human origin, aggravated by hydrologic modifications and encroachment into flood prone landscapes.

In the words of Ogunbodede and Sunmonu^[5], urbanization is one of the principal factors influencing frequency, intensity and magnitude of flood disasters across the globe. This is compounded in Nigeria by poor urban planning, weak urban governance structures and haphazard land use development. The impact of climate change as a result of industrialization and emission of greenhouse gases with respect to flooding was remarked by Okonkwo and Onyeizugbe^[6] as factor that increase global temperature which, invariably, stimulate torrential rainfall, sea level rise and glacier melt. Socio-economic standings of man have also been adduced to be one of the elemental variables influencing vulnerability to flood disasters. Residents with low income status are often disposed to living in less hazard resistant structures in flood prone environment owing to intricate pauperism characterized by lack of alternative and well located safer places of abode^[7].

The devastating effect of flooding in Nigeria is heart-rending, leaving victims in a state of despair. Agbonkheshe et al^[8] documented that residents of Ibadan would not forget in a hurry the historic August 31st flooding that claimed 300 lives and rendered 50,000 people homeless while properties estimated at over 300 million Naira were lost to the flood. According to Federal Government of Nigeria^[9], the national calamity of the 2012 flooding which was described as the worst disaster in forty years is still fresh in the memory of Nigerians where 363 people lost their lives, 5851 were injured and 3,891,314 affected in one way or the other while 387,153 were displaced. According to this document, flooding through watercourses occasioned by excessive downpour is a regular phenomenon in Nigeria, leaving these rivers overflowing their banks to proximate residential areas with dire consequences on

health and socio-economic wellbeing of residents. It is an establish fact in literature that human interference on river catchments is a potent factor influencing flood behavior^[3]. On this note, this study is set to examine anthropogenic activities influencing incessant flooding in Ala riverfront residential zones of Akure, Nigeria. It will identify areas vulnerable to flood risk using GIS device with a view to providing recommendations that could assist in upstream policy dialogues towards mitigating persistent flood hazard in the study area.

2. Literature Appraisal

Suffice to say that incidences of flooding have done more harms than good to humanity. Going by the words of Ajie and Frank^[10], it is regarded as the worst natural disaster across the globe responsible for one-third of all natural exigencies with grave impairments on infrastructure, the built environment and human life. Thus, it becomes a source of concern to all and sundry looking at the fact that, whether developed or developing, no nation is immune to incidents of flooding.

Expositing on the issue of flooding in the developed nations, Salami et al^[11] avowed that, in spite of technological advancement and increased technical know-how, calamities arising from flood cases is yet unabated. Jha et al^[4] were of the view that modifications of Yangtze River Basin in Southern China through the process of reclamation which birthed cities like Wuhan, Changsha and Nanchang has heightened issues of flood disasters in the region. They further argued that human-induced activities in these vulnerable areas led to flood disaster in 1998 which resulted in the death of more than 4,000 people while economic activities and material possessions worth 25 billion US dollars were lost to the flood.

The United States is not left out in the fret of flood catastrophe. Nwala^[12] reported that heavy downpour in mid-May of 2002 precipitated into flooding where homes were destroyed and fatalities recorded. Genovese^[13] equally lamented that issues of flooding in Central Europe remained the most significant hazard to her environmental landscape, population and economy. It is worth noting to point out that cases of flood disasters in United Kingdom, Australia, and other developed climes are replete and well documented in literature. However, there is a consensus among scholars that the developed world had, over the space of time, put in place effective disaster management strategies coupled with strong institutions to prepare, respond and recover as well as mitigate effects of impending flood disaster in their environment.

Going by the level of vulnerability to flooding, it can be deduced that Africa is fast evolving as the epicenter

of flood related disaster casualties. Mulugata et al ^[14] recounted that from 1990 to 2006, flood related problems have adversely affected almost 40 million Africans including 19,150 deaths and damages valued at about 4 billion US Dollars. Notable among these flood adversities include that of the Natal Province inundation in 2009 orchestrated by a non-stopping five-day rainstorm which swept away 400 lives and rendered 55,000 homeless in South Africa ^[15]. Kita ^[16] reported the Malawian flood tragedy in 2015 where 1.1 million people were affected; 230,000 displaced, 106 deaths recorded while 176 were declared missing.

