



**HAL**  
open science

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

Olusegun A. Dada, Donatus Bapentire Angnuureng, Rafaël Almar, Selorm Dzantor, Pierre Morand

► **To cite this version:**

Olusegun A. Dada, Donatus Bapentire Angnuureng, Rafaël Almar, Selorm Dzantor, Pierre Morand. Social perceptions of coastal hazards in the Anlo Beach Community in the Western Region of Ghana. *Journal of Coastal Conservation: planning and management*, 2022, 26 (article 63), pp.1-25. 10.1007/s11852-022-00909-9 . hal-03888870v1

**HAL Id: hal-03888870**

**<https://hal.science/hal-03888870v1>**

Submitted on 13 Jan 2023 (v1), last revised 20 Feb 2023 (v2)

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

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

Olusegun A. Dada<sup>1,2</sup>, Donatus B. Angnuureng<sup>3</sup>, Rafael Almar<sup>1</sup>, Selorm Dzantor<sup>3</sup> and Pierre Morand<sup>4</sup>

<sup>1</sup>Université de Toulouse, LEGOS (IRD/CNES/CNRS/UPS), Toulouse, France; <sup>2</sup>Dept of Marine Science & Tech., Federal University of Technology, Akure, Nigeria; <sup>3</sup>ACECoR, Centre for Coastal Management, SBS, University of Cape Coast, Ghana; <sup>4</sup>UMI SOURCE (IRD/UVSQ), Bondy, France

## 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

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

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

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

57

## 58 **Study site**

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

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

75

#### 76 **The intensity of the use of natural resources in Anlo Beach**

77 Anlo Beach has a vast array of livelihood assets and potentials and a few services. Natural capital  
78 includes the sea and fisheries resources, beach, sand, River Pra Estuary, wetlands including  
79 swamps and salt marshes, mangrove swamp, mangrove forests, dry land, and farmlands. The  
80 surrounding area possesses ecological features that are interesting to eco-tourism. The Pra River  
81 estuary provides suitable roosting and nesting grounds for birds and marine turtles. Mangroves of  
82 the genera *Avicennia*, *Rhizophora*, and *Laguncularia* are found along the entire perimeter of the  
83 Pra River and its estuary and extend over three kilometres on both sides of the estuary (Okyere,  
84 2015; Coastal Resources Center / Friends of the Nation, 2010). These mangroves are highly  
85 exploited as the main source of firewood for cooking and smoking fish and for construction  
86 purposes in the community thereby resulting in the degradation of the mangrove forest and  
87 reduction in the size of this critical habitat for fish breeding activities. Degraded mangrove areas  
88 are used as refuse disposal sites. In addition, sand is mined from the beach for construction purposes  
89 in the study community. This activity tends to increase coastal erosion and flooding (Kutir et al.,  
90 2022). Further north of the community has located the farmlands. Fishers in this community are  
91 actively involved in artisanal marine fishing as well as estuary fishing. Fishing and fish mongering  
92 are the major livelihood activities running from mid-July to late April while subsistence farming  
93 becomes the predominant occupation after April, lasting for about three months in the off-fishing  
94 season after which the community switches back to fishing in mid-July or early August for the

95 main fishing season. Not all fishermen practice farming during the off-fishing months, and only a  
96 few members of the community are small-scaled farmers who only fish for subsistence. Cassava  
97 and maize are the major crops produced although a few farmers cultivate cash crops such as oil  
98 palm and coconut (Okyere, 2015; Coastal Resources Center / Friends of the Nation, 2010).

99



100  
101 Fig. 1. a) Map Anlo Beach coastal fishing community. Inset: map of Ghana (sources: Mutimukuru-Maravanyika et al.,  
102 2017).

103



104  
105 Figure 2. The environmental situation in the Anlo Beach community: a) erosion; b) loss of mangroves due to erosion;  
106 and c) impact of salinization.

107

## 108 2 Materials and Methods

109 A household survey was conducted in the Anlo Beach community in the Western Region of Ghana  
110 to obtain information on household risk perceptions. The survey, in which 156 respondents  
111 participated, was conducted as part of the West Africa Coastal Area – mapping Vulnerability,  
112 Adaptability and Resilience in changing climate (WACA-VAR) project, between July and August  
113 2021 by a team of researchers from the Centre for Coastal Management-African Centre of  
114 Excellence in Coastal Resilience (CCM-ACECoR), University of Cape Coast, Ghana, and the  
115 Institut de Recherche pour de Developpement (IRD), Toulouse, France. The interviews were  
116 conducted face-to-face with a systematic selection of every 5th household to ensure that the results  
117 that will be obtained from our survey will approximate what would have been obtained if the entire  
118 population had been surveyed.

119 The survey, with 156 questions, consists of several parts, out of which three are common  
120 to all respondents. First, an identification of the survey site with its GPS coordinates and locality

121 (section A). Then section B is based on the characteristics of the respondents, focusing on the  
122 respondents' place of residence, age, sex, professional activity, level of academic education, and  
123 attachment to the place. Section C is composed of two questions, dealing with the risks linked to  
124 the hazards and potentially dangerous phenomena observed and identifying the two phenomena  
125 that most affected the respondents. The respondents were allowed to rank the hazards that largely  
126 impact their lives, whether salinization, coastal erosion, coastal flooding, plastic pollution, or oil  
127 pollution.

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

135

### 136 *2.1 Descriptive statistics analysis*

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

139

### 140 *2.2 Construction of composite indices for Linear Regression analysis*

141 To consolidate and make more synthetic information in the evaluation of global perceptions, we  
142 created composite indices from binary/multi-modal answers to basic inquiries. To do it, we  
143 employed different subsets of questionnaire answers for this construction, which were sometimes  
144 binary choice answers and sometimes responses on ordered qualitative scales. Each composite  
145 index was calculated by adding values of 1 or 0 applied to the response categories obtained, thereby  
146 creating two synthetic indices: indices of (i) perceived impact and (ii) adaptive measures. The two  
147 indices were presented in the form of quantitative scores which will play, in turn, the role of the  
148 dependent variable for the analyses carried out using the linear model. Each of the two synthetic  
149 indices was then analyzed using a linear model. For the two indices, seven variables were used. No  
150 variable taken into account in the construction of a composite index is reused as an explanatory  
151 factor for the same index, which prevents any risk of circularity in the interpretation of the results.

152 The coefficients of the model were estimated using the Linear Regression analysis in the SPSS  
 153 software. Only significant effects up to the 10% ( $p < 0.1$ ) threshold were retained and discussed.  
 154 The value of the coefficient was used to identify the direction of the effect (positive or negative)  
 155 on the evolution of the index.

