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Social perceptions of coastal hazards in the Anlo Beach Community in the Western Region of Ghana

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Abstract

Due to climate change, coastal areas are becoming increasingly susceptible to more frequent and severe environmental catastrophes that endanger the health, safety, and way of life of coastal dwellers. Understanding the social perceptions of risk and hazard-related concerns can help in the development of adaptive capacity and associated management strategy preferences. This study employed structured questionnaires to obtain basic information on how the households of the Anlo Beach fishing community in the Western region of Ghana perceived and responded to coastal hazards. The respondents ranked coastal erosion and salinization first and second, ahead of seawater flooding and other hazards in terms of important risks in the study area. Responses illustrated high levels of knowledge and awareness about coastal hazards but low levels of trust in government and commitments in terms of taking personal mitigation measures. To varying degrees, respondent characteristics such as length of residency and occupancy status are positively and significantly associated with coastal hazard perception whereas the level of education was negative. Generally, the findings illustrated the need for better education and awareness campaigns about self-mitigation actions such as discontinuing beach sand utilization and exploiting mangroves as firewood and embracing the restoration of mangrove ecosystems. More importantly, the government should reconsider her earlier shelved plan of relocating the entire community to a safer location.

Keywords: *Social perception; coastal hazards; coastal erosion; salinization; Anlo Beach; Ghana coast*

Introduction

Globally, coastal areas are becoming more vulnerable to the impacts of increased extreme weather events, storm surges, and sea-level rise due to climate change (Barnard *et al.*, 2019; Cazenave and Le Cozannet, 2014; Mölter *et al.*, 2016; Neumann *et al.*, 2015) that pose threats to health, safety, and livelihoods of the coastal dwellers (Elrick-Barr *et al.*, 2015; Nicholls *et al.*, 2011; Burkett and Davidson, 2012). Aside from pressure resulting from the growing coastal population, most coastal areas are increasingly affected by climate change-induced coastal erosion and/or flooding (Barnard *et al.*, 2019) resulting from sea-level rise (Cazenave and Le Cozannet, 2014) and possible changes in wind/wave conditions and storm regimes (Ruz *et al.*, 2020; Mölter *et al.*, 2016). Climate change will therefore increase the vulnerability of the coastal areas to hazards.

Understanding public perceptions and the relative priorities given to coastal risk can help in the development of adaptive capacity and associated adaptation strategies (Button, 2013; Carlton and Jacobson, 2013), as perceptions tend to shape individual behaviour (Slovic, 1987; Lindell and Hwang, 2008) and management strategy preferences (Slovic, 1987; Steg and Sievers, 2000; Peacock *et al.*, 2005; Button, 2013). Also, Social perception of risks can constrain and influence political, social, and economic activities (Leiserowitz, 2006). The household has been identified as a valuable unit of analysis for perceptions of risk because it is a unit of action that exists between individuals and society, where personal values, societal norms, and institutional demands converge (Elrick-Barr *et al.*, 2015; Collins, 2015).

This paper assesses the risk perceptions and preferred strategies for facing future coastal hazards at the household scale of the Anlo coastal community of the Western region of Ghana. The study area was chosen because it is characterized by the problem of coastal erosion and marine flooding that may likely increase in the future due to rising sea levels and a higher frequency of extreme events associated with climate change (IPCC, 2012; 2021). We begin the paper by outlining the methods adopted to evaluate household risk perceptions in Anlo coastal community. Finally, results are discussed, highlighting variation in risk perceptions within and between the communities, before outlining key considerations for policy and research.

Study site

The Anlo Beach community (Figure 1) was purposefully selected as the study site because coastal flooding and shoreline erosion are increasingly impacting people, property, and ecosystems in this section of the Ghana coast (CRC, 2013; Mutimukuru-Maravanyika et al., 2017). Thus, it is believed that people in this area will recognize their vulnerability and have higher perceptions of risk (Brody et al., 2008).

The Anlo Beach coastal community, comprising 740 households (population ca. 4500), is located in the Shama District, Western Region of Ghana (Fig. 1). It is bordered to the north by mangroves and wetlands associated with the Pra River Delta that extends from the north-eastern to the western side of the community and on the south by the open Atlantic Ocean. The community, built on a dune and sandwiched between the wetlands and the ocean, is highly vulnerable to floods and erosion (Mutimukuru-Maravanyika et al., 2017). Although the Pra River and its associated mangroves and wetland areas are highly important for livelihoods, pollution of the river by illegal gold mining and indiscriminate cutting of mangroves is increasing (Mutimukuru-Maravanyika et al., 2017). The dominant livelihoods in the Anlo Beach community are fishing, petty trading, fish selling, and processing. Other popular occupations included: tailoring, hairdressing, catering, and fabric dyeing.

The intensity of the use of natural resources in Anlo Beach

Anlo Beach has a vast array of livelihood assets and potentials and a few services. Natural capital includes the sea and fisheries resources, beaches, sand, River Pra Estuary, wetlands including swamps and salt marshes, mangrove swamp, mangrove forests, dry land, and farmlands. The surrounding area possesses ecological features that are interesting to eco-tourism. The Pra River estuary provides suitable roosting and nesting grounds for birds and marine turtles. Mangroves of the genera *Avicennia*, *Rhizophora*, and *Laguncularia* are found along the entire perimeter of the Pra River and its estuary and extend over three kilometres on both sides of the estuary (Okyere, 2015; Coastal Resources Center / Friends of the Nation, 2010). These mangroves are highly exploited as the main source of firewood for cooking and smoking fish and for construction purposes in the community thereby resulting in the degradation of the mangrove forest and reduction in the size of this critical habitat for fish breeding activities. Degraded mangrove areas

are used as refuse disposal sites. In addition, sand is wined from the beach for construction purposes in the study community. This activity tends to increase coastal erosion and flooding (Kutir et al., 2022). Further north of the community has located the farmlands. Fishers in this community are actively involved in artisanal marine fishing as well as estuary fishing. Fishing and fish mongering are the major livelihood activities running from mid-July to late April while subsistence farming becomes the predominant occupation after April, lasting for about three months in the off-fishing season after which the community switches back to fishing in mid-July or early August for the main fishing season. Not all fishermen practice farming during the off-fishing months, and only a few members of the community are small-scale farmers who only fish for subsistence. Cassava and maize are the major crops produced although a few farmers cultivate cash crops such as oil palm and coconut (Okyere, 2015; Coastal Resources Center / Friends of the Nation, 2010).



Fig. 1. a) Map Anlo Beach coastal fishing community. Inset: map of Ghana (sources: Mutimukuru-Maravanyika et al., 2017).

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109

110 Figure 2. The environmental situation in the Anlo Beach community: a) erosion; b) loss of mangroves due to erosion;
 111 and c) impact of salinization.

112

113 2 Materials and Methods

114 A household survey was conducted in the Anlo Beach community in the Western Region of Ghana
 115 to obtain information on household risk perceptions. The survey, in which 156 respondents
 116 participated, was conducted as part of the West Africa Coastal Area – mapping Vulnerability,
 117 Adaptability and Resilience in changing climate (WACA-VAR) project, between July and August
 118 2021 by a team of researchers from the Centre for Coastal Management-African Centre of
 119 Excellence in Coastal Resilience (CCM-ACECoR), University of Cape Coast, Ghana, and the
 120 Institut de Recherche pour de Developpement (IRD), Toulouse, France. The interviews were
 121 conducted face-to-face with a systematic selection of every 5th household to ensure that the results
 122 that will be obtained from our survey will approximate what would have been obtained if the entire
 123 population had been surveyed.

