Fish Farmers Adaptive Capacities to Climate Change, in Port Harcourt Riverine Areas of Rivers State, Nigeria.

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ABSTRACT

This study estimated fish farmers' adaptive capacities to climate change and its effect on their productivity in Port-Harcourt riverine areas of Rivers-State. The simple random sampling technique was used, since the respondents have equal opportunity of being selected i.e. homogeneity of fish farmers. The adaptive capacities of fish farmers were estimated quantitatively and categorized into high, moderate and low adaptive capacities. Double logarithmic regression model of Cobb – Douglas production function was used to quantify the effects of adaptive capacities on the productivity of fish farmers in the study area. On the average, the fish farmers interviewed were moderately adaptive to climate change; also, high adaptive fish farmers obtained 0.30% increase in their fish farm productivity than fish farmers with low adaptive capacities. Therefore, the more a fish farmer has the ability to adjust to climate change, the more the number of fish species he or she produces. Fish farmers should be empowered through better extension services (training) on the available adaptation strategies to adopt in their fish farm, to attain higher adaptive capacity status, so as to help them obtain an increase in their fish farm productivity.

Key words: Climate change, adaptive capacities, productivity, fish, adaptation strategies and *cobb-Douglas* production function.

Introduction

The lives of the entire global community are in increasingly threatened by the effects of current climatic conditions. The activities of man are gradually destroying the environment thereby affecting its suitability for habitation for natural creatures.
IPCC (2001) defined climate changes as a significant shift in the average weather condition especially average temperature and precipitation. Globally, the earth has over the years observed a significant increase in temperature but decreased precipitation (Fanchearan et al., 2003). Climate change has raised a lot of concerns by scientists and world authorities of both developed and developing countries. Many researchers have shown that agriculture in Africa is negatively affected by climate change (Deressa et al., 2008, Kurukulasuriya and Mendelssohn 2006). The changing climatic conditions are affecting the water which may affect fish family adversely in Nigeria. Fish farming involves the planned growth and cultivation of fishes in tanks or proper enclosures or natural fish ponds for harvesting as food or for commercial purpose. Fishery products are by far the most popular animal products in the market, constituting more than 60% of meat products in the Nigerian market. Fish farming is very profitable, with proper planning and good management, N3 million investments in fish farming and easily result to N4 Million of pure profit within six months does not cause any environmental hazard. Unlike poultry farming, one can set up fish farm

anywhere including residential areas or within one's backyard without any regulatory precaution.

Therefore, this work is developed to widen the Understanding on fish farmers adaptive capacities to climate change. IFAD and other development agencies have recognized climate change as one of the greatest threats facing mankind today (IFAD 2007, World Bank, 2010) and have highlighted the fact that the poorest and most vulnerable will be disproportionately affected by its impacts (IFAD, 2008).
The effects of climate change on fish farming have called for the need to adopt certain adaptation strategies to cope with its harmful effects. IPCC (2OO7) defined adaptation to climate changes as "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effect, which moderates harm so as to take advantage of opportunities. Fish farmers can achieve food security, high income and livelihood security objectives if they adapt effectively to climate change (Hasan and Nhemachena, 2008).
Climate change stresses will compound existing pressures on fisheries and aquaculture and threaten their capacity to provide food and livelihoods. Worldwide, fish products provide 15% or more of the protein consumed by nearly 3 billion people and support the livelihoods of 520 million people, many of them women (FAO 2010). But the changing climatic conditions are affecting fish farming. Unfavourable changes in climatic factors such as high water temperature, global warming, how oxygen levels, warm summers and emissions causing eutrophication in water bodies are expected to affect fish farm productivity adversely and farmers need to adapt effectively to climate change.
According to Nyong (2005), fish farmers are vulnerable to climate change because they lack the capacity to adapt. The technologies and strategies for adapting to climate change are limited and so "the ability of a fish farmer to adopt an adaptation strategy so as to reduce the adverse effects of climate change on fish farming is called adaptive capacities.

