



The dilemma of flood occurrence in Accra: climate change or poor land use planning and practices?

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Received: 21 January 2021 / Accepted: 6 July 2022 / Published online: 19 July 2022
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Abstract

Over the years, climate change and land use planning are considered debateable perspectives on the true cause of the perennial flooding in many African cities, with inconclusiveness on the subject matter. This paper thus contributes to the debate with trend analysis on which of the two perspectives is the major cause of the perennial flooding situation in African cities, taking Accra as a study case. The focus of this paper is therefore to examine the nature of flooding to succinctly draw a justified conclusion on the deliberations regarding whether flooding in Accra is caused by climate change or land use planning. The paper achieves this using the case study research design with data drawn from both primary and secondary sources, specifically, review and synthesis of relevant literature and interviews with state agencies and 100 households. The findings showed variations in responses on the major cause of flooding—climate change and weak enforcement of land use planning. However, most households (52%) and all agency officials, supported by climate change-flood occurrence data revealed that floods in Accra are mostly human induced. Due to population growth, the city has expanded onto wetlands and flood-prone areas, thus distracting the natural flow of water. This paper, therefore, supports the school of thought that the flooding occurrence in Accra, among others, is caused by poor and uncoordinated land use planning efforts which is as a result of several institutional constraints. A well-maintained physical development such as the protection of wetlands by city authorities will go a long way to minimise the perennial occurrence of flood events and the associated impacts.

Keywords Accra · Climate change · Land uses · Regulations · Flooding · Urbanization

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Introduction

Urban flooding is a major problem in many parts of the world, with resultant damages due to its social, economic and ecological cost. Flood has adversely affected physical urban development and increased casualties across the globe (UN-International Strategy for Disaster Reduction [UNISDR] 2015; Khan 2012). For example, between 1960 and 2000, 5 million people were displaced by floods and imposed huge economic burden on governments (Rehman et al. 2019; Marchiori et al. 2012). Urbanization is often blamed for the uncontrolled physical developments (Mcgranahan and Satterthwaite 2014; Amoako and Inkoom 2017), which in many developing economies, has resulted in perennial flooding, specifically, the areas with river beds and lowlands. Relatedly, the activity of steering behaves on the effectiveness of existing land use regulations which are deemed relevant to avert the congestion and associated effects such as flooding, which has become a major characteristic of many cities in the developing world. In Africa, physical urban development is poorly controlled and managed despite the existence of several land use regulations (Poku-Boansi et al. 2020; Amoako and Inkoom 2017). An important dimension of the flooding discourse in African cities is the climate change phenomenon. Rain et al. (2011) note that coastal cities within the south of the Sahara experience climate change in the form of an upsurge in sea levels which culminates into coastal inundation, storm surges as well as flooding. Their findings, similar to several others (see Cobbinah et al. 2019; Mensah and Ahadzie 2020; Oludare et al. 2012), further point to an identification of Africa as one of the most vulnerable continents to the adverse impacts of climate change.

Accra, Ghana's capital city, is noted to be the most vulnerable Ghanaian city to flood due to its proximity to the sea (Attipoe 2014). The city epitomizes the disconnection between regulatory frameworks for land use and physical urban development (Lambini 2009). It experiences the highest incidence of urban flooding since the early 1930s (Karley 2009; Mensah and Ahadzie 2020). Accordingly, the Emergency Events Database (2012) reveals that flood constitutes a major form of disaster in Ghana, particularly, Accra. Available records on worst form of annual natural disasters in terms of the number of people affected reveal flooding recurring nine out of ten times. Not only are floods a frequently occurring natural disaster in Accra, but with regards to lives lost, floods rank second only to epidemics (Okyere et al. 2013).

Studies on the subject of the perennial flooding situation in Ghana attribute the phenomenon to several factors. Some of the studies attribute its occurrence to improper settlement layout and development, reduced drainage capacity as a result of being clogged by silt and refuse, poor physical development control and poor waste management practices in the city (see Karley 2009, Asumadu-Sarkodie et al. 2015; Okyere et al. 2013; Afeku 2005). Other scholars, which often represents the dominant narrative (e.g., Amoako and Frimpong-Boamah 2015; Asumadu-Sarkodie et al. 2015; Rain et al. 2011, Appeaning-Addo et al. 2011) are however of the view that the problem of flooding is caused by changes in rainfall and temperature patterns as well as coastal inundation and erosion

(Rain et al. 2011). Other views espoused by scholars which is closely linked to climate patterns has to do with city topography. They opine that flooding manifest in cities characterized by lowlands, close to riverbeds/floodplains or sea sites. These views represent a point of contention that has become more conspicuous in the conventional literature, originating from two perspectives, namely; climate change variability and land use planning. It is within the premise of this scholarly contentions regarding the major cause of flooding in cities like Accra that this paper examines the nature of flooding in Accra—in order to succinctly draw a justified conclusion on the deliberations regarding whether flooding in Accra is caused by climate change or land use planning. The resultant conclusion is expected to contribute to the body of knowledge regarding the dominant cause of flooding in cities. It will also serve as basis and guide for policies aimed at tackling the flooding challenge in cities like Accra, the capital town of Ghana.

Theoretical framing

This paper adopts the theory of causality which focuses on establishing a cause-effect relationship (Adom et al. 2018) on the causes of the perennial flooding situation in the city of Accra. The study also employs the theory of exploratory data analysis in establishing patterns and trends in light of the adopted two perspectives from which the causes of flooding will be assessed, namely climate variability and land use planning. Additionally, the variables under the adopted perspectives to be analysed for include climate variability, annual rainfall pattern of Accra (Amoako and Frimpong-Boamah 2015; Asumadu-Sarkodie et al. 2015), land use planning, level of compliance to land use regulations and effectiveness of implementation (Awuah and Hammond 2014). Exploratory data analysis is also complemented with the theory of confirmatory data analysis through a comparison between previous studies and recent observations to establish the relevance and confidence in the study for adoption and application of findings towards the creation of a resilient city (Adom et al. 2018). The exploratory data analysis approach is summarised in the conceptual framework (see Fig. 1).