The survey, with 156 questions, consists of several parts, out of which three are common to all respondents. First, an identification of the survey site with its GPS coordinates and locality (section A). Then section B is based on the characteristics of the respondents, focusing on the respondents' place of residence, age, sex, professional activity, level of academic education, and attachment to the place. Section C is composed of two questions, dealing with the risks linked to the hazards and potentially dangerous phenomena observed and identifying the two phenomena that most affected the respondents. The respondents were allowed to rank the hazards that largely impact their lives, whether salinization, coastal erosion, coastal flooding, plastic pollution, or oil pollution.

Section D corresponds to a series of detailed questions based on the most impacted hazard noticed in section C. Questions were broadly structured around the manifestation of the hazard observed by the respondent, its evolution in recent years, the impact of the hazard on the individual, and possible measures that are taken or could be put in place in the management of these potential or actual hazards (Louarn, 2020; Morand, 2021). Kobo connect software, installed on mobile phones, was used to conduct the interview. In most cases, responses provided to the questionnaire were used directly as binary or multi-modal variables.

2.1 Descriptive statistics analysis

A descriptive statistics analysis was performed to describe the personal characteristics of the respondents, thus providing the structure of the sample.

2.2 Construction of composite indices for Linear Regression analysis

To consolidate and make more synthetic information in the evaluation of global perceptions, we created composite indices from binary/multi-modal answers to basic inquiries. To do it, we employed different subsets of questionnaire answers for this construction, which were sometimes binary choice answers and sometimes responses on ordered qualitative scales. Each composite index was calculated by adding values of 1 or 0 applied to the response categories obtained, thereby creating two synthetic indices: indices of (i) perceived impact and (ii) adaptive measures. The two indices were presented in the form of quantitative scores which will play, in turn, the role of the dependent variable for the analyses carried out using the linear model. Each of the two synthetic indices was then analyzed using a linear model. For the two indices, seven variables were used. No

variable taken into account in the construction of a composite index is reused as an explanatory factor for the same index, which prevents any risk of circularity in the interpretation of the results. The coefficients of the model were estimated using the Linear Regression analysis in the SPSS software. Only significant effects up to the 10% ($p < 0.1$) threshold were retained and discussed. The value of the coefficient was used to identify the direction of the effect (positive or negative) on the evolution of the index.

3. Results

3.1 Descriptive analysis

3.1.1 Basic characteristics of the respondents

Ninety-nine percent of the survey respondents lived at the study site. About 53% of them were permanent homeowners while 46.5% were non-permanent owners. Only 10% of the respondents had lived less than 10 years in the study site, indicating the majority (90 %) of them had lived in the area for more than 10 years. Of the survey respondents, 61% were females while 39% were males. Out of the entire respondents, 57.1% were between the ages of 18 and 50 years. About 11.5% of the respondents had a higher tertiary education while 26.3% never went to school (Table 1).

Table 1. Descriptive statistics of the respondents

Variable	Response	Percentage
Gender		
Female	95	60.9
Male	61	39.1
Age		
17-25	17	10.9
26-50	75	48.1
>50	64	41
Education		
Illiterate	41	26.3
Primary	59	37.8
Secondary	38	24.4
Tertiary	18	11.5

Length of residence

Permanent	83	53.2
>10 years	57	36.5
5-10 years	7	4.5
<5 years	9	5.8

Occupancy status

Permanent owners	83	53.5
Non-permanent owners	72	46.5

3.1.2. Intensity in the usage of natural resources

As shown in Table 2, freshwater, mangrove wood, and beach sand were identified by the respondents to be of high use in the study area. About 75.7% of the respondents indicated high usage of freshwater while 9.6 and 14.7% of the respondents, respectively, indicated low and moderate utilization of freshwater. About 58.8% of the respondents indicated high use of mangrove wood for domestic and professional activities, while 32.7 and 8.5% indicated low and moderate usage. While beach sand was highly used by 62.8% of the respondents, river sand had low utilization (by 76.7% of the respondents).

Table 2. Usage of coastal natural resources in Anlo Beach based on the respondents' perception***Freshwater usage***

Low	15	9.6
Moderate	23	14.7
High	118	75.7

Mangrove wood usage

Low	50	32.7
Moderate	13	8.5
High	90	58.8

River sand usage

Low	115	76.7
Moderate	8	5.3
High	27	18

Beach sand usage

Low	43	27.6
Moderate	15	9.6
High	98	62.8

3.1.3 Perceived coastal hazards assessment

To explore the level of perception of coastal hazards in the study area, first, the respondents were asked to select three hazards they perceived to have the greatest impacts on their lives and properties (Fig. 2).

As shown in Figure 2, coastal erosion (46.8 %) was on top of the list of the first major ranking coastal hazards perceived by the respondents in the study area, followed by salinization (30.1 %) and seawater flooding (23.1 %). Salinization (50.6 %) overwhelmingly topped the list under the second major ranking of coastal hazards perceived by the respondents, followed by coastal erosion (23.7 %) and seawater flooding (21.2 %). Plastic and wastewater pollution were not cited under the first major ranking of coastal hazards perceived by the respondents in the study area but only slightly mentioned under the second major ranking of coastal hazards perceived by the respondents (Fig. 2) whereas oil pollution and sewage pollution were never mentioned at all. Thus, coastal erosion and salinization being the first 2 major coastal hazards perceived by the respondents in the study area were considered in the present study.

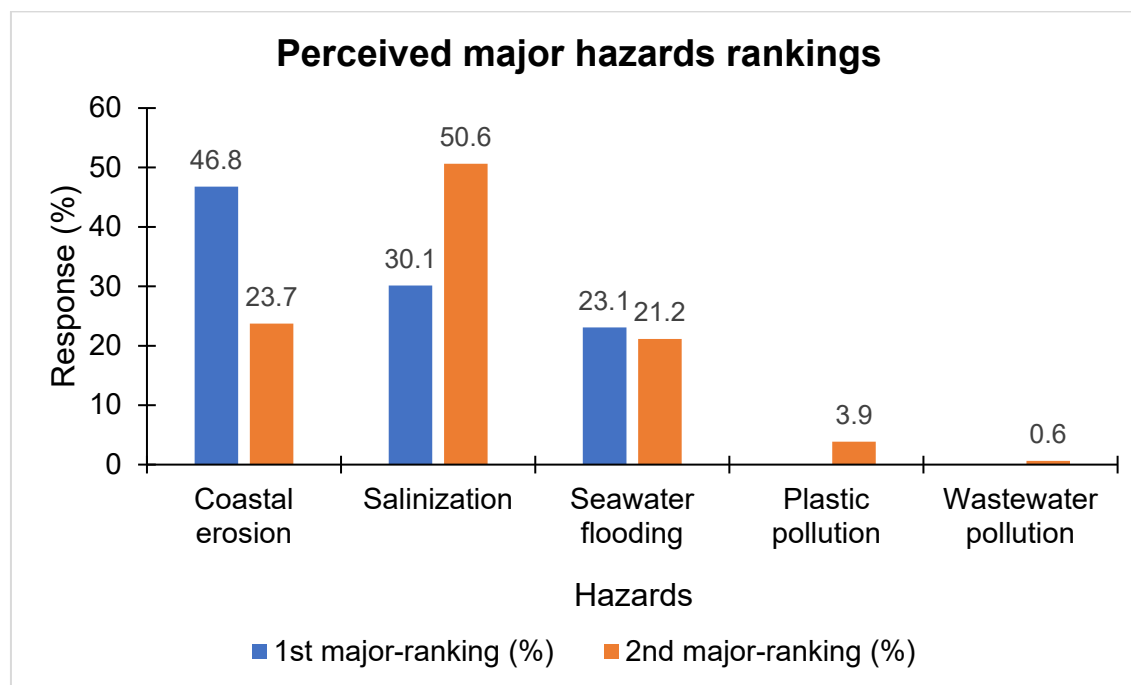


Fig. 2. Major ranking of coastal hazards as perceived by the respondents

3.1.4. Knowledge, causes, potential impacts, and approaches to reducing coastal hazards risks

This section explores respondents' perceptions of the causes and potential impacts and their approach to mitigating the major coastal hazard risks.