Therefore, understanding the linkages between fish farming, climate change, adaptation strategies, adaptive capacities, livelihood and food security is critical for designing policies and management strategies for fish farming in the communities, nations and regions that depend on them.
Objectives of the study: The broad objective of this research is to determine fish farmers' adaptive capacities to climate change in the study area. Specific objectives are to:
*determine the degree of adaptive capacities of fish farmers in minimizing the effect of climate change.
*analyze the effect of adaptive capacities of fish farmers on fish farm productivity.

Materials and Methods

Study Area: They study was carried out in Port-Harcourt riverine areas in Rivers State, Nigeria. Rivers state is currently made up of 23 local government Area. It has a landmass of 360 km^2. Port-Harcourt is the capital of Rivers state, Nigeria. It lies along the Bonny River and is located in the Niger Delta and therefore has riverine areas. According to the 2006 Nigerian population commission), Port-Harcourt has a population of 1,382,592. The port was built in 1912, but not given a name until August 1913, when the Governor of Nigeria, Sir Fredrick Lugard, named it Port-Harcourt in honour of Lewis Vernon Harcourt, who was then, the secretary of state for the colonies.

Sampling Selection and Sampling Technique: A total of 150 fish farmers were randomly selected from five communities from Port Harcourt riverine areas, thirty fish farmers from each community.

Data Collection Procedure: The result employed basically primary data which was obtained from fish farmers through a well-structured questionnaire.

Method of Data Analysis: Data were analysed with the use of descriptive statistics. The Cobb Douglas production function was used in estimating the effect of adaptive capacities of fish farmers on productivity.

Model Specification:

Specification of model for the degree of adaptive capacities of fish farmers.
The degree of each fish farmers' knowledge on each adaptation strategy was sought. The highest degree of attainment of each of the attribute affecting adaptive capacities was scored I.00 whereas the lowest was scored 0.25. The score level for a fish farmer with a higher degree is 0.5 and lastly, the score for high degree of achievement is 0.5. The table below summarizes how each attribute was measured:

Table 1. The degree of adaptive capacities of fish farmers to climate change.

Degree	Scores	Knowledge	Use	Availability	Accessibility	Consultation
Highest degree	4.0	Very well	Several	Very Regular	Easily Accessible	Several
Higher degree	3.0	Well	Twice	Regular	Accessible	Twice
High degree	2.0	Fairly well	Once	Occasionally	Not easily Accessible	Once
Lowest degree	1.0	Not well	Never	Never	Not accessible	Never

Nakuia et al., (2012) score levels of fish farmers' achievement of attributes.

The adaptive capacity $AdapCap_{ij}$ of an ith fish farmer to jth adaptation strategy is calculated as shown below:

$$Adapcap_{ij} = \frac{K_ij+U_{ij}+V_{ij}+A_{ij}+C_{ij}}{N_A} \quad \text{--- fig. 1}$$

Where :

* $AdapCap_{ij}$ is the adaptive capacity of ith fish farmer to a jth adaptation strategy.
*Kij is the knowledge of the ith fish farmer on jth adaptation strategy.
*U_{ij} is the level of usage of jth adaptation strategy by ith fish farmer.
*Vij is the availability of innovations on jth adaptation strategy to ith fish farmer.
*Aij is the accessiblity of innovations on jth adaptation strategy to ith fish farmer.
*Cij is the level of consultation on jth adaptation strategy by ith fish farmer.
*N_A is the sum of applicable attributes.

The adaptive capacities of fish farmers in the study area were scored according to the ranges in the table below:

Table 2 : The ranges of the adaptive capacities of fish farmers

Degree of adaptive capacities	Ranges of indices for $AdapCap_{ij}$
Low adaptive capacity	$0 < AdapCap_{ij} < 1.33$
Moderate adaptive capacity	$1.34 < AdapCap_{ij} < 2.66$
High adaptive capacity	$2.67 < AdapCap_{ij} < 4.00$

Modified from Nakuja et al., (2012).

Fish farmer i is lowly adaptive to adaptation strategy j if the adaptive capacity calculated falls in the range of $0 < AdapCap_{ij} < 1.33$The range for moderate and high are $1.34 < AdapCap_{ij} < 2.66$ and $2.67 < AdapCap_{ij} < 4.00$ respectively.

Analyzing the effect of fish farmers' adaptive capacities.