156

157 **3. Results**

158 **3.1 Descriptive analysis**

159 **3.1.1 Basic characteristics of the respondents**

160 Ninety-nine percent of the survey respondents lived at the study site. About 53% of them were  
 161 permanent homeowners while 46.5% were non-permanent owners. Only 10% of the respondents  
 162 had lived less than 10 years in the study site, indicating the majority (90 %) of them had lived in  
 163 the area for more than 10 years. Of the survey respondents, 61% were females while 39% were  
 164 males. Out of the entire respondents, 57.1% were between the ages of 18 and 50 years. About  
 165 11.5% of the respondents had a higher tertiary education while 26.3% never went to school (Table  
 166 1).

167

168 **Table 1. Descriptive statistics of the respondents**

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

169

170 **3.1.2. Intensity in the usage of natural resources**

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

178 **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

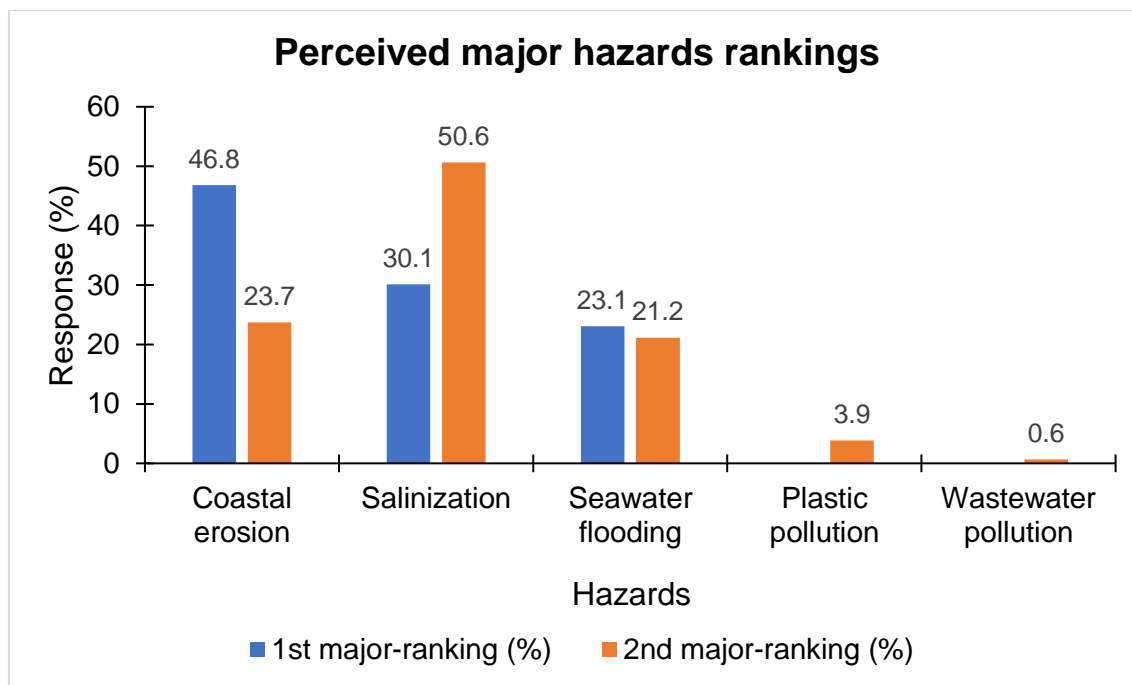
179

180

181 **3.1.3 Perceived coastal hazards assessment**

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

185 As shown in Figure 2, coastal erosion (46.8 %) was on top of the list of the first major ranking  
186 coastal hazards perceived by the respondents in the study area, followed by salinization (30.1 %)  
187 and seawater flooding (23.1 %). Salinization (50.6 %) overwhelmingly topped the list under the  
188 second major ranking of coastal hazards perceived by the respondents, followed by coastal erosion  
189 (23.7 %) and seawater flooding (21.2 %). Plastic and wastewater pollution were not cited under  
190 the first major ranking of coastal hazards perceived by the respondents in the study area but only  
191 slightly mentioned under the second major ranking of coastal hazards perceived by the respondents  
192 (Fig. 2) whereas oil pollution and sewage pollution were never mentioned at all. Thus, coastal  
193 erosion and salinization being the first 2 major coastal hazards perceived by the respondents in the  
194 study area were considered in the present study.



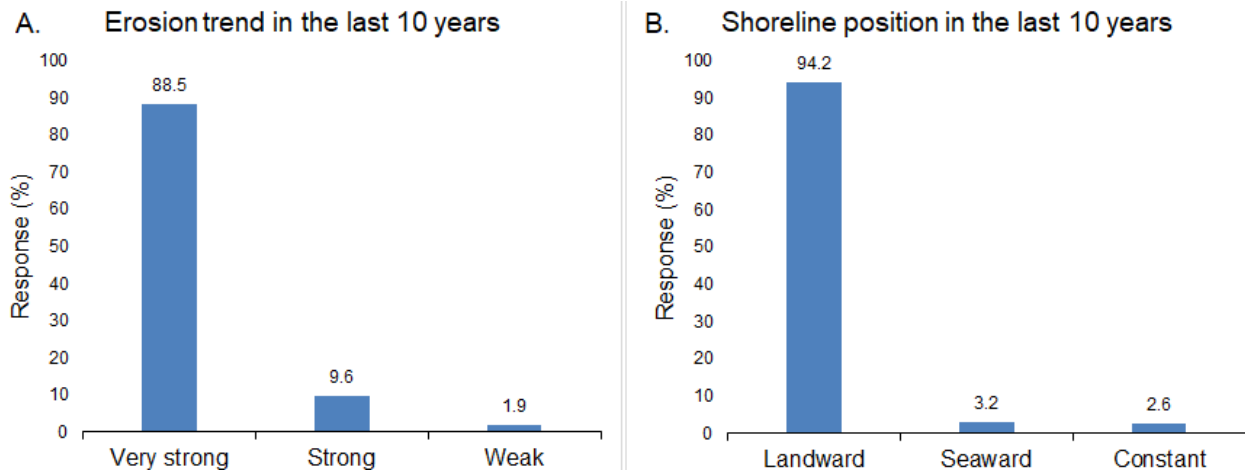
195

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

### 197 3.1.4. Knowledge, causes, potential impacts, and approaches to reducing coastal hazards risks

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

200 *Perceived knowledge and awareness about coastal erosion*  
 201 The majority of the respondents (88.5%) stated that there has been strong coastal erosion in the last  
 202 10 years while only a few (1.9%) believed that it was little (Fig. 3a). About 94.2% of respondents  
 203 believed that the shoreline had moved landward more than it was 10 years ago, and 2.6% argued  
 204 that it was constant (Fig. 3b). While most respondents (70%) pointed out that the erosion was  
 205 highest near the Pra Estuary inlet, others (30%) believed that it was everywhere along the coast.  
 206