The storyline is not different in Nigeria. It could be argued that instances of flood related disasters in the nation abounds in literature and could not be chronicled in a single piece of writing. Memorable ones include Ibadan flood calamities in 1980, 1985, 1987, 1990, 2011 and 2012 ^[6,17,18]. Osogbo in 1992, 1996 and 2002, Yobe in 2000, Akure in 1996, 2000, 2002, 2004, 2006 (even up to 2018, 2019 till date), as well as Kengana (Sokoto State) in 2010 ^[6,17]. Adamawa, Taraba, Benue, Niger, Kogi (Lokoja), Anambra, Delta, Edo, Rivers, Cross River and Akwa-Ibom in 2012 ^[19]. Others include Yenegoa in 1999, 2001 and 2012, Kano in 1988 and 2001 and Lagos in 2011, 2012 and 2017 ^[6,8,20]. However, the most devastating of all flood disasters in Nigeria in terms of magnitude, intensity and casualties was that of the 2012 cataclysm where 31 states were severely affected.

The scenarios illustrated above necessitated the need to create a flood disaster management cycle (FDMC) as a measure towards mitigating the adverse effects of flooding. In the work of Ranjan and Joseph ^[21] on Integrated Approach to Urban Flood Control and Management, some steps were advocated as necessary actions towards effective flood management and control. This is shown in Figure 1.

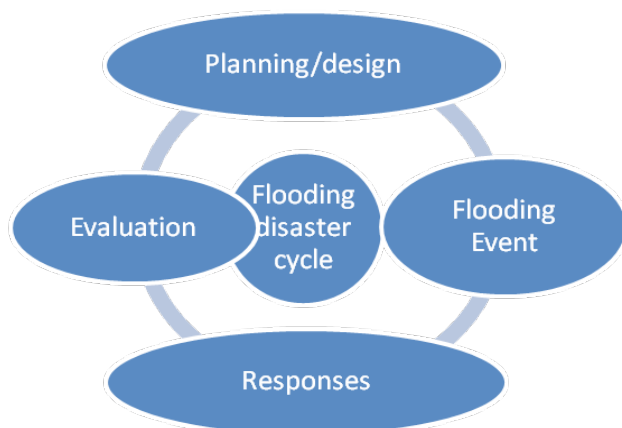


Figure 1. Flood Disaster Management Cycle (FDMC)

Source: Ranjan and Joseph ^[21]

From the figure, the cycle commenced with planning and design stage, otherwise called predevelopment stage, where all criteria set by client is measured and checked in acquiescence to the appropriate standards. The next stage is the flood event itself, where early warning signs and forecasting are made available; depending on the operating system in the observation area. This is followed by response stage, which often involve flood mitigation measures like flood insurance and damage control. The last phase is the evaluation stage where the level of damage and extremity of flood is being assessed. Essential factors affecting decision making at this stage is often determined by politics, costs, and national guidelines or operating standards.

It is pathetic to note that issues of flood disaster management in Nigeria is still largely unaddressed by both government and the governed thereby subjecting larger proportions of her citizens who are underprivileged to flood vulnerability. It is even disheartening to know that Nigeria is constrained of adequate infrastructure to deal with storm and surface water which tends to accelerate flood cases. To address this ugly development, the Federal Government of Nigeria, through National Emergency Management Agency (NEMA) put together a policy document known as National Disaster Management Framework (NDMF) to tackle flood and other socio-natural related disasters ^[22]. Conversely, Wahab and Faboyede ^[23] argued that the policy framework has not achieved significant result going by the review of flood related challenges in Nigeria. Their sticking point was not unconnected to the fact that NEMA orientation towards flooding over the space of time had been more of reactionary approach, centering on evacuation and provision of relief materials with little or no efforts on preventive and reduction strategies. In spite of technological innovations, Saleh ^[3] averred that scholars had come to a conclusion that incidence of flooding is inevitable. As such, it behooves on humanity to adopt resilient and harmonious synchronicity with flood issues. The crux of this matter is captured in the words of Ezemonye and Emeribe ^[24] where they concluded that the cost implication of recovery and rehabilitation measures are huge; thus, precautionary strategies should be accorded topmost priority with a view to stemming the tide of flood disaster in Nigeria.