Perceived knowledge and awareness about coastal erosion

The majority of the respondents (88.5%) stated that there has been strong coastal erosion in the last 10 years while only a few (1.9%) believed that it was little (Fig. 3a). About 94.2% of respondents believed that the shoreline had moved landward more than it was 10 years ago, and 2.6% argued that it was constant (Fig. 3b). While most respondents (70%) pointed out that the erosion was highest near the Pra Estuary inlet, others (30%) believed that it was everywhere along the coast.

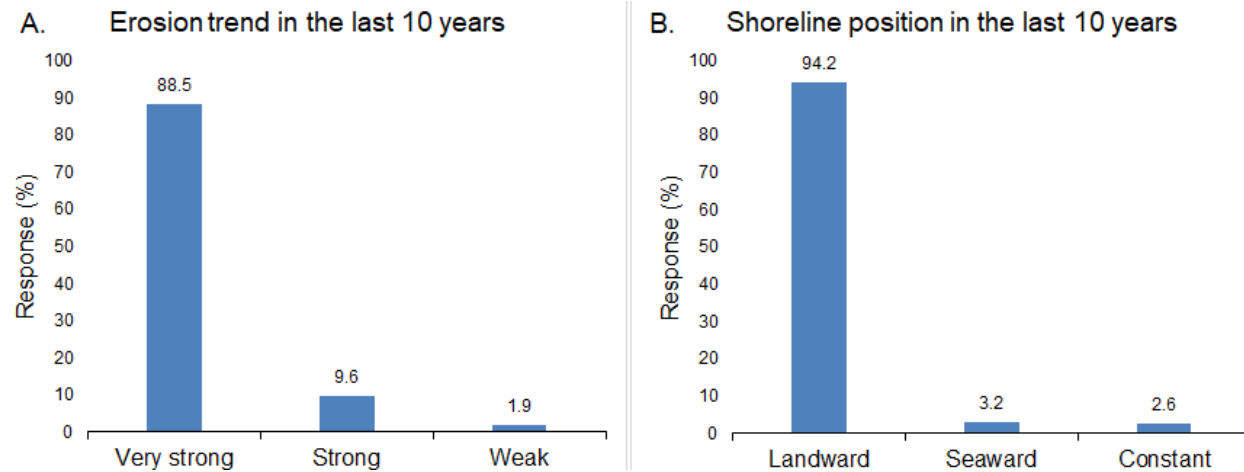


Fig. 3 a) Erosion trends in the last 10 years; b) Shoreline positions in the last 10 years as perceived by the respondents

Seasonality and major causes of erosion

As shown in Fig. 4a, the respondents considered coastal erosion (or a landward advance of the sea) to be higher between May and September and least between October and April. However, about 58% of respondents maintained that the beach never returned to where it was previously, indicating a high level of vulnerability in the area. When asked about the major causes of the erosion phenomenon in the study area, the majority of the respondents (68.7%) linked it to the combined effects of natural factors (Fig. 4b) such as wave actions, sea-level rise, tidal waves, river flooding, and seasonal cycles. While about 12.7% of the respondents linked erosion in the study area to human activities (Fig. 4b) like beach sand mining, harbour construction at Sekondi and Takoradi, nearby sea defense at Aboadze, the opening of the Pra River estuary inlet, and building houses near

the coast; 18.6% of them believed it was both natural and human-induced (Fig. 4b). The majority of respondents (75%) believed that erosion became aggravated during some events or years. For example, the combined effects of river and sea flooding events during the 2005/2006, 2014/2015, and 2017/2018 periods were considered to have aggravated coastal erosion in the study area, indicating a high level of awareness about the vulnerability of the area.

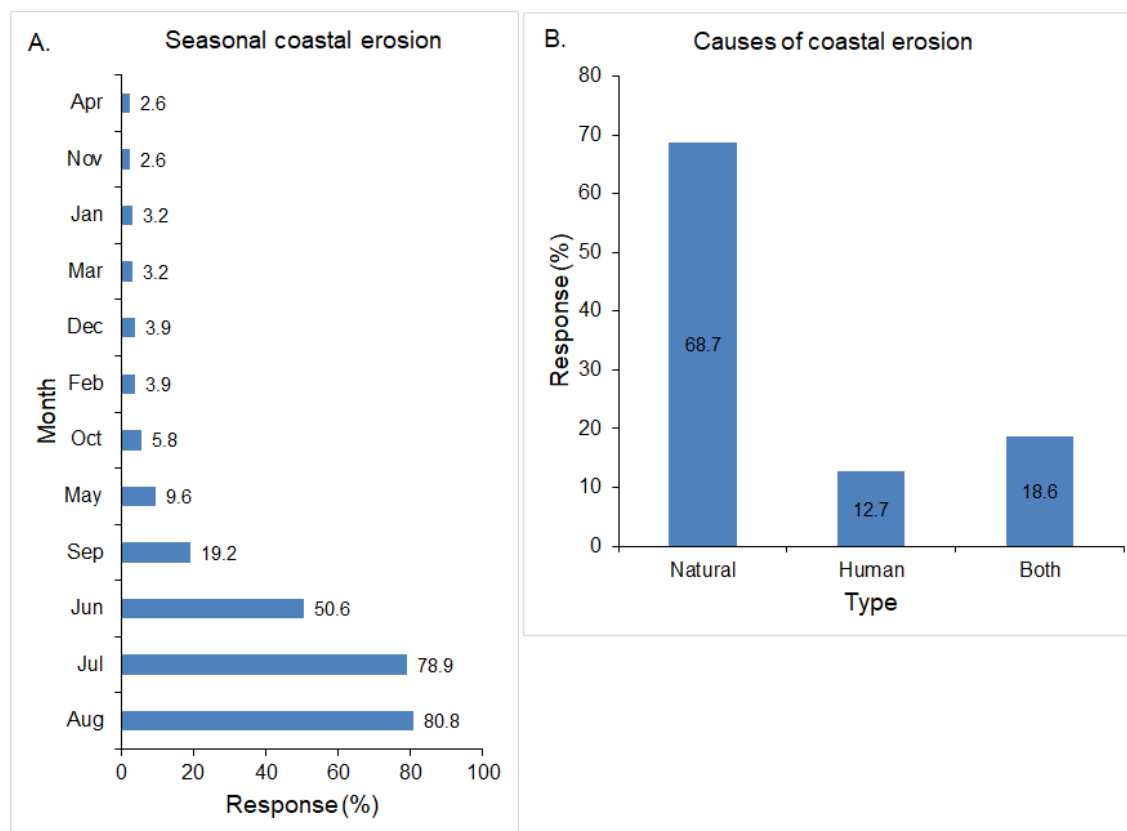


Fig. 4. a) Monthly/ Seasonal coastal erosion trends; b) Causes of coastal erosion as perceived by the respondents.