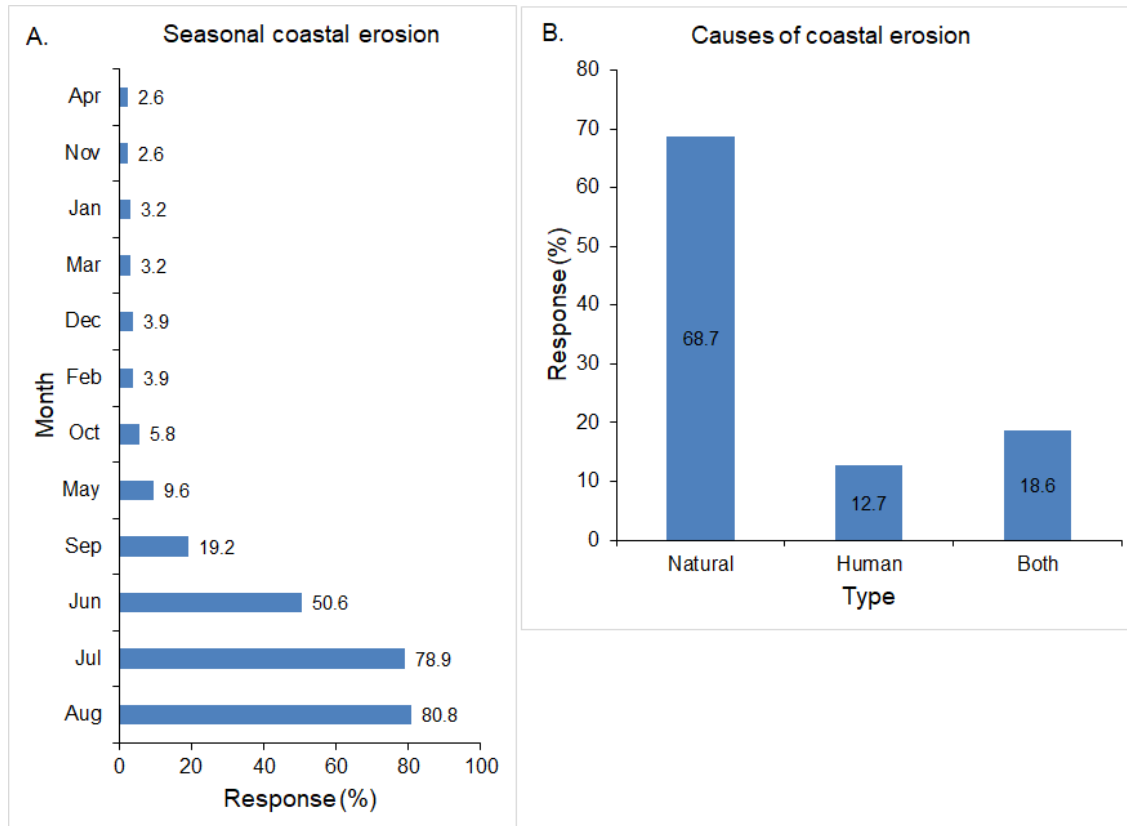
207  
 208 **Fig. 3** a) Erosion trends in the last 10 years; b) Shoreline positions in the last 10 years as perceived by the respondents  
 209

210 *Seasonality and major causes of erosion*

211 As shown in Fig. 4a, the respondents considered coastal erosion (or a landward advance of the sea)  
 212 to be higher between May and September and least between October and April. However, about  
 213 58% of respondents maintained that the beach never returned to where it was previously, indicating  
 214 a high level of vulnerability in the area. When asked about the major causes of the erosion  
 215 phenomenon in the study area, the majority of the respondents (68.7%) linked it to the combined  
 216 effects of natural factors (Fig. 4b) such as wave actions, sea-level rise, tidal waves, river flooding,  
 217 and seasonal cycles. While about 12.7% of the respondents linked erosion in the study area to  
 218 human activities (Fig. 4b) like beach sand mining, harbour construction at Sekondi and Takoradi,  
 219 nearby sea defense at Aboadze, the opening of the Pra River estuary inlet, and building houses near  
 220 the coast; 18.6% of them believed it was both natural and human-induced (Fig. 4b). The majority  
 221 of respondents (75%) believed that erosion became aggravated during some events or years. For  
 222 example, the combined effects of river and sea flooding events during the 2005/2006, 2014/2015,

223 and 2017/2018 periods were considered to have aggravated coastal erosion in the study area,  
224 indicating a high level of awareness about the vulnerability of the area.

225



226  
227 **Fig. 4.** a) Monthly/ Seasonal coastal erosion trends; b) Causes of coastal erosion as perceived by the respondents.  
228

### 229 *Perceived impacts, efforts at mitigating coastal erosion, and suggested solutions*

230 As presented in Table 3a, 91.7 and 92% of the respondents, respectively, stated that coastal erosion  
231 had a high to extremely high impact on their domestic activities and general living conditions  
232 whereas 8.3 and 8% of the respondents said it had a moderate to low impact. Most of the  
233 respondents (84%) stated that they suffered physical or property damages as a result of coastal  
234 erosion (Table 3b). However, they displayed low preparedness levels for mitigation measures.  
235 When asked whether they were taken any measures to combat erosion, the majority (83.3%) of the  
236 respondents said they were not making any efforts (Table 3c). Owing to various impacts of coastal  
237 erosion, about 68.4% of them had been forced to relocate to other parts of Anlo Beach while  
238 ~76.7% are still contemplating moving in the future (Table 3b).

