

Socio-economic Factors Influencing Fishers' Adaptation to Climate Change in the Atlantic Coast of Akwa Ibom State, Nigeria

Elizabeth Atairet Atairet¹, Gabriel Sunday Umoh², Atairet Clifford Atairet³

¹Department of Agricultural Economics and Extension, Akwa Ibom State University, Obio Akpa Campus, Akwa Ibom State, Nigeria.

²Department of Agricultural Economics and Extension, University of Uyo, Nigeria.

³Department of Public Administration, Akwa Ibom State University, Obio Akpa Campus, Akwa Ibom State, Nigeria.

Corresponding Author E-mail: elizabethatairet2016@gmail.com

Received 11 May 2024; Accepted 24 June 2024; Published 5 July 2024

ABSTRACT: Fisheries production, particularly from marine sources, plays a crucial role in the socio-economic development of Nigeria and contributes significantly to the nation's economic growth as measured by Gross Domestic Production. The environmental interdependence of marine fisheries means that changes in the environment can have direct impacts on fishing activities and the livelihoods of fishers. One of the key challenges that has garnered attention from researchers and policy makers is the potential impact of climate change on fisheries. As environmental changes continue to unfold, it is imperative to consider the implications for the sustainability and resilience of marine fisheries and the communities that depend on them. Climate change poses a significant challenge to fisheries production in Nigeria, particularly affecting artisanal fishers' income. This study aims to investigate factors influencing fishers' adaptation to climate change impacts by examining the strategies employed. Data was collected from 140 Bonga Fishers using interview schedules, Focus Group Discussions, and key Informant Interviews to gain comprehensive insights into fishers' perspectives. Descriptive statistics and a Multinomial Logit Model (MNL) were utilized to evaluate the adaptation strategies employed by Bonga fishers. The findings revealed a predominant shift towards using motorized equipment and engaging in longer fishing trips, while integrating aquaculture with fishing was the least common approach. The MNL analysis highlighted that age, education, income, and social group membership positively impact adaptation. To enhance fishers' response to climate change, it is recommended to provide training and make affordable smart fishing technologies available.

Keywords: Adaptation, climate change, Bonga fishers, multinomial Logit

Citation: Atairet, E. A., Umoh, G. S., and Atairet, A. C. (2024). Socio-economic Factors Influencing Fishers' Adaptation to Climate Change in the Atlantic Coast of Akwa Ibom State, Nigeria Direct Res. J. Agric. Food Sci. Vol. 12(2), Pp. 222-231. <https://doi.org/10.26765/DRJAFS06742025>. This article is published under the terms of the Creative Commons Attribution License 4.0.

INTRODUCTION

The Sixth Assessment Report (AR6) of the United Nations (UN) Intergovernmental Panel on Climate Change (IPCC, 2023) provides a comprehensive definition of climate change as long-term shifts in temperature and weather patterns, predominantly attributed to human activities, particularly the combustion

of fossil fuels. This definition aligns with the previous characterization by IPCC in 2014, which described climate change as alterations in the state of the climate identifiable through changes in its mean and/or variability, persisting over extended periods, typically spanning decades or longer. The ongoing and projected changes

in the climate system are anticipated to have increasingly substantial and adverse impacts on both human and natural systems. These impacts have already led to the deterioration of various ecosystems, encompassing terrestrial, freshwater, oceanic, and coastal environments, including the decline of tropical coral reefs. Furthermore, climate change has contributed to diminished food security, driven migration and displacement, jeopardized livelihoods, compromised human health and security, and exacerbated societal inequality (IPCC, 2023).

The global challenge of food security and sustainability from the ocean has been well-documented. The impact of climate change on fisheries has been significant, with the fraction of fishery stocks within biologically sustainable levels decreasing to 64.6 percent in 2019, a 1.2 percent drop from 2017 (State of World Fisheries and Aquaculture, 2022). This trend has raised concerns about the long-term viability of fisheries and the availability of seafood as a food source. The Food and Agriculture Organization (FAO, 2020) has noted that the effects of climate change are particularly pronounced in tropical regions of Africa and Asia, where higher temperatures are contributing to a reduction in fishery productivity. Addressing these challenges will require coordinated efforts at both local and global levels to mitigate the impact of climate change on ocean ecosystems and ensure the sustainability of fisheries for future generations.

The significance of fish as a crucial source of animal protein cannot be overstated, particularly in developing countries such as Nigeria. With over 3.3 billion people globally relying on fish for a substantial portion of their animal-protein intake, and in some cases exceeding 50% in developing nations, it is evident that fish plays a vital role in addressing protein needs. Moreover, the fisheries sector not only contributes to national economic growth but also provides employment for over 10 percent of the world's population, generates income for numerous individuals, and supports livelihoods in rural areas. It is essential to recognize the multi-dimensional impact of the fisheries sector, not only in terms of economic growth but also in elevating the standard of living for many. As such, sustainable development in this sector is imperative for ensuring food security, economic stability, and improved livelihoods for a significant portion of the global population.

