

Partial climatic risk screening, adaptation and livelihoods in a coastal urban area in Ghana

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ABSTRACT

Coastal urban areas worldwide are increasingly becoming convergence points for climatic hazards, demographic shifts, and spatial development. However, the presence of societal demands that impact both livelihoods and urban planning in response to climatic hazards undermines the potential positive outcomes. This research, conducted in a coastal urban area of Ghana's Greater Accra Region, utilized the Community-based Risk Screening Tool – Adaptation and Livelihoods (CRiSTAL) developed by the International Institute for Sustainable Development (IISD) to analyze the experiences of climatic hazards and overall livelihoods of the population. The study employed Ghana's Census Sampling Frame for implementation, and Participatory Learning Approaches, to collect data which it identified floods, heavy storms, and heat stress as the most significant hazards. These hazards greatly influenced the population's physical, social, and financial livelihood assets, resulting in losses and damages caused by heavy rains, storms, and subsequent floods. Extreme heat also had a notable impact on human and financial resources. The local population prioritized human mobility and livelihood diversification as important adaptation strategies. The findings have important policy implications, highlighting the need to address barriers and disruptions in resilience-building and sustainability efforts, emphasizing the significance of prioritizing policy investment and considering climate change uncertainties in planning towards minimizing "urban climate policy inhibition" (Urban-CPI). The study also revealed valuable lessons, such as CRiSTAL's ability to bridge the gap between climatic risk and livelihood issues, bringing them closer to communities and enhancing preparedness to adapt to climatic risks and impacts on livelihoods.

1. Introduction

It is well established that with the rise in global warming, even small increases in average temperatures are expected to lead to an increase in the type, frequency, and intensity of extreme events in the form of floods, droughts, heat and heavy precipitation (Intergovernmental Panel on Climate Change, IPCC, 2007, 2014; Meehl et al., 2007, United Nations Framework Convention on Climate Change, UNFCCC, 2007). This, in turn, will have far-reaching consequences for the environment, socio-economic sectors, and related sectors such as water resources, agriculture, food security, human health, terrestrial ecosystems, biodiversity, and coastal zones (Bates et al., 2008; Boko et al., 2007, pp. 433–467; UNFCCC, 2007). The impact of climate change on urban areas globally introduces new challenges for livelihoods and urban transitions (Abdrabo et al., 2022; Ridha et al., 2022; Uddin et al., 2021; Chu et al., 2017; Meerow et al., 2016; Garschagen, 2016). The IPCC's Sixth

Assessment Report confirms with high confidence that urban populations and livelihood assets face an increased risk from climate change-related hazards (IPCC, 2022). These effects on socio-economic sectors include feedback mechanisms that affect the livelihoods of vulnerable populations. Social and political networks play a role in influencing livelihoods, resulting in varying levels of cohesion and resilience in the face of climate hazards and emerging risks (Brauch, 2005). The literature on climatic risks, adaptation, and livelihoods in coastal urban areas explores the challenges and opportunities associated with climate change impacts in urban coastal regions, particularly in relation to the well-being and livelihoods of local populations (e.g. Adger et al., 2007; Birkmann et al., 2010; Hallegatte et al., 2013; Hinkel et al., 2014; Solecki et al., 2011). This body of literature aims to understand the vulnerabilities and adaptive capacities of coastal communities facing climatic risks, and to identify strategies and policies for enhancing resilience and sustainable development. The literature highlights the complex interactions between

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climate change, urbanization, and socio-economic factors in shaping vulnerability and adaptive capacity. It explores how climatic risks intersect with other social and economic stressors, such as poverty, inequality, governance structures, and access to resources, which can exacerbate the impacts of climate change on coastal communities. Consequently, countries worldwide are seeking effective ways to address climatic hazards in urban areas, particularly along coastlines, as they drive livelihood-related climate adaptation decisions. The multiplicity of factors driving these decisions and the underlying motivations are of great interest (Dovie, 2017). Climate change has already caused significant loss and damage to major resources, investments, and livelihoods, with floods, storms, and heat-related events being prominent (IPCC, 2022; Ellena et al., 2020; Heslin et al., 2018; Swan, 2010). The increasing societal demand for land, water resources, services, physical infrastructure, and industrial expansion in urban settings exacerbates the burden of climatic hazards (de la Luz Hernández-Flores et al., 2017; Friend & Moench, 2015; Oliveira et al., 2022). Urban managers and policymakers face immense pressures to meet immediate livelihood demands, often prioritizing them over planning for uncertainties such as climate change (Hurlimann et al., 2021; Dovie et al., 2020).