According to Onumah et al (2010), the cob Douglas production function restricts the return to scale to one. Even though this is limitation, Cobb- Douglas production function has been used by Battese (1997) for its simplicity. This function shows a technical relationship between inputs and output. For the purpose of this research study, an argument Cobb-Douglas production function is specified as:-

$Q_1 = B_o k_i^{B1} L_i^{B2} FF_i^{B3} FP_i^{B4} Age_i^{B5} e^{B6GENi} e^{B7EDUi} e^{B8AdapCapi} e^{Ui}$ -----------------------------Fig. 2

Taking the natural log above gives the double log equation below:-

$In(Q_i) = B_0 + B_1 In(K_i) + B_2 In(L_i) + B_3 In(FF_i) + B_4 In(FP_i) + B_5 In(Age_i) + B_6 GEN_i + B_7 EDU_i + B_8 AdapCap_i + U_i$ ---------Fig 3

According to the log, this will be done by including dummy variables such as:

Q_i =Total number of fish produced per annum (in kilogrammes).

Ki = the capital input for ith fish farmer (in Naira).

Li = the labour input for ith fish farmer (in Naira).

EDU_i = Access to education (At least primary education, dummied 1 for fish farmers who have access to education, secondary=2, tertiary=3, no formal education=0)

GEN_i = A male fish farmer will be given a score of 1 whereas a female 0.

And adaptive capacity indicators and continuous endogenous variable inputs such as:

FF_i = quantity of fish feed (in kilogrammes).

FP_i = Number of fish pond.

Age_i = Age of a fish farmer (in years).

$AdapCap_i$ = adaptive capacities of fish farmers in the study area. (High adapters will be dummied 1 and 0 otherwise).

B_o = the constant.

B_1—B_8 = the slope coefficients for the independent variables.

Ui = the error term for ith fish farmer.

Table 3. The a priori expectations of the variables.

Variables	Parameters	A Priori Expectation
Capital	B1	Positive
Labour	B2	Positive
Fish feed	B3	Positive
Number of fish pond	B4	Positive
Age	B5	Positive
Gender	B6	Negative
Access to education	B7	Positive
High adaptive capacity	B8	Positive

Results and Discussion:

The degree of adaptive capacities of fish farmers:

The degree of adaptive capacities of fish farmers in the study area to the adaptation strategies adopted by them is presented in the table below.

Table 4. The degree of adaptive capacities of fish farmers to climate change.

Attributes	**Very well** (4)	**Well**(3)	**Fairly Well**(2)	**Not Well**(1)	**Mean**
Degree Knowledge (K_{ij}	24(16.0)	35(23.3)	34(22.7)	57(38.0)	3.3
Higher degree Use (U_{ij})	0(0.00)	37(24.7)	55(36.7)	58(38.7)	2.8
Higher degree Availability (V_{ij})	0(0.00)	38(25.3)	69(46.0)	43(28.7)	3.0
Higher degree Accessibility (A_{ij})	0(0.00)	34(22.7)	47(31.3)	69(46.0)	2.7
Higher degree Consultation (C_{ij})	0(0.00)	34(22.7)	55(36.7)	61(40.7)	2.7
Higher degree Grand mean value	------	-------	-------	------	14.5

Source: field survey data, 2014

Score levels of fish farmers' achievement of attributes.

From table 4 above, K_{ij}, U_{ij}, V_{ij}, A_{ij} and C_{ij} represents the attributes to the strategies adopted by the fish farmers, which are: Knowledge, Use, Availability, Accessibility, Consultations on the strategy used by each fish farmer in the study area. All these five(5) attributes adopted by the fish farmers in the study area, have higher degrees, because they are approximately 3.0 score level of degree. This implies that the fish farmers in the study area are not lower adapters but are moderate adapters to climate change. Among the score levels of the fish farmers on these attributes, the level of knowledge on the adaptation strategies has the highest score, followed by the level of useage, then, the availability of innovations, while the accessibility of innovations and the level of consultations are the same and have the least score, even though their degree is not low.

