



Climate change dynamics and youth participation decisions in aquatic food systems: Case of the oyster sector in The Gambia, West Africa

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ABSTRACT

Climate change adversely affects aquatic food systems, causing livelihood challenges and other socioeconomic complexities. We use the case of the oyster sector in The Gambia to explore the awareness of climate change impacts and its effect on youth participation decisions. The paper also examines how family ties to oyster activities, climate adaptation strategies, capacity development opportunities, and introductions of climate-smart innovations influence youths' decisions to engage in oyster value chain activities. We conducted focus group discussions (FGDs) with youths to explore the factors affecting their participation decisions in the oyster sector. We then used information from the FGDs to design a survey questionnaire to collect data from 312 youths through a simple random sampling technique. Through the probit model, the results show that awareness and training opportunities on climate change, discussions about climate change with family members, training on oyster management, awareness on the use of climate-smart tools, decisions to stay or leave the oyster harvesting community, family ties to oyster harvesting, and awareness of climate change adaptation strategies, positively influenced youths' decisions to succeed in oyster activities. The educational level and climate-related stressors negatively influenced youths' succession decisions. This paper contributes to the existing literature on the need to improve the human capital of youths through relevant skills and capacity-building opportunities to encourage their participation in aquatic food systems. The study suggests that the successful engagement of youths in the oyster sector requires an enabling environment supporting the recruitment and retention of youths despite the challenges of climate change.

1. Introduction

Aquatic food systems support the economic livelihoods and social wellbeing of millions of people in coastal communities [1,2]. Aquatic foods also contribute to meeting the growing demand for nutritious food across the globe [3,4]. In developing countries, aquatic foods are a rich source of essential protein and micronutrients for children and adults [5,6]. However, climate-related stressors are affecting aquatic food systems, especially those in developing countries that are even more vulnerable and less resilient to the impacts of systemic and emerging shocks [7–9]. Moreover, there are projections that by 2050 fish production will decrease significantly due to climate change impacts [10,11].

The increased vulnerabilities of resource-poor small-scale fishing communities to climatic stressors directly affect their livelihoods and

sustainability [12–15]. Most developing countries' small-scale aquatic food system actors are unprepared to respond to climate change [16,8,17], including the ability to deal with the challenges and pressures of new shocks.

The continuous report on the reduction in fish catch and income generated from participation in aquatic food systems due to climate change influences the participation of small-scale actors in fishing-related activities [18]. Nevertheless, people are understanding and responding innovatively, to harness aquatic food system's resilience through various climate-smart approaches [19,20], and there is a growing trend of youth engagement in climate change adaptation strategies [21].

Climate change remains a global challenge and concern that needs to be addressed through increased awareness and participation, especially among youths [22–24]. Climate change impacts have been reported to

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intersect with the social and economic wellbeing of youths [21]. Youths have a role in climate change adaptation and mitigation, considering the immense pressure and uncertainty about their future [25]. Youth awareness and knowledge of climate change implications are crucial to enable them to develop the capacity and skills to better manage and respond to future climate and non-climate stressors [26]. However, there is a growing need for more understanding and awareness of climate change impacts among youths [21,27,23]. A more sustainable climate change action would be one where youths engage and participate in the science and policy processes.

In this study, we report how improvement in agency among youths through climate change awareness, climate-smart innovations, and capacity development opportunities are important in promoting youth succession decisions and participation in the oyster sector in The Gambia. Although youth unemployment levels are high in Sub-Saharan Africa, climate change concerns are causing parents to discourage their children from engaging in fishing-related activities. The current climate in The Gambia suggests an increase in the severity and frequency of extreme climatic stressors [28,29]. Annual temperature changes increased by 1.0 °C from 1960 to 2020, at a mean rate of 0.21 °C per decade. Rainfall decreased significantly between 1960 and 2006, at a mean rate of 8.8 mm per month per decade [30]. In the Gambia, dependency on wetland resources has increased significantly over the past decades and significantly contributed to the country's Gross Domestic Product (12 %) [31]. However, The Gambia is one of the Sub-Saharan African countries severely impacted by climate change stressors, with an estimated coastline erosion of about 1–2 m per year [29]. According to a baseline study in four regions in the Gambia, about 82.4 % of households surveyed in The Gambia were affected by at least one climate change crisis in the past five years, thus, confirming the risk profile of the country to climatic stressors [28,29].

In The Gambia, aquaculture production and productivity, including oysters, have declined from 35 metric tons in 2017 to 33 metric tons in 2020 [32]. Oyster is one of the most important aquatic foods in The Gambia, significantly contributing to food and nutrition security. Oysters are also very common and the cheapest source of animal protein in The Gambia [33,34]. Although a high value is placed on oysters, oyster catches, income generation, and employment in the sector continue to decline [35,36]. As reported elsewhere, there is a growing and urgent need to understand how and where climate change stressors affect the livelihoods of small-scale fishing actors [17,37], including aspects of succession and continuity in the fish supply chain. Along these lines, this study examines how climate change awareness, capacity development opportunities, family ties, and awareness of climate-smart innovations could influence youths' succession and participation decisions in the oyster sector in The Gambia. The specific objectives of the study are: (a) to explore family opinion about youth participating in the oyster value chain and (b) to investigate how sociodemographic factors, climate change stressors, awareness of climate-smart innovations, climate change awareness, and climate change adaptations strategies influences youths' succession decisions in the oyster sector The Gambia.

