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Research Article

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Fish Farmers Perception of the Effects of Climate Change on Water Resource Use in Rivers State, Nigeria

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Abstract The study assessed perceived effects of climate change on water resource use in Rivers State. It describes the socioeconomic characteristics of the respondents; respondents' awareness of climate change; describes the effects of climate change on water resource use; identified adaptation strategies adopted to mitigate the effect of climate change. Data were collected using structured questionnaire administered to one hundred and fifty (150) respondents randomly selected from the zone II agricultural zone of Rivers State Agricultural Development Programme (RISADP). Descriptive statistics were used to analyze the data collected. Results showed that 44% of the respondents were females and 55.3% were males. Over 80% had various levels of formal education. The study showed that the respondents were very much aware of climate change. Climate change had the following effects on water resource use: water shortage ($\bar{x}$=2.35), reduced water quality ($\bar{x}$=2.18), poor water supply ($\bar{x}$=2.15) among others. Adaptation strategies employed included, planting of different crop varieties, breeding of that resist high temperature among other measures.

Keywords Water resource, climate change, agriculture, farmers, Nigeria

Introduction

Agriculture places heavy burden on the environment in the process of providing humanity with food and fiber, while climate is the primary determinant of agricultural productivity. Given the fundamental role of agriculture in human welfare, concern has been expressed by federal agencies and others regarding the potential effects of climate change on agricultural productivity. Interest in this issue has motivated a substantial body of research on climate change and agriculture over the past decade [1-4]. Climate change is expected to influence crop and livestock production, hydrologic balances, input supplies and other components of agricultural systems. However, the nature of these biophysical effects and the human responses to them are complex and uncertain.

It is evidenced that climate change will have a strong impact on Nigeria-particularly in the areas of agriculture; land use, energy, biodiversity, health and water resources. Nigeria, like all the countries of Sub-Saharan Africa, is highly vulnerable to the impacts of Climate Change [5-6]. It was also, noted that Nigeria specifically ought to be concerned by climate change because of the country's high vulnerability due to its long (800km) coastline that is prone to sea-level rise and the risk of fierce storms. In addition, almost 2/3 of Nigeria's land cover is prone to drought and desertification. Its water resources are under threat which will affect energy sources (like the Kainji and Shiroro dam). Moreover, rain-fed agriculture practiced and fishing activities from which 2/3 of the Nigerian population depend primarily on foods and livelihoods are also under serious threat besides the high population pressures of over 160 million people surviving on the physical environment through various activities within an area of 923,000 square kilometers [5-6].

Water is life. This is a popular axiom in Africa, underpinning the high level of importance the people of the continent place on the resource. In all its forms –rainwater, aquifers, streams, ponds, springs, lakes, rivers, ocean water, snowpack ice and water vapour –water is an essential and central resource [7]. Water resources are important to both society and ecosystems. We depend on a reliable clean supply of drinking water to sustain our health. We also need water for agriculture, energy production, navigation, recreation, and manufacturing. Many of these uses put pressure on water resources, stresses that are likely to be exacerbated by climate change. In many areas, climate change is likely to increase water demand while shrinking water supplies. This shifting balance would challenge water managers to simultaneously meet the needs of growing communities, sensitive ecosystems, farmers, ranchers, energy producers, and manufacturers.

In Rivers State, the livelihoods of families and households depend essentially on land and water. The effects of climate change on land and water are evidenced in the sea level rise on low lying coastal and delta areas where urban settlements, large population concentration, productive agricultural areas, natural ecosystems and coastal fisheries will be at risk [8]. The impacts include the likelihood of increased migration from rural areas where agriculture and natural resource based livelihoods will be undermined into urban areas and other rural areas which may be less affected where greater land competition will occur. There is a likelihood of increased displacement of urban residents particularly in coastal areas, and there will be a need for enhanced systems for land delivery and resettlement in both urban and rural areas. These regions will require improved systems for land use planning, flood risk management, drainage, and coastal protection but also for land access for resettlement and to facilitate both planned and spontaneous migration, including both temporary and permanent displacement as a result of high impact flood events.

According to the Tyndall Centre the bulk of the population currently exposed to coastal flooding is in South Asia and East Asia, and these regions continue to dominate when predicting in its relative contribution. Actual experience of flooding (as opposed to risk) depends not only on sea level rise, and other climate related factors including frequency of storm events and storm surges, precipitation levels and rates of glacial melt feeding major river systems but also on population, socio-economic scenarios, and most especially assumptions about protection. Small Islands and deltaic areas appear most vulnerable, but contain less people. Greater numbers are at risk everywhere under the high population IPCC A2 scenario, under which sea level rise and frequency of extreme coastal storm events would have greater, but coastal populations would have grown more rapidly and people would be exposed to the risks.

