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Empırıcal Analysıs of Flood Impact on Food Securıty in Nıgerıa's Coastal Regıons

ODIOR, K. A.[1,*]***, ELUGWU, F.***[1]

[1]*Department of Statistics, Delta State Polytechnic, Otefe, Oghara, Delta State*

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ABSTRACT

One common and recurrent natural disaster associated with the coastal region of Nigeria is flooding. The disaster created by flooding is exacerbated by climate change and rising sea levels with huge consequences on food availability, accessibility, stability and utilization. The impact of flood is profound and multifaceted in the region. Therefore, this study seeks to empirically explore and examine the impact of flooding on food security in the coastal region of Nigeria. Mixed statistical methods of Multiple Regression Analysis (MRA) and Geographically Weight Regression (GWR) were utilized to assess the relationship between flooding and food security indicators. Data for the study was collected from the coastal communities in Nigeria affected by flooding over the years. The findings demonstrated a significant negative impact of flooding on food security in the coastal region of Nigeria. GWR analysis reveals that the severity of food insecurity is more pronounced in communities with lower social economic status and limited adaptive capacities. The study established that the selected independent variables are statistically significant, an indication of the negative impact of flooding on crop yields. Thus, the study underscores the critical need for targeted intervention to enhance food security in flood affected coastal regions of Nigeria.

1. INTRODUCTION

One common natural event that often characterized the coastal region of Nigeria is flooding with it attendant consequences on the environment, agricultural activities, food production, properties and human survival. Flooding is the overflow of water into normally dry land due to heavy rain fall, storm surges (dam failure), rising sea-levels such that oceans, rivers, lakes cannot accommodate the water and cannot be absorbed by the ground or contained by artificial barriers. Therefore, flooding occurs in the coastal region when excessive amount of water from heavy rainfall or ocean surges inundates normally dry land. This region is characterized by the low-lying areas and proximity to large bodies of water hence vulnerable to flooding. The coastal region comprises of inshore waters, coastal lagoons, estuaries and mangroves especially in the Niger Delta states of Nigeria. Floods are recurrent natural disaster in this region that impact negatively on the environment including available farmland, access road thereby affecting and altering food supply

*Corresponding author, e-mail: odifullness@gmail.com
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chain and availability, stability and perhaps utilization. Floods depending on the intensity and severity submerge farmland and destroy crops with large scale consequences on crop yields, food availability, food prices and household food consumption patterns.

Onwabiko *et al.* (2017) examined the impact of recurrent flooding on rice production in the Niger Delta. The findings indicated a substantial drop in crop yields due to flood-induced soil erosion and water logging which severely affect the growth conditions for rice, availability and prices. Food security is an intentional process of ensuring that the entire population has adequate access to sufficient, safe, healthy and nutritious food all year round. However, flood impacts on food security through direct and indirect pathways affecting agricultural productivity, food supply chains and socio-economic conditions of flood prone communities.

Eze (2018) focused on cassava farms in the coastal areas of Lagos State. The study revealed that flooding resulting in 30% decrease in cassava yields, primarily due to root rot and delayed planting season. The disaster created by floods on a yearly cycle is enormous as practically all crops were affected from the planting point to the harvest period. Flood event resulted in huge financial losses, induced poverty on smallholder farmers and reduced farmer capacity to reinvest in agricultural inputs and technology (Nwaogazie and Odigure 2018).

Chikezie *et al.* (2019) explored the broader economic impacts of flooding on rural livelihoods, demonstrating how the destruction of farmlands and farm related infrastructure led to increased poverty and food insecurity among coastal communities. Floods continue to ravage and wreck unimaginable havoc on the coastal towns and villages destroying buildings, roads, farmlands and crops resulting to huge shortage in crop yields, food supply and food availability. The consequences of the foregoing are food shortage and perhaps food insecurity in the land.

