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Climate change perception and adaptation among farmers in coastal communities of Bayelsa State, Nigeria: a photovoice study

Received 31 July 2022
Revised 22 September 2022
10 March 2023
2 May 2023
Accepted 30 May 2023

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Abstract

Purpose – There is an increasing need for greater awareness and understanding of the risks climate change poses to farming communities so as to inform appropriate adaptive responses. The purpose of this study is to investigate farmers' climate change impacts, awareness, risk perception and current adaptation strategies adopted to deal with the impacts of climate change on their livelihood.

Design/methodology/approach – This research was undertaken with 67 farmers in Bayelsa State, Nigeria. This study used a combination of focus group discussion and quantitative survey to obtain data. Surveyed farmers were invited to an initial workshop and asked to take photos of climate change impacts on their land and the adaptation strategies being adopted. The photos were analysed and discussed with the farmers in a second workshop. Then, in a third workshop, farmers and other stakeholders came together to rank the most important consequences of climate change and shared knowledge on adaptation strategies. The survey and photovoice data were analysed using descriptive and inferential statistics.

Findings – The results of this study showed that a majority of the farmers were knowledgeable of climate change, mostly got climate information through media. Floods and high temperatures were perceived as the most occurring climate change-related disaster risks. Majority of the farmers perceived climate change as high risk and have taken up multiple adaptation strategies in response to it, including changing planting times, mulching their land and digging irrigation pits. Farmers' responses indicated that they want to do more but are restricted by financial resources.

Practical implications – This study outcomes provide evidence for a need to consider stakeholders' participation in planning climate change responses to effectively address the challenges posed by climate change, particularly in coastal agricultural communities. Government and relevant agencies as recommended need to support farmers to undertake needed adaptive strategies to adapt with future flooding, high temperature and drought, providing them with necessary facilities to enhance their adaptive capacities.

The research was supported by grant #CSC\R1\211023 from the Royal Society under the Commonwealth Science Conference Follow-on Travel Grant 2021. The views expressed here are those of the authors and not of the Royal Society.

International Journal of Climate Change Strategies and Management
Vol. 15 No. 5, 2023
pp. 745-767
Emerald Publishing Limited
1756-8692
DOI 10.1108/IJCCSM-07-2022-0100

Originality/value – To the best of the authors' knowledge, this was one of the first studies to use photovoice to investigate climate change awareness, impacts and adaptations strategies with majority female farmers in west Africa. This study highlights the importance of participatory approaches to capture grassroots climate adaptation approaches.

Keywords Adaptation, Coastal, Climate change, Farmers, Photovoice, Perception, Risk

Paper type Research paper

1. Introduction

Climate change is the effect of long-term changing climatic conditions which is caused, among other human activities, by carbon dioxide and carbon monoxides released from incomplete burning of fossil fuels; deforestation and methane emission from animal dungs, rice fields, landfill sites, agricultural chemicals and pesticides (Eneji *et al.*, 2020). Climate change is intimately linked with agriculture. Its impacts on livelihoods and economies dependent on agriculture have been recorded in many places (Ullah *et al.*, 2018; Abraham, 2018). By implication, the poor are the most vulnerable to climate change because of their dependence on agriculture as mainstay of livelihood. Though a global issue, climate change impacts are felt differently across the world (Matemilola *et al.*, 2019). For instance, coastal regions of the world are experiencing flooding because of rise in sea level, coastal erosion, intrusion of sea-water into fresh water sources and it is destabilising ecosystems such as the mangrove and affecting livelihoods (Uyigue and Agho, 2007). Billions of people in developing countries are facing shortages of water and food and greater risks to health and life as a result of climate change (UNFCCC, 2007). Specifically, in Pakistan farming communities, climate change has affected agricultural production negatively through occurring incidences of disastrous floods that led to loss of farmlands, through severe droughts, extreme maximum temperatures, changes in rainfall pattern and crop diseases (Ullah *et al.*, 2018). Also, in Malaysia, climate change has had a negative impact on paddy production (Zainal *et al.*, 2014).

Furthermore, African countries in particular are highly vulnerable to climate change impacts (Tangonyire and Akuriba, 2021) because of their highly variable climate, prevalent poverty, limited technology, poor infrastructure and weak institutions among others. For example, a study of agricultural households in coastal communities of Benin Republic showed that a majority of the surveyed farmers observed variation in climate and declared that climate variation decreased their crop production (Teka *et al.*, 2013). In response to observed climate variation, Benin Republic farmers adopted adaptation and mitigation measures such as the use of more resistant crop varieties, crop diversification, changed planting times and improved irrigation and draining systems (Teka *et al.*, 2013). Elsewhere in Tanzania, it was observed that smallholder farmers took up resilient practices that could lower destruction linked to climate change (Ojoyi and Mwenge Kahinda, 2015). Although, communities in Africa have developed many approaches to effectively deal with extreme climatic events in the past, future extreme climatic events occurring at higher intensity and greater frequency will present new challenges for the continent (Bele *et al.*, 2013).

With regard to Nigeria, most farmers have already perceived/experienced climate change, experiencing its effects in diverse forms (Yila and Resurreccion, 2013). Rainfall and temperature variations were observed to significantly influenced gross margins from arable crop production in Nigeria (Onoja and Achike, 2014). The agricultural sector in Nigeria provides a source of livelihood for majority of the population who have also been documented as poor and living below poverty line (OXFAM and Development Finance International, 2019). This implies that a large section of the population is being impacted by climate change, particularly, the majority of people in coastal and rural areas such as the farmers in the Niger Delta region located in the Atlantic coast of Southern Nigeria. The region has been identified to be highly vulnerable to climate change impacts because of its peculiar nature (Matemilola *et al.*, 2019), being mostly coastal and home to most of the country's oil exploration and exploitation activities. The intensity and pattern of rainfall has changed in the region. Evidently, those in coastal areas are increasingly experiencing annual flooding in the rainy seasons as a result of increased amount and frequency of rainfall that has been attributed to climate change (Echendu, 2020). Flooding and coastal erosion have led to displacements of coastal settlements (Uyigue and Agho, 2007). Aquatic habitats have also been destroyed through erosion of watersheds. Farmers in southern Nigeria where rain-fed agriculture is mostly practiced have seen their livelihoods affected by climate change impacts in recent years because of rainfall variation, acid rains, rising temperature and coastal erosion (Nzeadibe *et al.*, 2011). As floods become frequent occurrence, poverty is further entrenched in the society as a result of its impacts, directly and indirectly on multiple pathways, negatively affecting the economy, social life, environment and health (Echendu, 2020).