2. Contextualization of the study

Acquiring adequate skills and knowledge is central to maximizing people's potential in everyday livelihood activities. Broadly, the concept of human capital development has been an important component and driver in development-oriented projects in the Global South [38]. Human capital encompasses the different skills and knowledge people acquire through formal or informal education, lived experiences, and training [39]. As myriad climatic and non-climatic changes continue to unfold across different geographical locales, creating an environment for people to have the necessary skills and capabilities to understand the changes around them is crucial. Moreover, capacity-building opportunities are also central to how people learn, prepare, and respond to change [40]. That being said, many studies have been carried out to

better characterize and understand the threats and underlying challenges of climate change stressors within capture and aquatic food systems [41,7,16,42,8]. However, few studies have been dedicated to understanding how these climatic stressors influence the participation of youths in fisheries-related activities [43–47].

Youths' engagement in small-scale fisheries remains understudied [48–53]. For example, in examining youths' attitudes towards participating in fishing in the future in the United States, Coleman et al. [48] found that youths were highly uncertain about their future engagement in fishing. Also, Lowe et al. [50] suggested that youths should seek career paths in higher education rather than pursuing career opportunities in the declining fisheries sector. Palmer and Sinclair's [51] study on youths in the Northern Peninsula of Newfoundland reported that many were not interested in engaging in fisheries-related careers in their communities and were moving out of the fishing communities for better employment opportunities.

Relatedly, few studies have teased out the role of climate-smart innovations and the opportunities they present in ensuring secure and sustainable future fish productivity and catches [19,54–58]. For instance, Okeke-Ogbuafor et al. [58] found that climate-smart innovations, like weather information, are vital to promoting sustainable fishing. The FAO [56] report highlights that climate-smart innovations could improve sustainable fisheries production and support resilient aquatic food systems. Munguti et al. [57] and Ahmed and Solomon [19] reported that climate-smart adaptation and mitigation strategies would help to improve the resilience of fish food systems to the impacts of climate change. However, none of these previous studies addressed the role of climate change awareness, innovations, and capacity development in influencing youths' succession decisions in developing countries such as The Gambia. Therefore, in this study, we hypothesize that human capital development via agency and knowledge of climate change impacts on aquatic food systems and training opportunities in various response strategies is needed to encourage youth participation and sustainability of the fisheries sector in The Gambia.

3. Methodology

3.1. Survey sites and sampling methods

The Gambia is one of the smallest land countries in Africa, with a population of about 2.6 million people [32]. The Gambia is particularly rich in different fish species [59], with a coastline of approximately 80 km long, 25 km lying within the mouth of the River Gambia, and 55 km facing the Atlantic Ocean [33]. The River Gambia is a key fishing area for oyster harvesters [59]. Over 2400 small-scale fish actors, primarily women, are involved in the oyster value chain [35]. The oyster sector provides households with a reasonable economic safety net [60].

In this study, we collected data from participants who identified to come from 16 different oyster harvesting communities in the Greater Banjul area in The Gambia (See Fig. 1). These communities are known to be the principal oyster harvesting areas with a large population of oyster harvesters.

The data was collected in two phases. First, 12 focus group discussions (FGDs) were conducted with youths from the oyster communities to explore the different challenges affecting youths' participation in the oyster sector in The Gambia. The youths were randomly selected and reported to come from 16 oyster communities. The FGDs helped strengthen the development of an in-person field survey questionnaire. As a second step, a simple random sampling procedure was used to target youths for our survey. Youths whose families have been engaged in oyster harvesting were approached at the oyster harvesting/processing sites and their homes for interviews between January and March 2022. According to the African Union and CGIAR, youths are those aged between 18 and 35 years [61], while the United Nations categorizes youths are those between the ages of 15–24 years [24]. Thus, given that youth is considered a stage of life that varies within the context [49], this

