Comparative Assessment of Crop Farmer's Vulnerability to Climate Change in Delta State, Nigeria

OMONIGHO GOODLUCK MAMURO[1], EDE TIEKURO[2]
[1]*Meteorology and Climate Change, Nigeria Maritime University, Okerenkoko, Delta State, Nigeria*
[2]*Physics Unit, Nigeria Maritime University, Okerenkoko, Delta State, Nigeria*

Abstract- Nigeria's agricultural sector, which supports a large proportion of the population, is highly susceptible to climate extremes, particularly in the Niger Delta region. This study provides a comparative analysis of crop farmers' vulnerability to climate change in Delta State's two major agro ecological zones: the mangrove swamp and freshwater swamp. A cross-sectional survey was conducted, and weighted mean scoring was applied to standardized indicators of exposure, sensitivity, and adaptive capacity. Using the IPCC vulnerability framework (VI = Exposure + Sensitivity − Adaptive Capacity), zone-specific indices were computed. In the mangrove zone, Exposure = 0.592, Sensitivity = 0.522, Adaptive Capacity = 0.212, yielding a Vulnerability Index (VI) of 0.902. In the freshwater zone, Exposure = 0.533, Sensitivity = 0.577, Adaptive Capacity = 0.328, yielding a VI of 0.782. These results indicate that while both zones are highly vulnerable, the mangrove zone faces greater risk due to higher exposure and markedly lower adaptive capacity. The findings underscore the importance of ecological differentiation in vulnerability assessments and highlight the inadequacy of generalized regional approaches. By providing empirical evidence of spatial variations in vulnerability, this study offers critical insights for targeted adaptation strategies and policy planning. Specifically, improving adaptive capacity in the mangrove zone is essential for safeguarding livelihoods and strengthening resilience in Delta State's coastal farming communities.

Index Terms- Climate Change, Vulnerability Index, Exposure, Sensitivity, Adaptive Capacity, Mangrove Swamp, Freshwater Swamp, Delta State

I. INTRODUCTION

Climate Change is one of the most critical global environmental challenges confronting humans and ecosystems in the 21st Century (Eniwotu and Ayegbunan, 2025). Within the last two centuries, variability in global climate and the associated Climate Change impacts has attracted people and society's attentions at distinct scales due to the need to sustain livelihoods and protect ecosystems. The change can be determined using measurable climate indicators such as rainfall, temperature, and sunshine whose durations, patterns and/ or, trends usually exert diverging influences on distinct livelihoods within given ecological zones.

The variability in climate has been recognized by (statistical tests of) alterations in the average and/ or the variability of its attributes in place for a period of time that often last for a century or longer (Intergovernmental Panel on Climate Change (IPCC), 2014; Reed, Podesta, Fazey, Geeson, Hessel, and Hubacek, 2013). The indicators of Climate Change impacts include a rise in surface temperature, changes in rainfall trend, and melting of polar ice which contribute to the rise in sea level and are among the current challenges to most coastal regions (Nwafor, 2006; Garg, Shukla, and Kapshe, 2007; Odjugo, 2010; IPCC, 2014a). The rise in sea level has led to alterations in beach migration, coastal erosion, alteration in shoreline, and flooding among others (Ogbeibu and Oribhabor, 2023); with its attendant effects on and high vulnerability of distinct socio-economic and agricultural livelihoods. In sub-Saharan Africa, where smallholder farmers depend heavily on rain-fed systems with limited adaptive capacity (IPCC, 2022; Numbere, 2018; Ogundele et al., 2022), shifting rainfall patterns, escalating temperatures, flooding, and salinization increasingly threaten crop productivity, household food security, and livelihoods.

In Nigeria's Niger Delta, the situation is especially acute due to its unique ecological confluence of mangrove and freshwater swamp zones. These ecosystems are inherently fragile subject to tidal flooding, saline intrusion, coastal erosion, and irregular inundation—exacerbated by anthropogenic pressures including oil spills, gas flaring, and deforestation ((Ogundele et al., 2022; Ogbeibu & Oribhabor, 2023) The degradation of mangroves, which act as vital carbon sinks and natural buffers against coastal hazards, further intensifies communities' vulnerability to climate shocks ((Balogun & Onokerhoraye, 2022).

Farmers across these ecosystems face divergent climate-facing exposure and adaptive constraints. In the mangrove swamp zones, saline water and tidal surges disrupt traditional cropping systems, while in the freshwater swamps, prolonged flooding and waterlogging impair soil health and limit agricultural access (Balogun & Onokerhoraye, 2022). Despite such clear ecological differences, vulnerability assessments rarely differentiate between these zones, instead aggregating findings at broader regional levels, thus limiting the relevance of adaptation policies.

There is a pressing need for comparative vulnerability analyses that contextualize how ecological specificity shapes exposure, sensitivity, and adaptive capacity. Empirical studies show that regions like the Niger Delta present heterogeneous vulnerability profiles, and policy responses must reflect this diversity (Eniwotu & Ayegbunan, 2025). However, most existing research remains generalized, failing to disaggregate vulnerability between mangrove and freshwater swamp zones—especially within key agricultural LGAs such as Warri North, Warri South West, and Burutu in Delta State.

