frontiers | Frontiers in Climate

TYPE Original Research
PUBLISHED 27 September 2022
DOI 10.3389/fclim.2022.975650

OPEN ACCESS

EDITED BY
Kees Van Der Geest,
Institute for Environment and Human Security (UNU), Germany

REVIEWED BY
Alex Arnall,
University of Reading, United Kingdom
Kelsea Best,
University of Maryland, College Park, United States

*CORRESPONDENCE
D. Yaw Atiglo
datiglo@ug.edu.gh

SPECIALTY SECTION
This article was submitted to Climate Mobility, a section of the journal Frontiers in Climate

RECEIVED 22 June 2022
ACCEPTED 26 August 2022
PUBLISHED 27 September 2022

CITATION
Abu M, Atiglo DY, Addoquaye Tagoe C and Codjoe SN (2022) Drivers of migration intentions in the Volta Delta: Investigating the effect of climate-related hazards and adaptation strategies.
Front. Clim. 4:975650.
doi: 10.3389/fclim.2022.975650

Drivers of migration intentions in the Volta Delta: Investigating the effect of climate-related hazards and adaptation strategies

Mumuni Abu[1], D. Yaw Atiglo[1]*, Cynthia Addoquaye Tagoe[2] and Samuel N. Codjoe[1]

[1]Regional Institute for Population Studies (RIPS), University of Ghana, Accra, Ghana, [2]Institute for Social, Statistical and Economic Research (ISSER), University of Ghana, Accra, Ghana

The decision to migrate involves multiple causes and motivations with environmental factors subsumed by economic and other dimensions. Deltas are rich in natural resources but are also vulnerable to environmental hazards making them a hotspot for out-migration. In spite of some infrastructural interventions, specifically in the Volta Delta, to minimize the environmental effects, there is scant evidence of their impacts on livelihoods and the potential to reverse out-migration trends and aspirations. Additionally, there is little knowledge on the key drivers of migration in the area. Using data from the 2016 DECCMA household survey in Ghana, we found that exposure to drought does not trigger migration intentions, however, exposure to erosion and salinity do. Households capable of diverse adaptation options have a higher likelihood of migration intention. Households whose main livelihood is ecosystem-based were less likely to have the intention to migrate compared with those whose livelihoods were non-ecosystem based. The study provides insights into future migration intentions and drivers of migration in the Volta Delta.

KEYWORDS

migration, migration intentions, climate hazards, environmental hazards, vulnerability, Volta Delta, Ghana

Introduction

Migration has been used by households and individuals in situations where environmental pressures push populations to consider it as a better option than adaptation *in situ* (Bardsley and Hugo, 2010). The motivation behind these migrations is a fusion of social, demographic, economic and environmental factors at the individual and aggregate levels (De Jong, 2000; Van Dalen and Henkens, 2008). Populations, however, continue to stay in an area based on several factors including economic and social factors, especially with regard to issues of culture, identity and place attachment (Adams, 2016). The decision to migrate is considered within a context of differentiated vulnerabilities and *in situ* adaptation options. Environmental hazards have increased globally and have had a significant effect on natural resource dependent populations who have high inclination to move out of their present condition (Bardsley and Hugo, 2010; Abu et al., 2013). Deltaic populations and livelihoods, particularly in low- and middle-income contexts, rely on natural resources which are negatively affected by the

impacts of environmental hazards resulting in high out-migration (Szabo et al., 2016; Safra de Campos et al., 2020). The vulnerability of delta regions has also attracted the attention of governments who have made some interventions to improve their resilience, particularly in high-income countries (Tessler et al., 2015; Owusu-Daaku and Diko, 2017). There is, however, little evidence of the sustainability and effectiveness of these hard engineering interventions (Owusu-Daaku, 2021) and how they have helped to reverse high out-migration from delta areas in developing contexts. More so, little is known about the key drivers of migration intentions in deltaic regions and the roles played by environmental hazards and adaptation measures by populations.

Deltaic populations in sub-Saharan Africa are vulnerable to sea level rise, erosion, drought and salinity due to their sociodemographic and economic characteristics (Loucks, 2019; Atiglo et al., 2022). Livelihoods of populations in some deltas including the Volta Delta are mainly organized around fishing and farming, which are both climate sensitive (Appeaning Addo et al., 2018). The recent low fish catch in the Volta Delta and destruction of landing beaches by high tidal waves is having a significant effect on fishing-related livelihoods. The soil is also not rich in nutrients and there is limited rainfall to enable the population to go into meaningful agriculture. As a result, households have resorted to using migration as a strategy to supplement the household income (Atiglo and Codjoe, 2015; Codjoe et al., 2020; Safra de Campos et al., 2020). There is a general difficulty in determining whether migration from a household is climate-related or due to social, historical and economic factors. This is because the climate-related factors are usually nested in other economic and social factors. This study will therefore, contribute to the existing knowledge on migration and climate change by critically investigating the following research questions: 1) what are the drivers of migration intentions in the Volta Delta? 2) how does adaptation influence migration intentions in the Volta Delta 3) how do climate-related hazards affect migration intentions in the Volta Delta?

This study is important because it uses unique data from the Volta Delta to understand the use of migration as an adaptation strategy to climate-related hazards. The data was collected in high out-migration areas that are affected by environmental hazards in the Volta Delta. This study therefore focuses on an environment that has gone through several environmental challenges and migration history to understand the crucial discourse on how environmental hazards affect migration intentions.