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

243

244 **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

245

246 **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

247

248 **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

249

250 **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

251

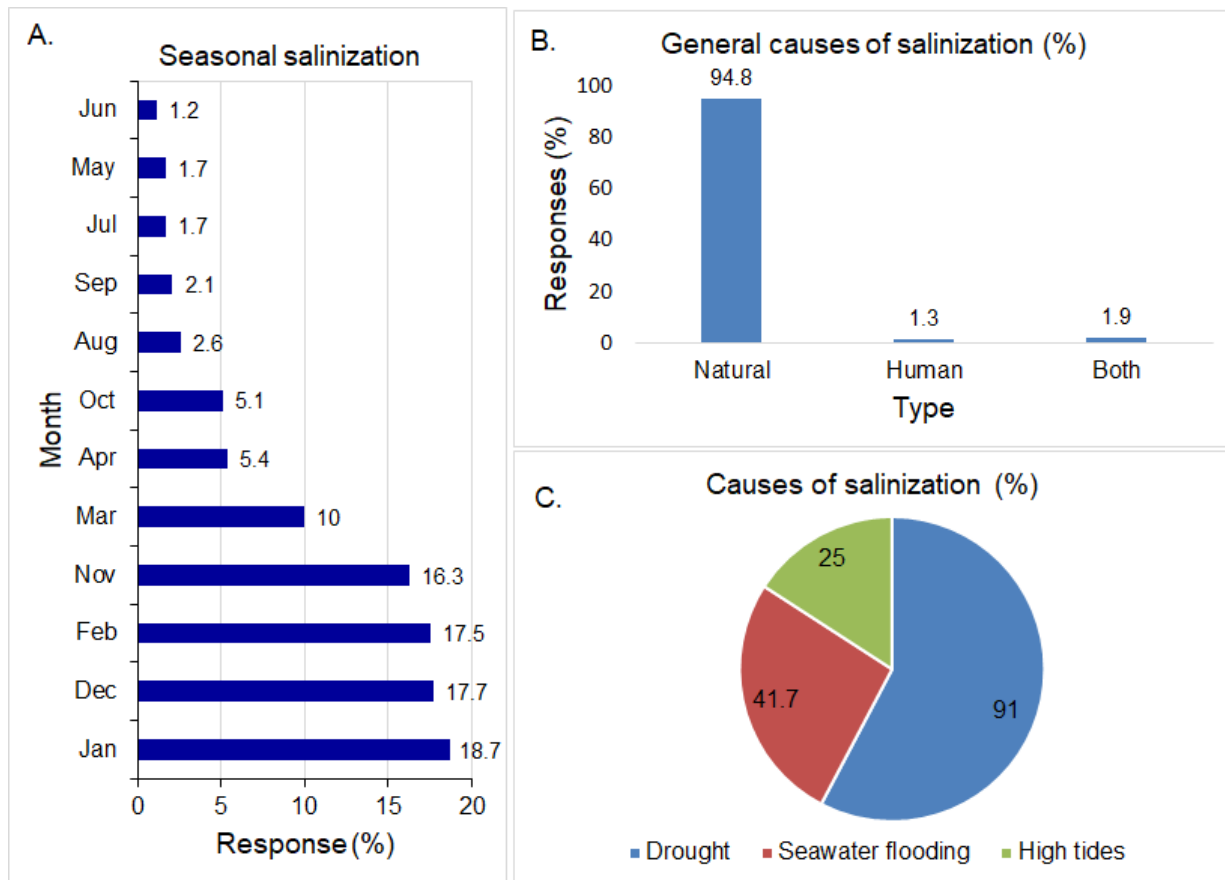
252 *Perceived knowledge and awareness about salinization and its major causes*

253 The perception of the respondents about salinization hazards was very high. About 89.1% of the  
 254 respondents stated that the situation is well-known to everyone in the community. The majority,  
 255 99.4 and 76.3% respectively, of the respondents, reported the presence of salt in the drinking water

256 from the well and river, in the study area. About 95.5% of the respondents stated that there was an  
 257 occurrence of high salinity in the well water during the dry season between November and March  
 258 of each year (Fig. 5a). This is consistent with nationally observed weather conditions; the wettest  
 259 months in Ghana are May-July and September-October, with the driest period occurring from  
 260 December to February and a brief period in August. The majority of the respondents, about 95.5  
 261 and 69.9%, described the salt in the well and river as higher than in the past 10 years. The overall  
 262 response to the questions was an indication of good knowledge of their local environment.

263 When asked about the causes of salinization in the study area, 94.8% of respondents (Fig.  
 264 5b) believed that it was a natural phenomenon due to drought (91%), seawater flooding (41.7%),  
 265 high tide (25%) (Fig. 5c). On the other hand, 1.3% of the respondents believed that it was caused  
 266 by humans while 1.9% said it was both human and natural (Fig. 5b). Others also believed that the  
 267 nearness of the community to the Ocean was a major factor.

268



269 **Fig. 5.** a) Monthly/ Seasonal coastal salinization trends; b) General causes of salinization; and c) Natural causes of  
 270 salinization as perceived by the respondents.  
 271  
 272

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

282 **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

283  
 284 **Table 4b. The effort to mitigate salinization in your community**

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

285  
 286 **Table 4c. How to mitigate salinization in your community**

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

287  
 288 3.2 Factors acting on perception: Linear model analysis (LMA)

289 *Perception of impact and adaptive measures regarding erosion hazard*

290 The results of the LMA show that the log of the odds of the respondents perceiving the impact of  
 291 coastal erosion (appreciated through a composite index) was negatively related to education level  
 292 ( $p < 0.05$ ; Table 5a) and positively related to Length of residency ( $p < 0.05$ ; Table 5a). Also, the  
 293 log of the odds of respondents taking adaptive measures to coastal erosion was only negatively  
 294 related to age ( $p < 0.01$ ; Table 5a). In other words, respondents who have spent a longer period in

295 the study area are more likely to perceive the impact of coastal erosion than those that have resided  
 296 in the study area for a short period. Given the same impact, the higher the education level of the  
 297 respondents the less likely they perceive the impact of coastal erosion. In addition, it was observed  
 298 that older (> 50 years) respondents are less likely to take adaptive measures than younger ones (<  
 299 50 years).

300  
 301 *Perception of impact and adaptive measures regarding salinization hazard*  
 302 As shown in Table 5b, the log of the odds of respondents perceiving the impact of salinization  
 303 (appreciate through a composite index) was negatively related to occupancy status ( $p < 0.05$ ) and  
 304 positively related to education level ( $p < 0.1$ ; Table 5b). Also, the log of the odds of respondents  
 305 taking adaptive measures (appreciate through a composite index) to salinization was negatively  
 306 related to occupancy status ( $p < 0.01$ ) and positively related to education level ( $p < 0.01$ ; Table 5b).  
 307 In other words, non-owners of land in the study area are more likely to perceive the impact of the  
 308 salinization than the landowners. Given the same impact, the higher the education level of the  
 309 respondents the more likely they perceive the salinization impact. In the same vein, non-owners of  
 310 land are more likely to take adaptive measures, and also, the higher the education level of the  
 311 respondents the more likely they take adaptive measures.