Therefore, the $MeanAdapCap_{ij}$ is calculated thus: $\frac{14.5}{4+3+2+1} = \mathbf{1.45}$

From Fig.3 above, the mean adaptive capacities of fish farmers to climate change is **1.45** and it falls within the range of $1.34 < AdapCap_{ij} < 2.66$, which indicates the moderate adaptive capacities of fish farmers in the study area. Generally, the **1.45** mean adaptive capacities of the respondents, implies that the fish farmers in the study area are moderate adapters to climate change. Therefore, they do not have all the necessary resources to aid them adapt highly and effectively to climate change, even though they are not low adapters to climate change. This is positively in support with Nakuja et, al; (2012).

Table 5.The effect of fish farmers' adaptive capacities on fish farm productivity.

Variables	**Co-efficient**	**Standard error**	**T_{value}**	**Significance**
Constant, (B_0)	7.520	1.843	4.081	0.000
Capital, $\ln(K_i)$	0.138	0.078	1.769	0.010**
Labour, $\ln(L_i)$	1.128	0.158	7.139	0.000***
Fish feed, $\ln(FF_i)$	0.156	0.076	2.053	0.042**
Number of fish pond, $\ln(FP_i)$	0.251	0.080	3.157	0.002***
Age, $\ln(Age_i)$	-0.131	0.160	-0.817	0.415
Gender, (GEN_i)	-0.066	0.086	-0.765	0.445
Access to education, (EDU_i)	-0.082	0.082	-1.001	0.319
Adaptive Capacities, $(AdapCap_i)$	0.304	0.152	2.003	0.018**
R-squared, (R^2)	0.631			
R-adjusted	0.687			
F-statistics	5.281			

Source: Field survey data, 2014. ** = 5%, *** =1%

The result of the analysis showed that the Coefficient of Determination (R^2) has a value of 0.631, which implies that 63.1% of the total variation in the productivity of fish farm was explained by the included variables. Five, out of the eight variables were statistically significant at different levels of probability (capital, labour, quantity of fish feed, number of fish pond used and adaptive capacities).

Capital has a positive relationship with the number of fish produced at 5% level of probability This also indicates that, as the capital increases, the productivity of the fish farm also increases. Therefore, 5% increase in capital by fish farmers results to an increase in the quantity of fish produced by 0.14%. This is a consistent a priori expectation but it does not support the findings of F. N. Mabe et al; 2012.

The labour input is consistent with the a priori expectation, because it was positively related to the total number of fish produced at 1% level of probability. This implies that, the more the labour input, the greater the number of fish produced by the fish farm workers. This is positively in-line with the findings of F. N. Mabe et al; 2012. Therefore, 1% increase in labour input results to an increase in the quantity of fish produced by 1.13%.

The quantity of fish feed consumed by the fish stock, also has a positive relationship with the total number of fish produced, at 5%level of probability. This implies that, the more the fish feed consumed by the fish stock, the more they grow and the more the reproduce, thereby, increasing the productivity of the fish farm.

The number of fish pond used by the fish farmers, also has a positive relationship with the number of fish produced, at 1% level of probability. This implies that, the higher the number of fish ponds used by the fish farmers, the more the quantity of fish species produced.

There is also a positive effect of the adaptive capacities of fish farmers to climate change, in the study area, on fish farm productivity, at 5% level of probability. This implies that, the higher the adaptive capacities of fish farmers to climate change, the higher the productivity of the fish farm. Therefore, a fish farmer that obtains a higher adaptive capacity status in adapting to climate change obtains 0.30% increase in his or her fish farm productivity than a fish farmer, who has a low adaptive capacity status. This means that, high adaptive capacity has a positive effect on fish farm productivity. In every spheres of farming, highly adaptive fish farmers adopt innovations to reduce risk posed by climate change. While high adaptive capacity positively affects fish farm productivity, low adaptive capacity therefore, negatively affects fish farm productivity.

Conclusion and Recommendations

The five attributes adopted by fish farmers were higher degrees with approximately 3.0 score level of degree and 1.45 mean adaptive capacities of fish farmers to climate change. It shows that the fish farmers are moderate adapters to climate change.

Also, by the significance of the five variables, the major conclusion from this study showed that fish farm productivity is significantly affected by the degree of adaptive capacities labour input, capital input, the number of fish pond used and the quantity of fish feeds consumed by the fish stock. Thus effective extension education on adaptation strategies to climate change should be improved through policy designs to train farmers.

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