The shortage of food supply due to the ravaging effect of coastal floods in the coastal communities together with continuous population growth has resulted in skyrocketing prices of staple food. Ayodele and Ikpi (2017) empirically investigated the impact of flooding on market access for farmers in Bayelsa state. The study revealed that poor transport infrastructure, massive flooding, limited farmer's ability to access market resulting in lower sales prices and huge post-harvest losses. Afolabi *et al.* (2018) assessed the food insecurity status of household affected by flooding in Delta state. The findings revealed that households affected by flood experienced higher levels of food insecurity, with reduced food intake and dietary diversity. The general level of food insecurity in the coastal regions and beyond are direct impact of flooding on farmland, road networks and residential areas within the coastal communities.

Obasi (2016) reported sharp price fluctuations of fish and other essential seafood in the Niger Delta where flooding significantly affected the availability of these products, causing remarkable price increases during and after flood event. Empirical literature underpins the significant impact of flooding on food insecurity indicators in Nigeria's coastal regions and other parts of Nigeria. Floods lead to reduced agricultural productivity, increased food prices and greater economic vulnerability and insecurity.

Iortyer and Yio(2023) examined the impact of flooding on food security and the findings revealed that there is always a gross inadequacy of food supply during the years of devastating floods compared to years of normal annual rainfall. Consequently, food insecurity indicators such as prices of agricultural product increase by almost 200% and household income decline significantly during the years that experinced flood disaster.

Okonkwo and Nwankwo (2020) conducted a longitudinal analysis of the impact of seasonal floods on maize production in the southern regions of Nigeria, specifically focusing on Cross River State. Using data collected over a 10-year period, the authors found that flood-prone areas consistently recorded 25–35% lower yields than upland regions. The study attributed these yield losses to prolonged water saturation that caused root suffocation, nutrient leaching, and delayed harvesting. They emphasized that this recurring pattern of reduced productivity places a heavy burden on subsistence farmers and contributes to regional food insecurity, especially in periods of consecutive flooding.

Umeh *et al.* (2021) evaluated the nutritional and food consumption impacts of recurrent flooding in selected coastal communities of Akwa Ibom State. The researchers administered structured questionnaires to over 200 households and found that families affected by flooding had a 40% decline in dietary diversity scores. Frequent displacement and crop destruction led to limited access to vegetables, protein sources, and carbohydrates. The study concluded that flooding not only reduces agricultural output but also undermines food access and nutrition, worsening malnutrition among children and women in low-income households.

Abdulraheem and Ibrahim (2017) focused on flood vulnerability mapping and its correlation with household food insecurity in Kogi State. Using GIS and remote sensing tools, they identified high-risk flood zones and overlaid food security data from household surveys. The analysis revealed that households located in highly flood-prone areas were 3.5 times more likely to experience food insecurity than those in low-risk zones. The study suggested that the combination of physical flood exposure and socio-economic vulnerability amplifies food insecurity risks in Nigeria’s riverine states.

Adetunji and Ogundele (2022) studied the socio-economic consequences of flood on rural farmers in Ondo State, where floodwaters had consistently wiped-out acres of farmland. Their findings showed that 68% of farmers experienced at least one crop failure in a two-year period due to flooding. The study noted that repeated income losses pushed many farmers into indebtedness and forced changes in consumption habits such as skipping meals or reducing food portions. This cyclical nature of post-flood food insecurity reflects the long-term impact of environmental shocks on rural food systems.

Ibrahim and Bassey (2019) explored the link between flood-induced displacement and food insecurity among fishing communities in Rivers State. Their research revealed that 45% of households had to abandon their homes and fish storage facilities due to flooding, resulting in significant spoilage of harvested fish and reduced food availability. Furthermore, the study reported that these communities faced food access difficulties for several months, relying on government relief materials that were often insufficient, delayed, or nutritionally inadequate.

Ogundipe and Adebayo (2020) investigated the impact of climate-related flooding on the storage and preservation of harvested food in coastal Lagos. The research found that flooding damaged over 60% of food storage structures, leading to post-harvest losses of yams, cassava, and grains. Many respondents reported that they lost a full season's harvest due to wet rot, mold infestation, or pest invasion after water ingress. These losses disrupted household food supply, triggered localized hunger, and discouraged reinvestment in farming.

