Volume 18 Issue 30
Originally issued as B3



Global Journal of human-social science: B
Geography, Geo-Sciences, Environmental Science & Disaster Management
Volume 18 Issue 3 Version 1.0 Year 2018
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-460x & Print ISSN: 0975-587X

# Flood Effects on Agricultural Productivity: Implications for Mangrove Forest Ecosystem in Akpabuyo, Cross River State, Nigeria

By Joy Eko Atu & Edet, Mary Okon
*University of Calabar*

*Abstract-* Flood is a natural disaster that affects lives, livelihoods, household food security and natural ecosystems. Hence, the study sought to determine flood effects on agricultural productivity: Implications for Mangrove Forest Ecosystem in Akpabuyo, Cross River State, Nigeria. Specifically, the paper identified high and low-risks flood areas in Akpabuyo, determined the frequency of flood events and extent of agricultural land inundation, identifying the crops species affected by flooding, and assessed the income and food survival strategies of farmers affected by annual flood events. Descriptive statistics (frequency counts, percentages, and averages were employed to analyze the data derived from a structured questionnaire and field measurement of elevation of high and low-risk flood areas. Results revealed that the agricultural land at high risk of flooding is those with 1-44 metres elevation above sea level Table 1. Findings on Table 4show that, the food staple most affected are the root or tuber species with 77.52 percent annual destruction, vegetable species were also at high risk, and some economic crops like Musa spp (plantain) were also at high risks of destruction. The result further revealed that, income loss and food shortages occasioned from flooding of agricultural land are mitigated by Mangrove Forest Ecosystem Resources Extraction Table 6. Thus, conservation of the Mangrove Forest ecosystem in Akpabuyo and Cross River State is tied to the efficient management and mitigation of flood events in agricultural land.

*Keywords:* *mangrove ecosystem, forest flood effects, agricultural productivity, elevation.*

*GJHSS-B Classification:* *FOR Code: 960399*



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# Flood Effects on Agricultural Productivity: Implications for Mangrove Forest Ecosystem in Akpabuyo, Cross River State, Nigeria

Joy Eko Atu [α] & Edet, Mary Okon [σ]

*Abstract-* Flood is a natural disaster that affects lives, livelihoods, household food security and natural ecosystems. Hence, the study sought to determine flood effects on agricultural productivity: Implications for Mangrove Forest Ecosystem in Akpabuyo, Cross River State, Nigeria. Specifically, the paper identified high and low-risks flood areas in Akpabuyo, determined the frequency of flood events and extent of agricultural land inundation, identifying the crops species affected by flooding, and assessed the income and food survival strategies of farmers affected by annual flood events. Descriptive statistics (frequency counts, percentages, and averages were employed to analyze the data derived from a structured questionnaire and field measurement of elevation of high and low-risk flood areas. Results revealed that the agricultural land at high risk of flooding is those with 1-44 metres elevation above sea level Table 1. Findings on Table 4show that, the food staple most affected are the root or tuber species with 77.52 percent annual destruction, vegetable species were also at high risk, and some economic crops like *Musa spp* (plantain) were also at high risks of destruction. The result further revealed that, income loss and food shortages occasioned from flooding of agricultural land are mitigated by Mangrove Forest Ecosystem Resources Extraction Table 6. Thus, conservation of the Mangrove Forest ecosystem in Akpabuyo and Cross River State is tied to the efficient management and mitigation of flood events in agricultural land.

*Keywords: mangrove ecosystem, forest flood effects, agricultural productivity, elevation.*

## I. Introduction

Flood is a global challenge in the face of a changing climatic pattern. Typically, floods are outcome of extreme weather events such as precipitation (e.g. prolong rainfall and melting snow from snowfall), which are exacerbated by the geographical location and human activities of a place. Abua, Ewara, Abua & Atu (2009) argued that these factors are responsible for the flooding events in Nigeria, as one-third of the landmass of Nigeria is at an elevation of less than eight meters above sea level. Areas liable to flooding are low-lying areas, but the southern parts of Nigeria are more vulnerable due to the double maxima rainfall experienced for a prolonged period, usually between March-October and as early as February-November in some southern states like Cross River and Rivers states.