Perceived impacts, efforts at mitigating coastal erosion, and suggested solutions

As presented in Table 3a, 91.7 and 92% of the respondents, respectively, stated that coastal erosion had a high to extremely high impact on their domestic activities and general living conditions whereas 8.3 and 8% of the respondents said it had a moderate to low impact. Most of the respondents (84%) stated that they suffered physical or property damages as a result of coastal erosion (Table 3b). However, they displayed low preparedness levels for mitigation measures. When asked whether they were taken any measures to combat erosion, the majority (83.3%) of the respondents said they were not making any efforts (Table 3c). Owing to various impacts of coastal

erosion, about 68.4% of them had been forced to relocate to other parts of Anlo Beach while ~76.7% are still contemplating moving in the future (Table 3b).

When asked what could be done to slow down to reduce coastal erosion hazards in their community, about 78.8% opted for the construction of sea defense along the coast as it was done in Cape Coast, a nearby city, while 10.9% suggested relocation of the community to a safer place by the government (Table 3d).

Table 3a. Impacts of coastal erosion on domestic activities, professional activities, and conditions of living

Variable	Low		Moderate		High		Very High		Extremely High	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
i. Impact on domestic activities	14	3.2	7	4.5	5	9	23	14.7	106	68
ii. Impact on professional activities	23	14.7	10	6.4	11	7.1	46	29.5	66	41.7
iii. Impact on condition of living	11	7.1	1	0.65	7	4.5	26	16.7	109	70.8

Table 3b. The severity of coastal erosion on the respondents and responses

	Yes		No	
	Freq.	%	Freq.	%
i. Have you suffered any physical or property damage	131	84	25	16
ii. Have you moved to a different location because of coastal erosion?	106	68.4	49	31.6
iii. Do you think you will have to move again?	115	76.7	35	23.3
iv. Any built coastal defense e.g., dikes, breakwaters, groins in your community?	1	0.6	154	99.4

Table 3c. Efforts at combating coastal erosion

	None		Personally		Collectively	
	Freq.	%	Freq.	%	Freq.	%
Any effort at combating coastal erosion in your community?	129	83.8	1	0.6	24	15.6

Table 3d. Suggested ways of combating coastal erosion

	No idea		Sea defense		Relocation	
	Freq.	%	Freq.	%	Freq.	%
What could be done to mitigate coastal erosion in your community?	17	10.9	123	78.8	16	10.3

Perceived knowledge and awareness about salinization and its major causes

The perception of the respondents about salinization hazards was very high. About 89.1% of the respondents stated that the situation is well-known to everyone in the community. The majority, 99.4 and 76.3% respectively, of the respondents, reported the presence of salt in the drinking water from the well and river, in the study area. About 95.5% of the respondents stated that there was an occurrence of high salinity in the well water during the dry season between November and March of each year (Fig. 5a). This is consistent with nationally observed weather conditions; the wettest months in Ghana are May-July and September-October, with the driest period occurring from December to February and a brief period in August. The majority of the respondents, about 95.5 and 69.9%, described the salt in the well and river as higher than in the past 10 years. The overall response to the questions was an indication of good knowledge of their local environment.

When asked about the causes of salinization in the study area, 94.8% of respondents (Fig. 5b) believed that it was a natural phenomenon due to drought (91%), seawater flooding (41.7%), high tide (25%) (Fig. 5c). On the other hand, 1.3% of the respondents believed that it was caused by humans while 1.9% said it was both human and natural (Fig. 5b). Others also believed that the nearness of the community to the Ocean was a major factor.

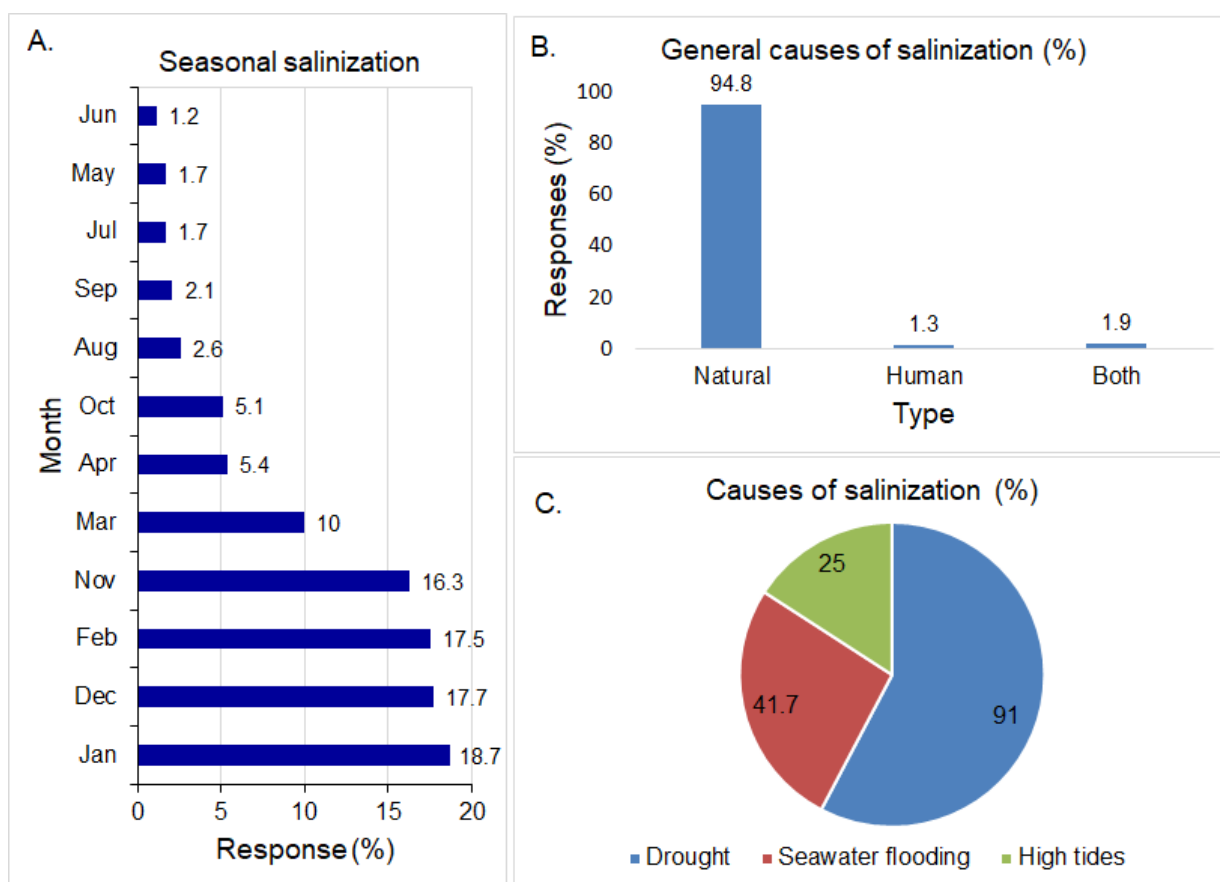


Fig. 5. a) Monthly/ Seasonal coastal salinization trends; b) General causes of salinization; and c) Natural causes of salinization as perceived by the respondents.