Sea level rise poses a particular threat to deltaic environments, especially with the synergistic effects of other climate and human pressures. This is particularly important since many of the largest deltas are home to large urban and rural farming populations and providers of important environmental services. The important sea level rise and increased storm surges on these areas must be seen in the context of the existing and ongoing impacts of human induced land changes [5]. Whereas, present rates of sea-level rise are contributing to the gradual diminution of many of the world's deltas, most recent losses of deltaic wetlands are attributed to human development. An analysis of satellite images of fourteen of the world's major deltas indicated a total loss of 15,845km^2 of deltaic wetlands over the past 14 years. Every delta showed land loss, but at varying rates, and human development activities accounted for over half of the losses.

The above situation is not different from what obtains in Nigerian Niger Delta region, where it is expected that Climate change is having a multitude of immediate and long-term impacts on water resources. These include flooding, drought, sea-level rise in estuaries, drying up of rivers, poor water quality in surface and groundwater systems, precipitation and water vapour pattern distortions, and snow and land ice mal-distribution. These effects when compounded together have devastating impacts on ecosystems and communities, ranging from economic and social impacts to health and food insecurity, all of which threaten the continued existence of many people in the area. The knowledge gap existing in the area necessitates the study. The following objectives were drawn;

1. To describe the socio-economic characteristics of the respondents,
2. Ascertain perceived evidence of climate change in the study area,
3. Examine perceived effects of climate change on water resource use in the study area
4. Identify strategies for climate change adaptations and mitigation by respondents in the study area.

Methodology

The study was carried out in Rivers State of Nigeria. The State has 23 local government areas. The State is bounded on the South by Atlantic Ocean, on the North by Anambra State, Imo and Abia States, on the East by Akwa Ibom State and the West by Bayelsa and Delta States. Rivers State which is in the Niger Delta has topography of flat plains with a network of Rivers and tributaries. These include New Calabar, Orashi, Bonny, Sombrero and Bartholomew Rivers. Rivers State lies between latitude five (5^0N^1) and North and midway between longitude five (5^0S^1) south of the Greenwich Meridian, with a tropical climates (Howard, 2007). Rivers State has numerous rivers and vast areas of land, the people of Rivers State have lived up to their tradition of agriculture, especially fishing and farming, commerce and industry. The state has a population of about 5.6million people who have a rich and unique cultural heritage. Rivers State is divided into 3 agricultural zones, according to the Agricultural zoning system of Rivers State Agricultural Development Project (RISADP). The zones which consist of the 23 Local Government Areas (LGAs) of Rivers State are divided into crop zone for zone I; zone II for fishing zone and zone III for crop/livestock (RISADP, 2000). The research was conducted in zone II agricultural zone of Rivers State Agricultural Development Programme (RISADP) made up of Abua/Odual, Degema, Akuku-Toru, Asari-Toru, Bonny, Andoni, Wakirike and Opobo/Nkoro notable for fish production. All the rural dwellers in these 7 Local Government Areas, making the zone constituted the population of the study. This study employed a purposive random sampling technique in selecting respondents for the study. A list of registered fish farmers in the zone was obtained from the extension officer in charge of the zone. The list has a total of 1500 registered fish farmers and 150 respondents were selected randomly from this list which is 10% of the population. Data was collected by the use of questionnaire. Data from the study was analyzed by use of descriptive statistics. Objectives 1 and 4 were achieved using percentages presented in tabular forms. Objective 2 looked at the evidence of climate change in the area and was achieved on a 3 point likert-type rating scale of very strong evidence strong evidence and not strong evidence assigned weight of 3, 2 and 1 respectively presented in tabular form. The scores were added to give 6 divided by 3 to give a mean of 2.0. Any mean 2.0 and above was adjudged strong evidence, while mean less than 2.0 was adjudged negative. Objective 3 looked at the effects of climate change on water resource use and were achieved on a 3 point likert-type rating scale of very strong effect, strong effect and not strong effect assigned weight of 3, 2 and 1 respectively presented in tabular form. The scores were added to give 6 divided by 3 to give a mean of 2.0. Any mean 2.0 and above was adjudged positive, while mean less than 2.0 was adjudged negative

Results and Discussion

Socio-economic Characteristics of Respondents

Table 1 shows the socio-economic characteristics of the respondents. The table reveals that 16.0% of the respondents were between 21 – 40 years, 36.6% were within 41 – 60 years, 40% were within 61-80 years, while 7.% were 81 years and above. The implication here is that age is important since it reveals one's knowledge and understanding of the phenomenon under study and other happenings in the society. High number of years in life affords individuals, especially in the study area to say exactly the various changes they have seen in the course of their fishing business. It is also interesting to note that while fishing is the major occupation of respondents, crop production (37.3%) and food processing (14%) are also practiced as supplementary occupations. This makes them self-sufficient in food production and balanced in responding to the questions asked them. Majority (55.3%) of the respondents were men, while 44.6% were women. Men act as family heads, husbands and fathers who own the farming business and takes vital decisions for the family. The table also shows that 71.3% of the respondents were married, 16.6% were single and 12% were widows.