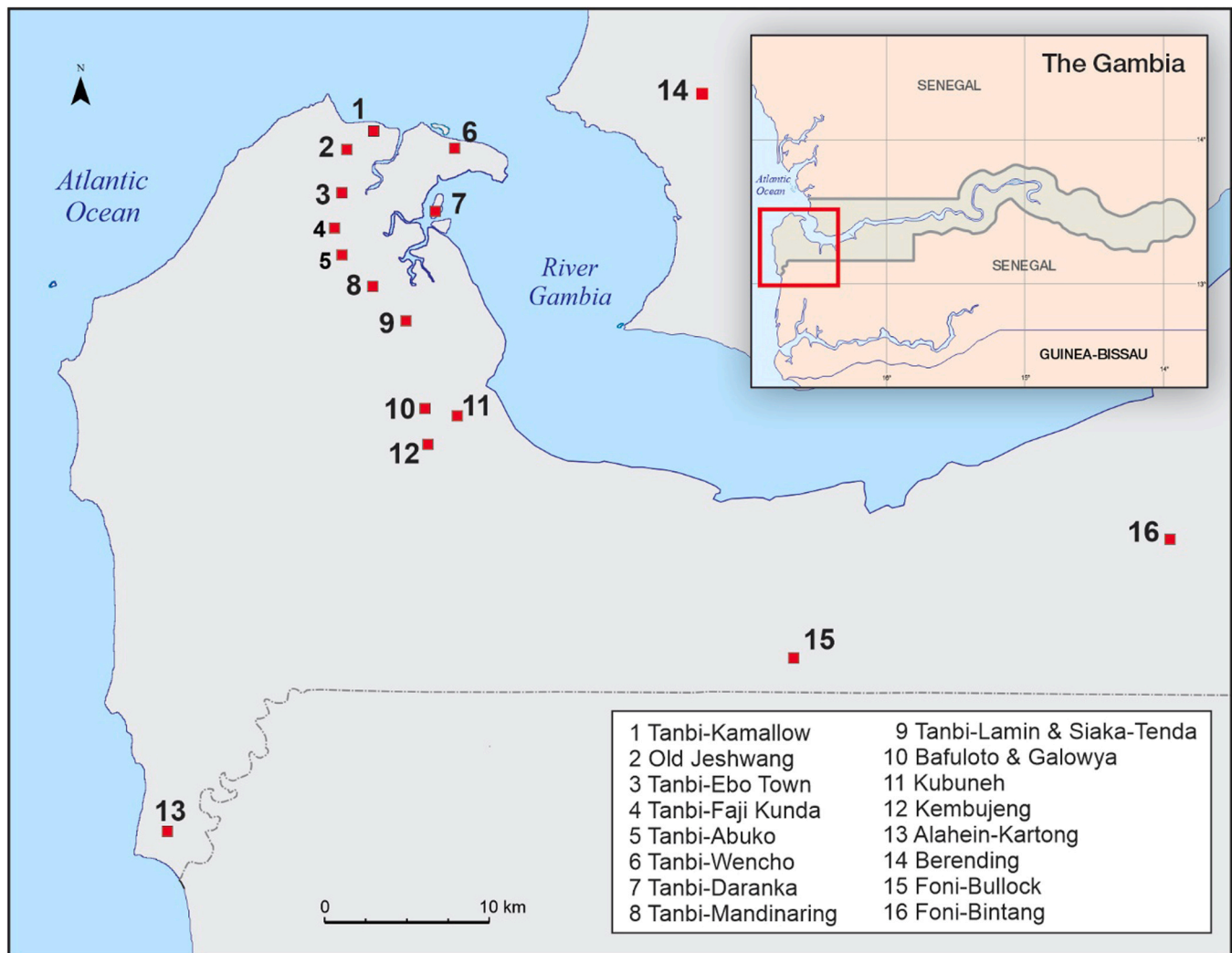


Fig. 1. Map of study area.

study considered people between the ages of 15–35 as youths. Approximately 20 youths from each oyster community were surveyed, with a total of 312 completed questionnaires that were valid for investigation. The questionnaires contained information on sociodemographic factors, youths' succession decisions, climate-smart innovations, family ties, and climate change indicators affecting oyster-related activities in The Gambia.

3.2. Measurement of variables

The variables explored in the study are presented in Table 1. Here, we define a potential successor as a youth willing to succeed their parents and continue participation in oyster-related activities. In The Gambia, oyster harvesting is carried out by females, and all the potential successors randomly surveyed are female, indicating that the sector is female-dominated.

3.3. Empirical framework

Descriptive statistics were carried out with Excel software, while econometric modeling was computed with STATA 15 software. The probit model was used to explore factors hindering/promoting youths' succession decisions in the oyster sector in The Gambia. The probit model is suitable to investigate the likelihood that youths will succeed

their parents or not succeed their parents in the oyster sector in the Gambia. The probit model was chosen since it is more sensitive to outliers, and its approach to interpreting its coefficients fits our study context [62].

The probit model for potential successors' decisions to succeed or not to succeed their mothers in the oyster sector in The Gambia is expressed as:

$$Y_i^* = \beta_i X_i + \varepsilon_i \quad (1)$$

$$Y_i = \begin{cases} 1, & \text{if } Y_i^* > 0 \\ 0, & \text{if } Y_i^* < 0 \end{cases} \quad (2)$$

where Y_i represents the i th potential successors' decision to succeed or not to succeed mother in oyster harvesting activities, X_i is a vector of independent variables that may affect the potential successors' succession decisions, β_i refers to the coefficients of the independent variables, and ε_i is the error term.

The probability that a potential successor i succeed the mother in oyster harvesting activities ($Y_i = 1$) is given by:

$$\begin{aligned} \Pr[Y_i = 1] &= \Pr[Y_i^* > 0] \\ &= \Pr[\beta_i X_i + \varepsilon_i > 0] \end{aligned} \quad (3)$$

Table 1
Description of variables.

Variable	Description	Unit of measurement
Sociodemographic factors		
Potential successors' decisions	Potential successors' decision to succeed or not to succeed mother in oyster harvesting	1 = succeed; 0 = otherwise
Marital status	Marital status of potential successor	1 = if married; 0 = if otherwise
Age	Age of potential successor	Years
Household size	Number of household members	Numbers
Experience	Years of experience of potential successor	Numbers
Education	Years of schooling of potential successor	Numbers
Stay	Potential successor desire to stay in the oyster community in the future	1 = if yes; 0 = if otherwise
Oyster specific factors		
Training on oyster management	Potential successors have followed mother to attend training on oyster management	1 = if yes; 0 = if otherwise
Training on value addition	Capacity, training, and equipment on value addition influence succession decisions	1 = if yes; 0 = if otherwise
Family ties to fishing	Fishing has influenced youths' succession decisions - intergenerational from mother-to-daughter	1 = if yes; 0 = if otherwise
Climatic variables		
Rainfall	Perception of increasing rainfall	1 = if increasing; 0 = if otherwise
Temperature	Perception of increasing temperatures	1 = if increasing; 0 = if otherwise
Training on climate change awareness	Attended training, conference, or seminar on climate change awareness	1 = if yes; 0 = if otherwise
Outreach on climate change	Participated in community outreach, talks or sensitization programs on climate	1 = if yes; 0 = if otherwise
Discuss about climate	Discussed climate change with family members or friends	1 = if yes; 0 = if otherwise
Climate-smart innovations		
Smartphone and internet	Awareness of the use of smartphone mobile apps and the internet to monitor daily weather information	1 = if yes; 0 = if otherwise
Climate change mitigation variable		
Adaptation	Aware of climate change adaptation strategies	1 = if yes; 0 = if otherwise

$$= 1 - \Pr[\varepsilon_i \leq -\beta_i X_i]$$

$$= F[\beta_i X_i]$$

$$= \int_{-\infty}^{\beta_i X_i} \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{z^2}{2}\right) dz$$

where Pr is the probability that the i^{th} potential successor is willing to succeed and 0 otherwise, Z is the standard normal distribution [$Z \sim N(0, \sigma^2)$], and $F(\beta_i X_i)$ is the cumulative distribution function.