Perceived impacts of salinization and mitigation efforts

Ninety-four percent (94%) of the respondents stated salinization has impacted their domestic activities, 66% of the respondents stated that it has affected their professional activities, while the general living conditions of 91% of the respondents have been impacted (Table 4a). When asked if the community had put any measure in place to prevent salt contamination, 85.9% indicated there was no measure on the ground (Table 4b). When asked what could be done to reduce salinization in their community, 5.1%, 3.2%, and 41.7% of the respondents suggested relocation, water treatment, and provision of pipe-borne water, respectively, while 50% of the respondents had no idea of what to do (Table 4c).

Table 4a. Impacts of salinization on domestic and professional activities and general condition of living

Variable	Low		Moderate		High		Very High		Extremely High	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Domestic activities	2	1.28	1	0.64	5	3.21	19	12.18	129	82.69
Professional activities	27	17.31	12	7.69	13	8.33	45	28.85	59	37.82
Condition of living	4	2.56	3	1.92	6	3.85	29	18.59	114	73.08

Table 4b. The effort to mitigate salinization in your community

	None		Personal		Collective	
	Freq.	%	Freq.	%	Freq.	%
Any effort at mitigating salinization in your community?	134	85.9	3	1.9	19	12.2

Table 4c. How to mitigate salinization in your community

	No idea		Pipe-borne water		Water treatment		Relocation	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
What could be done to mitigate salinization in your community?	78	50	65	41.7	5	3.2	8	5.1

3.2 Factors acting on perception: Linear model analysis (LMA)

Perception of impact and adaptive measures regarding erosion hazard

The results of the LMA show that a high level in the perception of the impact of coastal erosion (appraised through a composite index) was negatively related to education level ($p < 0.05$; Table 5a) and positively related to Length of residency ($p < 0.05$; Table 5a). Also, the propensity of respondents to take adaptive measures to coastal erosion was only negatively related to age ($p < 0.01$; Table 5a). In other words, respondents who have spent a longer period in the study area are more likely to perceive the impact of coastal erosion than those that have resided in the study area for a short period. Given the same impact, the higher the education level of the respondents the less likely they perceive the impact of coastal erosion. In addition, it was observed that older (> 50 years) respondents are less likely to take adaptive measures than younger ones (< 50 years).

Perception of impact and adaptive measures regarding salinization hazard

As shown in Table 5b, a high level in the perception of the impact of salinization (appraised through a composite index) was negatively related to occupancy status ($p < 0.05$) and positively related to education level ($p < 0.1$; Table 5b). Also, the propensity of respondents taking adaptive measures (appraised through a composite index) to salinization was negatively related to occupancy status ($p < 0.01$) and positively related to education level ($p < 0.01$; Table 5b). In other words, non-owners of land in the study area are more likely to perceive the impact of the salinization than the landowners. Given the same impact, the higher the education level of the respondents the more likely they perceive the salinization impact. In the same vein, non-owners of land are more likely to take adaptive measures, and also, the higher the education level of the respondents the more likely they take adaptive measures.

Table 5a. Linear model analysis of social factors affecting the perception of coastal erosion impact and the propensity to engage in adaptation measures vs erosion

	Coastal Erosion hazard			
	Indice of perceived impact		Indice of adaptive measures	
	coefficient	p-value	coefficient	p-value
Age	-0.094	0.258	-0.375	0.005
Gender (F vs M)	-0.067	0.482	-0.061	0.277
Level of education	-0.234	0.011	-0.105	0.189
Length of residency	0.170	0.039	0.154	0.175
Occupancy status (owner vs non-owner)	0.124	0.148	-0.007	0.889
Occupation (Farming)	-0.024	0.782	0.017	0.822
Occupation (Fishing)	0.177	0.041	0.033	0.521

Note: Bolded values are significant at $p < 0.05$

Table 5b. Linear model analysis of social factors affecting the perception of salinization impact and the propensity to engage in adaptation measures vs salinization

	Salinization hazard			
	Indice of perceived impact		Indice of adaptive measures	
	coefficient	p-value	coefficient	p-value
Age	0.132	0.112	- 0.018	0.600
Gender (F vs M)	0.019	0.578	0.015	0.302
Level of education	0.089	0.073	0.085	<0.0001
Length of residency	0.055	0.437	- 0.045	0.113
Occupancy status (owner vs non-owner)	-0.066	0.031	- 0.038	0.002
Occupation (Farming)	-0.047	0.312	0.019	0.301
Occupation (Fishing)	-0.014	0.667	0.013	0.327

Note: Bolded values are significant at $p < 0.05$

4. Discussion

The results of the present study show that the respondents are more concerned about coastal erosion than all other coastal hazard types in the Anlo community of the Western region of Ghana. This is in concordance with geomorphological studies that found that this section of the Ghana coast is eroding (e.g., [Addo, 2009](#); [Boateng, 2012](#); [Boye et al., 2018](#)). For instance, [Boateng \(2012\)](#) observed an erosion rate of 2.7 ± 0.4 m per year between Sekondi port jetty and Pra estuary in the long term. [Boye et al. \(2018\)](#) noted that in both the short and long term, the western part of the study area is eroding at a faster rate than the eastern section. Findings from the study carried out by [Friends of the Nation \(2015\)](#) in the study area revealed that about 146 houses close to the shore of the Atlantic Ocean are highly exposed to coastal erosion. Several houses stand threatened once the highly exposed ones are eroded. Another report showed that more than 1,000 houses have been destroyed by the sea in the last 30 years ([Graphic Online, 2017](#)). According to the same report, more than 198 houses were washed away, and more than 800 residents were displaced during the 2017 tidal wave that hit the area ([Graphic Online, 2017](#)). It is important to note that the Anlo Beach community is built on a dune between the wetlands and the Atlantic Ocean, and it is highly vulnerable to floods and erosion ([Mutimukuru-Maravanyika et al., 2017](#)).

Although seawater flooding is a well-recognized problem in the study area ([Mutimukuru-Maravanyika et al., 2017](#)), it was the third hazard identified by the respondents. Studies have shown that laypeople can make a subjective assessment based on sentiments and psychometric factors

(Slovic, 1987; Slovic et al., 1984) and/or social values (Wildavsky and Dake, 1990; Dake, 1991) rather than on data. This may be because seawater flooding was perceived by some respondents as one of the natural causes of salinization in the study area (Fig. 5), and as it emerged, about 26% of the respondents saw it as a major cause of salinization (Fig. 5).

Looking at it from a different perspective, it could also be due to the systematic failure of the government (Liddle et al., 2015) to provide piped water services, thereby prompting the inhabitants to rely on water from wells and boreholes (Grönwall, 2016). About 49% of Ghanaian coastal dwellers rely heavily on groundwater from shallow aquifer systems for domestic and professional purposes (Ghana Statistical Service, 2012; Kortatsi, 1994). Salinization of surface wells and groundwater has been reported as a major problem in many coastal areas of Ghana (e.g., Lutterodt et al., 2021; Helstrup et al., 2007; Bannerman, 1994; Gill, 1969). A study indicates that the salinization of wells in these areas is a result of saltwater intrusion (Helstrup et al., 2007). This has caused the abandonment of several water wells in the Anlo community (Fig. 2). This may have caused salinization to be seen as more impactful than seawater flooding. Therefore, there is a need for control measures to check the further degradation of freshwater through the landward movement of seawater into these coastal areas.