In Nigeria, fisheries sub-sector contributes about three to four percent to the country's Gross Domestic Product (GDP) in 2019 (Rotowa *et al.* 2019); a little above one percent in 2020 and less than one percent in 2021 (NBS 2022). Low fish production in the face of abundant resources could be attributed to a number of factors, one of which is climate change. Climate change contributes to increase frequency and severity of disasters with adverse

impacts on humans, natural ecosystems including coastal environment (FAO, 2018). Extreme variability of climate has been reported to cause sea level rise, storm surge, flooding, land erosion, water logging, and salinity intrusion in soil and water with adverse effect on the livelihoods of people especially those living in environmentally fragile areas.

The ongoing impact of climate change on the ocean environment has been well-documented, particularly in its effect on vulnerable fisheries (Mendenhall *et al.*, 2020; Atairet and Umoh, 2022). These impacts carry significant implications for coastal communities and ecological systems, as highlighted by Whitney *et al.* (2020). The continued trend of climate change will undoubtedly lead to further consequences for livelihoods. As a result, adaptation is imperative. The Intergovernmental Panel on Climate Change (IPCC) defines adaptation as "the process of adjusting to actual or expected climate variability/change and its effects to moderate harm or exploit beneficial opportunities" (Field *et al.*, 2022). However, this process of adjustment is often hindered by various socio-economic factors and conditions, complicating efforts to address climate change and its effects. The Nigerian government's commitment to addressing climate change, as demonstrated by signing the Paris Agreement, is commendable. However, despite these efforts, there is a consensus among policy makers, practitioners, and researchers that the pace of adaptation to climate change is inadequate. This may be attributed to a lack of awareness among Bonga fishers regarding the most effective adaptation strategies, as well as socio-economic factors influencing their ability to adopt these strategies. Furthermore, there is a dearth of information regarding the level of adoption of available strategies among Bonga fishers in the Atlantic Coast of Akwa Ibom State. Therefore, this study aims to explore the socio-economic factors influencing the adaptation to climate change by fishers in this region with specific objectives to identify common adaptation strategies used by Bonga fishers and examine the socio-economic factors influencing their level of adaptation. By shedding light on these factors, it is hoped that more targeted and effective interventions can be developed to support Bonga fishers in adapting to the challenges posed by climate change.

Literature Review

The socio-economic characteristics within a household play a significant role in shaping the adaptive capacity of coastal communities towards climate change. Shaffril *et al.* (2015) emphasized the importance of considering social and economic activities when assessing community awareness towards climate change in Malaysia. Their findings highlighted the influence of age, income, experience, and educational status on the

community's adaptation practices. This was further supported by Ramli et al (2018), who noted that individuals with lower educational backgrounds exhibited a lower level of awareness towards environmental changes, particularly among Malaysian fishermen. Additionally, Salik et al. (2015) conducted a study on the socio-economic vulnerability of mangrove-dependent communities in the Indus Delta of Pakistan, shedding light on the impact of climate change on these communities. These studies collectively underscore the critical role of socio-economic factors, particularly education, in shaping the adaptive capacity and awareness of coastal communities towards climate change.

The integration of primary and secondary data in the studies conducted by Allam and Mallick (2022), Douxchamps et al. (2016), Abu Samah et al. (2019), D'silva et al. (2012), Shaffril et al. (2015), and Senapati and Gupta (2017) has provided valuable insights into the impact of climate change on various communities. These studies have highlighted the vulnerability of certain regions to climate change driven threats, particularly in relation to the adaptive capacity of fishers and small-scale farmers. Factors such as inadequate income diversification, low education levels, and lack of access to basic facilities have been identified as key barriers to effective adaptation. Additionally, the use of agricultural and fisheries technologies, alternative job opportunities, and higher education have been shown to positively influence adaptive practices. The findings underscore the importance of addressing socio-economic and educational factors in enhancing adaptive capacity and resilience to climate change within these communities.

The same study also pointed that household with increased number of income earners plays a major role as it help accommodate the fishermen's adaptive capacity due to a sharing of household income responsibilities. Alam *et al.* (2021) identified that the economic factors influencing fishers' adaptation to climatic change are divided into climatic factors and non-climatic factors. The non-climatic factors include: fishing ban, no return on investment and low supply of caught fish.

Isam *et al.* (2014) studied limitations and barriers to adaptation to climate change in fishing communities in Bangladesh and argued that low-income groups, lack of access to credit, lack of education, skills and livelihood alternative and lack of enforcement of fishing regulations and maritime laws were constrained by economic barriers for adaptation.