Contextualizing the model specification to fit our study as specified in Eq. (4):

$$Y_{ij} = \beta_{ij} + \beta_1 age_{ij} + \beta_2 hsize_{ij} + \beta_3 edu_{ij} + \beta_4 mar_{ij} + \beta_5 train_{ij} + \beta_6 stay_{ij} + \beta_7 rain_{ij} + \beta_8 famt_{ij} + \beta_9 temp_{ij} + \beta_{10} trainc_{ij} + \beta_{11} outr_{ij} + \beta_{11} disc_{ij} + \beta_{11} smartp_{ij} + \beta_{11} adapt_{ij} + \beta_{11} trainv_{ij} + \mu_{ij} \quad (4)$$

where *age* is the age of the potential successor, *hsize* is the household size, *edu* is education, *mar* is the marital status, *train* is training on oyster management, *stay* is stay in the oyster community, *rain* is the rainfall, *famt* is family ties to fishing, *temp* is the temperature change, *trainc* is training on climate change awareness, *outr* is outreach on climate change, *disc* is discussed about climate change, *smartp* is awareness of the use of climate-smart innovations, *adapt* is awareness of climate change adaptation strategies, *trainv* is training on value addition. Beta (β_i 's) are the parameters to be computed, and μ_i is the error term.

4. Results

4.1. Sociodemographic characteristics of oyster harvesting households

The households' social and demographic factors are presented in Table 2. Most of the respondents are locals from The Gambia (97.1 %). About 11.5 % of the respondents are married. Nearly 90.4 % of the potential successors' parents belong to oyster associations, and about 51.9 % of the potential successors have followed their mothers to attend training on oyster management. The mean age of the potential successor

is about 19 years, while their average number of years of schooling is approximately 8 years. The average years of experience in oyster harvesting for current potential successors engaged in oyster harvesting is about 4 years. About 65.4 % of the potential successors do not desire to succeed their mothers in oyster activities due to declining fish catches and income from oyster-related activities caused by worsening climate change impacts, with just 34.6 % willing to succeed their mothers in oyster activities.

Table 2
Household socioeconomic variables.

Variable	Measure	Percentage
Categorical variables		
Origin	Gambian	97.1
	Migrant	2.9
Marital status	Married	11.5
	Not married	88.5
Mother of the potential successor belongs to a fishing association	Yes	90.4
	No	9.6
Potential successor followed mother to attend training on oyster management	Yes	51.9
	No	48.1
Youth willing to fully succeed mother in the oyster activities	Yes	34.6
	No	65.4
Continuous variables		
Variable	Mean	Standard deviation
Age of potential successor	18.91	3.20
Household size	7.59	2.84
Education of potential successor	8.01	2.65
Number of years of experience of potential successor	4.13	4.68

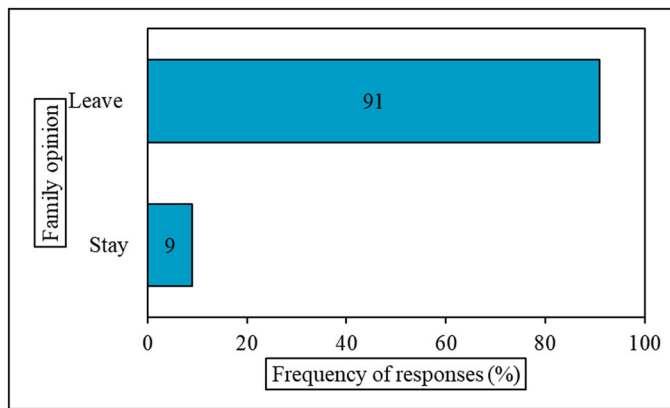


Fig. 2. Family opinion about succession in oyster activities due to climate change impacts and declining oyster catches.

4.2. Family opinion about succession and potential successors' willingness to succeed or not to succeed their mother in oyster activities

4.2.1. Family opinion about succession in oyster activities

Family members' opinion regarding succession in the oyster sector is presented in Fig. 2. Potential successors were asked if climate change impacts and declining oyster catches influenced the opinions of their mothers, who are currently engaged in oyster harvesting, and other family members not to encourage them to stay in the oyster sector in The Gambia. Based on the responses of the potential successors, most of the current women oyster harvesters and family members (almost 91 %) do not wish their children or siblings to engage or continue in oyster harvesting due to the impact of climate change, including declining oyster catches and income from oyster-related activities.

4.2.2. Willingness and opinions of potential successors to stay or leave the oyster communities

The perceptions of the potential successors regarding their desire to stay or leave the oyster communities in the future (Fig. 3) were explored. Their opinions on staying in the community (Fig. 4) were also examined. Approximately 42 % of the potential successors surveyed are willing to stay in the community in the future, while almost 58 % are not willing to stay. Based on the 42 % of respondents who are willing to stay in the oyster community, 46 %, 22 %, 17 %, 11 %, and 4 % are happy living in the oyster community, sees the community as a good place to raise a family, thinks the future looks good for people who stay in this community, thinks livelihood sustenance is cheap in this community, and loves oyster harvesting, respectively.