To address this knowledge gap, this study undertakes a comparative analysis of crop farmers' vulnerability to climate change across the mangrove and freshwater swamp ecological zones of Delta State. Specifically, it examines differential exposure to climatic hazards, varying levels of sensitivity rooted in socioeconomic characteristics, and the scope of adaptive capacity in these distinct ecological settings. The aim is to generate nuanced, zone-specific insights that can inform targeted adaptation policies—enhancing resilience, safeguarding agricultural productivity, and promoting sustainable livelihood systems in Nigeria's coastal delta communities. While the specific objectives are to: (i) examine the socio-economic characteristics of crop farmers in the mangrove and freshwater swamp ecological zones of Delta State, (ii) assess the level of farmers' exposure, sensitivity, and adaptive capacity to climate change in both ecological zones and (iii) compare the nature and extent of climate change vulnerability between farmers in the mangrove and freshwater swamp zones.

II. METHODOLOGY

2.1 Research Design

The study adopted a comparative cross-sectional survey design. This design is appropriate because it enables the assessment and comparison of crop farmers' vulnerability to climate change across the mangrove and freshwater swamps of Delta State.

2.2 The Study Area

The research was carried out in Warri North, Warri South West, and Burutu LGAs of Delta State, which fall within the freshwater swamp and mangrove swamp ecological zones of the Niger Delta region. The area is characterized by high rainfall (2,500–3,000 mm annually), a tropical humid climate, extensive river networks, mangrove forests, and freshwater swamps. The primary occupations include crop farming, fishing, and trading, with cassava, maize, yam, and vegetables as dominant crops. Farmers in the area are highly exposed to flooding, saline intrusion, and seasonal variability, making it suitable for vulnerability analysis.

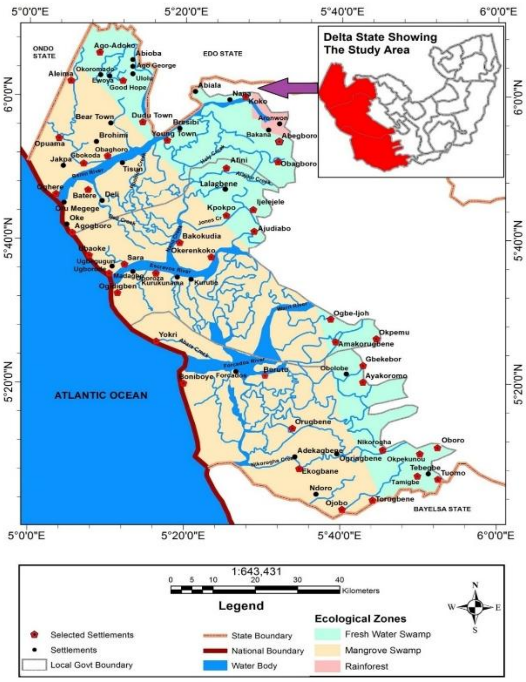

Figure 1.3: Drainage, Ecological Zones and Selected Settlements.

Source: Modified by the researcher after Ministry of Land and Survey, Delta State (2025).

2.3 Population of the Study

The target population comprises all smallholder crop farmers residing in the Mangrove and Freshwater swamp ecological zones of the selected LGAs.

2.4 Sample Size and Sampling Technique

Multistage sampling technique was employed in the study. Warri North, Warri South West, and Burutu LGAs were Purposively selected based on their ecological characteristics. A total of fourteen (14) settlements were purposefully selected from each LGA. This comprises of seven settlements from each ecological zones, making a total of 42 settlements for the three (3) LGA. respondents were selected randomly from each ecological zone.

879 respondents were systematically selected as recommended in Berenson and Levine (1998) for sample size determination. The formulae is presented thus;

$$SS = \frac{Z^2P(1-P)}{c^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{Equation 1}$$

Where SS denotes sample size. P is the proportion of households in the total population. C is the permitted sampling error. Z represents the level of confidence.

2.5 Sources of Data

2.5.1 Questionnaire Survey

A total of 879 copies of structured questionnaire were administered in this study. The questionnaire was used to elicit the responses of household heads in the selected settlements on crop farmer's vulnerability to climate change, of which 860 (97.8%) were retrieved from the field.

2.5.2 Focused Group Discussion

Focused Group Discussion (FGD) was used to collect additional data on crop farmers vulnerability to Climate Change in each ecological zone. A small group of seven (7) household heads as recommended by Uyigue and Agho (2007) were brought together to discuss their crop farming livelihoods vulnerability to Climate Change.

2.6 Methods of Data Analysis

2.6.1 Descriptive and Inferential statistics

Descriptive statistics (frequencies, percentages, means, standard deviations) were used to summarize socioeconomic characteristics and perceived impacts while inferential statistics was used to evaluate variation between the two ecological zones.

