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Rising incidence of urban floods: understanding the causes for flood risk reduction in Kumasi, Ghana

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Abstract Urban areas in Ghana have experienced worsening floods in terms of scale and number of affected people. In many instances, attribution has been made to one dominant factor as the cause of the rising flood incidence. The nature of the problem however suggests a complex interplay of factors at work but which have received limited research attention. Drawing on climatic data, household and key informant interviews, as well as direct observations, the paper examined the factors that underlie the rising incidence of floods in Kumasi. From the lens of urban political ecology, findings from the study suggest that multiplicity of factors rooted in weak institutional and legal frameworks underlie the worsening flood situation in the city. Key among these are rapid and unplanned urban growth, poor waste management culture and institutional ineptitude. Effective land-use planning and control through smart growth policies, alongside efficient waste management culture, are critical in stemming the problems of floods but the effectiveness of these measures depend on adequate resourcing of the relevant institutions and enforcement of land use regulations.

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Introduction

Projections show that the level of urbanization will increase in all regions in the coming decades but at a faster rate in Africa and Asia (United Nations Population Division 2015). Unplanned urbanization can lead to changes in land use and land cover with implications for floods. Floods are the most common natural hazard at the world scale and pose a major risk to life and property at global and local levels (Clement 2012). Annually, floods affect about 520 million people and their livelihoods and claim approximately 25,000 lives worldwide (WMO-UNESCO 2007). In Africa, floods represent 77.3% of all disasters, causing huge losses to life and property (Yengoh et al. 2017).

Urbanization is associated with landscape conversion to built-up environments which are characterized by high population density (Barasa and Perera 2018), changing hitherto permeable surface to impermeable concrete surface. With little or no open surface such as soil necessary for water storage, surface runoffs from heavy rainfall flow into surface waterbodies or urban sewage systems. Thus, urbanization has a direct relationship with hydrological characteristics by reducing infiltration, increasing runoff rates and

frequency of floods (Alaghmand et al. 2010). However, urban floods are results of the multivariable socio-ecosystem process with many drivers (Zambrano et al. 2018). Heavy rainfall (Manhique et al. 2015), poor spatial planning, inadequate waste management practices and blocked sewers (Stevaux et al.2009; Zambrano et al. 2018) are some of the causes of urban floods. While many drivers are at play, city authorities quite commonly, settle on those that are easily observable as in the case of sewage blockages and buildings in waterways (Zambrano et al. 2018). This may explain why measures taken to address urban floods have been less successful.

In urban Ghana, human vulnerability to floods continues to increase with each successive flood incident impacting lives negatively than the preceding one (Aboagye 2012). Studies on floods incidence in urban Ghana have shown varied attributions. One of these factors is climate variability, with increasing flood incidence explained in terms of changes in rainfall and temperature patterns (Rain et al. 2011; Addo et al. 2011). Other factors are poor physical planning, poor and inadequate drainage network, rapid city growth and expansion, poor waste management practices, informal housing development practices and poor physical development control (Amoako and Boamah 2015; Gyekye 2011).

In Kumasi, a rapidly growing urban area in Ghana, perennial floods continue to be a threat to human lives and properties (Amoateng et al. 2018; Campion and Venzke 2013). In most cases, the city authorities blame the floods on people building in waterways (Campion and Venzke 2013). However, the increasing regularity and widening spatial extent of floods in the city would suggest a rather complex mix of factors at play. Scholarly works on causes of flood in urban Ghana centered on rainfall variability and floods (Campion and Venzke 2013); urbanization dynamics and floods (Korah and Cobbinah 2017); land use, sanitation infrastructure and flooding (Owusu-Ansah 2016); climate change and coastal inundation (Addo et al. 2011). Missing from this body of empirical literature is an interrogation of the intricate dynamics that explain the rising incidence of floods in urban Ghana. Besides, institutional and policy issues have generally been ignored in scholarly discourses on floods. Unravelling these factors could provide an avenue for managing the flood menace in an integrated manner and make the city sustainable. The paper interrogates the anthropogenic and natural factors that underlie the rising incidence of floods in terms of frequency and the scale of impact. The rest of the paper proceeds as follows: Section two examines the theory informing the paper while section three discusses the methods. In section four the paper presents and discusses the data in relation to the theory of urban political ecology. The fifth section looks at the conclusion and policy recommendations.

