



Research Articles

Institutional arrangement for mitigating and adapting to climate change-related flood risk in Greater Accra Metropolitan Area (GAMA)

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ABSTRACT

Episodic floods, attributable primarily to climate change, global warming, and sea level rise, have worsened and continue to be a significant threat to life. Building resilience and improving the adaptive capacities of communities under threat will require institutional and cross-agency collaboration. This paper assessed institutional arrangements for mitigating and adapting to climate change-related flood risk in GAMA, Ghana. Using a descriptive cross-sectional survey, the study collected and analysed data from 65 private businesses and governmental, community, and civil society organisations to assess how institutions collaborate in preparing and adapting to flood risks in the study area. The study finds that frequent flooding, destruction of property and lives, and regular community agitations have triggered high-level consciousness, institutional arrangements, and collaboration within and among communities to build capacity and resilience. In addition, organisations have been educating indigenes on flood preparedness, providing relief items to support flood victims, and conducting training and research. Organisations have also supported communities in developing sandbags, planning sea defence mechanisms, providing rescue and evacuation assistance, providing transportation and logistics, and relocating stranded flood victims. Despite these efforts, the lack of adequate funding and logistics, coupled with the absence of proper consultation and involvement of most organisations in making national-level decisions on climate change and flood-related issues, have rendered flood management efforts less effective. This paper makes the case that proactive and collaborative flood responses should replace reactive and individual approaches to improve flood control efficacy and minimise casualties and property losses.

Introduction

Even under the best-case scenarios of emissions and climate sensitivity, scientists agree that the earth's climate is changing, and its effects are impossible to avoid [29,30]. Some of the common effects include flooding, sea level rise, and drought. In river valleys, deltas, and coastal regions, societies have thrived over climate change effects due to successful mitigation measures for flood risks [18]. However, because of climate change, the associated effects, i.e., sea level rise and increased exposure, floods have been happening more frequently and with more ferocity [18]. Climate change poses an increasing danger to the continuation of life globally. It has unquestionably emerged as one of the world's most significant problems in the twenty-first century. All nations are vulnerable, although some have been identified as more so than others [41]. According to Maruyama and Mimura [34], coastal regions are particularly vulnerable to sea level rise brought on by climate

change. The global scientific community agrees that climate change is the main factor causing the recent acceleration of sea level rise (Gaël et al., 2022; [14,39]). Wide-ranging repercussions from this sea level rise include the growing threat to coastal wetlands, coastal inundation, flooding, and destruction of lives and property [44]. The immediate effects of climate change and the rising sea level in Ghana are widely documented [52;63,65]. The effects of climate change and rising sea levels are linked to rising temperatures, changing rainfall patterns, unexpected extreme weather, increasing releases of greenhouse gases, and the disappearance of carbon sinks. According to Perks et al. [49] and Griggs and Reguero [27], the strength and incidence of coastal floods are predicted to increase under climate change projections.

Consequently, the sea level rise brought on by climate change has put coastal areas in grave danger. At the same time, other parts of the world have seen significant coastal erosion, and comparatively low-lying areas have also experienced either temporary or chronic inundation

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[32,27;26]. In the case of GAMA, climate change and sea-level rise have thus led to more frequent flooding, increased erosion, and the inundation of susceptible areas [4]. The nature of climatic processes that drive the environmental components of the hydrologic cycle, the heart of the hydrologic land-surface, and the subsurface processes within which flood develops determines the nature of climate change-related sea level rise and flood interactions, which function on numerous time and space dimensions [28]. It is anticipated that inundation and episodic flooding tides in low-lying areas of GAMA will be made worse by the accelerating rate of sea level rise brought on by warming temperatures in the latter parts of the twenty-first century [66,37]. This threat undermines human progress, and the surrounding ecosystems within such coastal towns thrive. Neighbourhoods in GAMA that would be more susceptible to the expected effects of climate change, related sea level rise, and floods are well documented (Apeaning- [7]).

Rising sea levels may become a significant problem [54]). Many sections of the coastal zone are already eroding at a phenomenal rate of about eight meters (8 m) per year. There have been reports of flooding along coastal areas [52], sometimes with devastating consequences. Climate change-related sea level rise is to blame for the current floods in some coastal villages in GAMA [4;52]. Under rising sea levels, the historical tendency of erosion brought on by flooding is anticipated to continue (Apeaning- [7]). Existing economic and political institutions and arrangements shape flooding mitigation and adaptation decisions. The ministries, non-governmental organisations, and civil society organisations are a few examples of national and private organisations whose work touches on climate change and matters connected to coastal flooding. However, efforts to manage coastal flooding in flood-prone areas involve interactions between multiple institutions and arrangements [48].

According to Wang et al. [62], flood management is widely recognised as an effective way to reduce adverse consequences. A more integrated and sustainable flood management approach has been the goal of recent studies. A certain amount of integration is required for actors to collaborate within the current governance structures to produce expertise and strategies that optimise partnerships, manage compromises, and deliver successful mitigation and adaptation to flooding [46]. We think that integration is desired because, despite being challenging to execute, it has the potential to produce superior results for climate-related flood risk management. Based on available flood statistics, most nations have created maps highlighting areas that are vulnerable to flooding, and Ghana is no different [9;65;46]. The innovative aspect of the current work is to show how various stakeholders work together to control the flood risk associated with climate change and how to encourage and strengthen this type of cooperation among the stakeholders. The study will also help readers understand disaster risk management policies and practices better, which will reduce the harm caused by disasters. The article has identified the key factor increasing the community's susceptibility to different climate-related disaster risks and has recommended particular ways of holistic or integrated management. Accordingly, this paper explores climate change-related flood risks from the perspective of institutional arrangements for promoting mitigating and adapting to flooding in Ghana.

Materials and method

The section is devoted to the methods employed in this study. The issues discussed are the study area and the research methodology. These include the study design, sampling and sample size, data sources, and data collection and analysis.

Study area

This research was conducted in GAMA, a commuter zone also known as the zone of influence of Accra (Accra Metropolitan Area), the capital city of Ghana, West Africa. GAMA is also defined as the metro bus

commuting end from the central business district (CBD) of Accra, where people commute daily for work and business activities [25;13]. GAMA comprises 25 Metropolitan, Municipal, and District Assemblies (MMDAs), that is, twenty-five of the Greater Accra Region's thirty administrative districts [2]. The most popular among them are the Accra Metropolitan Area (AMA), Tema Municipal Area (TMA), Ga West Municipal Area (GWMA), Ga East Municipal Area (GEMA), Ga South Municipal Area (GSMA), and Ga North Municipal Area (GNMA). Fig. 1 provides an overview of the study area. These make up one sizeable urban agglomeration as a whole. According to the Ghana Statistical Service (GSS, 2021), GAMA is the largest metropolitan region in Ghana, with a population of around 2.7 million in 2000 and 1.3 million in 1994. The metropolitan area is one of the top 90 largest agglomerations in the world, with a population of about five million [1]. GAMA has a 225-kilometer-long coastline stretching from Kokrobite in the west to Ada in the east.

