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Notions' Of Climate Change And Response To Climate Variability Impacts By Artisanal Fish Farmers In A Nigerian Coastal Settlement Of Oron

John O. Esin (PhD)

[1]Department of Hydrology & Water Resources Management

Maritime Academy of Nigeria, Oron, Akwa Ibom State

Abstract

There is strong evidence that the fisheries sub-sector of agriculture is experiencing major challenges, some of which are directly linked to climate change. This study investigated fish farmers' notion of climate change and response to climate variability impact on fish production in the coastal settlement of Oron, Akwa Ibom State, Nigeria. Through the use of structured questionnaires complemented by data obtained from focus group discussions, oral interview and direct field observations, 200 artisanal fish farmers were randomly selected from four settlements noted for intensive fishing activities in a coastal settlement of Oron. The analysis of the data using descriptive statistical methods revealed a very low awareness level of the concept of climate change by the fish farmers even though they have considerable knowledge of major changes such as variation in rainfall pattern, increase temperature and delay in rainfall cessation, un-noticeable august break characterized by short dry season in their environment,. The artisanal fish farmers perceived low yield from fish capture to be a consequence of the negative impact of climate variability. As adaptation strategy, all the artisanal fish farmers resorted to fishing afar, investment in improved vessel stability to checkmate the effect of increase surge/storm, while some resorted to occupational change. The study recommends that Adult Education Agency be instituted in the fishing communities; since it is revealed that majority of the fish farmers are uneducated. Education and skills upgrading are powerful adaptive strategies for individuals, families and communities. Higher educational attainment may enable fisher folk to make a broader series of choices, ranging from engaging in safe construction practices to assessing potential risk that result in fewer deaths when an extreme event strikes.

Keywords: Notion, climate change, impact, artisanal fishing, and adaptation**.**

1.1 Introduction

Climate change has serious repercussions for global fisheries and aquaculture development. Asides the physical and financial drivers, climate is a major driver that enhances the aquaculture sector growth and sustainability. Climate variability exerts important threats to fisheries in addition to many other significant pressures such as overfishing, habitat degradation, pollution, introduction of new species amongst others (Brander, 2010). Globally, relative to the level that would support maximum sustainable yield, 20 per cent of targeted fishery resources are moderately exploited, 52 per cent are fully exploited with no further increases anticipated, 19 per cent are overexploited, 8 per cent are depleted and 1 per cent is recovering from previous depletion (FAO, 2009). Alterations in biophysical features of the marine habitat and recurrent occurrence of life-threatening events poses significant impacts on the ecological unit that support fish productivity with obvious effects on food security. This is so because annihilation of some fish species could results in lower fish yield for local consumption while relocation of many fish species to other aquatic ecosystems with ideal weather condition could have a remarkable effect on artisanal fish-farmers who may not be able to fish afar due to economic, technological and political factors. Given that most of the fish harvested for sales in many unindustrialized countries is provided by small-scale fisheries, this could lead to reduced fish production, thereby reducing earnings from fish export, which would considerably reduced capacity to import food and thus intensified national food insecurity.

Although it is not possible to take a broad view of the impacts of climate change on fisheries, it is expected that climate change is very likely to results in fluctuations in fish stocks, with considerable economic consequences for many vulnerable communities and national economies that heavily depend on fisheries (Brander, 2010). The impacts of climate change on fish stocks can be categorized as physical and biological changes. Physical changes include sea surface temperature rise, sea level rise, changes in salinity and ocean acidification while biological changes include changes in primary production, and fish stock distribution. These factors when combined together will have adverse impacts on the marine resource. According to African Action (2007), changes in ocean temperatures can change the dynamics of aquatic environment while changes in ocean dynamics could lead to changes in migration patterns of fish and possibly reduce fish landings, especially in coastal fisheries. Rising water temperature also threatens biodiversity. Usually, fish have a temperature threshold that optimizes physiological processes (Abowei, 2010). If water temperature rises above the maximum tolerable threshold of a species, then its existence is threatened. Urama and Ozor (2010) provide an example from the Lebialem Highlands in Cameroon where women have started to hunt for tadpoles and frogs because there are no fish in most of Bangwa Rivers. Yet, even the number of tadpoles and frogs they hunt for have significantly declined partly due to an increase in the warming of rivers that have increased the amount of predator fish in an area they have never inhabited before.

