Direct RESEARCH JOURNALS

Impacts of climate change on fishing and fish farming in the Niger Delta region of Nigeria

Direct Research Journal of Agriculture and Food Science (DRJAFS) Vol.3 (1), pp. 1-6, January 2015
Available online at directresearchpublisher.org/drjafs
ISSN 2354-4147 ©2015 Direct Research Journals Publisher

Research Paper

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ABSTRACT

The study specifically evaluated the perceived impacts of climate change on fishing and fish farming activities in the region. The study adopted descriptive survey research design, and was guided by two research questions. Out of the nine Niger Delta states, Bayelsa and Delta states were randomly selected for the study. The findings of the study revealed that the extent of impacts of climate change on fishing and fish farming in Niger Delta region of Nigeria are moderate. Findings further revealed that climate change has impacted greatly on the access/distance to fishing ground. The study recommends that fish farmers should be retrained by government and well-meaning local and international organizations on recent fish keeping practices suitable in this era of climate change. Fishermen should be provided with standard fishing gears especially motorized canoes and boats to enable them travel less tediously to the long distance in search of the displaced (school of) fish for a good catch and as well as a means of encouraging continued fishing in the region to reduce hardship.

Key words: Climate change, fishing, flooding, sea level rise, displacement.

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Accepted 21 November, 2014

INTRODUCTION

Climate change has become a global issue affecting to varying degree various aspects of economic activities in different parts of the world. Its effects are being felt in different extent and nature by many countries, triggering change in economic response to the impacts. Climate change is the complete variation or average state of the atmosphere over time scales, ranging from decades to millions of years in a region or across the entire globe, and is caused by processes internal to the earth, external forces from space or human activities (Lemke, 2006). Climate change in the context of this study refers to the variation in the statistical distribution of average weather conditions over a prolonged period of time. Anthropological activities have influenced climate change causing increased effects on different sectors of agriculture and livelihoods in many communities of the world. The major human attributed cause of climate change is the increase of Greenhouse Gases (GHG) in the atmosphere resulting from gas flaring, fossil burning and deforestation arising from clearing of land for agricultural and industrial uses, in addition to other human activities that have led to increased concentrations of GHG especially carbon IV oxide (CO_2) (Intergovernmental Panel on Climate Change, IPCC 2007; Uyigue and Agho, 2007). The projected effects of climate change on agricultural production is numerous and varied.

The main effect of climate change is the increasing average temperature which causes a variety of secondary effects (IPCC, 2007). The secondary effects caused by increased temperature include changes in patterns of precipitation and rainfall, rising sea levels, altered patterns of agriculture, extreme weather events, expansion of the range of tropical diseases, and the opening of new trade routes among others (Ogundele and Jegede, 2011; Ogundele, 2012). These secondary

effects of climate change have affected various agricultural activities, as agriculture is heavily dependent on climate and any observed change, will have a noticeable impact such as the current effects in fishing and fish farming.

The world's fisheries provide more than 2.6 billion people with at least 20% of their average annual per capita protein intake (Food and Agriculture Organization, FAO, 2007). In the high CO_2 world, it is generally considered that ocean temperature will rise, currents will spin-up, acidification will occur, sea ice will decrease, area of oligotrophic gyres will increase, and seasonality of biological productivity will change which poses adverse effects on marine species include their reproduction, ecological connectivity and biodiversity (Sumaila and William, 2010). Other changes in oceans, lakes and rivers impacting on aquatic ecosystems and fish population include increased salinity, alteration in density and stratification, sea and river levels sedimentation brought about by climate-induced variation in land use. In turn, these physical alterations have the potential of changing the physiological, spawning and growth processes of aquatic lives such as fishes, affecting primary (e.g. diatoms and phytoplankton) and secondary (e.g. zooplankton) producers, distributions of fishes (through permanent movement, or changes in migration patterns), fish density (due to changes in primary and secondary producers), phenology (e.g. timing of life-cycle events such as spawning), species and disease invasions and other food web impacts (Ugboma, 2010).

Climate change has affected fisheries through alterations in potential catch due to shifts in species' range and decline in primary prey available to the species caused by acidification of the oceans from higher CO_2 levels, loss of coral reefs as a result of ocean warming, and variations in ocean biogeochemistry, such as oxygen levels (Sumaila and William, 2010). The displacement of regular fish species to other region could led to disputes among international neighbors and could led to increased implications for aquatic management across international water boundaries.