Nwachukwu and Ezeh (2015) assessed flood risks and their implications for food availability and affordability in Imo State. Using econometric analysis, the study revealed that during flood years, average household food expenditure increased by 45%, while food availability dropped by 30%. The authors explained that floods damaged rural roads and disrupted supply chains, raising transportation costs and retail prices. The cumulative effect, they concluded, was a spike in hunger prevalence and a reduction in per capita caloric intake.

Scientific studies and existing literature revealed that flooding has profound effect on the environment by submerging farmlands, destroy farm infrastructure, obstruct pre planting, planting and post planting operations. Consequently, food security within and beyond the affected communities is threaten due to likely substantial reduction in crop yields, food supply, farmers' income, food availability, accessibility and utilization. Additionally, food insecurity created by massive flooding is stark reality confronting our nation demanding urgent and all-encompassing proactive interventions by all stakeholders. In the light of the foregoing, the study seeks to examine empirically flood impact on food security.

Nigeria's coastal regions are essentially important for the nation's food security due to their rich fertile soil, huge agricultural resources and significant contributions to the national food production. The large volume of water bodies such ocean, lakes, river, lagoons; estuaries are large reservoir of sea food that can contribute immediately to food production. However, these areas are increasingly vulnerable to flooding, a natural disaster exacerbated by climate change, rising sea levels and inadequate infrastructure resilience. Flooding poses a severe threat to food security through its devastating effects on farmland, crops yields, farm infrastructure, and access road thereby affecting food availability, accessibility and utilization.

Thus, the coastal regions face recurrent flooding which has profound implications for agricultural productivity, farmer's livelihoods and overall food security. This empirical study seeks to understand the extent of these impacts and identity key factors contributing to food insecurity in flood-prone areas. The study therefore in aim to provide evidence-based insights that can inform and direct policy making and strategic interventions to enhance the resilience of coastal communities.

Flooding, a recurring natural disaster in coastal regions, disrupts agricultural activities by submerging farmlands, damaging crops, and degrading soil quality, ultimately leading to reduced crop yields and decreased food availability. Additionally, flooding affects food supply chain through destruction of farm facilities and road infrastructure. The cumulative effects of these disruptions contribute immensely to food insecurity, particularly in areas with high poverty rates and limited adaptive capacities. Consequent upon the foregoing, the study therefore is intended to address the following main issues:

1. Empirically assess the impact of flooding on food security indicators in Nigeria" coastal regions
2. Evaluate the frequency and severity of floods and their direct effects on crop yields and agricultural productivity
3. analyse the relationship between flood events and food security indicators like crop yields
4. providing policy recommendations to mitigate the adverse effects of flooding on flood security

2. METHODOLOGY

Flood possess significant environmental challenges that disproportionately affects agricultural regions, especially the coastal areas. The impact of flooding on food security in Nigeria coastal regions is diverse and multifaceted in nature. Therefore, mixed statistical methods will be employed in this study integrating quantitative data with qualitative field observations. Data were collected from the coastal communities through interview, survey and secondary sources. Multiple Regression Analysis (MRA) and Geographically Weighted Regression (GWR) were employed to assess the relationship between flooding and food insecurity indicators. This empirical analysis is aim to provide actionable insights to enhance to enhance food security community resilience in the face of the recurrent floods.

In further search for food insecurity indicators created by flooding, a quantitative technique is adopted to determine the influence of the selected variables on crop yields.