To evaluate the strength of respondents' perception, with respect to exposure, sensitivity and adaptive capacity components the Likert frequencies were obtained. These frequencies were determined as a product of individual frequencies and the assigned scores of individual points on the scale. The summation of all the frequencies in each variable/factor under considerations were divided by the sample size in other to obtain the weighted means score (WMS). The WMS was therefore used as the bases for explaining the overall level of respondents' perception on investigated indicators/variables in each vulnerability component as well as comparison between the two ecological zones. The weighted mean score were categories using equal interval scale, were 3.42 – 4.60 were classified as high, 2.38 -3.41 were classified as moderate and 1.26 -2.37 were classified as low.

2.6.2 Vulnerability Index (VI): Farmers' vulnerability will be estimated using the IPCC framework:
VI = f (Exposure, Sensitivity, Adaptive \ Capacity)

2.6.3 Comparative analysis: Independent samples t-test was employed to test for significant differences in vulnerability of crop farmers the between mangrove and freshwater swamp ecological zones.

III. RESULT AND DISCUSSION

3.1 Crop farmer's Exposure to Climate Change

The assessments of Crop farmer's exposure to Climate Change in the Freshwater and Mangrove Swamp ecological zones were evaluated and the results presented in Table 3.1 reveal varieties in weighted mean scores (WMS) and ranks. Within the Mangrove Swamp Ecological zones (MSEZ), the results showed that flooding constituted the highest exposure indicator with WMS of 4.60 and ranked 1st, followed by rainfall intensity with WMS of 4.59 and ranked 2nd, and rain-days with WMS of 4.57 and ranked 3rd in the series. On the contrary, the sampled Crop farmer's identified high temperature/ extreme heat as the highest Climate Change exposure indicator with a WMS of 4.27 and ranked 1st, followed by violence windstorm 4.25 and ranked 2nd, and rain-days and flooding with WMS of 4.24 each and ranked 3rd in the Freshwater Swamp ecological zone (FWSEZ).

A further comparison of the results in Table 3.1 reveals that the lowest indicator of Crop farmer's exposure to Climate Change in MSEZ of Delta is drought with WMS of 1.26, followed by soil erosion with WMS of 1.29 and ranked 21st, while the lowest Crop farmer's exposure indicator to Climate Change in FWSEZ was drought with WMS of 1.61 and ranked 22nd followed by extreme cold at night with WMS of 1.94 and ranked 21st respectively.

The results in Table 3.1 also indicated that some Climate Change exposure indicators were adjudged with moderate influence on rural livelihoods in the two ecological zones, although disparities existed based on their weighted mean scores and ranks in the two ecological zones. In MSEZ for instance, absent/ shorter harmattan attracted a WMS of 3.27 and ranked 15th, while the same indicator recorded WMS of 3.14 and ranked 18th in FWSEZ. Also, warmer nights attracted WMS of 2.58 and ranked 20th in MSEZ, but in FWSEZ, the WMS remained at 2.95 and ranked 19th in the series

Generally, it is established that a total of seventeen (17) Climate Change exposure indicators were perceived by SRH as highly exposed to their livelihoods in FWSEZ, while fourteen Climate Change exposure indicators were adjudged as highly exposed to their livelihoods in MSEZ. Furthermore, while six (6) exposure indicators to livelihoods were scaled to moderate in MSEZ, only three (3) were identified and ranked as moderate in FWSEZ. However, only two (2) Climate Change exposure indicators were associated with lowly exposed to rural livelihoods in both MSEZ and FWSEZ of Delta State. The variations in Crop farmer's exposure indicators between the MSEZ and FWSEZ noticed in this study, especially with respect to exposure level and their respective positions speaks volume of the extent of Crop farmer's exposure in the zones. The result corroborates earlier work by Osland et al. (2014), Rogers et al. (2014b), and Abaje (2016) who reported emphatically that the exposure of a system or region to Climate Change varies from one geographical region to another.

Table 3.1: Perception of Rural Livelihoods Exposure to Climate Change

	Climate Change indicators	Weighted mean score (WMS)	
		Freshwater swamp N = 388	Mangrove swamp N = 472
1.	High temperature/ extreme heat	4.27 (High)1st	4.54 (High) 4th
2.	Violent windstorm	4.25 (High) 2nd	4.52 (High) 5th
3.	Rain-days	4.24 (High) 3rd	4.57 (High) 3rd
4.	Flooding	4.24 (High) 4th	4.60 (High) 1st
5.	Rainfall intensity	4.23 (High) 5th	4.59 (High) 2nd
6.	Salinity intrusion	4.21 (High) 6th	4.46 (High) 6th