Theoretically, there is a clear distinction between actual migration and migration intention though the latter is commonplace in recent research. Literature has shown that intentions usually translate into reality and assessing people's migration intentions provides a pragmatic approach to understanding the phenomenon (Carling, 2014; van Praag et al., 2021b). Migration intentions are the first steps in the actual migration process, especially in relating internal migration with environmental factors (Macleod, 1996; Van Dalen and Henkens, 2008; Van Praag, 2021).

Migration intentions reflect individual hopes and life goals which underlie migration decision-making (Carling and Collins, 2018; Schewel and Fransen, 2018). Assessing migration intentions helps to better understand the processes involved in the migration decision-making and actual migration (van Praag et al., 2021a). Migration intentions may not result in actual migration due to barriers or obstacles that reduce individuals' ability to migrate. That notwithstanding, people's intentions to migrate are independent of the facilitators and barriers to actual migration and reflect an intrinsic desire rather than ability (Carling, 2014). Thus, focusing on intentions help establish a link between vulnerability to environmental hazards and migration decision-making. Recent research on the environment-migration nexus tend to use migration intentions to assess people's belief that migrating is preferable to staying (Abu et al., 2013; Suckall et al., 2016; Codjoe et al., 2017; Adger et al., 2021). In this paper, we assessed migration intentions because they provide an opportunity to understand how populations affected by climate-related hazard consider migration as an option, especially in areas where there is already high out-migration (Atiglo and Codjoe, 2015). In order to understand what motivates migration and predict migration it is important to assess migration intentions rather than actual migration (Aslany et al., 2021). Migration intentions have been established in other studies to have translated into actual migration, and they also provide opportunity to follow-up with the population to find out if their intentions have been achieved (Mallick et al., 2020).

Why focus on a deltaic region?

Delta regions are dynamic with rich resources that attract a lot of social and economic activities. As a result, most deltaic regions have concentrations of populations because they have overtime attracted population who anticipate availability of livelihood opportunities (Seto, 2011; Safra de Campos et al., 2020). It has been estimated that about 7% of the global population reside in delta regions which only occupy 1% of the global land area (Ericson et al., 2006). There are, however, fast changing trends in delta regions in recent times including threats of sea level rise and coastal indundation (Tessler et al., 2015). These changes are a result of multiple factors including human activities such as the construction of dams on major rivers, deforestation, crop farming, mining, and urbanization (Milliman et al., 1989; Walling and Fang, 2003; Woodroffe et al., 2006; Nicholls et al., 2016).

Due to these biophysical changes, deltas are attracting major research attention in recent times. The impacts of

climate-related hazards on deltas have exacerbated the already stressful conditions of deltaic populations requiring livelihood-improving and coastal defense interventions to minimize the impact (Agrawala et al., 2003). The natural vegetations of deltas have changed, and this has affected the livelihoods of the population. Even though some deltas have received some interventions, such as the construction of sea defense walls to protect the shoreline, these interventions have not been enough to reverse disruptions to livelihoods and ecosystem services (Mensah and FitzGibbon, 2013; Owusu-Daaku, 2017; Appeaning Addo et al., 2020).

The Volta Delta located in the Keta Basin has a history of human interference over the years. The construction of dams (Akosombo, Kpong, and Bui Dams in 1964, 1982, and 2013, respectively) along the catchments have had significant impact on water discharge systems in the area (Anthony et al., 2016; Appeaning Addo et al., 2018). The livelihoods of the population in the delta have been negatively impacted by such activities, and some households choose migration as a strategy to address the environmental and economic challenges in the area (Appeaning Addo et al., 2018; Codjoe et al., 2020). The Volta Delta area is one of the areas with the highest out-migration rates with destinations in Accra and Tema, capital and industrial cities, respectively in Ghana (Atiglo and Codjoe, 2015). The impact of climate-related hazards in the area is an additional stress to the already existing problems in the Volta Delta and therefore requires urgent research attention to provide practical solutions to the problem. Due to the impacts of coastal inundation and erosion, there have been some infrastructural interventions including the sea defense system as well as resettlement housing schemes for displaced households (Afram et al., 2015; Owusu-Daaku, 2017, 2021). The Volta Delta comprises nine administrative districts in Ghana, defined as the land below the 5-meter contour in the lower portion of the Volta River Basin within the Accra-Ho-Keta Plains (Appeaning Addo et al., 2018) (Figure 1).

Data and methods

The data for the study is derived from the Deltas, Vulnerability and Climate Change: Migration and Adaptation (DECCMA) survey collected in the Volta Delta of Ghana between March and October 2016. The survey collected data on variables key to examining the climate and migration nexus including migration and household demographics, environmental hazards, socio-economic status and household adaptation strategies. In all, 1,364 households, selected from 50 enumeration areas across 9 districts, responded to the questions in the Volta delta.

The dependent variable in the study is future migration intention, which is measured as a dichotomous variable. The question asked in the survey was "Do you or other household members intend to migrate in the future?" The responses were coded as 1 for those households with a member who expressed the intention to migrate and 0 for those who did not. The survey also asked questions about actual migration from each of the households. In all, 49% of the households indicated that they had member(s) who had migrated. We used future migration intention and not actual migration because it provides an opportunity to find out from the population at the place of origin, whether despite the adaptation interventions in the area, they still consider migrating out of the area. Assessing current migration intentions eliminates the flaw in trying to use current experiences of environmental hazards in the area to explain out-migrations from the delta area that may have taken place decades ago.