It is therefore important to advocate for a paradigm shift in flood disaster management by employing geospatial technologies, which include remote sensing and GIS applications, to identify and map out vulnerable landscapes susceptible to flooding. Data from these applications, coupled with institutional forecasts from Nigeria

Meteorological and Hydrological agencies, would help in aiding decision dialogues towards flood risk management with emphasis on raising resident's awareness to flood vulnerable zones and possible mitigating measures to combat the phenomenon headlong.

3. Materials and Method

3.1 The Research Locale

The study area is Ala river basin, situated in Akure city in Southwestern Nigeria. It covers the riverfront residential areas, demarcated with the aid of goggle imagery at 40m buffer left and right sides of the river. It occupies a landmass of 110 km², spatially located within Latitudes 7°14'N and 7°19'N of the equator, and longitudes 5°8'E and 5°16'E of the Greenwich Meridians. Generally, Akure is a city located within the tropical rain forest region of Nigeria where rainfall is high in about 8 to 9 months of the year [25]. It is the administrative headquarter of Akure South LGA and Ondo State capital. The centrality nature of the city put together with her administrative functions had seen the city growing in leaps and bounds, cutting across different sphere of development, as it provides home to people of different divide. Ala River is a major waterway that cut through Akure city. The total spatial coverage of the river is estimated at about 57km, flowing across regional boundaries through Oba-Ile to Edo State. Figures 2, 3 and 4 elucidate the study area in both national and local contexts.

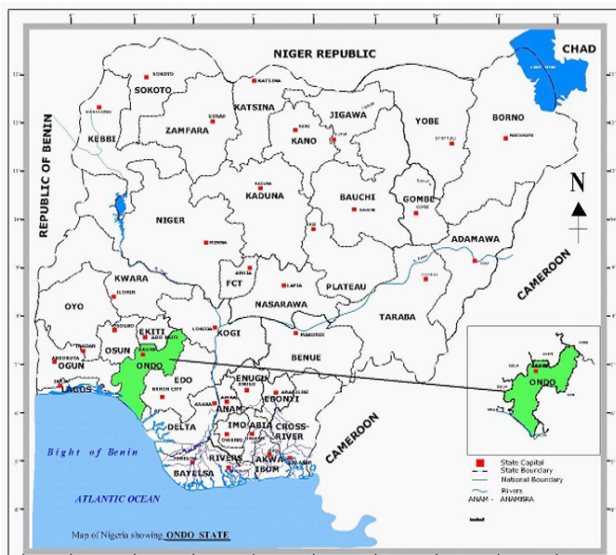


Figure 2. Ondo State in the National Setting

Source: Ondo State Ministry of Physical Planning and Urban Development (2019)

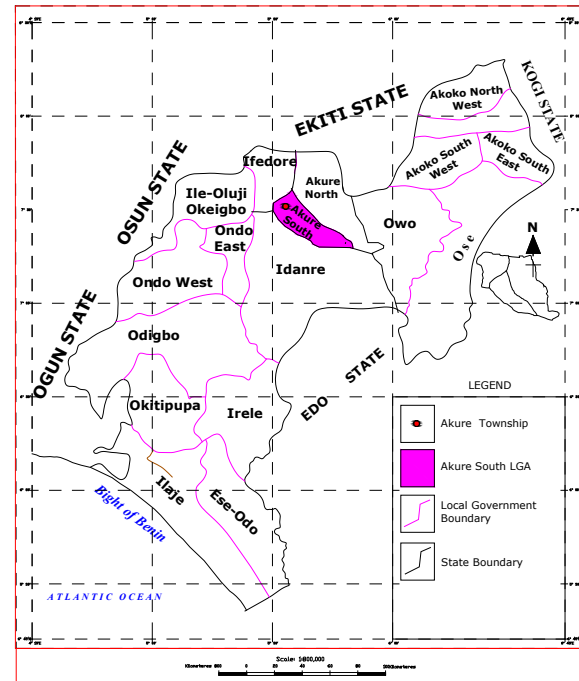


Figure 3. Ondo State Map Showing Akure South LGA.