7.	Pest & diseases	4.10 (High) 7th	4.38 (High) 7th
8.	Coastal erosion	4.08 (High) 8th	4.32 (High) 8th
9.	Proliferation of weeds	4.07 (High) 9th	4.37 (High) 8th
10.	Sunshine intensity	4.07 (High) 10th	4.26 (High) 11th
11.	Excessive soil moisture	4.05 (High) 11th	4.24 (High) 12th
12.	Soil erosion	4.04 (High) 12th	1.29 (Low) 21st
13.	Intensifying harmattan	4.01 (High) 13th	3.93 (High) 14th
14.	Decreasing soil moisture	4.01 (High) 13th	3.25 (Moderate) 16th
15.	Early cessation of rains	3.97 (High) 15th	4.24 (High) 12th
16.	Declining rainfall trend	3.86 (High) 16th	3.18 (Moderate) 17th
17.	Growth of water hyacinth	3.69 (High) 17th	2.92 (Moderate) 19th
18.	Shorter/absence of harmattan	3.14 (Moderate) 18th	3.27 (Moderate) 15th
19.	Warmer nights	2.95 (Moderate) 19th	2.58 (Moderate) 20st
20.	Late onsets of rains	2.56 (Moderate) 20th	3.17 (Moderate) 17th
21.	Extreme cold at night	1.94 (Low) 21st	2.76 (Moderate) 18th
22.	Drought	1.61 (Low) 22nd	1.26 (Low) 22nd

Source: Author's Analysis (2025).

From the findings, it is therefore, not surprising to notice high temperature/extreme heat, violent windstorm, flooding, increasing rainfall intensity, rain-days, and salt water intrusion as among the most perceived CCEI in both the FWSEZ and the MSEZ of Delta State although with different degree of exposure to Climate Change. The result collaborated Mjata (2015) report of appalling fluctuations in annual and seasonal precipitation patterns, decrease in August break, rising frequency of temperature, and aggressive windstorm as some of the climatic variables that rural household livelihoods are exposed to. Similarly, Odjugo (2013) reported escalating heat event, alterations in precipitation distribution, amplified washing away of the topsoil by water and wind as the most devastating CCEI in many rural communities in Nigeria.

The patterns in low to moderate levels of livelihood exposure to some Climate Change indicators as evidence in the two ecological zones affirmed Odjugo (2011) and Egbule (2014) who reported that the incidence of drought is not common in the Niger Delta area and that the MSEZ and FWSEZ experience rainfall almost every month. Moreover, the trend analysis of rainfall in the preceding chapter suggests that rains normally starts in early March, particularly in the mangrove ecosystem. Also, respondents were of the view that rainfall intensity and strong winds is becoming very common in recent days as compared to 30 years ago.

3.2 Assessment of Variations in Crop farmer's Exposure to Climate Change

In order to test for variations in the Crop farmer's exposure indicator to Climate Change between FWSEZ and MSEZ based on the null hypothesis, student T-test was employed. The T-test (for equality in the means) results show differences in terms of the range, t-values, and levels of significance. The calculated T – test values range between a minimum of – 10.6 for extreme cold at night to the maximum value of 8.7 for growth of water hyacinth. A critical appraisal of the P – values in the significance column reveal unambiguousness in all the Climate Change exposure indicators (CCEI), except short/ absence of harmattan (P = 0.104) and intensifying harmattan (P = 0.146). Their P – values were lower than the critical limit set for the test. This invariably means that the null hypothesis could no longer be regarded as valid on these CCEI, excluding short harmattan and intensifying harmattan.

This study therefore, established that there is a statistical significant variation in the extent of Crop farmer's exposure to Climate Change between the two ecological zones. The indicators that validated the alternative hypothesis are high temperature/ extreme heat, rainfall intensity, rain-days, salinity intrusion, flooding, violent windstorm, late onsets of the rains, early cessation of rains, declining rainfall trend, soil erosion, proliferation of weeds, growth of water hyacinth, pest and diseases, extreme cold at night, warmer nights, sunshine intensity, drought, excessive soil moisture and decreasing soil moisture in the Mangrove Swamp and Freshwater Swamp ecological zones of Delta State.

3.3 Assessment of the Effects and Sensitivity of Crop Farmers to Climate Change

The crop farmer's sensitivity indicators to Climate Change in the Freshwater Swamp ecological zone (FWSEZ) and Mangrove Swamp ecological zone (MSEZ) were assessed based on research question three. The results of the analysis using weighted mean score (WMS) and ranked are presented in Table 3.2. Detailed analysis of the WMS is shown in appendix V (e and f). The study shows that the highest crop farmer's sensitive indicator to Climate Change was annual loss of income from crop production with a WMS of 3.65 and ranked 1st in Mangrove Swamp ecological zone (MSEZ). On the contrary, limited level of crop yield was identified as variable with the highest sensitive indicator of crop farmers to Climate Change with the highest WMS of 3.84 and ranked 1st in FWSEZ of Delta State. Other parameters ranked with high effects/ sensitive to crop farmers livelihood in MSEZ were flooding of farmland (3.59) and scorching effect of the sun on seedling (3.59) each ranked 2nd, while clearing of farmland (3.49) and limited level of crop yield (3.84) were the only additional parameters ranked high in FWSEZ.