Several studies have shed light on the vulnerability of agricultural sectors, particularly fisheries and aquaculture, to the impacts of climate change in various regions of Africa. For instance, research in Mozambique highlighted factors such as lack of awareness about climate change,

limited preventive measures, and poor adaptive capacity as contributors to the susceptibility of the sector to extreme events. Similarly, studies in Nigeria and Uganda identified various adaptation strategies employed by farmers, including crop diversification, improved seed varieties, and conservation practices. However, common constraints such as limited access to resources, low education levels, and inadequate financial support were found to hinder effective adaptation. Furthermore, findings from different regions emphasized the significance of socio-economic factors such as education level, farming experience, and access to agricultural inputs in influencing farmers' adoption of climate change adaptation strategies. These studies underscore the importance of targeted policies and support mechanisms to enhance resilience and adaptive efficiency within agricultural communities facing climate-related challenges.

Objectives of the study

The specific objectives of this study are to:

1. identify common adaptation strategies used by Bonga fishers in the study area
2. examine the socio-economic factors influencing their level of adaptation.

METHODOLOGY

Study area

The study was conducted in Akwa Ibom State of Nigeria. Akwa Ibom State is located in the coastal south eastern part of Nigeria. It lies between latitudes 4°32'N and 5°33'N, and longitudes 7°25'E and 8°25'E. The State is bounded on the north by Abia State, on the West by Rivers State and on the East by Cross River. The entire of the southern boundary is the Atlantic Ocean. The State occupies a land area of 8,412 square kilometers. Projection population of Akwa Ibom State is put at 7, 200,000 (<https://akwaibomstate.gov.ng>). This study was conducted in Akwa Ibom coastal communities. The occupational life of the people in this area is fishing which they engage in fulltime, both at subsistence and commercial scales. Other occupations apart from fish business include local boat caving, production of net mending needles, mining of sharp sand, production of inputs for fish processing like pinning sticks and rackets. They are also involved in different types of agricultural activities like crop farming and vegetables. Important cash crops are also grown, like oil palm, coconut and raffia palm. Livestock rearing is carried out by the residents though in small scale. Extraction of mineral

resources are an important primary activity in the area and crude oil extraction for petroleum products. This study was carried out in three local government areas in Akwa Ibom State that are bounded by Atlantic Ocean. They are referred to as Atlantic coastal areas (Gulf of Guinea).

Sampling methods

The sampling procedure adopted in this study was two-stage. Firstly, the three local government areas on the Atlantic coast were studied. They are: Eastern Obolo, Ibeno and Mbo (Bight of Bonny or Gulf of Guinea). The second stage was a purposive selection of six (6) fishing settlements in each of the 3 Local Government Areas. Subsequently, six fishing settlements were purposively selected within each of the three Local Government Areas, totaling 18 fishing settlements/villages. Data collection instruments included structured questionnaires, Focus Group Discussion Guides, and In-depth Interview Guides, all tailored to gather information on activity-based adaptation strategies and challenges faced by fishers in adopting climate change adaptation strategies. To ensure comprehensive data collection, both quantitative and qualitative methods were used. Pre-testing of the instruments was conducted to verify their reliability, validity, and clarity in addressing the research objectives. Additionally, In-depth Interviews with key informants, particularly experienced professional fishers, were conducted to capture historical perspectives on weather and climate change within the community.

Analytical techniques

Multinomial Logit Model

Hosmer et al. (2013) provided a definition of Multinomial Logit (MNL) as a model used to explain the correlation between dependent and independent variables obtained with rating scales. This model, along with Multinomial Probit (MNP), is commonly used in adaptation decision studies involving multiple choices. Multinomial logistic regression is employed when dependent variables involve three or more categories. The multinomial logit model is a major tool for such studies, as it is polytomous and recognizes the index nature of various response categories. According to Ying and Warren (2003) and Ari (2016), the multinomial logit model is used to model relationships between a polytomous response variable and a set of regressor variables, handling explanatory variables that are continuous or take different values for different categories of responses. In multinomial logit model, the response Y of an individual unit is restricted to one of m ordered values. Also, Garcia-Perez (2013) added that multinomial logistics regression is applied

for multi-categorical outcomes. Logistic regression can also be used to describe the relationship between an independent variable(s) (either continuous or not) and a dichotomous or multi-categorical dependent variable.

Liang and Zhan (2020) demonstrated an example of a model using cause-specific death classification in the field of medicine. In this model, the dependent variable is defined as having three categories: alive, deceased due to lung cancer, and deceased due to other causes. The cumulative logit model is utilized to account for the continuous nature of the observed response, which is attributed to methodological limitations in data collection. This approach allows for the grouping together of values of an otherwise continuous response variable. Generalized logit models, similar to ordinary regression models, can accommodate both continuous and discrete dependent variables.

