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RESEARCH PUBLICATIONS
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Climate change perceptions and determinants of adaptation strategies among rural farmers in coastal communities in Delta state

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Abstract

Climatic changes have been predicted to have a devastating effect on rural livelihoods particularly agriculture. These impacts will vary from one ecosystem to another and from one sub-population to another depending on the length of coastline, level of emergency preparedness and livelihood sensitivity to climate related elements among other factors. The study area (Delta state) is located in the Atlantic coast and structurally lying in a low land. The rural economy of area is closely tied to its natural environment and highly sensitive to climate related elements. This makes the area to be highly vulnerable to climate change. Recent studies in the area present mounting evidences of climate change. It therefore becomes imperative to assess how rural farmers in coastal communities in the area percieve climate change and the determinants of their adaptation strategies since they actually bear the brunrt of climate change. A total of three hundred and thirty questionaires (330) were administered while two hundred and eighty-five (285) questionnaires were retrieved. Analysis of the questionnaire reveals that rural farmers in the region are aware of climate change and have devised various strategies to mitigate the impacts. However, these strategies vary from one farmer to another depending on the level of access to different capital assets. This paper calls for full integration and mainstreaming of local farmers perceptions and adaptation strategies into policies directed at mitigating the impact of climate change at the international, national and local levels.

Keywords: Adaptation, Climate Change, Determinants, Rural farmers, Strategies, Delta state

Introduction

The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as a change of climate which is attributable directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over a comparable time periods (IPCC, 2001). Similarly, in recent usage, the term "climate change" often refers to changes in modern climate which according to the IPCC (2007) are 90-95 percent likely to have been in part caused by human action.This definition implies that climate change only refers to changes in climate brought about by human activities. However, climate change has been noted to be caused by both human activities (anthropogenic) and natural processes (bio-geographical). The human factors that cause climate change have been identified as industrialization, technological development, urbanization, deforestation and burning of fossil among others, while the natural factors include solar radiation quality and quantity, astronomical position of the earth among others (Odingo, 2008; Odjugo, 2009).

Climate change is expected to affect food and water resources that are critical for livelihoods in Africa where much of the population, especially the poor, rely on local supply systems that are sensitive to climate variation. Disruptions of the existing food and water systems will have devastating implications for development and livelihoods and are expected to add to the challenges climate change already poses for poverty eradication (De Wit & Stankiewicz, 2006; IISD, 2007). However, the nature of these biophysical effects and the human responses to them are complex and uncertain (Apata and Adeola, 2009). Consequently, climate change is attracting more attention from the media, academics, politicians and even businesses, as evidence mounts about its scale and seriousness, and the speed at which it is affecting the world (Madu, 2010).

The predicted impacts of climatic changes are not uniform across the globe. In the international sphere, the impacts are expected to be more in developing countries to which Nigeria belongs due to the fact they rely heavily on climate-sensitive sectors, such as agriculture and fisheries, and have a low GDP, high levels of poverty, low levels of education and limited human, institutional, economic, technical and financial capacity (Preston *et al*., 2006; IPCC, 2007; UNFCCC, 2007). While at the country level, the impacts will vary from one ecosystem to another and from one sub-population to another depending on the length of coastline, level of emergency preparedness and economic and livelihood sensitivity to climate related elements such as rain, wind etc (NEST, 2004; IPCC, 2007).

The country level impact is most relevant to this present study due to the variables influencing the level of climate change impacts as identified above. Delta state where the study is based is located in the Atlantic Coast of southern Nigeria. Structurally, the area is characterized by lowlands. Except in the Northeast, where it rises to 10-15 m, most of the area is less than 6 m above sea level (Ashton-Jones, 1998). Therefore, the area is potentially vulnerable to any rise in sea level. The low-lying nature of the coastline makes it prone to coastal erosion and flooding, all of which are climate change-induced forms of land degradation (BNRCC, 2008). The area lacks requisite manpower and infrastructures needed for the building of shoreline groin to effectively counter surging waters (Zabbey, 2007).

In addition, the rural economy of the area is closely tied to its natural environment. A large part of the rural economy depends on natural resources which are vulnerable to climate change. When these resources are affected, the whole communities are implicated. Agriculture and fishing activities which are the main livelihood activities of the poor rural household depend primarily on rainfall. This implies that changes in rainfall pattern and intensity will have a long range impact on agriculture and fishing which are the main livelihood activities of the people in the region. The above itemized vulnerability context of the area makes the analysis of climate change perception and adaptation strategies among local communities important. The rural households in the area are already experiencing climate change. This is evidenced in the perennial flooding, sea level rise, changing rainfall pattern and rising temperature in the region (Awosika, 1995; Okali and Eleri, 2004; and Uyigue and Agho, 2007).