On number of dependents, table 1 also shows that 23.3% had 1 – 5 persons who depend on them, 55.3% had 6 – 10 persons depending on them and 15.3% that had 11 – people and above that depended on them. On level of education, 12.6% had no formal schooling, 32% had primary education, 49.3% had secondary education, only about 6% had tertiary education. Education levels if an individual helps in knowledge acquisition and transfer. It has been reported by Agwu and Anyanwu (1996) [9] that increase in educational status of farmers positively influences their perception and adoption of improved technologies and practices. Majority (69.3%) have been fishing for more than 21 years, 22% had put in 11 – 20 years, while 8.6% had put in 1- 10 years. Earthen pond is common in the study area as indicated by 68%, 16% had homestead pond, 5.3% had cage, while 10% had concrete ponds. This also reveals the fish farming practices and pound type of the respondents. Majority (73.3%) rear fish extensively, 16.6% semi–intensive and intensive system (10%) respectively.

Table 1: Socio – economic Characteristics of Fish Farmers

Parameters	Frequency	Percentage
Age		
21 – 40	24	16.0
41 – 60	55	36.6
61 – 80	60	40.0
81 and above	11	7.3
Occupation		
Fishing (main)	123*	82.0
Crop production	56	37.3
Food processing	21	14.0
Sex		
Male	83	55.3
Female	67	44.6
Marital status		

Single	25	16.6
Married	107	71.3
Widow	18	12.0
Household size		
1 – 5	44	23.3
6 – 10	83	55.3
11 and above	23	15.3
Educational level		
No formal education	19	12.6
Primary	48	32.0
Secondary	74	49.3
Tertiary	9	6.0
Fishing farming experience		
1 – 10	13	8.6
11 – 20	33	22.0
21 and above	104	69.3
Type of pond		
Earthen pond	102	68.0
Concrete pond	15	10.0
Cage	8	5.3
Home stead	25	16.6
Fish farming system		
Extension	110	73.3
Semi intensive	25	16.6
Intensive	15	10.0

Multiple responses. Source: Field survey, 2015

Perceived Evidence of Climate Change

Table 2 shows the distribution of the respondents based on their indication with statement on the perceived evidence of climate change. The result shows that majority of the respondents indicated very strong evidence to the evidences itemized. Delayed rainfall ($\bar{x}$=1.98) was the only evidence that was found to be not strong evident. This result conform with Lobell, et al (2009), and Apata *et al.*, (2009) who reported that the major determinants of climate change were higher temperature, water evaporation, poor soil conditions and unusual heavy rainfall [1-2].

Table 2: Perceived evidence of climate change

Statement	VSE	SE	NSE	Mean($\bar{x}$)	Remark
High temperatures	93	44	13	2.53	VSE
Increase pests & diseases	51	78	21	2.20	VSE
Reduced crop yields	65	48	37	2.19	VSE
Flooding	58	63	29	2.19	VSE
Poor soil conditions	51	55	44	2.05	VSE
High water evaporation	43	67	40	2.02	VSE
Delayed rainfall	40	67	43	1.98	NSE
Unusual heavy rainfall	51	59	40	2.07	VSE
Drought	51	55	44	2.05	VSE
Undefined season	61	51	38	2.15	VSE

Field survey data, 2015.

VSE = Very Strong Evidence, SE = Strong Evidence, NSE = Not Strong Evidence

Effects of Climate Change on Water Resource Use

The effects of climate change on water resource use were determined by knowing the extent to which climate change impacts on water resource use. Table 3 revealed the distribution of effects of climate change on water resource use in the study area. From the table, effects such as "water shortage ($\bar{x}$=2.35), increase water demand ($\bar{x}$=2.18), reduction in water quality ($\bar{x}$=2.04), poor water supply ($\bar{x}$=2.15), change in water storage pattern ($\bar{x}$=2.16), water pollution ($\bar{x}$=2.25), limited access to safe drinking water ($\bar{x}$=2.17), excessive water withdrawals and depletion of fishing vessels ($\bar{x}$=2.00) and competing demand for irrigation water ($\bar{x}$=2.02)" were found to be very strong effects. Decline in irrigation supplies ($\bar{x}$=1.86), and depletion of fishing vessel ($\bar{x}$=1.79) were found to be not strong effect. This implies that most of the effects of climate change on water resource use were very strong in the study area. This result are in line with Ole *et al.,* (2009), Butt *et al.,* (2005), Sonneveld *et al.,* (2002) and Apata *et al.,* (2009) who reported that climate change has a very strong effect on Nigeria particularly in the areas of water resources and on the physical production factors [1, 10-12]. Climate change is expected to affect water quality in both inland and coastal areas. Specifically, precipitation is expected to occur more frequently via high-intensity rainfall events, causing increased runoff and erosion. More sediments and chemical runoff will therefore be transported into streams and groundwater systems, impairing water quality.