Ahadzie and Proverbs (2011) show that traces of the evidence of flooding in Ghana dates back to 1936. Reports on flooding events in Accra divulge that the city has been overwhelmed with flooding for decades (Tengan 2017). Significant flood events have been recorded in 1973, 1986, 1995, 1999, 2001 and 2002. Major flood events in Ghana are noted to have affected about 3.81 million people and killed about 298 people from the year 1968 to 2011 (Okyerere et al. 2013). Additionally, an estimated cost of damages of \$43.71 million has been recorded over a twelve-year period as a result of flooding (Amoako and Frimpong-Boamah 2015). Accra is specifically noted to have a flood occurrence rate of 17–20% in any given year (Asumadu-Sarkodie et al. 2015). Evidence shows that in the recent past, the June 3rd flood and fire disaster in Accra in 2015, has gained momentous reference as the worst to befall the country, involving a national declaration of a state of mourning. The incident was described as historic, given its ghastly

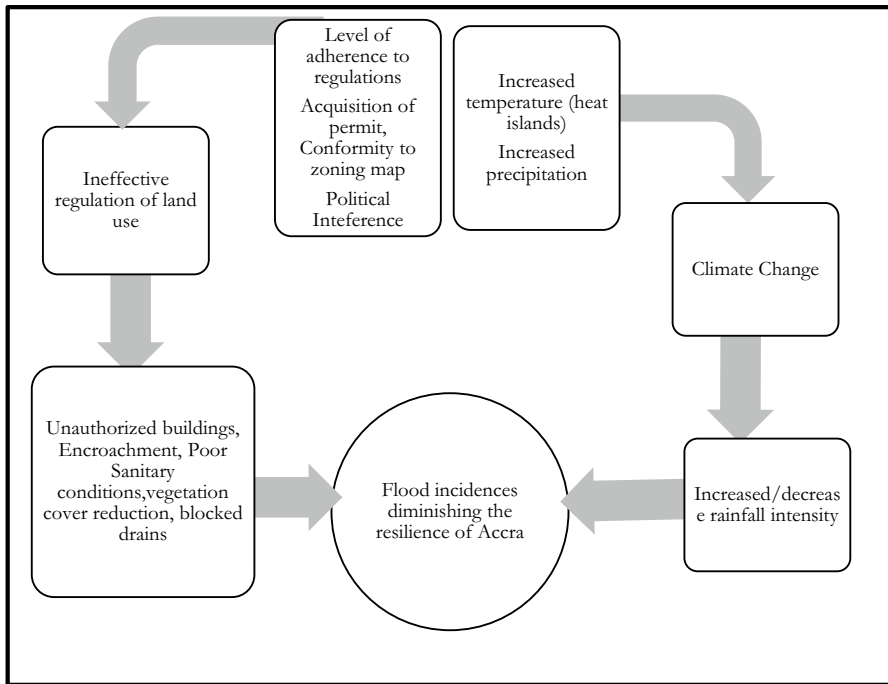


Fig. 1 Conceptual framework

outcome from the combination of flooding and explosion of a fuel sales point, which claimed the lives of over 150 people (Agboklu 2015).

As earlier discussed, climate change is considered a major significant factor resulting in the occurrence of flooding. Rainfall as an element of climate change has intensified over the years (Chan 2017). Also, higher temperatures leading to higher rates of evaporation and eventually higher precipitation has resulted in rivers and other water bodies overflowing their shores and banks (Okyere et al. 2013). This is emphasized by Trenberth (2011), who reveal that the water holding capacity of air increases by about 7% per 10 °C warming; thus, increasing the amount of water vapour in the atmosphere. This has contributed to the downpour of the held-up water with higher intensity rather than steadiness which increases the risk of flooding (Trenberth 2011).

Coastal inundation due to proximity to the sea as in the case of coastal areas, is noted to be another cause of flooding. The rise in tidal waves measuring up to 10 m rise in sea level affect settlements and structures located within 100 km of the sea coast, as is the case for 12% of the urban population in Africa, including Ghana (Douglas et al. 2008). It is important to note that coastal flooding is inevitable in the wake of global warming as the resulting rise in temperature causes the surface water of oceans to expand (Stuart 2006; Asibey and Cobbinah 2022). The severity of flooding with regards to coastal inundation predicts that about 400 km² and 137,000 people in Ghana are at risk from storm surges and coastal

inundation with the likelihood of 70% being the urban poor residents in Accra (Rain et al. 2011).

The extreme climatic conditions and heavy rainfall however are not the only catalysts to flooding in urban areas. In support of this argument, Gyimah (2017) states that there is a vast and dense coverage of concrete structures and surfaces as well as tarred surfaces in cities which create difficulty regarding permeation of water into the soil. As such, a moderate downpour of rain results in large volumes of runoff and a quick rate of flow. Subsequently, the runoff is obstructed by structures built in such areas which are originally natural channels for the flow of water (Gyimah 2017; Jha et al. 2012). In light of topography, the place of slopes cannot be underemphasised as runoff converges from various parts of cities on higher elevations into floodplains (Amoako and Frimpong-Boamah 2015). The intensity of flow, given the impervious surface and degree of inclination, thus result in devastating effects (Douglas et al. 2008; Amoako and Frimpong-Boamah 2015). Further, the limited capacity and in some cases the absence of constructed drains, sewage systems and engineered drains in cities to adequately and effectively channel storm water to the naturally designated points of deposition are other important causes of flooding in most African cities (Afeku 2005; Aforope 2016; Karley 2009; Okyere et al. 2013). Consequentially, storm waters overflow the confines of the drains onto city streets and into dwellings, resulting in damage to lives and properties. The severity of poor drainage is further upscaled by poor waste management practices, common in urban areas of developing countries (Asumadu-Sarkodie et al. 2015; Okyere et al. 2013). Ahadzie and Proverbs (2011) further contribute to this viewpoint by stating that human activities such as poor and unregulated construction practices as well as inadequate and poorly maintained drainage systems have been considered as contributors to flooding.

In all of the above, Thurman (2010) argues that despite extensive statutory interventions, issues such as chieftaincy disputes and protracted land disputes and litigation have contributed to the loss of public confidence in the legal justice (court) system, with people resorting to self-help (e.g., land guards), freezing land for development, encroachment on public and private land, multiple sales of land, unapproved development and violent confrontations. Additionally, Rain et al. (2011:10) argues that "...expansion in the fringe areas of Accra is occurring in a largely unplanned and uncontrolled manner, creating the sprawling of low-density development that is uneconomic in terms of land use", representing a contradiction to the purpose and principles of effective and efficient urban land management.

The lapses in the enforcement of land use regulations in the case of Accra are largely evident in the existence of settlements on floodplains in many suburbs (Asumadu-Sarkodie et al. 2015; Lambini 2015). Additionally, Lambini (2009) reports that the rampant breaches of land use regulations were found to be mostly deliberate, stirred by the dearth of evidence about the benefits of land use requirements to warrant the costs and inconveniences of compliance. Lambini (2009) further argued that political interference regarding the enforcement of land use regulations is one added cause of the emergence of slum settlements and economic activities in demarcated flood prone areas.