Source: Ondo State Ministry of Physical Planning and Urban Development (2019)

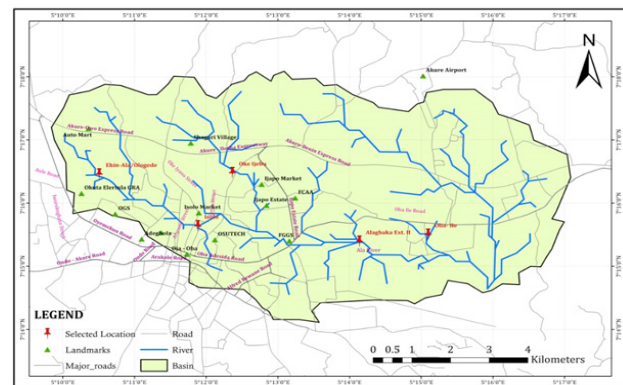


Figure 4. The Study Area - Ala River Basin - showing the River Course and its Tributaries

Source: Shuttle Radar Topography Mission (SRTM) Imagery (ArcGIS, 2019)

The study area is composed of rock outcrops which include Chanockite, Migmatite gneiss, Quartzite and Biotite gneiss among others [2]. For the purpose of lucidity, the spatial coverage for this study is limited to contiguous residential areas to Ala River. They comprise Oba Ile, Alagbaka Extension II, Oke Ijebu, Isolo and Ehin-Ala/Ologede communities, as clearly represented with red colour in Figure 4. With exponential increase, in terms of demography and morphology of the city; occasioned by urbanization, economic and socio-political development, the floodplain of Ala River was not spared. Riparian lands

bordering this river had continued to witness invasive encroachment for developmental activities. The end result of this intrusion into the wetland area of the river is made manifest in recurrent flood discharge and displacement of people living in this area at the peak of every rainy season. Olatona, et al ^[2] accepted that issues of human and material possessions along contiguous neighbourhood to this river has always been an issue of major concern looking at the fact that properties worth billions of naira are damaged annually.

3.2 Research Database

With respect to data collection for this study, building population of the research locale were obtained through Google Earth Imagery and digitized using GIS device to arrive at 1061 buildings. The report of the Ondo State Bureau of Statistics ^[26] on Integrated Household Survey conducted put an average household size in Akure urban and other major cities in the state at five persons per family (5ppf) and five households per building (5hpb). Thus, the population of the study area was estimated at 26,525. For the purpose of questionnaire administration, 1% of the estimated research population (265 persons) was served with questionnaire, using simple random sampling with replacement. This is considered reasonable taking into cognizance the homogeneous environmental morphology and socio-cultural background of the study area. The 264 questionnaires retrieved from respondents were used for the analysis through descriptive techniques, involving frequencies, percentages and photographs.

4. Results and Discussion of Findings

Result of findings on the anthropogenic activities influencing flood vulnerability in Ala riverfront residential areas of Akure is presented and discussed under different subheadings as follow:

4.1 Distance Location of Buildings to Ala River

Data retrieved from respondents, as shown in Table 1, and personal observation made in the course of this survey revealed that overwhelming majority of residents in Ala River proximate settlements, amounting to 26.9%, 40.9%, and 10.2% erect their structures between 5-10m, 11-20m and 21-30m to the river. This was inconsistent and not in consonance with town planning regulations which stipulates minimum of 30m setback from waterways. These developmental activities had encroached on riparian land in this locale thereby aggravating people's vulnerability to flooding with devastating effect ranging from displace-

ment of people, loss of hard-earned properties and human lives any time there is heavy downpour. This finding was in tune with the submission of Jha et al ^[4] who argued that issues of structures been subjected to town planning and building control was nothing to write home about in developing nations, like Nigeria.