As a result, there are significant knowledge gaps regarding the experiences of livelihoods at the intersection of climate governance, resource use, and livelihoods, which are critical considerations for climate change policy and urban planning. This study aims to examine the foundations of livelihoods in building climate resilience within selected Greater Accra Region’s coastal urban area of Ghana and provide insights for policy interventions. The complexities arising from the intersections of urban livelihood demands and climatic hazards, coupled with urban policy actions, are still emerging and have received limited attention in climate-related livelihood policies in urban spaces (Dai et al., 2022; de la Luz Hernández-Flores et al., 2017; Filho et al., 2019; Fitcher et al., 2017; Lindberg et al., 2016; Rana et al., 2021; Ren, 2015). Social capital and social learning play a vital role in building resilience (Uddin et al., 2021). Urban areas now frequently experience intensified and more frequent heavy storms, floods, and heat stress, directly affecting livelihoods (Abdrabo et al., 2022; Garschagen, 2016; Onur & Tezer, 2015; Gu et al., 2011). Vulnerable population groups, including low-income individuals, minority residents, and new migrants, often settle in high climate risk areas within urban regions due to the availability of affordable housing (Bakkensen & Ma, 2020, United Nations Human Settlements Programme & United Nations Environment Programme, 2010; Zickgraf et al., 2016). Currently, approximately 56% of the global population resides in urban areas, a figure projected to reach 66% by 2050 (United Nations, 2019). There is an increasing body of literature highlighting floods as a significant risk factor influencing individual relocation decisions and resulting in adverse impacts (Twerefou et al., 2023; Baker et al., 2018; Fan & Davlasheridze, 2015). Ghana is particularly vulnerable to various climatic hazards, with temperature projections indicating an increase of 1–3 °C by 2060 and between 1.5 and 5.2 °C by the 2090s (Environmental Protection Agency, 2021). Mean annual precipitation is also expected to undergo a wide range of changes, leading to increased total annual rainfall (Environmental Protection Agency, 2021). Additionally, a gradual rise in sea level is anticipated, with estimates of 5.8 cm, 16.5 cm, and 34.5 cm by 2020, 2025, and 2080, respectively. These changes will significantly impact Ghana’s coastal zone, where more than 25% of the population resides. Key economic sectors such as energy, agriculture, health, cities and infrastructure, water resources, and coastal areas will be severely affected (Environmental Protection Agency, 2021, Fig. 1). As a result, the case of the Greater Accra Region within Ghana’s coastal zone is examined to glean insights into how local populations are addressing the impacts of climatic hazards and the implications for governance issues within the climate change-livelihoods-urban nexus. Thus, providing insights into the complex dynamics of climate change impacts, vulnerabilities, and adaptation strategies in these unique and vulnerable settings, and contributes to the development of knowledge and

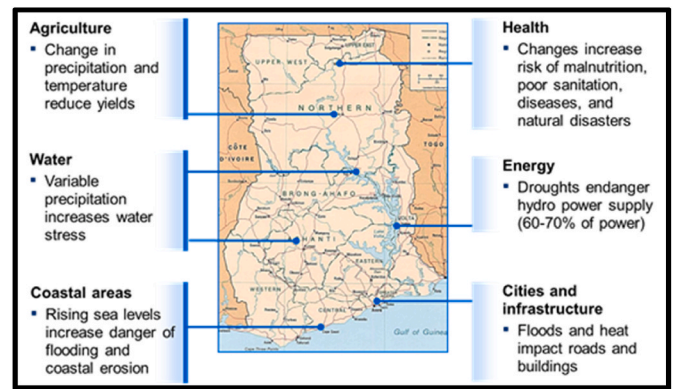


Fig. 1. Map of Ghana showing major vulnerabilities to climate change including the coastal fringes of the Greater Accra Region (Source: Environmental Protection Agency, 2021).

evidence-based approaches for building resilience and sustainable development in coastal areas.

2. Methodology

2.1. Study site description

The Greater Accra Region (Fig. 2), is located in the southern part of Ghana along the Gulf of Guinea in West Africa, occupying a total area of 3245 square kilometers, of which the national capital, Accra is part, with the entire landscape having both urbanized and rural areas (World Bank, 2017). The Region has a coastline of approximately 225 km, from west to east within the dry coastal equatorial climatic zone. Daily temperatures are between 20 °C and 30 °C, with mean annual precipitation of 635 mm and comprises of two distinct rainy seasons from April to July and September to November. The topography is generally gentle with undulating low plains, drained by the Volta and Densu rivers in addition to small streams such as the Odaw, Lafa, Chemu, Nima, Dakobi, Ponpon, Nsaki, Onyansia and Doblo). The 2021 Population and Housing Census (GSS 2021), shows that the Greater Accra Region has as of 2021 a population of close to 5.5 million people (over 91% urbanized) (Ghana