The foregoing shows that several factors result in the occurrence of perennial flooding in African cities. Notable among them are climate change, political,

physical and land management issues. Taking Accra, Ghana as a case region, this paper inquires if perennial flood occurrence in Accra is as a result of climate change or poor land use planning, although both could result in the phenomenon. The findings of this study is deemed relevant to guide policy and practice on what issues in terms of priority or necessity need to be tackled to mitigate the occurrence of flooding and its attendant adverse effects. Thus, understanding the main cause of flooding in Accra will give more impetus to policy formulations and efforts at addressing the effects of flooding.

Research approach and methodology

Study context

The study focuses on the Accra Metropolitan Assembly, one of the twenty-nine (29) administrative metropolitan, municipal and district assemblies (MMDAs) of the Greater Accra Region. Since its establishment in 1898, the Accra Metropolitan Area (AMA) has been the Regional capital for the Region and the national capital of Ghana. The AMA covers a total land area of 139.674 km² (Ghana Statistical Service, [GSS] 2014).

The study adopts Accra as the geographical scope due to the similarity of its socio-economic characteristics to most cities within the coastal West African and developing countries. Accra is the most populous city in Ghana with a population of 2.277 million, which represents 8% of the country's total population with a population density of 1,300 people per km². The city is arguably the biggest economic and administrative hub of Ghana, and has experienced rapid urbanization in the last two decades (GSS 2014). Majority of its households are engaged in trading, construction, fishing, farming, services, and manufacturing. Until recently, the indigenous people were mostly engaged in fishing and farming (GSS 2014). Informal settlements or slums dominate the centre of the Metropolis. Increasing demand for land due to population increase has significantly contributed to the existence and expansion of temporary dwellings such as kiosks, containers and attachment to shops (Okyere et al. 2013). Accra is noted for its persistence and perennial flood occurrence in Ghana which intensifies the risks involved in investing in the city. Some of the notable flood prone areas are the Kwame Nkrumah Circle Interchange, Adabraka and Kaneshie (see Fig. 2).

Accra lies within the dry equatorial climatic zone and experiences two rainy seasons. The first begins in May and ends in mid-July, while the second season begins in mid-August and ends in October. It records an average annual rainfall amount of about 730 mm which is argued to be the lowest in the country (GSS 2014). There is however very little variation in temperature throughout the year, with the mean monthly temperature ranging from 24.7 °C in August (the coolest) to 33 °C in March (the hottest) with annual average of 26.8 °C. Accra was selected for this study based on: (i) its rapid urban population growth; (ii) perennial occurrence of flooding; (iii) its weak urban planning agencies which have consistently failed to ensure improved

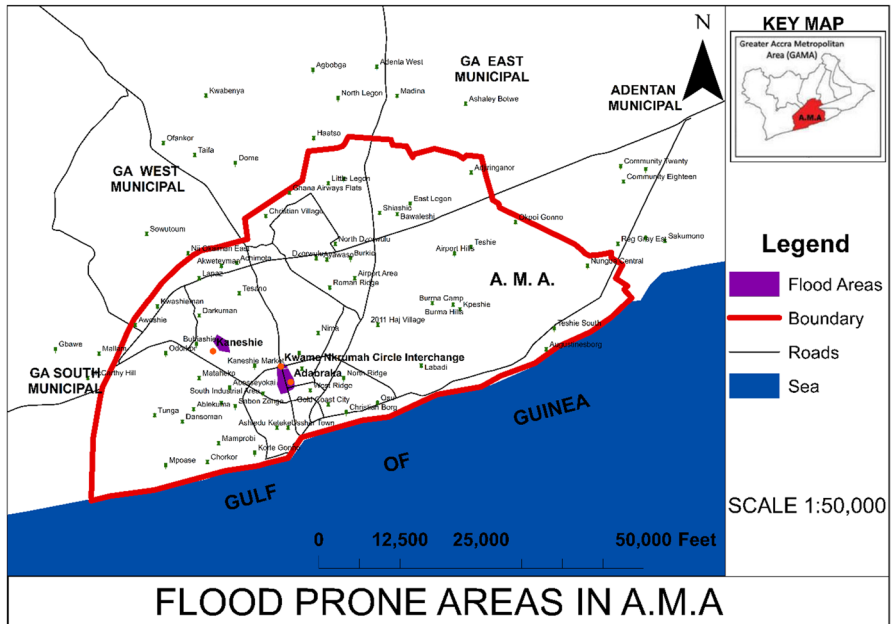


Fig. 2 Map of Accra Metropolitan assembly showing study flood prone areas. Source: Amoako and Frimpong-Boamah (2015)

city development (Amoako and Frimpong 2015); and (iv) available relevant information on the city which provides background data for the study.

Research methodology

The case study approach was adopted for this study to obtain an in-depth understanding of flooding situation and the impact of climate change and land use planning on its occurrence to ascertain the dominant factor leading to flood risk in its natural real-life context. Bhattacharjee (2012) note that the case study approach is relevant to studies that seek to understand complex processes (including why and how) rather than mere listing of factors or causes (what). Thus, the case study is relevant for the current research. In this regard, the study examined the complex dynamics—the how and why of flooding occurrence with no control over the variable under consideration. The nature of flooding—as occurred in real context together with unstructured environment—consisting of social, cultural and organizational issues within which they operate makes the case study an ideal approach for this research and thus, justified its adoption in this research. The design also allowed for the use of multiple data collection methods and different data types.

The case study method is criticised both for its inadequacy in obtaining ‘hard’ accurate data for statistical analysis and comparisons, and its reliability and scientific rigour. The use of multiple sources of data was useful in addressing the above

challenges, avoiding biases and answering the research questions, as conclusions were supported by a chain of multiple evidences from different sources. Hartley (1994) also asserts that a case study method allows generalisations of results, as the use of multiple cases can lead to some form of replication. Data for this study was obtained from both from primary and secondary data sources. The secondary data was obtained through a review of relevant annual and action plans of government agencies on flooding, climate change and land use planning and management issues in Ghana from the National Disaster Management Organisation (NADMO), Ghana Meteorological Agency (GMA/GMET), GIS digital images (i.e. to identify flood risk areas and changes over the past years), Physical Planning Department of the Accra Metropolitan Assembly and the Lands Commission.