Changes in species distributions will alter the distance fishermen need to travel to catch their traditional target species, sometimes crossing international sea boundaries. In the United Kingdom (UK), at the North Sea, a large number of cold water species (e.g. grey gurnard, cod, anglerfish, lemon sole and saithe) have deepened their residential water depth with an average of 5.5m per decade while some warm water species have moved to shallower depths, such as sole (7.6m per decade) and bib (6m per decade) (Grossmann, 2005).

The changing temperature may affect migratory behavior in fishes with earlier migration seen in western mackerel stocks, while flounders' migration from some south-west estuaries is delayed by warmer conditions (Grossmann, 2005). Increased sea level rise and storms events leads to loss of fish stocks, and considerable economic impacts, by damaging fish farm cages. A total of 2.18 million fish escaped over a seven year period from Scottish fish farms, of which 38% escaped during a single storm event in 2005 (United Nations Framework Convention on Climate Change, UNFCCC, 2011). The escape of farmed fishes in storm events could result in their hybridization with wild stocks. Storm damage can also lead to the introduction of predators and disease into cages, leading to further loss of stock. If climate change increases the frequency or intensity of storms, farm cages will be more likely to get damaged, leading to greater economic losses.

In small Islands, deterioration in coastal conditions, such as beach erosion and coral bleaching, has affected local resources such as fisheries, as well as the value of tourism destinations (Mimura et al., 2007). The effect of drought leads to streams, ponds and wells drying up causing a sharp decline in fish population around the world (Osinem, 2005) in certain regions. Climate change may occur across the whole earth or can be limited to a specific region where causative factors are available (UNFCCC, 2011), such as the Niger Delta region of Nigeria.

The Niger Delta region of Nigeria is densely populated and occupies about 12% of the total land mass of Nigeria with a land area of about 70,000km² out of which 2,370km^2 consist of rivers, creeks and estuaries, while stagnant swamps cover about 8,600km² (Ugolor, 2004). The region is endowed with great potentials for high productive and profitable agricultural practice (Fapojuwo et al., 2012). The region is divided into drier landward part where crop farming is the major agricultural activity and the seaward part (riverine and swampy area) which is characterized by extensive creeks and water bodies, where fishing and aquaculture replaces crop farming as the dominant aspect of the rural economy (Aweto, 2011). The economic activities of the communities in the region are either land-based or water-based to include crop and animal farming, fishing and fish farming, forest resources utilization and trading (Rosemary et al., 2012).

Being a coastal region, more than 75% of over 30 million inhabitants of the region live along the coastal area and survive mainly on fishing and farming (Aletan et al., 2011). Some of the people, especially the women engage in marketing of the aquatic produce in the region. Nigeria's fisheries (domestic production) profile include; artisanal (coastal) fishing (80%), industrial coastal (trawl) fishing (10%), artisanal inland fishing (6%) and aquaculture (4%) (Ayansanwo, 2003). Most of the fishery activities occur in the coastal states of Nigeria that account for 960km of the coastline, shared by Akwa-Ibom and Cross River States (108 km), Bayelsa and River States (390 km), Delta State (126 km), Lagos State (230 km), Ogun State (18 km) and Ondo State (88 km) (Ayansanwo, 2003). Thus Niger Delta accounts for 74.2%

of the coastline of Nigeria. The brackish water in the region is home for several species of aquatic animals and is a favourable breeding sites for several migratory species (Awosika, 1995). An estimated 50% of fishes consumed in Nigeria come from the Niger Delta region (Uyigue and Agho, 2007).

Aquaculture is an important aspect of agriculture in the Niger Delta region, especially as the trend to move from capture to culture fisheries is gaining more ground. The most commonly reared fish species are Tilapia species, Hetebranchus species; *Clarias* sp. and *Heterotis* sp. Other aquatic animals found in the region include crayfish (crustaceans), periwinkle (*Littorina littorea*) and snails (mostly, *Achatina fulica*). Adverse effect of sea level rise in the Niger Delta has increased salinity of both surface and underground water due to the intrusion of sea water which results to the death of aquatic plants and animals that cannot tolerate high salinity (Uyigue and Agho, 2007).

The salination of the brackish waters in the region has been greatly affected by flooding and sea water intrusion leading to lose of indigenous aquatic species (Awosika, 1995). Sea water intrusion could have serious impact on food security in the region as it affects the coastal agriculture. Temperature rise have increased algal blooms in lakes, favouring invasive species, increasing stratification and lower lake levels (Lemke, 2006). Other effects are the flooding of fish ponds especially those sited in wet farmlands near rivers (Idowu et al., 2011) and increased pond temperature resulting to increased death rate in cultivated fishes in the region.