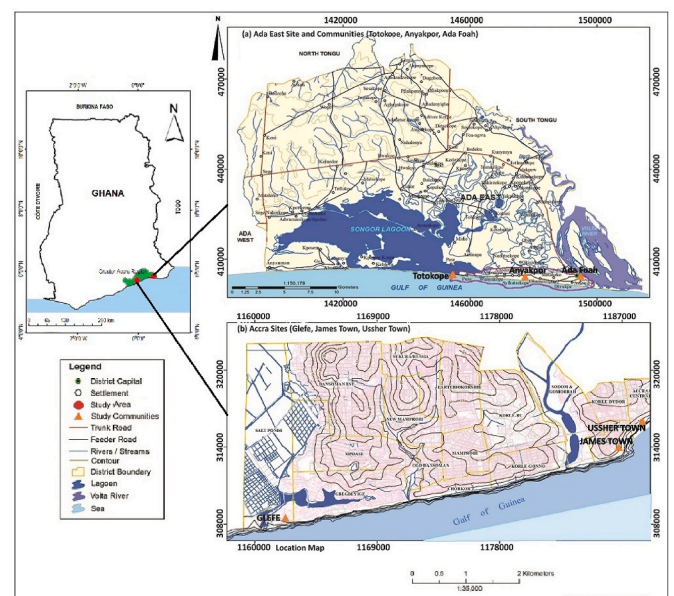


Fig. 2. Map of Ghana (inset) showing the Accra Plains which host the Accra Metropolitan and Ada East coastal areas of the study location.

Statistical Service, GSS, 2021), of which over 50% lived in the coastal areas. Two study localities were selected: (a) the Ada East coastal area (Totokope, Anyakpor, and Ada Foah), which is not as densely populated and urbanized as the Accra coastal area, characterized by gradual increases in populations and severely predisposed to erosion, flooding and inundation; (b) Accra Metropolitan coastal area (Glefe, James Town, and Ussher Town) with communities characterized by very dense and socio-economically vulnerable populations, many of them indigenous or settlers, who are dominantly fisher folks, and migrants. Many of these coastal areas are unplanned informal settlements, which have limited social infrastructure and identified as favorable exposure units to climate change impacts associated with extreme rise in the levels of the sea (O’Neal Campbell, 2006; World Bank Hazard Management Unit, 2005).

2.2. Sampling frame

A flood risk history for the coastline of the Greater Accra Region was constructed and flood risk-prone map was developed to guide the selection of two Districts for the study following a combined Remote Sensing and Geographical Information System tools, and ground truthing (Fig. 3a: Level 1), A participatory workshop each was carried in the two districts to discuss the risk-prone maps that led to the selection of three communities each within the Districts (Fig. 3a: Level 2), totaling six communities in all. The National Master Sampling Frame for the 2010 Ghana Population and Housing Census (Ghana Statistical Service, GSS, 2013) was used to validate the communities within Enumeration Areas (EA) (Fig. 3a: Level 3), to ensure comparability with existing national level universal data management protocol. The respondents’ groupings were seemingly participatory, agreed during the District inception workshops (Fig. 3a: Level 3), which were fed into the Community-based Risk Screening Tool – Adaptation and Livelihoods (CRiSTAL) Version 5 (IISD, 2012) (Fig. 3a: Level 4). The communities were further given the opportunity during a study feedback, to validate and appraise the findings before they were subject to the next level of policy analysis using policy dialogues (Fig. 3a: Level 5).

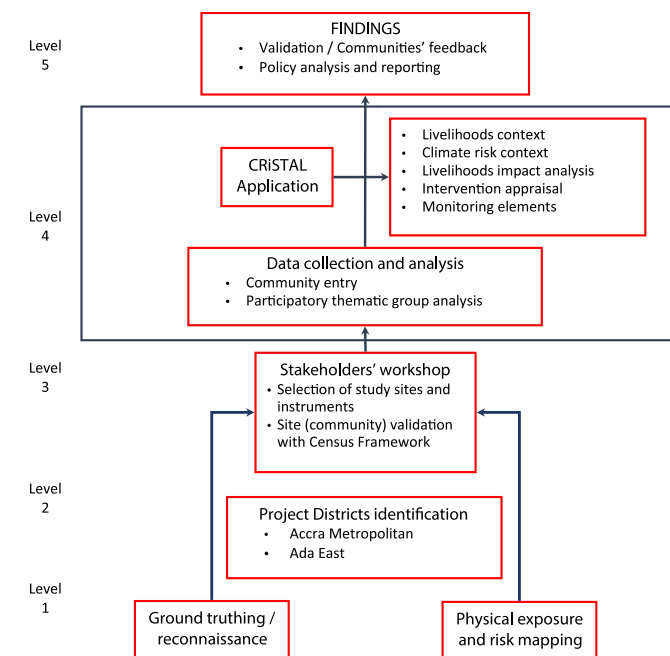


Fig. 3a. Schematic representation of the data collection framework.

2.3. Data collection and analysis

The CRiSTAL served as the primary tool for collecting information on livelihoods and the local climate context, specifically focused on climatic hazards (Fig. 3b). The engagement of communities was integral throughout the entire CRiSTAL process, spanning steps 1 to 5 (Fig. 3b). The aim was to gather information on livelihoods, the local climate context, and explore the interconnection between them rather than implement the full array of the CRiSTAL. Key questions addressed included:

- (a) What are the climate-related hazards, impacts and coping strategies?
- (b) Which livelihood resources are important to people’s livelihoods?
- (c) How do current climate hazards affect livelihood resources?
- (d) How do livelihood resources influence coping strategies?
- (e) How crucial are these resources in responding to climate risks?