Additionally, primary data was obtained through semi-structured interviews with purposively selected agencies who were engaged in discussions on the contribution of climate change and land use regulations to flood occurrence in Accra. Key among them is the NADMO established by Act 517 (1996) to provide disaster response and recovery assistance. Most importantly, NADMO has the primary responsibility of leading and co-ordinating national disaster response efforts by the various and relevant stakeholders. The agency is thus responsible for pre-disaster phase (prevention, mitigation), disaster or emergency phase (response) and post disaster phase (recovery) (GoG 2010). The new NADMO law, Act 2016 (Act 927) gives the agency a paradigm shift from reactive to proactive disaster risk management. Other agencies covered included the GMA/GMET to provide data on climate pattern within AMA, Physical Planning Department (PPD) of the AMA responsible for the orderly planning of human settlements within the Metropolis, the Lands Commission, and the Environmental Protection Agency (EPA) responsible for environmental development and management in Accra. Representatives of the above-mentioned institutions were interviewed for relevant data on their perception on: (i) the nature and areas most prone to flooding in the study area, (ii) the frequency of occurrence of flooding, (iii) climate change issues and their influence on flood occurrence, and (iv) land use planning and regulations and their influence on flood.

With respect to the household survey, the sample size was determined from the total number of houses of 149, 689 (Accra Metropolitan Assembly 2018), based on the assumption that each property is at least owned by a household. The assumption is premised on the housing dynamics in the Metropolis, where 96% of the housing units in the Metropolis is delivered by private individual with only 10% being supplied collectively by private estate developers, central government and other quasi—government organization (AMA 2018). A sample population of 100 households/property owners was obtained at a 90% confidence level and 10% marginal error. The 100 households within the study area (specifically, within the areas of Kaneshie, Adabraka and Kwame Nkrumah Circle) were purposively (based on their experiences of flood situations) and conveniently (based on their willingness and availability to participate in the study) sampled and interviewed to further understand the nature of flood situation, causes and effects within the study area.

Given the need to ensure maximum spatial distribution, the study area was divided into two clusters—north and south—with focus on the flood prone areas and the questionnaires administered accordingly. The state institutions were however

sampled purposively with particular reference to their unique roles. It should be emphasised that the focus of the study is beyond providing only statistical representativeness. Rather it focuses more on making deliberative and empirical deductions from the data. It is within this purview that the study interviewed extensively both households (majority of which have had lived experiences of flooding) and institutions responsible for making cities more liveable. The import of this, is thus, to make it more deliberative and provide basis to document relevant perspectives on the dominant cause of flooding in Accra and the justifications therein. Analysing the perspectives from the lived experience of the stakeholders in conjunction with the statistics allowed the research to properly juxtapose the two angles (household perspectives and statistics)—providing a robust basis for determining the dominant cause of flooding. Prior to the interviews, informed consent was sought from the participants. The rationale and need for the study, procedures involved, rights of respondents, confidentiality, voluntary participation and the right to dissociate at any time of the study without prejudice; were further explained to participants. The interviews were conducted in either Twi or English, since all respondents were fluent in one of the languages. The interviews were conducted between February and March 2020. The average time spent with an interviewee was approximately ninety minutes. The content analysis was used to analyse responses from the study participants and secondary data through an inductive and deductive coding process by the use of the NVIVO 12 software package used for identifying themes from interview transcripts (see Fig. 3). Research participants' perspectives on issues such as influence of climate change and land use regulations on flood occurrence were deductively created based on the findings from the literature and the research objectives. However, similar to that of Cobbinah et al. (2019), relationships were developed by reconciling categories into more conceptual categories based on common themes

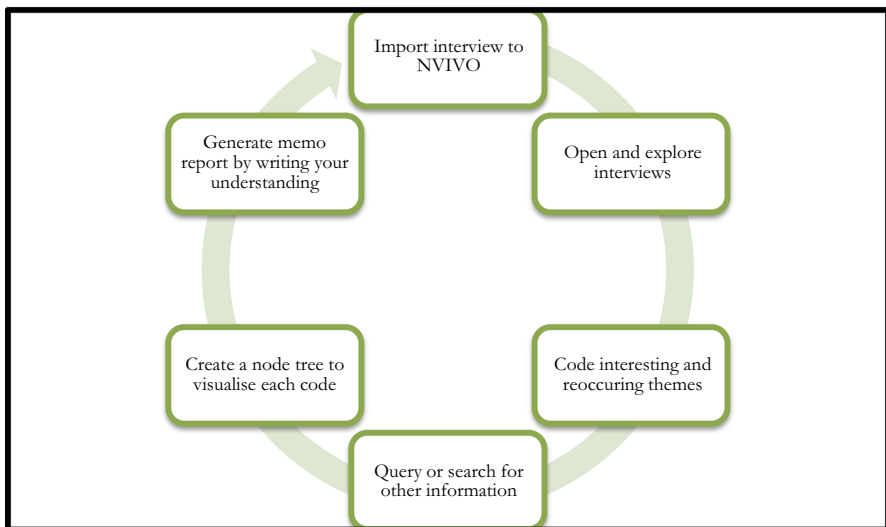


Fig. 3 Process of identifying themes from interview transcripts

to avoid inconsistencies in the results. The themes included effectiveness of land use regulation (Awuah and Hammond 2014) and the relationship drawn from spatial analysis and causes of flooding.

Results and discussion

The incidence of flooding in Accra and climate change: participants' perspectives and synthesis of relevant literature

The incidence of flooding in Accra has been increasing at an alarming rate in the last decade (Amoako and Frimpong-Boamah 2015) (see Fig. 4). The city experienced an all-time peak of 65,236 victims to flood in 2011 (see Fig. 4), but a subsequent significant decline in the number of victims to flood incidents in 2012. The rising dominance of commercial activities in the central parts of Accra, replacing residential land uses, is argued to have significantly contributed in the receding number of persons falling victim to adverse flood effects (Oosterbaan et al. 2012). Another reason given for a reduction in the number of victims according to the NADMO official is the increased awareness and adoption of mitigation measures by flood victims. This corroborates the assertion of Douglas et al. (2008) that flood victims have various adaptive and mitigation measures to flood, which comprise among others the creation of elevated platforms to keep valuables and delicate possessions, and temporarily residing with friends and family in anticipation of rains and to wait out the floods.