The results in Table 3.2 further reveal that crop farmers' livelihoods ranked with moderate sensitive indicator to the Climate Change effect composed of twelve (12) each, in both MSEZ and FWSEZ. However, variances were observed based on their respective WMS and ranks. For instance, While planting month with WMS of 3.39 and ranked 4th in MSEZ, it WMS was 3.13 and ranked 18th in FWSEZ. Furthermore, while pest and disease control with WMS of 3.33 and ranked 8th in MSEZ, it WMS was 3.25 and ranked 10th in FWSEZ. Also, while quantity and quality of produce with WMS of 3.27 ranked 11th in MSEZ, its WMS was 3.10 and ranked 10th in FWSEZ of Delta State respectively. The perceived disparities in the score values and ranks suggest the influence of the representative sampled population, differences in type of crops cultivated by farmers, level of crop sensitivity to climate stressors, and crop farmer's interest in the Mangrove Swamp and Freshwater Swamp ecological zones of Delta State.

The results collaborates Daressa et al. (2007) notion that reduction in yield was among the major indicators of rural farmers' livelihood sensitivity to the effect of extreme weather events in Ethiopia. It also affirmed Iduwu et al. (2011) report that Climate Change manifestation such as uncertainties and variation in the pattern of rainfall and floods enhance pest and diseases migration in response to weather, while high temperature reduced crops yield.

Table 3.2: Crop Farmers' Sensitivity to Climate Change

	Climate Change sensitivity indicators	Weighted mean score (WMS) of extent of effect/sensitivity	
		Mangrove Swamps N = 472	Freshwater Swamps N=388
1.	Annual loss of income from crop production	3.65 (High) 1st	3.47 (High) 3rd
2.	Scorching of seedlings	3.59 (High) 2nd	3.24 (Moderate) 4th
3.	Flooding of farmlands	3.59 (High) 2nd	3.30 (Moderate) 7th
4.	Planting month	3.39 (Moderate) 4th	3.13 (Moderate) 18th
5.	Clearing of farmland always	3.36 (Moderate) 5th	3.49 (High) 2nd
6.	Erosion/leaching occurrence	3.35 (Moderate) 6th	3.17 (Moderate) 16th
7.	Planting depth	3.34 (Moderate) 7th	3.21 (Moderate) 14th

8.	Pest and disease infestation of crops	3.33 (Moderate) 8th	3.38 (Moderate) 15th
9.	Storage and marketing	3.33 (Moderate) 8th	3.22 (Moderate) 12th
10.	Pest and disease control	3.33 (Moderate) 8th	3.20 (Moderate) 4th
11.	Quantity and quality of produce	3.27 (Moderate) 11th	3.25 (Moderate) 10th
12.	Germination of crop seeds	3.26 (Moderate) 12th	3.31 (Moderate) 6th
13.	Harvesting time/period	3.25 (Moderate) 13th	3.26 (Moderate) 9th
14.	Limited level of crop yields	3.24 (Moderate) 14th	3.84 (High) 1st
15.	Growth rate of crops	3.22 (Moderate) 15th	3.27 (Moderate) 8th
16.	Weed growth	3.21 (Moderate) 16th	3.32 (Moderate) 5th
17.	Quantity of fertilizer application	3.21 (Moderate) 16th	3.25 (Moderate) 10th
18.	Duration of dry season (drought)	3.11 (Moderate) 18th	3.16 (Moderate) 17th

Source: Author's Analysis (2025).

In another dimension, uneven and erratic rainfall and sunshine hours (albedo and photoperiods) continue to take the toll on hitherto low-level harvest as evidence by the high sensitivity of annual income from crop farming in the two ecological zones. Nevertheless, the score value is higher in the Mangrove Swamp ecological zone (WMS =3.57) than the Freshwater Swamp ecological zone (WMS =3.47) when compared. The results validated the responses generated during focus group discussion that the submergence of large hectares of farmland by flood events have destroyed crops and forced farmers to harvest their crops prematurely.

3.4 Test of Variations in Crop Farmers Sensitivity Indicators to Climate Change

A total of fifteen (15) rural livelihoods sensitivity indicators of crop farmers to Climate Change were evaluated between FWSEZ and MSEZ based on the null hypothesis. The Student's T-test was employed as basis for analysis and test of variability in the mean. The T-test results show differences in terms of the range, t-values, and levels of significance. The calculated T – test results range between a value minimum of – 7.223 for limited level of crop yield due to excess sun and a maximum value of 3.106 for sensitivity to erosion/ leaching occurrence.

A comparison of the P – values in the significance column reveal disparities in the rural livelihoods sensitivity indicators to Climate Change. The test results at 95 percent level of confidence led to a conclusion that there is a statistical significant variation in the extent of crop farmer's sensitivity to Climate Change between the FWSEZ and MSEZ of Delta State. However, the inference is only applicable to clearing of farmland always, planting month, and limited level of crop yield, excess heating of seedlings by sun, flooding of farmlands, erosion /leaching occurrence, and loss of income from crop production as crop sensitivity indicators. The observed differences in the results affirmed Onwuemele (2015) observation that there are variations in crop farmers' sensitivity to Climate Change due to the nature of system of stressor in distinct agro-ecological zones of Delta State.