To achieve the objective of the study, the selected communities actively participated in site visits, informal meetings, and workshops utilizing Participatory Learning Approach (PLA) tools. Various focus groups, representing different social groups including men and women, acknowledging that their priorities and responses to climate risks might vary. By considering the experiences and opinions of these diverse groups, the analysis captured the differential impacts and responses to climate risks. The CRiSTAL approach integrated knowledge from the past, present, and ongoing resilience-building activities, including related outcomes. It also provided insights into the best available options tailored to specific locations and spaces. In addition to assessing the vulnerabilities of human populations and their activities, CRiSTAL facilitated the identification of adaptation-related activities linked to livelihoods. It offered a means to explore future options and understand the potential outcomes associated with different approaches to adaptation.

The sampling involved three respondent groups: fishmongers, fishermen, and individuals engaged in various other trades (e.g., dress-makers, carpenters, construction workers, food vendors) operating within coastal communities. In each community, these groups consisted of approximately six to twelve participants. To assess the influence of climate hazards on livelihood assets, participants evaluated the extent of influence on a scale ranging from 0 (no influence) to 5 (very strong influence). Thus,

$$\text{Influence Score for each livelihood asset, } IS_{(n = 0-15)} = IS_{(eh)} + IS_{(hr)} + IS_{(ff)}$$

where:

- $IS_{(eh)}$ = influence score for extreme heat.
- $IS_{(hr)}$ = influence score for heavy rainfall/storm.
- $IS_{(ff)}$ = influence score for flooding.

This evaluation, which is a newly introduced index, was part of the CRiSTAL protocol using the five livelihood assets examined:



Fig. 3b. The step by step application process of the CRiSTAL (Source: IISD, 2012).

- (a) Natural resources: The stocks of natural elements upon which people rely directly or indirectly.
- (b) Physical resources: Basic infrastructure and productive capital necessary for development.
- (c) Financial resources: Monetary exchanges aimed at achieving livelihood objectives.
- (d) Human resources: Knowledge, skills, capacity, and good health crucial for pursuing livelihoods.
- (e) Social resources: The social relationships and institutions that shape people’s livelihoods.

To comprehensively engage stakeholders and gather feedback, a Participatory Stakeholder Analysis (PSA) approach was employed (Granville et al., 2016; Kazadi et al., 2016; Missonier, 2014). This involved key informant interviews, transect walks, participant observations, and participatory learning through focus group discussions. These methods helped refine and redefine the scope of the climatic risks, fostering increased awareness and complementing existing data. By engaging key change actors within the urban space, the resilience-building framework derived from CRiSTAL was appraised and enhanced.

3. Findings

The three main climatic hazards recorded within GAMA were extreme heat, heavy rains/storms, and flooding due to sea level rise and increased surface runoff, which tended to negatively affect livelihood assets of the population as follows:

- (a) natural resources (sea, lagoon, sand and mineral stones)
- (b) physical resources (fish containers, drying kilns and equipment, roads)
- (c) financial resources (local savings, ‘susu’ – informal financial cooperative, loans)
- (d) human resources (bargaining and trading skills, knowledge, informal tutelage)
- (e) social resources (Local banking network called ‘susu’, family/friends’ network, church group)

Extreme heat had strong influence on human resources than the remaining livelihoods, with natural resources being the least influenced (Fig. 4a). Similarly, social livelihood assets were influenced most by heavy rains and storms followed by physical and human resources, and consistent with the greater exposure associated with urbanization which is explained by physical infrastructure and human population growth (Fig. 4b). The combined high tide from sea level rise and increased surface runoff from high intense rainfall had the highest influence on the physical resources followed by financial resources (Fig. 4c). Although the influence of flooding on financial livelihood assets was indirect, it overlapped with the destruction of physical infrastructure which in turn

triggered heavy financial loss. Natural livelihood assets was least influenced by the three climatic hazards (Fig. 4), yet natural resources had diminished to a large extent, and reducing the physical exposure units available to influence the hazards (Fig. 4).