Table 1. Location of Buildings to Ala River

Building Location in Meters	Frequency	Percent
5m - 10m	71	26.9
11m - 20m	108	40.9
21m - 30m	27	10.2
31m - 40m	49	18.6
Above 40m	9	3.4
Total	264	100

Source: Field Survey (2019)

4.2 Condition of Drainage System in the Study Area

Results from this survey with regards to condition of Ala River drainage channel showed that human induced activities have made the waterway becoming strait, thereby limiting its capacity to absorb excess water during torrential rainfall. The resultant effect is narrowed water channel that manifest in regular inundation of contiguous neighbourhood to the river as many of the drainages in those residential areas are in poor condition. This was empirically elicited in Table 2 with 46.2% of residents interviewed alluding to the poor condition of drainage system as major cause of incessant flooding while 28.4% assess the drainage system to be fair.

Table 2. Condition of Drainage System in the study area

Condition of Drainage	Frequency	Percent
Very Good	21	8.0
Good	46	17.4
Fair	75	28.4
Poor	122	46.2
Total	264	100

Source: Field Survey (2019)

This statistical discovery was in tandem with the findings of Uche ^[27] where he lamented that blockage of regular and synthetic drainage system in Nigeria was a principal factor triggering incidents of flooding. Figures 5, 6, 7 and 8 express the physical condition of drainage system in some parts of the study area.



Figure 5. Ala River Channel at Ehin-Ala/Ologede Area

Source: Field Survey (2019)



Figure 6. Ala River Drainage at Oba-Ile Community

Source: Field Survey (2019)



Figure 7. Dredging of Drainages at Alagbaka Ext. II

Source: Field Survey (2019)



Figure 8. Inundating Drainages during heavy rainfall

Source: Field Survey (2019)

Figure 9 shows a radar topographical imagery of Ala river drainage system. As shown in the figure, the drainage system in the study area is very narrow and ineffective to allow sufficient passage of surface run-off during heavy rainfall; hence, the road surfaces are washed away, houses are inundated, lives and properties are lost annually. Figures 10 and 11 show some few casualties. Therefore, there is need for provision of efficient drainage system that will assimilate the volume of run-off generated by the river.

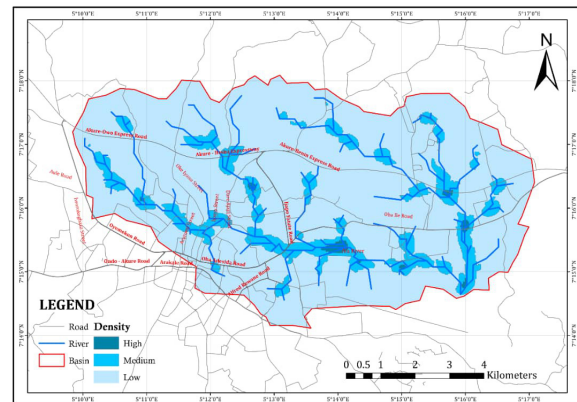


Figure 9. Map showing Drainage System in Ala River Basin

Source: Shuttle Radar Topography Mission (SRTM) Imagery (ArcGIS, 2019)



Figure 10. Houses submerged by flood at Isolo and Oke-ijebu area respectively

Source: Field Survey (2019)





Figure 11. Motor-bicycle rider that was rescued and people whose properties were carted away by flood

Source: Field Survey (2019)

Table 3 shows the annual rainfall pattern in Akure between 2010 and 2019 as received from the Nigerian Metrological Agency (NMA). From the table, it can be deduced that the mean annual rainfall has been relatively high over the years, which accounted for the incessant flooding in the study area. There is need, therefore, to put in place effective management control measures to reduce this menace.