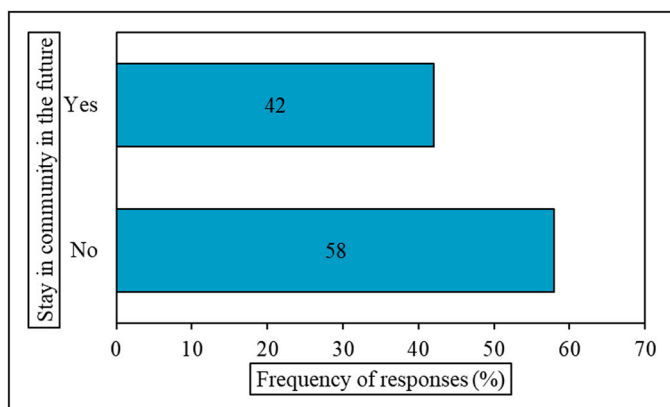


Fig. 3. Potential successors who desire to leave or stay in the oyster communities in the future.

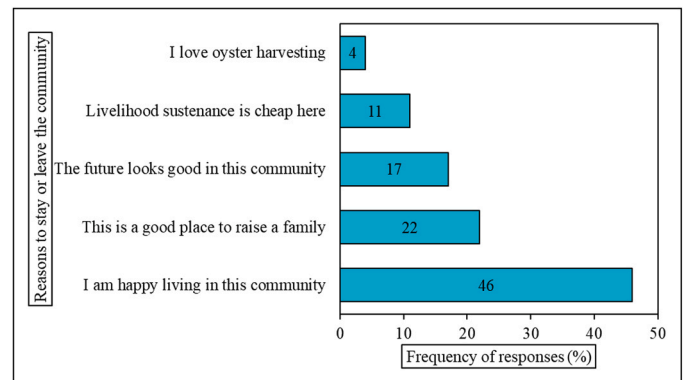


Fig. 4. Opinion of potential successors about staying in the oyster communities in the future.

4.2.3. Opinions of current potential successors and prospects of succeeding in oyster activities

We explore the opinions of potential successors on why they or other youths might not want to succeed their mothers in oyster activities (Fig. 5). The respondents ranked better alternative income sources (30 %) as the most important factor influencing their decisions to move out of the oyster sector. Declining oyster catches and sizes, not interested in oyster harvesting in the future, declining income from oyster sales, and worsening climate change affecting the growth and productivity of oysters have percentages of 22 %, 20 %, 15 %, and 13 %, respectively.

4.2.4. Potential successors' last oyster harvesting experiences

Fig. 6 shows the last harvesting experiences of potential successors currently engaged in oyster harvesting, despite seeking alternative employment in other sectors. Nearly 28 % of the potential successors were not satisfied with the quantity and sizes of oysters harvested, while just 4 % were very satisfied. Most of the harvesters were moderately satisfied (68 %).

4.3. Climate change impacts and climate change adaptation awareness

4.3.1. Potential successors' views and experiences of the impact of climate change on oyster availability

With the escalating climate change stressors in the oyster communities, we assessed potential successors' views and experiences of the impact of climate change on the growth and availability of oysters in the future (Fig. 7). About 40 % of the respondents considered climate change impacts very risky to the future growth and availability of oysters. Nearly 59 % and 1 % of the respondents consider the oyster sector

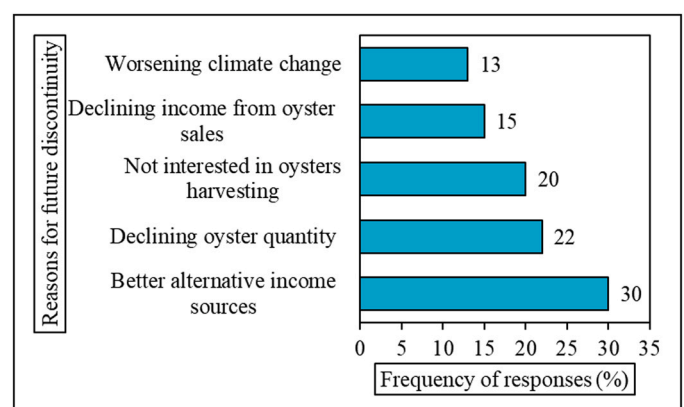


Fig. 5. Potential successors' reasons for not being willing to participate in oyster activities.

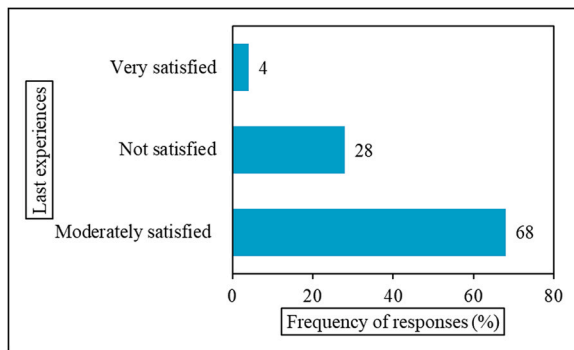


Fig. 6. Potential successors' last oyster harvesting experiences.

to be a moderately risky and not risky sector, respectively, in the future due to the impacts of climate change stresses.

4.3.2. Climate change adaptation awareness

The study explored the most prevalent climate change adaptation strategies that potential successors are aware of identified from the FGDs (Fig. 8). The most common adaptation strategy that potential successors are aware of is planting new mangrove trees (42 %). The second most prevalent adaptation strategy they are aware of is avoiding the cutting down of mangrove trees and the root of mangrove trees (40 %). About 18 % of the respondents are aware of reducing human-induced water erosion.

4.4. Econometric results

The implications of socioeconomic and demographic factors, awareness of climate-smart innovations, capacity-building, family ties, climate change impacts, and climate change adaptation strategies on the succession decisions of potential successors in the oyster sector in The Gambia were assessed, and the results are presented in Table 3. The chi-square value of 114.6 from the diagnostic test is statistically significant at the 1 % level, indicating that the predictors' regression coefficients differ from zero. McFadden's pseudo-R-squared value is 0.3, indicating that the predictors explain about 30 % of the variations in the succession decisions of potential successors in the oyster sector in The Gambia. However, scholars advise that caution be taken in interpreting the pseudo-R-squared value in probit models. Thus, the probit model was appropriate for data analysis, and the fitted model performed reasonably well in predicting youths' succession decisions in The Gambia's oyster sector.