When examining the impact of climatic hazards on livelihood resources across three trade groups, it was observed that heavy rains/storms had a significant influence on all livelihoods within each group, with an influence score (IS) ranging from 3 to 14 (Fig. 5). Fishermen particularly emphasized that their social livelihood resources were most affected by these hazards. Similarly, extreme heat predominantly influenced the human livelihood resources of both fishmongers and fishermen, with IS values of 10 and 12, respectively (Fig. 5). Among the individual trades, fishmongers reported pronounced influences on their livelihoods due to climatic hazards. Social livelihood resources such as peer group meetings and religious activities were affected by all three hazards, with heavy rains/storms having the highest impact (IS = 13). Human livelihood resources were equally influenced by all three hazards (IS = 10), while financial resources were least affected by them. Physical livelihood resources were influenced by heavy rains/storms but not extreme heat, whereas natural livelihood resources were affected by both extreme heat and heavy rains/storms (Fig. 5). Fishermen cited that all three hazards influenced all their livelihood resources, with heavy rains/storms and extreme heat having the most significant impact on physical and financial livelihood resources. Flooding was mainly associated with social and financial livelihood resources for the fishermen. In the third trade group, financial and physical livelihood resources were the most affected by all three hazards, with extreme heat strongly

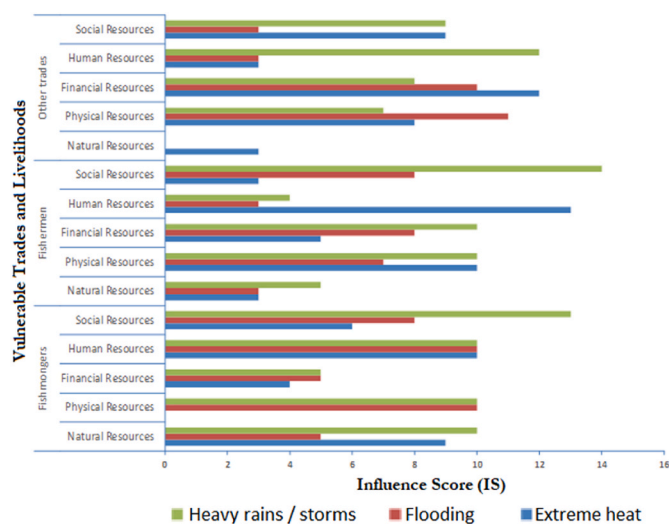


Fig. 5. The characterization of the measure of the influence of climatic hazards on livelihood assets by trade.

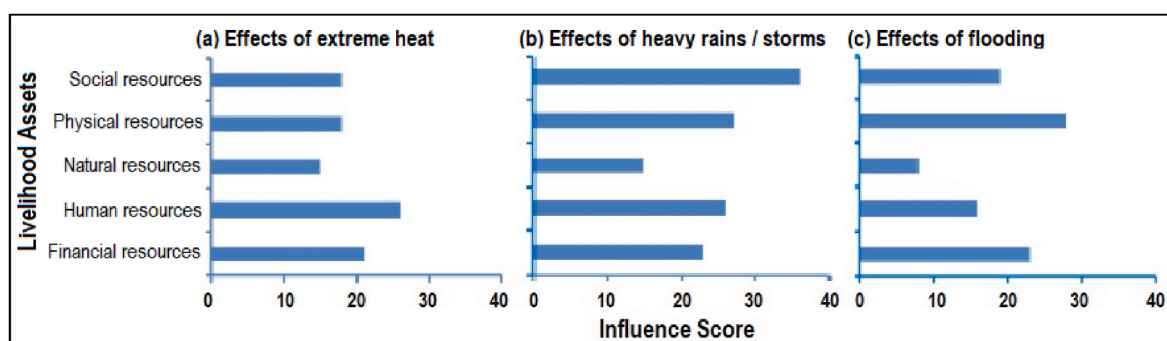


Fig. 4. Livelihood assets and the summed measure of the influence of the climatic hazards (a) extreme heat, (b) heavy rains/storms, and (c) flooding from sea level rise and surface runoff (on the scale 0–5 of no influence to very high influence).

influencing financial resources (IS = 13) and flooding impacting physical resources (IS = 10). Heavy rains/storms and flooding were not reported to influence natural livelihood resources within the other trade group.

Soil erosion, biodiversity loss, and environmental pollution were some exhibits of the effects of climatic hazards on the biophysical environment of urban areas. Restricted human mobility from inundated roads and disrupted vehicular movement was topical. Coping strategies cut across all livelihood assets as the informal economy measures were visible. Floods were due to (a) high tidal wave from the sea attributed to decades of gradual sea level rise, (b) floods from surface runoff, and (c) rainstorms. Extreme heat stress was identified as the topmost climate – related hazards experienced by the population (Table 1).

4. Discussion

4.1. Climatic hazards, exposure pathways and livelihoods

The study underscores the importance of analyzing adaptation in the broader urban planning processes and policy frameworks. It emphasizes the need for multi-level and multi-sectoral approaches that involve collaboration among stakeholders, including local communities, government agencies, academia, and non-governmental organizations to understand key livelihood determinants of adaptive capacity of coastal communities in the face of climatic risks. The exposure of physical infrastructure to climatic hazards and related risks in the study locations (Figs. 4 and 5, Table 1) is linked to economic activities of society. It includes production, transportation and distribution, as well as storage, constituting critical societal identity within the coastal urban areas. Understanding the barriers and enablers to such intersectionality dynamics at different levels and scales, need planning pathways that recognize the local level pressure – state – response dynamics of climatic risks. The differences in the extent of the influences of climatic hazards on livelihood assets as perceived by the different trade groups (Fig. 5), means heterogeneity of policy response will be key as the trade groups looked at climate hazards and related risks differently. The associated

Table 1

Major climatic hazards and coping strategies within the Greater Accra Metropolitan Area in Ghana. (Source: This study).

