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Evaluation of exposures to extremes of climate variability among rain-fed dependent vegetable farmers in a Niger Delta Region, Nigeria

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ABSTRACT

Over the last ten years, every farming season is faced with change in climatic and environmental conditions and these changes influence the decisions of farmers, who depend on its clemencies for meaningful productivity. In order to have an understanding of the nature and frequency of occurrence of the climatic changes in this region, the experiences of the arable crop farmers over the years in their efforts to ensure food security in the riverine communities were assessed.Thisstudyprimarily assessedthe coupling effects of exposures to extremes of changing state of climate on rain-fed agriculture in an upland area within theNiger Delta region in Nigeria. In addition, the socio-economic characteristics of farmers were identified, the variations of index of exposure to extremes climate variability were assessed and how vulnerablethe farmers were to climate variability were deduced. Data for the study were obtained from the seven clans that makeupOkobo local government area in Akwalbom State, Niger Delta region of Nigeria using questionnaire. Random sampling technique was employed, and 80 respondents willingly participated in the exercise. Data obtained were analyzed using composite index analysis and descriptive statistical tools like frequency counts and percentages. The result of the findings reveals that, majority (52.5%) of the respondents were female, about 51.3% were aged between 32 and 42 years, majority (65.0%) of the respondents were married and 50.0% had secondary education, 50.0% earned monthly income ranging between ₦10,000 and₦22,500 while 47.5% had 11–15 years of farming experience. The study also showed that the respondents were averagely vulnerable to climate variability as a result of their exposure to extreme climatic events, and this was depicted by the mean score of 3.0 and above.

Keywords: Exposures, Extremes, Rain-fed Agriculture, Vulnerability, Climate Variability

INTRODUCTION

Agricultural practices in Nigeria are mainly influenced by two climatic regimes commonly described as wet and dry seasons.Depending on the geographical location, the duration of these seasons varies considerably. The Niger Delta region is characterized by climatic variables that define the region as humid tropical rainforest ecological belt. With regards to a typical rural life in the Niger Delta region, farming and fishing are the primary means of livelihood, excluding secondary economic systems. The agricultural activities are generally dependent on the vagaries of weather and the weather conditions have

ever been the supportive resource for food and human security. The importance of the climatic variables especially rainfall and temperature; towards supporting human existence, have no popular alternative and the nature of extreme events of climate thus informs the intensity and frequency of the vulnerability index of this geographicalregion (Hulme, 1992). In the rural communities of the Niger Delta region, the uncertainties about the science and drivers of climate variability are discernible due to various beliefs and knowledge level of the dwellers.

Irrespective of the varying opinions on the changing state of climate in the region, there is a general belief that the current state of the environment is not the same as it was in the last ten years, and this can be attributed to the pattern of land use, urbanization and even agricultural practices. Irrespective of the activities of multinational oil companies in the regionwith the attendant negative effects of gas flaring, it is our belief that some traditional agricultural practices and outcomes have serious negative influence on the changing state of the climate and environment. Argumentsarise among researchers on the relationship between the unfriendly agricultural practice and climate variability,to ascertain which of the twoprocessesis affecting the other. We assert that climate variability and agriculture are interrelated processes and the coupling effects of the interactions take place at a global scale. The vulnerability of the agricultural sector to both climate change and variability is well established in the literature and the world attention is geared towards improving the adaptive capacity of farmers. Fischer, Shah and Velthuizen(2002) and Marty and Williams (2002) noted thatglobal warming and the continuous buildupof carbon dioxide in the atmosphere have significant impacts on agriculture particularly as the pattern of temperature, precipitation and glacial run-off are vast changing. These conditions determine the carrying capacity of the biosphere to produce enough food for human consumption and domesticated animals.