Concerning the area's soils, the capacity for crop production is constrained by the soils' low organic contents and shallow top soils. Coastal savannah shrubs are the predominant type of vegetation, with thickets scattered. However, the Dangme West and Ga districts are the prominent locations for several trees [60]. Due to its place in the dry coastal equatorial climate zone, which has temperatures between 20° and 30° Celsius and an annual rainfall range from 635 mm along the coast to 1,140 mm in the northern sections, the area is relatively dry—rainfall peaks twice a year, notably in June and October [60]. The primary farming season in April through July coincides with the first rainfall season. However, sizeable fractions of vegetable farmers are becoming more reliant on the minor season (September–October) due to frequent flooding during the primary season in several sections of the region. According to [42], only granite, clay, and salt are found in the area's mineral resources, which are not particularly abundant. The Volta and Densu Rivers are the principal waterways that drain the area [19].

Additionally, there are several lagoons through which minor seasonal streams enter the sea, especially from Akwapim Ridge. Because the Gulf of Guinea borders the area on the south, AMA, Tema, and Dangme East include ecologically significant but heavily polluted lagoons and marshes [60]. The urban environmental health problem and the requirement for disaster preparedness are crucial for GAMA's sustainable and healthy development, which is the focus of the monitoring exercise given the region's size, complexity, and growing poverty [58].

Research

This work is part of a bigger study on climate change, urbanisation, and city liveability of GAMA. This paper reports on the section of the study that focused on the institutional arrangement for mitigating and adapting to climate change-related flood risks in the study area. In general, data was collected using a mixed-method approach that collected qualitative and quantitative data. According to Tashakkori and Teddie [59] and Creswell [16], the mixed-method approach is gradually becoming a credible research strategy. According to Mertens [38] and Punch [51], the mixed method aids in better understanding the study subject by including converging numerical trends from quantitative data and precise details from qualitative data. Neuman [40] advocated for using mixed-method research, arguing that mixing several ways in a study is the best method to utilise because looking at a situation from multiple perspectives is preferable to a single one. A questionnaire and in-depth interviews were utilised in this study to collect data from the field. The quantitative method was used for primary data collection through the distribution of questionnaires, which assessed institutional arrangements for mitigating and adapting to climate change-related flood risk in GAMA, Ghana. The qualitative method was used to derive a deeper understanding of the stakeholders under consideration. The survey approach was adopted in response to Creswell and Creswell [15], who argue that the survey design gives a quantitative picture of the population's trends and attitudes by evaluating a sample of that group.

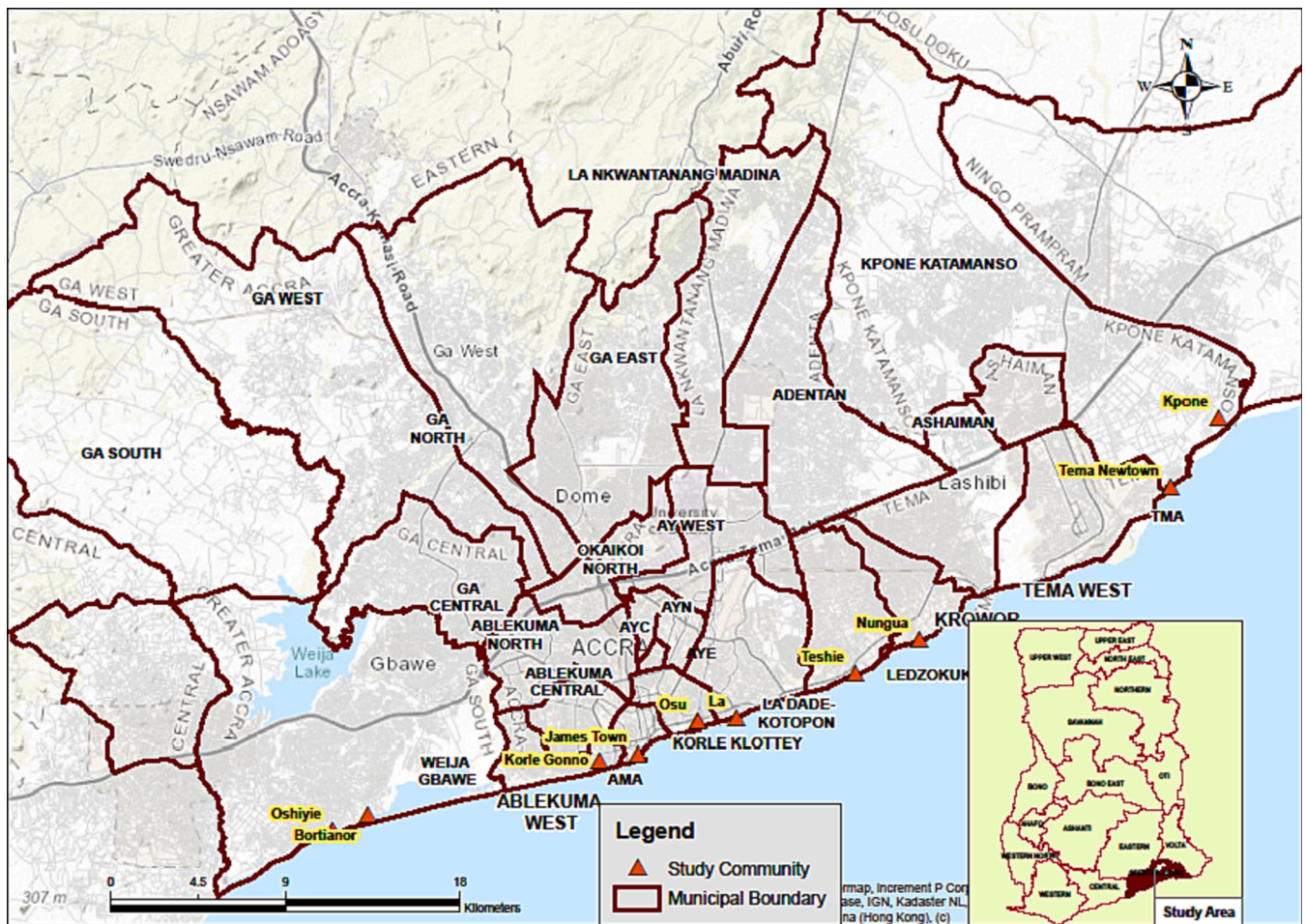


Fig. 1. Map of GAMA showing the selected communities. Source: Remote Sensing and GIS Applications Laboratory, Department of Geography and Resource Development, University of Ghana, Legon, Ghana (2023).

According to Bryman (2012), employing a cross-sectional design facilitates the simultaneous data collection of multiple cases at a specific time, enabling the exploration of relationships between two or more variables. The researcher does not influence or modify the study setting with a cross-sectional design. Employing cross-sectional design allows for making more precise distinctions between cases while evaluating correlations between variables. Additionally, a cross-sectional design offers a structured and consistent methodology to assess and quantify issue variations (Bryman, 2012).