*Author α σ: Department of Geography & Environmental Science, University of Calabar, Nigeria. e-mails: joye.atu@gmail.com, edetmary75@yahoo.com*

Flood over the years has caused severe damage to property, infrastructure, crops and deaths across the country, and has been considered as a source of increased risks to disease and hunger (Baiye 1988; Edward-Adebiyi 1997), damage to property, loss of life, contamination, and spoiling of agricultural land (Umoh, 2008). Akpabuyo in Cross River State is an agrarian community dependant on optimal production of their farm enterprise for food security and livelihood needs, but, the undulating, low-lying topography enmeshed within the Great Kwa and Calabar River makes Akpabuyo a candidate for frequent and prolonged inundation. The literature on flood events and the impacts on different sectors of the Nigerian environment is robust (see, Akintola and Ikuyatum, 2006; Umoh 2008, Abua, et al. 2009; Kalu 1984, Areola and Akintola 1980). But, none of the studies related degradation of forest ecosystem with destruction of farmlands by flood and this is the focus of this study. Therefore, the study:

1. Identified high and low-risks flood areas in Akpabuyo, Cross River State.
2. Determined the frequency of flood events and extent of agricultural land inundation.
3. Identify the crops species affected by flooding.
4. Examined the relationship between flood, cultivated crops and forest resource exploitation and degradation in Akpabuyo, Cross River State.

## II. Methodology

*Study Area:* Akpabuyo is a Local Government Area (LGA) in the Southern axis of Cross River State, Nigeria. The LGA was created in 1991with an administrative headquarters located at Ikot Nakanda. Akpabuyo is made up of 28 villages of three major dialectical groups (the Efiks, Quas, and the Efuts), but, the English language is the official spoken language (Tip Top Globe, 2016). Akpabuyo is located between latitude $4^0$5' North and $5^0$4' South and longitude $8^0$25' West and $8^0$32' East Fig 1 and had a total population of 271,325 in 2006 (NPC, 2006). The population is projected to be 307, 4117 as at 2017 using 3.0 growth rate of the region.

A reconnaissance survey was undertaken before the actual field work to identify the areas prone to flooding, identify farmers and seek their consent for the



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sample. The study adopted the methodology of (Atu and Bisong, 2013) in selecting sample sites. Thus, 10 villages were purposively chosen out of the existing 28 villages to form the sample, based on their elevation and dominance in agricultural activities and flood events. Five of the villages are in areas prone to flooding and five in areas not too prone to flooding. The geographical coordinates and elevation were noted. Field observation and measurement, interview and household (HH) questionnaire were utilized in collecting data. A total of 400 questionnaire were administered by adopting the Yaro Yamane's formula given as:

$$n = 11 + Ne2$$

Where: n=Sample Size; N=Population Size; e=Level of Confidence (taken as 0.05) and 1=constant. Hence, 400 copies of questionnaire were distributed, and 13 copies of the questionnaire were found to be inconsistent with the objectives of the study. Therefore, 387copies of the questionnaire were retained for the study. Two hundred and two copies of the questionnaire were those of communities at high risk of flood and 185 are from communities at low risks of flood.




*Source: (Atu & Iwuanyanwu 2017)*

*Fig. 1:* Akpabuyo Local Government Area (insert: Cross River State & Nigeria)



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## III. Results and Discussion

*a) Identified High and Low Risks Flood Areas in Akpabuyo*

The areas liable to annual flood event depicted on Table 1 lie within longitude $8^0$ 23' 39.6'' and latitude $4^0$ 54' 11.6" with an elevation of 18-44 meters above sea level. Therefore, Esuk Mba, Akans Oko, Ikot Ene Umo, Idebe and Atim Asam are the areas at risk of flooding annually. But the community with the highest risk is Ikot Ene Umo with only 18 meters elevation above sea level.

*b) Frequency of Flood*

Table 2 shows the frequency of flood events as responded to by the sampled population. 71.28 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. The annual flooding has implications for the variety of crops cultivated as the arable crops such as maize (*Zea mays*), cassava (*Manihot esculenta*), and cocoa yam (*Dioscoreaspp*) cannot withstand prolonged submergence. These crop types are highly susceptible to stagnant water as the roots of the crops rot easily.