Findings from the household interviews showed that approximately 40% attribute flooding occurrence in Accra to both weak enforcement of land use regulation

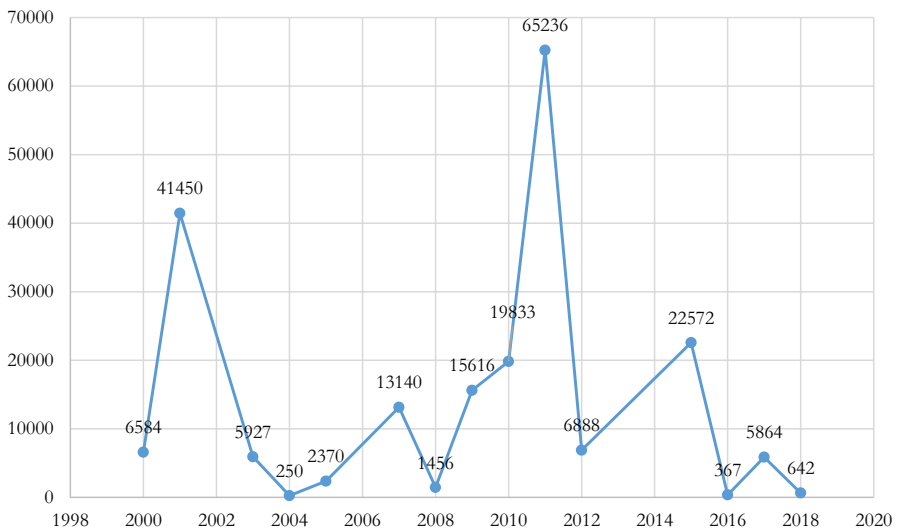


Fig. 4 Number of Flood Victims from 2000 to 2018. *Source* Field data from NADMO (2019)

and changes in rainfall pattern. Majority of the households (52%) attributed flooding occurrence in Accra to the weak enforcement of land use regulations whilst 8% attributed it to changes in land use regulations. In as much as there has been some level of variations in rainfall pattern in Accra between 2008 and 2018, the variations are not significant enough for it to constitute climate change. For example, an official of the GMET stated that for the past 10 years, the volume of rainfall decreased from 395.3ml³ to 138.9ml³ for the month of May. However, the volume of rainfall increased from 61.2ml³ to 102.9ml³ for the month of October. Within the same period, all agency officials and households reported on an observable increase in rate at which people encroached wetlands as well as increased indiscriminate waste disposal practices among households.

With the agglomeration of commercial activities and vehicles (Oosterbaan et al. 2012) and over 90% impermeable surface coverage (Gyimah 2017), the Kwame Nkrumah Circle and its surrounding areas are considered as urban heat islands and as such, experience high temperature in addition to an increased probability of thunderstorms, as reported by officials of the EPA, GMET and NADMO officials. On this, Gyimah (2017) points out that urban heat islands result from the formation and growth of cities, and is characterised by a dense coverage of concrete surfaces/ landscape, presenting a viable situation for the absorption and retention of heat. Further, the GMET official stated that flooding in Accra results from heavy rains, which however normally lasts for a short while. Additionally, the intensity of rainfall, especially heavy storms, according to the officials influence the extent of damage resulting from floods. On the foregoing, Amoako and Frimpong-Boamah (2015) reported that the intensity of rainfall is a viable catalyst of the incidences of flooding in Accra, given the absence of adequate facilities for the effective management of surface runoffs. A similar finding to the foregoing school of thought is observed

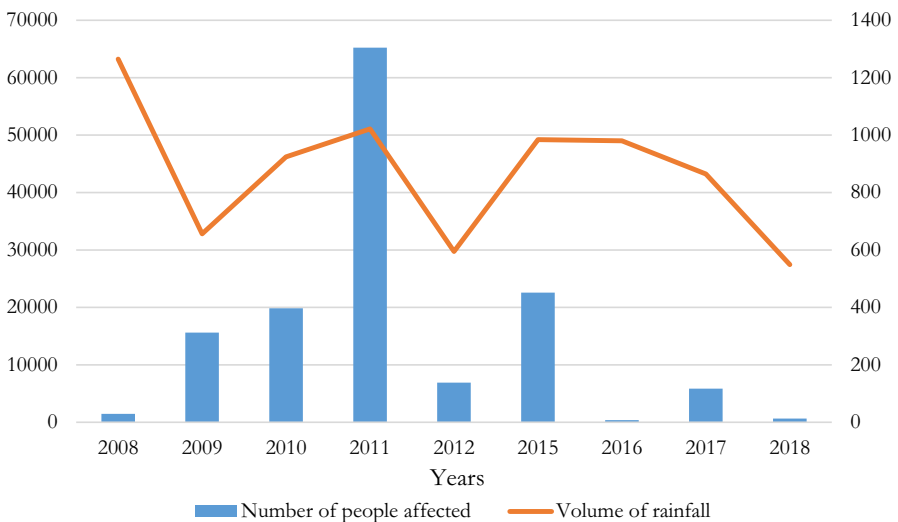


Fig. 5 Incidence of Flooding against Changes in rainfall Pattern. *Source* Authors’ construct with data compiled from GMA and NADMO, 2019

in Fig. 5, which shows that from the year 2011 to 2018, an increase in the volume of rainfall resulted in a corresponding increase in the number of people affected by flooding.

Analysis of the recorded data on flood incidence and rainfall pattern from 2008 to 2018 reveals that an average change of 41% in the quantity of rainfall has a corresponding average of 85% change or influence on the occurrence of flooding. However, an odd observation is recorded in the year 2017 when there was a decrease in rainfall and a contrasting increase in the incidence of flooding. This finding disrupts the correlation between the intensity of rainfall and occurrence of flooding observed in the previous years. This finding points to the fact that there are other factors other than climate variable such as rainfall, that are contributing to flood occurrence in the city. As a result, the next section presents findings on the flooding-land use activities nexus.

The incidence of flooding in Accra and land use activities: participants' perspectives and synthesis of relevant literature

Scholars (e.g., Attipoe 2014; Afeku 2005) argue that the nature of drainage channels at the Kwame Nkrumah Circle and its surrounding areas have been the major contributors to the flooding situation in the city of Accra. For instance, Afeku (2005) reported that the depth of the main drains and others within the areas of the Kwame Nkrumah Circle, Kaneshie and Adabraka ranged from 80 to 160 cm, with width ranging from 90 to 190 cm. These, according to interviews with the NADMO and PPD officials revealed that such drains, which happen to be the same as at now, are ineffective by about 20% to 50% less than their originally engineered capacity. The observations of Afeku (2005) on the situation regarding the drainage channels at the Kwame Nkrumah Circle are reiterated in the findings of Rain et al. (2011) as undersized, unconnected or improperly channelled drains, which this paper similarly observed.

According to all the representatives of the agencies interviewed, the Kwame Nkrumah Circle as well as Kaneshie and Adabraka, where flooding is reported to occur often, have experienced major physical developments over the years in the form of roads, multi-storey structures, bus stations and market centres, among others. These developments were reported to have occurred due to rapid population growth and corresponding changes in the morphology associated with major towns in Accra, particularly the Central Business District (Gyimah 2017; Rain et al. 2011). In the central part of Kwame Nkrumah Circle lies the Kwame Nkrumah Interchange, which was completed in the year 2016. To the west of the interchange lies the Odaw river with its surrounding land area covered with informal economic activities and informal settlements (AMA 2018). According to the NADMO and PPD officials, there has been a significant reduction (more than 75%) in the vegetation cover (greenery) due to the construction of concrete structures and surfaces to manage runoffs. There was thus the observed dominance of concrete structures in the area. On this, Gyimah, (2017) similarly reported that the green cover at Kwame Nkrumah Circle forms just 4% of the land cover against 96% impermeable surface.