This study is particularly focused on the coastal farming communities in low-lying tidal areas of Bayelsa State that have experienced climate manifestations in forms of increasing rainfall, increased salinity of freshwater resources, rising temperature, persistent flooding, etc. Bayelsa State by virtue of its location in the Niger Delta (a coastal region) is highly susceptible to adverse environmental changes caused by climate change. The State was one of the worst affected States of the 2012 flood disaster in Nigeria; hundreds of persons were displaced in the Southern Ijaw local government area of Bayelsa State, and this led to the disruption of social life and cultural heritage of the people (Odubo and Raimi, 2019). Considering the threats that climate change has posed to communities on the frontline such as those in coastal areas, it becomes important to foster engagements with such communities to formulate appropriate responses. The process of natural or human systems adjusting in response to actual or expected climatic stimuli or their effects is known as climate adaptation [Intergovernmental Panel on Climate Change (IPCC), 2007].

Adapting to climate change has become an urgent reality globally, for farmers whose livelihoods are directly threatened. However, how farmers adapt to climate change is notably dependent on various environmental and socio-economic factors (e.g. age, income, education, etc.) that invariably differ across the globe. Therefore, localising responses to climate change is essential (Yila and Resurreccion, 2013). To develop localised responses to climate change, it is important to be aware of what consequences farmers are already experiencing and how they are adapting to this simultaneously. This would aid identification and mainstreaming of appropriate location-specific adaptation measures into existing or new rural development policies or practices to sustain effective adaptation and maintain resilience (Pilli-Sihvola *et al.*, 2018; Rojas-Downing *et al.*, 2017). The IPCC (2022) noted that indigenous and local knowledge is important to adaptive capacity and community-led adaptation because studies have shown that local stakeholders' participation in adaptation planning and implementation improve communities' capacity to respond to climate change. It is on this background, the study uses the photovoice activity as a participatory tool whereby farmers are invited to take photos that capture the climate change impacts they are experiencing and how they are adapting to it. The tool has been used with coffee farmers in Latin America (Hochachka, 2022) and fishers in South-East Asia (Bennett and Dearden, 2013). An essential part of photovoice is the sharing of these experiences with other stakeholders to develop critical understanding of how they are affected by climate change and what adaptation strategies are already being implemented (Wang and Burris, 1997).

In the context of this study, the objective of the photovoice activity was to have farmers tell their climate impact stories through pictures among themselves and to other stakeholders from the agriculture ministry and academia. Combining the experiential and scientific knowledge of stakeholders can result in a more holistic understanding of what the impacts are of climate change for farmers and what can be done to mitigate these impacts. Hence, the study aimed to co-produce a knowledge system that ultimately can help farmers and other stakeholders make better informed decisions on climate change adaptation. It did this by:

- eliciting information on farmers' climate change knowledge, risk perception and adaptation strategies through a combined survey and participatory research; and
- facilitating participatory workshops with farmers and other stakeholders to share their climate knowledge and start co-creating a knowledge system.

Thus, this study while contributing to the literature on climate change-impacted communities, increases public support for positive actions that enhances livelihoods in coastal communities. It is also expected that stakeholders' enhanced knowledge will contribute to mainstreaming climate responses into community development plans to boost food production and improve the sustainability of livelihoods in coastal communities. This study provides data-backed evidence to relevant bodies on the need to effectively support farmers on climate change adaptation strategies. The paper is structured as follows: Section 2 presents a conceptual view, Section 3 presents the survey and participatory methodologies used. Sections 4 and 5 present the findings and discussions, respectively, while Section 6 draws on the analytical findings and synthesis of the literature to conclude.

2. Conceptualising farmers' climate change perception and adaptation

The conceptual framework of the study relates climate change awareness with climate risk perception and adaptation strategies adoption. Climate change risk perception is a process that relates to three indicators, namely, awareness, worry and preparedness (Bradford *et al.*, 2012). According to Bradford *et al.* (2012), an individual can be aware of a risk, but if the individual is not worried about the risk, then no action might be taken in preparation to prevent or mitigate possible fallouts. The degree of worry would further determine the extent or level of preparedness. Likewise, Netzel *et al.* (2021) stated that risk perception involves cognitive aspects (such as knowledge or awareness of background of the issue), experiential processing (i.e. affective evaluations and personal experience), socio-cultural factors (i.e. social norms) and socio-demographic aspects. Therefore, perception has implication for the design of adaptation interventions.

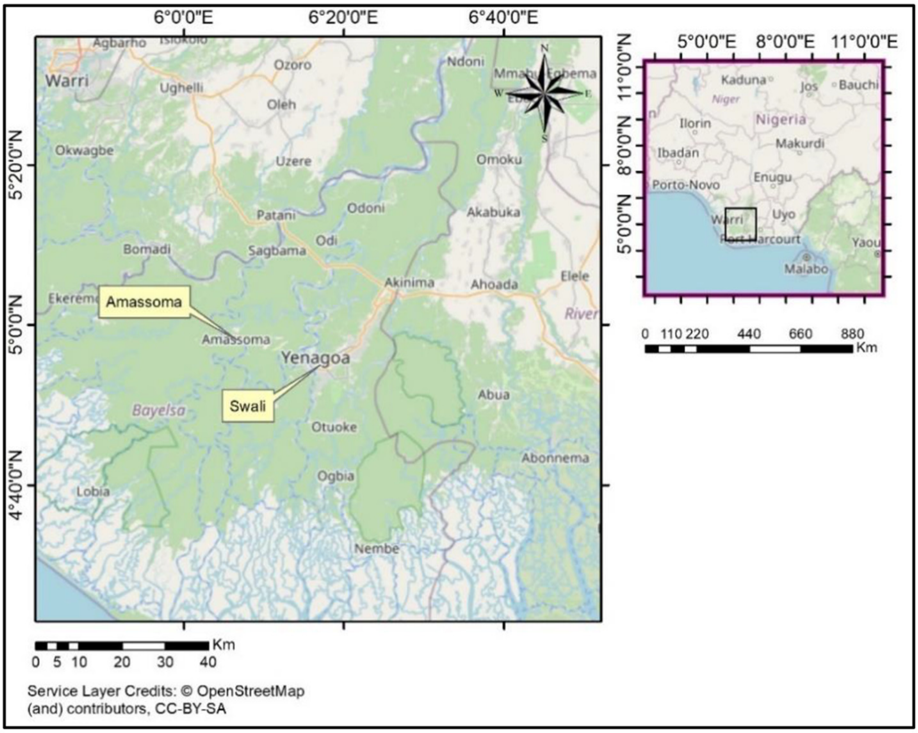
In this study, adaptation is conceptualised as a function of climate change awareness, risk perception and impacts experienced. The framework expresses that for effective adaptation, it is important for communities to be aware of climate change, its causes, impacts and the threats posed. According to Yila and Resurreccion (2013), factors influencing farmers' adaptation strategies of climate change are built on the theory of diffusion of innovations which proposes that adoption of any innovation undergoes a decision process beginning with awareness of the new practice, then perception towards the practice and, finally, the decision to adopt the practice or not. Subsequently, Yila and Resurreccion (2013) noted that climate change adaption is a two-step process that requires that farmers perceive a change in climate in the first step and then take a decision to initiate adaptation practices. Furthermore, Ofoegbu and New (2021) opined that the ability of farmers to take up adaptation strategies depended on comprehensive sharing of climate information, that is, farmers being aware of climate risk warning and risk response strategies. Agreed, adaptation as a climate change response is necessary for sustainable livelihood, but people must first recognise their personal risk to become active and take personal precautionary measures.