However, Doss and Morris (2001) have emphasized the importance of local communities in addressing the impacts of climate change. They noted that the perception of rural households, the way they think and behave in relation to climate change, as well as their values and aspirations have a significant role to play in addressing climate change. This is particularly important since they bear the brunt of climate change impacts in their respective communities. In spite of this, local farmers are hardly considered in academic, policy and public discourses on climate change, despite the fact that they are greatly impacted by changes of climate (Berkes and Jolly, 2001). Accordingly, there is the need to gain a better understanding of what rural farmers know about climate change and their adaptation strategies in order to strenghten these adaptation practices among rural farmers in the area of study. It is also gainful to identify relevant factors which enhances famers adaptive capacity to climate change. While efforts are being made towards fighting climate change from scientific views, research and policies directed towards local communities perceptions are highly important in this context. It is

based on this premise that this study analyses climate change perception and adaptation strategies in coastal communities in Delta state of Nigeria.

The justification for this study emanates from the fact that analysing climate change perceptions and adaptation strategies is an important way of helping farmers to adapt to climate change. Adaptation helps farmers in local communities achieve their food, income and livelihood security (Kandlinkar & Risbey, 2000). Farmers can reduce the potential damage by making tactical responses to these changes. It is instructive to note that most rural farmers have devised various strategies to cope with the impact of climate change over the years, a better understanding of how they have done this is essential for enhancing their low capacity of adaptation through appropriate public policy.

Objectives of the Study

The objectives of this study are to:

1. identify the perception of rural farmers to climate change;
2. identify adaptation strategies to climate change;
3. determine the factors influencing adaptative capacity of local communities; and
4. identify policy measures that will boost the adaptative capacity of local communities in the area of study.

Hypothesis of the Study

There are underlying factors which determines the adaptive capacity of local communities in the area of study.

Materials and Methods

The study utilized both primary and secondary data. The primary data were collected through questionnaire administration. The secondary data such as population data were obtained from National Population commission. Two Local Government Areas (LGAs) located along the coastline were purposively selected. They are Isoko South and Isoko North Local Government of Delta state. Three communities each that are prone to coaster flooding (Umeh, Erohwa, Aviara, Aradhe, Okpe and Ofagbe) were purposively selected from each LGAs. A four scale likert questionnaire was designed on farmers perception to climate change. A total of 330 questionnaires were administered while 285 questionnaires were retrieved. The data were analyzed using percentages, mean (X) and logistic regression. For the likert questions on farmers perception to climate change, the point of decision was fixed at 2.0 since the questionnaire is a four point scale. Any item that attracts a mean of 2.0 and above was regarded as agreed while any

item that attracted a mean of less than 2.0 was regarded as disagree. Logistic regression was used to test the hypothesis of the study

Model Specification

Logistic model was used to identify the determinants of the adaptive capacity of rural farmers to climate change. The choice of the explanatory variables in the model was based on review of relevant literature. Logistic regression analyzes binomially distributed data of the form

$$Y_i \sim B(n_i, p_i), \text{ for } i = 1, \ldots, m, \tag{1}$$

Where the numbers of Bernoulli trials n_i are known and the probabilities of success p_i are unknown. The model proposes for each trial i there is a set of explanatory variables that might inform the final probability (Wikipedia, 2010). These explanatory variables can be thought of as being in a k vector X_i and the model then takes the form:

$$p_i = \mathrm{E}\left(\frac{Y_i}{n_i}\middle| X_i\right). \tag{2}$$

The logits, natural logs of the odds of the unknown binomial probabilities are modeled as a linear function of the X_i.

$$\operatorname{logit}(p_i) = \ln\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \beta_1 x_{1,i} + \cdots + \beta_k x_{k,i}. \tag{3}$$

The dependent variable is a dichotomous variable (Di), which is 1 when a respondent has diversified into the non-farm sector and zero otherwise. The explanatory variables used in the Logit Models and hypothesized as determinants of respondents adaptative capacity to climate change are:, Age (X_1), sex (X_2), marital status (X_3), educational qualification (X_4), income (X_5), household size (X_6), size of farm (X_7), access to remittance (X_8), access to credit facilities (X_9), farming experience (X_{10}),access to extension facilities (X_{11}), access to ICT (X_{12})

Discussion of Results

Of the total 285 respondents used for the study, 165 representing 67.8% were males. 79.5% of the respondents were married while 12.6 % were single. Also, the results indicates that the majority (52.1%) of the respondents had secondary education, 24.7% had primary education while

17.3% had no formal education. Only 6.2% of the respondents had tertiary education.