The MRA model is specified as follows:

$$Y=\beta_0 + \beta_1 X_1+\beta_2 X_2+\beta_3 X_3 + \beta_4 X_4+\beta_5 X_5+\beta_6 X_6 + \beta_7 X_7+\varepsilon \quad (1)$$

Where

Y= Crop yield

X_1 = Number of flood event in a year

X_2 = Duration of flood events (days)

X_3 = Total area covered by flood (ha)

X_4 = Total annual rainfall (mm)

X_5= farm size

X_6= Soil PH level

X_7 = Farm input expenditure (#)

Also the model for Geographically Weighted Regression (GWR) is specified as follows:

$$Y_i = \beta_0(u_i v_i) + \sum_{k=1}^{p} \beta_k (u_i v_i), X_{ik} + \varepsilon \quad (2)$$

where:

Y_i = crop yieldβ_1 ($u_i v_i$). Number of flood event in a year, β_2 ($u_i v_i$). Duration of flood events (days), β_3 ($u_i v_i$). Total area covered by flood (ha), β_4 ($u_i v_i$). Total annual rainfall (mm),β_5 ($u_i v_i$). Farm size, β_6 (u_i v_i). Soil PH, β_7($u_i v_i$). Farm input expenditure (#).

β_1 ($u_i v_i$), β_2 ($u_i v_i$), β_3 ($u_i v_i$), β_4 ($u_i v_i$),β_5 ($u_i v_i$), β_6 (u_i v_i) and β_7($u_i v_i$) are the vary across, reflecting the impact of independent variables on crop yields

3. RESULTS AND DISCUSSION

In this section of the study, the researcher presents the results of the data analysis that was accomplished through R. code Statistical software. The study primary interest lies in empirically determining the influence of selected food insecurity indicators (independent variables) on crop yields in coastal region of Nigeria. The results were presented in Table 1, Table 2, Table 3 and Table 4 respectively.

Table 1: Empirical influence of selected food insecurity indicators

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig.
1	(Constant)	1.192	1.204		.990	.332
	Number of Floods per Year	-.019	.197	-.048	-.097	.002
	Duration of Flood Events (Days)	-.003	.043	-.022	-.058	.003
	Total Area Covered by Flood (ha)	-.005	.004	.601	-1.134	.002
	Total Annual Rainfall (mm)	-.001	.000	-.814	-3.203	.004
	Farm Size (ha)	.039	.009	.346	4.181	.000
	Soil pH Level	.567	.170	.574	3.346	.062
	Farm Input Expenditure (₦)	-1.502E-6	.000	-.108	-1.070	.029

a. Dependent Variable: Crop Yield per Hectare (tons/ha)

Standardized coefficients allow direct comparison of the relative importance of predictors. It also helps determine which variables have the strongest effects, especially when units differ. Parameters were standardized using z-scoring algorithm available in SPSS 27.0. However, since the focus of the study is on making predictions or understanding real-world impact of the predictors, the unstandardized coefficients were useful.

Considering **Table 1,** the fitted multiple regression model yields:

$$\hat{y} = 1.192 - 0.019x_1 - 0.03x_2 - 0.005x_3 - 0.001x_4 + 0.39x_5 + 0.56x_6 - 1.502x_7$$

(1.24) (0.197) (0.043) (0.004) (0.000) (0.009) (0.170) (0.000)

Where the values in parenthesis are the respective standard errors. The standard errors are relatively close to the parameter estimates, inevitable consequences of noncollinearity inherent in the structure of the data. The estimated regression parameters have negative signs except for x_5 and x_6. The negative signs clearly suggests that the number of flood in a year, duration of flood events (days), total area covered by flood(ha), total annual rainfall and total expenditure on farm inputs (₦) induces reduction in crop yields, thus creating food shortages and food insecurity.

From table 1 above, the regression results indicate that among the factors examined, Total Annual Rainfall has the strongest negative influence on crop yield per hectare (Beta = -0.814, p = .004), suggesting that excessive rainfall significantly reduces crop productivity. Soil pH Level (Beta = 0.574, p = .062) and Farm Size (Beta = 0.346, p = .000) positively affect crop yield, implying that more neutral soil conditions and larger farm sizes are beneficial for output. Although Total Area Covered by Flood and Number of Floods per Year show negative relationships with yield, their standardized effects are relatively smaller. Flood Duration and Farm Input Expenditure have weaker and less consistent effects, with the latter showing a slight negative influence.