The probit regression analysis shows that most variables and their coefficients significantly contributed to explaining the potential successors' willingness to succeed or not to succeed their mothers in the oyster sector in The Gambia. Years of schooling of the potential successors, perception of increasing temperature, and perception of increasing rainfall negatively influenced their decisions to succeed their parents in the oyster sector in The Gambia. Our findings align with previous studies by Caracciolo [63] and Haugen et al. [64] in Oregon's fishing communities, who found that climate change stressors resulted in aging fishermen and a decline in interest from young people to participate in the sector. Also, potential successors' desire to stay in the oyster community in the future, the potential successors have followed their mother to participate in training on oyster management, and family ties to oyster harvesting positively influenced their decisions to succeed their mothers in oyster harvesting. Compared to previous findings, Coleman et al. [48] also showed that family ties to fishing and fishing experience influenced youths' participation decisions in fishing.

Potential successors who attended conferences, seminars or training on climate change awareness, participated in community outreach on climate change, discussed climate change with family or friends, and were aware of climate change adaptation strategies positively influenced their decisions to succeed their mothers in oyster harvesting. Our results also support the findings of Pickering et al. [65], Mugambiwa and Dzomonda [26], Frick et al. [66], Miler and Sladek [67], and Suh and Molua [68], who reported that awareness of climate change impacts and adoption of climate adaptation strategies influences people's behavior. Similarly, potential successors' awareness of the use of smartphone mobile apps and the internet to monitor weather information positively influenced their decisions to succeed their mothers in oyster harvesting. Similarly, previous studies by Calderwood [69] found that mobile smartphone applications can help improve sustainable fisheries production, and youths are crucial to adopting smartphone mobile apps in sustainable fisheries management [70]. On the contrary, the coefficients of the age of the potential successor, marital status of potential successors, and training on value addition are not statistically significant in explaining succession decisions.

5. Discussion

In this section, we discussed the implications of the effects of climate-related stressors, combined with related social and cultural factors, on youths' succession decisions and participation in the oyster sector in The Gambia. Here, we outline our discussion in two folds: (1) the implication of climate-related stressors, awareness of climate-smart innovations, and climate adaptation strategies on youth succession decisions, and (2)

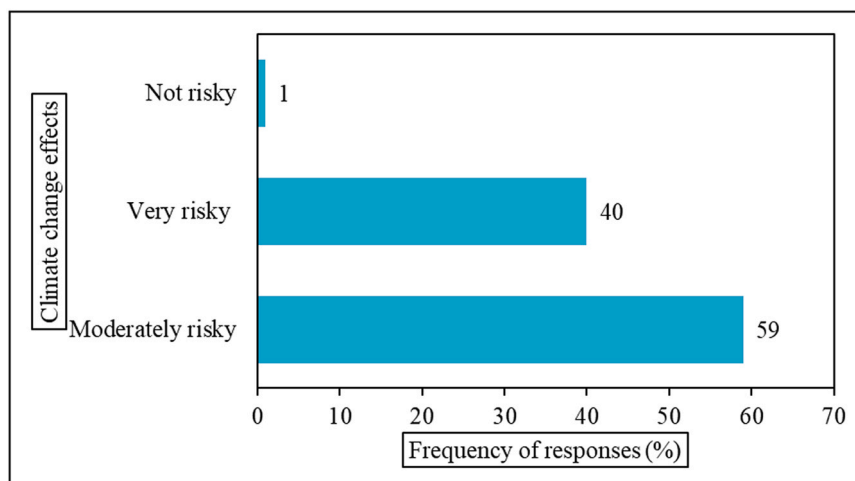


Fig. 7. Potential successors' views and experiences of the impact of climate change on future oyster availability.

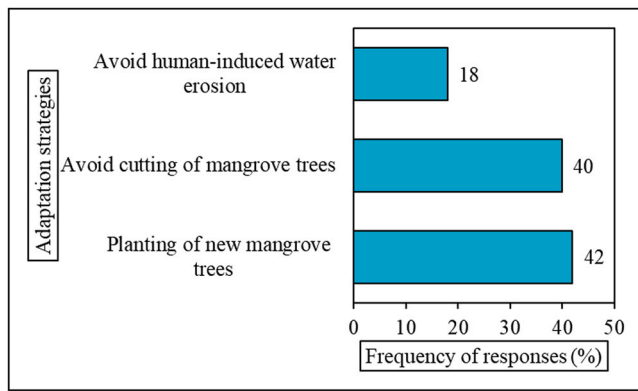


Fig. 8. Potential successors' awareness of climate change adaptation strategies.

the social and cultural factors influencing youth succession in oyster activities.

First, climate variabilities, such as changing weather and rainfall patterns, directly influence youths' decisions not to engage in oyster activities in The Gambia. In The Gambia, the probability of youths' decisions to succeed their parents reportedly decreases as fluctuations in rainfall continue to increase. According to the youths engaged in oyster-related activities, heavy rainfall adversely affects production, productivity, and livelihoods. This is similar to Ian [71], who reported that heavy rainfall patterns adversely reduced oyster availability in the United States. Moreover, youths' perception of increasing temperature negatively influenced their decisions to succeed their parents. As increasing uncertainties in temperature change are becoming frequent in The Gambia, there is increased risk in oyster productivity and sustainability. Increased temperatures are reported to have contributed to increased water salinity, altering oysters' natural habitat to thrive and flourish. Our finding on the impact of increased temperature on oyster productivity in The Gambia confirms the report of the World Fish Center [17], which highlights that higher temperatures might reduce aquatic food availability through alterations in water quality, bringing new predators and pathogens and reducing the abundance of natural food resources available to aquatic species.