The main independent variables are exposure to each of the following climate-related hazards: flood, drought, erosion, salinity and storm surges. These are the main hazards experienced in the Volta Delta. For each hazard, households that reported to have experienced any of the hazard events in the last 10 years (annually, seasonally, once per decade) were coded 1 as being exposed to the hazard, otherwise 0 meaning no exposure to the specific hazard. We examined all the hazards separately because households are exposed to these hazards differently, and different hazards may affect different households depending on their location in the study area. There are also households who experience multiple hazards while others may experience none. The differences in exposure are expected to produce differences in adaptation strategies.

Households may be involved in single, multiple or no adaptation strategies. The adaptation strategies considered in this study included taking up a loan, insurance, cooperative, improvement on house, planting trees around home, using hired labour to support in generating income, moving to a new house, planting or stop planting climate tolerant crops, increasing or reducing fertilizer use, and putting up or taking out irrigation (Suckall et al., 2018). These adaptation strategies were recoded as 0=no adaptation; 1=single adaptation; and 2=multiple adaptation. This helped to distinguish between households that were not doing anything, those engaged in just single adaptation and those engaged in two or more adaptation strategies.

We controlled for socio-demographic and economic variables that significantly predict migration intentions to enable us test the relationship between climate-related hazards and migration intentions. Specifically, we controlled for the sex of the household head, which has proven in literature to have implications for the wellbeing of individual household members. Men have long been considered as primary agents of migration, however, the recent feminization of migration in Ghana (Awumbila, 2015) warrants that we explore the gendered dimension of environment and migration. In a patriarchal society like that of the Volta Delta, women are at a disadvantage in terms of ownership of resources like

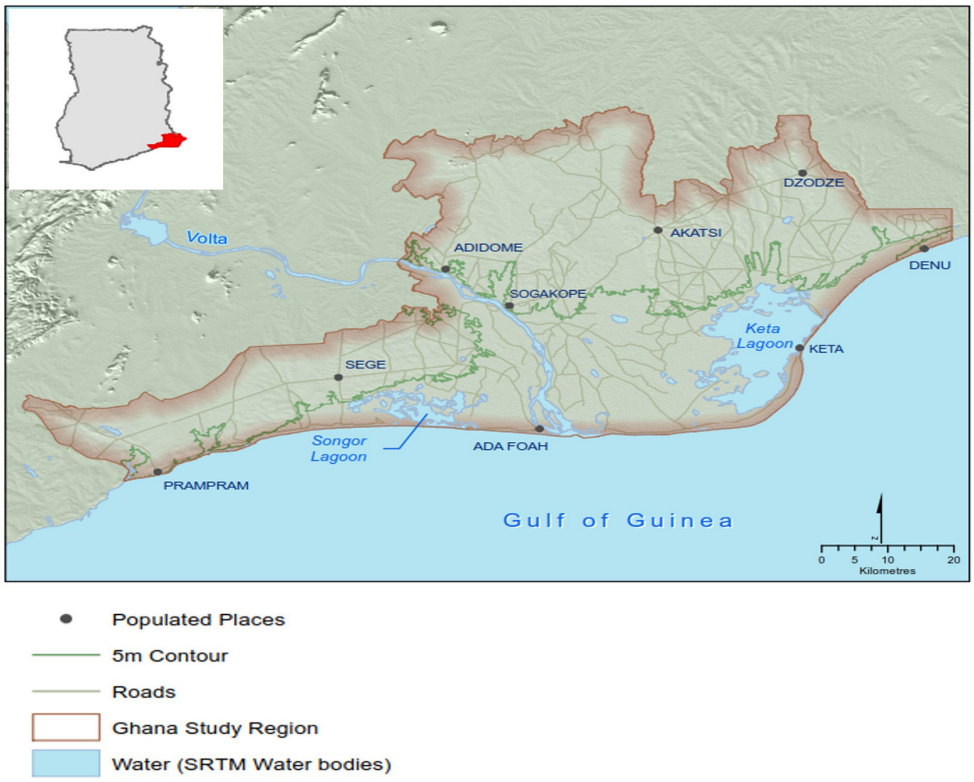

FIGURE 1
Map of the volta delta study area.

agricultural land in addition to being burdened with social reproduction and care responsibilities. It is expected therefore that people who belong to male headed households will better respond to environmental hazards than those in female headed households. We also controlled for the mean age of the household members, level of education completed by the head of the household, household size, marital status of household head, household income, household dependency ratio, place of residence, and migration network, which was measured by a proxy derived from the question on whether a respondent had a family member or friend who had migrated. In addition, we controlled for the main livelihood of household head, which we recoded into 0=non-ecosystem based, and 1=ecosystem based. Ecosystem based livelihoods refer to those activities related to agriculture, fishing and aquaculture, forestry among others.

In terms of analysis, we employed a binary logistic regression to examine how climate-related hazards are associated with migration intentions in the Volta Delta. In all, two models were run. The first model examined the relationship between climate-related hazards, adaptation strategies and migration intentions. The second model controlled for the effect of the sociodemographic and economic variables to test the robustness of the relationship between climate-related hazards, adaptation strategies and migration intentions. The level of significance for interpreting the results is $p < 0.05$.

Results

Descriptive statistics

Table 1 shows descriptions of the distributions of the outcome and the explanatory variables in the study. A little over two-fifths (44%) of the households had intentions to send a migrant from the Volta Delta in future. In terms of exposure to climate-related hazards, a higher proportion (48%) of the respondents indicated that they were exposed to drought than to any other hazard. A little over one-third mentioned that they were exposed to flood (35%) whilst 30% indicated that they were exposed to erosion. More than one-third mentioned that they were exposed to storm surges whilst 31% said they were exposed to salinity. Overall, drought is the hazard that is experienced by the highest proportion of households exposed to at least one hazard in the Volta Delta.