Table 3. Annual Rainfall Pattern in Akure between 2010 and 2019

Year	Rainfall (MM)
2010	170.3
2011	142.2
2012	132.6
2013	135.4
2014	134.6
2015	144.8
2016	134.29
2017	134.56
2018	134.87
2019	135.11
Mean = 139.873; SD = 11.8	

Source: Nigerian Metrological Agency (2016)

4.3 Methods of Waste Disposal Facility in the Study Area

It is nothing but a cliché to point out that issues of waste management in Nigeria is a hydra-headed problem with most of her urban and rural landscapes in dearth of infrastructure to manage their wastes. With regards to Ala riverfront residential area, it was heartrending to reveal that larger proportion of residents in this locale has been so lackadaisical in their attitude towards indiscriminate

dumping of solid and liquid wastes on waterways. As shown in Figures 12 and 13, coupled with onsite observation, about 66% of the respondents dump their wastes in either drainages or directly into this river. This unhealthy practice often obstructs the swift flowing nature of this watercourse by creating bends and meanders which reduces its velocity and carriage capacity to contain excess water in the event of heavy downpour. The resultant effect of this unwholesome development did heightened incidents of flooding with devastating impacts on residents in the study area, ranging from health to socio-economic challenges. This finding is in consonance with the revelation of Akinola and Adewale^[19], Owioye and Adedeji^[28] where it was uncovered that indiscriminate dumping of solid waste into streams, rivers and drainages, was a common practice in Ibadan and Akure metropolitan environment respectively with upsetting effects.

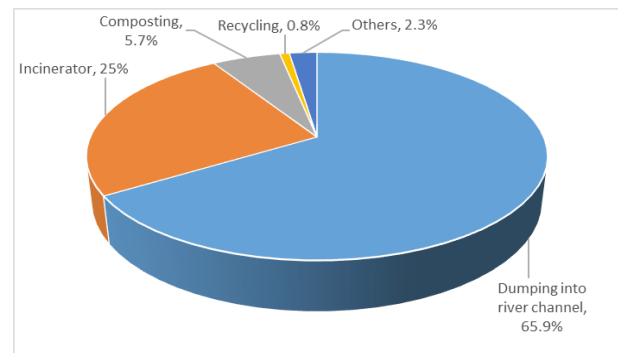


Figure 12. Waste Disposal Methods in the Study Area

Source: Field Survey (2019)



Figure 13. Drainage blocked by wastes in the study area

Source: Owioye and Adedeji^[28]

4.4 Level of Vulnerability and Community Compliance to Flood Control Measures

Issue of community participation in flood disaster management in terms of preparedness, response, recovery and mitigation is a topical discourse among scholars in Nigeria looking at the fact that the current top-down approach has failed from time immemorial. This is even considerate taking into account that matters of local peculiarities

and cultural anthropology would be better addressed. Conversely, data retrieved from residents in this locale with regards to this subject-view, as elicited in Figure 14, showed that community compliance to flood control measures was poor with about 56.1% of sampled respondents lend credence to this submission. Areas of concern by contiguous communities include contravention to town planning regulations, defiance to institutional forecast and warnings of impending flood incidents, among others.

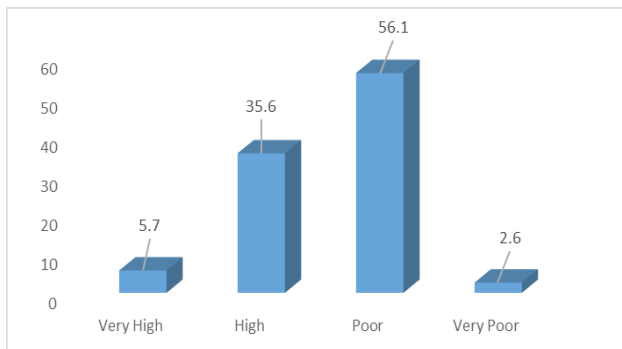


Figure 14. Level of community's compliance to flood control measures

Source: Field Survey (2019)

Quite disheartening to reveal from the interview with respondents that residents in these environs are hampered by socio-economic challenges which serve as principal factors accelerating their vulnerability to flooding. For instance, the income distribution of sampled respondents displayed in Figure 15 revealed that over 60% earn not more than N40,000 as monthly incomes. This practically reduce the capability to observe all precautionary measures by translating flood disaster forecasts and recommended mitigating measures into reality.