Source of data and methods of data collection

The instruments used for data collection were both questionnaires and interview guides for the quantitative and qualitative data, respectively. This was designed to elicit information on the socio-demographics of respondents, knowledge, awareness, and perception of flood risk and climate change issues, institutions working to mitigate and adapt to flooding, institutional collaboration, and challenges. It also covered past, current, and future flood mitigation and adaptation issues. The study's research instrument was a five-part questionnaire (ABCDE). The instrument was open-ended, with the first section focusing on the socio-demographic features of the participants. Enumerators from the Department of Geography and Resources Development of the University of Ghana, Legon, were employed in the collection of data. The researchers guided them after they were trained in data-gathering skills and procedures. The rest concentrated on the substantial issues of climate change-induced floods in GAMA. The surveys were created using literature research and expert discussion criteria. The questionnaires were then administered to the respondents in both English and

the local language (Akan) to determine the level of agreement for each standard. Secondary data from the National Disaster Management Organisation (NADMO) and other agencies such as the Environmental Protection Agency, Ghana National Fire Service, La Municipal Assembly, Ledzokuku Krowor Municipal Assembly, and Spatial Planning Authority were obtained to validate the field data collected from the respondents. A face-to-face survey was conducted for both the in-depth interviews and questionnaire administration. The interview lasted between 45 and 60 min. The survey was performed according to established ethical guidelines, and verbal consent was obtained from the participants.

Sampling technique and sample size

The study administered 300 questionnaires in 10 coastal towns in GAMA, and the respondents were household heads. In addition, five focus group discussions were held in five (5) communities. Participants included both males and females, drawn from opinion leaders, community leaders, and identifiable groups. The diversity in the composition of the respondents was to ensure that rich data was collected from different participants with broad knowledge of the subject matter under consideration. An average of 9 people participated in each focus group discussion. Finally, to facilitate a better understanding of institutional collaboration, a transdisciplinary learning meeting was organised for selected institutions, community members, and experts with more profound knowledge, experience, and working relationships with flood management in GAMA. The meeting was held at the Department of Geography and Resources Development, University of Ghana, Legon. This publication focuses on data collected during the meeting with the participants of the interdisciplinary stakeholder workshops. So, the

sample for this study was the participants who participated in the transdisciplinary research and were involved in a two-day stakeholders' workshop meeting. There were 65 participants involved in this stakeholder meeting, and the data generated from these 65 participants are the data analysed and reported in this paper. The participants were conveniently selected from institutions, civil society groups, and residents. The participants comprised six (6) experts selected from six (6) fields of specialisation and 19 working community members with varying backgrounds residing in the community. There were 11 representatives from Governmental agencies. **Table 1** provides details on participants of the transdisciplinary learning who served as the sample for this current study of which the data is being reported.

The transdisciplinary study participants were between 20 and 60 years old. The sixty-five (65) participants were censured because they were the institutions and individuals that were either nominated by their institution or were purposefully invited by the Department for the two-day stakeholder workshop. An advantage of this method is that it provides intensive and in-depth information covering many facets of the problems of discussion [44]. We purposively considered all the participants who took part in the two-day workshop. The participants included representatives from the Ministry of Water, Resources, Works and Housing, Environmental Protection Agency, Ghana National Fire Service, La Municipal Assembly, Ledzokuku Krowor Municipal Assembly, National Disaster Management Organisation, and Spatial Planning Authority. Overall, there were about 11 key informants from government agencies, 12 from municipal/district assemblies, 31 from private business enterprises, mostly managers of beach resorts, and about 11 local community leaders.

The participants went through three (3) stages of data collection and validation. In the first stage, participants self-completed a questionnaire each, although with the guidance of facilitators. The questionnaire covered past, current, and future flood mitigation and adaptation issues. The study's research instrument was a five-part questionnaire (ABCDE). One-on-one interviews focus on understanding the details of the institutional collaborations specific to those institutions interviewed (whom, how, levels and specifics of their collaboration) in mitigation and adaptation to climate change-related flooding. In the third stage, there was an open forum and validation of the data gathered. The primary objective of the open forum was to create a venue for accomplished specialists and invited organizations to engage in an extensive dialogue concerning the study's thematic domains. The main purpose was to heighten awareness of significant concerns, collect input from relevant parties, and foster cooperation and originality. Subsequent to the open forum, the Validation workshops took place, which had a more concentrated approach and were tailored to assess and improve particular propositions, schemes, or approaches. A select group of stakeholders attended these workshops with a vested interest in the workshop's outcome. Summaries were projected onscreen, and where necessary, comments were invited and duly addressed.

Data analysis

The data collected from these surveys were analysed using the Statistical Package for Social Sciences (SPSS) Model (Version 20), and we generated descriptive statistics. Moreover, Microsoft Excel was used for the development and improvement of tables and graphs. Because of its

Table 1
Key respondents for the study.

Respondent	Frequency	Percentage
Government agencies	11	17
Municipal/district assemblies	12	18
Private business enterprises	31	48
Local community leaders	11	17
Total	65	100

considerable statistical features, SPSS version 20 was used. The unique program can construct variables from existing data (MacInnes, 2016). The programme incorporates automatic algorithms to recognise anomalies and statistical alterations and account for exceptions (Sen & Yildirim, 2022). We can do statistical calculations for meta-analysis on the data gathered using SPSS software and analyse outcomes. Based on the study's objectives, qualitative interview data were transcribed, manually coded, and organised into relevant themes. To illustrate essential findings, selected narratives from in-depth interviews were presented as direct quotes. The coding involved deductive and inductive coding techniques. Using inductive and deductive analytical methodologies, according to Bonner, Tuckerman, Kaufman et al. (2021), can assist in developing a more comprehensive knowledge of events. The deductive coding approach commenced with creating a codebook utilising our original collection of codes. The research questions from the interview guide were used to create this collection [57]. Induction provided additional support for the deductive codes. In this coding, we built new codes inductively and iterated on them as we sifted through the data for novel trends that had not previously been captured in the codebook. Inductive reasoning, for instance, investigates patterns in data to answer research questions [11].

Limitations of the study

The following shortcomings confronted the authors. A key limitation of this study was our inability to engage a larger sample size for this paper, even though we earlier engaged a large sample during the interdisciplinary stage of the workshop. Again, the inaccessibility of some locations within GAMA as a result of flooding during the field observation was a shortcoming as it prevented the team from visiting those places. Furthermore, providing training for the participants who were involved in the study was challenging due to inadequate resources in terms of finance and other related logistics needed. Notwithstanding these limitations, the findings are valid to promote research and practice.