According to Adam and Peck (2008) water quality may be further impaired if decreases in water supply cause nutrients and contaminants to become more concentrated [13]. Rising air and water temperatures will also impact water quality by increasing primary production, organic matter decomposition, and nutrient cycling rates in lakes and streams, resulting in lower dissolved oxygen levels. Lakes and wetlands associated with return flows from irrigated agriculture are of particular concern. This suite of water quality effects will increase the number of water bodies in violation of today's water quality standards, worsen the quality of water bodies that are currently in violation, and ultimately increase the cost of meeting current water quality goals for both consumptive and environmental purposes. Rising sea levels could also reduce water quality and availability in coastal areas.

Table 3: Effects of climate change on water resource use

Statement	VSE	SE	NSE	Mean($\bar{x}$)	Remark
Water shortage	73	57	20	2.35	VSE
Increased water use and demand	54	69	27	2.18	VSE
Reduction/change in water quality	56	44	50	2.04	VSE
Poor water supply	57	58	35	2.15	VSE
Change in water storage pattern	62	50	38	2.16	VSE
Severe drought reduction	65	58	27	2.25	VSE
Limited access to safe drinking water	53	69	28	2.17	VSE
Excessive water withdrawals					
Decline on irrigation supplies	52	44	54	2.00	VSE
Depletion of fishing vessel	37	55	58	1.86	NSE
Competing demand for irrigation water	30	59	61	1.79	NSE
Increased precipitation and stream flow	43	40	67	2.02	VSE
Death of aquatic ecosystem					
Increased water run off	58	53	39	2.12	VSE
Increased evaporation rate of water	65	59	26	2.26	VSE
Increased water pollution from sediments	60	63	27	2.22	VSE
Farmland flooding	67	59	24	2.28	VSE
	57	72	21	2.06	VSE
	75	70	8	2.29	VSE

Field survey data, 2015.

VSE = Very Strong Effect, SE = Strong Effect, NSE =Not Strong Effect

Adaptation and Mitigation Strategies to Climate Change

Table 4 presents adaptation and mitigation strategies actually adopted by the respondents From the table, there are 10 adaptation strategies adopted by the respondents. All the respondents (100%) adopted the breeding of fish tolerant to very high temperature. Other measures included adjustment in crop mix (92.6%), reduced total planted land hectarege (84%), planting early maturing crops (89.3%), reduced tillage for water infiltration (98%), changing drinking water mode (90%), construction of water storage facilities (78.6%), building water transfer channels (81.3%), digging well for livestock/fishes (79.3%), and water saving technology (70.6%). Again, oral interview with respondents indicated that they were able to develop their livelihood and adaptation strategies in a way that enabled them to constantly cope with an erratic impact of climate change on land and water resource use. These results are in line with Rudolf and Hermann (2009) and Apata *et al.,* (2009), who reported that the main strategies for reducing climate risk is to diversify production and livelihood systems like soil and water management measures, and plant protection measures that varied to maintain adequate crop yields [1, 14].

Table 4: Adaptation and mitigation strategies to climate change

Statement	Frequency	Percentage (%)
Adjustment in crop mix	139	92.6
Reduced total planted land hectarage	126	84.0
Planting early maturing crop varieties	134	89.3
Reduced tillage for water infiltration	147	98.0
Changing drinking water mode	135	90.0
Construction water storage infrastructure	118	78.6
Building water transfer channels	122	81.3
Digging well for livestock/fishes	119	79.3
Constructing water saving technology	106	70.6
Breeeding fish tolerant to high temperature	150	100

Field survey data, 2015.

Conclusion

Climate change consequences on water resources manifested themselves in such events as flooding, drought, sea-level rise, drying up of rivers, poor water quality, changes in surface and groundwater systems, changes in precipitation and water vapour. These alterations are already having serious impacts on the economy of the respondents as well as on social welfare and the health status of many disadvantaged people seen in such areas as water shortage, reduced water quality among others. Farmers adapt building watr storage and transfer services.

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