Church et al., (2001) cited in OECD (2010) noted a global rise in sea level by 10 to 20 cm during the 20th century, largely due to thermal expansion, and also predicted an estimated global rise in sea level between 9cm and 88 cm by 2100 based on the Intergovernmental Panel on Climate Change's full range of 35 climate projection scenarios. Hlohowskyjl et al., (1996) opined that sea level rise in coastal areas may modify the salinity of estuarine habitats, inundate wetlands, and reduce or eliminate the abundance of submerged vegetation which could adversely affecting those species which rely on these coastal habitats for reproduction and recruitment. With high sea levels rise, sea ports, existing fishing facilities like jetties and fish storage centres built on the coastal fringes slightly above the mean high tide line will be subjected to more frequent tidal and storm inundation (Ibe and Awosika, 1991). This implies that sea level rise is very likely to have a negative impact on fishery production (due to salt stresses on the fish stock and its habitat) and fish landing, processing and marketing facilities.

Climate change can bring about an increase or decrease in water salinity in several ways. While tropical oceans are increasingly becoming saltier, oceans closer to the poles have become fresher. This suggests that tropical oceans are very likely to suffer more from the possible impacts of increasing water salinity relative to waters in higher latitudes. Changes in water salinity have different effects depending on the tolerance level of the organisms and the nature of their ecosystem – whether freshwater, marine or estuarine. IPCC (2001) predicted an increase in the salinity of some freshwater ecosystems due to anthropogenic climate change. Such physical changes will negatively impact the population of both plankton and bigger prey fish species by affecting the organisms' ability to osmo-regulate (Schallenberg et al., 2003). An empirical study by Schallenberg et al. (2003) has shown that change in salinity has a negative impact on zooplankton population, particularly in freshwater ecosystems. The study depict that zooplankton communities of low-lying, coastal, tidal lake and wetlands are adversely affected by small increases in salinity levels; warning that such changes in zooplankton abundance may further disturb the ecological functioning of these valuable but vulnerable ecosystems. Thus, changes in zooplankton populations or other planktonic primary and secondary producers disrupt the food chain, thus having a considerable negative impact on fishery.

Salinity has been identified as one of the most important variables determining the survival of organisms in estuarine ecosystems; either by having a direct impact on the organisms or indirectly by destroying their habitat, including their breeding and nursery grounds (Marshall and Elliot, 1998 in Abowei, 2010). It is stated that all estuarine fish are euryhaline (able to cope with salinity fluctuations), but their ability to do so varies from species to species and hence changes in salinity may influence their distribution (Blaber, 1997). Although salinity changes may not have a direct negative impact on estuarine fish species, it could, however, have a negative impact on their habitat. For example, IPCC (2007) asserted that increase in water salinity has contributed to destruction of 60 per cent of mangrove areas in Senegal while Parkins (2000), projected that each acre of mangrove forest destroyed leads to an estimated 300 kg loss in marine harvest.

This implies that changes in water salinity would have a tremendous negative impact on fisher, asides threatening the livelihoods of many impoverished coastal communities.

Oceans are believed to have the capacity to absorb most of the anthropogenic Carbon dioxide (CO_2) emissions (Caldeira and Wickett, 2003). Carbon dioxide is soluble in water and reversibly converts to carbonic acid. As a result of this chemical reaction, the world's oceans are acidifying at an alarming rate (Dupont and Thorndyke, 2009). Cooley et al., (2011) stressed that quantifying the effects of ocean acidification caused by climate change on human communities entails considering the direct and indirect chemical impacts on valuable marine ecosystem services such as fisheries. Le Quesne and Pinnegar (2011), highlighted the direct effects of ocean acidification to include: changes in physiological processes such as reduced growth of calcified structures, otolith development, and fertilization success which may eventually lead to direct impacts at the whole-organism level, including reduced growth and reproductive output, increased predation and mortality, alteration in feeding rates and behaviour, reduction in immune-competence and reduced thermal tolerance. Indirect effects include alteration in predator or pray abundance, effects on biogenic habitats such as coral reefs, and changes in nutrient recycling. Byrne et al., (2010), noted that increased Carbon dioxide (CO_2) level in oceans can potentially narcotize male gametes which portends that acidification may impair fertilization, aggravating problems of sperm limitation, with dismal implications for marine life. Ocean acidification could potentially slow the growth of plankton and invertebrates that are at the bottom of the food chain. Accordingly, acidification can change the productivity at certain trophic levels, thereby disrupting the complex food chain of aquatic ecosystems with effects on the productivity of fisheries. One of the very likely socio-economic impacts of ocean acidification is a decrease in populations of calcifying organisms such as mollusks. This may have remarkable socio-economic effects either by lowering export earnings of net mollusk exporting nations; reducing jobs for many fishers involved in mollusk farming and harvest; or increasing mollusk prices which may exclude marginal consumers – further widening protein and wealth gaps between the rich and poor. It could thus be adduced that ocean acidification induced by climate change has tremendous negative effects on fishery development.