Table 2: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.995[a]	.990	.987	136.36594

Result in table 2 reveal that above 99% of the changes in crop yield is accounted for by the independent variables included in the study. Additionally, **Table 2** revealed the Adj R^2 (0.987). The value reaffirmed the adequacy of the model that 98.7% of the variability associated with crop yields and perhaps food insecurity are explained by the changes in selected flood induce independent variables.

*Corresponding author, e-mail: odifullness@gmail.com
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Table 3: ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	42898391.417	7	6128341.631	329.557	.000[b]
	Residual	446296.083	24	18595.670		
	Total	43344687.500	31			

The **ANOVA** output presented in **Table 3** provides the F variance ratio. The relatively large value of the F ratio is an indicative of the adequacy of the model revealing the negative influence of flood induce independents on crop yields.

Table 4: Model Summary Based on Geographic Locations

Location	Intercept	Rainfall Coefficient	Soil pH Coefficient	GWR Estimate	Prediction	Local R^2
Edo	3.0287	-0.001070	0.3148	-0.3215 to 0.5604	4.0287 to 4.3328	0.7592
Bayelsa	2.6066	-0.001013	0.3727	-0.2934 to 0.2104	2.2320 to 3.9896	0.8309
Delta	2.8514	-0.001048	0.3394	-0.4963 to 0.5472	2.5912 to 4.3649	0.7976

The geographically weighted regression (GWR) results show that the relationship between crop yield predictors, rainfall and soil pH, varies slightly across Edo, Bayelsa, and Delta states. Across all three locations, rainfall consistently has a negative effect on crop yield, with Bayelsa showing the weakest negative coefficient (-0.001013) and Edo the strongest (-0.001070). Conversely, soil pH has a positive influence across the regions, with Bayelsa again exhibiting the highest positive coefficient (0.3727), indicating that more favorable soil pH in Bayelsa may enhance yield more than in other areas. The local R^2 values suggest a good fit of the model in all three states, with Bayelsa showing the highest explanatory power (0.8309), followed by Delta (0.7976) and Edo (0.7592).

The literature review strongly corroborates the study's findings by reinforcing the spatial, environmental, and socioeconomic variability of flooding impacts on crop yield and food security across different coastal regions of Nigeria.

Firstly, the negative effect of rainfall on crop yield identified in the findings, particularly its most pronounced impact in Edo, aligns with Onwabiko et al. (2017) and Eze (2018),

*Corresponding author, e-mail: odifullness@gmail.com
DIO

who documented that excessive rainfall leads to waterlogging, soil erosion, and crop root damage, which reduce productivity, especially in regions with poor drainage or fragile soil structures. This consistency affirms the conclusion that rainfall, beyond a threshold, becomes a limiting factor for crop yield.

Secondly, the positive relationship between soil pH and crop yield, especially in Bayelsa, supports studies such as Adetunji and Ogundele (2022) and Ogundipe and Adebayo (2020), which emphasized that soil quality is a key determinant of post-flood agricultural recovery. Their works suggest that soils with more balanced pH (closer to neutral) enable faster regeneration of farming activities and better root development, which complements the observed data showing higher crop yield potential with increasing soil pH in Bayelsa.

Moreover, the high local R^2 values, particularly in Bayelsa (0.8309), suggest that flood-related factors and soil conditions strongly explain crop yield variation in that region. This reflects findings from Umeh et al. (2021) and Abdulraheem and Ibrahim (2017), who identified Bayelsa as being more vulnerable to flood-related agricultural losses, yet also showed greater sensitivity to interventions, such as improved land and soil management practices.

Additionally, the spatial heterogeneity captured by the GWR results, showing that the relationship between predictors (e.g., rainfall and soil pH) and crop yield varies not just between but within states, is consistent with Nwachukwu and Ezeh (2015) and Okonkwo and Nwankwo (2020), who both highlighted that flood impacts are highly localized due to differences in elevation, infrastructure, and land use patterns.

Finally, the variability in predicted crop yields and the observation that Edo had the highest baseline productivity while Bayelsa showed greater variation corresponds with Chikezie et al. (2019) and Afolabi et al. (2018), who noted that agricultural performance and food insecurity indicators fluctuate widely depending on geographic and infrastructural resilience to flooding.