3.5 Adaptive Capacity of Crop farmer's in Ecological Zones of Delta State

The assessment of Crop farmer's adaptive capacity to Climate Change in the Freshwater Swamp ecological zone (FWSEZ) and Mangrove Swamp ecological zone (MSEZ) were carried out using weighted mean score (WMS) and the results are presented in Table 3.3. The result reveals differences in the adaptive capacity of rural households between FWSEZ and MSEZ, but dominantly low. However, only years of rural household experiences attracted a WMS of 3.50 in FWSEZ and 3.70 in MSEZ respectively and each ranked 1st with high adaptive capacity.

The comparative assessments of the distributive pattern of WMS show variations. In FWSEZ, the rural households' adaptive capacity range from 3.50 for years of experience to 1.44 for both number of fishing gears and use of improved varieties of crop/livestock yield. On the other hand, WMS of rural households' adaptive capacity in MSEZ range between 3.70 for years of experience to 1.28 for irrigation potentials. However, ownership of livestock by rural households (1.64) ranked 2nd with low adaptive capacity to Climate Change impacts in the MSEZ, while access to insecticide and pesticide supply exhibited a WMS of 1.55 and ranked 2nd with low level of rural households livelihood adaptive capacity to Climate Change in FWSEZ.

A further review of the findings indicated general inadequate adaptive capacity by rural household to mitigate or avert Climate Change impacts on their livelihoods in the two ecological zones of Delta. The rural household limited adaptive capacities were more dominance in areas such as income level, level of technological applications, ICT compliances, educational levels, access to Climate Change information, power supply, ownership of fishing vessels and membership of cooperative society, transportation, household size, and access to seedlings whose WMS range within 1.55 and 1.44 in the MSEZ and FWSEZ.

Table 3.3: Rural Household's Adaptive Capacity to Climate Change

Adaptive capacity	Weighted mean score (WMS)	
	Freshwater swamp N = 388	Mangrove swamp N = 472
Years of experience	3.50 (High) 1st	3.70 (High) 1st
Insecticide and pesticide supply	1.55(Low) 2nd	1.63 (Low) 3rd
Success to Climate Change information	1.54 (Low) 3rd	1.60 (Low) 5th
Good road network	1.53 (Low) 4th	1.58 (Low) 7th
Ownership of fishing vessels like canoes/boats	1.53 (Low) 4th	1.56 (Low) 12th
Ownership of livestock	1.53 (Low) 4th	1.64 (Low) 2nd
Membership cooperative society	1.53 (Low) 4th	1.55 (Low) 13th
Improved food supply	1.51 (Low) 8th	1.63 (Low) 3rd
Level of income	1.51 (Low) 8th	1.48 (Low) 21st
Level of technology	1..50 (Low) 10th	1.55 (Low) 14th
Availability of labour	1.50 (Low) 10th	1.53 (Low) 16th
Subsidize transport fare	1.49 (Low) 12th	1.52 (Low) 20th
Access to land	1.49 (Low) 12th	1.59 (Low) 6th
Level of education	1.47 (Low) 14th	1.53 (Low) 16th
Ownership of farm implement	1.47 (Low) 14th	1.53 (Low) 16th
Irrigation potentials	1.46 (Low) 16th	1.28 (Low) 23rd
Household size	1.46 (Low) 16th	1.54 (Low) 15th
Access to credit facilities	1.46 (Low) 16th	1.48 (Low) 21st
Access to seedlings	1.46 (Low) 16th	1.53 (Low) 16th
Availability of electricity	1.46 (Low) 16th	1.57 (Low) 11th
Ownership of ICT (Radio/TV/Phone/Computer/ Internet	1.46 (Low) 16th	1.58 (Low) 7th

Number of fishing gears	1.44 (Low) 22nd	1.58 (Low) 7th
Using improved varieties of crop/livestock animals	1.44 (Low) 23rd	1.58 (Low) 7th

Source: Author's Analysis (2025).

The results supported Oyegun et al. (2016) and Ikehi (2014) reports of low adaptive capacity in the Niger Delta region, but was at variance with the work of Abaje et al. (2016) who reported high adaptive capacity level in some selected rural settlement of Kaduna State. The disparities is directly associated with differences in the level of existing intervention within ecological zones. Adaptive capacity upsets vulnerability through moderating exposure and sensitivity and thereby inducing both the biophysical and the social elements of a system. Thus, the more the adaptive capacity within a system, the greater the likelihood that the system will be resilient in the face of Climate Change stresses. Also, Ikehi (2014) reported that the ability of persons or families to adapt to Climate Change impacts is linearly connected to their access to resources.