Impacts/impacted sectors	Hazard type	Coping strategy
Physical infrastructure (damages to: canoe, homes, fish smokers, market stalls)	Flood, heavy rain/storm, sea level rise	Locally improvised drain management, creating physical barriers, alternate livelihoods pursued, neighborhood networks, increased borrowing, migration, and long vacation from work.
Disruption of business (loss of urban agriculture, low fish catch, crop losses and lowered yields)	Flood, heavy rain/storm, sea level rise	Trade relocation away from community of origin, and trade diversification dependence on savings, farm relocation and migration
Health challenges (e.g. sick building syndrome, mosquitoes, water pollution, Insects infestation)	Flood, heavy storm, heat stress	Fumigation of infected buildings, use of costly bagged potable water (sachet water), draining of stagnant water with water pump
Reduced human mobility and hawking	Flood, heavy rain/storm	Depended on social networks and neighbors, sedentary trading
Loss of market wares and commodities	Heavy rain/storm	Increased borrowing trade diversification
Increased exposure to headache, convulsion, skin rashes, heat stroke	Heat stress	visited local pharmacy and health post
Poor food storage	Heat stress, heavy rain/storm	Use of cooler boxes Smoked/ fried or dried products
Increased indoor heat	Heat stress	Most time spent outdoor

barrier at the national level is the universality in the processes and outcomes to mainstream climate change and climate variability in critical areas, defining how the population responded and adapted to the hazards. However, the differences in the level of development activities within the urban area had differential impacts and diversified response strategies of the population to build resilience. Most of the study area are impacted negatively especially for the population that embarked on “other trades” category related to (i) informal small businesses, farming and lagoon fishing, (ii) ownership of assets such as canoes and fishing gears, buildings, land and fish processing platforms. The study demonstrates the burden which climate change brings in hampering societal development within the coastal urban area. Emphasis was placed on climate compatible physical infrastructure designs such as sea defense walls, to keep the rising waters away from the population. Climatic risk reduction activities spanned boundary issues of poverty, knowledge, institutions, legislation and policy, adding to engineering and technological solutions within the urban area, similarly reported in other studies (e.g., Kibwami & Tutesigensi, 2016; Miranda Sara et al., 2016). The rise in sea level is affecting fishing, prompting the fisher folks to search for new fishing places to which sometimes involved having to travel very far into the ocean across maritime borders, observed across similar circumstances in Senegal and Côte D’Ivoire including migrating temporarily (Zickgraf, 2019). The reported damage to infrastructure by the sea has been repeatedly reported in similar studies, but in this study, the issue of place attachment to sites such as burial grounds as part of important ancestral homes was of significance to the population. Thus placing limitations and or disrupting the intention of the population to migrate or relocate in the face of loss of cultural heritage. The decision to relocate usually is complex and interconnected to a diversity of factors at different scales and levels (Codjoe et al., 2017). Many flood disaster victims for example, have been found to prefer living with the floods by adaptation or undertaking emergency planning to enhance their livability survivability of own flood-prone place of residence (e.g. King et al., 2014; Laurice Jamero et al., 2017; Mensah & Ahadzie, 2020; Warner, 2010). It was observed that the resilience building response measures were associated with increased risk of water-related disruptions of livelihoods, similarly, observed in another study (Dovie, 2017).

Livelihood assets were impacted differently by various climatic hazards, with physical, social, and financial resources experiencing the most significant losses. This was not evident with natural resources livelihood assets, and contrary to a study which reported the impact of climatic risk on financial resources livelihood assets (Dalu & Shackleton, 2018). Consequently, aligning service demand with climate resilience is often perceived as uncertain and potentially detrimental to economic growth and wealth creation associated with urbanization. However, this study highlights that the influence of major climatic hazards can pose developmental risks when the implementation of climate actions is delayed. Given that the urban area’s microeconomy is predominantly composed of a workforce highly vulnerable to climate change impacts (Table 1), the success or failure of sustaining development within the urban area hinges on prudent climate action. This findings suggest that water-related negative outcomes of climate change exacerbated by inadequate utilization of green spaces, inappropriate spatial development, including poorly located infrastructure and networks prevail. To address these challenges, it is crucial for urban planners to engage in learning more about the climate policy regime (Argyriou et al., 2012). The effects of increasing population, unplanned urban settlements, and inappropriate structural solutions have contributed to climatic hazards, particularly urban flash floods, which have had severe adverse impacts on livelihoods, land use, human settlements, and public infrastructure globally (Hajdukiewicz et al., 2016; Kantamaneni, 2016; Rufat et al., 2015). Therefore, enhancing adaptive strategies is instrumental in making progress towards building urban resilience. The adoption of social livelihood asset to adapt to climate change in urban settings has emerged in recent times (Karunaratne, 2021). Historically, vulnerable populations have developed their own strategies and coping