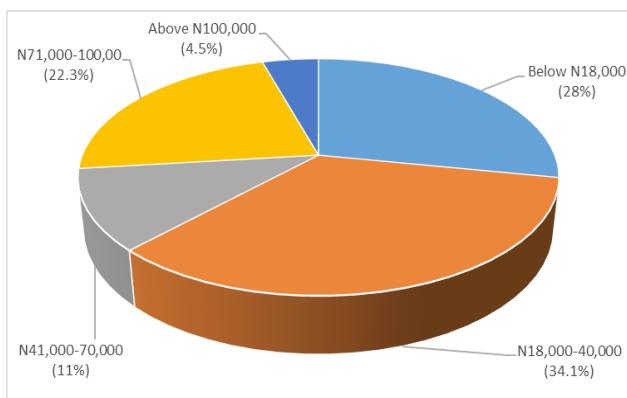


Figure 15. Monthly Income Distribution of Sampled Respondents

Source: Field Survey (2019)

The flood vulnerability map displayed in Figure 16 shows the area of high, medium and low vulnerability. The areas identified as highly vulnerable to flood are plac-

es where there is high drainage density with poor drainage system; especially, locations where the tributaries flow directly into the main river course. The medium and low vulnerable areas are less affected due to their distances from the main river course. Hence, there should be effective flood management measure for the areas vulnerable to curtail incessant flooding.

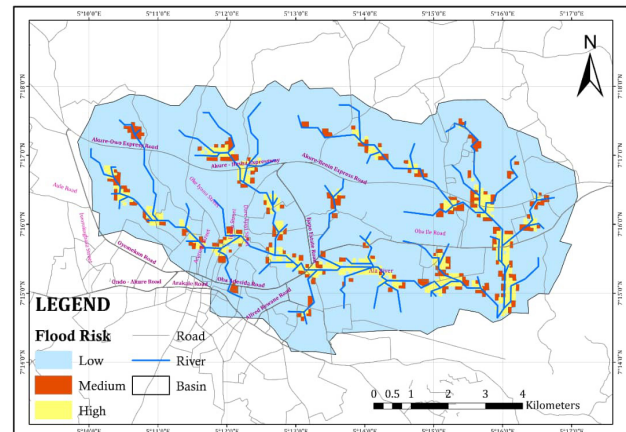


Figure 16. Map showing Flood Vulnerability in Ala River Basin

Source: Shuttle Radar Topography Mission (SRTM) Imagery (ArcGIS, 2019)

5. Conclusion and Policy Recommendations

Scholars across different professions in the built environment had overtime advocated for the need to reconcile human activities with nature so as to ebb down tendencies of socio-natural disasters arising from this binomial interplay. Paradoxically, this only exist in fiction as policy makers across different clime appears to show little or no commitment towards this direction. Investigation into human-environment interactions in the neighboring communities revealed indiscriminate erection of structures on wetlands, dumping of refuse into river channels and blockage of drainage system as well as defiance to environmental laws by residents in the community. The result of this incursion into Ala riparian zone had heightened issues of flood disasters in this locale with recurrent disruptions on socio-economic livelihoods and damages to material possessions. Thus, the following policy recommendations are proffered with a view to stemming the tide of flood disasters in the area:

(1) Public enlightenment campaign on the need to educate the residents on probable danger of flood disasters in their locality with a view to reducing their vulnerability.

(2) Enforcement of town planning regulations in Ala proximate residential areas by communicating appropriate notices to owners of buildings on flood prone landscape.

(3) Provision of waste management infrastructure, which should be of utmost priority as residents are often constrained to dumping their wastes in river channels owing to dearth of these facilities within their vicinity.

(4) Regular cleanup of drainage systems in Ala contiguous communities should be enhanced with a view to ensuring free flow of water during heavy downpours to reduce incidents of flooding.

(5) Regular dredging of the river waterway to increase its capacity to absorb excessive water during and after torrential rainfall.

(6) Finally, the creation of integrated artificial lake as natural basin to collect large volume of water discharged from all watersheds leading to the river will be a sustainable invention to check incessant flooding in the area. This can, as well, be used for sustainable urban agriculture around the place in the form of irrigated farming and fishing activities.

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Conflict of Interest

Authors declare no conflict of interest regarding the publication of this article.

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