Results and discussion

This section presents the results and discussions of the paper, mainly on the analysis of data covering institutional arrangements for mitigating and adapting to climate change-related flooding. The items discussed are based on the objectives of the study. The first part gives a synopsis of the socio-demographics of the respondents. It is followed by the major thematic areas of the research, which include the respondents' knowledge, awareness, and perception of climate-related flood risk, institutional collaboration, networking, challenges in flood risk management, past, current, and future flood mitigation, and adaptation issues. Finally, efforts aimed at managing flooding in coastal communities were also presented. The section begins with the study results and is followed by discussions of the various thematic areas.

Results

Regarding respondents' roles or status within the communities sampled, about 11 were government agencies; thus, managers of various institutions constituted about 17% of all those surveyed. At the same time, 18% were individuals working at different district and municipal assembly levels in GAMA. There were 31 (48%) representing private business enterprises and 17% representing local community leaders. The implication is that the survey participants were people with diverse information floods in GAMA based on their regional roles. This is significant because community participation is one way of achieving success in flood monitoring and programme implementation agenda.

Knowledge, awareness, and perception of flood risk and climate change

This paper section concerns the respondents' knowledge, awareness

level, and flood risk perception. Flood risk perception is an integral part of flood risk management because it assesses the likelihood of hazards and the likelihood of outcomes seen by society. Effective risk communication is a prerequisite for advances in risk gathering and analysing information and decisions regarding future investments. To evaluate the knowledge based on respondents, they were asked if they had observed any changes in the coastal area that could be interpreted as Sea Level Rise (SLR). The results showed that about 44 (67%) responded in the affirmative, while about 20 (30%) responded in the negative in Table 2. About 1 (3%) could not state whether such changes have occurred.

One respondent stated that;

“Notable modifications observed on the coast include seasonal changes in the sea level due to weather changes and frequent coastal inundation, resulting in the sea taking up more land compared to past years when the sea and coastal areas were almost a hundred meters. In addition, it has been observed that the sea is eroding inland and inundating nearby households, coupled with many sand-winning activities along the coast” (Nadmo Coordinator, La Municipal Assembly).

Regarding observed changes in the coastal area that could be understood as coastal flooding, about 42 (65%) of the respondents disclosed such changes, and 21 (32%) specified that no changes of that nature have occurred. A small percentage, 2 (3%), did not respond. Respondents asserted that many areas along the shore have experienced inundation and erosion of the sea further inland. It was disclosed that there had been numerous reports of erosion along the coast, including the formation of small lagoons. It was also announced that the sea had taken over school facilities and people’s properties within the coastal areas. Coastal erosion was also gradually affecting some parts of communities, especially roads. The study also discovered that coastal flooding becomes more severe during the rainy season.

The respondents surveyed were asked whether areas along the coast are likely susceptible to flooding from rainfall and sectors particularly exposed to possible coastal flooding in coastal communities in GAMA. As shown in Table 2, of most of the participants surveyed, 47 (73%) disclosed that areas are likely to be susceptible to flooding from rainfall, but 18 (27%) of the respondents stated otherwise. As depicted in Table 2, 33 (50%) of the respondents surveyed perceive that local institutions and organisations involved in risk management can manage or cope with possible coastal flooding. About 29 (44%) perceive otherwise, while the remaining 2 (6%) are unsure. Again, most of the respondents, 46 (70%),

Table 2
Respondent’s knowledge and awareness of flood risk and climate change.

Statement	Percentage Yes	Percentage (No)	Percentage Undecided
a. Observed changes in the coastal area that could be interpreted as sea level rise	44 (67%)	20(30%)	1(3%)
b. Observed changes in the coastal area that could be interpreted as coastal flooding	42 (65%)	21 (32%)	2 (3%)
c. Areas along the coast are likely to be susceptible to flooding from rainfall	47 (73%)	18 (27%)	0(0%)
d. Local institutions’ capacity to manage or cope with possible coastal flooding	33 (50%)	29 (44%)	2 (6%)
e. SLR is a major threat to coastal communities in Ghana	46(70%)	12 (18%)	8 (12%)
f. Consideration of climate change and flooding in GAMA Plans	39(61%)	14 (21%)	12 (18%)
g. Necessary funding to address issues concerning climate change and flood	31 (48%)	25 (38%)	9 (14%)

Source: Fieldwork, (2022).

believe that Sea Level Rise is a significant threat to coastal communities. About 12 (18%) of respondents responded negatively, while the remaining 8 (12%) do not think SLR is a significant threat to coastal communities. From Table 2, 39 (61%) officials disclosed that they consider climate change and flooding issues in the GAMA Plan; 14 (21%) indicated that they had not considered it, while 12(18%) were undecided.

Meanwhile, about 18% of officials specified that they had thought about it but had to put it officially into their plans. When asked whether the organisations have the necessary funding to address climate change and flooding issues, most informants, about 54%, as shown in Table 2, declared that they do not have the necessary funding to address changing climate and flooding issues. On the other hand, about 38% intimated that they have the funding required to address such problems. Furthermore, (11% of the officials also disclosed that they have inadequate financing that will enable them to address climate change and flooding issues.

Regarding the concern areas or environmental features particularly exposed to possible coastal flooding, about 26 (40%) mentioned buildings, structures, or households near and along the coast. This is shown in Table 3. Approximately 5 (8%) stated forts, castles, and beach resorts, and 7 (11%) specified lagoons or Ramsar sites. About 14 (21%) stated that they can’t tell, while 13 (20%) of respondents did not provide answers. This means there are observations by the respondents on the susceptibility and dangers posed by the sea to lives and properties, including the wetlands. These dangers also pose financial loss to the state and the property owners, as most resources are required to revitalise the lost ecosystem. It is worth mentioning that a few respondents expressed difficulty in providing an accurate answer (can’t tell) to the question at hand. This can be attributed to the fact that the question was designed to assess field experience, while the respondents were institutional representatives who may not possess such experience. It is conceivable that these individuals do not reside in any of the relevant communities or are simply office administrators representing their respective institutions. Such variables may have had an impact on their responses.

Institutional collaboration, networking, and challenges flood risk management

Flood-prone communities are central to all flood management activities and are important stakeholders. Furthermore, other local populations influence flood hazards through land use change and can play a significant role. Collaborative research on flood resilience in urban settings is an international, interdisciplinary effort that examines sophisticated and unique solutions and provides suitable metrics for enhanced flood management in cities. When done effectively, participatory planning may be a process of co-creation and social innovation, resulting in increased societal well-being. This section of the paper is devoted to institutional collaboration, networking, and challenges to flood risk management.

Results in Table 4 above indicate some level of collaboration between most organisations concerning flood risk management. For instance, about 21 (32%) of respondents disclosed that they mainly collaborate with the works department of the National Disaster

Table 3
Knowledge and awareness of coastal flooding.

Areas particularly exposed to possible coastal flooding	Frequency	Percentage
Buildings/structures/households close to and along the coast	26	40
Forts/Castles/Resorts	5	8
Lagoons/Ramsar sites	7	11
I can’t tell	14	21
N/A	13	20

Source: Fieldwork, (2022).