As a result of households' exposure to different climate-related hazards, several adaptation strategies are embarked on by households to reduce the impact of hazards. Table 1 indicates

10.3389/fclim.2022.975650

TABLE 1 Description of intention to migrate, exposure to environmental hazards, adaptation strategies and household sociodemographic and economic factors.

Variable	Count (Mean)	% (SD)
Outcome		
Intention to migrate		
No	769	56.4
Yes	595	43.6
Explanatory Variables		
Exposure to flood		
No	888	65.1
Yes	476	34.9
Exposure to drought		
No	701	51.4
Yes	663	48.6
Exposure to erosion		
No	955	70.0
Yes	409	30.0
Exposure to salinity		
No	946	69.4
Yes	418	30.6
Exposure to storm surges		
No	870	63.8
Yes	494	36.2
Adaptation Strategies		
No adaptation	304	22.3
Single adaptation	322	23.6
Multiple adaptation	738	54.1
Sex of household head		
Male	804	58.9
Female	560	41.1
Mean Age of household members	(30.42)	(15.39)
Level of education of household head		
No education	386	28.3
Primary	391	28.7
Secondary	523	38.3
Higher	64	4.7
Marital status of household head		
Never married	158	11.6
Currently married	776	56.9
Co-habiting/living together	39	2.9
Widowed	206	15.1
Divorced	85	6.2
Abandoned/separated	96	7.0
Missing data	4	0.3
Household size	(3.98)	(2.51)
Household dependency ratio	(0.83)	(0.90)
Household income	($135.44)	($170.91)
Main livelihood of household head		
Non-ecosystem based	713	52.3
Ecosystem based	651	47.7
Migration network of household		
Yes	665	48.8
No	699	51.2
Place of residence		
Rural	1,146	84.0
Urban	218	16.0
Total	1,364	100.0

that more than half (54%) of households embark on multiple adaptation whilst 24% embark on single adaptation. There are also a little over one-fifth (22%) of households who do not embark on any adaptation strategy.

With regards to the sociodemographic profile of households, Table 1 shows that 41% of household heads were females, indicating a higher proportion of female headship in the delta compared to the then national average of 31% (Ghana Statistical Service, 2013). The mean age of household members is 30 years indicating a young population in the delta. Mean household size is about 4 persons per household while the dependency ratio is 0.83. Majority (38%) of the household heads also had secondary level education whilst 29% and 28% had primary and no education, respectively. More than half (57%) of household heads were married at the time of the survey whilst 12% were single. In terms of economic activity, a higher proportion (52%) of the household heads were engaged in non-ecosystem based livelihoods. The mean annual income per household was $134.4. A little over half of households (51%) did not have migration networks, and a higher proportion (84%) of the households interviewed were living in rural areas.

Association between climate-related hazards, sociodemographic variables and migration intentions

The bivariate analysis in Table 2 shows that exposure to floods, drought, erosion and salinity was associated with future migration intentions. Additionally, adaptation strategies, sex of household head and level of educational attainment were statistically and significantly associated with migration intentions. Overall, a higher proportion of households that were exposed to floods, erosion and salinity had the intention to migrate in the future compared with lower proportions for their counterparts who were not exposed to any of these hazards. However, a lower proportion of households exposed to drought had the intention to migrate compared with households that were not. In terms of adaptation, a higher proportion (47%) of

TABLE 2 Association between exposure to environmental hazards, sociodemographic and economic variables and intention to migrate.

Variables	Intention to migrate			Chi-square test	*P*-value
	No	Yes	Total		
Exposure to floods				5.987	0.014
No	58.8	41.2	888		
Yes	51.9	48.1	476		
Exposure to drought				6.996	0.008
No	52.9	47.1	701		
Yes	60.0	40.0	663		
Exposure to erosion				11.604	0.001
No	59.4	40.6	955		
Yes	49.4	50.6	409		
Exposure to salinity				14.06	0.001
No	59.7	40.3	946		
Yes	48.8	51.2	418		
Exposure to storm surges				2.355	0.070
No	57.9	42.1	870		
Yes	53.6	46.4	494		
Adaptation strategies				5.829	0.054
No Adaptation	61.2	38.8	304		
Single Adaptation	58.4	41.6	322		
Multiple Adaptation	53.5	46.5	738		
Sex of household head				14.477	0.001
Male	52.1	47.9	804		
Female	62.5	37.5	560		
Mean age of household members $r = -0.059$			0.001		
Level of education of household head			25.822	0.001	
No education	66.1	33.9	386		
Primary	56.8	43.2	391		
Secondary	50.3	49.7	523		
Higher	45.3	54.7	64		
Marital status of household head			75.452	0.001	
Never married	30.2	69.8	162		
Currently married	56.6	43.4	776		
Co-habiting/living together	38.5	61.5	39		
Widowed	71.4	28.6	206		
Divorced	67.1	32.9	85		
Abandoned	64.6	35.4	96		
Household size	$r = -0.002$				0.930
Household dependency ratio	$r = -0.059$				0.035
Household income	$r = 0.047$				0.080
Livelihood of household head				2.68	0.057
Non-ecosystem based	54.3	45.7	713		
Ecosystem based	58.7	41.3	651		
Migration network				32.368	0.001
Yes	64.2	35.8	665		
No	48.9	51.1	699		
Place of residence				1.837	0.100
Rural	55.6	44.4	1146		
Urban	60.6	39.4	218		
Total	769	595	1364		

households that were engaged in multiple adaptation had the intention to migrate in the future. A little over two-fifth (42%) of those who were engaged in single adaptation and 39% of those who were not engaged in any form of adaptation also had the intention to migrate in the future. A higher proportion (48%) of male household heads had the intention to migrate in the future compared to female household heads (38%). In addition, the intention to migrate is higher among household heads with higher education compared with those with lower or no education. Indeed, the proportion of households with the intention to migrate increases with the level of education of their household heads.