The study established that nearly 40 % of the potential successors considered climate change impacts detrimental to the growth and availability of oysters in the future; thus, increasingly, the oyster sector is considered a nonviable activity for supporting livelihood and social wellbeing. Moreover, the increasing uncertainties in weather patterns are detrimental to the growth and survival of oysters, coupled with declining oyster productivity, thus, forcing many potential successors out of the oyster sector in The Gambia. The declining oyster catches reported by youths corroborates with the World Bank [32] report, highlighting that aquaculture production in The Gambia, including oyster catches, declined from 35 metric tons in 2017 to 33 metric tons in 2020.

Although potential successors' awareness of climate change adaptation strategies was positive and statistically significant, the strategies they are aware of are limited to mangrove tree restoration and water erosion reduction. Such limitation calls for more capacity-building and knowledge-sharing opportunities on different adaptation strategies. According to Knut et al. [29], continually raising awareness of climate change stressors in The Gambia is crucial to contribute to mitigating climate change impacts. Denton et al.'s [72] study also found that increased awareness of climate change risk and adaptation strategies is crucial for sustainable climate-resilient pathways. Information and awareness of climate change, in whatever form it comes, shape youths' sense of efficacy and agency to persuade changes within their communities. Indeed, some studies [65,66] have reported that knowledge and awareness of climate change correlate with improving adaptation strategies and intentions to engage in environmentally friendly climate

change adaptation interventions.

Further, participation in any form of training, seminar or conference on climate change awareness was statistically significant with a positive coefficient. Potential successors who had participated in any form of training, seminar or conference on climate change awareness were more likely to influence their decisions to succeed their parents. This is because climate change awareness programs educate potential successors on the impacts of climate change stressors and their role in helping promote climate-resilient food systems. The findings corroborate the studies of Mugambiwa and Dzomonda [26], who noted that knowledge and awareness of youths on climate change are crucial to equip youths with the capacity and skills to respond and better manage future climate change impacts.

We also found that discussing climate change with family members and friends was positively associated with potential successors' decisions to succeed their parents in the oyster sector in The Gambia. Moreover, potential successors' willingness to succeed their parents in oyster activities was positively and significantly associated with those who participated in community outreach, talks or sensitization programs on climate change. Thus, potential successors who participated in any outreach programs on climate change are more likely to influence their decisions to succeed their parents.

Finally, potential successors who were aware of the use of smart-phone mobile apps and the internet to get weather information

Table 3

Fitted model for factors influencing potential successors' willingness to succeed in the oyster sector in The Gambia.

Variables	Coefficient
Socio-economic variables	
Age of potential successor	-0.01 (0.03)
Education	-0.07* (0.04)
Marital status	-0.35 (0.29)
Stay in the community in the future	0.69*** (0.18)
Oyster specific variables	
Training on oyster management	0.34* (0.19)
Training on value addition	0.00 (0.21)
Family ties to fishing	0.42** (0.20)
Climate change variables	
Increasing rainfall	-0.62** (0.28)
Increasing temperature	-0.73*** (0.15)
Training, conference, or seminar on climate change awareness	0.74*** (0.20)
Participated in outreach on climate change	0.52*** (0.22)
Discussed climate change with family or friends	0.65*** (0.26)
Climate-smart innovations	
Awareness of the use of smartphones to monitor weather information	0.69*** (0.21)
Climate change mitigation variable	
Aware of climate change adaptation strategies	0.81** (0.31)
Intercept	1.26 (1.24)
Diagnostic statistics	
Log likelihood value	-143.97
Chi-square	114.56
Number of observations	312
Prob > chi ²	0.00
Pseudo R ²	0.29

Note: ***p < 0.01, **p < 0.05, *p < 0.1 and Robust standard errors in parentheses.

positively and significantly influenced their decisions to succeed their mothers in the oyster sector. This reveals that potential successors who are aware of the use of the internet and smartphone mobile apps to monitor weather information are likely to be more knowledgeable about climate variations and climate change and are more likely to succeed their parents in oyster harvesting activities. Arulingam et al. [70] reported that youths are highly adaptive to new knowledge and technological advancements; thus, introducing and integrating climate-smart technologies is crucial to make the wild-caught aquaculture sector in The Gambia more attractive to youths. Relatedly, Calderwood [69] studied the use of mobile smartphone applications in capture fisheries and found that smartphone mobile apps can help provide timely information on climate variability and can also be used to improve sustainable fishing practices.

Second, sociocultural factors influence youth succession decisions. The historical intergenerational family ties with oyster activities were positive and statistically significant. The more the intergenerational family ties to oyster harvesting, the more likely the decision of potential successors to succeed their mothers in oyster activities. However, nearly 91 % of current women oyster harvesters and other family members do not wish that any of their household members should participate or continue in oyster activities due to climate change impacts and declining oyster catches, even though oyster harvesting has long been a way of life in this community, characterized by generational renewal. Our results present new findings contrary to an earlier UNDP [36] report, which found that women oyster harvesters engaged in oyster activity because their mothers and grandmothers were also oyster harvesters, indicating a strong commitment to generational inheritance. The study reveals that the growing threat of climate change stressors and its impact on reducing income from oyster sales is forcing women oyster harvesters and other household members not to encourage their children to engage in oyster activities. Thus, it is evident that youth succession in the oyster sector is at threat even at the level of household decision-making. The findings substantiate Coleman et al.'s [48] work, which found that family ties in commercial fishing were crucial in influencing succession decisions. Moreover, they reported that only 11 % of surveyed youths in fishing communities in the Kodiak Archipelago were encouraged to engage in fishing by their parents or extended family members. Likewise, Power et al. [73] found that despite the long family connection to fisheries, in rare cases, it was also an important factor in encouraging youths to engage in fisheries, with most parents not encouraging their children to engage in the fisheries sector.