*c) Extent of Agricultural Land Affected by Flood Annually*

The extent of agricultural land annually affected by flood on Table 3 between 51-100 hectares and above (The extent of farmlands annually affected by flood was estimated from calculating the sizes of the farmland of farmers that indicated that their farmlands are annually flooded (47.03 and 16.04% cumulatively to 63.07 %).

*Table 1:* Geographical Location of High and Low-Risks Flood Areas

| | High-Risks Flood Areas | | | | |
|---|---|---|---|---|---|
| | **Esuk Mba** | **Akans Oko** | **Ikot Ene Umo** | **Idebe** | **Atim Asam** |
| Longitude | $8^0$ 23' 39.6" | $8^0$ 27' 51" | $8^0$ 35' 30' 8" | $8^0$ 26' 49.8" | $8^0$ 24' 47.2" |
| Latitude | $4^0$ 54' 11.6" | $5^0$ 2' 25.3" | $4^0$ 54' 24.9" | $4^0$ 51' 33" | 4' 57' 34.5" |
| Elevation (M) | 44 | 27 | 18 | 34 | 39 |
| | **Low-Risks Flood Areas** | | | | |
| | **Akwa Ikot Effanga** | **Ikot Edem Odo** | **Ikot Effiong Essien** | **Ikot Ene** | **Ikot Offiong Amba** |
| Longitude | $8^0$ 29' 12.8" | $8^0$ 24' 31.9" | $8^0$ 24' 52" | $8^0$ 27' 41.9" | $8^0$ 26' 59.6" |
| Latitude | $4^0$ 57' 39.3" | $4^0$ 53' 15.7" | $4^0$ 52' 17.8" | $4^0$ 54' 54.6" | $4^0$ 55' 56.7" |
| Elevation (M) | 75 | 52 | 59 | 45 | 62 |

*Table 2:* Frequency of Flooding

| High-Risks Flood Areas | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Frequency of Flooding** | **Esuk Mba** | **Akans Oko** | **Ikot EneUmo** | **Idebe** | **Atim Asam** | **Total** | **%** |
| Annually | 45 | 32 | 16 | 23 | 28 | 144 | 71.287 |
| Every 2 Years | 13 | 8 | 3 | 10 | 6 | 40 | 19.802 |
| Once in Three Years | 4 | 2 | 1 | 0 | 2 | 9 | 4.455 |
| Once in Four Years | 1 | 2 | 0 | 0 | 0 | 3 | 1.485 |
| Once in Five Years | 1 | 0 | 0 | 1 | 2 | 4 | 1.980 |
| Once in Six Years | 1 | 1 | 0 | 0 | 0 | 2 | 0.990 |
| Never | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tallied Responses and Percentage | | | | | | 202 | 1000 |
| **Low-Risks Flood Areas** | | | | | | | |
| **Frequency of Flooding** | **Akwa Ikot Effanga** | **Ikot Edem Odo** | **Ikot Effiong Essien** | **Ikot Ene** | **Ikot Offiong Amba** | **Total** | **%** |
| Annually | 12 | 10 | 2 | 14 | 2 | 40 | 21.622 |
| Every 2 Years | 9 | 13 | 6 | 9 | 6 | 43 | 23.243 |
| Once in Three Years | 6 | 10 | 6 | 1 | 4 | 27 | 14.594 |
| Once in Four Years | 14 | 8 | 5 | 4 | 1 | 32 | 17.297 |
| Once in Five Years | 1 | 4 | 1 | 4 | 12 | 22 | 11.892 |
| Once in Six Years | 0 | 4 | 0 | 0 | 3 | 7 | 3.784 |
| Never | 2 | 6 | 1 | 1 | 4 | 14 | 7.568 |
| Tallied Responses and Percentage | | | | | | 185 | 100 |