In addition, marital status of household head, and migration network of household are also statistically and significantly associated with the intention to migrate. Household heads that were single (70%) and those that were cohabiting (62%) had the highest proportion of members who had the intention to migrate in the future compared to other households. The proportion intending to migrate was lowest among the widowed. A higher proportion of households without migration (51%) networks had the intention to migrate in the future compared with those who had migration networks (36%). Household dependency ratio and the mean age of household members have significant correlations with intention to migrate in the future.

The multivariate results of Model 1 in Table 3 show that about three percent of the variation in the intentions to migrate in the future is explained by climate-related factors in the Volta Delta. Household exposure to drought, erosion, and salinity are significant predictors of the intentions to migrate in the future, while exposure to flood and storm surges is not. Exposure to drought has a negative effect on intentions to migrate in the future whilst exposure to erosion and salinity have a positive effect on intentions to migrate in the future. Households that were exposed to drought were less likely to consider migration in the future, while households that were exposed to erosion and salinity were more likely to have intentions to migrate in the future. Model 1 also shows that households engaged in multiple adaptation were more likely to have the intentions to migrate in the future compared to those who do not engage in any form of adaptation.

To test the robustness of the relationship established in Model 1, Model 2 controlled for socio-demographic and economic variables to see if the relationship will hold. In Model 2 eight percent of the variation in the intention to migrate in the Volta delta is explained by the climate-related hazards, adaptation strategies and socio-demographic and economic variables. The results show that exposure to drought, erosion, salinity, adaptation strategies, mean age of household members, marital status of household head and main livelihood of household head are significant predictors of intentions to migrate in the future. Households exposed to drought are less likely to have intentions to migrate in the future compared to those who were not exposed. However, exposure to erosion and salinity is more likely to be associated with future migration intentions in households compared with those who are not exposed to erosion and salinity. A unit increase in the mean age of household will decrease migration intentions in households by 0.997. Household heads that are currently married, cohabiting, widowed or abandoned are less likely to have migration intentions in the future compared with household heads who have never married. Finally, a household head whose livelihood is ecosystem based is less likely to have intentions to migrate in future compared with household heads whose livelihood is non-ecosystem based.

Discussion

The study hypothesized that exposure to climate-related hazards explains future migration intentions in the Volta Delta, which is already going through some environmental and social stress (Appeaning Addo et al., 2018). The analysis show that exposure to various climate-related hazards is high in the Volta Delta. Overall, more than 30% of the sampled households have experienced flood, drought, erosion, salinity and storm surges. It is also evident in the analysis that more than half (54%) of the households were engaged in multiple adaptation to address the challenges they encounter. The main livelihood of a little over two-fifths (48%) of households was ecosystem based and these households are likely to face major challenges with regard to the climate-related hazard conditions.

At the bivariate level, we established a statistically significant association between exposure to the climate-related hazards and intentions to migrate. Additionally, some sociodemographic factors such as sex of household head, level of education attained by household head, marital status of household head, mean age of household members, household dependency ratio, migration network and main livelihood of household head were significant predictors of intentions t8o migrate in the Volta delta. These sociodemographic and economic factors determine household's resilience capacity and play a critical role in the decision to migrate or stay.

The final model of the study shows that households' exposure to drought, erosion and salinity is a significant predictor of intention to migrate in the future. These hazards generally occur slowly, and they tend to have significant impact on the livelihoods of the population over a long period of time. Exposure to drought is less likely to influence migration intentions whilst exposure to erosion and salinity is more likely to explain migration intentions in the future. Due to the impacts of droughts on agricultural activities in the Volta Delta, there have been some adaptation measures by the population, including the construction of several wells that for irrigation purposes (Atiglo, 2017). Water from

10.3389/fclim.2022.975650

TABLE 3 Binary logistic regression of predictors of future migration intentions as a result of experience of climate-related hazards.

Variables	Odds ratio	Robust Std. Err.	Odds ratio	Robust Std. Err.
	Model 1		Model 2	
Exposure to flood (RC = No)				
Yes	1.139	0.125	1.244	0.135
Exposure to drought (RC = No)				
Yes	0.607***	0.120	0.732*	0.133
Exposure to erosion (RC = No)				
Yes	1.553***	0.128	1.514**	0.140
Exposure to Salinity (RC = No)				
Yes	1.418**	0.125	1.470**	0.135
Exposure to storm surges (RC = No)				
Yes	1.123	0.122	1.211	0.132
Adaptation Strategies (RC = No Adaptation)				
Single adaptation	1.159	0.166	1.155	0.179
Multiple adaptation	1.412*	0.141	1.555**	0.157
Sex of household head (RC = Male)				
Female			0.842	0.147
Mean age of household members			0.977***	0.006
Household size			0.968	0.033
Marital Status of household head (RC = Never Married)				
Currently married			0.359***	0.215
Co-habiting / living together			0.645	0.390
Widowed			0.344***	0.284
Divorced			0.321***	0.318
Abandoned / separated			0.316***	0.306
Household head level of education (RC = No Education)				
Primary			1.156	0.171
Secondary			1.297	0.166
Higher			1.606	0.307
Income			1.000	0.000
Main Livelihood of household head (RC = Non-ecosystem based)				
Ecosystem based			0.764*	0.129
Household dependency ratio			0.871	0.084
Migration Network (RC = No)				
Yes			0.781	0.133
Place of Residence (RC = Rural)				
Urban			0.942	0.178
Constant	(−0.56962)***	0.133	(1.230)***	0.325
Pseudo R^2		0.025		0.080
Wald Chi	(7, 1,364) = 44.58***		(23, 1,280) = 129.42***	