In the analysis of the present and future impacts of climate variability and change in the Arid and Semi-Arid tropic of Africa, Nyong(2009), Adejowon (2006), Sivakumar*et al.* (2005) and Fischer *et al.* (2002) show evidences of occurrences of extremes of rainfall and temperature events over a sixty years period and its impacts on agriculture and the economy. These two climatic elements (rainfall and temperatures) determine the success of agriculture and economic viability of the environment depending on whether the year is occasioned by short or long rainfall period over a given region. In Africa, extensive droughts and dry spells had been documented for instance, 1965-1966, 1972-1974, 1981-1984, 1986-1987, 1991-1992 and 1994-1995 (WMO, 1995), and with regards to the effect of drought in Nigerian economy, Benson and Clay (1998) asserted that the aggregate impact of drought affected the GDP of Nigeria in 1984 by 4-6%. Aside Nigeria, Nicholson*et al.* (2000) upheld that long-term changes in rainfall had occurred in the semiarid and sub-humid zones of West Africa, and the average rainfall between 1968-1997 was some 15-40% lower than during the 1931-1960. It could be inferred that, over a sixty year period, African regions have witnessed a marked decline in rainfall pattern. In the same period under the analysis, Hulme (1992) posited that there was a reduction in duration of rainfall of well over $0.4mmday^{-1}$ across Africa. With a decline in rainfall pattern, the air temperature would likely be on the increase, which in West Africa, growing aridity has increasingly been witnessed over the 60 years period under consideration. Sivakumar (1998) asserted that air temperatures in the Sahelian and Sudanian Zones of West Africa (SSZ) went high due to high radiation load. Thus, agricultural production suffered since environmental conditions became quite unfriendly with the rise in mean maximum temperatures. The observable trend is a serious threat to the poor socioeconomic

status of the vast majority of Nigerian farmers especially the low resource holders in the Niger Delta region of Nigeria. Though, the opinion that indigenous knowledge systems of rural farmers could offer some useful hints towards mitigating the effects of exposures to extremes of climate variability in the Niger Delta region of Nigeria, such envisaged outcome would rather be suicidal owing to limitations of such system.

The greatest challenge of African states towards advancing the science of climate change is virtually in two folds: poor state of development of information sciences and non-availability of consistent data or information on the salient changing state of the environment (Adejowon, 2006 and Pachova, 2006). Based on these factors, the indigenous knowledge systems would be characterized by tales of adverse effects of climate and probable mitigation ideas as a coping strategy. Dependence on indigenous knowledge as a strategy to solve the challenge of climate would therefore offer limited potentials since sub-Saharan Africans are not consistent in keeping records. Traditionally, information was passed between generations, in most cases to loved persons, and the quality of information or knowledge are threatened by generational erosion, message distortions and differences in perceived interpretation. Although indigenous knowledge system is quite meaningful in some circumstances but with regards to climate change, it potentials would be quite rudimentary. It is rather unfortunate that current information on the present climatology status of African continents are not offered by the indigenous knowledge system but from climate information and data system generated off the shores of Africa (Sivakumar*et al.*, (2005); Mason *et al.* (1999); Katz and Acero (1994; Tusker *et al.*(1991); Le Barbe and Lebel (1991) and Wigley(1985)). It is obvious that advanced climate information science and technologies are needed for African states to make useful predictions about the early warning system due to its unfolding climatic condition. A number of theoretical, modeling and empirical analysts have suggested that noticeable changes in the frequency and intensity of extreme events, including floods may occur when there are only small changes in climate (Wagner, 1996; Katz and Acero, 1994 andWigley, 1985).

There are predictions that as the climate variability is unfolding, according to projections by IPCC(2001), rainfall in the very humid region of Southern Nigeria is expected to increase. This may be accompanied by increase in cloudiness and rainfall intensity, particularly during severe storms. If these predictions are to be exact, there will be shifts in thegeographical pattern of precipitation and changes in the sustainability of the environment and management of resources would require some level of improvement to handle flooding and erosion in the upland and sea level rise in riverine communities. Though the increase in temperature could increase evaporation and potential evapo-transpiration, there would be a tendency towards "dry spell" in parts of these humid areas of the country but drought might not be a common feature. Recent studies:Hulme*et al.* (2001) Ringuis*et al.* (1996) and Herne*set al.* (1995) have shown that there has been decreases (about 10-25% or about 2-5% per decade) in precipitationin the humid regions of West Africa, including Southern Nigeria, since the beginning of the century. If this trend persists, rainfall in the humid regions of Southern Nigeria may be about 50% to 80% of the 1900 values by 2100. With respect to temperature, future annual warming across Africa is projected to range from 0.2°c per decade to more than 0.5°c and this warning is considered as greatest over the interior of the semi-arid margins of the Sahara and Central Southern Africa. Withincrease in ocean temperatures, however, there could be inerease in the frequency of storms in the coastal zone of the country.