3. Methodology

3.1 Location and participants

This was a mixed methods study, using photovoice, participatory ranking in workshops with a quantitative survey to understand farmers' experiences with and knowledge of climate change and adaptation strategies. The study was conducted in Bayelsa State, Nigeria. Bayelsa State has its headquarters in Yenagoa (Figure 1).

The State has an estimated population of 2,386,468 million people (National Bureau of Statistics, 2018) and covers a total land area of about 21,110 km^2/10,773 km^2. The state is divided into three senatorial districts (Bayelsa East, Bayelsa West and Bayelsa central) and eight local government areas (Brass, Ekeremor, Kolokuma/Opokuma, Nembe, Ogbia, Sagbama, Southern Ijaw and Yenagoa). The major crops grown in the state include rice, cassava, maize, citrus, mango, sweet potatoes, cocoyam, oil palm, ogbono and okra. Small ruminants such as goat and sheep and non-ruminants such as swine, rabbits and poultry are also reared in the state. Farming and fishing are the major occupations of the Bayelsa State indigenes (known as Ijaws). The rural communities and indigenous



Source: Authors' illustration (2022)

Figure 1.
Map showing study area

farming communities are mostly small-scale farmers who depend mainly on rainfall for production.

The study used a multistage sampling technique to select the respondents. In the first stage, two local government areas (Southern Ijaw and Yenagoa LGA's in Bayelsa Central Senatorial District) were purposively selected, as both had communities characterised by floodplains (Akankali *et al.*, 2014). In the second stage, two coastal communities (Amassoma and Swali communities) were purposively selected, and from these, farmers were randomly invited using the list of farmers from both communities (a total of 1,625) as provided by the State' Agricultural Development Program (ADP) as the sampling frame. Accessing the farmers was made possible with the help of research assistants who were indigenes of Bayelsa State. For time and resource constraints, 40 farmers were invited to the workshops; however, given the small size of the community, words spread to other farmers and more farmers attended. A total of 67 farmers were surveyed. The sample size, though small, meets the minimum number required for quantitative survey at 90% confidence level as indicated in Jalil (2013) sample size selection.

3.2 Photovoice activity

A photovoice activity was undertaken with the farmers. In line with the photovoice activity described by Wang and Burris (1997), this process consisted of four steps:

(1) an introductory session;
(2) period of taking photos;
(3) an analysis and story-telling workshop; and
(4) a participatory workshop with the farmers and other stakeholders.

The introductory session was held in the Swali community with farmers from Amassoma travelling to the Swali. During this session, the farmers were introduced to the project and the researchers. They were handed SD cards that they were to use in their cell phones to take photos. During this workshop, farmers participated in the quantitative survey (see below) and brainstormed on what they could take photos of within the three themes of: climate change impacts – what is showing climate change impacts on their lands; climate adaptations – what are they doing in response to these impacts; and effective farming practices – what do they think are effective farming practices.

Period of taking photos – Farmers were given three months to take photos based on the aforementioned themes. A couple of weeks before the second workshop, research assistants visited the communities to collect the SD card with the photos. At this stage, it was found that majority of the farmers had not taken any photos yet. In response, the research assistants spent time with the farmers to understand their experiences of climate change and to support them in taking the photos. A total of 77 photos were taken and printed before the second workshop.

Analysis and storytelling workshop – A second workshop was again organised in Swali, with the farmers from Amassoma travelling to Swali. During the workshop, the printed photos were shared with the farmers who were then asked to form small groups to discuss their photos. Each group picked three photos that aligned with the three themes mentioned above. The SHOWED method (Wang and Burris, 1997) was used to facilitate the farmers' analysis of their photos, what they think about their experiences with climate change and adaptation and what they can tell others about it. Following the small group discussions, each group shared one of their photos and their discussions back to the big group and the researchers. Other farmers were invited to add their experiences to what the group was presenting. The workshop finished with farmers having small group discussions around future visioning of what their ideal situation would be to improve their lives, how they can get there and who can help them get there.

Stakeholders and farmers' workshop – This third workshop was attended by farmers and other stakeholders from academia, agriculture ministry and the ADP. This workshop was set up as an opportunity for the farmers to share their photos and experiences and for the academics and ADP representatives to share their knowledge on climate adaptation with the farmers so as to combine these sources of knowledge into one knowledge base on climate change adaptation strategies for coastal Bayelsa farmers. Before the workshop, the authors processed the information from the second workshop and prepared this as a short presentation at the start of the third workshop. Following the presentation, farmers were invited to share any additional thoughts they had. This also functioned as a way to validate the conclusions of the authors with the farmers to ensure that what is shared, fairly represents their perspectives. Other stakeholders shared presentations from their sides on climate change and adaptation. Furthermore, there was a participatory ranking exercise where issues related to climate change that surfaced during the second workshop were ranked by the farmers.