Urban political ecology in relation to floods

The theoretical underpinning of this paper is the Urban Political Ecology (UPE), whose antecedents could be traced to the early 1970s at a time when human-environmental interactions came under close public and scholarly scrutiny (Nygren and Rikoon 2008).

Viewed as a subfield of political ecology and with a strong Marxist leaning, Urban Political Ecology (UPE) developed from the work of Harvey (and Lefebvre) (Marks 2015). Harvey held the view that the city is a tangible, built environment but also a social product. Applying this Marxist framework, he argues that cities are founded upon the exploitation of the many by the few. Urban political ecologists elaborating on Harvey's theory of the city, perceive landscapes and infrastructure of cities as hybrids and historical products of human-nature interaction (Keil 2003). Thinking of the city as a socio-spatial hybrid demonstrates how the social production of urban space spreads the vulnerability to hazards, exposure to risk and ecological breakdown in an uneven manner (Murray 2009). Prior to the development of this field of political ecology, both academics and policymakers mistakenly often sought to address environmental problems with technical or management solutions that did not tackle the political economy dimensions of these problems (Marks 2015). Political economy analysis focuses on institutions through which policies are developed and the links between politics and the economy, with a focus on power relations, incentives, and the influences within formal and informal processes (Williams 2011). Blaikie pioneered the argument that environmental problems cannot be solved unless these dimensions are addressed (Blaikie 1985). Together with Bloomfield, Blaikie argued that not only was the state biased but also that it often bestows

its power to the dominant group and classes while marginalizing the least powerful.

Urban political ecology has proven to be a useful theoretical approach to understanding the consequences of human–environment interactions. Part of the challenge taken up in UPE is how to use critical social theory, especially theories associated with political economy, to better frame the problems faced by people living in cities. As a geographic approach, UPE is geared towards understanding how political, economic, and ecological processes work together to transform cities and the lives of the people who live in them (Heynen 2017). A number of empirical works have employed this theoretical approach in the study of different aspects of floods. Marks (2015) examined the urban political ecology of the 2011 floods in Bangkok while the study by Ranganathan (2015) focused on the political ecology of flood risk in post-colonial Bangalore. Tran (2020) employed a political ecology framework to analyze the state-society-flood nexus in the Vietnamese Mekong Delta. In Africa, Rono-Bett (2018) analyzed the decision-making on natural disaster preparedness in Kenya from the lens of political economy while Aboagye (2012) employed political ecology to examine environmental hazards in Accra, Ghana.

The UPE framework brings two dimensions to policy-oriented research on flooding. The first is the understanding that flooding occurs in political spaces in both its origins and social consequences (Padawangi and Douglass 2015). Its origins invariably show the influence of human interventions in natural ecologies, and its impacts do not fall evenly among people, but rather work through social, political and economic differences with the poor and marginalized being the most affected (Padawangi and Douglass 2015). Similarly, Marks (2015) noted that the uneven vulnerabilities experienced by different individuals during floods are largely due to the state and market institutions protecting the lives and the interests of the elite while failing to protect marginalized groups or making them more vulnerable. Likewise, an environmental disaster can be understood as a rupture in the status quo that has different possible outcomes ranging from reinforcing the power of dominant forces to mobilizing social energies for political reform (Padawangi and Douglass 2015). Second, UPE perspective brings into focus the entire regional ecosystems, rather than only one dimension of causes of floods. UPE thus gives an idea that the drivers of natural disasters in urban settings are not to be limited to natural factors because socio-political factors also create and shape these disasters. Normally, it is the state's responsibility to undertake investments in flood risk reduction, such as flood protection structures, the designation of public floodways and land-use controls and therefore plays a key role in determining how vulnerable people are to floods (Marks 2015).