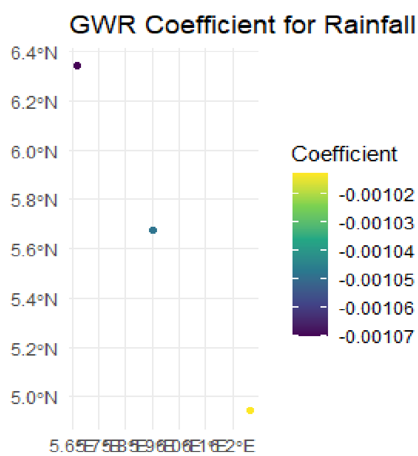

Figure 1: Spatial plot of GWR Coefficient for Rainfall

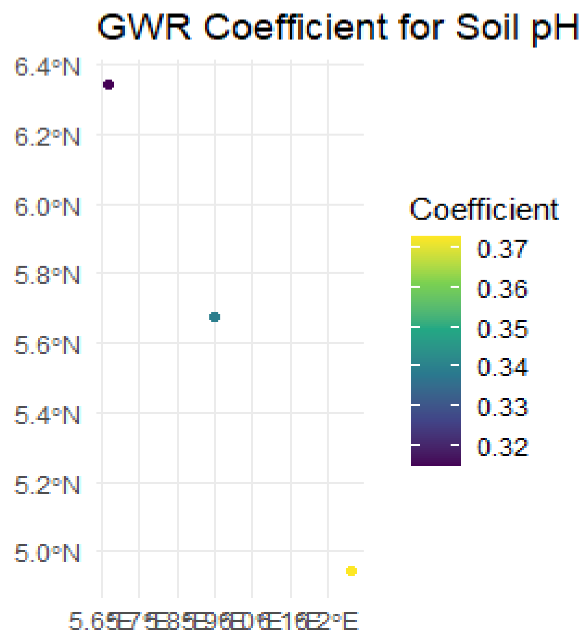

Figure 2: Spatial plot of GWR Coefficient for Soil pH

The model results reveal significant geographic variability in the relationships between the dependent variable and the predictors across Edo, Bayelsa, and Delta. While the intercepts are similar, indicating a comparable baseline level of the dependent variable across locations, the coefficients for rainfall and soil pH show notable differences. Rainfall consistently has a slight negative effect on the dependent variable across all regions, but its impact is most pronounced in Edo. Conversely, soil pH has a positive effect, with the strongest influence observed in Bayelsa, suggesting that soil quality may play a more crucial role in this area.

The geographically weighted regression (GWR) estimates and predictions further emphasize the spatial differences, particularly within each location. Edo exhibits the widest range in GWR estimates, highlighting the variability in the relationships within the region itself. Bayelsa has the highest local R^2, indicating the model's strong explanatory power there, while the other regions also show substantial but slightly lower model fit. These findings underscore the importance of considering geographic context in environmental data analysis, as the impact of factors like rainfall and soil pH can vary significantly from one location to another.

4. CONCLUSION

This study concludes that flooding exerts a spatially variable yet measurable impact on food security indicators, particularly crop yield, across Nigeria's coastal regions. Rainfall negatively affects agricultural productivity in all examined states, most notably in Edo, while soil pH positively influences crop yield, with Bayelsa showing the most pronounced response. The significant variation in geographically weighted regression (GWR) estimates and high local R^2 values, especially in Bayelsa, indicate strong location-specific dynamics in the flood-crop yield relationship. Therefore, the study recommends that flood mitigation and agricultural adaptation policies be tailored to the unique environmental and geographic conditions of each region. Specifically, policies should promote improved drainage systems and early warning infrastructure in high-risk flood zones, encourage soil quality enhancement practices, and invest in location-specific data systems to guide adaptive agricultural strategies. Such targeted interventions will strengthen resilience in vulnerable farming communities and enhance overall food security in Nigeria's coastal belt.

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