Such a measure could be increased public awareness of the need to lower water abstraction rates and usage of other water resources that can contribute to an increase in freshwater volume, which slows the infiltration of saltwater. This is the simplest, most direct, and most economical solution to problems with saltwater intrusion and groundwater balance in aquifers. However, a supplemental source of water will be required to substitute for the mandated reduction in the groundwater pumping plan (Hussain et al., 2019; Abd-Elhamid et al., 2018; Bruington, 1972). As suggested by the majority of respondents, this additional water source can be the community being provided with pipe-borne water by the government (Table 4c). It is notable that, while the respondents' perception of increasing coastal hazards was high, their propensity to take adaptive measures was very low for both hazards (Table 3). More than 80% of the respondents were not making any effort to mitigate either coastal erosion or salinization because they viewed them as natural (Tables 3c and 4b). This is not surprising because previous studies also found no connection between people's risk perception and their intentions to take mitigation measures (Diakakis et al., 2018; Baron and Petersen, 2015; Wachinger et al., 2013; Bubeck et al., 2012; Siegrist and Gutscher, 2006; Kreibich et al., 2005; Takao et al., 2004). According to Brilly and Polic (2005), proper

actions and countermeasures do not always follow perceived threats. Based on this, Diakakis et al. (2018) is of opinion that future public sensitization should focus more on the importance of self-protection measures, rather than emphasizing only the risks.

Concerning the variables or factors that influenced the perception of the respondents, our findings show that respondents' perceptions of increasing coastal erosion hazards were negatively associated with their level of education and occupancy status, whereas some type of occupation (fishing) was positively associated with coastal erosion hazard perception. The two factors that were always statistically significant among all the relevant socio-demographic characteristics were level of education and occupancy status (owner versus non-owner) (Table 5 a, b). These findings are consistent with previous studies, which suggest that demographic, attitudinal, and social contextual characteristics have a significant impact on perceptions of ecological risks (Bord et al., 1998; Kempton, 1993; Peters and Slovic, 1996).

For instance, O'Connor et al. (1999) and Savage (1993) found that people with higher levels of education and household income have lower levels of ecological risk perception. House ownership (occupancy status) is also found to be associated with perceived risks. For example, Burningham et al. (2008) and Grothmann and Reusswig (2006) argued that owning a property could result in higher levels of perceived risk than renting a residence. A study has also shown that permanent residence (length of residency) in a risky place may increase risk perception (Kellens et al., 2011; Burningham et al., 2008; Lindell and Hwang, 2008).

Regarding taking adaptive measures to combat coastal hazards, age was negatively associated with the perception of coastal erosion risks, which is similar to that of Kellens et al. (2013) but at variance with earlier studies that found older respondents to display a higher perception than younger people. (e.g., Lindell and Whitney, 2000; Grothmann and Reusswig, 2006; Knoke and Kolivras, 2007; Miceli et al., 2008; Burningham et al., 2008; Bonem et al., 2015). Taking adaptive measures to salinization was positively influenced by the level of education and associated with occupancy status. Higher education levels may increase respondents' promptness to take adaptive measures (Kellens et al., 2011). The varying outcome may be due to methods of measuring risk perception and different subjects (Kellens et al., 2011). For instance, while Burningham et al. (2008) measured risk awareness, Grothmann and Reusswig (2006) focused on the perceived ability to take protective actions against flood risks. Previous studies may not be

directly related to coastal erosion and salinization hazards, they shed light on the effects of socio-demographics on perceptions of coastal hazards.

From our findings, there is a belief that the government is solely responsible for the implementation of protective measures, whereas self-effort by individuals is far less important. Further, they saw structural coastal protection measures as the key management strategies instead of taking personal measures. A larger emphasis was placed by residents upon measures to reduce coastal hazards, rather than concentrating on reducing community activities (such as the construction of new buildings) in hazard-prone areas. Similarly, Wisner et al. (2004) found that disadvantaged people (economically or politically) are bound to stop trusting their means of self-protection and lose self-confidence. This behaviour is intensified by a lack of government attention. Consequently, the people were blaming the government instead of increasing their resilience capacity at the local level.

We believe that the people also have a role to play. For instance, our findings (see Table 2; Fig. 2) revealed that mangrove woods are heavily exploited (58.8%) in the study area, and beach sand (62.8%) is heavily utilized compared to river sand (18%). However, mangroves are known to be a natural protector of coastlines and builders of beaches (Besset et al., 2019; Gracia et al., 2018; Spalding et al., 2014). While the aerial roots of mangroves encourage sediment deposition and prevent erosion, the roots, trunks, and canopy dampen the force of oncoming waves and storm surges and thus reduce seawater flooding. So, there is a need for attitudinal change: to discontinue beach sand utilization and exploitation of mangroves as firewood for cooking and smoking fish in the community and embrace the restoration of mangrove ecosystems.

5. Conclusions

This research examines the societal perceptions of coastal risks in the Anlo Beach Fishing Community in Ghana's Western Region. We identified and explained numerous critical factors determining household risk perception using descriptive statistics and multivariate regression models. Our findings not only reveal how individuals view coastal risks, but also provide crucial information to policymakers interested in reducing the negative effects of coastal hazards on local populations. Although this research gives insight into the factors that influence people's perceptions of coastal risks in the study area, it should only be used as a starting point for further research. More real actions are required, such as actual legislative responses to coastal dangers. Further,

findings from this study call for interventions from the appropriate authorities. These interventions should take the form of educating people about the necessity of self-protection measures like ceasing to use of beach sand exploitation of mangroves for fuel, as well as embracing mangrove ecosystem restoration; and awareness about the need to lower water abstraction rates and usage of other water resources such as the provision of pipe borne water to the community to an increase in freshwater volume and slows the infiltration of saltwater.

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References

- Abd-Elhamid, H.F., Abd-Elaty, I., Negm, A.M., 2018.** Control of Saltwater Intrusion in Coastal Aquifers. In: Negm, A. (eds) Groundwater in the Nile Delta. The Handbook of Environmental Chemistry, vol 73. Springer, Cham. https://doi.org/10.1007/698_2017_138
- Addo, K.A., 2009.** Detection of coastal erosion hotspots in Accra, Ghana. *Journal of Sustainable Development in Africa* (Volume 11, 4).
- Bannerman, R.R., 1994.** Appraisal of the limestone aquifer of the Keta Basin, Ghana. In: Soveri J. and Suokko T. (Eds.), *Future Groundwater Resources at Risk*. Publ. 222. International Association for Hydrological Sciences, Wallingford, pp. 315–321.
- Barnard, P.L., Erikson, L. H., Foxgrover, A.C., Finzi Hart, J.A., Limber, P., O'Neill, A. C., van Ormondt, M., Vitousek, S., Wood, N., Hayden, M.K. and Jones, J.M., 2019.** Dynamic flood modeling essential to assess the coastal impacts of climate change. *Scientific Reports*, 9: 4309.
- Baron, N. and Petersen, L.K., 2015.** Climate change or variable weather: rethinking Danish homeowners' perceptions of floods and climate, *Reg. Environ. Change* 15, 1145–1155.
- Besset, M., Gratiot, N., Anthony, E. J., Bouchette, F., Goichot, M. and Marchesiello, P., 2019.** Mangroves and shoreline erosion in the Mekong River delta, Viet Nam. *Estuarine, Coastal and Shelf Science*, 226, 106263.
- Boateng, I., 2012.** An application of GIS and coastal geomorphology for large scale assessment