The dominant narrative however indicates that the presence of vegetation cover, in addition to drainage channels, are important in reducing flood occurrence and associated risks in many cities across the world. This is however not the case in the city of Accra; hence, experiencing perennial flooding with enormous adverse impacts on the landscape and residents.

The NADMO official further stated that the main drain in the Osu Klottey sub-Metro which is the Odaw river and its connecting drains are almost always filled with solid waste and debris. Additionally, the residents in the surrounding communities deliberately and indiscriminately dump solid waste in the environment which are easily carried off by runoff water, while others dump them directly into the connecting drains when it rains.

The poor solid waste management attitudes of residents [dumping refuse into drains] causes the overflowing waters resulting from choked drains during a downpour to chart courses through the dwellings of households in the surrounding areas thereby destroying properties, and act as a threat to human life. The untimely collection of refuse by waste management services can also be attributed to this situation. Hence, the refuse deposits along the roads, especially after a desilting exercise, pile up and are washed back into the drains. This presents a cyclical situation in the conditions leading up to the perennial floods ... [Interview with the NADMO official]

The above findings are sights common at major areas within the centre of the city, notably, the Kwame Nkrumah Circle, Kaneshie and Adabraka. The above findings in a way corroborates the assertion of Douglas et al. (2008) that floods though natural, are associated with damages and losses consequential of the actions of man. The EPA official further reported on Accra as a city vulnerable to flooding, that impervious surfaces, which comprise the roads, rooftops, sidewalks, bedrock outcrops and compacted soil prevent infiltration of water into the soils. This results in an increase in the volume and flow of surface runoff which over flows the drainage channels. The NADMO official further indicated that the existing situation of flaws in the drain system characterised by undersized, unconnected or improperly channelled drains do not help in the sustainable management of excess water flow to minimise the occurrence of flooding and its risks. Added causes reported included poor development controls, limited garbage collection and indiscriminate disposal block channels and sewers, which slow drainage through the city.

Incidence of flooding and land use regulations in Accra

Land uses in Accra, especially in some flood prone areas such as Kwame Nkrumah Circle, Adabraka and Kaneshie, are largely commercial, residential and/or industrial (Appiah 2012). This is mainly because of the increasing trend of urbanization and its demands. Nonetheless, it can be inferred that the various land use demands in cities involve the construction of buildings and complementary concrete works such as pavements, which results in the reduction of green cover. The GMET official similarly stated that the construction of pavements has significantly reduced vegetation cover and obstructed the infiltration of raindrops into the soil:

The construction of pavements and concrete slabs around buildings and along the streets in the cities increases the volume of water that is channelled to the drains. These volumes of water would have originally infiltrated into the soil.

The PPD official also indicated that;

As part of the various documents required for the acquisition of a building permit, the plans for the building and its compound should include an area for green cover.

The above supports the observation that there has been intense economic activities (largely retail, wholesale and service commercial) in recent times in most Ghanaian cities (Oosterbaan et al. 2012; Amoako 2016). The trend of conversion from residential to commercial activities in the city centre of Accra has resulted in the emergence of economic activities which are largely informal and small-scale. These economic activities generate a converging effect that draws large numbers of buyers and sellers to the centre and its surrounding towns. With the existence of such a robust setting, large deposits of plastic and glass bottles, as well as food wrappers are a common phenomenon in most parts of the city. Respondents resident in Adabraka and Kaneshie stated that since the early years of the 1990s, the banks of the Odaw river have been burdened with the construction of a significant number of structures both residential and commercial on lands that originally would have been immersed in water after it rains. The increasing slum development in areas along the Odaw river (Odawnaa and Old Fadama) presents another troubling situation with regards to the vulnerability of such areas to the devastating effects of flooding (Amoako 2016). Interview with the NADOMO official further revealed that the siting of unauthorized buildings and the encroachment of the Odaw river buffer is a situation which could have been averted if the enforcement of land use regulation was without political interference.

On the above, the agency officials stated that the role of the government through its institutions and systems in the creation of flood vulnerability in Accra are conceptualised in two ways, namely, (i) the strict role assumed by the state in formulating planning standards and enforcing regulations through its local administrative bodies, and (ii) the absence of the institutions and authorities evident in the unplanned development and negligence with regards to the provision of the needed infrastructure in the informal settlements. The disharmony between government institutions and households regarding the strict role of the state is evident as respondents described in the processes involved in acquiring development permit as tiresome and requires one to make additional payments to statutory ones, thus rendering the process expensive. In addition, respondents considered the effectiveness of land use regulations as being a 'two-way street', implying that the institutions and households should share equal blame. Upon enquiry, all household participants interviewed considered the effectiveness of the implementation of land use regulations as poor since they considered the efforts of city authorities in enforcing the regulations as being absent.

The findings revealed a weak collaborative function, particularly between the PPD and the traditional landowners with regards to land management. This was

reported to manifest in the lack of consultation between government entities and traditional landowners, in disregard of the fact that majority of lands are owned by the latter. Owing to this absence, there has been an upsurge in uncontrolled spatial developments characterised by encroachments and poorly planned layout. According to the officials of NADMO, the PPD and Lands Commission, the level of adherence to land use regulation in Accra is low, where developers often come to only acquire building permits after major works have begun on their structures. Some developers ignore the caution to produce permit boldly inscribed on the walls of their ongoing structures, while others inscribe the caution ('Stop work, produce permit') on the structures themselves to literally hide in plain sight. This was largely blamed on the weak collaboration between land owners (specifically, chiefs) and city authorities.

Again and as earlier reported, the household survey showed that 40% of them perceived flooding in their communities to be as a result of both poor enforcement of land use regulations and volume of rainfall. One respondent who shared a similar view remarked that:

Over these past few days, you would agree with me that the heat in the atmosphere is just unbearable. The little knowledge I have about science also makes me aware that high temperature intensifies evaporation which condenses and falls back as rain. So, you can appreciate why I think it rains a lot lately. However, Accra is not the only place that experiences so much rain, so why then does it always flood?

About 8% of the household respondents were of the view that the incidences of flooding in Accra is as a result of increased intensity and volume of rainfall. Lastly, approximately 52% attributed the major cause of flooding to weak enforcement of land use regulations. The generic opinion in this regard was that attitude of people with regards to properly disposing off waste and acquiring permits for their buildings, is poor. Karley (2009) and Asumadu-Sarkodie et al. (2015) argue that the absence of adequate and highly functional drainage networks for the collection and safe channelling of storm water as a contributing factor to flooding. This is worsened by the indiscriminate disposal of waste materials into the available drains and surface water bodies. Also, the weak enforcement of planning regulations, which has led to the construction of structures on flood plains and in water ways is also a major contributory factor to the flooding situation in Accra.