Table 4
Organisations that Collaborate on Flood Risk Management in GAMA.

Collaborating Institution	Frequency	Percentage
NADMO (Works Department)	21	32
No Collaboration yet		
Others (RIPS, Z.M.L.Engineers)	12	18
Nature of Collaboration		
Works and Provisions of Relief Items	13	20
Support/Assistance	10	15
Research, Data Collection, and Education	1	2
First Aid & Fire Fighting	1	
Projects and Programs Implementation	3	5
N/A	37	56

Source: Fieldwork, (2022).

Management Organization on issues concerning floods. Additionally, 12 (18%) also specified collaboration between the Regional Institute of Population Studies (RIPS), Zoom Lion Ltd. (ZML), Ghana Police Service, and Ghana National Fire Service. Others were the Environmental Protection Agency, District/Municipal Assemblies, and the 48 Engineers Regiment of the Ghana Armed Forces (48 Engineers). The study revealed that 50% of the invited agencies collaborated, with NADMO partnering with others involved in flood-related risk management. The joint effort focused on aiding regions impacted by flooding by implementing evacuation procedures, educating and raising awareness among residents who reside in flood-prone zones, and offering first aid and fire-fighting assistance during the subsequent fire outbreak. Additionally, the team collaborated to supply essential relief provisions including Wellington boots, mattresses, medication, sustenance, and emergency shelter. There was a sharp contrasting observation where 32 (50%) respondents indicated no collaboration between their institutions. When further interrogated, it was realised that, due to limited personnel and resources, they are most often informed of disasters but not involved in the work. This limits the proper use of their skills and is therefore often considered to play a minimal role in flood risk management.

Regarding the nature of cooperation between the organisations stated above, 13 (20%) of the surveyed respondents indicated that partnership is in the work area and relief items’ provisions when there is an incidence of disaster in GAMA. Another 10 (15%) stated that their collaboration is in general support, any support desired or requested by the other agency or the communities, while 1 (2%) each mentioned the collaboration in research, data collection, education, firefighting, and first aid provision. About 3 (5%) also said their cooperation is found in projects and program implementation. Similarly, 37 (56%) of the surveyed respondents could not indicate the nature of their partnership, and it was therefore implied that they are involved in any venture considered to be risk management or are not in a position to categorise their role in flood risk management. The reason for the answer “no collaboration yet” may be due to the respondent’s interpretation of the question and the diverse composition of the participants. The group consisted of private business individuals, government agencies, community leaders, and district assemblies. Although some organizations, like the district assemblies, receive aid in both resources and funding, they may not partake in joint ventures with other entities. Similarly, certain government agencies may offer legislative and institutional backing, but they may not collaborate directly with other agencies in the field. As shown in Table 5, about 17 (25%) of those surveyed declared that barriers prevent them from working effectively with the agencies they collaborate with. Approximately 21 (33%) indicated that no barriers inhibit their collaboration with other agencies. However, most of the respondents did not provide any response at all. In Table 5, most respondents in the various organisations, particularly the district assemblies, disclosed no relationship with other adjoining districts or sub-metros regarding coastal flood management 33 (50%). The information about no connection seems to support the idea that each metropolis or neighbourhood considers itself autonomous and is, therefore, expected

Table 5
Issues of institutional collaborations.

Statement	Yes	No	N/A
Barriers that prevent effectively working with agencies	17 (25%)	21 (33%)	27 (42%)
Relationship with other districts or sub-metros on coastal flood management	21 (33%)	33 (50%)	11 (17%)
Collaboration with sub-metros on other issues beyond flood management	27 (41%)	33 (50%)	5 (9%)
Engagement with communities on coastal flood management	31 (47%)	29 (44%)	5 (9%)

Source: Fieldwork, (2022).

to deal with its challenges to the best of its ability. This lack of collaboration, in most cases, affects those who are ill-resourced in terms of personnel, infrastructure, funding, machines, etc. About 21 (33%) declare some connection between them and adjoining communities. The remaining 11 (17%) did not provide any response at all.

In Table 5, about 27 (41%) of the participants surveyed revealed that they collaborated with other districts and sub-metros on issues beyond flood management. Similarly, 33 (50%) said they do not cooperate with those institutions beyond flood management. The remaining 5 (9%) of respondents did not have any idea at all. As illustrated in Table 5, about 31 (47%) of those who specified that they do not collaborate with other institutions currently on anything except flood management added that they have plans to engage with those institutions on issues beyond flood management. About 29 (44%) indicated they have no plans for such collaboration in the future either. Again, 5 (9%) did not express their view on this either. This means that most coalitions are ad hoc and typically happen based on the magnitude or intensity of the problem. It could be inferred that the association may not be long-term, so the closeness of the MMDAs is primarily based on proximity. This was affirmed by one Assembly Member, who said.

“We cannot invite everybody to come and assist us when floods have inundated our houses and other properties. We often consult assemblies closer to us for evacuation, logistic support, and other flood-related supplies” (Ledzokuku Krowor Municipal Assembly).

This is a clear indication of cooperation among assemblies in times of need. It is also worth noting that some municipalities are self-sufficient and, therefore, can manage the incidence of floods.

Past, current and future flood mitigation and adaptation issues

Adaptation is responding to climate change’s existing and necessary modifications to offset future effects. Mitigation refers to making the impact of climate change less severe. Appropriate flood management strategies can be adopted, including soft adaptation measures like preserving natural ecosystems and ‘hard’ acts like building dikes and flood-resistant building walls. The section covered GAMA’s previous and current mitigation and adaptation initiatives.

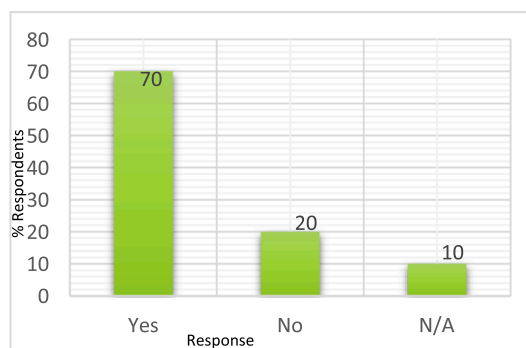


Fig. 2a. Experience with Floods over the Past Decade in Coastal Communities.

In Fig. 2a, participants expressed having had experiences with floods over the past decade in the coastal communities. 70% of the respondents disclosed that they had had some experience with floods in their communities. About 20% said they had not had flood experiences over the past decade. A small percentage of 10% did not provide any response in that regard. The implication is that the geographical location of the settlement is a deciding factor in how susceptible an infrastructure may be to the incidence of floods. Location is an essential variable in the influence of torrents in a place. When asked whether there has been any initiation for flood mitigation action in this coastal community, about 41% responded in the affirmative, and 49% answered that they had not taken any initiation. About 10% had no idea, as illustrated in Fig. 2b. The respondents with limited knowledge of flooding believed that the landscape is natural, indicating how sea level rise and other anthropogenic perturbations could trigger flooding. This means the participant associated flood incidence with human and natural causes.