312  
 313 **Table 5a. Linear model analysis of social factors affecting the perception of coastal erosion impact and the**  
 314 **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	<b>0.005</b>
Gender (F vs M)	-0.067	0.482	-0.061	0.277
Level of education	-0.234	<b>0.011</b>	-0.105	0.189
Length of residency	0.170	<b>0.039</b>	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	<b>0.041</b>	0.033	0.521

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

316  
 317  
 318



319 **Table 5b. Linear model analysis of social factors affecting the perception of salinization impact and the**  
 320 **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	<b>0.073</b>	0.085	<b>&lt;0.0001</b>
Length of residency	0.055	0.437	- 0.045	0.113
Occupancy status (owner vs non-owner)	-0.066	<b>0.031</b>	- 0.038	<b>0.002</b>
Occupation (Farming)	-0.047	0.312	0.019	0.301
Occupation (Fishing)	-0.014	0.667	0.013	0.327

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

#### 322 **4. Discussion**

323 The results of the present study show that the respondents are more concerned about coastal erosion  
 324 than all other coastal hazard types in the Anlo community of the Western region of Ghana. This is  
 325 in concordance with geomorphological studies that found that this section of the Ghana coast is  
 326 eroding (e.g., [Addo, 2009](#); [Boateng, 2012](#); [Boye et al., 2018](#)). For instance, [Boateng \(2012\)](#)  
 327 observed an erosion rate of  $2.7 \pm 0.4$  m per year between Sekondi port jetty and Pra estuary in the  
 328 long term. [Boye et al. \(2018\)](#) noted that in both the short and long term, the western part of the  
 329 study area is eroding at a faster rate than the eastern section. Findings from the study carried out  
 330 by [Friends of the Nation \(2015\)](#) in the study area revealed that about 146 houses close to the shore  
 331 of the Atlantic Ocean are highly exposed to coastal erosion. Several houses stand threatened once  
 332 the highly exposed ones are eroded. Another report showed that more than 1,000 houses have been  
 333 destroyed by the sea in the last 30 years ([Graphic Online, 2017](#)). According to the same report,  
 334 more than 198 houses were washed away, and more than 800 residents were displaced during the  
 335 2017 tidal wave that hit the area ([Graphic Online, 2017](#)). It is important to note that the Anlo Beach  
 336 community is built on a dune between the wetlands and the Atlantic Ocean, and it is highly  
 337 vulnerable to floods and erosion ([Mutimukuru-Maravanyika et al., 2017](#)).

338 Although seawater flooding is a well-recognized problem in the study area ([Mutimukuru-](#)  
 339 [Maravanyika et al., 2017](#)), it was the third hazard identified by the respondents. Studies have shown  
 340 that laypeople can make a subjective assessment based on sentiments and psychometric factors  
 341 ([Slovic, 1987](#); [Slovic et al., 1984](#)) and/or social values ([Wildavsky and Dake, 1990](#); [Dake, 1991](#))  
 342 rather than on data. This may be because seawater flooding was perceived by some respondents as

343 one of the natural causes of salinization in the study area (Fig. 5), and as it emerged, about 26% of  
344 the respondents saw it as a major cause of salinization (Fig. 5).

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

357 Such a measure could be increased public awareness of the need to lower water abstraction  
358 rates and usage of other water resources that can contribute to an increase in freshwater volume,  
359 which slows the infiltration of saltwater. This is the simplest, most direct, and most economical  
360 solution to problems with saltwater intrusion and groundwater balance in aquifers. However, a  
361 supplemental source of water will be required to substitute for the mandated reduction in the  
362 groundwater pumping plan (Hussain et al., 2019; Abd-Elhamid et al., 2018; Bruington, 1972). As  
363 suggested by the majority of respondents, this additional water source can be the community being  
364 provided with pipe-borne water by the government (Table 4c). It is notable that, while the  
365 respondents' perception of increasing coastal hazards was high, their propensity to take adaptive  
366 measures was very low for both hazards (Table 3). More than 80% of the respondents were not  
367 making any effort to mitigate either coastal erosion or salinization because they viewed them as  
368 natural (Tables 3c and 4b). This is not surprising because previous studies also found no connection  
369 between people's risk perception and their intentions to take mitigation measures (Diakakis et al.,  
370 2018; Baron and Petersen, 2015; Wachinger et al., 2013; Bubeck et al., 2012; Siegrist and Gutscher,  
371 2006; Kreibich et al., 2005; Takao et al., 2004). According to Brilly and Polic (2005), proper  
372 actions and countermeasures do not always follow perceived threats. Based on this, Diakakis et al.

373 (2018) is of opinion that future public sensitization should focus more on the importance of self-  
374 protection measures, rather than emphasizing only the risks.

375 Concerning the variables or factors that influenced the perception of the respondents, our  
376 findings show that respondents' perceptions of increasing coastal erosion hazards were negatively  
377 associated with their level of education and occupancy status, whereas some type of occupation  
378 (fishing) was positively associated with coastal erosion hazard perception. The two factors that  
379 were always statistically significant among all the relevant socio-demographic characteristics were  
380 level of education and occupancy status (owner versus non-owner) (Table 5 a, b). These findings  
381 are consistent with previous studies, which suggest that demographic, attitudinal, and social  
382 contextual characteristics have a significant impact on perceptions of ecological risks (Bord et al.,  
383 1998; Kempton, 1993; Peters and Slovic, 1996).

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

391 Regarding taking adaptive measures to combat coastal hazards, age was negatively  
392 associated with the perception of coastal erosion risks, which is similar to that of Kellens et al.  
393 (2013) but at variance with earlier studies that found older respondents to display a higher  
394 perception than younger people. (e.g., Lindell and Whitney, 2000; Grothmann and Reusswig,  
395 2006; Knocke and Kolivras, 2007; Miceli et al., 2008; Burningham et al., 2008; Bonem et al.,  
396 2015). Taking adaptive measures to salinization was positively influenced by the level of education  
397 and associated with occupancy status. Higher education levels may increase respondents'  
398 promptness to take adaptive measures (Kellens et al., 2011). The varying outcome may be due to  
399 methods of measuring risk perception and different subjects (Kellens et al., 2011). For instance,  
400 while Burningham et al. (2008) measured risk awareness, Grothmann and Reusswig (2006) focused  
401 on the perceived ability to take protective actions against flood risks. Previous studies may not be  
402 directly related to coastal erosion and salinization hazards, they shed light on the effects of socio-  
403 demographics on perceptions of coastal hazards.