- of coastal erosion and management: a case study of Ghana. *Journal of Coastal Conservation*, 16:383–397.
- Bord, R. J., Fisher, A., and O'Connor, R. E., 1998.** Public perceptions of global warming: United States and international perspectives. *Climate Research*, 11, 75-84.
- Bonem, E.M., Ellsworth, P.C., and Gonzalez, R., 2015.** Age differences in risk: perceptions, intentions and domains, *J. Behav. Decis. Mak.* 28, 317–330.
- Boye, C. B. Appeaning Addo, K., Wiafe, G. and Dzigbodi-Adjimah, K., 2018.** Spatio-temporal analyses of shoreline change in the Western Region of Ghana. *Journal of Coastal Conservation*. <https://doi.org/10.1007/s11852-018-0607-z>
- Bradford, R. A., O'Sullivan, J. J., van der Craats, I. M., Krywkow, J., Rotko, P., Aaltonen, J., Bonaiuto, M., De Dominicis, S., Waylen, K., and Schelfaut, K., 2012.** Risk perception – issues for flood management in Europe, *Nat. Hazards Earth Syst. Sci.*, 12, 2299–2309.
- Brilly, M., and Polic M., 2005.** Public perception of flood risks, flood forecasting and mitigation, *Nat. Hazards Earth Syst. Sci.* 5, 345–355.
- Brody, S.D., Zahran, S., Vedlitz, A. and Grover, H., 2008.** Examining the relationship between physical vulnerability and public perceptions of global climate change in the United States. *Environment and Behavior* 40(1), 72–95.
- Bruington, A. E., 1972.** Saltwater intrusion into aquifers 1. *JAWRA Journal of the American Water Resources Association*, 8(1), 150-160.
- Bubeck, P., Botzen, W. J. W., Kreibich, H., and Aerts, J. C. J. H., 2013.** Detailed insights into the influence of flood-coping appraisals on mitigation behaviour. *Global Environ. Chang.*, 23, 1327–1338.
- Bubeck, P., Botzen, W.J., and Aerts, J.C., 2012.** A review of risk perceptions and other factors that influence flood mitigation behaviour, *Risk Anal.* 32, 1481–1495.
- Burkett, V.R. and Davidson, M.A., 2012.** Coastal impacts, adaptation and vulnerability: a technical input to the 2012 national climate assessment. cooperative report to the 2013. *National Climate Assessment* 150, 1–89.
- Burningham, K., Fielding, J., and Thrush, D., 2008.** “It’ll never happen to me”: Understanding public awareness of local flood risk. *Disasters* 32(2):216–238.
- Button, C., 2013.** Coastal vulnerability and climate change in Australia: public risk perceptions and adaptation to climate change in non-metropolitan coastal communities. PhD Thesis, School of Social Sciences, The University of Adelaide, Australia, 361 pp.
- Carlton, S.J and Jacobson, S.K., 2013.** Climate change and coastal environmental risk perceptions in Florida. *Journal of Environmental Management*, 130, 32-39.
- Cazenave, A. and Le Cozannet, G., 2014.** Sea level rise and its coastal impacts. *Earth's Future*, 2, 15-34.
- Coastal Resources Center (CRC, 2013).** Coastal Hazards and Flooding Risk in Ghana's Western Region. Issue Brief 7 in series “Hen Mpoano: Our Coast, Our Future”. Narragansett, RI: Coastal Resources Center, Graduate School of Oceanography, University of Rhode Island. USAID Integrated Coastal and Fisheries Governance Program for the

- Western Region of Ghana. Narragansett, RI: Coastal Resources Center, Graduate School of Oceanography, University of Rhode Island. 15 pp.
- Collins, R., 2015.** Keeping it in the family? Re-focusing household sustainability. *Geoforum* 60, 22–32.
- Coastal Resources Center / Friends of the Nation, 2010.** Report on characterization of coastal communities and shoreline environments in the Western Region of Ghana. Integrated Coastal and Fisheries Governance Initiative for the Western Region of Ghana. Coastal Resources Center, University of Rhode Island, 425pp.
- Dake, K., 1991.** Orienting dispositions in the perception of risk: an analysis of contemporary worldviews and cultural biases, *J. Cross Cult. Psychol.* 22, 61–82.
- Diakakis, M., Priskos, G. and Skordoulis, M., 2018.** Public perception of flood risk in flash flood prone areas of Eastern Mediterranean: The case of Attica Region in Greece, *International Journal of Disaster Risk Reduction* 28, 404-413.
- Elrick-Barr, C.E., Smith, T.F., Thomsen, D.C. and Preston, B.L., 2015.** Perceptions of Risk among Households in Two Australian Coastal Communities. *Geographical Research* 53 (2), pp. 145-159
- Friends of the Nation (2015).** Shama Disaster Management Committee Meeting and Field Work to Plan Anlo Beach Resettlement, The USAID/Ghana Sustainable Fisheries Management Project (SFMP). Narragansett, RI: Coastal Resources Center, Graduate School of Oceanography, University of Rhode Island and Friends of the Nation, Adiembra – Parks and Gardens. GH2014_ACT085_FON 26 pp.
- Ghana Statistical Service (GSS), 2012.** Summary report of final results for 2010 population and housing census. Ghana Statistical Service. Accra, Ghana.
- Gill H. E., 1969.** A groundwater reconnaissance of the Republic of Ghana, with a description of geohydrologic provinces. US Geological Survey Water-supply Paper 1757-K Washington, DC, 37pp.
- Gracia, A., Rangel-Buitrago, N., Oakley, J. A., and Williams, A. T., 2018.** Use of ecosystems in coastal erosion management. *Ocean & coastal management*, 156, 277-289.
- Graphic Online, 2017.** Anlo Beach to be wiped out in a year. Retrieved 24th of February 2022 from <https://www.graphic.com.gh/news/general-news/anlo-beach-to-be-wiped-out-in-a-year.html>
- Grönwall, J., 2016.** Self-supply and accountability: to govern or not to govern groundwater for the (peri-) urban poor in Accra, Ghana. *Environ. Earth Sci.* 75, p.1163
- Grothmann, T. and Reusswig F., 2006.** People at risk of flooding: Why some residents take precautionary action while others do not. *Natural Hazards* 38(1–2):101–120.
- Helstrup T., Jorgensen N. O. and Banoeng-Yakubo, B., 2007.** Investigation of hydrochemical characteristics of groundwater from the Cretaceous–Eocene limestone in southern and southern Togo using hierarchical cluster analysis. *Hydrogeology* 15, p. 977–989.
- Hussain, M.S., Abd-Elhamid, H.F., Javadi, A.A. and Sherif, M.M., 2019.** Management of Seawater Intrusion in Coastal Aquifers: A Review. *Water* 11(12):2467.
- IPCC, 2012.** Summary for policymakers. In: Field CB, Barros V, Stocker TF, Qin D, Dokken DJ, Ebi KL, Mastrandrea MD, Mach KJ, Plattner G-K, Allen, SK, Tignor M, Midgley PM, editors. *Managing the risks of extreme events and disasters to advance climate change*