Fish is the main source of animal protein for over 3 billion people worldwide as it also provides a valued protein supplement to the starchy diet predominant among the global poor. Fish is a vital source of important vitamins and fatty acids. Globally, about 520 million people and their dependants, mostly in developing countries, live by fishing and aquaculture. Fish provides a significant source of income earnings for many poor households and is an extensively merchandized food commodity. Asides stimulating local market economies, fish can be a major source of foreign exchange. Fishing is frequently integral to mixed livelihood strategies, in which people take advantage of seasonal stock availability or resort to fishing when other forms of food production and income generation fall short. According to FAO (2009), global fish production came to about 144 million metric tons (mmt) comprising 92mmt from capture and over 51mmt from aquaculture. Production of 92mmt from capture represents a decrease of 2.2mmt compared to figures for 2005. In view of Nigeria's enormous water resources, human capital and other natural endowments, the Federal Department of Fisheries estimated fish production of over 1.7mmt comprising 201,300mt (offshore fisheries), 288,200mt (inland fisheries) and 1,180,215mt (aquaculture) (George, 2010). According to World Bank, Nigeria produced about 1,169,478 in 2018, which is about 40 per cent of Nigeria's total annual fish demand of about 3.4 million metric tons; the remaining 60 per cent of demand is met through fish importation. The world total fisheries report by the World Bank in 2018 revealed that Nigeria is currently Africa's 3rd largest producer of fish in Africa at 1,169,478 metric tons, with Egypt (1st) and Morocco (2nd) leading the continent at 1,934,743 and 1,387,815 metric tons respectively. However, similar report by the World Bank (2022) indicated that the estimated total fisheries production (metric tons) in Nigeria in 2020 was 1044812 metric tons which indicated a significant decline of 124666 metric tons from the 2018 yield. Nigeria's household fish consumption per capita is 13.3kg annually, which is low compared to the world's average, which is at 20.3kg per capita annually. According to the GDP data released by the National Bureau of Statistics (NBS) for Q1 2021, the fisheries sector had a 3.24% contribution to the country's GDP. This indicated a positive indicator for the fisheries sector, which had a -3.60% and -2.07% growth contribution in Q4 and Q3 2020. Despite having a 5.68% contribution in Q2 2020, its total contribution to the country's GDP in the year 2020 was 0.26%.

Impediments to total fish contribution to the country's GDP include, among others, climate change effects (including sea level rise, coastal erosion and flooding, increase in sea temperatures, ocean acidification, ocean salinity and wind storms). In spite of the perceived impacts of climate change on fisheries development, it is said that the precise and localized impacts of climate change on fisheries are, however, still poorly understood (FAO, 2008a; WorldFish Center, 2007a; Stern, 2007). This is because "the inherent unpredictability of climate change and the links that interlace fishery and aquaculture livelihoods with other livelihood strategies and economic sectors make unravelling the exact mechanisms of climate impacts hugely complex" (WorldFish Center, 2007b). Furthermore, tropical fisheries, which are the most important to small-scale fishers in developing countries, have received less scientific study than those in the waters of developed countries (Roessig et al., 2004). This suggests that there is a need to investigate fish farmers notion of the effect of climate variability on fish harvesting, particularly in a coastal settlement like Oron in Akwa Ibom State, where fishing constitutes major source of the inhabitants' livelihood activities, as this will help evolve policy towards the development of adaptive measures and possibly control of the perceived impacts of climate variation on fish yield. Given this background, the study therefore aims at assessing fish-farmers notion of climate variability impacts on fish production in Oron, a coastal settlement in Akwa Ibom State, Nigeria with the following specific objectives to:

1) Identify the level of fish farmers' awareness of climate change/ variability in Oron coastal settlement.
ii) Determine fish farmers' perception of climate variability impacts on fish production in the study area.
iii) Find out the adaptive measures employed by the fish farmers in adjusting to climate variability impact in Oron coastal settlement.