Let $\pi_j(x_i)$ denote the probability of response j , $j = 1, \dots, j$, at the i th setting of values of k explanatory variables

$$x_i = (1, x_{i1}, \dots, x_{ik}).$$

In terms of response probabilities, the generalized logit model is stated as;

$$\pi_j(x_i) = \frac{\exp(\beta_j' x_i)}{\sum_{h=1}^j \exp(\beta_h' x_i)} \quad \text{Equation 1}$$

β_j assumes $0 \leq \beta_j \leq 1$
 $\text{Log} [\pi_j(x_i) / \pi_1(x_i)] = \beta_j' x_i, j = 1 - 1 \quad \text{Equation 2}$

Multinomial logit model is one of the most widely used models for ordinal response data. Several empirical studies in which the dependent variable has to be measured in an ordinal categorical manner and in which multinomial logit model has been employed include study conducted by Ibok *et al.* (2014), Al- Neyazy (2021); Dung, (2020) and Asampana *et al.* (2017). Stratton *et al.* (2003) also employed multinomial logit model to estimate the attrition that distinguishes between stop out and dropout behaviour. The respondents in the study were made to face three choices; continuous enrolment =1, short term enrolment =2 and long-term dropout=3. This category was modelled as a function of individual specific characteristics x that affect the category associated with each choice differently; Hence, $U_{ji} = X_i \alpha_j + \epsilon_{ji}$

Where

- j = denotes the category
- i = denotes the individual.

Udo *et al.*, (2019) also used multinomial model in their study of food safety knowledge and practices of students in public Universities to determine the factors affecting food safety knowledge and determine the factors affecting respondent's willingness to adopt food safety practices. Again, Al-Neyazy (2021) used MNL model to analysed the characteristics of married women using family planning methods with three choices level (1= do not use, 2= use a traditional method, 3 = use a modern method). Therefore, in this study the factors influencing the level of adaptation strategies practice by Bonga fishers are estimated, the dependent variable "number of adaptation strategies practiced" is defined to have three (3) possible values; value 1, if the adaptation strategies are within the class ranked Low; value 2, if Moderate and value 3, if High. The socio-economic characteristics of the fishers constitute the explanatory variables for this study. By implication, after estimating the parameters, one can predict the probability that a sampled group of fishers either with a specified set of socio-economic characteristics may have a particular level of climate change adaptation strategies utilized as either low, moderate or high.

Determining the factors influencing fishers' adaptation level

Multinomial Logit Model (MNL) was used to assess the influence of socio-economic characteristics of the fishers on their level of climate change adaptation. The following stages were considered;

Computation of activity-based adaptation index (AAI)

The following steps were followed in computing the AAI:

Step 1: Identifying adaptation strategies employed by fishers and ranking them on a scale of 3 to 5 (3 = popular, 4 = more popular, 5 = most popular (Table 1). The weights/ranks assigned to the strategies were generated at the Focus Group Discussion. The basic assumption of doing this is that fishers who are applying a high number of effective and feasible practices for adaptation to climate change can better respond to climate change. Analyzing the weights assigned by the Focus Group Discussion yields insights into expectation about the adaptation potential of the area.

Step 2: Estimating the activity-based adaptation index (AAI) for each fisher using the formula:

$$AAI_j = W_1P_{1j} + \dots + W_2P_{2j} + \dots + W_nP_{nj} \quad \text{Equation 3}$$

Where:

AAI_j=Activity-based adaptation of fisher j,

W=weighting/ranking factor of adaptation practice (ranging from 3 to 5) P_j=jth fisher's value for practice (1, if fisher practices the strategy, 0 otherwise)

This was calculated for each of the 140 Bonga fishers sampled. For example, if fisher 1 responded that he practice strategies 1 and 7 (Table 1). Its Activity-based adaptation index would calculate as;

$$AAI_{f1} = W_1P_{1j} + \dots + W_2P_{2j} \\ AAI_{f1} = 5 + 3$$

The ranking was done based on 3 point likert scale, the result of the ranking of the adaptation strategies are presented in (Table 2).

Step 3: Distributing fishers into various AAI classes (≤ 5 , $6 \geq 10$, >10).

The multinomial logit model was estimated with a set of coefficients $\beta^{(1)}$, $\beta^{(2)}$ & $\beta^{(3)}$ as follows:

$$\Pr (Z = 1) = \frac{e^{\beta^{(1)}}}{e^{\beta^{(1)}} + e^{\beta^{(2)}} + e^{\beta^{(3)}}} \quad \text{Equation 4}$$

$$\Pr (Z = 2) = \frac{e^{\beta^{(2)}}}{e^{\beta^{(1)}} + e^{\beta^{(2)}} + e^{\beta^{(3)}}} \quad \text{Equation 5}$$

$$\Pr (Z = 3) = \frac{e^{\beta^{(3)}}}{e^{\beta^{(1)}} + e^{\beta^{(2)}} + e^{\beta^{(3)}}} \quad \text{Equation 6}$$