mechanisms to protect assets and ensure livelihood security amidst climatic hazards. These strategies include non-farm-based micro-enterprises and seasonal migration, as observed in this study and others (e.g., Jameson & Baud, 2016; Yamashita et al., 2016; Surminski & Oramas-Dorta, 2014). Non-governmental organizations and civil society have played a crucial role in empowering households and communities to acquire skills, protect assets, and access necessary resources for adapting to climate change and restructuring their livelihoods. Initiatives promoting savings, micro-credit, and micro-insurance have been encouraged both before and after climatic events (e.g., Surminski & Oramas-Dorta, 2014; McMaster & Baber, 2012). It is worth noting that vulnerable populations, often comprising migrants, have actively participated in and assumed responsibility for building leadership skills and establishing linkages between disasters and livelihoods, enabling them to cope effectively. The adverse effects of climate change on rural systems have led to population displacement towards urban areas as a means to address insecurity in rural regions (Fig. 6). However, this influx of people into urban areas, often settling in environmentally hazardous locations, increases the at-risk populations in these receiving urban areas (Tellman et al., 2021; Bakkensen & Ma, 2020). This study identifies water shortage, drought, water pollution, and groundwater salinization due to sea level rise and related groundwater intrusion as significant outcomes of climate change and variability that affect various sectors within urban areas. These natural impacts are further exacerbated by human population growth which is a critical element of urbanization (Fig. 6). Therefore, to foster resilience through policy actions, the study suggests the following measures: (a) efficient and effective coastal urban management, (b) heightened awareness of climate change and coastal urban disasters in national development agendas, (c) management of rural-urban migration, and (d) improved understanding of climate policy actions to facilitate and sustain comprehensive and targeted approaches to addressing livelihoods in coastal urban areas. Consequently, the importance of building resilience, both through endogenous and exogenous measures, to mitigate climate-related stresses and shocks is becoming increasingly significant (Chu et al., 2017). These measures are expected to address potential disruptions to key economic sectors such as energy, fisheries, water, and transportation known to significantly drive the urban economy (Duan et al., 2022; Green & Healy, 2022; Selvaraj et al., 2022). The study

recognizes the internal response, whereby socio-ecological connections within the urban space leverage local resources, knowledge, and skills to foster resilience. Additionally, external support from institutions and interventions, separate from the population’s own response arrangements, plays a role in planned and anticipatory adaptation (Devkota et al., 2022).

4.2. Implications for climate change policy mainstreaming and urban planning

In Ghana, significant national-level efforts have been undertaken to integrate adaptation into all levels and scales of planning, aligning with the ambitious elements of the Paris climate agreement (United Nations, 2015). Earlier observations by Tompkins et al. (2008) highlight that the early integration of society into climatic risk assessment and management practices during planned adaptation in urban areas facilitates problem-solving, execution, and ownership. It is important for coastal urban planners and managers to actively engage in decision-making processes that prioritize livelihoods and resilience-building in the urban area while ensuring sustainable growth and development (Hurlimann et al., 2021; Satorras et al., 2020; Argyriou et al., 2012). However, the limited consideration of livelihoods at a comprehensive scale and insufficient engagement have hindered urban policies from effectively addressing climate change. This creates an institutional trap known as “urban climate policy inhibition” (Urban-CPI) (Fig. 6). The Urban-CPI occurs when national climate change policies fail to align and harmonize with local-level policy actions and planning horizons for climate adaptation in the urban planning process. The Urban-CPI has two primary drivers: (a) increased societal demand resulting from urbanization, which requires redirecting policy focus and investments toward managing climate hazards, and (b) the long-term uncertainty of investment returns in climate change. The Urban-CPI can be attributed to national development planning frameworks that inadequately create a favorable policy environment to effectively align targeted local-level dominate policy actions, often becoming a barrier rather than an enabler. Similar cases have been observed globally (e.g., Filho et al., 2019; Lebel et al., 2010).

The urban environment’s predominant focus on infrastructure expansion, economic investments, and profitability has led to the oversight of global change factors that could potentially undermine or reverse development gains (Dovie et al., 2020). In the coastal urban areas examined in this study, the Urban-CPI manifests as a limited practice of bridging policy gaps between higher-level climate change policy goals and development policies, such as Sustainable Development Goal 11 (SDG 11). SDG 11 aims to create safe, resilient, and sustainable cities and human settlements (United Nations, 2015). The integration of climate policy decisions into multi-sectoral planning and coordination is still an evolving practice globally. In Ghana, national development traditionally prioritizes the fiscal economy, often overlooking physical risks such as climate change and its impact on livelihoods. This lack of emphasis on climate change within urban planning contributes to the existence of Urban-CPI. Resolving the Urban-CPI requires urban managers to recognize the vulnerability of livelihoods and climate-sensitive sectors to climate change, thereby avoiding detrimental effects on urban investments (Caprario et al., 2022; Spaans & Waterhout, 2017). Bridging the gap between scientific knowledge and public policy (Miyahara et al., 2022) regarding climate change and understanding the livelihoods of populations is inevitable in reducing the impacts and consequences of the Urban-CPI (Fig. 6). Sharing lessons from best practices, experiences, and technologies related to climate hazards, adaptation, and livelihoods across different regions worldwide will enhance resilience practices in critical urban areas (e.g., Argyriou et al., 2012; Spaans & Waterhout, 2017). Furthermore, the exchange of scientific findings and practical outcomes among urban managers implementing climate-resilient policies in priority sectors will raise awareness, engage stakeholders, inform decision-makers, and foster

