Full title: To live with floods or not: Intersectionality of drivers of urban households' adaptation and relocation intentions.

Running title: Socio-demographics of flood risks

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To live with floods or not: Intersectionality of drivers of urban households' adaptation and relocation intentions.

Abstract

The intent of households to relocate amidst floods in Ghana's Greater Accra Metropolitan Area, using combined socio-demographic and physical factors is analyzed within 1,206 households. The National Master Sampling Frame of Ghana's Population and Housing Census is utilized for the sampling. The Probit estimation technique is employed to understand the intersectionality of social, economic, demographic, and physical considerations influencing households' decision-making regarding relocation amidst flood risks. The findings show households' reluctance to relocate contrary to relocation considered mostly as preferred adaptation. The likelihood of relocating exhibited a non-linear pattern, decreasing only when a population was younger until age 55 before reversing. Indigenous households preferred not to relocate. In communities where place attachment and revenue sources significantly impacted relocation decisions, households with secondary education, past flood experiences, and non-indigenous status influenced higher perception of flood risk. Therefore, relocation as an effective global adaptation strategy to floods is not widespread. Thus, empowering households to accept a certain level of flood risk potentially avoids maladaptation and involves a combination of hard infrastructure measures and regulatory approaches in places of residence that do not compromise livelihoods. However, if relocation becomes necessary, a right-based approach must be favored over an absolute risk-based approach.

Keywords

Sub-Saharan Africa, climatic risks, disaster, household characteristics, intersectionality, loss and damage, migration, urbanization

1.0 INTRODUCTION

The Intergovernmental Panel on Climate Change (IPCC) predicts an increase in land precipitation, leading to intensified flooding that requires clearly defined adaptation pathways to address the future risks (IPCC, 2022, 2023). However, the limited understanding of the complex interplay between social, economic, demographic, and physical factors underlying flood risks in urban areas of population densification and critical livelihood assets hinder effective flood risk management (Møller-Jensen et al., 2023; Islam et al., 2022; Jenkins et al., 2017; Skougaard Kaspersen et al., 2017). In particular, informal settlements that house vulnerable populations in urban areas are at higher risk accompanied frequently by decisions to relocate or not (Dovie et al., 2023; Mallick et al., 2023; Birkmann et al., 2016; Almoradie et al., 2020; Neumann et al., 2015; IPCC, 2023). However the concept of intersectional mobility and related migration analysis of combined socio-demographic and physical analysis is still emerging with mobility as adaptation tool for flood risks. Hence, this study analyzes the intersectionality of socio-demographic and physical determinants of households' decisions on using relocation as an adaptation strategy in Ghana's Greater Accra Metropolitan Area (GAMA). A large proportion of rural-urban migrants in Sub-Saharan Africa reside in informal settlements, facing extreme vulnerabilities to environmental changes (Bakkensen & Ma, 2020, United Nations Human Settlements Programme, 2010; Zickgraf et al., 2016). The growing population in flood-prone areas, especially in Sub-Saharan Africa and Asia, underscores the importance of individual behaviors in managing risks through voluntary relocation or retreat (Duijndam et al., 2023; Ekoh et al., 2023; Tellman et al., 2021). The impacts of floods are changing due to rapid urbanization, increased occupation of floodplains, and the state of flood management infrastructure (Tellman et al., 2021, Drews et al., 2020; Samu & Kentel, 2018; Atreya et al., 2017). However, relocation is often complex and undesirable, particularly for those with strong place attachment (Mallick et al., 2023; Dewa et al., 2022; McMichael et al., 2019). In Ghana, multiple hazards influence flood risks and outcomes, but data scarcity hinders understanding the key drivers of relocation decisions (Dewa et al., 2022; IPCC, 2022; Almoradie et al., 2020; Twerefou et al., 2019). Thus, there is much to learn about households' autonomous flood adaptation decision-making, considering the principles of intersectionality. In this paper, relocation refers to the movement of residents to physically separate locations, including perceived differences in neighborhoods (Kearns & Mason, 2013). However, a comprehensive understanding of the multifaceted interplay between socio-demographic factors (e.g., age, psychological state, perception, education, and tenancy) and physical factors (e.g., relative sea level, flood characteristics, and information) in adapting to floods is still emerging (Bubeck et al., 2012; Poussin et al., 2014). While relocation offers a certain level of adaptation, particularly in terms of physical security, it can lead to a reduction in livelihood security, cultural connections, and social capital (Arnall, 2018; Kablan et al., 2017; Usamah & Haynes, 2011). Culture and place attachments are significant factors shaping households' mobility decisions, whilst previous flood experiences and their perception of risk are crucial for effective flood risk management (Wiig et al., 2023; Oakes, 2019; Rana et al., 2020; Schlef et al., 2018; Shah et al., 2017).