Conceptual Issues/Literature Review

Literature abound on indigenous notion of climate change (Ayanwuyi and Nwabeze, 2012; Acquah, 2011; Devkota, Bajracharnya, Maraseric, Cockfield and Updahyay, 2011; Combest-Friendman, Christie and Miles, 2012; Haque, Yamamote, Malik and Sauer born, 2012; Aphunu and Nwabeze, 2012; Kpadoni, Adegbola and Tovignan, 2012; Baul, Ullah, Tiwari and McDonald 2013 and Tambo and Abdoulaye, 2013). These studies are significant in understanding different approaches that may be used in assessing peoples' notion to climate variability in local communities as well as their determinants. Central to the methodological approach employed by these scholars is the use of primary data on several variables among which are socio-economic characteristics of households such as age sex, educational attainment, household income, occupation, etc. notions or perceptions of change in climate parameters such as rainfall, temperature, storm frequency etc using focus group discussions, questionnaires and oral interviews. The data obtained are this analysed using descriptive statistics. Also, considerable number of these studies have compared the perceptions to meteorological data on the respective variables to ascertain whether the perceptions or notions are in line with actual data (Devkota et al, 2011; Combest – Friedman et al, 2012 and Amos et al, 2014), while others have examined the determinants of the perceptions using the socio-economic variables and other indicators of exposure to climate change vulnerability as explanatory variables – (Ayanwuyi et al, 2010; Aphunu and Nwabeze, 2012; Adeyanju, and Esin, 2015; Esin and Uwajuonye, 2018; Esin and Mercy, 2022a; Esin, 2022b and Esin and Arisabor, 2023).

1.2 Materials and Methods

1.2.1 The Study Area

The study was carried out in Oron Local Government Area, in Akwa Ibom State, Nigeria. The Local Government Area is basically a coastal settlement located at approximately between Latitudes 4^0 46' – 4^0 52' North and Longitudes 8^0 12' – 8^0 18' East with a total land mass of about 309.27km^2. Oron LGA is located at the right bank estuary of the Cross River close to the Atlantic Ocean. It is a river port and ferry or packet station, linking Calabar and other rivers and coastal ports in the region and the Cameroon and Equatorial Guinea outside Nigeria. It also forms a terminus for roads linking important towns in the mainland – Uyo, Eket and Ikot Abasi. Oron LGA is bounded by Okobo LGA in the North West, by Urueoffong/Oruko, Mbo and Udung Uko LGA in the South and South-West respectively. To the East and the South-East, it is bounded by the Cross River, close to the Atlantic Ocean. The LGA is situated in the coastal areas of Akwa Ibom State with gentle rolling coastal plain sands typified by sedimentary basin formation of largely unconsolidated deposits. Rainfall is heavy and last about 10 months in the year.

The LGA has two different seasons, namely: wet and dry seasons. The wet seasons last for about 10-11 months. The wet seasons start about February – March and last till mid-November and are characterized by the little dry spell, which occurs about two weeks in August. The rate of development in the study area is indeed very tremendous. Oron Local Government Area is made up of five clans with 17 villages. The economy of the study area is dominated basically by fishing and subsistence farming. Although the inhabitants are also engaged in petty trading and production, fishing and farming still remain the most important and primary occupation of the people as other activities are carried out on part time basis.

1.2.2 Methods of Data Collection

Data for the study was collected through interview guided by the use of structured questionnaire. This was complemented by data obtained through focus group discussions, in-depth interviews with key informants and direct observation approaches. These methods were adopted in preference to the formal approach considering the cost, scope, structure, statistical analysis and other advantages associated with them. Focus group discussions (FGDs) were employed to bring together all the fishing households in the selected communities. Each focus group consisted of 15 fish farmers' head of households. Effort was made to ensure that the focus group discussions were as representative as possible, while particular attention was paid to gender representation and age differential. The study population covers all the fish farming household heads in the study area. A population sample of 200 respondents was drawn from four major fishing communities purposively selected known for increase fishing activities.