Regarding how extensive the damage caused by flood has been, it was disclosed that, in terms of spatial extent, the flooding affected a vast expanse of coastal communities. Regarding property damage, it was announced that the floods caused a lot of wear and destruction to properties; we discovered that several belongings were also washed away. It was further revealed that houses, other buildings, and roads were submerged. Other properties, such as cars, clothes, bedding, etc., have been washed away during flood events. In terms of damage caused to human life, informants affirmed that there had been a loss of lives when flood incidents occurred. It was also disclosed that infrastructure-wise, school buildings, roads, and bridges have largely been destroyed.

Efforts at managing flooding in coastal communities

Floodwaters can endanger lives, inundate homes and businesses, destroy valuables, damage critical infrastructure, and obstruct access to essential public services as they spread. The flood’s impacts are sometimes long-lasting and can be highly costly, unpleasant, and upsetting for the communities affected. Coastal cities that suffer harm from rising sea levels, increasing storm surges, waves, and rain intensity might adapt by taking precautions to keep water out or learning to live with more regular flooding. The section is dedicated to flood management in GAMA’s coastal areas.

Details in Table 6 depict the contributions made by various organisations in managing the last flood in the diverse coastal communities. About 6% of officials disclosed that their organisation had educated indigenes on pre-flooding preparations, and 12% said they contributed by providing funds and relief items to support flood victims. Another 9% said they had been part of planning sea defence mechanisms and rescue and evacuation assistance, respectively. 6% indicated that they provided transportation and logistics to relocate stranded flood victims. However, for most of the officials interviewed, 58% did not contribute to managing the last flood that occurred in 2022. In effect, various organisations are trying to assist the victims of floods, although their contributions may not be sufficient to defray the losses made by the

Table 6
Contributions to Managing Flooding in Coastal Communities.

Nature of Contribution	Frequency	Percentage
Pre-flooding education	4	6
Funds and relief items to support flood victims	8	12
Planning sea defence mechanisms	6	9
Rescue and evacuation assistance	6	9
Transportation and logistics to flood victims	4	6
No contribution made	37	58

Source: Fieldwork, (2022).

residents. They may reduce the shocks and their vulnerability to some extent. This was shown by the percentage (58%) of respondents who spoke about not contributing to managing the last incidence of floods. This could be attributed to the specific location of the flood incidence within GAMA and how severe it may be.

One participant has this to say:

“The incidence of flooding was not as widespread as it used to be. Our zone of operation was not significantly affected, so we did not see how severe it was. It was a holiday for us since the severely affected zones did not even invite our staff” (Korley Klotey Municipal Assembly).

In Fig. 3a, about 27% intimated that they are consulted or involved in national-level decisions, including policies informing flood-related issues. However, about 67% of respondents surveyed claimed they were not consulted or involved in national-level decisions, including guidelines reporting flood-related matters. Just about 6% of those polled did not provide any answer. When asked if it is appropriate to incorporate SLR/Coastal flooding risks into property development decisions on the coast, most respondents, 89%, as shown in Fig. 3b, responded in the affirmative. About 6% responded negatively, whilst the remaining 5% did not express their views.

As shown in Table 7, about 18% of officials declared that their organisations/institutions need to do more in environmental health/public health to help flood management along the coast. Of about 15%, each stated they needed to do more in social, community, safety, and emergency services. In addition, about 8% indicated that their area of concern is administration and finance. Only 2% of officials stated the area of engineering and public works, whilst about 9% said they needed to work in development planning to help flood management along the coast. One respondent said this about the need for deeper cooperation among the agencies in providing social and other community support.

“I think we need to do more as state institutions in bringing our resources together regarding needs. This will greatly reduce the pressure and tension on the residence and other institutions” (Physical Planning Department, Accra Metropolitan Assembly).

Discussion

This section presents the discussions of the main results of the paper.

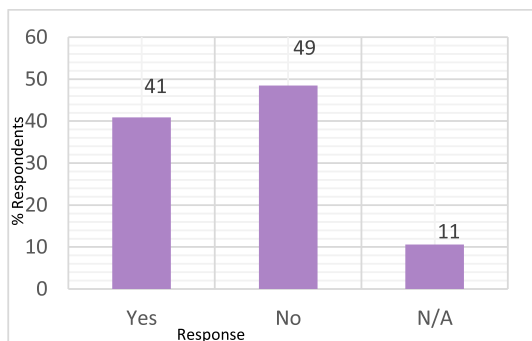


Fig. 2b. Initiation of any Flood Mitigation Action in any Coastal Community.

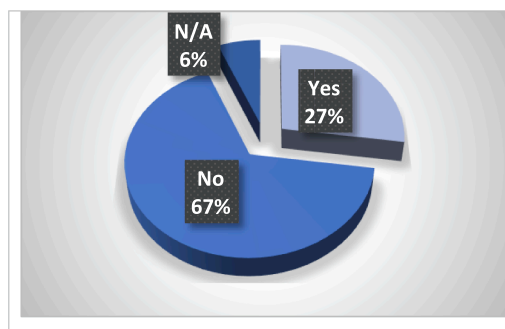


Fig. 3a. Consulted in taking National Level Decisions.

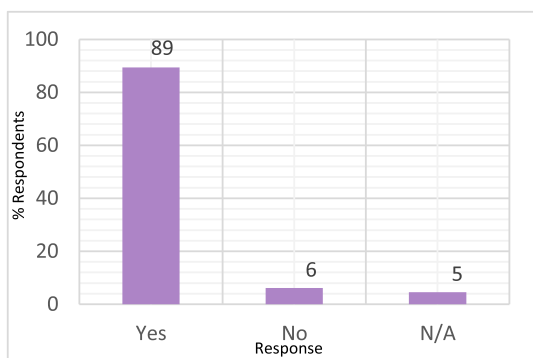


Fig. 3b. Incorporation of SLR/ Coastal Flooding in Development Decisions.

Table 7
Areas of Needs by Organisations in Flood-related Management.

Areas of Concern	Frequency	Percentage
Environmental health/public health	12	18
Social/community/safety services	10	15
Emergency services	10	15
Administration	5	8
Finance	5	8
Engineering/public works	1	2
Development planning	6	9
N/A	16	25

Source: Fieldwork, (2022).

The results have been linked with works done in flood risk management, the role played by institutions, and how institutions collaborate in flood management. The ensuing paragraphs are a detailed write-up to connect the data and previous studies.

Knowledge, awareness, and perception of flood risk and climate change issues

This study demonstrated a high level of awareness when 67% of respondents were aware of the changes brought by climate change phenomena. In comparison, about 30% responded that they were unaware, and 3% could not state whether such changes had occurred. Flood risk and climate change issues are well known among officials drawn from various GAMA institutions, as they mentioned they had observed some significant changes in the coastal areas. The high level of awareness is considered appropriate, as flooding has continued to be a substantial challenge for the people in GAMA and neighbouring regions [64]. These coastal changes could be interpreted as a result of SLR. Observed changes manifest in seasonal changes in the sea level due to weather changes and frequent coastal inundation, which resulted in the sea claiming more land [64,52]. In the results, 65% of the respondents disclosed that such changes had been witnessed, and 32% specified that no changes of that nature had occurred. Only 3% were undecided.