Projected reductions in water flows and increases in sea level may negatively affect water quality and fish species in the region.

This is expected to have economic effects on communities that depend on these resources especially, the fishermen and fish keepers in the region whose occupation is mainly fishing and marketing of cultured fishes. It is thus the consideration of this study to understand from the perception of fishermen and fish farmers, the extent to which climate change has affected fishing and fish farming activities in the region.

Research Questions

To what extent has climate change has impacted on

1. Fishing activities in the Niger Delta region.
2. Fish farming activities in the Niger Delta region.

MATERIALS AND METHODS

The study was carried out to determine the extent to which climate change has impacted on fishing and fish farming in Niger Delta region of Nigeria. The study adopted descriptive survey research design and was carried out in the Niger Delta region of Nigeria. The region which is located in the Southern part of Nigeria is made up of 9 states, namely: Abia, Akwa-Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo and River. Bayelsa and Delta states were randomly chosen for the study. The population for the study was 400 respondents. The respondents were fishermen and fish keepers in Bayelsa and Delta states.

The respondents were drawn from Ogbia/Otuekpeti axis; Yenogoa/Amassoma axis in Bayelsa State, Oleh/Ozoro axis, and Warri/Ughelli axis in Delta State. From the selected axes, 100 random respondents were contacted: 50 fishermen and 50 fish keepers (farmers) in both states. The instruments for data collection were structured questionnaire and interview. The instruments were divided into two sections (A and B), each section corresponding to research questions 1 and 2, respectively.

The use of the questionnaire was to generate quantifiable data while the interview was to enable the respondents to elaborate their view on each item and as well to state the nature of perceived impacts. Each item in both sections of the questionnaire had a four point response options of High Extent (HE), Moderate Extent (ME), Low Extent (LE) and No Extent (NE) and were weighted 4, 3, 2 and 1 respectively. Three experts validated the instruments: one from Agricultural Development Programme (ADP) at Delta state Ministry of Agriculture and Natural resources, and two lecturers from Agricultural Education Unit at the Department of Vocational Teacher Education, University of Nigeria, Nsukka. The reliability of the questionnaire instrument was established using Cronbach Alpha method and a co-efficient of 0.79 was obtained.

The researchers with the help of 4 research assistants physically administered and collected the completed instruments from the respondents. Four hundred (400) copies of the instruments was administered, of which 362 copies were retrieved and used for data analysis. The Statistical Product and Service Solutions (SPSS v 20.0) was employed for data analysis. The statistical tools used for data analysis were mean and standard deviation. Standard deviation was used to validate the closeness of the respondents from the mean and from each other in their responses. The research questions were answered using real limit of number of the mean to interpret the observations, as presented on (Table 1).

In taking decision for the research questions, any item with a mean value ranging from 3.50 – 4.00, 2.50 – 3.49 or 1.50 – 2.49 was interpreted as high, moderate or low extent of impact, respectively while any item with a mean value below 1.50 (0.50 – 1.49) was interpreted as no extent, meaning climate change has no perceived impact on the item. The structured interview was analyzed

Table 1.Respondents' response and mean interpretation.

Response Option	Mean weight	Real limit of number
High Extent (HE)	4	3.50 – 4.00
Moderate Extent (ME)	3	2.50 – 3.49
Low Extent (LE)	2	1.50 – 2.49
No Extent (NE)	1	0.50 – 1.49

Table 2. Mean ratings and standard deviation of respondents on the extent to which climate change has impacted on fishing in the Niger Delta region of Nigeria.
N=362.

S/N	Fishing activities and climate change	Respondents								
		Bayelsa			Delta			Av Resp.		
		$\bar{X}$	SD	Dec.	$\bar{X}$	SD	Dec.	$\bar{X}$	SD	Dec.
1.	Access/distance to fishing ground	3.51	0.87	HE	3.65	0.81	HE	3.58	0.84	HE
2.	Fish density in an area	2.91	0.60	ME	3.24	0.82	ME	3.08	0.71	ME
3.	Loss of fishing gear	2.13	1.06	LE	3.09	0.90	ME	2.61	0.98	ME
4.	Capsizing of fishing boat due to wave	1.19	0.88	NE	2.88	0.88	ME	2.04	0.88	LE
5.	Sizes of fish caught	3.18	0.75	ME	2.88	0.48	ME	3.03	0.61	ME
6.	Number of fish per catch	2.53	0.55	ME	2.50	0.62	ME	2.52	0.59	ME
7.	Distribution of fish species in an area	2.98	1.00	ME	2.91	0.93	ME	2.95	0.97	ME
8.	Loss of fishermen	2.04	0.80	LE	2.00	1.95	LE	2.02	1.38	LE
9.	Algal and water hyacinth growth	2.69	1.10	ME	3.18	1.06	ME	2.94	1.08	ME
Cluster Response		2.57	0.85	ME	2.92	0.94	ME	2.75	0.89	ME