Many issues (both anthropogenic and non-anthropogenic activities) drive the

climatic and environmental variability in the region and the two variables have detrimental and beneficial effects on agricultural productivity. The overall outcome of climate variability and change on agriculture will depend on the balance of climatic and environmental variability. Also, agriculture has been known to produce significant effects on climate variability and change primarily through the production and release of greenhouse gases such as carbon dioxide, methane, nitrous oxide and also by altering the earth's land cover, which can change its ability to absorb or reflect heat and light, thus contributing to radiative forcing. Deforestation and desertification together with the use of fossil fuels are also major sources of carbon dioxide (Fischer *et al.*, 2002). Significant changes in temperature or precipitation can make the cultivation of a primary crop no longer feasible in a given area. Such shifts in growing patterns can render large investment in machinery and other agricultural inputs unrecoverable (Marty and Williams, 2002).

Exposure describes the degree of climate stress upon a particular unit of analysis; it may be represented by either long-term changes in climate conditions or changes in climate variability, including the magnitude and frequency of extreme events (O'Brien *et al.* 2004). Exposure in this study area is considered based on two elements: frequency of climate extremes and predicted change in temperature and rainfall. Of all economic sectors, agriculture would be one of the most vulnerable to climate variability and increased frequency of climate extreme events.Thevulnerability will arise from issues that include direct climate-related threats such as extremes in temperature, precipitation and changes in the growing seasons, and indirect impacts such as decline in soil quality, pest and pathogen outbreak and increased risk of fires. Developing countries are particularly affected as nearly 70 per cent of their populations live in rural areas where agriculture is the largest supporter of livelihoods, but technology generation, innovation and adoption do not keep pace with the adverse effects of climate variability. Poor communities are especially vulnerable as they tend to have limited adaptive capacities and are more dependent on climate-sensitive resources such as local water and food supplies.

Agriculture or farming activities in the Niger Delta Region of Nigeria depend on the on-set of rainfall. And the erratic pattern ofrainfall experienced in the region affects farming activities. This renders farming vulnerable to variations in climatic stimuli. It is against this background that this study was designed to evaluatethe effects of exposuresto extremes of climate variability among rain-fed dependent vegetable farmers inOkobo Local Government Area of Akwalbom State. The study specifically was intended toidentify the socio-economic characteristics of farmers, assess the variations of index of exposure to extremes of climate variability and deduce how vulnerable the farmers are to climate variability.

METHODOLOGY

The study was conducted in Okobo Local Government Area of Akwalbom State, Niger Delta Region of Nigeria. Okobo is located within the coastal belt of Atlantic Ocean and has a land mass of about 343,496 square kilometers. It lies between latitude $4^{0}4^{1}$ North and longitudes $8^{0}16^{1}$ East. The area has seven clans namely: Eta, Odu, Ataobong, Ibighi, Okiuso, Ukwong and Ebughu. It has two distinct seasons viz: the rainy and the dry season. Most of the inhabitants of the area are farmers, and they also engage in fishing.

Random sampling technique was employed and about 80 vegetable farmers willingly participated in the exercise from all the seven clans. A pre-tested and validated questionnaire was administered to the farmers to obtain data for the study. The data obtained were subjected to composite index analysis and descriptive statistical analysis using frequency counts and percentages. The composite index analysis was adopted to derive the proportional level of a measurable

attribute of the exposures to or the extent of occurrence of climate extremes, through a mathematical relationship as used in the studies of Inyang*et al*. (2004). The exposures to or the extent of occurrence of climate extremes index was obtained through summative rating of the scaled responses of each respondent. The index value was derived by dividing the summative rated scores by their possible maximum score of the scaled variables for each of the respondents. According to Kerlinger and Lee (2000), the index value is probabilistic or can be considered as a probability or likelihood since the value only ranges from 0 to 1. It can also be expressed in percentage if multiplied by hundred. For ease of explanation or description of the degree of the measurable estimates, the index distribution can be discretionally categorized into intervals of choice for ameaningfulexplanation of its implications.Theindex of exposures to extremes of climate variability among vegetable farmers was estimated for each of the items based on the responses of the 80 respondents using composite index that range between 0.00 and 1.00. As the estimated index tends toward 1.00 it implies the respondents had ahigh level of Exposures to Extremes of Climate event and vice versa as it tends towards 0.00. The index of exposures depicts the ratio or proportion of the population of the vegetable farmers that experienced or suffered the extremes of climate variability.