3.3 Survey

Following Ho *et al.* (2008), the survey questionnaire consisting of open- and close-ended questions solicited information on the demographics of the participants, risk rating, risk perception and adaptive strategies. Demographics included age, gender, household size, farming experience, annual income, education and farm land ownership. Risk rating and perception was measured using seven questions and key terms adapted from Ho *et al.* (2008) that address the characteristics of climate-related disasters on a scale of 1 (very small) to 4 (Very large). Risk perception questions included how likely were climate-related disaster events (e.g. floods, ocean surge, fire, environmental pollution and contagious diseases) to occur and to what extent were the farmers affected? While adaptation questions were about what strategies the farmers have applied to reduce the negative effects of the climate-related events (e.g. changed times of farm operations, harvested rain water, used drip irrigation, engaged in crop diversification and relocation of crop, etc.).

3.4 Analyses

Photo analysis – As is common in photovoice projects, the small group discussions served the function of analysing the photos and for the farmers to make sense of their data. The SHOWED method assisted this analysis by asking the questions of: "What do you see here? What is really happening here? How does this relate to our lives? Why does this condition or strength exist? What can we do to educate others about this condition or strength? What can we do about it?" This flow of questions helps the participants to move from a simple description of what can be seen in the photo to understanding what is happening and what can be done about the issue. The notes taken during the discussions were synthesised to produce the lists of important issues and adaptation strategies currently undertaken or desired by the farmers. These were validated with other stakeholders in the third (final) workshop.

Survey analysis – Data was analysed using descriptive and inferential statistics with the help of SPSS version 26. The principal component analysis (PCA) was applied on the climate risk perception instrument of measurement. In addition, a Poisson regression model was used to examine the determinants of farmers' adaptation strategies uptake. A Poisson model is often used for count outcomes (Taruvinga *et al.*, 2016). In addition, the Kendall's coefficient of concordance was used to test the farmers' rating of climate change disaster risk to know if they used the same standard in rating the statements (Elum and Simonyan, 2016). The null hypothesis is that there is no agreement among the farmers in their ratings. With perfect agreement, Kendall's coefficient is equal to 1; otherwise, it is equal to 0. It is computed as:

$$\text{Kendall's coefficient (W)} = \frac{12s}{m^2\ n(n^2-1)} \quad 0 \leq W \leq 1$$

where s is the sum of squared deviation of ranks for each event from the mean rank sum, m is the number of farmers and n is the number of events ranked. The significance of W is tested for with a chi-square value. Technical details are provided in the Appendix.

4. Results

4.1 Socioeconomic characteristics of the surveyed farmers

The statistical distribution of the demographics and socioeconomic characteristics of the surveyed farmers is presented in Table 1. The average age of the farmers was 47 years, mostly females and married. More than half of the farmers had just up to primary school education. On average, the farmers had been involved in farming for about 25 years, and the average household size among the farmers was made up of seven persons. The average annual income of the farmers was $1,170. Nearly all of the farmers were into crop farming practise and more than half of them planted three or more crops.

4.2 Farmers' knowledge and risk perception on climate change consequences

More than two-third of the farmers (68%) identified that they had knowledge of climate change (see Table A1 in Appendix). The majority (79%) identified it to be very likely that climate change would impact their livelihoods and that the occurrence of floods is largely a consequence of climate change. Most of the farmers (Figure A1) got information about climate change through the news media (73%) followed by those who got information from private persons (52%) who may have been relatives or non-relatives. Finally, about half of the farmers identified they got information based on their own experiences and observations (46%). The PCA analysis of the six-item perception measuring instrument that met validity standard (see notes and Tables A2 and A3 in Appendix) showed that the risk perception items were significant with high factor loadings (> 0.6) and the variables loaded under two factors that could be broadly classified just as in Ho *et al.* (2008) into two groups (impact and controllability). Furthermore, a Risk Perception Index was developed from the factor scores generated from the PCA analysis (Mavhura *et al.*, 2017) by adding the two factor loadings for each item. The Risk Perception Index scores ranging from −4.22 (least risk perception) to 1.72 (highest risk perception) were divided into three categories that ranged from 1 (low) to 3 (high) as presented in Table A4. It was observed that a higher proportion of the farmers fell in high-risk perception group. The aforementioned links to what the farmers shared with their photos, which will now be detailed.

4.3 Experienced climate change impacts

Analysis of participatory ranking of climate change impacts by farmers during the group discussions is presented in Table 2, and the rating of perceived riskiness of climate-related disasters from survey responses is represented in Figure 2. It could be inferred from both results that high temperatures and flooding were the biggest consequences of climate change

Variables	Frequency (%)
Age (years)	
19–34 years	11 (16.4)
35–50 years	32 (47.8)
51–66 years	17 (25.4)
> 66 years	7 (10.4)
Marital status	
Single	15 (22.4)
Married	52 (77.6)
Gender	
Female	50 (74.6)
Male	17 (25.4)
Education	
No formal schooling	16 (23.9)
Primary	19 (28.4)
Secondary	21 (31.3)
Tertiary	11 (16.4)
Farming experience (years)	
1–15 years	24 (35.8)
16–30 years	22 (32.8)
31–45 years	11 (16.4)
46–60 years	10 (14.9)
Household size (number of individuals)	
1–5	17 (25.4)
6–10	42 (62.7)
11–15	8 (11.9)
Annual farm income (US$)	
< 1,126	51 (76.1)
1,126 < 2,252	10 (14.9)
2,252 and above	6 (9.0)
**Farming practice*	
Crop	60 (89.6)
Livestock	4 (6.0)
Poultry	6 (9.0)
Aquaculture	14 (20.9)
Crop diversification (types of crops)	
≤ 2	23 (38.3)
≥ 3	37 (61.7)

Note: *Multiple responses recorded
Source: Authors' (2022) own creation

Table 1. Demographic characteristics of surveyed farmers ($N = 67$)

experienced by the farmers. A Kendall's Coefficient of Concordance test indicated a moderate and significant agreement among the farmers in ranking the risk events (Table A5).

Based on photovoice discussions, photos (Plate 1) illustrated the farmers' severe experiences of high temperatures leading to crops dying off and causing them to lose money on the crops. According to the farmers, extreme flooding has been happening every year since a big flood happened in the area in 2012. The land is under water for about five months of the year, and given that the water is contaminated with oil, it also contaminates the farmers' land.