- adaptation. A special report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, 19 p.
- IPCC, 2021: Climate Change 2021.** The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, In press, doi:10.1017/9781009157896.
- Kellens, W., Zaalberg, R., Neutens, T., Vanneuville, W. and De Maeyer, P., 2011.** An Analysis of the Public Perception of Flood Risk on the Belgian Coast. *Risk Analysis* 31 (7), 1055-1068.
- Kellens, W., Terpstra, T. and De Maeyer, P., 2013.** Perception and communication of flood risks: A systematic review of empirical research. *Risk Anal.* 33, 24–49.
- Kempton, W., 1993.** Will public environmental concern lead to action on global warming? *Annual Review of Energy and the Environment* 18, 117-145.
- Knocke, E.T. and Kolivras, K.N., 2007.** Flash flood awareness in southwest Virginia, *Risk Anal.* 27, 155–169.
- Kortatsi B. K., 1994.** Groundwater utilization in Ghana. *Future Groundwater Resources at Risk* (Proceedings of the Helsinki Conference). IAHS Publ. no. 222.
- Kreibich, H., Thieken, A.H., Petrow, T., Müller, M. and Merz, B., 2005.** Flood loss reduction of private households due to building precautionary measures - lessons learned from the Elbe flood in August 2002, *Nat. Hazards Earth Syst. Sci.* 5, 117–126.
- Kutir, C., Agblorti, S.K.M., and Benjamin B. Campion, B.B., 2022.** Migration and Estuarine Land use/land cover (LULC) change along Ghana's coast. *Regional Studies in Marine Science* 54, 102488.
- Leiserowitz, A., 2006.** Climate change risk perception and policy preferences: the role of affect, imagery, and values. *Climatic Change*, 77, 45-72.
- Lindell, M.K. and Hwang, S.N., 2008.** Households' perceived personal risk and responses in a multi-hazard environment. *Risk Analysis* 28(2), 539–556.
- Liddle, E.S., Mager, S.M., and Nel, E.L., 2015.** The suitability of shallow hand-dug wells for safe water provision in sub-Saharan Africa: lessons from Ndola Zambia. *Appl. Geography*. 57, pp.80-90.
- Louarn, A., 2020.** Vulnerability of coastal socio-ecosystems in West Africa: design of a survey to analyse the role(s) of communities in erosion, submersion, salinisation and pollution processes, 2020. M2 internship thesis.
- Lutterodt, G., Miyittah, M.K., Addy, B., Ansa, E.D.O. and Takase, M., 2021.** Groundwater pollution assessment in a coastal aquifer in Cape Coast, Ghana. *Heliyon* 7(4), e06751. <https://doi.org/10.1016/j.heliyon.2021.e06751>.
- Miceli, R., Sotgiu, I. and Settanni, M., 2008.** Disaster preparedness and perception of flood risk: a study in an alpine valley in Italy, *J. Environ. Psychol.* 28 (2), 164–173.
- Mölter, T., Schindler, D., Albrecht, A. and Kohnle, U., 2016.** Review on the projections of

- future storminess over the North Atlantic European region. *Atmosphere*, 7(4), doi.org/10.3390/atmos7040060.
- Morand, J-A, 2021.** Statistical and geomatic analysis of perceptions of environmental change by coastal communities in Senegal. M1 internship thesis. University of Savoie Mont-Blanc, 53p.
- Mutimukuru-Maravanyika, T., Mills, D.J., Asare, C., Asiedu, G.A., 2017.** Enhancing women's participation in decision-making in artisanal fisheries in the Anlo Beach fishing community, Ghana, *Water resources and rural development* 10, pp. 58-75.
- Neumann, B., Vafeidis, A.T., Zimmermann, J. and Nicholls, R.J., 2015.** Future coastal population growth and exposure to sea-level rise and coastal flooding - A global assessment. *PLOS ONE* 10(3): e0118571.
- Nicholls, R.J., Marinova, N., Lowe, J.A., Brown, S., Vellinga, P., de Gusmao, D., Hinkel, J. and Tol, R.S., 2011.** Sea-level rise and its possible impacts given a 'beyond 4°C world' in the twenty-first century. *Philos Trans A Math Phys Engineering and Science* 369, 161–181.
- O'Connor, R. E., Bord, R. J., and Fisher, A., 1999.** Risk perceptions, general environmental beliefs, and willingness to address climate change. *Risk Analysis*, 19, 461-471.
- Okyere, I., 2015.** Assessment of aquatic ecosystems, the fishery and socio-economics of a coastal area in the Shama District, Ghana (Doctoral dissertation, University of Cape Coast).
- Peacock, W.G., Brody, S.D. and Highfield, W., 2005.** Hurricane risk perceptions among Florida's single family homeowners. *Landscape Urban Plan.* 73, 120-135.
- Peters, E., and Slovic, P., 1996.** The role of affect and worldviews as orienting dispositions in the perception and acceptance of nuclear power. *Journal of Applied Social Psychology*, 26(16), 1427-1453.
- Ruz, M.-H., Rufin-Soler, C., Héquette, A., Révillon, R., Hellequin, A.-P., Deboudt, P., Herbert, V., Cohen, O., Lebreton, F., Le Goff, L., Schmitt, F.G., Marin, D., 2020.** Climate change and risk perceptions in two French coastal communities. In: Malvárez, G. and Navas, F. (eds.), *Proceedings from the International Coastal Symposium (ICS) 2020* (Seville, Spain). *Journal of Coastal Research*, Special Issue No. 95, pp. 875-879.
- Savage, I. (1993).** Demographic influences on risk perceptions. *Risk Analysis*, 13(4), 313-420.
- Siegrist, M. and Gutscher, H., 2006.** Flooding risks: a comparison of lay people's perceptions and expert's assessments in Switzerland, *Risk Anal.* 26, 971–979.
- Slovic, P., 1987.** Perception of risk, *Sci. New Ser.* 236 (1987) 280–285.
- Slovic, P., Fischhoff, B. and Lichtenstein, S., 1984.** Behavioral decision theory perspectives on risk and safety, *Acta Psychol.* 56, 183–203.
- Spalding, M., Mcivor, A., Tonneijck, F., Tol, S., and Eijk, P. V., 2014.** Mangroves for coastal defence. Guidelines for coastal managers & policymakers. Published by Wetlands International and The Nature Conservancy. 42 p
- Steg, L. and Sievers, I., 2000.** Cultural theory and individual perceptions of environmental risks. *Environment and Behavior* 32, 250–269.
- Takao, K., Motoyoshi, K, T., Sato, T. and Fukuzono, T., 2004.** Factors determining residents' preparedness for floods in modern megalopolises: the case of the Tokai flood disaster in Japan, *J. Risk Res.* 7 (2004) 775–787.
- Wildavsky, A. and Dake, K., 1990.** Theories of risk perception: who fears what and why? *J.*

Am. Acad. Arts Sci. 119, 41–60.

Wachinger, G., Renn, O., Begg, C. and Kuhlicke, C., 2013. The risk perception paradox – implications for governance and communication of natural hazards, *Risk Anal.* 33, 1049–1065.

Wisner, B., Blaikie, P., Cannon, T., and Davis, I., 2004. At-risk. Natural hazards, people's vulnerability and disasters, Routledge, London, 471 pp.