2.0 METHODOLOGY

2.1 Study area description

The Greater Accra Metropolitan Area (GAMA) describes the urbanized local government areas of the Greater Accra region of Ghana which also has Accra as its regional and national capital. The region lies between longitude 0°1'W and 0°15'E and latitude 5°30'N and 0°15'E (Figure 1), covering an estimated area of 3,245 square kilometers with a projected population of about 4.9 million in 2019. The seven administrative areas in which the study was undertaken are referred to as the District (Figure 1) which represent the local arm of government, along a coastal low-lying – inland gradient to capture differences in social, economic, demographic and physical features. GAMA partly covers the southern part of Ghana, occupying a total area of 3,245 square kilometers, including Accra, the capital city, and located in the dry coastal equatorial climatic zone (The World Bank, 2017). Temperatures range between 20°C and 30°C, and annual rainfall is between 635 mm along the coast and 1,300 mm in its northern inhabitants. The GAMA has a history of floods with significant flood events recorded in 1973, 1986, 1995, 1999, 2001, 2002 and 2015 (The World Bank, 2017). It experiences two rainy seasons: a major season that occurs between May and ending in mid-July and a minor season that occurs between mid-August to the end of October which are interspaced with dry seasons (Government of Ghana, 2017). Rainfall at the seasonal scale is made up of increasing intensity and unusual cessation that makes onsets and occurrence difficult to predict. The GAMA records the highest flood-related deaths, injury, and damage to property in Ghana, which has almost become an annual event (Asumadu-Sarkodie et al., 2015; Codjoe & Afuduo, 2015; Twerefou et al., 2019), and mostly due to flash floods (e.g., Drews et al., 2020). Heavy and strong sea tidal waves erode the sandy coastline resulting in occasional flooding and estimated that by 2100, the coastline would retreat by 189 - 202m (The World Bank, 2017). Additionally, GAMA is no exception to pluvial and coastal floods, and at times fluvial during the peak of the major rainy season that results in rivers overflowing their banks both within and across the boundaries of the urbanized areas (Government of Ghana, 2017).

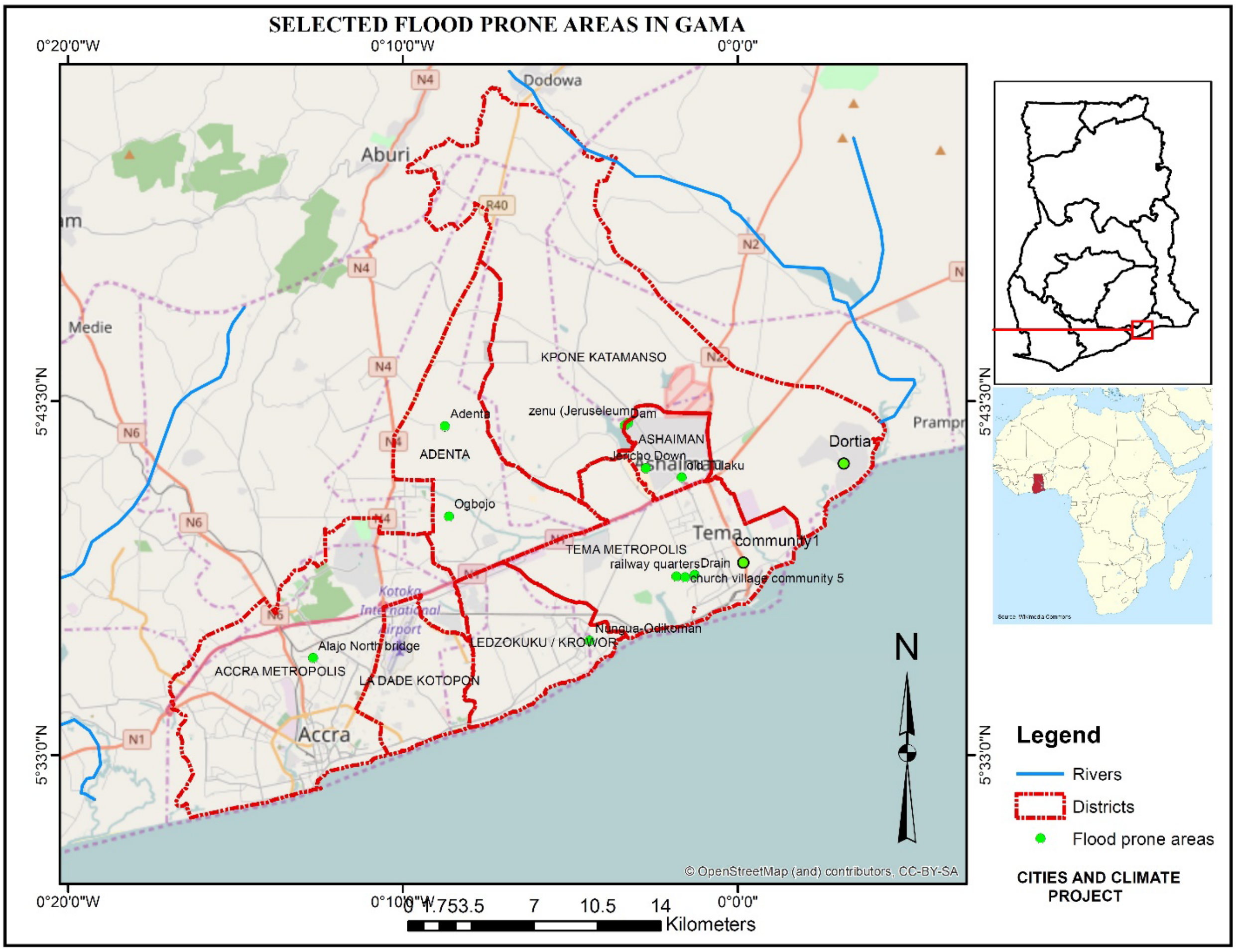

Figure 1. The Greater Accra Metropolitan Area (GAMA) in Ghana showing flood prone areas (green dots), and the study districts (Source: IDRC Cities and Climate Change Project 2020).