Okyere et al. (2013) makes reference to Amidu (2010) findings on flooding which indicate some causes of floods to be flawed engineering works, encroachment on flood plains and river basins, land use changes resulting from urbanization, ineffective land administration, planning and management, poor attitude towards sanitation and defunct drainage channels; all of which are attributed to weak enforcement of land use regulations. Other causes that have been explored in existing literature from the perspective of climate change and variability include proximity to the sea, resulting in coastal inundation and change in rainfall pattern and temperature resulting from climate variability. The observed situation encompassing the perennial floods experienced in some flood prone areas of Accra are extensively addressed in the findings of Karley (2009), where he indicates that " whilst heavy rain and increased intensity of rainfall may result in flooding, the fundamental problem is that water

courses are being blocked as a result of human activities such as building houses on river beds and across water courses, the lack of adequate and right drainage infrastructure and the siltation of limited drainage systems ...” Overall, the findings of this study support the school of thought that argue that the flooding in Accra is caused by the weak enforcement of land use regulations. Thus, poor land use planning efforts resulting from non-enforcement of regulations is a dominant cause of the flooding menace in Accra.

Conclusion

Addressing disasters and management remain a central focus towards achieving the Sustainable Development Goals, particularly goals 11 and 13. Effective urban flood risk reduction approaches have the fundamental aim of creating places that are “environmentally sustainable, socially inclusive and economically vibrant” (Cobbinah et al. 2019, p. 269). Human encroachment on flood risk zones, poor flood management strategies, lack of early flood warning systems and disposal of solid waste into drainage channels, among others, are as much to be blamed for being the major contributory factors to perennial flood occurrence than climate change in urban areas. In Ghana, over the years, “climate change” and “land use planning” are considered debateable perspectives on the true cause of the perennial flooding in major cities, specifically, Accra and the Greater Accra region as a whole. This research contributed to the ongoing debate by assessing the various schools of thought together with trend analysis to present a conclusive submission on which of the two perspectives is the ‘true’ cause of the perennial flooding situation in Accra.

Findings from the paper showed that poor land use planning efforts triggered by non-compliance and/or non-enforcement of land use regulations are as much to be blamed for the floods in many areas within Accra. These floods are mostly human-induced. Due to population growth, cities have expanded onto wetlands and flood prone areas, thus distracting the natural flow of water. A well-maintained physical development such as the protection of wetlands by city authorities will consequently prevent flood events and its impacts. It was revealed that ineffective land use regulation has been a major catalyst of flooding occurrence in Accra. Drains along streets overflowing their boundaries due to siltation and encroached areas inundated in water when rivers overflow their banks (specifically, the Odaw river) are proof of the dominant influence of ineffective land use regulations in flood occurrence. Planning for urban areas should provide for areas of natural water flow, including creating a well-structured drainage system to cater for excess flow and surplus water due to activities of urbanization. The perennial flooding in parts of Accra reflects a situation of absence with regards to adequate provisions to avert the effects of surplus water and excess flow resulting from urbanization in light of an annually receding volume of rainfall.

Given the conclusion that land use malpractices—including improper disposal of solid waste that eventually block drains and results in water overflow in times of heavy rainstorm; building on wetlands as a result of non-compliance and or non-enforcement of land use regulations—remain the dominant cause of flooding bases

in Accra, the study makes some suggestions directed toward addressing the issues surrounding land use malpractices.

In addressing flooding from the land use regulation perspective, there is the need to encourage the implementation of green infrastructure in city centres and urban areas. On this, green infrastructure should encompass rain gardens, green roofs, permeable pavement, street trees and rain harvesting systems which should be incorporated into urban design techniques. This is considered environmentally sustainable and cost-effective approaches to managing storm water; significant in making up for the impervious and concrete laden land surfaces resulting from urbanization.

Another suggested approach entails a collaborative effort with commercial actors and leaders of trader associations within the market centres. This effort should take the form of a polluter-pay policy, which could entail a system of tax payment where the taxes paid by traders are determined by the quantum of waste produced from their economic activities. The quantum of waste should be measured by standards designed and revised by the PPD, EPA and the Waste Management Department of AMA. Tax incentives can also be an added package that encourages the people in various waste-creating economic activities to initiate deliberate efforts towards the reduction of waste volumes.

Data availability Data of this manuscript will be made available upon request.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

References

- Abugtane AF (2015) Assessing the effectiveness of physical development planning and control mechanisms in Ghana: The Experience of Wa Municipality. Kumasi, p. 139.
- Accra Metropolitan Assembly (2018) 2018–2021 Metropolitan medium-term development plan, development planning unit. Accra Metropolitan Assembly (AMA), Accra, Ghana
- Adom D, Hussein EK, Joe A (2018) Theoretical and conceptual framework: mandatory ingredients of a quality research. *Int J Sci Res* 7(1):6–9
- Afeku, K. (2005). Urbanization and flooding in Accra, Ghana. Accessed at https://etd.ohiolink.edu/etd_send_file?accession=miami1123271331&disposition=inline on 31/08/2020
- Afornope EK (2016) Flood vulnerability and adaptation in Accra: examining aspects of both climate and non-climate factors. A thesis submitted to the University of Ghana, Legon in partial fulfilment of the requirement for the award of M.Phil Geography and RESOURCE Development Degree
- Agboklu G (2015) Why the Accra floods occur—reasons from scientific studies. <https://laboneexpress.com/2015/06/why-the-accra-floods-occur-reasons-from-scientific-studies/>. Accessed 31 Aug 2020
- Ahadzie DK, Proverbs DG (2011) Emerging issues in the management of floods in Ghana. *Int J Saf Secur Eng* 1(2):182–192
- Amoako C (2016) Brutal presence or convenient absence: the role of the state in the politics of flooding in informal Accra, Ghana. *Geoforum* 77:5–16
- Amoako C, Frimpong-Boamah E (2015) The three-dimensional causes of flooding in Accra, Ghana. *Int J Urban Sustain Dev* 7(1):109–129
- Amoako C, Inkoom DKB (2017) The production of flood vulnerability in Accra, Ghana: re-thinking flooding and informal urbanization. *Urban Stud* 55(13):2903–2922
- Appiah WK (2012) The management of urban land in Ghana: the case of Accra and Kumasi metropolitan areas. A thesis submitted to the School of Graduate Studies, Kwame Nkrumah University of Science