The previous report of low income of the majority of the SRH who earns little above ₦50,000.00 monthly in both ecological zones has serious implication on the ability of Crop farmer's to adapt effectively to a changing climate. That means, riches are an important variable of adaptive capacity to Climate Change in rural communities. It aids rural settlements to captivate and get well from damages and other effects of Climate Change more quickly than settlement or households that are deprived of wealth (Cutter et al., 2003). Lack of wealth will contribute massively to the susceptibility of rural household in the study area as fewer individuals and communities' assets for salvaging shocks are available, thereby making the communities less resilient to the impacts of Climate Change. More so, households with small family manpower and that lack the requisite resources to employ labour are likely to be constrained from coping measures that will help moderate the influence of Climate Change in a bid to reduce the vulnerability in their households and the community (Deressa et al., 2007b; Abaje et al., 2014).

In a perspective, Gbetibouo et al. (2010) reported that high level of income largely offers access to markets, farm inputs, technology and other resources that can be used to adapt to Climate Change. The comparison of the notion with the results showed that they are lacking in the study area especially the Mangrove Swamp ecological zone mainly because of its remoteness and poor terrain. As a result of this, rural communities in these ecological zones with low adaptive capacity are most unlikely to adapt to the impacts of Climate Change more strongly compared with urban areas with high adaptive capacity, and will likely be the most susceptible to the effects of Climate Change in terms of income generation.

The unavailability and lack of access to livelihood inputs translate to low adaptive capacity among rural households in both ecological zones. Because, the use of pest and diseases resistance seeds, the use of salt-tolerant or early maturing varieties of crops, and accessibility to ancillary inputs such as fertilizers, herbicides and pesticides in those rural areas would have contributed positively to their successful adaptation measures. According to Gbetibouo et al. (2010), access to livelihood inputs provides a broad picture of the financial status of a household or settlement which is lacking in the area. Hence rural household in this region with low adaptive capacity in terms of unavailability and access to farm implements, access to seedling, ownership of ICT, inadequate access to credit facilities, lack of subsidized transport fare among others will continue to be worst hit by Climate Change impacts.

The low quality and availability of infrastructure and institutions in the two ecological zones are essential indicators of adaptive capacity to Climate Change. For examples, the unavailability of infrastructures such as good roads inhibits the distribution of necessary livelihood inputs to rural household at all-time. The inadequate road network also limits the likelihood and efficacy of aid supply programs in response to disasters resulting from Climate Change such as floods as was the case in 2012 and 2018. This might not be unconnected with the view of one of the respondents, during Focus Group Discussion (FGD) who stated that with the huge amount released during the last flood incidence, their community did not get any relief from the government. Besides, the unavailability of health services as evidence in most communities within the region can trigger high vulnerability of rural household, because of lack of provision of preventive treatments to the rural inhabitants for ailments like malaria and cholera that are allied with climatic changes (Deressa et al., 2009b). Likewise, the low level of access to credit institutions such as microfinance that supports rural dwellers by providing credits for technology packages which are important variables of adaptive capacity to Climate Change; and the availability and access to good markets will aggravate the plight of rural dwellers who are already enmeshed with the problem of Climate Change.

Settlements with advanced and systematized infrastructures and institutions are often better able to cope with climatic stresses compare with settlements with less effective infrastructure and institutional settings (Moss et al., 2001; Adger et al., 2006; O'Brien et al., 2004). This scenario which is deficient in the sampled settlements within the two ecological zones contributed to the low adaptive capacity. Rural household living in fringe locations and zones with stumpy or dilapidated infrastructures are those with low adaptive capacity to Climate Change. Hence, this ecological regions with a low adaptive capacity will likely be the most threatened to the impacts and vulnerability of Climate Change because the rural household lacks the capacity to support their livelihoods which is primarily dependent on the environment, taking into cognizance the projected increase in sea level rise, rainfall and temperature by the end of this century compared to the present global warming and its negative impacts that are already visible in the area.

In terms of the level of education, the notion is that higher education levels enhance adaptive capacity by increasing people's competences and access to knowledge, thereby enhancing their ability to cope with difficulties (Gbetibouo et al., 2010). As a result of that postulation, both regions with a low level of education are therefore considered to have low adaptive capacity to Climate Change. The finding on low level of education according to Cutter et al. (2003) constraint the people ability to respond and appreciate warning information and access to recovery facts.

From the dimension of capital, there are indication that availability of wealth can enhance the adaptive capacity of a household by providing better access to livelihood inputs, markets, infrastructure and institutions, and other assets that can contribute to their coping level to Climate Change impacts. This is contrary to the case in both ecological zones where income and education level hindered household adaptive capacity. These two variables (income and education level) might have helped the rural household in having access to other resources that could be used for Climate Change adaptation, and hence the region might be less vulnerable to the impacts of Climate Change.

3.6 Assessment of Crop farmer's Vulnerability to Climate Change

The Climate Change vulnerability index of rural household livelihoods was computed using an integrated approach and the results summarized in Table 3.4. The index considered exposure, sensitivity and adaptive capacity and were classified using equal interval classification scheme in the Mangrove and Freshwater Swamp ecological zones. From the results, variations were observed based on components' indices between the two ecological zones. In terms of exposure, the result showed that rural households livelihood in the Freshwater ecological zone with an exposure index of 0.533 and Mangrove Swamp ecological zone with an exposure index of 0.592 were adjudged as moderately exposed to Climate Change impacts. However, the livelihood exposure index value was higher in MSEZ than in FWSEZ.