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

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

423  
424 **5. Conclusions**  
425 This research examines the societal perceptions of coastal risks in the Anlo Beach Fishing  
426 Community in Ghana's Western Region. We identified and explained numerous critical factors  
427 determining household risk perception using descriptive statistics and multivariate regression  
428 models. Our findings not only reveal how individuals view coastal risks, but also provide crucial  
429 information to policymakers interested in reducing the negative effects of coastal hazards on local  
430 populations. Although this research gives insight into the factors that influence people's perceptions  
431 of coastal risks in the study area, it should only be used as a starting point for further research.  
432 More real actions are required, such as actual legislative responses to coastal dangers. Further,  
433 findings from this study call for interventions from the appropriate authorities. These interventions  
434 should take the form of educating people about the necessity of self-protection measures like  
435 ceasing to use of beach sand exploitation of mangroves for fuel, as well as embracing mangrove

436 ecosystem restoration; and awareness about the need to lower water abstraction rates and usage of  
437 other water resources such as the provision of pipe borne water to the community to an increase in  
438 freshwater volume and slows the infiltration of saltwater.

439

#### 440 **Acknowledgments**

441 This study was carried out as part of the West Africa Coastal Area – mapping Vulnerability,  
442 Adaptability, and Resilience in a changing climate (WACA-VAR) project, sponsored by the  
443 OCEAN Department of the Institut de Recherche pour de Developpement (IRD) and supported by  
444 the JEA1 COASTS-UNDER-CONTROL between IRD and ACECoR. The first author is grateful  
445 to the leadership of the IRD OCEAN Department for supporting his Postdoctoral fellowship. He is  
446 equally thankful to the staff of the Centre for Coastal Management-African Centre of Excellence  
447 in Coastal Resilience (CCM-ACECoR), the University of Cape Coast, Ghana, especially the  
448 Director, Professor Denis Aheto; and Associate Director, Dr. Precious Mattah. The authors thank  
449 the Editor and anonymous reviewers for their comments and suggestions.

450

451

#### 452 **References**

- 453 **Abd-Elhamid, H.F., Abd-Elaty, I., Negm, A.M., 2018.** Control of Saltwater Intrusion in Coastal  
454 Aquifers. In: Negm, A. (eds) Groundwater in the Nile Delta. The Handbook of  
455 Environmental Chemistry, vol 73. Springer, Cham. [https://doi.org/10.1007/698\\_2017\\_138](https://doi.org/10.1007/698_2017_138)
- 456 **Addo, K.A, 2009.** Detection of coastal erosion hotspots in Accra, Ghana. *Journal of Sustainable*  
457 *Development in Africa* (Volume 11, 4.
- 458 **Bannerman, R.R., 1994.** Appraisal of the limestone aquifer of the Keta Basin, Ghana. In: Soveri  
459 J. and Suokko T. (Eds.), *Future Groundwater Resources at Risk*. Publ. 222. International  
460 Association for Hydrological Sciences, Wallingford, pp. 315–321.
- 461 **Barnard, P.L., Erikson, L. H., Foxgrover, A.C., Finzi Hart, J.A., Limber, P., O’Neill, A. C.,**  
462 **van Ormondt, M., Vitousek, S., Wood, N., Hayden, M.K. and Jones, J.M., 2019.** Dynamic  
463 flood modeling essential to assess the coastal impacts of climate change. *Scientific Reports*,  
464 9: 4309.
- 465 **Baron, N. and Petersen, L.K., 2015.** Climate change or variable weather: rethinking Danish  
466 homeowners' perceptions of floods and climate, *Reg. Environ. Change* 15, 1145–1155.
- 467 **Besset, M., Gratiot, N., Anthony, E. J., Bouchette, F., Goichot, M. and Marchesiello, P.,**  
468 **2019.** Mangroves and shoreline erosion in the Mekong River delta, Viet Nam. *Estuarine,*  
469 *Coastal and Shelf Science*, 226, 106263.
- 470 **Boateng, I., 2012.** An application of GIS and coastal geomorphology for large scale assessment  
471 of coastal erosion and management: a case study of Ghana. *Journal of Coastal*  
472 *Conservation*, 16:383–397.
- 473 **Bord, R. J., Fisher, A., and O’Connor, R. E., 1998.** Public perceptions of global warming: United  
474 States and international perspectives. *Climate Research*, 11, 75-84.
- 475 **Bonem, E.M., Ellsworth, P.C., and Gonzalez, R., 2015.** Age differences in risk: perceptions,

476 intentions and domains, *J. Behav. Decis. Mak.* 28, 317–330.

477

478 **Boye, C. B., Appeaning Addo, K., Wiafe, G. and Dzigbodi-Adjimah, K., 2018.** Spatio-  
479 temporal analyses of shoreline change in the Western Region of Ghana. *Journal of Coastal*  
480 *Conservation*. <https://doi.org/10.1007/s11852-018-0607-z>

481 **Bradford, R. A., O’Sullivan, J. J., van der Craats, I. M., Krywkow, J., Rotko, P., Aaltonen,**  
482 **J., Bonaiuto, M., De Dominicis, S., Waylen, K., and Schelfaut, K., 2012.** Risk perception –  
483 issues for flood management in Europe, *Nat. Hazards Earth Syst. Sci.*, 12, 2299–2309.

484 **Brilly, M., and Polic M., 2005.** Public perception of flood risks, flood forecasting and  
485 mitigation, *Nat. Hazards Earth Syst. Sci.* 5, 345–355.

486 **Brody, S.D., Zahran, S., Vedlitz, A. and Grover, H., 2008.** Examining the relationship between  
487 physical vulnerability and public perceptions of global climate change in the United States.  
488 *Environment and Behavior* 40(1), 72–95.

489 **Bruington, A. E., 1972.** Saltwater intrusion into aquifers 1. *JAWRA Journal of the American*  
490 *Water Resources Association*, 8(1), 150-160.

491 **Bubeck, P., Botzen, W. J. W., Kreibich, H., and Aerts, J. C. J. H., 2013.** Detailed insights into  
492 the influence of flood-coping appraisals on mitigation behaviour. *Global Environ. Chang.*,  
493 23, 1327–1338.

494 **Bubeck, P., Botzen, W.J., and Aerts, J.C., 2012.** A review of risk perceptions and other factors  
495 that influence flood mitigation behaviour, *Risk Anal.* 32, 1481–1495.

496 **Burkett, V.R. and Davidson, M.A., 2012.** Coastal impacts, adaptation and vulnerability: a  
497 technical input to the 2012 national climate assessment. cooperative report to the 2013.  
498 *National Climate Assessment* 150, 1–89.

499 **Burningham, K., Fielding, J., and Thrush, D., 2008.** “It’ll never happen to me”: Understanding  
500 public awareness of local flood risk. *Disasters* 32(2):216–238.

501 **Button, C., 2013.** Coastal vulnerability and climate change in Australia: public risk perceptions  
502 and adaptation to climate change in non-metropolitan coastal communities. PhD Thesis,  
503 School of Social Sciences, The University of Adelaide, Australia, 361 pp.