2.2 Materials and Methods

2.2.1 Analytical framework

The study follows the framework of utility maximization under uncertainty (Gbetibouo et al., 2010; Lokonon, 2016) to investigate the factors influencing households' decision to relocate or otherwise, from flood-prone areas. Assuming a household, ***i***, aim at maximizing the net present value of expected utility over a given period by choosing between flood risk-loving and flood risk-aversion. Then, following the revealed preference assumption, the household will choose option ***j*** (*leave the flood-prone area; risk aversion*) over option ***k*** (*remain in the flood-prone area; risk-loving)* if it believes that results in a high utility than the other. Thus:

$$U_{ij}(\beta_j^{'} X_i + \varepsilon_j) > U_{ik}(\beta_k^{'} X_i + \varepsilon_k) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

where the perceived utility by a household (***i***) from options ***j*** and ***k*** are respectively U_{ij} and

U_{ik} , $\boldsymbol{X_i}$ is a vector of explanatory variables influencing the option to be chosen, the vector of parameters to be estimated are $\beta_j^{'}$ and $\beta_k^{'}$ with the error terms given as ε_j and ε_k (Lokonon, 2016)

The observable choice of flood risk option can be related to the unobservable (latent) continuous net benefit variable as:

Y_{ij}=1 if U_{ij}>0 and Y_{ij}=0 if $U_{ij} \leq 0$.

where: Y is a binary dependent variable with a value of 1 when an option is chosen and 0 otherwise.

The probability that a household will choose flood risk option ***j*** over ***k*** can therefore be represented as:

$$P(Y_i = 1 \mid X_i) = P(U_{ij} > U_{ik} \mid X_i) \qquad \text{(2)}$$

$$P\left[\beta_j^{'} X_i + \varepsilon_j - \left(\beta_k^{'} X_i + \varepsilon_k\right) > 0 \mid X_i\right] \qquad \text{(3)}$$

$$P[(\beta_j^{'} - \beta_k^{'})\mathrm{X}_i + \varepsilon_j - \varepsilon_k > 0 \mid X_i] \qquad \text{(4)}$$

$$P\left[\varepsilon^* < \beta^* X_i \mid X_i\right] = F(\beta^* X_i) \qquad \text{(5)}$$

From equation (5), β^* $(\beta_j^{'} - \beta_k^{'})$ represents a vector of coefficients of factors considered to influence the decision of a household to relocate from a flood-prone area or not, ε^* $(\varepsilon_j - \varepsilon_k)$ is the error term with a cumulative distribution function (CDF) $F(\beta^* X_i)$ when evaluated at $\beta^* X_i$ and assumed to be normally distributed (Gbetibouo et al., 2010).

2.2.2 Empirical model

The empirical model that follows assumes that the error term has a normal distribution and hence the link function is probit. which can be specified as:

$$Y = \phi(X\beta + \varepsilon) \qquad \text{(6)}$$

$$\phi^{-1}(Y) = X\beta + \varepsilon \qquad \text{(7)}$$

$$Y = X\beta + \varepsilon \qquad \text{(8)}$$

$$relocation_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_n X_n + \varepsilon_i \qquad \text{(9)}$$

where: *relocation* is the dependent variable, β_1, β_2... β_n represent parameters to be estimated and X_1, X_2 ... X_n are variables influencing the choice decision of a household, categorized as socioeconomic, flood related, psychological and community variable. ε is a normally distributed error term.

Qualitative choice techniques such as linear probability, logit and Probit models are appropriate for this analysis because the dependent variable is binary. The linear probability model suffers from heteroscedasticity, non-normality of some elements and the possibility of the predicted value of the dependent variable not falling within the unit interval. Even though generalized least squares may partly overcome the problem of heteroscedasticity, truncating values of the dependent variable through logit analysis causes the problem of estimating parameters of a threshold decision model to remain (Jones et al., 1989). The Probit model is chosen because it overcomes these challenges by generating bounded probability estimates (Tambi et al., 1999) while the assumption of normality in the error term helps to overcome several specification problems (Wooldridge, 2013).

2.2.2.1 Dependent Variable

Households were asked if they will relocate from their community because of flooding, with a response of "Yes" (household is risk-averse) or "No" (household is risk-loving) (Lokonon, 2016). Based on this question, a Probit model to determine the factors influencing the relocation decision was run, with those not prepared to relocate as the reference. The summary statistics from the survey indicates that approximately 29% of households were prepared to relocate from their homes in flood-prone areas if that proposal is made to them.

2.2.2.2 Independent variables

Our model included twenty independent variables which have shown significant association with relocation due to environmental hazards from previous studies (Table 1). These variables capture socioeconomic, demographic, flood-related, and community-related factors.

2.2.3 Index of Adaptive Measure

An index representing "Adaptive Measure", based on eighteen indicator variables (Appendix 1) (e.g., availability of drainage network, early warning systems, emergency response system, access to health care facilities etc.) was constructed to estimate households' perception of measures put in place by the community and the local government to adapt to flooding. A positive response was assigned a value of one and zero otherwise. The responses were assigned equal weights and summed up. A higher value indicates that households perceive enough measures have been put in place to help them adapt to flooding.

2.2.4 Likelihood of households relocating

A stepwise robust and reliability analysis to assess the probability of households' decision to relocate as a result of floods was carried out (Table 2). Model 1 was used to assess the association between the socioeconomic and demographic variables and intensions to relocate. The Model 2 included the flood experiences of respondents such as the frequency and speed of water flow. Perceived flood risk was added to Model 3, and geophysical community level factors such as elevation introduced in the Model 4. The Pseudo R^2 improved as variables were added one after the other. Consequently, Model 4, becomes the preferred model and forms the basis for the analysis on relocation as it explains the most variance in relocation decisions building into it the effects of variables intersectionality.