Potential successors' feelings about their futures and staying in the fishing communities are uncertain and complex. The variable 'stay in the community in the future' was positive and statistically significant. The more the number of potential successors willing to stay in the community in the future, the more likely their decisions will positively influence their willingness to succeed in the oyster sector. Our findings revealed that only about 42 % of the potential successors desire to stay in the oyster community in the future. We noted that, from the 42 % of potential successors who desire to stay in the oyster communities, just 4 % opted to stay in the communities due to their love and willingness to succeed in oyster harvesting activities. This indicates that most potential successors who choose to stay in the communities in the future do not wish to engage in oyster activities but rather due to other economic and social benefits associated with living in the fishing communities. The increasing desire of potential successors to leave the oyster communities is reportedly due to the growing climate change impacts, which have significantly reduced oyster catch and income. Similarly, Coleman et al. [48] found that about 63 % of the youths enjoyed staying in the fishing communities, but 23 % of the youths perceived that the future does not look good for people who stay in the fishing communities.

Moreover, this study found that, despite few alternative income sources, most potential successors ranked better alternative income sources as the most important factor influencing their decisions and desires not to succeed in oyster harvesting. Declining income from

oyster sales, owing to declining oyster catches, were also key factors influencing the decisions of potential successors not to succeed in the oyster sector. Also, over 65 % of the potential successors are not willing to succeed their mothers in the oyster sector, including the potential successors who are already participating in oyster activities but still looking for other livelihood options or are willing to leave the oyster sector at any time. Worsened climate change impacts mangrove tree degradation, increasing the salinity in the oyster rivers, affecting the growth and productivity of oysters, and influencing potential successors' decisions not to succeed. However, existing evidence suggests that co-management of mangroves and fisheries can improve mangrove habitats and improve fish catches [74]. Our findings are similar to the reports of Kalikoski et al. [11], who noted that 2050 fish catch quantities will decline due to climate change stressors. Thus, our finding of decreasing oyster catches also decreases potential successors' interest in participating in oyster activities. This is evident as potential successors currently engaged in oyster harvesting were not satisfied with their last oyster harvesting experiences; indeed, just 4 % of the potential successors were very satisfied.

Relatedly, about 51 % of the potential successors have followed their parents to participate in training on oyster management. As illustrated, potential successors who followed their mothers to attend training on oyster management were statistically significant at a 1 % level with a positive coefficient. Compared to potential successors who followed their mothers to attend training on oyster management, potential successors who have not participated in any form of training are more likely not to succeed in oyster activities. However, with a reported decline in interest from the potential successors to follow their mothers to participate in training on oyster management, this shows a declining interest from potential successors to engage in oyster harvesting activities. According to Coleman et al. [48], enduring family ties to fishing provide skills and knowledge to facilitate and encourage youth engagement in fishing.

Lastly, a negative and significant association was established between the years of schooling of potential successors with their succession decisions, implying that education is an important factor that will influence their decision not to succeed their mothers in the oyster sector. Moreover, the more the number of years of schooling for the potential successor, the more likely the decision of the potential successor to not succeed their mother in the oyster sector. However, the educational status of the surveyed potential successors is still meager, with an average education of 8 years of schooling.

6. Conclusion

This study assesses the extent to which the unfolding impacts of climate change, climate-smart innovations, and climate adaptation strategies influence youth participation in the oyster sector in The Gambia. The study also demonstrates how social and cultural factors such as family ties to oyster harvesting and discussions among family members influence youths' decisions to succeed or not to succeed their parents in oyster-related activities. In The Gambia, youths are worried about existing vulnerabilities of the oyster sector, especially challenges from climate-related stressors. Due to climate change impacts, most youths reported being worried about future oyster availability and livelihood challenges within the oyster sector. From the results, youths who are potential successors of their parents in oyster-related activities have limited understanding and knowledge of different climate change adaptation strategies in aquatic food systems. However, the youths are willing to engage in learning opportunities that will expand their knowledge and support a resilient fisheries system, including the utilization of climate-smart tools if the opportunities are made available. Improving climate change awareness amongst youths through education, conferences, training opportunities, and workshops is crucial in improving participation and establishing solutions to the growing impacts and the changing dynamics and patterns within the oyster sector in

The Gambia. Moreover, in oyster communities where historical family connections with oyster harvesting remain instrumental for local livelihoods, there is a need for interventions and development-oriented pathways that engage young people and strengthen the sustainability and posterity of the oyster sector. The study suggests a more holistic policy framework that links oyster value chain activities to climate-resilient strategies in The Gambia. There is a need for governments and NGOs to invest in intervention strategies to ensure a more secure fishery-based livelihood and social wellbeing for those interested in activities along the oyster supply chain. Climate-smart innovations will also be key in designing and supporting sustainable oyster production and climate-resilient aquatic food systems.

Ethics Approval

This study applied and received the University of Guelph Research Ethics Boards certificate of ethical acceptability of research involving human participants – REB#21-05-029.

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Author Statement

Neville N. Suh: Conceptualization, Methodology, Software, Data curation, Formal analysis and interpretation, Investigation, Writing - original draft, Writing - review, editing, & finalizing. Richard A. Nyiauwung: Conceptualization, Methodology, Investigation, Data interpretation, Writing - original draft, Writing - review, editing, & finalizing. Funding acquisition, Obtained research ethics approval

Declaration of Competing Interest

The author declares no conflict of interest.

Data Availability

Data will be made available on request.

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