Note: Dec. – Decision; Av Resp. – Average Response; High Extent (HE=3.50 – 4.00); Moderate Extent (ME=2.50 – 3.49); Low Extent (LE=1.50 – 2.49); No Extent (NE=0.50 – 1.49).

qualitatively.

RESULTS

Research Question 1

To what extent has climate change impacted on fishing in the Niger Delta region of Nigeria?

While the respondents in Bayelsa reported low and no extent (LE and NE) of impact for items 3 and 4 respectively, the respondents in Delta perceived moderate extent of impact of climate change on those activities in fishing. However, on average response of the respondents, one item (No. 1) had high extent (HE) of impact as its mean value fell within 3.50 – 4.00 real limit of number. Seven items (No. 2, 3, 5-7 and 9) had moderate extent (ME) as their means were between 2.50 and 3.49 while the remaining two items (No. 4 and 8) had low extent of impact as their mean values fell within 1.50 – 2.29. In summary, the extent of impact of climate change on fishing in the Niger Delta region of Nigeria is moderate (ME) as indicated by the average mean response (2.75) of the respondents. The standard deviation of the average response for all the items ranged from 0.59 – 1.38 with an average value of 0.89; indicating that the respondents were not far from the mean and from one another in their responses.

The information from the structured interview complemented the data from the questionnaire presented on (Table 2). It was revealed that climate change has impacted noticeably to a moderate extent on fishing in the region. It was also revealed that the nature of impact is slightly negative with the greatest impact on the distance covered for a good catch during fishing. There is also complains of rapid growth of water plants and algal blocking water routes and channels to good fishing areas and causing discomfort for the fishermen.

Research Question 2

To what extent has climate change impacted on fish farming in the Niger Delta region of Nigeria?

The perceived impacts of climate change as reported by respondents in Bayelsa and Delta states on some fish farming activities slightly differ. While the respondents in Bayelsa reported no, low, moderate and low extent (NE, LE, ME and LE) for items 1, 3, 6 and 14 respectively, the respondents in Delta indicated that the impacts for the same items were LE, ME, LE and ME, respectively. This observation recorded could be explained, as initially

Table 3. Mean ratings and standard deviation of respondents on the extent to which climate change has impacted on fish farming in the Niger Delta region of Nigeria.
N=362.

S/N	Fish keeping activities and climate change	Respondents						Av Resp.		
		Bayelsa			Delta					
		$\bar{X}$	SD	Dec.	$\bar{X}$	SD	Dec.	$\bar{X}$	SD	Dec.
1.	Construction of pond	1.42	0.94	NE	1.71	0.83	LE	1.57	0.89	LE
2.	Stocking rate of fingerlings	2.56	0.72	ME	2.65	1.10	ME	2.61	0.91	ME
3.	Stocking time and method for the fingerlings	2.22	0.56	LE	2.68	0.88	ME	2.45	0.72	LE
4.	Type of fish raised	3.13	0.84	ME	2.88	0.84	ME	3.01	0.84	ME
5.	Breeding cycle and Egg hatchability	3.00	1.30	ME	2.65	1.12	ME	2.83	1.21	ME
6.	Quality and Size of fries/fingerlings	2.53	1.22	ME	2.21	0.81	LE	2.37	1.02	LE
7.	Growth rate of the fishes	2.62	0.72	ME	2.56	1.19	ME	2.59	0.96	ME
8.	Feed consumption	2.73	0.54	ME	3.03	0.72	ME	2.88	0.63	ME
9.	Feeding period/time	2.82	0.44	ME	2.65	0.65	ME	2.74	0.55	ME
10.	Disease infestation of the fishes	2.84	0.88	ME	3.32	0.68	ME	3.08	0.78	ME
11.	Death rate in the pond	3.38	0.72	ME	3.24	0.99	ME	3.31	0.86	ME
12.	Quantity/Yield of fish	3.00	0.71	ME	3.09	0.75	ME	3.05	0.73	ME
13.	Pond temperature	3.16	0.71	ME	3.21	0.73	ME	3.19	0.72	ME
14.	Availability of water for ponds	2.47	0.55	LE	2.56	0.70	ME	2.52	0.63	ME
15.	Marketing of harvested fish	3.02	0.84	ME	2.71	0.63	ME	2.87	0.74	ME
Cluster Response		2.73	0.78	ME	2.74	0.84	ME	2.74	0.81	ME