Farmers' Subjective Perception of Climate Change

Table 1 shows farmers subjective perception of climate change in the area of study. Table 1 shows the responses of the respondents. Analysis of item 1 shows a mean of 3.69 which implies that temperature in the area is rising on a yearly basis. The respondents also agreed that rainfall is increasing on a yearly basis with a mean response of 3.49. On item number four, the respondents agreed that there is an increasing incidence of flooding in their community. However, for item number five, the respondents disgreed to the fact that there is an increasing incidence of drought in their community with a mean of 2.78. For item number six, the respondents also disgreed to the fact that rainfall for the year are not enough for agricultural production. What is obvious from Table 1 is the fact that the respondents are aware of the changing temperature and rainfall pattern in their community. They are also aware of the increasing incidence of flooding and sea level rise. This finding is in agreement with Awosika (1995), Okali and Eleri (2004) and Uyigue and Agho (2007) who have separately noted the incidence of rising temperature, rainfall, flooding and sea levels in the area of study.

Table 1: Subjective Assessment of Farmers Perception of Climate Change

S/N	Items	Respondents	Cumulative Responses	$\bar{X}$	Decision
1	Temperature is rising yearly	285	1054	3.69	Agreed
2	Rainfall is increasing yearly	285	997	3.49	Agreed
3	There is increasing incidence of flooding in my community	285	891	3.12	Agreed
4	There is increasing incidence of drought in my community	285	794	2.78	Disagreed
5	There is increasing incidence of sea level rise in my community	285	912	3.20	Agreed
6	The rainfall for the year are not enough for agricultural production	285	798	2.80	Disagreed

Fieldwork, 2010

Adaptation Strategies of Rural Farmers to Climate Change

The respondents were asked to identify their main response strategies to the changing climatic elements. Table 2 shows the main strategies adopted by rural farmers to cope with the changing climate in their respective communities.

Table 2: Adaptation Strategies of Rural Farmers to Climate Change

Adaptation	Frequency	Percentage
Diversification out of agriculture	89	31.2
Soil conservation	7	2.5
Early and late planting	45	18.8
Irrigation	5	1.7
Planting trees	18	6.3
No adaptation	121	42.5
Total	285	100.0

Fieldwork, 2010

Table 2 shows that the main strategy adopted by rural faemers is diversification out of agriculture. In this respect, respondents are engaged in non-farm activities. 31.2% of the respondents identified this strategy. Another 18.8% of the respondents adopted early and late planting. However, 42.5% of the respondents have not adopted any strategy so far. Thus, the paper further probes into factors determining the adaptive capacity of farmers in the area of study. This is the focus of the hypothesis of the study which states that there are underlying factors which determines the adaptive capacity of local communities in the area of study.

Underlying Factors Determining the Adaptive Capacity of Rural Farmers

Tables 3, 4 and 5 show the results of the logistic regression used in testing the hypothesis of the paper.

Table 3: Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	202.631	12	.000
	Block	202.631	12	.000
	Model	202.631	12	.000

Table 4: Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	119.537(a)	.509	.751

a Estimation terminated at iteration number 8 because parameter estimates changed by less than .001.

Table 3 shows the chi-square statistic and its significance level. The Chi-square value test the null hypothesis that the independent variables have no effect on the dependent variable. The value of 202.631 is significant at 0.05 implying that the model is statistically significant showing strong explanatory power of the model. Table 4 shows the pseudo r-square statistics. The large pseudo r-square statistics of Cox & Snell (0.509) and Nagelkerke (0.751) indicate that more of the variation in the dependent varible is explained by the model.

Table 5 Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step	**Sex (x_1)**	**1.246**	**1.987**	**.393**	**1**	**.531**	**3.475**
1(a)	**AGE (x_2)**	**.875**	**.259**	**11.372**	**1**	**.001**	**2.398**
	MARITAL (x_3)	**-.833**	**.484**	**2.962**	**1**	**.085**	**.435**
	EDUCATION (x_4)	**-1.148**	**.570**	**4.065**	**1**	**.044**	**.317**
	INCOME (x_5)	**.894**	**.339**	**6.956**	**1**	**.008**	**2.444**
	HHSZ (x_6)	**2.949**	**1.005**	**8.620**	**1**	**.003**	**19.095**
	FARMSIZE (x_7)	**-1.625**	**.704**	**5.325**	**1**	**.021**	**.197**
	ACESSREMIT (x_8)	**-3.026**	**.965**	**9.831**	**1**	**.002**	**.049**
	ACEESCREDIT (x_9)	**-3.193**	**.950**	**11.298**	**1**	**.001**	**.041**
	FARMEXP (x_{10})	**-1.350**	**.714**	**3.581**	**1**	**.068**	**.259**
	EXTENSION (x_{11})	**8.137**	**1.383**	**34.637**	**1**	**.000**	**3417.778**
	ICT (x_{12})	**-3.390**	**.838**	**16.367**	**1**	**.000**	**.034**
	Constant	**-.940**	**3.249**	**.084**	**1**	**.772**	**.391**

a Variable(s) entered on step 1: sex, AGE, MARITAL, EDUCATION, INCOME, HHSZ, FARMSIZE, ACESSREMIT, ACEESCREDIT, FARMEXP, EXTENSION, ICT.