2.3 Data

Data for the study was obtained from a Cities and Climate Change Project funded under a bilateral agreement in Ghana. The National Master Sampling Frame constructed from the 2010 Ghana Population and Housing Census (Ghana Statistical Service, GSS, 2013) was used to select households. A flood risk history and flood risk-prone map was developed to guide the choice of two purposively selected communities in each of the seven local government areas known as "districts", totaling fourteen. The Enumeration Areas (EA) demarcated by GSS for national surveys was adopted to ensure comparability with existing national statistics that included household listing and map-spotting exercises. Following the ordered sampling frame, thirty households were systematically selected using an equal probability procedure from each EA. Out of the total 1,260 targeted households 1,234 were surveyed of which 1,206, representing 97.73 % were completed. Of the 808 households that provided responses regarding their relocation decision, 770 were valid and used for the analysis.

2.4 Study limitations

2.4.1 The study was mainly cross-section which did not allow for comparisons to be made across the households and the districts over different flood periods.

2.4.2 The study focused on relocation within shorter distances rather than migration at the place of origin without capturing how destination events contributed to adaptation except for those ever relocated but returned to their places of origin.

2.4.3 The absence of separate national dataset linking flood-related variables to socio-demographic information meant that not much of the analysis compares favorably with existing national level datasets, although the Census Master Sampling Framework provide the non-flood specific variables to compare with the census dataset.

3.0 RESULTS

3.1 Background characteristics of households and relocation

The age of household heads ranged between 19 and 99 years (Table 1) across the study area, averaging 43.5 years, similar to the national average age of 45.2 years (GSS, 2019). An estimated 22.5% of households took residence within 5 years, 20,4% from 5 to 10 years and 57.1% over 10 years, as opposed to the national average of 46%, 18% and 36%, respectively (Ghana Statistical Service, 2013). For education, 9.2% of households did not have formal education, compared to the national dataset for urban households at 13.2%, Homeowners consisted of 40.9% against 59.1% tenants, comparing favorably with the 2010 Population and Housing Census (GSS, 2013) which established, that 35.2% of houses are occupied by owners while 64.1% are not, with 0.7% as other occupancies.

For those who owned houses, 13.3% were prepared to relocate in anticipation of flooding and 86.7% not. The indigenous households consisting of 17.5% would hardly relocate of which 91.1% of that proportion have had over ten years' stay. For the 82.5% households that were non-indigenes, half (49.9%) have stayed in their communities for more than ten years with 24% willing to relocate. Generally, 31.2% of the non-indigenous households would like to relocate in anticipation of flood compared to 15.6% of the indigenes. The proportion of households willing to relocate shows 56% attained Basic School Education, 23.1% Secondary / Technical education, 11.7% and 9.2%, with Tertiary Education and no formal education, respectively (Table 1), and within national level statistics.

Table 1: Descriptive statistics of the background characteristics of households

Variables	**Values**	**Min**	**Max**	**Average**	**Std. Dev**	**Exp. Sign**	**References that used variable.**
Relocate	1 if will relocate and 0 otherwise	0	1	0.2974	0.4574	-	Lokonon (2016), Bukvic et al. (2018), Landry et al. (2007)
Independent Variables							
Socioeconomic Variables							
Age	Continuous	19	99	43.4909	13.9635	+/-	Lokonon (2016), Shah et al. (2017)
Age Square	Continuous	361	9801	2086.187	1392.581	+/-	
Indigene	1 if born in community and 0 otherwise	0	1	0.1753	0.3805	-	Landry et al. (2007)
Length of stay in community	Less than five years (Yes =1, No =0)	0	1	0.2246	0.4176	+/-	Lokonon (2016), Landry et al. (2007), Bukvic et al. (2018)
	Between five to ten years (Yes =1, No =0)	0	1	0.2039	0.4032		
	Ten years and above (Yes =1, No =0)	0	1	0.5714	0.4952		
Ownership of a house	1 if house owner and 0 otherwise	0	1	0.4091	0.492	-	Shah et al. (2017), Landry et al. (2007)
Education	No formal Educ. (Yes =1, No =0)	0	1	0.0922	0.2895	+/-	Shah et al. (2017), Landry et al. (2007)
	Basic Educ. (Yes =1, No =0)	0	1	0.5597	0.44967		
	Secondary/Technical Educ. (Yes =1, No =0)	0	1	0.2312	0.4219		
	Tertiary (Yes =1, No =0)	0	1	0.1169	0.3215		
Home Loss	1 if lost home in previous floods and 0 otherwise	0	1	0.1052	0.307	+	Osberghaus (2017)
Income Loss	1 if lost income in previous flood and 0 otherwise	0	1	0.0922	0.2835		
Disease	1 if suffered from disease in previous floods and 0 otherwise	0	1	0.1390	0.3361	+	
Livestock loss	1 is lost livestock in previous floods and 0 otherwise	0	1	0.0260	0.1591	+	Osberghaus (2017)
Asset loss	1 if lost assets in previous floods and 0 otherwise	0	1	0.3896	0.4880	+	Osberghaus (2017), Bukvic et al. (2018)
Flood Related Variables							
Speed of Flow	Continuous	0.50	92.43	10.7234	21.4889	+/-	
Flood frequency	1 if flooding is frequent in community and 0 otherwise	0	1	0.7265	0.4460	+	
Material Support	1 if received material support and 0 otherwise	0	1	0.0506	0.2194	+/-	