504 **Carlton, S.J and Jacobson, S.K., 2013.** Climate change and coastal environmental risk  
505 perceptions in Florida. *Journal of Environmental Management*, 130, 32-39.

506 **Cazenave, A. and Le Cozannet, G., 2014.** Sea level rise and its coastal impacts. *Earth’s Future*,  
507 2, 15-34.

508 **Coastal Resources Center (CRC, 2013).** Coastal Hazards and Flooding Risk in Ghana’s  
509 Western Region. Issue Brief 7 in series “Hen Mpoano: Our Coast, Our Future”.  
510 Narragansett, RI: Coastal Resources Center, Graduate School of Oceanography, University  
511 of Rhode Island. USAID Integrated Coastal and Fisheries Governance Program for the  
512 Western Region of Ghana. Narragansett, RI: Coastal Resources Center, Graduate School  
513 of Oceanography, University of Rhode Island. 15 pp.

514 **Collins, R., 2015.** Keeping it in the family? Re-focusing household sustainability. *Geoforum* 60,  
515 22–32.

516 **Coastal Resources Center / Friends of the Nation, 2010.** Report on characterization of coastal

517 communities and shoreline environments in the Western Region of Ghana. Integrated  
518 Coastal and Fisheries Governance Initiative for the Western Region of Ghana. Coastal  
519 Resources Center, University of Rhode Island, 425pp.

520 **Dake, K., 1991.** Orienting dispositions in the perception of risk: an analysis of contemporary  
521 worldviews and cultural biases, *J. Cross Cult. Psychol.* 22, 61–82.

522 **Diakakis, M., Priskos, G. and Skordoulis, M., 2018.** Public perception of flood risk in flash  
523 flood prone areas of Eastern Mediterranean: The case of Attica Region in Greece,  
524 *International Journal of Disaster Risk Reduction* 28, 404-413.

525 **Elrick-Barr, C.E., Smith, T.F., Thomsen, D.C. and Preston, B.L., 2015.** Perceptions of Risk  
526 among Households in Two Australian Coastal Communities. *Geographical Research* 53  
527 (2), pp. 145-159

528 **Friends of the Nation (2015).** Shama Disaster Management Committee Meeting and Field Work  
529 to Plan Anlo Beach Resettlement, The USAID/Ghana Sustainable Fisheries Management  
530 Project (SFMP). Narragansett, RI: Coastal Resources Center, Graduate School of  
531 Oceanography, University of Rhode Island and Friends of the Nation, Adiembra – Parks  
532 and Gardens. GH2014\_ACT085\_FON 26 pp.

533 **Ghana Statistical Service (GSS), 2012.** Summary report of final results for 2010 population and  
534 housing census. Ghana Statistical Service. Accra, Ghana.

535 **Gill H. E., 1969.** A groundwater reconnaissance of the Republic of Ghana, with a description of  
536 geohydrologic provinces. US Geological Survey Water-supply Paper 1757-K Washington,  
537 DC, 37pp.

538 **Gracia, A., Rangel-Buitrago, N., Oakley, J. A., and Williams, A. T., 2018.** Use of ecosystems  
539 in coastal erosion management. *Ocean & coastal management*, 156, 277-289.

540 **Graphic Online, 2017.** Anlo Beach to be wiped out in a year. Retrieved 24th of February 2022  
541 from [https://www.graphic.com.gh/news/general-news/anlo-beach-to-be-wiped-out-in-a-](https://www.graphic.com.gh/news/general-news/anlo-beach-to-be-wiped-out-in-a-year.html)  
542 [year.html](https://www.graphic.com.gh/news/general-news/anlo-beach-to-be-wiped-out-in-a-year.html)

543 **Grönwall, J., 2016.** Self-supply and accountability: to govern or not to govern groundwater for  
544 the (peri-) urban poor in Accra, Ghana. *Environ. Earth Sci.* 75, p.1163

545 **Grothmann, T. and Reusswig F., 2006.** People at risk of flooding: Why some residents take  
546 precautionary action while others do not. *Natural Hazards* 38(1–2):101–120.

547 **Helstrup T., Jorgensen N. O. and Banoeng-Yakubo, B., 2007.** Investigation of hydrochemical  
548 characteristics of groundwater from the Cretaceous–Eocene limestone in southern and  
549 southern Togo using hierarchical cluster analysis. *Hydrogeology* 15, p. 977–989.

550 **Hussain, M.S., Abd-Elhamid, H.F., Javadi, A.A. and Sherif, M.M., 2019.** Management of  
551 Seawater Intrusion in Coastal Aquifers: A Review. *Water* 11(12):2467.

552 **IPCC, 2012.** Summary for policymakers. In: Field CB, Barros V, Stocker TF, Qin D, Dokken  
553 DJ, Ebi KL, Mastrandrea MD, Mach KJ, Plattner G-K, Allen, SK, Tignor M, Midgley PM,  
554 editors. *Managing the risks of extreme events and disasters to advance climate change*  
555 *adaptation. A special report of Working Groups I and II of the Intergovernmental Panel on*  
556 *Climate Change.* Cambridge University Press, Cambridge, UK, 19 p.

557 **IPCC, 2021: Climate Change 2021.** The Physical Science Basis. Contribution of Working Group  
558 I to the Sixth Assessment Report of the Intergovernmental Panel on Climate  
559 Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N.  
560 Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R.

561 Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)].  
562 Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, In  
563 press, doi:10.1017/9781009157896.

564 **Kellens, W., Zaalberg, R., Neutens, T., Vanneuville, W. and De Maeyer, P., 2011.** An Analysis  
565 of the Public Perception of Flood Risk on the Belgian Coast. *Risk Analysis* 31 (7), 1055-  
566 1068.

567 **Kellens, W., Terpstra, T. and De Maeyer, P., 2013.** Perception and communication of flood  
568 risks: A systematic review of empirical research. *Risk Anal.* 33, 24–49.

569 **Kempton, W., 1993.** Will public environmental concern lead to action on global warming?  
570 *Annual Review of Energy and the Environment* 18, 117-145.

571 **Knocke, E.T. and Kolivras, K.N., 2007.** Flash flood awareness in southwest Virginia, *Risk*  
572 *Anal.* 27, 155–169.

573 **Kortatsi B. K., 1994.** Groundwater utilization in Ghana. *Future Groundwater Resources at Risk*  
574 (Proceedings of the Helsinki Conference). IAHS Publ. no. 222.