Furthermore, heating of the soil, crop disease, birds and pests, inadequate rainfall and heavy winds were also identified as key consequences of climate change, and these were indicated with photos (Plate 2). Soil heating makes it hard for the crops to grow. In addition to heating of the soil by the sun, the soil retains more heat because of its contamination with the oil that enters the land as a result of flooding. The farmers also noted the health consequences from the contaminated soil, in that it impacts on their skins when they get in contact with the soil. Drought resulting from inadequate rainfalls and high temperatures was identified as a less commonly experienced issue in the survey and participatory ranking, but it was highlighted during the photovoice session as presently having severe effects on the crops. Also, crop disease, birds and pests menace were being experienced by the farmers as consequences from climate change. During the third workshop, the representatives from the academia and agriculture ministry also confirmed to the farmers

Table 2. Climate change consequences ranked by farmers following participatory exercise

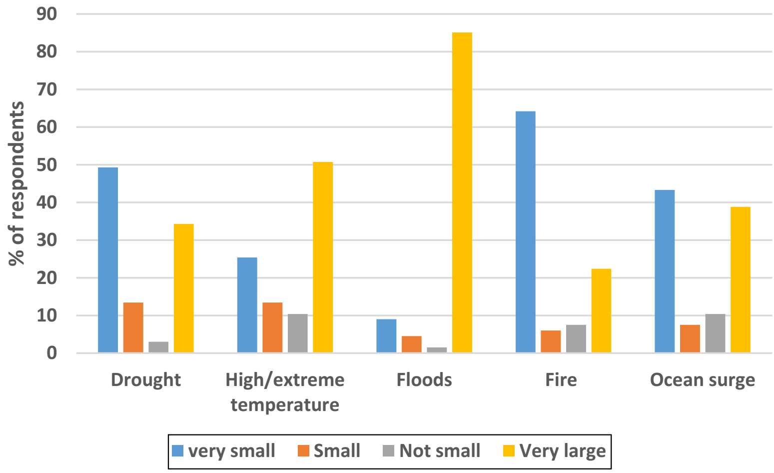
Climate change consequence	Times ranked as most pressing
High temperature	40
Flooding	7
Heating of the soil	6
Crop disease	4
Inadequate rainfalls	3
Insects	3
Birds/pests	2
Heavy winds	2
Soil pollution	1
Water pollution with oil	0

Source: Authors' (2022) own creation

Table 3. Poisson regression result of determinants of farmers' adaptation strategies

Variables	B	Standard error	Exp (B)	*p*-value
Intercept	0–763	0.696	2.144	0.273
Gender (1 = male)	−0.910	0.251	0.403	0.000***
Age	−0.007	0.007	0.993	0.286
Education (0 = no formal education)				
Primary	−0.496	0.265	0.609	0.061*
Secondary	−0.382	0.294	0.682	0.194
Tertiary	−0.125	0.349	0.882	0.720
Land ownership (1 = self-owned)	−0.456	0.170	0.634	0.007**
Household size	−0.022	0.029	0.979	0.455
Farming experience	−0.002	0.007	0.998	0.768
Annual farm income	1.288e-7	7.113e-8	1.000	0.070*
Climate risk perception (1 = low risk group)				
Moderate risk perception group	1.383	0.540	3.987	0.010***
High risk perception group	1.369	0.537	3.933	0.011**
Omnibus Test:		34.179 (0.000)***		
Likelihood Ratio Chi-square				
Pearson Chi-square (degree of freedom = 55)		63.796 (0.20)		

Note: *** $p < 0.001$, ** $p < 0.05$ and * $p < 0.10$
Source: Authors' (2022) own creation



Source: Authors' (2022) own creation

Figure 2. Level of risks expected by farmers from climate-related disasters (survey)

(a) (b) (c) (d)

Notes: From left to right – (a) Flooding – Arrow indicates a farmer showing flood marks on a wall in the community, (b) Shown here is a tree that has always been submerged in flood over the years except for the past one year; according to the farmers, its survival over time has earned it the name "tree of life". The farmers reported that the biggest flood occurred in 2012, and since then, big floods occur every year; the land is covered by water from June to November. (c) Hot temperature – High temperature is killing the maize. The maize farm is not doing good given the high temperatures. (d) The yam crop seen here is struggling to grow because of high atmospheric and soil temperature. In the farmers' words, "the crop ought to have grown more than the current state, but the problem of intense heat and drought has reduced growth". This was affecting their livelihood and causing hardship
Source: Authors' (2022) own creation

Plate 1. Photos and narratives illustrating flooding and hot temperatures

that birds were changing their migration patterns in line with changing weather patterns, and as a reflection, the birds are now arriving at the time the crops are fruiting (ripening), causing the birds to feed on them. This was affecting the farmers' output. This problem was very evident on the pepper farms.

Plate 2.
Farmers' photos and narratives of climate change impacts

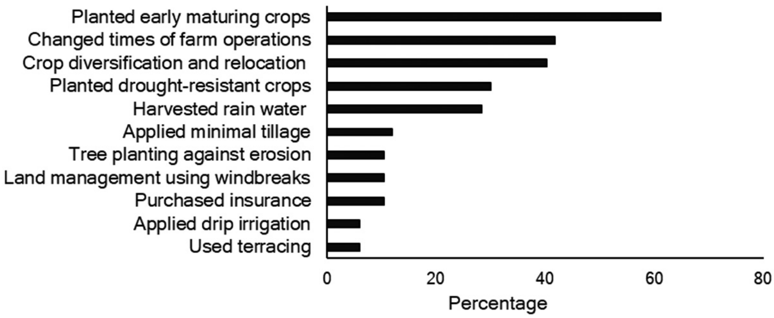
Notes: From left to right, moving clockwise – Top row: (a) Heating of the soil – "Intensive heat impact on soil. Excessive heating of the soil due to high temperatures from the sun and the oil already deposited in the soil brought about by flooding water mixed with oil from illegal oil refining activities in the terrain. Even the farmers get impacted on their skin from contacting the soils." (b) Bird and pests – "This is a pepper farm. Though the peppers are growing, the sun kills them. Also, the peppers are eaten by birds as soon as they start ripening and are sometimes eaten by ants thereby reducing their harvestable quantity and quality." Bottom row: (c) Heavy winds – Pepper farm with a fallen pepper crop. Heavy winds dislodge the crop, reducing crop yield. "Change in climate has brought about high temperature, strong winds and heavy rain fall." (d) Inadequate rainfall – "the soil is caked and the crop here is affected by lack of rain (drought). High temperature of heat affects the survival of the crops. We experience drought in this year and it has affected our livelihood and income."
Source: Authors' (2022) own creation

4.4 Farmers' adaption strategies

The survey responses to the types of strategies adopted by the farmers in dealing with the impact of climate change at farm level are presented in Figure 3. It was revealed that the most frequently adopted adaptive strategy was the planting of early maturing crops (61%) followed by changed times of farm activities (42%) and crop diversification (40%). The majority of farmers (71%) indicated that they used between 1 and 3 adaptation strategies (Figure A2).