Variables	Values	Min	Max	Average	Std. Dev	Exp. Sign	References that used variable.
Flood information	1 if receives flood information and 0 otherwise	0	1	0.2104	0.4079	+/-	
Psychological Variables							
Perception of flood risk	1 if perception of flood risk has not changed and 0 otherwise	0	1	0.5364	0.4990	+/-	Kellens et al. (2011), Liu et al. (2018)
	Increased (Yes =1, No =0)	0	1	0.1299	0.3364		
	Decreased (Yes =1, No =0)	0	1	0.3338	0.4719		
Predict flood	1 if able to predict flood and 0 otherwise	0	1	0.2494	0.4329	+	
Adaptive measures	Continuous	0	13	3.7493	2.5032	+/-	Mabuku et al. (2018)
Helpless	1 if perceive floods can be controlled and 0 otherwise	0	1	0.0831	0.2762	+/-	Wouter Botzen &Van Den Bergh (2012)
Physical / Community Variables							
Level above sea	Continuous	0	215.67	71.7204	57.9376	+/-	
Polluted water	1 if suffered from polluted water resulting from floods and 0 otherwise	0	1	0.4026	0.1967	+	

3.2 Experiences of floods and the response measures

3.2.1. Physical factors

Thirty-nine percent (39.0%) of households lost some assets, 10.4% lost homes, 13.9% suffered from flood-related ailments and some 2.6% lost livestock. Information on flood response measures from responsible institutions was received by 21.0% of households and related to awareness, effective preparation and evacuation. For households that receive some flood information, 38.3% are willing to relocate. Additionally, about 72.7% of the households stated that flood is a frequent occurrence in their communities and approximately 83.8% of households that are willing to relocate reported flood to be a frequent occurrence in their communities. Of the 5% of households that received some external material support from disaster managers, less than half (37.5%) would relocate if given the opportunity.

3.2.2. Flood risk perception

As indicated in Table 1, The value of flood risk perception which ranged from zero to thirteen (13), elicited an average value of 3.7 which is quite low compared to the expected maximum of 13. With regards to the perceived level of flood risk, an estimated 53.6% of households indicated that the level of flood risk has not changed, or they perceive no flood risk at all compared to the past five years. Estimated 13% and 33.4% of the households indicated that their perceived level of flood risk, respectively, increased and decreased compared to the previous five years. Additionally, 24.9% of households use their own experiences to predict flood occurrence towards reducing flood disaster risks, and for such households, 32.8% reported willingness to relocate.

3.2.3. Physical / community factors

The floor level of a household's dwelling was measured with reference to the sea level and ranged from 0 to 215.7 meters, averaging 71.7 meters. Coastal communities are mostly characterized by houses with low floors, making them easily prone to floods. Households also alluded to the fact that over the past 5 years, measures such as construction of additional drains, cleaning of clogged gutters and upgrading of existing drains to reduce flooding have been undertaken by them while the District Assemblies have improved waste collection, constructed sea defense walls, filled low-lying areas with sand and organized community clean-ups. The study further revealed that 6.7% of households suffered consequences of polluted water in previous floods.

3.3 Likelihood of households relocating

The Model 4 output suggests that age has a non-linear effect which is convex on the probability of relocating as a mitigation measure against flood, and thus, as individuals grow, they are less likely to relocate. However, if at later ages in their place of residence, they will be willing to relocate with external motivation.

Table 2: Factors Explaining the Likelihood of Relocating (Probit model)

Dependent Variable: Decision to relocate	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Socioeconomic Variable				
Age	-0.0330	-0.0403**	-0.0439**	-0.0470**
	(0.0205)	(0.0204)	(0.0206)	(0.0214)
Age Square	0.0003	0.0004*	0.0004**	0.0004**
	(0.0002)	(0.0002)	0.0002)	(0.0002)
Indigene	-0.0599	-0.0846	-0.0996	-0.1344
	(0.1574)	(0.1618)	(0.1624)	(0.163)
Length of Stay (Ref: 10 years and above)				
5-10 years	0.2719**	0.2545*	0.2661	0.2619*
	(0.1371)	(0.1391)	(0.1414)	(0.1419)
Less than 5 years	0.3824*	0.3758**	0.4079**	0.4157**
	(0.1408)	(0.11430)	(0.1474)	(0.1482)
House Owners (Ref: non-owners)	-0.8306***	-0.8437***	-0.8363***	-0.8319***
	(0.1195)	(0.1202)	(0.1239)	(0.1249)
Education (Reference: No education)				
Basic	0.2560	0.2361	0.3000	0.3025
	(0.2006)	(0.2049)	(0.2109)	(0.2151)
Secondary/Technical	0.4663**	0.4289*	0.4578	0.4674**
	(0.2199)	(0.2235)	(0.2298)	(0.234)
Tertiary	-0.1085	0.01313	0.1968	0.2213
	(0.2460)	(0.2529)	(0.2576)	(0.2622)
Home Loss	0.3339*	0.3188*	0.2635	0.1998
	(0.1710)	(0.1681)	(0.1761)	(0.1954)
Income Loss	0.3880**	0.3651**	0.3917	0.3662**
	(0.1654)	(0.1674)	(0.1745)	(0.1744)
Disease	0.2605*	0.2559*	0.2050	0.2482
	(0.1483)	(0.1504)	(0.1530)	(0.1699)
Livestock Loss	-0.1210	-0.1453	-0.1439	-0.1419
	(0.3268)	(0.3231)	(0.3423)	(0.3432)
Asset Loss	0.4915***	0.3819***	0.3128	0.2800**
	(0.1071)	(0.1120)	(0.1259)	(0.1281)
Flood Related Variables				
Speed of flow		0.0009	-0.0008	-0.0015
		(0.0026)	(0.0027)	(0.0028)
Flood Frequency		0.4062**	0.3710***	0.4239**
		(0.1300)	(0.1332)	(0.1348)
Material Support		0.0542	0.1392	0.1056
		(0.2196)	(2240)	0.2211)
Flood Information		0.3433**	0.3710*	0.3255**
		(0.1286)	(0.1301)	(0.1324)
Psychological Variables				
Perception of Flood risk (Ref: not changed)				
Increased			0.4268***	0.4322**
			(0.1747)	(0.1755)
Decreased			0.0894**	0.0671
			(0.1301)	(0.1313)
Predict flood			-0.1437	-0.1766
			(0.1322)	(0.1354)
Adaptive Measures			-0.0584	-0.0555**
			(0.0215)	(0.0216)
Feeling Helpless about Flooding			0.3802	0.3368*
			(0.1887)	(0.1986)
Community Variables				
Level above sea				-0.0024**
				(0.0010)
Polluted Water				0.0864