*p < 0.05; **p < 0.01; ***p < 0.001.

these wells are used mostly for vegetable cultivation to supplement the major livelihood activity in the area, which is fishing. Exposure to salinity and storm surge is critical because the population do not have any solutions to the problem, and the most available option is usually relocation or migration. Salinity destroys the fertility of the soil and the quality of groundwater for irrigation making it difficult for people to have alternative livelihoods, while erosion, destroys landing places for fishing activities. Similar to findings from a previous study in three fishing communities that had experienced flooding along the coast of the Volta Delta (Codjoe et al., 2017), flooding is not a significant predictor

of migration intentions. This is also consistent with findings from Bangladesh that flooding has modest effects on migration (Gray and Mueller, 2012). That different hazards have different effects on migration intentions reflect the complexity of the environment-migration nexus which is influenced largely by the population's cumulative vulnerability and reliance stemming from their socioeconomic, demographic, cultural and environmental characteristics (Zickgraf et al., 2016).

Finally, households that are engaged in multiple adaptation are more likely to have the intentions to migrate in the future compared with households that do not engage in any form of adaptation. Households engaged in multiple adaptation may be going through multiple hazards and one of the solutions that such households may consider is migration to avoid all the troubles that are associated with to climate-related hazards. This aligns with the capabilities perspective that persons with expanded capabilities for self-efficacy are empowered to aspire for higher goals (Suckall et al., 2016). Thus, households that can undertake multiple adaptation strategies reflect increased capital resources to enable them undertake migration.

Conclusion

This present study sought to assess how exposure to climate-related hazards and the adaptation processes influence migration intentions. The study, using data from the Volta Delta of Ghana, shows the importance of environmental hazards and adaptation measures for migration intentions in the Volta Delta. Exposure to drought, erosion and salinity are issues that require policy attention to help the population cope with the situation. Multiple adaptation measures employed by households are associated with migration intentions. It is important for policy makers to come up with a comprehensive adaptation solution to environmental hazards in the Volta Delta. This will reduce the stress households go through in trying to find solutions to environmental problems by engaging different strategies that can be expensive to the households.

It is surprising to note that households that are engaged in ecosystem-based livelihoods were less likely to have migration intentions as a result of exposure to environmental hazards. All things being equal, these are households who are hardest hit by environmental hazards and therefore, should rather have high inclinations to migrate. That notwithstanding, these are households whose livelihoods depend mainly on natural resources may be unable to move for diverse reasons. First, local-resource dependent households are likely to be involved in labour-intensive livelihoods which may restrict their willingness to send out active household members (Aslany et al., 2021). Also, such households may be hesitant to embark on migration due to the uncertainty of what alternatives exist in the destination areas. Finally, populations whose main livelihood is ecosystem-based get trapped in this situation because the impacts of climate-related hazards may undermine household resources required to undertake migration (Gray and Mueller, 2012).

It is important for policymakers to pay attention to environmental hazards by introducing solutions to address the consequences of these hazards, especially among natural resource dependent populations. Efforts at addressing climate-induced migration should consider the complex interrelationship with household compositions, livelihoods and *in situ* adaptation strategies. Government efforts at addressing climate-related and environmental problems should aim at providing sustainable livelihood solutions and adaptation options.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

MA curated, analyzed and interpreted the data, and drafted the manuscript. DA interpreted the data and contributed to drafting the manuscript. CA and SC contributed to drafting the manuscript and revised it for important intellectual content. All authors made substantial contributions to the conception of the study. All authors provide approval for publication of the content and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Funding

This paper was authored under the Deltas, vulnerability and Climate Change: Migration and Adaptation (DECCMA) Project (IDRC 107642) under the Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA) programme with financial support from the UK Government's Department for international Development (DFID) and the International Development Research Centre (IDRC), Canada. The authors also received open access funding from the HABITABLE project from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 869395. The content reflects only the authors' views.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Author disclaimer

The views expressed in this work are those of the creators and do not necessarily represent those of DFID and IDRC or its Boards of Governors. The content reflects only the authors' views.

References

Abu, M., Codjoe, S. N. A., and Sward, J. (2013). Climate change and internal migration intentions in the forest-savannah transition zone of Ghana. *Popul. Environ.* 35, 341–364. doi: 10.1007/s11111-013-0191-y

Adams, H. (2016). Why populations persist: mobility, place attachment and climate change. *Popul. Environ.* 37, 429–448. doi: 10.1007/s11111-015-0246-3

Adger, W. N., de Campos, R. S., Codjoe, S. N. A., Siddiqui, T., Hazra, S., Das, S., et al. (2021). Perceived environmental risks and insecurity reduce future migration intentions in hazardous migration source areas. One *Earth* 4, 146–157. doi: 10.1016/j.oneear.2020.12.009

Afram, S., Kwofie, T., and Attipoe, J. (2015). "The influence of beneficiary participation in resettlement schemes in ghana; a case study of the keta basin Sea defence resettlement project," in *4th International Conference on Infrastructure Development in Africa–Kumasi, Ghana, 25th-26th March*. Available online at: http://www.researchgate.net/profile/Titus_ebenezer_Kwofie2/publication/276489311_THE_INFLUENCE_OF_BENFICIARY_PARTICIPATION_IN_RESETTLEMENT_SCHEMES_IN_GHANA_A_Case_Study_of_the_Keta_Basin_Sea_Defence_Resettlement_Project/links/5559edb108ae6943a877c476.pdf

Agrawala, S., Ota, T., Ahmed, A. U., Smith, J., and Aalst, M. V. (2003). "Development and climate change in bangladesh: Focus on coastal flooding and the sundarbans," in *Organisation for Economic Co-operation and Development* Paris: OECD.