Multinomial logit model is a choice between three or more alternative responses (Kartels *et al.*, 1999). The model however, is unidentified in the sense that there is more than one solution to $\beta^{(1)}$, $\beta^{(2)}$ and $\beta^{(3)}$ that lead to the same probabilities for $Z = 1$, $Z = 2$ and $Z = 3$. To identify the model, one of the $\beta^{(1)}$, $\beta^{(2)}$ and $\beta^{(3)}$ was arbitrarily set to 0. That if $\beta^{(2)}$ is arbitrarily set = 0, the remaining coefficients $\beta^{(1)}$ and $\beta^{(3)}$ will measure the change relative to the $Z = 3$. In other words, this study compared the case of moderate level (2) of the fishers to climate change adaptation with other possible levels (1 and 3). Therefore, using three category response as used in the model for this study and setting $\beta^{(2)} = 0$, the equation became.

$$\Pr (Z = 1) = \frac{e^{\beta^{(1)}}}{e^{\beta^{(1)}} + e^{\beta^{(2)}} + e^{\beta^{(3)}}} \quad \text{Equation 7}$$

$$\Pr (Z = 2) = \frac{e^{\beta^{(2)}}}{e^{\beta^{(1)}} + e^{\beta^{(2)}} + e^{\beta^{(3)}}} \quad \text{Equation 8}$$

$$\Pr (Z = 3) = \frac{e^{\beta^{(3)}}}{e^{\beta^{(1)}} + e^{\beta^{(2)}} + e^{\beta^{(3)}}} \quad \text{Equation 9}$$

Table 1: Adaptation strategies and their ranking by fishers.

Adaptation Strategies	Ranking/Weight Level
Increasing fishing gears/ facilities	5
Changing from canoes to motorized equipment	5
combing fishing with crop/ livestock farming	5
Combing fishing with crafts making	4
Temporal relocating to other fishing ports/settlements	4
Going farther into the shore	3
Part-time employment in other sector	3
Spending more time on a fishing trip	3

Field Data, 2023. Rank: 3= popular, 4 = more popular, 5 = most popular

Table 2: AAI rank and classification.

AAI Class	Adaptation level categorization	Response categories
≤ 5	1	Low
6 ≥ 10	2	Moderate
>10	3	High

Source: Field Data, 2023.

The relative probability of Z = 2 to the base category is

$$\frac{\Pr(Z = 2)}{\Pr(Z = 3)} = e^{x\beta^{(1)}} \quad \text{Equation 10}$$

for one unit change in X_i relative to the base category is then stated as;

$$e^{\beta_1^{(1)} x_1 + \dots + \beta_1^{(1)} (x_1+1) + \dots + \beta_k^{(1)} x_k} \quad \text{Equation 11}$$

If this is called the relative likelihood and assume that X and $\beta_k^{(2)}$ are vectors equal to (X_1, X_2, \dots, X_n) and $(\beta_1^{(1)}, \beta_2^{(1)}, \dots, \beta_k^{(1)})$ respectively, the ratio of relative likelihood

$$e^{\beta_1^{(1)} x_1 + \dots + \beta_1^{(1)} x_1 + \dots + \beta_k^{(1)} x_k} \quad \text{Equation 12}$$

Table 3: Socio- economic variables used in the model and their unit of measurement.

X_1	= Age of fisher	Measured in years
X_2	= Gender of the fisher	Gender of fisher (1= male, 0 = female) dummy
X_3	= Level of education	Years of formal education of the fisher (in years)
X_4	= Household size	Number of persons living in the same house sharing the same cooking arrangement
X_5	= Fishers income	ln (naira) (monthly income)
X_6	= Member of social association	(Yes =1, No = 0) dummy
X_7	= Non-fishing job	(Yes =1, No = 0) dummy

Enete (2003) citing StataCorp (1999) reported that, the exponential value of a coefficient is the relative likelihood ratio for one-unit change in the corresponding variable. As pointed out, the dependent variable “Fisher’s level adaptation” have three (3) possible values; value 1 if the level of adaptation is low (L), value 2 if moderate (M) and value 3 if it is high (H). An individual fisher’s level of adaptation to climate change is as either low, moderate or high. The socio-economic variables used in the model and their measurement are shown in (Table 3).