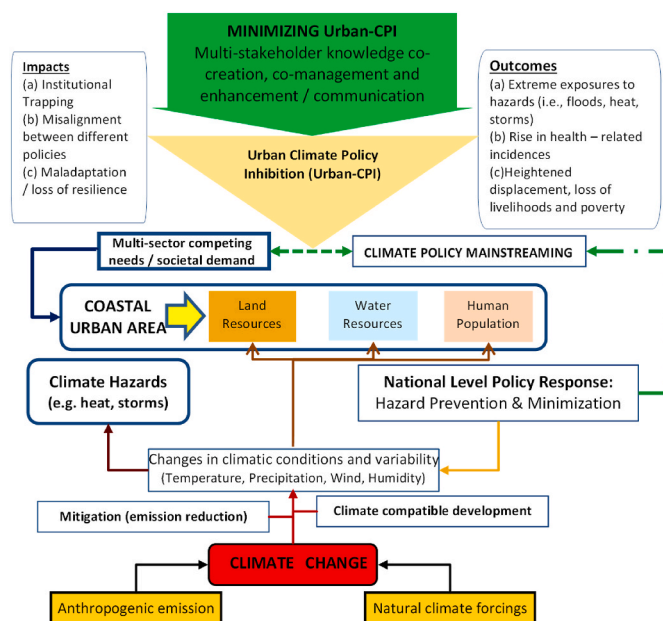


Fig. 6. Implications of the exposure pathways of the climatic hazards for urban planning and the management of related policy challenges for resilience building. (Source: This study).

cooperation between relevant institutions and nations (e.g., Filippi, 2022).

5. Conclusion

The study sites exhibited similar socio-ecological exposures primarily due to their geographical location rather than demographic factors. However, variations in the level of development activities within the communities influenced the state of the hazards, impacts, and response strategies among the local population. The most prominent sources of hazards in these areas were sea level rise, floods, rainstorms, and extreme heat. These hazards negatively affected a large portion of the population, impacting their livelihoods across different categories. Generally, the livelihood resources of the outdoor trades were mostly affected by the climatic risks. The local economy relied on various factors such as personal incomes, infrastructure including canoes, fishing gears, buildings, equipment, and fish processing platforms, which played a crucial role in enabling adaptive capacities. The presence of climatic hazards also posed socio-ecological, human security, and well-being challenges, including an increased risk of storm-related incidents like drowning and the intrusion of saltwater into vital livelihood sources such as tube wells and soils, leading to localized economic downturn. The study highlighted the significant impacts of soil erosion, biodiversity loss, and pollution, while also emphasizing the issue of human mobility resulting from flooded roads and disrupted transportation, as well as the importance of place attachment intentions. The communities deployed coping strategies that encompassed all livelihood assets, empowering them to diversify their livelihoods and adapt to changing circumstances. Three major pathways were identified through which climatic hazards escalated into risks in urban areas through human population dynamics, which are migration, land, and water resources. These pathways also served as major physical exposure units, exposing urban areas to risks associated with extreme weather events, sea level rise, land degradation, and ecosystem deterioration. Hence, there is the need to understand and address these hazards and their interconnected impacts across sectors from a multi-sectoral perspective. Mapping climatic hazards onto livelihood sources revealed a network of factors and interactions that households need to consider in building their resilience. Innovative approaches such as climate-smart planning within coastal urban areas are expected to play a leading role in building resilience in livelihoods. These approaches should include effective early warning systems, hazard information dissemination, insurance mechanisms, and responsible financial practices and service delivery by relevant stakeholders. The study found that CRiSTAL facilitated the integration of knowledge from the past, present, and resilience-building experiences. It relied on primary information gathered from diverse sources, bridging knowledge gaps across different interest groups. CRiSTAL also facilitated closer engagement between climate change adaptation discussions related to livelihoods and the decision-making processes and structures of local populations.

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CRedit roles

Delali Benjamin K. Dovie: Conceptualization; Data curation; Formal analysis; Funding acquisition; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Roles/Writing - original draft; Writing - review & editing. Opoku Pabi: Project administration; Resources; Software; Validation; Visualization; Writing - review & editing.

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.

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