- and Technology in partial fulfilment of the requirements for the degree of Master of Science in Development Policy and Planning
- Asibey MO, Cobbinah PB (2022) The evidence for climate change on our planet. In: Brinkmann R (ed) *The Palgrave handbook of global sustainability*. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-030-38948-2_23-1
- Asumadu-Sarkodie S, Owusu-Phebe A, Rufangura P (2015) Impact analysis of flood in Accra, Ghana. *Adv Appl Sci Res* 6(9):53–78
- Attipoe S (2014) An assessment of flood mitigation measures in Accra, Ghana (Masters). Kwame Nkrumah University of Science and Technology, Kumasi, Ghana. Retrieved from <http://ir.knust.edu.gh/bitstream/123456789/7044/1/ATTIPOE%2c%20SELASIE%20KOFI.pdf>
- Awuah KGB, Hammond NF (2014) Determinants of low land use planning regulation compliance rate in Ghana. *Habitat Int* 41(2014):17–23
- Bhattacharjee A (2012) Introduction to research, social science research: principles, methods, and practices. In: Textbooks collection. <https://doi.org/10.1351/pac198961091657>
- Chan NW (2017) Urbanization, climate change and cities: challenges and opportunities for sustainable development. A paper presented at the Asia-Pacific Chemical, Biological and Environmental Engineering Society (APCBEEES) International Conference at: School of Humanities, Universiti Sains Malaysia, Penang, Malaysia Volume: 1
- Cobbinah PB, Poku-Boansi M, Peprah C (2017) Urban environmental problems in Ghana. *Environ Dev* 23:33–46
- Cobbinah PB, Asibey MO, Opoku-Gyamfi M, Peprah C (2019) Urban planning and climate change in Ghana. *J Urban Manag*. <https://doi.org/10.1016/j.jum.2019.02.002>
- Douglas IAN, Alam K, Maghenda M, McDonnell Y, Mclean L, Campbell J (2008) Unjust waters: climate change, flooding and the urban poor in Africa. *Environ Urban* 20(1):187–205
- Ghana Statistical Service (2014) 2010 Population and housing census. Analytical report of Accra Metropolitan Area, Accra, Ghana: Ghana Statistical Service (GSS)
- Gyimah KA (2017) Building safer cities: assessing green infrastructure for storm water management at Kwame Nkrumah interchange, Accra. In: *The Proceedings of the 6th International Conference on Infrastructure Development in Africa*, 12th April, 2017, Knust, Ghana
- Jha AK, Bloch R, Lamond J (2012) *Cities and flooding: a guide to integrated urban flood risk management for the 21st century*. World Bank, Washington, D.C.
- Karley NK (2009) Flooding and physical planning in urban areas in West Africa: situational analysis of Accr. Ghana. *Theor Empir Res Urban Manag* 4(13):25–41
- Khan AZ (2012) Climate change: cause and effect. *J Environ Earth Sci* 2(4):48–53
- Korah PI, Cobbinah PB, Nunbogu AM (2017) Spatial planning in Ghana: exploring the contradictions. *Plan Pract Res* 32(4):361–384
- Lambini CK (2009) Land reforms and conservation in Ghana, Oral Presentation at the 1st Society for Conservation Biology—Africa Section Conference, Ghana, 2009 Chapter one: Introduction Chapter Three: Land Management and Ref*, (February 2009). <https://doi.org/10.1088/1755-1307/6/3/42047>.
- Marchiori L, Maystadt JF, Schumacher I (2012) The impact of weather anomalies on migration in sub-Saharan Africa. *J Environ Econ Manag* 63(3):355–374. <https://doi.org/10.1016/j.jeem.2012.02.001>
- Mcgranahan G, Satterthwaite D (2014) *Urbanization concepts and trends*. International Institute for Environment and Development (IIED), London. Accessed at <https://pubs.iied.org/pdfs/10709IIED.pdf>
- Mensah H, Ahadzie DK (2020) Causes, impacts and coping strategies of floods in Ghana: a systematic review. *SN Appl Sci* 2(5):792. <https://doi.org/10.1007/s42452-020-2548-z>
- Okyere CY, Yira Y, Gilbenbach D (2013) The problem of annual occurrences of floods in Accra: An integration of hydrological, economic and political perspectives. Bonn. Retrieved from University of Bonn website: http://www.zef.de/fileadmin/downloads/forum/docprog/Termpapers/2012_2_Gilbenbach_Okyere_Yacouba.pdf
- Oludare A, Bashir O, Olusegun A (2012) Building capabilities for flood disaster and hazard preparedness and risk reduction in Nigeria: need for spatial planning and land management. *J Sustain Dev Afr* 14(1):45–58
- Oosterbaan C, Arku G, Asiedu AB (2012) ‘Conversion of residential units to commercial spaces in Accra, Ghana: a policy Dilemma. *Int Plan Stud* 17(1):45–66
- Poku-Boansi M, Amoako C, Owusu-Ansah JK, Cobbinah PB (2020) What the state does but fails: Exploring smart options for urban flood risk management in informal Accra, Ghana. *City Environ Interact* 5:100038. <https://doi.org/10.1016/j.cacint.2020.100038a>

- Rain D, Engstrom R, Ludlow C, Antos S (2011) Accra Ghana: a city vulnerable to flooding and drought-induced migration. <http://unhabitat.org/wp-content/uploads/2012/06/GRHS2011CaseStudyChapter04Accra.pdf>
- Rehman J, Sohaibab O, Asif M, Pradhanab B (2019) Applying systems thinking to flood disaster management for a sustainable development. *Int J Disaster Risk Reduct* 36:101–101. <https://doi.org/10.1016/j.ijdr.2019.101101>
- Stuart JD, Lindsay RA (2006) Global climate change triggered by global warming. A position paper from the center for Inquiry Office of public Policy. https://www.centerforinquiry.org/wp-content/uploads/2018/05/global-climate-change_1.pdf. Accessed 31 Aug 2020
- Tengan C (2017) Addressing flood challenges in Ghana: a case of the Accra Metropolis. In: A paper presented at 5th International Conference on Infrastructure Development in Africa
- Thurman KG (2010) Land use regulations and urban planning initiatives in Accra, Ghana. PLAN A6211.001 Advanced Issues in Development Planning. <http://mci.ei.columbia.edu/files/2013/03/Land-Use-Regulations-and-Urban-Planning-Initiatives-in-Accra-Ghana.pdf>. Accessed 31 Aug 2020
- Trenberth KE (2011) Changes in precipitation with climate change. *Clim Res* 47:123–138. <https://doi.org/10.3354/cr00953>
- UN-International Strategy for Disaster Reduction (UN-ISDR) (2015) Global Assessment Report on Disaster Risk Reduction 2015, International Strategy for Disaster Reduction (ISDR). 9789211320282

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