				(0.3355)
Constant	-0.1479	-0.3034	-0.1131	0.1671
	(0.5360)	(0.5360)	(0.5555)	(0.5708)
Observations	**770**	**770**	**770**	**770**
Pseudo R^2	**0.1459**	**0.1656**	**0.1836**	**0.1895**

Source: Authors' estimation from survey, 2017
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

3.3.1. Home ownership

The Probit model shows that households in their own dwelling are less likely to relocate compared to those who are not. The marginal effect indicates that the probability of homeowners not relocating compared to tenants was 23.3%.

Table 3: Results of Marginal Effects

Dependent Variable: Decision to relocate	Marginal Effects (*Model 4*)
Socioeconomic Variables	
Age	-0.0132** (0.0059)
Age Square	0.00012** (0.00006)
Indigene	-0.0376 (0.0453)
Length of Stay (Ref: 10 years and above)	
5-10 years	0.0737* (0.0409)
Less than 5 years	0.1207** (0.0441)
House Owners (Ref: non-owners)	-0.2326*** (0.0317)
Education (Reference: No education)	
Basic	0.0787 (0.0520)
Secondary/Technical	0.1264** (0.0590)
Tertiary	0.0563 (0.0657)
Home Loss	0.0559 (0.0545)
Income Loss	0.1024** (0.0481)
Disease	0.0694 (0.0472)
Livestock Loss	-0.0397 (0.0959)
Asset Loss	0.0783** (0.0354)
Flood Related Variables	
Speed of flow	-0.0004 (0.0008)
Flood Frequency	0.1185** (0.0371)
Material Support	0.0295 (0.0618)
Flood Information	0.0910** (0.0364)
Psychological Variables	
Perception of Flood risk (Ref: not changed)	
Increased	0.1284** (0.0537)
Decreased	0.0186 (0.0365)
Predict flood	-0.0494 (0.0378)
Adaptive Measures	-0.0155** (0.0060)
Feeling Helpless about Flooding	0.0942* (0.0551)
Community Variables	
Level above sea	-0.0007** (0.0003)
Polluted Water	0.0242 (0.0938)
Observations	**770**

Source: Authors' estimation from survey, 2017
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

3.3.2. Length of stay in residence

Households that have stayed in their communities for less than five years or between five to ten years are more likely to relocate compared to those for more than ten years. From the marginal effect, the probabilities were estimated at 12.1% and 7.4%, for those that have stayed less than five years, and between five and ten years, respectively.

3.3.3. Education

The models further explain that household heads that have attained secondary/technical education have a higher probability of relocating, compared to household heads without education, with a probability of 12.6% from the marginal effect results. There was no significant difference between the probability of those with Basic and Tertiary education relocating compared to those without education.

3.3.4. Effects of previous floods

Households that lost income and assets from previous floods are more likely to relocate compared to those that did not. The marginal effect indicates that households that have been impacted by previous floods and suffered losses in income and assets are 10.2% and 7.8%, respectively more likely to relocate compared to those who have not suffered such losses. This supports Osberghaus (2017) who showed that households that have been affected by floods have the motivation to relocate to reduce vulnerability to flooding. Seemingly so households that perceive flood as occurring frequently in their place of residence, have a higher probability of relocating compared to those who do not, having a marginal effect of approximately 11.9% from the model.

3.3.5 Climate and welfare support services

Households that receive prior flood information are more likely to relocate, and an estimated 9.1% higher probability to relocate than not. The marginal effect shows that households that feel helpless in times of floods which account for 9.4% of all households in this study will likely relocate. Households' perception of the responsiveness of flood disaster managers through relief, ambulance services and security would influence their willingness to relocate or otherwise, as the probability of relocating decreases with increased adaptive measures. Thus, a unit increase in adaptive measures reduced the probability of relocating by 1.6%.

3.3.6 Flood prediction

Households that perceived flood risk as having increased over the past five years in their communities are more likely to relocate compared to those that perceived no change in flood risk. There was no significant difference between households that perceive flood risk to have decreased and those that perceive it to be the same regarding their readiness to relocate if they were presented with the opportunity.