Other adaptation strategies identified during the photovoice session as presented in photos (Plate 3) included mulching which was being done to mitigate the effect of high temperature on soil and the use of dug out pits for irrigation to increase farmers' ability to irrigate their farms and control soil heating.

In addition, other stakeholders present at the third workshop shared with the farmers, further adaptation strategies that they could implemented. These included:



Source: Authors' (2022) own creation

Figure 3. Strategies adopted by farmers in response to climate change (survey)

(a) (b) (c)

Notes: Moving from left to right – (a) Changing planting times – "A land prepared for late planting and late germination due to change in climate," (b) Mulching – "Crop farm planted with vegetable; seeds already germinated and dried grasses spread underneath the plants to retain moisture and reduce weed growth." (c) Irrigation pits – "Pit (indicated by arrow) is dug out in a farm to capture rainwater for irrigation."
Source: Authors' (2022) own creation

Plate 3. Farmers' photos of their climate adaptation strategies

- planting in bags to minimise the impacts of soil hotness and floods on the crops;
- engaging in minimal tillage;
- planting in transverse rows to control soil leaching as flood recedes;
- using extension services, including planting improved seeds provided by agriculture agencies; and
- setting up scarecrows in the farms to ward off birds.

There was a future envisioning exercise during the workshop in which the farmers were asked to identify further actions that they ideally would like to see happen, to help reduce climate change impacts on their farm or enhance their adaptation. The farmers primarily identified strategies that should be implemented or actions that should be taken to enhance farmers' access to more resources. These included:

- improved access to irrigation equipment;
- acquiring working materials and farming equipment;
- planting of improved variety crops and climate tolerant seeds and education on the use of the crops and seeds;
- increased mulching on farm land;
- increased use of fertilizers;
- control of environmental pollution;
- general government support;
- adapting planting cycles; and
- providing an accessible database for farmers with information about farming and related issues, such as weather forecasting.

During this exercise, the farmers noted unanimously that it is up to government, international donors, non-governmental organisations, the ADP and researchers to take up further climate change actions.

4.4.1 Determinants of farmers' adaptation strategies. Furthermore, the determinants of adaptations taken up by the farmers were examined with the Poisson regression analysis, and the results presented in Table 3 showed that the variables: gender, climate risk perception, land ownership and farm income were significant determinants of the number of adaptation strategies taken up by farmers. The B-coefficient for farm income indicated the expected increase in log count for a one-unit increase in annual farm income is 1.288e-7, while the expected log count for moderate risk perceived group compared to low risk perception (reference group) increases by 1.383 and the expected log count of adaptation strategies for men compared to women reduces by 0.91. For the Exp (B) values of gender (0.403), land ownership (0.634) and annual farm income (1.000), it meant 60% reduction in the number of adaptation strategies adopted by men, 37% reduction in the number of adaptation strategies adopted by farmers who own their farmlands and no change in the adoption frequency as income increases. The Omnibus test of 34.179 (0.000) was an indication that the explanatory variables were collectively statistically significant. A chi-square value of 63.796 with 55 degrees of freedom gave a p-value of 0.20 that was not statistically significant, and thus, an indication that the Poisson model fits the data reasonably well.

5. Discussion

The combined use of the survey and participatory research methods was to have a holistic evaluation of farmers' climate change awareness, risk perception and adaptations as well as co-produced recommendations. Many studies (Nguyen *et al.*, 2019; Odubo and Raimi, 2019) have adopted these mixed methods such as using both survey/key interview informants and focus group discussions as research methods. The study captured the experiences of and adaptations to climate change of farmers in the coastal areas of Nigeria. The farmers were largely female, and given their years of experience in farming, they were well-placed to discuss any changes they have observed over the past three decades. A majority of the farmers were still in their middle and actively productive years. The result agrees with studies (Anugwa and Agwu, 2018; Ochuba and Cookey, 2020) that have documented that women in Bayelsa State are more involved in food crop farming, processing and marketing of artisanal fisheries than their male counterparts; noting that historically, Ijaw men are not farmers by nature.

5.1 Farmers' knowledge, risk perception and experience of climate change consequences

The study illustrated that the farmers in coastal communities have knowledge of climate change and mostly through news media; have high perception of risk from climate change; are using adaptation strategies; and are willing to learn about and use further adaptation strategies. This is in line with the diffusion of innovation theory (Yila and Resurreccion, 2013) which offers that adoption of any innovation undergoes a decision process that includes awareness and perception. As have been proven, risk perception characteristics play a role in building social resilience models (Bradford *et al.*, 2012). It has been observed that people with low levels of personal risk perception are less likely to protect themselves, while those with higher personal risk perception are more likely to implement protection measures (Netzel *et al.*, 2021).

It is inferred from the results that farmers experienced high level of climate change impacts as have been observed with standardised surveys (Elum *et al.*, 2017; Ho *et al.*, 2008) such as high temperatures and flooding. Also, through the participatory processes using photovoice, farmers indicated more local impacts, such as heating of the soil, birds and pests menace, heavy winds and droughts. The farmers' experience of both flooding and drought highlights the extremes of weather events that are consequences of climate change (Weber, 2010). As noted by Ochuba and Cookey (2020), the most common natural/climate change-related disaster in Nigeria coastal communities is flooding (Ochuba and Cookey, 2020). However, at the time of conducting this study, farmers indicated high temperatures and drought as severe climate change consequences being experienced presently, and for them, this was a dilemma as they have been most challenged by flooding up till the last production season and have had to change their planting times, but now, the rains have not come as expected. Importantly, the farmers were also affected by the worsened environmental degradation because of contamination of the water and the soil by local oil refining activities. Socioeconomic and environmental costs of oil production can be extensive, ranging from destruction of wildlife and aquatic ecosystems, loss of biodiversity, air and water pollution and degradation of farmlands (Elum *et al.*, 2016). This study, thus, highlights the multiple sources of environmental and climate crisis that are affecting those at the frontline. It also points out that while farmers have their own agency to adapt to the climate crisis, they heavily rely on others for more effective strategies to be implemented, such as irrigation, planting improved crop varieties and reducing environmental degradation, because of their own limited financial resources. By implication, the results indicate a need to build coping and mitigating strategies to safeguard livelihoods in the community.