The selected fishing communities are Esin Ufot, Esuk Mma, Idua Ukpata and Ine Edekehekpu. Multi-stage sampling technique was employed in selecting the representative respondents (fish-farmers). The first stage was the purpose selection of the four (4) fishing communities non for large scale fishing, while the second stage involves the simple random selection of 50 fish farmers' head of households in each of the purposively selected communities, thereby bringing the total number of fish-farmers head of households selected for the study to 200. The study subscribes to interviewing only heads of households. But where relevant information could not be provided by the head of households (assumed to be the decision-maker), their spouse or other household members were asked to provide such information. Descriptive statistical technique such as the use of simple percentage and arithmetic mean were employed in analysing the data generated for the study.

Table 1: list of indices (dependent variables) and units of measurement

Group A	Sub Component	Description/Coding
A:Socio-economic profile of fish farmers	A1= Age of head of household A2 = Sex of head of household A3 = Household size A4 = Level of Education	Numeric Binary option: male and female numeric this is coded on an ordinal scale from "no formal education" = 0 to "completed university degree = 4
	A5 = Number of years lived in the village	Numeric
	A6 = Number of years involved in farming	Numeric
	A7 = Distance of home from Coastline	Numeric. Lies between 0 – 300m
B: Climate change Awareness	B1: Knowledge of the term "Climate Change"	Binary options: Yes or No
C: Fish farmers notion of changes in climate variables	C1: Notion of change in rainfall Amount	Qualitative data (Not at all, mildly, moderately, significantly)
	C2: Notion of change in timing of the average raining season C3: Notion of change in the length of the average rainy season	Qualitative data (not at all, mildly, moderately, significant)
	C4: Notion of change in temperature	Qualitative data (not at all, mildly, moderately, significant)
D: Livelihood exposure to climate variability	D1: Extent to which change in temperature affects income from farming	Coded on an ordinal scale from "does not affect" = 0 to significant by affects = 3
	D2: Extent to which change in rainfall affects income from farming	Coded on an ordinal scale from "does not affect" = 0 to significant by affects = 3

	D3: Extent to which sea level rise affects income from farming	Coded on an ordinal scale from "does not affect" = 0 to significant by affects = 3
E: Fish farmers' response to climate Change	E1: Extent of response or adaptation	This is coded on an ordinal scale from "not able to respond" = 0 to Responding well" = 3
	E2: Methods of Response	Qualitative data
	E3: Challenges of response	Qualitative data

Source: Fieldwork (2023)

Results and Discussions

The result of the artisanal fish farmers' knowledge and response to climate variability as well as the perceived impacts of climate variability on marine fishery/aquaculture exploitation is presented in Table 2.

Table 2: fish farmers' awareness of climate change and variability in Oron LGA

Variables	Response	%
Awareness		
Yes	71	35.5
No	129	64.5
Total	200	100
Extent of awareness of climate variability		
Fully aware	15	7.5
Not fully aware	103	52.3
Not aware	82	41.6
Total		
Knowledge of climate variability indicators		
Long rainfall duration	53	26.5
Short and heavy rainfall	19	9.5
Long total dry season	5	2.5
Short total dry season	10	5.0
August break not noticed	29	14.5
Higher temperature than usual	27	13.5
Unusual early rains not sustained	19	9.5
Delay in rain onset	8	4.0
Delay in total rain cessation	16	8.0
Early rain onset	14	7.0
Total	**200**	**100**

Source: fieldwork (2023)

Results of the survey on fish farmers awareness of climate change (Table 2) indicate that majority (64.5%) of the respondents were not aware of the concept of climate change. With respect to the extent of climate change knowledge, while majority (52.3%) of the fish farmers are not fully aware, only 6.1% have full knowledge with 41.6% having no knowledge of climate change and its possible impacts. This corroborates recent findings by Nzeadike et al, (2011) that the level of awareness of local communities of climate change impacts in the Niger Delta region of Nigeria is still very low and the position of Aklilu (2007) that information about climate change in Africa is still confined within the academia and research institutes and as a result many local farmers though aware of it, lack sufficient knowledge about it. This has obvious implications in the development of climate change adaptation measures. Although considerable numbers of the artisanal fish farmers do not have adequate knowledge of the term climate change, significant numbers of the artisanal fish farmers' are aware of climate variability and its possible indicators. Specifically, majority (54.5%) of the artisanal fish farmers attributed their knowledge of climate change indicators to long rain duration, unnoticed August break and higher temperature above the usually threshold levels.