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*Table 3:* Extent of Agricultural Land Inundation

| Farms Flooded in Hectares | Esuk Mba | Akans Oko | Ikot Ene Umo | Idebe | Atim Asam | Total | % |
|---|---|---|---|---|---|---|---|
| Less than 20 | 2 | 7 | 10 | 2 | 3 | 24 | 11.881 |
| 21- 50 | 6 | 15 | 13 | 6 | 10 | 50 | 24.753 |
| 51-100 | 10 | 18 | 30 | 17 | 20 | 95 | 47.030 |
| Above 100 | 2 | 5 | 12 | 5 | 9 | 33 | 16.337 |
| Tallied Responses and Percentage | | | | | | 202 | 100 |
| | | | | | | | |
| Farms Flooded in Hectares | Akwa Ikot Effanga | Ikot Edem Odo | Ikot Effiong Essien | Ikot Ene | Ikot Offiong Amba | Total | % |
| Less than 20 | 12 | 26 | 5 | 21 | 24 | 88 | 47.568 |
| 21- 50 | 17 | 18 | 10 | 7 | 6 | 58 | 31.351 |
| 51-100 | 14 | 8 | 5 | 4 | 1 | 32 | 17.297 |
| Above 100 | 1 | 3 | 1 | 1 | 1 | 22 | 3.784 |
| Tallied Responses and Percentage | | | | | | 185 | 100 |

*d) Crops Species Affected by Flood Waters*

The major crop species affected by flood listed on Table 5 revealed that household food staples are at most risks. These food staples include: vegetables, spices, legumes, tubers, grains, and fruits. Loss crops translate to loss income Table 6 and household food security which must be met via alternate sources. The most viable option for make-up source of livelihood and income for the farmers is harvesting from the Mangrove Forest Ecosystem resulting in exacerbated degradation of the Mangrove ecosystem. The demand on Mangrove Forest Ecosystem in the face of the challenging flood event is massive. Over 77.52 percent of the population sourced their energy needs from the forest, 51.68 looked to the forest for their protein, and 90.34 percent augment their vegetable need from the forest when crops are destroyed by flood. These findings have implications for the Mangrove ecosystem management and conservation, because, unless the menace of flooding agricultural land is tackled by relevant agencies the pressure to meet the food and economic needs of farmers will be met by the Mangrove forest.

*Table 4:* Crop Species Affected by Flood in Akpabuyo, Cross River State, Nigeria

| Crop Types | Local Name | Botanical Name | Frequency of Cultivation | Percentage Cultivation |
|---|---|---|---|---|
| Vegetables | Fluted Pumpkin | Telfairiaoccidentalis | 202 | 52.20 |
| | Waterleaf | Talinum fruticosum | 187 | 48.32 |
| | Okro | Abelmoschus esculentus | 160 | 41.34 |
| | Green | Amaranthus spinosus | 66 | 17.05 |
| | Bitterleaf | Vernonia amygdalina | 59 | 15.25 |
| Spices | Pepper | Capsicum maximum | 100 | 25.84 |
| | Tomatoes | Solanum lycopersicum | 40 | 10.34 |
| | Curry | Murrayakoenigii | 30 | 7.75 |
| | Scentleaf | Ocimumgratissimum | 37 | 9.56 |
| Legumes | Melon | Cucumis melo | 69 | 17.83 |
| Tubers | Cassava | Manihot esculenta | 300 | 77.52 |
| | Yam | Dioscoreaspp | 101 | 26.09 |
| | Sweet Yam | Dioscorearotundata | 200 | 51.68 |
| | Water Yam | Dioscoreaalata | 150 | 38.76 |
| Grains | Maize | Zea mays | 167 | 43.15 |
| Fruits | Oranges | Citrus sinesis | 77 | 19.90 |
| | Mango | Mangiferaindica | 86 | 22.22 |
| | Banana | Musa sepentum | 100 | 25.84 |
| Economic | Plantain | Musa x paradisiaca | 200 | 51.68 |
| | Oil Palm Fruit | Elaeisguineensis | 47 | 12.45 |