4.0 DISCUSSION

4.1 Sociodemographic related dynamics of flood

Floods pose significant threats to lives and properties, attributed to the increasing acquisition of household assets in flood-prone areas and lack of adequate risk transfer mechanisms in Accra (Amoako & Frimpong Boamah, 2014). The ownership of household items such as fans, televisions, and fridges has increased in urban households, and contributing to the growing risk (GSS, 2014, 2019). Managed relocation or retreat has emerged to address flood risks, particularly in coastal cities affected by climate change (Dovie, 2017; Wagner et al., 2021; Siders et al., 2019). However, vulnerability to floods is perceived differently and influenced by population attributes of which age plays significant role in flood perception and relocation decisions. Older individuals often are more vulnerable due to mobility and place attachment concerns (Lokonon, 2016), and health fragility as observed in countries like Côte d'Ivoire (Kablan et al., 2017). Successful short-distance relocation of primarily older households has been reported in Vietnam (Zickgraf, 2019). Homeowners are generally less likely to relocate compared to tenants, as a result of place attachment and property protection incentives (Duijndam et al., 2023; Landry et al., 2007; Zickgraf, 2019). Relocation has been shown to provide physical and mental health security following floods, yet the effects of indigeneity and place attachment are key (Yiannakoulias et al., 2018), varying with temporary relocation in anticipating floods, reinforcing houses, and other protection (Shah et al., 2017). As communities become more familiar with flood occurrences over time, they develop adaptive strategies and build resilience, decreasing the likelihood of relocation (Wiig et al., 2023; Douben, 2006).

4.2 Knowledge management and relocation intentions

The findings show that households equipped with prior flood information are more inclined to consider temporary relocation, including early flood warning and access to location-specific risk knowledge and preparedness. Permanent relocation frequently comes with concerns about the adverse impact of prospective relocation including education of children's education (Lokonon, 2016), when lifelong residents develop a strong sense of belonging, entitlement, and emotional attachment (Dewa et al., 2022; Askman et al., 2018; Mabuku et al., 2018). Individuals deeply connected to their personal, intergenerational, cultural, and spiritual roots tend to be relocation - averse regardless of existing risks (Heslin et al., 2018; Hino et al., 2017; Seebauer & Winkler, 2020; Wagner et al., 2021). The study's finding that relocation probabilities decrease as adaptive measures increase underscores the importance of prior knowledge of flood risks in enhancing preparedness. Addressing the lack of awareness among households settling in flood-prone areas is crucial, necessitating the integration of flood risk information into land use plans and settlement zoning whilst deploying timely and user-friendly communication (Dovie, 2017). Educating local populations about current and expected changes in their communities will facilitate informed mobility decisions (Zickgraf et al., 2016) by engaging at-risk populations through understandable warning dissemination (Wagner et al., 2021). Higher levels of flood preparedness have been reportedly associated with a stronger sense of community and self-efficacy (Mabuku et al., 2018), indicating that resilient neighborhood networks can fortify resident preparedness and discourage relocation. To ensure effective dissemination of flood risk information, early flood warning and location-specific information remain critical to household preparedness and aligning with the principles of the Sendai Disaster Risk Reduction Framework (UNISDR, 2015).

4.3 Policy and adaptation perspective

In flood-prone urbanized Accra, restricting settlement is not feasible due to the heavily built environment, weak regulations, and poorly planned infrastructure. The second-best option is implementing engineering measures like upgrading floodwalls, dams, channels, and levees (Skougaard Kaspersen et al., 2017; Liu et al., 2017). However, high population densities hinder the effectiveness of these solutions. Under such conditions, strategic relocation of settlements and populations is inevitable (Bukvic et al., 2018; Siders et al., 2019; Fernando, 2018). Relocation programs should incorporate incentives and effective risk communication to encourage participation, given the generally low support for relocation found in this study and others. Lack of awareness indicates weak perception among households regarding available adaptation measures. Thus, targeted risk communication efforts should focus more on young people, while specific schemes for the elderly can provide additional welfare benefits for the younger population. Globally, relocation decisions are challenging, and a rights-based approach is crucial, considering that at-risk residents often depended on disaster-prone situations for livelihoods (Zickgraf, 2019). Economic factors and access to public services play significant roles in relocation choices (Douben, 2006), but does not represent underestimation of flood risks but rather reflects individuals' risk preferences (Willis et al., 2011). Households feeling helpless about mitigating floods are more likely to consider relocation, but potential traps may arise in the process (Dewa et al., 2022; Codjoe et al., 2017). The success of relocation, whether voluntary or compulsory, depends on people's trust in the safety and suitability of the new location (Jha, 2010), and that, households that perceive flooding as beyond human control are less likely to obtain flood insurance, making relocation a preferable option (Wouter Botzen & Van Den Bergh, 2012). Generally, populations that perceive high flood risk are more inclined to relocate (Burnside et al., 2007; Liu et al., 2018). Dwellings situated at higher elevations are less likely to relocate, as they feel less vulnerable to flooding often waiting for the flood run-offs to recede quickly (Siders et al., 2019; Zickgraf, 2019). Managed relocation or retreat programs have become integral to climate-smart flood management, contributing to adaptation and overall development goals (Siders et al., 2019; Zickgraf, 2019). Thus, managing relocation based solely on risk is not sustainable for addressing the multifaceted outcomes of risk reduction, and climate change adaptation. The awareness of flood risks alone does not drive relocation decisions for most households, and elsewhere, up to 30% of households abandoned relocation in favor of permanent return to their original areas, despite their vulnerability to flooding (Arnall, 2018). This implies that the assertion of migration an important adaptation for those in flood prone areas in the face of increased climate change will lose its significance (Wiig et al., 2023).