Table 3: notion of climate variability impacts on fish production

Possible impacts	Response	%
Poor yield (harvest)	186	93.0
Destruction of fishing gears	174	86.5
Damage to boat/boat capsize	142	71.0
Increase fish mortality	163	81.5
High temperature resulting in fishery migration	197	98.5
Increase fish species infestation	151	75.5
Windstorms obstructs fishing	138	69.0
Food insecurity/hunger	148	74.0
Reduced income	162	81.0
High risk of occupational change	135	67.5
Unemployment and poverty	133	66.5

Source: fieldwork (2023)

Table 3 reveals that majority of these artisanal fish farmers identified the indicators of their knowledge of climate variability to include long rainfall duration (96%), higher temperature (92%) unusual early rains not sustained (95.5%), delay in total rain cessation (84%) and august break not noticed (88%) among others. To buttress the aforementioned, one of the participants at the focus group discussion sessions opined that there is no month in the year that the study area does not receive rainfall, the only variation being the amount of rainfall received, which in recent time increases more than observed in the past. They noted that the rainfall pattern and the seasons had become unpredictable; this has severely affected their livelihood in terms of fish catch. Besides the evidence of increase and unpredictable rainfall, the general notion of the fish farmers is that the seasons appeared to have shifted as the rains now commence sometimes earlier than expected, and in some cases, late than expected with delay in total rain cessation. Results in Table 3 further show that the artisanal fish farmers were of the general opinion that climate variability (high temperature and rainfall) has caused drastic change in weather condition, which results in fishery migration (98.5%); poor catch (93.0%) destruction of fishing gears (86.5%); increase fish mortality (81.5%); and increase fish species infestation (75.5%).

With respect to the knowledge of climate change by the artisanal fish farmers', both contributors' in the focus group discussion and respondents in the artisanal fish farmers' questionnaires completely demonstrated a high level of climate change awareness as they all agreed that widespread climate and environmental changes had occurred over the period that they have lived in the area. Some noted that the changes centred on rainfall and temperature variability, using the significant changes in the length of the average rainy seasons, which usually start from March/April and ends on November in their vicinity to bolster their position. Meaning that majority of the artisanal fish farmers' have noticed that there are evident changes in climate pattern but they do not know much about the causes. The artisanal fish farmers' in the focus group discussions were further undivided in their opinion that rainfall pattern had changed extensively with remarkable increased in the extent of precipitation in the study area. They further stressed that the rainfall pattern and the seasons had become unpredictable. The generally held position among the participants in the focus group discussion is that the rainfall amount has increased significantly, leading to extinction of some fish species and migration of many fish species to other aquatic environment with suitable climate condition. This the fish farmers' belief has impacted negatively on their socio-economic wellbeing due to low fish yield with attendant effects on their earnings.

The artisanal fish farmers' also noted that floods which result from increase in the amount and duration of rainfall have continued to pose a serious threat to lives and property asides exposing the locality to high risks of submergence. Besides the evidence of increase rainfall amount and duration, there is also the issue of increasing temperatures which the artisanal fish farmers' linked with increased heat wave or stress and mostly considered detrimental to both humans and fish production. This corroborates the assertion by African Action (2007) that changes in ocean temperatures can change the dynamics of aquatic environment while changes in ocean dynamics could lead to changes in migration patterns of fish and possibly reduce fish landings, especially in coastal fisheries in addition to the threats on biodiversity pose by rising water temperature. The artisanal fish farmers' further stated that higher temperature in the study area heightens the spread of vector borne diseases in the locality and the higher night-time temperatures observable in recent

time could adversely affect fishery development. Variations in sea surface temperature can produce more frequent harmful algal blooms, less dissolved oxygen, increased incidence of disease and parasites, and modified local ecosystems with changes in competitors, predators and invasive species, and changes in plankton composition.
Climate changes may affect fisheries development either directly by influencing the abundance and distribution of fish stocks and the global supply of fish for consumption, or indirectly by inducing fish prices or the cost of goods and services required by the artisanal fish farmers.