RESULTS

A. Demographic Characteristics of the Vegetable farmers

With regards to Table 1 Item1, about 47.5% of the respondents were male while 52.5% of the respondents were female. Item 2reveals thatmajority of the respondents (51.3%) were between the age range of 32-42 years and 22.5% of the respondents were between the ages of 43-53 years. Item 3 shows that majority of the respondents (65.0) were married.Item 4reveals that 50.0% of the respondents had secondary education, 22.5% had no formal education, 17.5% have primary education, and while 10.0% of the respondents acquired tertiary education. Item5 indicates that the majority of the respondents (52.5%) had 6-9 members in their household; 20.0% had a household of 10-13 members while 15.0% of the respondents had 14-17 persons in their household. Only 12.5% of the respondents had 2-5 household members.Item 6 shows that 50% of the respondents had a monthly income ranging between ₦10,000- ₦22,500, about 35% had monthly income ranging between ₦22,501- ₦35,000; about 10.0% earned monthly income ranging between ₦ 35,001-₦47,500. Only5.0% of the respondents earned monthly income ranging between ₦47,501 - ₦60,000. Item8 shows that majority (60%) of the respondents had over ten years of farming experience.

B. Variations in the index of Exposures to Extremes of Climate Variability among Vegetable Farmers.

Table 2 presents the variations in experiences of vegetable farmers to climate variability using index of exposures or extent of occurrence of climate extremes over the past years of production (see Table 1 Item 8). Generally, the results shown in table 2 can be classed into two major sets of most occurring and moderately occurring exposures to climate extremes experienced by the vegetable farmers in the study area. The most occurring group was made of eight out of fifteen identified climate extremes situation. The remaining seven were considered as moderately occurring extremes.

Analysis of the most occurring extremes reveals five underlying patterns of exposures to extremes of climate change. The two most outstanding effects were:erosion due to flooding and dry spell, and these had an incidence index of 0.750; in other words, the two extremes affected about 75% of the vegetable farmers. Reductions in farm produce due to flooding was identified as the next coupling effect in the region

Table 1: Distribution of Vegetable Farmers by Demographic Characteristics

Item	Socioeconomic Characteristics	Frequency (n=80)	Percentage
1	**Sex**		
	Male	38	47.5
	Female	42	52.5
2	**Age Range**		
	21-31	10	12.5
	32-42	41	51.3
	43-64	18	22.5
	54-64	11	13.7
3	**Marital Status**		
	Single	6	7.5
	Married	52	65.0
	Divorced/Separated	12	15.0
	Widowed	10	12.5
4	**Educational Attainment**		
	No formal Education	18	22.5
	Primary Education	14	17.5
	Secondary Education	40	50.0
	Tertiary Education	8	10.0
5	**Household Size**		
	2-5	10	12.5
	6-9	42	52.5
	10-13	16	20.0
	14-17	12	15.0
6	**Income Range**		
	10,000 – 22,500	40	50.0
	22,501 – 35,000	28	35.0
	35,001 – 47,500	8	10.0
	47,501 – 60,000	4	5.0
7	**Family types**		
	Nuclear family	38	47.5
	Extended family	42	52.5
8	**Farming Experience**		
	1 – 5	12	15.0
	6 – 10	20	25.0
	11 – 15	38	47.5
	16 – 20	10	12.5

Source: Field Survey, 2011.

with incidence pattern of about 0.650, implyingthat about 65% of vegetable farmers were affected.

With regards to the moderately occurring extremes of climate variability; winds and thunderstorms had moderate exposure index of which about 75% of thevegetable farmerswere affected. The next moderately occurring extremesthat hadinfluence on about 67.50% of the farmers was, theincidence of limited rainfall or water supply, whichcreatedthe needfor irrigation, and the anticipation of possible

Table 2: Analysis of Pattern of Exposures to Extremesof Climate Variability among the Farmers

Items	Climate extremes	Extent of Climate Extreme Occurrence			
		Not at all	Less	Most frequent	Intensity
A	**Most occurring Group**				
1	The top soil of your farm washed away by rain,.	0.00	0.250	0.750	A
2	Expect to have increased temperature or hot weather condition in subsequent years.	0.025	0.20	0.750	A
3	Vegetable harvests had been reduced in recent years due to flooding.	0.000	0.350	0.650	B
4	Do you experience too much sunshine during dry season that make your environment or surrounding to be hotter than as it was before now?	0.025	0.350	0.625	C
5	Have you experienced delayed start of rainy season?	0.000	0.375	0.625	C
6	The soil of your farmland no longer supports good harvest in recent years.	0.100	0.325	0.575	E
7	Do you experience any form of excess rainfall that overflows into your farms and surroundings?	0.50	0.425	0.525	F
8	Do you always have high incidence of flood?	0.025	0.450	0.525	F
B	**Moderately Occurring Group**				
1	Have you any incidence of strong wind or thunder storm in your place?	0.025	0.725	0.125	A
2	Does your farmland need to be irrigated or watered during the dry season?	0.175	0.675	0.250	B
3	Do you expect or perceive to have decreased rainfall in subsequent years?	0.00	0.675	0.350	B
4	Have you any incidence of prolonged dry season?	0.10	0.675	0.225	C
5	Has the volume or size of water in your streams or river increase in recent times/	0.050	0.600	0.350	D
6	Do you always have high incidence of drought?	0.275	0.600	0.225	D
7	Is the duration of rainy season in recent years shorter than before?	0.150	0.475	0.375	E