5.0 CONCLUSION

Most households will reluctantly adopt relocation as an adaptation strategy in responding to flood risk, linked to destination uncertainties and their unique and varied background characteristics. Therefore, the intersectionality of socio-demographic and physical factors either enables or hinders relocation decisions. Looking into the future, and rethinking risk-led approaches to relocation management of flood risk faces challenges due to the influence of autonomous adaptation, requiring comprehensive evaluation to transform household decision-making. Relocation decisions are structured based on aspirations and capabilities, with some households lacking both. Flexibility and adaptive management strategies are necessary, along with a combination of human, physical, and nature-based approaches, to effectively address flood risks and sustainable livelihoods. Analyzing acceptable flood risk levels of households and increasing adaptive capacities are crucial policy concerns, as smart engineering solutions and co-benefits for resilience and sustainability are part of the solutions. Hence, the entirety of households' origins and destinations must be thoroughly studied using the intersectionality approach to understand the role of relocation as adaptation strategy to floods and its impact on agglomeration economies and livelihoods.

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Appendix 1: Probit model input of eighteen variables

	relocate	agey	agey2	indegen	length~y	houseo~p	educle~l	homeloss	income~s	disease	livest~k	asset	gamaflow	flood_~y	hhmats~p	floodi~o	percei~k	predic~d	availa~m	helpless	gamaelev	pollut~r
relocate	1.0000																					
agey	-0.1768	1.0000																				
agey2	-0.1638	0.9844	1.0000																			
indegen	-0.0684	0.0004	0.0116	1.0000																		
lengthofstay	0.1777	-0.3235	-0.2991	-0.2957	1.0000																	
houseowner~p	-0.2986	0.3255	0.3190	0.1096	-0.2852	1.0000																
educlevel	0.0375	-0.2277	-0.2171	0.0536	0.1204	-0.0995	1.0000															
homeloss	0.1044	0.0042	0.0003	-0.0227	-0.0479	0.0110	-0.0992	1.0000														
incomeloss	0.0971	0.0406	0.0343	-0.0053	-0.0512	0.0270	-0.0748	0.1122	1.0000													
disease	0.0836	-0.0653	-0.0618	-0.0371	-0.1091	0.0094	-0.0552	0.2693	0.0536	1.0000												
livestock	-0.0169	0.0627	0.0555	0.0750	-0.1000	0.0634	0.0257	0.1317	0.0044	0.0996	1.0000											
asset	0.1677	-0.0399	-0.0439	0.0659	-0.1003	0.0394	-0.1016	0.1120	0.1228	0.0794	0.0370	1.0000										
gamaflow	0.0429	-0.0403	-0.0538	-0.0309	-0.0410	0.0002	-0.0370	-0.0173	-0.0491	-0.0363	0.0094	0.1979	1.0000									
flood_freq~y	0.1723	-0.0311	-0.0400	-0.0542	0.0039	0.0198	-0.0805	0.0989	0.1391	0.1506	0.0293	0.2855	0.0334	1.0000								
hhmatsupp	0.0441	-0.0493	-0.0484	0.0025	-0.0250	0.0126	-0.0113	0.0184	0.0902	0.1298	-0.0005	0.1434	0.1115	0.0519	1.0000							
floodinfo	0.0963	-0.0109	-0.0123	0.1391	-0.0420	-0.0212	0.0182	-0.0400	-0.0324	-0.1060	0.0359	0.0515	0.2221	0.0386	-0.0030	1.0000						
perceivedf~k	0.1198	-0.0030	-0.0023	0.0613	-0.1684	0.0053	-0.0421	0.1973	0.1153	0.2337	0.1888	0.4615	0.1320	0.2357	0.1360	0.0939	1.0000					
predictflood	0.0387	0.0040	0.0036	0.0500	-0.0125	0.1493	-0.0579	0.0694	0.1691	0.0896	0.0191	0.3521	0.0442	0.2730	0.1270	0.0486	0.2634	1.0000				
available_~m	-0.1131	0.0183	0.0193	-0.0166	-0.0549	0.0380	-0.0219	-0.0050	0.0212	-0.0168	0.0131	-0.0871	-0.0210	-0.0314	0.0373	0.0568	0.0091	-0.0166	1.0000			
helpless	0.0099	-0.0072	-0.0044	-0.0027	-0.1076	0.0748	-0.0691	0.0671	-0.0797	0.0422	0.0396	-0.0380	0.0178	-0.0738	-0.0266	-0.0400	-0.0002	-0.0648	0.0621	1.0000		
gamaelev	-0.1234	-0.0078	0.0027	-0.1281	0.0838	0.0126	0.0949	-0.0876	-0.0772	0.0968	-0.0411	-0.2884	-0.4135	-0.0321	-0.1109	-0.2369	-0.1783	-0.1636	0.0655	-0.0501	1.0000	
pollutewater	0.0691	-0.0801	-0.0716	-0.0249	-0.0904	0.0043	-0.0536	0.4499	0.0032	0.4143	0.1327	-0.0011	-0.0333	0.0396	0.0732	-0.0085	0.2270	-0.0264	0.0813	0.2016	-0.0199	1.0000