The crop farmers' sensitivity to Climate Change gave the indices of 0.577 and 0.522 for FWSEZ and MSEZ respectively, and each was classified as moderately sensitive. A further evaluation using fishing livelihood reveals an index of 0.339 for FWSEZ and was classified as lowly sensitivity to Climate Change impacts, while that of MSEZ gave an index of 0.543 and was classified as moderately sensitive to Climate Change impacts. That means fishermen in MSEZ were moderately sensitive to Climate Change while fishermen sensitivity in FWSEZ were low.

Further analyses based on livestock rearers' sensitivity gave the indices of 0.621 and 0.580 for FWSEZ and MSEZ respectively, and were classified as moderately sensitive to Climate Change impacts. Amidst the homogeneity in the classification of rural household livestock livelihood, FWSEZ possessed a higher index than MSEZ. With respect to hunting, the analyses gave the indices of 0.634 and 0.619 respectively and were grouped with moderate sensitivity to Climate Change in the Freshwater and Mangrove swamp ecological zones of Delta State. Furthermore, the adaptive capacity index of sampled rural household in the Freshwater and Mangrove swamp ecological zones of Delta State reveals that rural households had a low adaptive capacity index of 0.328 and 0.212 in the Freshwater and Mangrove swamp ecological zones respectively.

The vulnerability index, which is exposure plus sensitivity less adaptive capacity, for crop farming livelihood as presented in Table 3.4, shows that the level of vulnerability in the Freshwater and Mangrove swamp ecological zones of Delta State are high, even though the extent of vulnerability differs slightly from one zone to the other. Hence, it could be seen that sampled rural households with high crop farmers' vulnerability index of 0.782 and 0.902 were found in the Mangrove and Freshwater swamp ecological zones of Delta State respectively.

Table 3.4: Vulnerability Components and Index Computation

Vulnerability Component	Ecological Zones/Indices/Classification	
	Freshwater Swamp	Mangrove Swamp
Crop Farmers Exposure	0.533 (Moderate)	0.592 (Moderate)
Crop Farmers Sensitivity	0.577 (Moderate)	0.522 (Moderate)
Crop Farmers Adaptive Capacity	0.328 (Low)	0.212 (Low)
Overall Vulnerability Analysis	Ecological Zones/Indices/Classification	
	Freshwater Swamp	Mangrove Swamp
Crop Farmers Vulnerability	0.782 (High)	0.902 (High)

Source: Author's Analysis (2025).

The findings with respect to high vulnerability of crop farmer's livelihoods to Climate Change affirmed IPCC (2007) observation that developing nations especially coastal areas are highly vulnerable to Climate Change impacts mainly because of their level of exposure and sensitivity to Climate Change, coupled with low adaptive capacity that is occasioned mainly by poverty, high level of illiteracy, low level of technology among others. Also, Oyegun (2016) attributed the high Climate Change vulnerability of coastal areas in Niger Delta to low elevation, proximity to the ocean and other water bodies among others. However, the findings contradicted Madu (2012) and Madu (2016) who reported that Delta State is moderately vulnerable to climate change.

3.7 Conclusion

This study set out to compare crop farmers' vulnerability to climate change across the freshwater and mangrove swamp ecological zones of Delta State. The analysis reveals that both zones exhibit high overall vulnerability driven by moderate-to-high exposure and sensitivity compounded by low adaptive capacity. Quantitatively, exposure indices were 0.533 (freshwater) and 0.592 (mangrove), sensitivity indices were 0.577 (freshwater) and 0.522 (mangrove), adaptive capacity indices were 0.328 (freshwater) and 0.212 (mangrove), and overall vulnerability indices were 0.782 (freshwater) and 0.902 (mangrove).

Key exposure factors across zones include flooding, intensified rainfall, prolonged rain-days, salinity intrusion and extreme heat, while the principal sensitivity factors are reduced crop yields, flooding of farmlands, and income loss from crop production. Adaptive capacity is undermined by low income, limited access to inputs and irrigation, poor infrastructure and weak institutional support, with these deficits more pronounced in the mangrove zone. Taken together, the results indicate that ecological specificity matters: the mangrove zone faces greater exposure and overall vulnerability, whereas freshwater areas show slightly higher sensitivity in some livelihood dimensions.

The findings imply an urgent need for targeted, zone-specific interventions: strengthen infrastructure and market access; expand access to credit, improved and salt-tolerant crop varieties, and irrigation; and scale up extension services, early-warning systems and community-based adaptation programs. Future research should track temporal changes through longitudinal monitoring, test the effectiveness of specific adaptation measures, and incorporate finer-scale hydrological and salinity modelling to support tailored policy design.

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