Table 4: fish farmers adaptation measures to climate variability

Adaptation Measures	Response	% Response
Shifting from nets to diving methods	121	60.5
Exploitation of more fish species not found in the locality	152	76.0
Fishing afar (long distance fishing)	200	100
Changes in fish harvesting techniques	181	90.5
Occupational mobility (exit fishery for other livelihood)	186	93.0
Diversification within the fisheries sector	105	52.5
Geographical mobility (change of fishing location)	163	81.5
Investment in improved vessel stability/safety	188	94.0
Seeking climate change information	24	12.0
Prevention/treatment of fish	102	51.0

Source: fieldwork (2023)

The consequence of the knowledge of climate change indicators is that since the artisanal fish farmers' have substantial knowledge of climate change with its possible negative effects on fishery development and their socio-economic wellbeing, they will likely develop and use adaptation strategies which would enable them to cope with the vagaries of changing climate and weather pattern. Adaptation necessitates anticipating the adverse effects of climate change and taking appropriate action to prevent or lessen the damage they can cause, or taking advantage of opportunities that may arise (Esin and Mercy, 2022a). According to Kitano (2002) adaptation is the process of responding or adjusting to actual and potential impacts of changing climate conditions in ways that moderate harm or take advantage of any positive opportunities that climate may afford. It includes policies and measures to reduce exposure to climate variability and extremes and the strengthening of adaptive capacity. It is discovered that well-planned and early adaptation action has the propensity of saving money and lives later. Local adaptation strategies represent those practices and knowledge which local people in various regions have developed over the years, through indigenous knowledge systems (IKS) which have enabled them to adapt and mitigate extensively from climate extremities (Nyong, Adesina and Elasha, 2007 cited in Esin and Mercy, 2022a) which vary from population to population and region to region and, are thus 'location-specific'. Adaptation would enable the artisanal fish farmers' to live or cope with the social and physical impacts of climate change on fishery development. Adaptation measures comprise all forms of activities including structural and non-structural measures to avoid (prevention) or to limit (mitigation and preparedness) adverse effects of climate change or climate-induced hazards.
Table 4 shows the different strategies adopted by the fish farmers in adapting to climate change impact on fish production. All the fish farmers (100%) favoured fishing afar (long distance fishing); 94% favoured investment in improved vessel stability/safety; 93% occupational change; and another 90.5% changes their fish harvesting technique. Other response strategies recorded high percentage of usage, except, the use of climate information which recorded low level of usage (12%). This implies that the farmers are inadequately disposed to the importance of climate information to fish harvesting. This finding corroborates findings by Esin (2022b) and Esin and Mercy (2022a) that rural farmers in the study area do not have adequate access to climate information.

Conclusions and Recommendations:

The study concludes that climate change/variability strongly impact on fish harvesting in the coastal settlement. It is recommended that Adult Education Agency be instituted in the fishing communities; since it is revealed that majority of the fish farmers are uneducated. Education and skills upgrading are powerful adaptive strategies for individuals, families and communities. Higher educational attainment may enable fisher folk to make a broader series of choices, ranging from engaging in safe construction practices to assessing potential risk that result in fewer deaths when an extreme event strikes. As an anticipatory adaptive measure, increasing access to climate information and forecasting with early warning systems would also reduce the vulnerability of the fishing sector. Recognizing and utilizing traditional knowledge for developing adaptation strategies is also a key determinant for the fish farmers ability to respond to climate variability and change impacts, for instance through the provision of additional forecasting abilities and observation on local environmental changes. Enhancing the resilience of fisher folk by supporting existing livelihood strategies and enabling diverse and flexible fisheries not only will address the impacts of climate variability and change, but will also support poverty reduction initiatives and sustainable fisheries management. However, diversification must not be promoted at all costs if it implies not taking into account the social, cultural and economic landscape where livelihoods unfold. In addition, diverse and flexible livelihoods require diverse and adaptable institutions and policies, as policies that support geographical mobility will require specific institutional arrangements regarding property rights.

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