5.2 Adaptation strategies following participatory sessions and survey

The farmers were engaging in multiple adaptation strategies. This supports Tarfa *et al.* (2019) assertion that farmers by nature adopt multiple strategies to manage climate risks and such decisions are made simultaneously. The planting of early maturing crops at different times as an adaptation strategy by the farmers in this study was in line with the findings reported by Ullah *et al.* (2018) on farmers in Pakistan adapting to climate change. The autonomous local adaptation strategies farmers perceived as effective (e.g. mulching and irrigation) have also been identified elsewhere (Eneji *et al.*, 2020). With regard to the future envisioning exercise, the farmers not identifying themselves as actors who should take further actions to reduce climate change impacts on their livelihood is an indication of their already financially handicapped state and the inability to take on more than they were already doing.

Despite a long history of participatory research with farmers (Canon *et al.*, 2021), it is only recently that photovoice is being used as a method to capture farmers' experiences of climate change. This is one of the first studies to undertake a photovoice project with majority female farmers in West Africa. As others have identified (Ardrey *et al.*, 2021; Bennett and Dearden, 2013), using photovoice helped to integrate bottom-up perspectives and a deeper understanding of everyday experiences of farmers. Such projects show the in-depth knowledge that farmers have of climate change, and this study showed that this is largely derived from their own observations or through the media. In line with the aim of this project to combine farmers' knowledge with academic knowledge, the photos created an accessible and engaging format for the farmers to share their experiences with the visiting stakeholders, who also used the engagement as a base to share their knowledge with the farmers. Perhaps most interesting was the creation of a shared list of adaptations strategies between the farmers and other stakeholders. Future research should explore whether participating in this photovoice projects resulted in positive outcomes for the farmers and the other stakeholders, for example, whether farmers implemented the suggested adaptation strategies and whether academics integrated what they learnt from the farmers in their future work.

Participatory methods are used because they are said to benefit participants, as they centre on the participants' voices and aim to be empowering. However, they are not without critique, and this project provided an opportunity to critically reflect on the use of photovoice within this context. While photovoice was developed with rural women in China (Wang and Burris, 1997) and has been used with farmers elsewhere (Bulla and Steelman, 2016; Hochachka, 2022), this study identified challenges with undertaking photovoice project with farmers with high levels of illiteracy and lack of access to technology. Some of the farmers did not know how to use the SD cards they were provided with to save pictures and others had given them away. This implies that some groups may need more direct support with taking photos as others have done (Hochachka, 2022). In retrospect, rather than undertaking photovoice, other participatory research methods such as transects walks on the land may have been more appropriate. This, therefore, highlights the need for ongoing reflexivity on the use of participatory methods in different contexts. Furthermore, an important element of participatory research is the relationship between the researchers and the community, with an assumption that the better the relationship and trust, the more both parties benefit from the process (Snijder *et al.*, 2020; Jagosh *et al.*, 2012). However, given the one-year timeline of this study, COVID-19 and a small budget, it was hard to do due diligence to building relationships and building on previous work that may have taken place in the communities. This may have undermined the empowering potential of the participatory processes in this research.

5.3 Determinants of adaptation strategies

Result showing that being male reduced the number of adaptation strategies implemented could be explained by the notion that Ijaw men are not naturally inclined to food crop farming. With regard to education, farmers with just primary school education had less number of adaptation strategies adopted when compared to those with secondary and tertiary education. It is argued that farmers with higher levels of education are more likely to perceive climate change and adapt better (Ndambiri *et al.*, 2013). This is, they have a higher probability of taking up adaptation actions to climate change. Furthermore, the Poisson result indicated a no-change in adoption as income increases, contrary to the expectation that higher income farmers will readily adopt more strategies than their counterparts (Tarfa *et al.*, 2019). Given the positive significance of the risk perception levels, it is inferred that individuals with high perception level of climate change risk will be more willing to take up more adaptive strategies and this support the literature (Yila and Resurreccion, 2013) that risk perception is an important part of adaptation process. The result also showed that farmers who owned their land had less number of adaptation measures contrary to expectations that land ownership positively affects farmers' decision to expand and invest, with likely increase in output (Amusa *et al.*, 2011). This may be attributed to majority of the farmers being women and who often are more economically constrained than their male counterparts.

6. Conclusion

This study captured famers' climate change knowledge and adaptation practices through mixed methods of survey and participatory approach. The results of the study showed the most highly rated climate-risk events experienced in the study area were floods and high temperature. The variables: gender, risk perception, land ownership, education and income significantly influenced the adoption of climate change adaptation strategies. The study concludes that majority of the farmers are aware of climate change and are affected by climate change impacts. The experience of impacts and ability to control the impacts were identified as influencers of farmers' risk perception. Also, a majority of the farmers were categorised as having moderate-high risk perception of climate change-related risks. As noted, the farmers were/are willing to undertake adaptive strategies to cope with prevailing climate change challenges particularly with regards to high temperature and drought but lacked the means. As such, they are hoping for support from the government, international donors and non-governmental organisations. Thus, the study highlights the need to take into cognisance farmers' risk perception, to enable for adopting appropriate strategies that build their capacity to mitigate climate change impacts. This study contributes to understanding how farmers are already adapting or are willing to adapt to climate change. The results can serve as basis for informed climate adaptation policies.