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*Table 5:* Estimated Average Income Losses from Destroyed Crops due to Flood

| High-Risks Flood Areas | | | | | | | |
|---|---|---|---|---|---|---|---|
| Income Loss (N) | Esukmba | Akansoko | Ikot Eneumo | Idebe | Atimasam | Total | % |
| ≤ 20,000 | 5 | 4 | 4 | 3 | 4 | 144 | 71.287 |
| 20,000-40,000 | 5 | 4 | 3 | 3 | 4 | 40 | 19.802 |
| 41,000-60,000 | 7 | 5 | 2 | 5 | 8 | 9 | 4.455 |
| 61,000-80,000 | 13 | 11 | 5 | 10 | 8 | 3 | 1.485 |
| 81,000-100,000 | 15 | 14 | 5 | 8 | 6 | 4 | 1.980 |
| ≥ 100,000 | 20 | 7 | 1 | 5 | 10 | 2 | 0.990 |
| Tallied Responses and Percentage | | | | | | 202 | 1000 |
| **Low-Risks Flood Areas** | | | | | | | |
| Income Loss (N) | Akwa Ikot Effanga | Ikot EdemOdo | Ikot Effiong Essien | Ikot Ene | Ikot Offiong Amba | Total | % |
| ≤ 20,000 | 3 | 4 | 2 | 4 | 3 | 40 | 21.622 |
| 20,000-40,000 | 10 | 13 | 7 | 10 | 7 | 43 | 23.243 |
| 41,000-60,000 | 18 | 22 | 6 | 10 | 6 | 27 | 14.594 |
| 61,000-80,000 | 5 | 8 | 5 | 5 | 5 | 32 | 17.297 |
| 81,000-100,000 | 3 | 4 | 0 | 2 | 5 | 22 | 11.892 |
| ≥ 100,000 | 5 | 4 | 1 | 1 | 6 | 7 | 3.784 |
| Tallied Responses and Percentage | | | | | | 185 | 100 |

*Table 6:* Make-up Food and Income Sourced from Mangrove Forest Ecosystem in Akpabuyo, Cross River State, Nigeria

| S/n | Mangrove Forest Ecosystem Resources Harvested | F | % |
|---|---|---|---|
| 1. | Fuelwood (Use & Sale) | 300 | 77.52 |
| 2 | Fishing / Game Hunting (Use & Sale) | 200 | 51.68 |
| 3 | Palmwine Tapping | 100 | 25.84 |
| 4 | Periwinkle (*Litorimalittorea*) & Snail (*Cornuaspersum*) | 260 | 67.18 |
| 5 | NTFP (e.g. Afang,-*Gnetum Africana*; Mushroom-*Agariscusbisporus)* | 350 | 90.44 |
| 6 | Timber | 40 | 10.34 |
| 7 | Oil Palm Fruit | 137 | 35.40 |
| 8 | Raffia Palm (*Raphia Farinifera*) & Indian Bamboo (*Bambusatulda*) | 200 | 51.67 |
| 9 | None of the Above | 10 | 2.59 |
| 10 | All the Above | 257 | 66.41 |

## IV. Discussion

This study is critical in the face of escalating extreme climatic events occasioned by changing global climate. The study revealed that the agricultural land at high risk of flooding is those with an elevation of 1-44meters above sea level and the community that is at the highest risk of flooding is Okot Ene Umo with an 18 meters elevation above sea level Table 1. Also, flood is an annual event implying that there is no respite from economic loss and household food shortages Table 2. From findings on Table 4, the crop types most affected are the root or tuber species with 77.52 percent annual destruction, vegetable species were also at high risk and some economic crops like plantain (*Musa spp*) were also at high risks of destruction from flood.

Furthermore, the finding demonstrated that the annual income loss of an individual farmer is as high as a hundred thousand naira, that is, about three hundred United States Dollar at current exchange rate of thirty-five naira to a dollar. Income loss and food shortages occasioned from inundation of agricultural land are mitigated from Mangrove Forest Ecosystem Resources Extraction Table 6. Thus, conservation of the Mangrove Forest ecosystem in Akpabuyo and Cross River State is tied to the efficient management and mitigation of flood events in agricultural land.



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## V. Conclusion

The results of this research are critical to the sustainability of family livelihood and the conservation of the Mangrove Ecosystem of Cross River State. The relevance lies in the fact that several conservation strategies have failed to yield the desired outcomes in the past years because the pressure, demand and harvest of the Mangrove Forest Ecosystem Resources has not been linked to the flooding and destruction of agricultural land and crops. These findings therefore have implication for the Mangrove ecosystem management and conservation, because, unless the menace of flooding of agricultural land is tackled, the protection of the remaining Mangrove ecosystem in Cross River State, Nigeria would remain a mirage.

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