Note: Dec. – Decision; Av Resp. – Average Response; High Extent (HE=3.50 – 4.00); Moderate Extent (ME=2.50 – 3.49); Low Extent (LE=1.50 – 2.49); No Extent (NE=0.50 – 1.49).

stated, that the extent and nature of the impacts of climate change on various sectors and activities varies from region to region and from geographical locations. However, on average response, twelve items (No. 2, 4, 5 and 7-15) had moderate extent (ME) as their means were between 2.50 and 3.49 while the remaining three items (No. 1, 3, and 6) had low extent of impact as their mean values fell within 1.50 – 2.29, indicating that climate change had little perceived effects on these items. In summary, the extent of impact of climate change on fish farming in the Niger Delta region of Nigeria is moderate (ME) as indicated by the average mean response (2.74) of both respondents.

The standard deviation of the average response for all the items ranged from 0.55 – 1.21 with an average value of 0.81; indicating that the respondents were not far from the mean and from one another in their responses.

Explanations of the respondents using interview was not at deviance with the data from the questionnaire as presented on (Table 3). Both group of respondents complained of increased pond temperature for ponds sited in the open which could explain the increased death rate in the ponds. Unlike drought scenario of arid regions, the Niger Delta region is a coastal one thus steadily receiving good amount of rainfall. They explained that there is enough water to serve whatever purpose in the region including adequate supply of water for fish ponds.

The observation is further explained by Lemke (2006) who stated that regions which are already dry today will become even drier while wet ones will receive more rain, according to different climate scenarios.

DISCUSSION

With changing conditions in the water bodies such as temperature rise, increased salinity and invasion of aggressive water species, the fish dominated region seems to be affected causing the fishes to move to different part of the water body thus forcing the fishermen to travel longer distance in search of abundant supply of fishes for a good catch. This finding is supported by Sumaila and William (2010) that stated that changes in water bodies will force the indigenous aquatic species to move to favourable locations while increasing the intrusion of invasive species into the local area. Construction of pond, stocking time and method are not affected by climate change mainly due to the required spacing and capacity of ponds. Furthermore, most farmed fishes have no specific stocking period as long as all conducive conditions are met. The increased water wave in the region seems to have caused little or no capsizing of fishing boat or loss of fishermen in the region. This could be attributed to the experience of the fishermen in the region as most of them are good water navigators and fishermen. This view is supported by Uyigue and Agho (2007).

CONCLUSION AND RECOMMENDATIONS

Findings of the Study

(i) Climate change has impacted highly on the access/

distance to fishing ground but has low impact on construction of pond, stocking time and method for the fingerlings, and on capsizing of fishing boat due to increased water wave.
(ii) Climate change has low impact on the water availability for ponds in the region.
(iii) Generally, the impact of climate change on fish production (fishing and fish farming) in the region is moderate.

Climate change has impacted moderately though negatively on most aspects of fish production in the region. This adverse conditions will alter conventional fish production and will result in decreased quality and quantity of harvested fish, majorly from the natural sources. To counter the major perceived impacts of climate change on fishing and fish farming in the region, based on the findings of the study, the study thus recommends the following to help the fishermen and fish farmers cope with these impacts:

(a) Fish farmers should be trained by government and well-meaning local and international organizations on recent fish keeping practices suitable in this era of climate change. The training could be done at the states ministries of agriculture or agricultural zones in the region.
(b) Fishermen should be provided with free or subsidized standard fishing gears especially motorized canoes and boats to enable them travel less tediously to the long distance in search of the displaced (school of) fishes for a good catch. The provision of the gears will also serve as a means of encouraging continued fishing in the region to reduce hardship and supply the required regional, national and international demand of fishes.
(c) The study encourages the fish farmers to adopt the use of shades on openly constructed ponds to reduce direct sun thus heating of the ponds which increases pond temperature causing discomfort and increased death in the pond. The shade materials could be palm fronts and tree branches.

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