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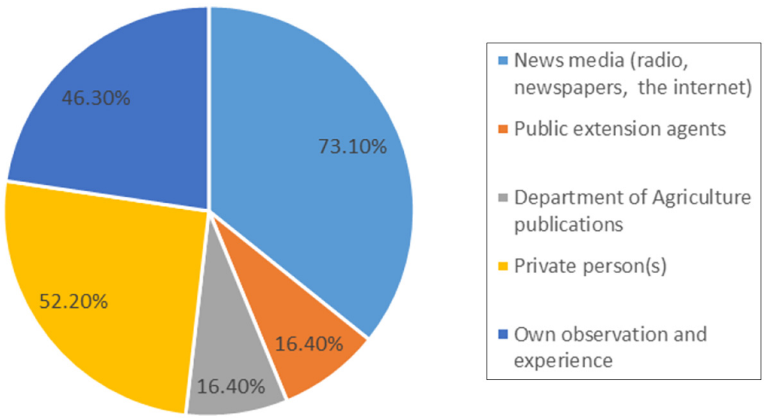
Appendix

Farmers' climate change knowledge and source of awareness

Items	Rank	Frequency (%)
How knowledgeable are you about climate change and its impacts?	1 = not knowledgeable at all	11 (16.4)
	2 = not knowledgeable	10 (14.9)
	3 = knowledgeable	36 (53.7)
	4 = very knowledgeable	10 (14.9)
How likely is it that a flood/ocean surge disaster could be as a result of climate change impacts?	1 = very small	10 (14.9)
	2 = small	4 (6.0)
	3 = not small	11 (16.4)
	4 = very large	42 (62.7)
How likely is it that climate change can have an impact on your livelihood?	1 = very small	9 (13.4)
	2 = small	5 (7.5)
	3 = not small	6 (9.0)
	4 = very large	47 (70.1)

Source: Authors' (2022) own creation

Table A1. Description of farmers' climate change knowledge



Source: Authors' (2022) own creation

Figure A1. Source of information on climate change

Validity and reliability of risk perception measurement instrument

The validity and reliability of the data were tested using the Spearman rank correlation and Cronbach's alpha, respectively. An item is considered called valid if the correlation value is greater than 0.300 (Nursalim *et al.*, 2021). An item that does not meet the validity standard is deleted and validity testing performed again. In this case, one item (do you know the mitigation actions you can clearly adopt?) indicating controllability had little or no significant correlation with the other items and as such removed. The validity test was redone, and all the remaining six items had correlation values of 0.300 and above and where significantly correlated with one another, meaning they were valid. Also, a reliability testing was done by looking at the Cronbach's alpha coefficient value which is the summary statistics that tells how reliable the survey instrument is. An instrument is said to be reliable if the Cronbach's alpha-coefficient value is ±0.60 or higher (Shaffril *et al.*, 2015). Here, the value was approximately 0.88, indicating that the instrument had a high degree of reliability and forms an internally consistent scale.

Factor analysis was applied on the remaining validated six items instrument, and the results are presented in Tables A2 and A3. First, as a minimum standard requirement, the Kaiser–Meyer–Olkin (KMO) statistical test was used to measure the sampling adequacy. A KMO value of equal or greater than 0.6 is recommended for model adequacy. In this case, the KMO value is 0.86, implying that the variables used were suitable for the PCA. Also, the Bartlett's test of sphericity was highly significant (df = 15; significance = 0.00), indicating that the PCA correlation matrix (of the items) was not an identity matrix, and the data was appropriate for a PCA analysis.

Table A2. Kaiser–Meyer–Olkin and Bartlett's test results

Kaiser–Meyer–Olkin measure of sampling adequacy		0.861
Bartlett's test of sphericity	Approximately Chi-square	257.331
	df	15
	Significance	0.000

Source: Authors' (2022) own creation

An initial PCA analysis of the six-item instrument measuring perception gave one factor loading, needing no rotation. But there was need to check and confirm this position, so a repeat of the PCA was done with specification of two factors extraction in place of using eigen values greater than 1. The direct Oblimin was used as the factors were expected to be correlated with one another. The PCA result becomes interpretable in terms of theoretical construct. It was seen that the total explained variance increased from 65.9% to 79.7%.

Table A3. Factor analysis of farmers' perception of climate change-related risk

Variables	Factor 1 (Impact)	Factor 2 (Controllability)	Communality
How likely is it that a flood/ocean surge disaster will occur in the community you live in?	*0.94*	−0.07	0.83
Are you capable of controlling the disaster to avoid a huge loss?	0.03	*0.97*	0.95
To what extent would the disaster flood/ocean surge threaten your life?	*0.96*	0–0.13	0.84
To what extent does a flood/ocean surge disaster affect the quality of your life?	*0.91*	0.02	0.84
To what extent does a flood/ocean surge affect your farming and bring you financial loss?	*0.66*	0.27	0.64
How afraid are you of the occurrence of a flood/ocean surge in your community?	*0.80*	0.08	0.68
Variance	3.95	0.83	4.78
% Variance	65.88	13.78	79.66

Notes: Extraction method: Principal component analysis; Rotation method: Oblimin with Kaiser normalisation
Source: Statements adapted from Ho *et al.* (2008)

Category	Frequency (%)	RPI score
1: Low risk perception	6 (9.0)	−4.22 to −2.24
2: Moderate risk perception	20 (29.9)	−2.25 to −0.26
3: High risk perception	41 (61.2)	−0.27 to 1.72

Source: Authors' (2022) own creation

Table A4. Description of the categorised risk perception index scores

Test of hypothesis of agreement between farmers

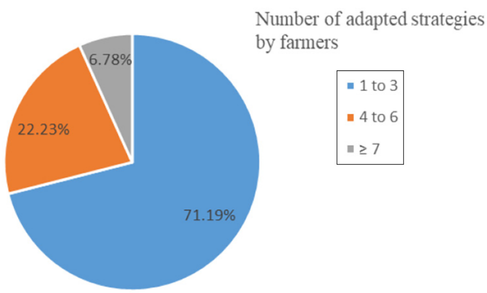
Presented in Table A5 is the Kendall's coefficient of concordance (W) which was 0.3 with a p-value $0.000 < 0.05$ with a calculated chi value of 72.48 that is greater than the chi table value of 9.5. The null hypothesis of no significant agreement among rankings is rejected, and by implication, the farmers applied the same standard in ranking the risk events.

Variable value	
Sum of rank	874
Mean sum of rank	174.8
Squared deviation of sum of rank	8.110.8
Kendall's coefficient	0.3
Chi-square	72.48 > critical value (9.5) at 5% level of significant

Source: Authors' (2022) own creation

Table A5. Test of degree of association among the rankings given by the farmers

Farmers' adaption strategies



Source: Authors' (2022) own creation

Figure A2. Frequency distribution of number of strategies adopted by farmers