Source: Computed from field survey, 2011

Further investigation of farmers' experiences with regards to prolonged dry spell in the study area revealed that 67.50% of them affirmed its moderate occurrence in the area.

DISCUSSION

Females were more involved in the farming or agricultural production than male in the study area. The majority of the respondents were within the age range of 32-42 years, they were generally more economically active and willing to learn more in order to boost their knowledge of adaptation and hence minimize their level of vulnerability to climate variability. They were more involved in adaptive planning to cope with variations in climatic pattern. Item 3 shows that the

vegetable production sector were dominated by those who must have been associated with family life. This suggest that the respondents have respect and value for marriage institution and this can help them to build social safety network to mitigate their vulnerability to the changing face of climate. Item 4 reveals that the categories of people with the highest educational attainment (10.0%) are likely to understand the incidences of climate variability and its vulnerability because of their level of exposure to information. They are believed to be more knowledgeable to boost their adaptive capacity and gain resilience in the changing face of climate. On the other hand, the respondents with no formal education (22.5%) are likely to be the least informed of the dimensions of climate variability and its vulnerability; which is a function of exposure, sensitivity and adaptive capacity. Hence, it could be adjudged that the least informed of the dimensions of climate variability are likely to be the most vulnerable to its adverse effects. This is in consonance with Adger*et al.* (2004) which posits that the least educated and lower-skilled members of the society are likely to be the most vulnerable to climate hazards in terms of livelihood and geographical locations. Item 5 indicates that only 15.0% of the respondents with 14-17 members in their households are believed to have stronger social safety nets to build adaptive capacity and gain resilience in the changing face of climate. Item 6 shows that 5.0% of the respondents with highest income earnings (₦47,501 – ₦60,000) had the financial resources to boost their adaptive capacity and minimize their vulnerability to climate variability. They are believed to be less vulnerable to climate variability. This agrees with Blaike,*et al.* (1994) which posits that households that have access to resources and social networks are less vulnerable.Item 7 reveals that the majority of the respondents were members of the extended family households. This result is indicative of the fact that most of the respondents live in groups with relatives such as uncles, nephews, nieces, cousins, etc. which implies that they attach importance to their lineage. This also suggests that they have social networks which could be pivotal to mitigating vulnerability to an extent. Item 8 indicates that there were respondents with farming experiences ranging between 16–20 years, who would likely have substantive knowledge about farming practices and challenges posed by climate variability on their agri-business. It is also believed that they are likely to be informed about the exposure and vulnerability of farming systems to variations in climate pattern in their area.

The index of exposure observed in the 'most frequent' columns (Table 2) indicate that the study area is vulnerable to climate variability with respect to the item under discussion. The fact that the most occurring group was made up of eight out of the fifteen identified climate extremes situations (Table 2), shows that the study area has high degree of occurrence of extreme climatic events which are indicators of vulnerability to climate variability. This suggests that the respondents were highly exposed to climate stimuli and their farming activities are highly sensitive to climate extremes or changes in climate. Hence, farmers in the study area were highly vulnerable to climate variability. This agrees with IPCC (2001) which posits that vulnerability is a function of exposure, sensitivity and adaptive capacity.

CONCLUSION

The distribution of the exposure to extreme climate variability index generally follows the IPCC, 2001 predictions of Southern Nigeria. Indeed, the resultant effects of rainfall or precipitation were felt intensely than the dry spells. This present level of occurrence should not be taken with laxity; preparedness to create innovative adaptive capacity towards drought tolerance agriculture should be our target. The study has shown that farmers in the study area are exposed to climate extremes and with regards to the result of this study, it could be

deduced that farmers in the study area were averagely vulnerable to the incidences of variations inclimate. Therefore, priority should be given to the development of more accurate systems for early warning of extreme climatic events (e.g. drought or flood) as well as appropriate relief programmes and agricultural insurance

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