Table 5 summarizes the roles of the independent variables in the model. Column B is the estimated coefficient of the expalantory variables. The ratio of B to S.E., squared, equals the Wald statistic. If the Wald statistic is significant (i.e., less than 0.05) then the independent variable is useful to the model. Thus, the independent variables predicting our dependent variable include age of the farmer, educational qualification, income, household size, farm size, access to credit and access to remittances, access to extension service and ICT facilities.

Summarily, diversification out of agriculture (DOA) is a function of age of the farmer, educational qualification, income, household size, farm size, access to credit and access to remittances, access to extension service and ICT facilities mathematically represented as:

$DOA= X_2+ X_4 + X_5 + X_{6+} X_7 +X_{8,} +X_{9,} +X_{11} + X_{12}$

Where:

DOA= diversification out of agriculturte

X_2 = age of farmer

X_4 = educational qualification

X_5 =income

X_6 =household size

X_7 = farm size

X_8 = Access to remittance

X_9 = access to credit

X_{11} =access to extension services

X_{12} =Access to ICT

Column B (Table 1.5) displays the values for predicting the dependent variable, given a score of the independent variable. Recall that the equation is:

$$\text{logit}(p_i) = \ln\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \beta_1 x_{1,i} + \cdots + \beta_k x_{k,i}.$$

The column labeled B in Table 1.5 contains the standardized coefficients of α, X_2, X_4 , X_5 , $X_{6,}$ $X_{7,}$ $X_{8,}$ $X_{9,}$ X_{11} and $X_{12}$where the standardized coefficient of α, X_2, X_4 , X_5 , $X_{6,}$ $X_{7,}$ $X_{8,}$ $X_{9,}$ X_{11} and X_{12} are -0.940, 0.875,-1.148, 0.894, 2.949, -1.625, -3.026, -3.193, 8.137, -3.390, respectively. The overall logistic regression model can thus be stated as follows:

DOA=-0.940+(0.875x_2)+(-1.148x_4)+(0.894x_5)+(2.949x_6)+(-1.629x_7)+(-3.026x_8)+(-3.193x_9)+(8.137 x_{11})+(-3.390 x_{12})

This means that given a unit increase in the value of X_2, *DOA* will increase by 0.875 units while holding other independent variables constant.

In the same way, if X_6 is increased by one unit, *DOA* will increase by 2.949 units while holding other independent variables constant.

Age of the farmer was identified as a factor determining adaptation. Young farmers are more aversed to access to higher education, access to information and ICT facilities and therefore facilitate the adoption of better strategies to climate change (Norris and Bati, 1987). Evidence from various sources indicates that there is a positive relationship between the education level of the household head and the adoption of improved technologies (Igoden *et al.,* 1990) and adaptation to climate change (Maddison, 2006). Therefore, farmers with higher levels of education are more likely to better adapt to climate change. Income is another model identified by the model. The study shows that higher income influences adaptation to climate change. Access to credit, remittances and farm sizes all contributes to household income. High income allows farmers to buy improved variaeties of crop, diversifiy into non-farm activities, among others. Thus, households with access these assets have higher capacity to adopt improve adatation strategies against climate chnage. This is supported by Franzel (1999) who revealed a positive correlation between higher income and adapation to climate change. The study also shows that household size influences adaptation to climate change. Evidence from various sources indicates that households with large family members may be forced to divert part of the labour force to off-farm activities in an attempt to earn income in order to ease the consumption pressure imposed by a large family size (Yirga, 2007). This study also shows that access to extension services and ICT facilities influences adaptation. These two variables provides relevant information to rural households to make decision on adaptation to climate change.

Conclusion and Recommendations

The analysis of the perception of the farmers on climate change shows that farmers are fully aware of the changing climatic conditions in their respective communities and have devised various strategies to cope with it. The coping strategies as identified by the study include diversification out of agriculture, early and late planting, planting of trees, irrigation and soil conservation. However, the study revealed that many farmers in the study area are yet to adapt any strategy to cope with the changing climatic elements. Thus, the study identified the factors determining the adaptive capacity of farmers to include age of the farmer, educational qualification, income, household size, farm size, access to remittances, credit among others. Based on the above findings, the study recommends the urgent need for the integration and mainstreaming of local farmers perceptions and adaptation strategies into policies directed at mitigating the impact of climate change at the international, national and

local levels, awareness creation on the importance of adapting to climate change and above all the provision of financial capital to farmers with low income capacity to enhance their adaptive capacity.

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