Anthony, E. J., Almar, R., and Aagaard, T. (2016). Recent shoreline changes in the Volta River delta, West Africa: the roles of natural processes and human impacts. *Afr. J. Aquatic Sci.* 41, 81–87. doi: 10.2989/16085914.2015.1115751

Appeaning Addo, K., Brempong, E. K., and Jayson-Quashigah, P. N. (2020). Assessment of the dynamics of the Volta river estuary shorelines in Ghana. *Geoenviron. Disast.* 7, 1–11. doi: 10.1186/s40677-020-00151-1

Appeaning Addo, K., Nicholls, R. J., Codjoe, S. N. A., and Abu, M. (2018). A biophysical and socioeconomic review of the Volta Delta, Ghana. *J. Coast. Res.* 34, 1216–1226. doi: 10.2112/JCOASTRES-D-17-00129.1

Aslany, M., Carling, J., Mjelva, M. B., and Sommerfelt, T. (2021). *Systematic Review of Determinants of Migration Aspirations. QuantMig Project Deliverable D2.2.* Southampton: University of Southampton.

Atiglo, D. Y. (2017). *Gender, Vulnerability to Environmental Change and Migration in the Volta Delta, Ghana [University of Ghana]*. Available online at: http://ugspace.ug.edu.gh

Atiglo, D. Y., Abu, M., Jayson-Quashigah, P.-N., Addo, K. A., and Ardey Codjoe, S. N. (2022). Sociodemographic and geophysical determinants of household vulnerability to coastal hazards in the Volta Delta, Ghana. *Int. J. Disast. Risk Reduct.* 78, 103146. doi: 10.1016/j.ijdrr.2022.103146

Atiglo, D. Y., and Codjoe, S. N. A. (2015). *Migration in the Volta Delta: A Review of the Literature (No. 107642; DECCMA Working Paper, Deltas, Vulnerability and Climate Change: Migration and Adaptation, IDRC Project)*. Available online at: http://generic.wordpress.soton.ac.uk/deccma/wp-content/uploads/sites/181/2017/07/FINAL-GHANA-Volta-Working-Paper-on-Migration.pdf

Awumbila, M. (2015). Women moving within borders: gender and internal migration dynamics in Ghana. *Ghana J. Geography* 7, 132–145. Available online at: https://www.ajol.info/index.php/gjg/article/view/129223

Bardsley, D. K., and Hugo, G. J. (2010). Migration and climate change: examining thresholds of change to guide effective adaptation decision-making. *Popul. Environ.* 32, 238–262. doi: 10.1007/s11111-010-0126-9

Carling, J. (2014). "The role of aspirations in migration," in *Paper Presented at Determinants of International Migration, International Migration Institute, University of Oxford, September* (Oslo), 23–25.

Carling, J., and Collins, F. (2018). Aspiration, desire and drivers of migration. *J. Ethnic Migrat. Stud.* 44, 909–926. doi: 10.1080/1369183X.2017.1384134

Codjoe, S. N. A., Appeaning Addo, K., Tagoe, C. A., Nyarko, B. K., Martey, F., Nelson, W. A., et al. (2020). "The Volta Delta, Ghana: challenges in an African setting," in *Deltas in the Anthropocene*, eds R. J. Nicholls, W. N. Adger, C. W. Hutton, and S. E. Hanson (Cham: Springer International Publishing), 79–102.

Codjoe, S. N. A., Nyamedor, F. H., Sward, J., and Dovie, D. B. K. (2017). Environmental hazard and migration intentions in a coastal area in Ghana: a case of sea flooding. *Popul. Environ.* 39, 128–146. doi: 10.1007/s11111-017-0284-0

De Jong, G. F. (2000). Expectations, gender, and norms in migration decision-making. *Populat. Stud.* 54, 307–319. doi: 10.1080/713779089

Ericson, J. P., V¨or¨osmarty, C. J., Dingman, S. L., Ward, L. G., and Meybeck, M. (2006). Effective sea-level rise and deltas: causes of change and human dimension implications. *Glob. Planet. Change* 50, 63–82 doi: 10.1016/j.gloplacha.2005.07.004

Ghana Statistical Service (2013). *2010 Population and Housing Census - National Analytical Report*. Accra. Available online at: https://statsghana.gov.gh/gssmain/fileUpload/pressrelease/2010_PHC_National_Analytical_Report.pdf

Gray, C. L., and Mueller, V. (2012). Natural disasters and population mobility in Bangladesh. *Proc. Natl. Acad. Sci. U.S.A.* 109, 6000–6005. doi: 10.1073/pnas.1115944109

Loucks, D. P. (2019). Developed river deltas: are they sustainable? *Environ. Res. Lett.* 14, ab4165. doi: 10.1088/1748-9326/ab4165

Macleod, L. (1996). The migration intentions of young people in Ullapool. *Scottish Affairs* 15, 70–82. doi: 10.3366/scot.1996.0022

Mallick, B., Sultana, Z., and Bennett, C. M. (2020). How do sustainable livelihoods influence environmental (non-)migration aspirations? *Appl. Geograp.* 124, 102328. doi: 10.1016/j.apgeog.2020.102328

Mensah, K., and FitzGibbon, J. (2013). Responsiveness of Ada Sea defence project to salt water intrusion associated with sea level rise. *J. Coastal Conservat.* 17, 75–84. doi: 10.1007/s11852-012-0219-y

Milliman, J. D., Broadus, J. M., and Gable, F. (1989). Environmental and economic implications of rising sea level and subsiding deltas: the Nile and Bengal examples. *Ambio* 18, 340–345.