RESULTS AND DISCUSSION

Common climate change adaptation strategies used by Bonga fishers

It is evidential from the (Tables 4a,b and c), that the majority of the Bonga fishers practiced strategy number 3 (change from the use of canoes to motorized type of equipment) with 26.4% as the highest percentage in the distribution; The next popular adaptation strategy embrace by Bonga fishers was spending more time in a typical fishing trip with over twenty one percent (21.5), followed by going farther into the shore and deeper with twenty percent (20.0). Again, relocating to other fishing settlement; seeking temporary employment in other sectors, increase fishing gear facilities, combining fishing with crop/livestock farming and combining with aquaculture were also practiced by Bonga fishers at 11.8, 10.3, 5.8, 3.9 and 0.4 percent respectively. Discussants during the FGDs confirmed the findings derived from

Table 4a: Adaptation strategies according to rank

Adaptation Strategies	Ranking/Weight Level
Increasing fishing gears/ facilities	5
Changing from canoes to motorized equipment	5
combing fishing with crop/ livestock farming	5
Combing fishing with crafts making	4
Temporal relocating to other fishing ports/settlements	4
Going farther into the shore	3
Part-time employment in other sector	3
Spending more time on a fishing trip	3
Practicing fishing along-side aquaculture	1

Source: Field Data, 2023

Table 4b: Fisher's Activity-based Adaptation Index

AAI Index	Frequency	Percentage
≤ 5	3	2.14
6 ≥ 10	47	33.57
11 > 15	90	64.28
Total	140	100

Table 4c: Common climate change adaptation strategies used by Bonga Fishers

Adaptation Strategies	Frequency	Percentage
Combining fishing with craft	-	-
Increase fishing gears facilities	30	5.8
Change from canoes to motorize equip	136	26.4
Combining fishing with crop farming/livestock	20	3.9
Seek temporary or part time employment to other economic sector	53	10.3
Relocate to other fishing settlement	61	11.8
Introducing aquaculture	2	0.4
Going farther into the shore and deeper	103	20.0
Spending more time in a fishing trip	111	21.5
Total	516	100

Source: Field Data, 2023.

analysis of data from the questionnaire. For instance, a middle-aged male discussant said:

In the past you could go for Bonga fishing around 4pm and will return by 6pm with a great catch but now 6-8 hours you cannot achieve same level of catch. So, we stay longer in the sea than before. Staying longer entails spending more money on fueling the outboard engine.

Results of multinomial logit analysis of socio-economic factors influencing fishers' level of adaptation

The explanatory power of factors influencing fisher's level of adaptation to climate change as reflected by the pseudo R^2 was high (0.785). The overall goodness of fit as reflected by $\text{prob} > \chi^2$ (0.0000) was good in terms of consistency with a priori expectations on the relationship between the dependent and the independent variables, the model seems to have behaved well. The parameter

estimates of the multinomial logit model only provided the direction of the influence of the explanatory variables on fishers' adaptation level of climate change and did not show the actual magnitude of change or probabilities in the coefficients. Therefore, the marginal effects (dy/dx) from the model, which measure the expected change in probability of adaptation level of climate change with respect to a unit change in an independent variable was also presented in (Table5).

Age of fishers in this specialization was significant but negatively correlated to the probability of practicing low level of adaptation strategies in relative to moderate the negative and significant implication of age to low level of adaptation to climate change strategies showed that aged fishers are likely to utilize low number of adaptation strategies. This shows that young fishers' have a longer planning horizon and have the ability to practice high level of adaptation strategies compared to their older counterparts. Years of formal education of the fisher has an inverse relationship with the probability of practicing low level of adaptation strategies but was positive and

Table 5: Parameter Estimates of the Multinomial Logit (MNL) Analysis of Factors Influencing Fishers' Level of Adaptation to Climate Change in the Study Area

Explanatory Variables	Coefficient		Marginal Effects	
	Low level (1)	High level (3)	Low level dy/dx	High level dy/dx
Age	-0.10452 (-3.08) ***	-0.08414 (-2.76) ***	-0.01221 (-2.43) ***	-0.01074 (-1.89) *
Gender	1.51247 (1.30)	1.08225 (0.94)	0.19642 (1.11)	0.08132 (0.47)
Level of education	-0.17237 (-2.36) **	0.13384 (1.96) **	-0.02049 (-1.97) **	0.01665 (1.85) *
Income	-0.00002 (-2.10) **	7.76E-06 (4.01) ***	-3.01E-06 (-2.06) **	2.16E-07 (6.15) ***
Membership of Cooperative society	-2.42368 (-3.48) ***	2.72470 (4.16) ***	-0.20768 (-2.91) ***	0.35768 (4.60) ***
Household Size	-0.17295 (-1.56) *	0.01142 (0.12)	-0.03107 (-1.92) *	0.10495 (0.83)
Participation in Non-fishing job	0.52484 (6.95) ***	0.13529 (0.23)	0.10407 (2.04) **	-0.01423 (-0.17)
Dependency Ratio	1.06300 (0.87)	-6.78598 (-1.89) *	0.12924 (0.73)	-0.09413 (0.45)
Value of Productive Asset	2.52E-08 (0.07)	2.36E-08 (0.08)	2.70E-09 (0.05)	3.32E-09 (0.06)
Constant Term	8.99377 (4.38) **	5.77251 (3.21) ***		