575 **Kreibich, H., Thieken, A.H., Petrow, T., Müller, M. and Merz, B., 2005.** Flood loss  
576 reduction of private households due to building precautionary measures - lessons learned  
577 from the Elbe flood in August 2002, *Nat. Hazards Earth Syst. Sci.* 5, 117–126.

578 **Kutir, C., Agblorti, S.K.M., and Benjamin B. Campion, B.B., 2022.** Migration and Estuarine  
579 Land use/land cover (LULC) change along Ghana’s coast. *Regional Studies in Marine*  
580 *Science* 54, 102488.

581 **Leiserowitz, A., 2006.** Climate change risk perception and policy preferences: the role of affect,  
582 imagery, and values. *Climatic Change*, 77, 45-72.

583 **Lindell, M.K. and Hwang, S.N., 2008.** Households’ perceived personal risk and responses in a  
584 multi-hazard environment. *Risk Analysis* 28(2), 539–556.

585 **Liddle, E.S., Mager, S.M., and Nel. E.L., 2015.** The suitability of shallow hand-dug wells for  
586 safe water provision in sub-Saharan Africa: lessons from Ndola Zambia. *Appl. Geography*.  
587 57, pp.80-90.

588 **Louarn, A., 2020.** Vulnerability of coastal socio-ecosystems in West Africa: design of a survey  
589 to analyse the role(s) of communities in erosion, submersion, salinisation and pollution  
590 processes, 2020. M2 internship thesis.

591 **Lutterodt, G., Miyittah, M.K., Addy, B., Ansa, E.D.O. and Takase, M., 2021.** Groundwater  
592 pollution assessment in a coastal aquifer in Cape Coast, Ghana. *Heliyon* 7(4), e06751.  
593 <https://doi.org/10.1016/j.heliyon.2021.e06751>.

594 **Miceli, R.,Sotgiu, I. and Settanni, M., 2008.** Disaster preparedness and perception of flood risk:  
595 a study in an alpine valley in Italy, *J. Environ. Psychol.* 28 (2), 164–173.

596 **Mölter, T., Schindler, D., Albrecht, A. and Kohnle, U., 2016.** Review on the projections of  
597 future storminess over the North Atlantic European region. *Atmosphere*, 7(4),  
598 [doi.org/10.3390/atmos7040060](https://doi.org/10.3390/atmos7040060).

599 **Morand, J-A, 2021.** Statistical and geomatic analysis of perceptions of environmental change by  
600 coastal communities in Senegal. M1 internship thesis. University of Savoie Mont-Blanc,  
601 53p.

602 **Mutumukuru-Maravanyika, T., Mills, D.J., Asare, C., Asiedu, G.A., 2017.** Enhancing  
603 women’s participation in decision-making in artisanal fisheries in the Anlo Beach fishing  
604 community, Ghana, *Water resources and rural development* 10, pp. 58-75.



605 **Neumann, B., Vafeidis, A.T., Zimmermann, J. and Nicholls, R.J., 2015.** Future coastal  
606 population growth and exposure to sea-level rise and coastal flooding - A global  
607 assessment. *PLOS ONE* 10(3): e0118571.

608 **Nicholls, R.J., Marinova, N., Lowe, J.A., Brown, S., Vellinga, P., de Gusmao, D., Hinkel, J.**  
609 **and Tol, R.S., 2011.** Sea-level rise and its possible impacts given a ‘beyond 4°C world’ in the  
610 twenty-first century. *Philos Trans A Math Phys Engineering and Science* 369, 161–181.

611 **O’Connor, R. E., Bord, R. J., and Fisher, A., 1999.** Risk perceptions, general environmental  
612 beliefs, and willingness to address climate change. *Risk Analysis*, 19, 461-471.

613 **Okyere, I., 2015.** Assessment of aquatic ecosystems, the fishery and socio-economics of a coastal  
614 area in the Shama District, Ghana (Doctoral dissertation, University of Cape Coast).

615 **Peacock, W.G., Brody, S.D. and Highfield, W., 2005.** Hurricane risk perceptions among  
616 Florida’s single family homeowners. *Landscape Urban Plan.* 73, 120-135.

617 **Peters, E., and Slovic, P., 1996.** The role of affect and worldviews as orienting dispositions  
618 in the perception and acceptance of nuclear power. *Journal of Applied Social Psychology*,  
619 26(16), 1427-1453.

620 **Ruz, M.-H., Rufin-Soler, C., Héquette, A., Révillon, R., Hellequin, A.-P., Deboudt, P.,**  
621 **Herbert, V., Cohen, O., Lebreton, F., Le Goff, L., Schmitt, F.G., Marin, D., 2020.** Climate  
622 change and risk perceptions in two French coastal communities. In: Malvárez, G. and  
623 Navas, F. (eds.), *Proceedings from the International Coastal Symposium (ICS) 2020*  
624 (Seville, Spain). *Journal of Coastal Research, Special Issue No. 95*, pp. 875-879.

625 **Savage, I. (1993).** Demographic influences on risk perceptions. *Risk Analysis*, 13(4), 313-420.

626 **Siegrist, M. and Gutscher, H., 2006.** Flooding risks: a comparison of lay people's perceptions  
627 and expert's assessments in Switzerland, *Risk Anal.* 26, 971–979.

628 **Slovic, P., 1987.** Perception of risk, *Sci. New Ser.* 236 (1987) 280–285.

629 **Slovic, P., Fischhoff, B. and Lichtenstein, S., 1984.** Behavioral decision theory perspectives on  
630 risk and safety, *Acta Psychol.* 56, 183–203.

631 **Spalding, M., Mcivor, A., Tonnejck, F., Tol, S., and Eijk, P. V., 2014.** Mangroves for coastal  
632 defence. *Guidelines for coastal managers & policymakers.* Published by Wetlands  
633 International and The Nature Conservancy. 42 p

634 **Steg, L. and Sievers, I., 2000.** Cultural theory and individual perceptions of environmental risks.  
635 *Environment and Behavior* 32, 250–269.

636 **Takao, K., Motoyoshi, K, T., Sato, T. and Fukuzono, T., 2004.** Factors determining residents'  
637 preparedness for floods in modern megalopolises: the case of the Tokai flood disaster in  
638 Japan, *J. Risk Res.* 7 (2004) 775–787.

639 **Wildavsky, A. and Dake, K., 1990.** Theories of risk perception: who fears what and why? *J.*  
640 *Am. Acad. Arts Sci.* 119, 41–60.

641 **Wachinger, G., Renn, O., Begg, C. and Kuhlicke, C., 2013.** The risk perception paradox –  
642 implications for governance and communication of natural hazards, *Risk Anal.* 33, 1049–  
643 1065.

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

648  
649