The finding manifests the changes observed by the participant in the study, which alluded to the fact that sea level rise is a matter of considerable concern. An earlier study by Puplampu et al. [52] on shoreline change observed that the sea is getting closer compared to previous years when the distance between the sea and coastal areas was almost a hundred meters. There is also an increased incidence of coastal erosion and flooding, which has compelled several households to relocate. In addition, it has been observed that the sea is quickly eroding inland and flooding homes that are close to the shore, coupled with many sand-winning activities along the eastern coastline of Ghana. Overall, it has been observed that SLR is causing much havoc to coastal communities [21,52]. Apart from that, there have been changes in the coastal area, which can be attributed to coastal flooding. Communities closer to or on the coast were discovered to have been repeatedly swamped and degraded by the water farther inland during the peak of

the flooding period. Flooding is typically more prevalent when the sea goes inland during the wet season (April to November). Numerous coastal erosion incidents were also reported. As a result of the SLR leading to flooding, the formation of small lagoons has also been noted [22]. Schools, facilities, roads, people’s properties, and many coconut trees have been destroyed. The findings indicate that coastal flooding has become more severe in recent years during the rainy seasons.

Further interaction with the respondents provided additional information on areas in GAMA that are highly susceptible to flooding. It was discovered that numerous regions along the coast are thought to be highly vulnerable to flooding brought on by heavy rain. Additionally, it was found that certain areas are highly vulnerable to potential coastal flooding in coastal villages in GAMA, which supports research by Appeaning Addo et al. [5]. The sectors and environmental features particularly exposed to possible coastal flooding include buildings, structures, households, forts, castles, beach resorts, lagoons, and Ramsar sites close to the coast. Some key coastal towns and communities in GAMA that are susceptible to flooding, as found in this study, include Agboghloshie, Old Fadama, James Town, Bortianor, Koklobite, Chorkor, and Mamprobi. Other areas are Mensah Guinea, Old Castle, Shiabu, Mpoase, Glefe, Gbegbesie Teshie-Nungua, Sakumono, and Tema Newtown Coastal Area. Sandik and Binns (2021) asserted that the risk of flooding in urban environments is affected by watershed characteristics, environmental conditions, and the presence and condition of flood management and mitigation technologies. The study shows that local institutions and organisations involved in flood risk management can manage or cope with possible coastal flooding. Some organisations with the capacity to manage possible flooding need funding and facilities, equipment, resources, logistics, and human resources to manage flooding as and when it occurs [3].

The study confirmed what earlier studies (Appeaning [5;21,3,52]) have found: that sea level rise poses an imminent danger to coastal communities. According to reports, several people have evacuated owing to coastal flooding brought on by sea level rise, owing to prolonged periods of substantial rainfall. It is anticipated that because of SLR, people will be forced to relocate further inland since there is limited land to occupy along the coast. The findings indicate that SLR has become a significant threat as it is enhanced by sand-winning activities along the coast, dumping of refuse, and displacing waterways for development projects. The result further shows that climate change and flooding issues are considered in AMA and other districts’ annual plans. Many district and municipal assemblies weigh flooding significantly and have policies preventing people from building on waterways [64]. Programs and education about climate change are undertaken occasionally but have not received the needed priority.

Although some organisations provide funds to cater to emergencies, including flooding, to support flood victims and other matters, it turned out that most of the organisations do not have the necessary funding to address changing climate and flooding issues [3,50]. It was disclosed that government institutions involved in flood management are primarily funded by organisations like the United Nations Development Program (UNDP). However, the funds go through many channels, which are almost always not enough; thus, they are also under budget. Even those who have some funding intimated that funding is woefully inadequate to enable them to address climate change and flooding issues. Given these, funding has been the major challenge for most flood management organisations.

Institutional collaboration, networking, and challenges

Concerning institutional collaboration, the result indicates low to medium-level cooperation between most organisations concerning flood risk management. From the results, about 32% of respondents disclosed that they mainly collaborate with the Works Department of the National Disaster Management Organization on issues concerning floods. Additionally, 18% specified collaboration between the Regional Institute of Population Studies, Zoom Lion Ltd (a private sanitation management

company), the Ghana Police Service, and the Ghana National Fire Service. Quite notably, there is a high level of cooperation among the works department of the National Disaster Management Organisation and Regional Institute of Population Studies, Zoom Ghana Lion Ltd., Ghana Police Service, Ghana National Fire Service, Forestry Commission, Environmental Protection Agency, District and Municipal Assemblies and the 48 Engineers Regiment of the Ghana Armed Forces [3,50]. It could be deduced from the study's outcome that most institutions are involved in some collaboration of a kind. These organisations collaborate effectively on issues concerning flood occurrences to provide support. The nature of cooperation between these organisations, as indicated by the results, is in the works and provisions of relief items, general support/assistance, research, data collection, education and firefighting and first aid, and projects and implementation of programs.

The finding corroborates the study by McGlynn et al. [36], who found collaboration between institutions in the same sub-sub-basins and not with those working in different sub-sub-basins. This implies that in most jurisdictions, cooperation among institutions is not in its entirety but is specific. Despite this collaboration, the study identified that some barriers prevent most organisations from working effectively with the agencies they collaborate with. Similar outcomes were arrived at by Rosmadi et al. [56], who aver that the capacity of local authorities and individuals in disaster management is inadequate, especially for flood risk preparedness and management. The obstacles come from a lack of funding for safety wear and resources, logistics tools, equipment, and transportation, and institutional arrangements and bottlenecks. Key informants in the various organisations disclosed that they have no relationship with other adjoining districts or sub-metros regarding coastal flood management. In addition, it emerged that there is no collaboration between most organisations, other communities, and sub-metros on issues beyond flood management. This aligns with Atanga [10], whose research findings revealed that flood-prone community leaders participate only in the implementation stage of flood risk management strategies and are not entirely involved. It implies that the only thing that brings collaboration is flood incidents [31].