Note: Moderate (2) is the Base Outcome

*** denotes $P \leq 0.01$, ** denotes $P \leq 0.05$, * denotes $P \leq 0.10$

Pseudo $R^2 = 0.785$ Prob> $\chi^2 = 0.000$

significant ($P \leq 0.05$) related to making high level adaptation to climate change in comparison with the moderate level of adaptation. The marginal effect of high-level adaptation indicates that a unit increase in the level of education of fisher would increase adaptation level by 0.01665 (0.16%) in the study area. In recognition of the significance of education in level of adoption of climate change adaptation measures, this result support the findings of Allam and Malick (2022) whose work revealed lack of education as one of the factors that influences adaptation level of fishers in southeast Bangladesh coast. Fishers' income was negatively and significant at 5% level related to the probability of practicing low level adaptation. The coefficient of income was positively and significantly at 1% confidence level related to the probability of utilizing high level of adaptation in relative to moderate level, the positive and significant effect indicated that the more the income of fisher, the more likelihood of the fisher to utilize high level adaptation

compare to moderate level. A unit increase in income of a fisher as shown in the marginal effect column would yield 2.16E-07 (2.1%) increase in the probability of utilizing high level of adaptation. This result agrees with the findings of Abu-samah et al. (2019); Shaffril et al. (2015), who found out that age, income, educational status was significant socio-economic factors which had influence on climate change adaptation practices.

The result showed that, there was a negative relationship between membership of social group and the probability of utilizing low adaptation strategies but was positive and significantly ($P \leq 0.01$) related to utilizing high number of adaptation strategies in comparison with moderate level. The positive and significant effect indicated that the more the involvement of fishers in social group the more the likelihood of the fisher utilizing high level of adaptation to climate change. A unit increase in fishers' involvement in social organization as shown in the (Table 5) would increase probability of

utilizing high level of adaption strategies by 0.35768 (3.5%) increase in the probability of utilizing high number of adaptation strategies.

Fishers' household size showed a negative significant relationship between household size and the probability of Bonga fish fishers practicing low adaptation strategies. This implies that the smaller the size of family, the lower the level of adaptation. The marginal effect indicated that a unit increase in household size would decrease the likelihood of fishers to utilize low level of adaptation to climate change by -0.03107 (-0.3%). This give credence to the work of Senapati and Gupta (2017) who reported that household with increased number of income earners plays a major role as it help accommodate the fishermen's adaptive capacity due to shared responsibilities. The coefficient of having NON-fishing job (NONFJOB) was positive and significantly ($P \leq 0.01$) related to the probability of practicing adaptation at the low level in comparison with moderate class level. The significant and positive relationship of off-fish jobs fishers is that they are likely to adopt adaptation strategies due to availabilities of fund. It is expected that a fisher who also involve in Non-Fishing Job will be able to cope with negative impact of climate wince he can adjust by taking up other job during crises period. Non-Fishing income can enhance adaptation by relaxing liquidity and credit constraint to fishers. A unit increase in number of fishers with non-fish job as shown in the marginal effects column would result in 0.1040 (1.0%) further increases in the probability of utilizing low level adaptation. The result agrees with Salik *et al.* (2015) revealed that lack of inadequate income diversification negatively affects the adaptive capacity.

The Dependency Ratio coefficient of fishers was significant but negatively relate to high level adaptation, at $P \leq 0.10$. The negative relationship between dependency ratio and high-level adaptation was expected as Bonga fishers are less likely to adapt high level of climate change adaptation strategies. This is because an increase in number of dependent members of household may indicate increase in the number of economically inactive members and consequently affect level of adaptation. The result of the marginal effect showed that increase in the number of dependent population of fishers' families shall result to -0.09413 (0.9%) decrease in the probability of practicing high level of climate change adaptation compare to moderate class level.

Conclusion

Common adaptation strategies in the study area were Combining fishing with craft, increase fishing gears facilities, change from canoes to motorize equipment, Combining fishing with crop farming/livestock, seek temporary or part time employment in other economic

sector, relocate to other fishing settlement, introducing aquaculture, going farther into the shore and deeper and spending more time in a typical fishing trip. The socio-economic factors that positively influence fishers' adaptation level were age, educational attainment, income and membership in social group. Age, education, income, membership to cooperative, household size and dependency ratio had an inverse relationship, and in the reverse, non-fishing job was positive and significantly related to low level of adaptation. Age, educational attainment, income and membership in social group had positive influence to high level of adaptation and were significantly and positively related to high level of adaptation. Nevertheless, dependency ratio was negative but significantly related to making high level of adaptation to climate change in comparison with moderate adaptation level.