Nicholls, R. J., Hutton, C. W., Lázár, A. N., Allan, A., Adger, W. N., Adams, H., et al. (2016). Integrated assessment of social and environmental sustainability dynamics in the Ganges-Brahmaputra-Meghna delta, Bangladesh. *Estuar. Coast. Shelf Sci.* 183, 370–381. doi: 10.1016/j.ecss.2016.08.017

Owusu-Daaku, K., and Diko, S. K. (2017). "The sea defense project in the ada east district and its implications for climate change policy implementation in Ghana's Peri-Urban Areas," in *Urban Perspectives, Vol*. Washington, DC *1*, 28–49.

Owusu-Daaku, K. N. (2017). *Climate change (Mal) adaptation as governmentality: The case of the Ada Sea defense system in the Volta River Delta of Ghana (Doctoral dissertation)*. University of South Carolina.

Owusu-Daaku, K. N. (2021). "Rationalities of government and webs of relations(hips) in the funding and implementation of sea defense systems in the Volta River Delta of Ghana," in *The Routledge Handbook of Development and Environment* (London: Routledge), 387–402.

Safra de Campos, R., Codjoe, S. N. A., Adger, W. N., Mortreux, C., Hazra, S., Siddiqui, T., et al. (2020). "Where people live and move in Deltas," in *Deltas in the Anthropocene,* eds R. J. Nicholls, W. N. Adger, C. W. Hutton, and S. E. Hanson (Springer International Publishing), 153–177.

Schewel, K., and Fransen, S. (2018). Formal education and migration aspirations in ethiopia. *Populat. Dev. Rev.* 44, 555–587. doi: 10.1111/padr.12159

Seto, K. C. (2011). Exploring the dynamics of migration to mega-delta cities in Asia and Africa: contemporary drivers and future scenarios. *Global Environ. Change* 21, 94–107. doi: 10.1016/j.gloenvcha.2011.08.005

Suckall, N., Fraser, E., and Forster, P. (2016). Reduced migration under climate change: evidence from Malawi using an aspirations and capabilities framework. *Climate Dev.* 5529, 1–15. doi: 10.1080/17565529.2016.1149441

Suckall, N., Tompkins, E. L., Nicholls, R. J., Kebede, A. S., Lázár, A. N., Hutton, C., et al. (2018). A framework for identifying and selecting long term adaptation policy directions for deltas. *Sci. Total Environ.* 633, 946–957. doi: 10.1016/j.scitotenv.2018.03.234

Szabo, S., Brondizio, E., Renaud, F. G., Hetrick, S., Nicholls, R. J., Matthews, Z., et al. (2016). Population dynamics, delta vulnerability and environmental change: comparison of the Mekong, Ganges–Brahmaputra and Amazon delta regions. *Sustain. Sci.* 11, 539–554. doi: 10.1007/s11625-016-0372-6

Tessler, Z. D., Vorosmarty, C. J., Grossberg, M., Gladkova, I., Aizenman, H., Syvitski, J. P. M., et al. (2015). Profiling risk and sustainability in coastal deltas of the world. *Science* 349, 638–643. doi: 10.1126/science.aab3574

Van Dalen, H. P., and Henkens, K. (2008). Emigration intentions: mere words or true plans? Explaining international migration intentions and behavior. *J. Populat. Econ.* 18, 741–778 doi: 10.2139/ssrn.1153985

Van Praag, L. (2021). Can I move or can I stay? Applying a life course perspective on immobility when facing gradual environmental changes in Morocco. *Clim. Risk Manag.* 31, 100274.

van Praag, L., Ou-Salah, L., Hut, E., and Zickgraf, C. (2021a). *Migration and Environmental Change in Morocco*. Springer. Available online at: http://www.springer.com/series/13502 doi: 10.1007/978-3-030-61390-7

van Praag, L., Ou-Salah, L., Hut, E., and Zickgraf, C. (2021b). "The nexus between environmental changes, culture of migration, and migration aspirations," in *IMISCOE Research Series* (Cham: Springer Science and Business Media B.V), 125–147.

Walling, D. E., and Fang, D. (2003). Recent trends in the suspended sediment loads of the World's Rivers. *Glob. Planet. Change* 39, 111–126. doi: 10.1016/S0921-8181(03)00020-1

Woodroffe, C. D., Nicholls, R. J., Saito, Y., Chen, Z., and Goodbred, S. L. (2006). "Landscape variability and the response of Asian megadeltas to environmental change," in *Global Change and Integrated Coastal Management* (Dordrecht: Springer), 277–314.

Zickgraf, C., Vigil, S., de Longueville, F., Ozer, P., and Gemenne, F. (2016). *The Impact of Vulnerability and Resilience to Environmental Changes on Mobility Patterns in West Africa* (No. 14; KNOMAD Working Paper). Available online at: www.KNOMAD.org.