Past, current, and future flood mitigation and adaptation issues

Most organisations disclosed that there had been some experiences with floods over the past decade in coastal communities, and about 70% of the respondents admitted that they had had some experience with an upsurge in flooding in their communities. About 20% said they haven't had flood experiences over the past decade. When asked whether there has been any initiation for flood mitigation action in their coastal community, about 41% responded in the affirmative, and 49% responded that they had never taken any initiation. The high percentages recorded indicate that the incidence of flood is severe and recurrent in GAMA, and this supports Attakora et al. (2023), who found that about 70% of AMA is susceptible to flooding based on biophysical assessment. Community members have to deal with it in their capacity. They opined that flood occurrences in coastal communities of Accra have become a yearly affair, especially in the rainy seasons. They have experienced annual floods in some coastal communities in recent times. It emerged that the extensive damage caused by floods has been quite significant, even in recent years. Flooding has affected a vast spatial extent of coastal communities. In terms of property damage, the floods caused a lot of wear and destruction to properties; several belongings have also been washed away. The outcome revealed that houses, other buildings, and roads do get submerged whenever flood incidents occur. Other properties, such as cars, clothes, bedding, etc., have been washed away during flood events. There has been a loss of lives due to flood incidents (Appeaning [5;21,31,3,50,52]). Significantly, infrastructure, including school buildings, roads, and bridges, has largely been destroyed.

Entirely several institutions have initiated flood mitigation actions in some coastal communities. Some of the key initiatives taken include sensitisation of residents on flood management, provision of sandbags for flood prevention, public awareness campaigns, community

participation, education of the community and preventing people from building in low-lying areas and on waterways, a national flood control program, the construction of new drains and desilting existing ones, education of the community on proper waste management, demolition exercise by the assembly to remove unauthorised and poorly sited facilities, and desilting of gutters and drains, and planting coconut trees along the coast. Whereas flood has persisted for the past decade, and the current year is no exception, there is high anticipation among stakeholders that floods will continue until a permanent solution is found. According to Attakora et al. 2023, given geophysical variables, 70% of the study area will suffer medium to severe flooding; therefore, it requires planning activities to intervene in these geophysical deficiencies and plan the area to avert flooding. Future flood risk mitigation may require strong physical re-engineering, development control, and sensitisation. While institutions have indicated their willingness to collaborate, we found competition, institutional bottlenecks, lack of standardised operational procedures, insufficient data, and collaboration as a challenge to future mitigation and adaptation to flood risk management in GAMA.

Efforts on managing flooding in coastal communities

Some organisations have made various contributions to assist in managing floods in different coastal communities over the years. Such contributions include educating indigenes on pre-flood preparations, providing funds and relief items to support flood victims, planning sea defence mechanisms, providing rescue and evacuation assistance, and providing transportation and logistics to relocate stranded flood victims [24,31]. However, it emerged that most did not make any contribution to managing the last flood that occurred. The study disclosed that the involvement of most organisations in making national-level decisions, including policies informing flood-related issues, has not been forthcoming. However, most organisations find it appropriate to incorporate SLR/coastal flooding risk approaches into property development decisions on the coast. To this end, the critical areas of concern in flood management are environmental health and public health, social community and safety services, emergency services, administration, engineering, and public, including development planning. The revelations of the study's outcome indicate that flood management is not an individual affair but a multifaceted venture that demands the participation of both state and non-state actors in providing a lasting solution to flood risk management. The finding is congruent with Almoradie et al. [3], whose results show how different actors perceive flood risk management in Ghana. They believed that stakeholders interviewed have other and even contradictory perceptions of the effectiveness of flood risk management (FRM), which are embedded in their diverse storylines. The similarity is found in the different views expressed by the participants of this study regarding flood management and how they approach it.

Conclusion and recommendations

This study has demonstrated a high level of awareness of flood risk and climate change-related issues among stakeholders from various institutions within GAMA. Some significant changes in the coastal areas have occurred due to an increased incidence of coastal erosion and flooding. Consequently, there has been some level of collaboration between some public institutions and organisations to make a proactive commitment toward effective flood risk management. Some organisations have affirmed their capacity to manage or cope with possible coastal flooding. Lack of adequate funding, logistics, types of equipment, and institutional arrangements or bottlenecks, coupled with an absence of proper consultation or involvement of most organisations in taking national-level decisions on climate change and flood-related issues, have rendered flood management efforts less effective. Some essential mitigation and adaptation initiatives taken include sensitisation of residents on flood management, erection of sandbags, public awareness creation, community participation, education of the community and preventing

people from building in low-lying areas and on waterways, a national flood control program, the construction of new drainage system and desilting of existing drains, education of the community on proper waste management, demolition exercise by the assembly and desilting of gutters, and planting coconut trees along the coast. We conclude this study with an assertion that, through some form of collaboration among the stakeholders and or institutions, it was evident that there are considerable weaknesses in the institutional arrangements for mitigating and adapting to climate change-related flood risk.

The study recommends a holistic approach to addressing the critical areas of institutional arrangement weakness identified to improve flood management. We recommend stronger institutional collaboration from the national level through regional, district, and community levels as a way of ensuring effective flood risk management. The recommendation corroborates the view of Ashraf et al. [8], who urge holistic inter- and intra-agency collaboration in research and analysis to help develop comprehensive and lasting solutions. We followed by recommending increased funding for sustainable risk management. Also, we recommend an integrated approach to flood risk management. The view of integrated approaches is believed to have the potential to enable better outcomes for FRM, including community participation [17]. On policy direction, the paper suggests the following policy guidelines for addressing the identified weaknesses in the institutional arrangements for mitigating and adapting to climate change-related flood risk in GAMA. The shortcomings in institutional agreements could be addressed by mainstreaming collaboration in flood management, developing Standard Operational Procedures (SOP) for flood management and inter-agency partnerships, and developing and periodically updating standard and openly accessible flood risk maps/data where all agencies will store and access data for their works, ensuring routine monitoring by flood risk management stakeholders, sharing flood forecasting information to raise awareness among agencies and provide them with accurate information, data exchange between and among stakeholders, institutional reforms to ensure collaborative efforts, and bridging gaps among organisations through consultative meetings, seminars, and workshops to share knowledge. Modifying operating standards to accommodate new trends in safety management may also aid in reducing flaws; they should also undergo frequent evaluation and adaptive control. Another strategy to remove institutional constraints is strengthening institutions' missions and ensuring their actions are coordinated. To ensure the success of local climate action for adaptation, mitigation, and sustainable development, we recommend greater commitment from government agencies and stakeholders in policy implementation and a more significant commitment to providing adequate support, such as funding for programs and project implementation. These will help to provide sufficient and efficient catastrophe risk management capabilities. Flood management must be proactive and not reactive. Local people must be an integral part of and own them rather than being implemented for them. They contribute to the problem and must, therefore, be the first to initiate a solution for which a change of attitude is critical. Future research in this subject matter should concentrate on communication and knowledge transmission among flood risk communities and stakeholders involved in risk management. Such knowledge would improve our understanding of what communication and information modes are most effective.

CRediT authorship contribution statement

Alex Barimah Owusu: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Original draft, Visualization. **Kofi Adu-Boahen:** Investigation, Methodology, Project administration, Validation. **Ishmael Yaw Dadson:** Validation.

Ethical Approval

Approval was obtained from the corresponding author institution's

Ethical Review Board (E.R.B.) that the procedures used in this study adhere to the tenets of the Declaration of Helsinki.

Informed consent

All participants and their legal guardians had written informed permission before the interviews.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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