In conclusion, results on fishers' adaptation to climate change reveal that though fishers have tried a few climate change adaptation measures shown to adopt a variety of adaptation measures, these do not seem to be protecting them technically and sufficiently from the impacts of climate change. The socio-economic attributes of the fishers significantly influence their adaptation levels. Therefore, improved socio-economic status of the fishers will heighten activity-based adaptation level for improved fish production in the area. There is an urgent need for government to focus on climate change mitigation/adaptation sector in the fisheries because of the sector's importance to food and livelihood security and economic development. There is the need, therefore, to train, create awareness and make climate smart fishing technologies available and affordable to fishers to enhance their response to climate change. What they are doing presently is simply to cope with the impact of climate change by adopting various strategies which are only supporting their immediate survival but not enough to help them adapt

REFERENCES

- Abu Samah, A., Shaffril, H. A.M., Hamza, A. and Abusamah, B. (2019). Factors affecting small-scale Fisher's Adaptation towards the impacts of climate change: Reflections from Malaysian Fishers. 1-11 *Journal.sagepub.com/home/sgo*
- Alam, E., Hridoy, A. E. E., & Naim, M. (2021). Factors affecting small-scale fishers' adaptation toward the impacts of climate change: Reflections from south eastern Bangladeshi fishers. *International Energy Journal*, 21(1A).
- Atairet, E. A., Umoh, G. S. (2022). Climate Vulnerability and Income Inequality Among Bonga Fishers in the Coastal Communities of Akwa Ibom State, Nigeria. 2022 AKSU. *Journal of Agricultural Economics, Extension and Rural Development*. (AKSUJAEERD) 5 (1), 53-63.
- Douxchamps, S., Wijk, M. T., and Rufino, M. C. (2016). Linking Agricultural Adaptation Strategies, Food Security and Vulnerability: Evidence from West Africa. *Regional, Environmental Change*.16 (5) 1305-1317.

- D'Silva J. L., Shaffril, H. A. M., Samah, B. A., and Uli, J. (2012). Assessment of social adaptation capacity of Malaysian fishermen to climate change. *Journal of Applied Science*, 12: 876-881.
- Enete, A. A. (2003) "Resource Use, Marketing and Diversification Decisions in cassava producing household of sub-Saharan Africa". A PhD Dissertation presented to the Department of Agricultural Economics, Catholic University of Louvain, Belgium.
- Ibok, O. W., Basse, N. E., Atairet, E. A. & Obot, O. J. (2014). "Food Security Determinants among Urban Food Crop Farming Households in Cross River State, Nigeria." *Asian Journal of Agricultural Extension, Economics and Sociology*, 3(1), 76-90
- Isam, M. M., Sallu, S., Hubacek, K. and Paavola J. (2014). Limits and Barriers to Adaptation to Climate Variability and Change in Bangladeshi Coastal Fishing Communities. *Marine Policy*, 43, 208-216.
- IPCC, (2023). Climate Change : Synthesis Report. Contribution of Working Groups 1, 11 and 111 to the sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. Ipcc, Geneva, Switzerland, 35-115, doi:19.59327/ipcc/AR6-9789291691647.
- Mendenhall, E., Hendrix C., Nyman E., Roberts P.M., Hoopes J.R., Watson J.R., Lam V.W. and Sumail U.R., (2020). Climate Change increases the risk of fisheries conflict. *Marine Policy*, 117, p. 103954.
- National Bureau of Statistics (NBS) (2022). Issues. Statistical Bulletin. National Bureau of Statistics, Abuja.
- Ramli, S. A., Abu Samah, A., Shaffril, H. A. M. (2018). Examining factors affecting change adaptation practices among small scale fishermen in Kelantan and Pulau Pinang. *International Journal of Education and Social Science Research*, 1(5), 35-43.
- Rotowa, O.J., Adekunle E.A., Adeagbe A.A., Nwanze O.I. and Fasiku O.O, (2019). Economic Analysis of Agriculture, Forestry and Fisheries to the Economic Development of Nigeria. *International Journal of Research Studies in Science, Engineering and Technology*, 6(6), 15-22.
- Salik, M. K., Jahangir, S., and Zahdi, Z. (2015). Climate Change vulnerability and adaptation options for the coastal communities of Pakistan. *Ocean and Coastal Management* 112, 61-73.
- Senapati, S., and Gupta, V. (2017). Socio-economic vulnerability due to climate change: Deriving indicators for fishing communities in Mumbai. *Marine Policy*, 76, 90-97
- Shaffril, H. A. M., D'silva, J. L., Kamarudin, N., Omar, S. Z., and Bolong, J. (2015). The coastal community awareness towards the climate change in Malaysia. *International Journal of climate Change Strategies and Management*, 7(16) 533.
- Udo, E. S. Okon, U. E. and Offor, S. O. (2019). Food Safety Knowledge and Practices of Students in Public Universities in Akwa Ibom State, Nigeria. *AKSU Journal of Agricultural Economics, Extension and Rural Development*. 2(1): 51-57. <https://akwaibomstate.gov.ng>.