The field of urban political ecology thus provides a useful framework for thinking about the creation and shape of disasters (Marks 2015). It helps to look at how politics and governmental practices shape environmental problems like floods. Despite its strengths, UPE is criticized on grounds that the agency of nature remains unnoticed (Robbins and Sharp 2006) and focuses too much on the cities of industrialized countries (Keil 2005). These notwithstanding, an assessment of urban flood problems through the lens of the political ecology framework would unravel the underlying causes, impacts and solutions to flood risk and vulnerability compared to a conventional method of evaluation (Salami et al. 2018).

In this paper, UPE is applied to analyze how the natural, socio-economic and political factors interact to explain the rising incidence of urban floods with varying spatial risks and vulnerabilities in Kumasi. It is believed that adopting this approach will provide a holistic perspective of the perennial flood problem and ensure effective solutions to flood incidence and related vulnerabilities.

Methods

The study area

This paper focuses on selected communities in Kumasi (namely Kwadaso, Nhyiaeso, Subin, Asokwa, Oforikrom, Manhyia, Old Tafo, Suame and Bantama. The study area falls within the wet sub-equatorial climatic region with average minimum and maximum temperatures of 21.5°C and 30.7 °C respectively. It has an average humidity of 84.16% at sunrise and 60% at sunset. Temperature and humidity are moderate with double maxima rainfall regime (214.3 mm in June and 165.2 mm in September) (GSS 2014). The mean annual rainfall is between 1250 and 2000 mm. The study area thus falls within a climatic region that

experiences heavy rainfall which may partly account for the perennial floods. The major soil type is the forest ochrosols, which has a high clay accumulation and almost impermeable near-surface sub-horizons (Adjei-Gyapong and Asiamah 2002). Even though Kumasi lies within the moist semi-deciduous forest, most of its vegetative cover is lost to rapid unplanned urban expansion. These conditions may have exacerbated the flood situation as they lead to high runoff rate (GSS 2014). The various drainage systems such as Subin, Aboabo, Sisa and Wiwi often result in floods due to floodplain intrusion and waste accumulation. These floods are fluvial (river) floods. There are also pluvial (or overland) floods caused by excessive runoff, increased imperviousness due to urbanization and the limited capacity of drainage systems. Flash floods are common and are characteristically rapid and often last for just a few hours. Less common are floods caused by a high water table combined with heavy rainfall. It is estimated that there are 929,203 migrants, translating into 53.7% of the population of the area (GSS 2014). With the poverty rate of 14.8% in the city, approximately 89,000 of its population live below the national poverty line of GHS 1314 per person per year (Forkuor and Agyemang 2018). Many of these migrants, with little economic resources, are unable to secure accommodation in high and middle-income residential areas in the city. Majority of these people find accommodation often in low cost and unplanned suburbs that are vulnerable to floods.

Data collection and analysis

Rainfall and temperature data for Kumasi were obtained from the Ghana Meteorological Agency (Gmet), Accra which covered 36 years (1980–2016) to determine rainfall and temperature trends and variability over the period. Secondary flood data was also obtained from the Ashanti regional office of the National Disaster Management Organization (NADMO) to explain the relationship between rainfall and flood incidence. The classical Mann–Kendall non-parametric trend test was used to analyse rainfall and temperature data in Kumasi between the years of 1980 and 2016 at 5 per cent significance level. This was to determine whether or not the historical pattern of rainfall and temperature in the city have changed due to climate impact.

The study also involved a qualitative study of households and key informants. The choice of qualitative approach stemmed from the need for depth of data to understand the natural and human factors responsible for floods, as well as the role of institutions. Following this approach, primary in-depth interviews (IDI) were conducted with household heads selected from eight flood-prone communities using convenience sampling. Interview guide was used as the instrument for data collection. Including households in the study was important because understanding their views may help proffer solutions to reduce flood and human vulnerability in Kumasi. To qualify for inclusion, a household head should have lived in their respective communities for at least 5 years. This is considered long enough for participants to have rich experience to share on the subject being studied. The eight communities were selected from a list of 18 flood-prone communities using a simple random sampling technique (fishbowl draw method). They include Anwomaso, Atonso, Ayigya, Old Tafo, Buokrom, Kwadaso, Dechemso and Breman (Fig. 4). A total of 55 household heads, 7 from each community took part in the study, except Anwomaso where 6 household heads participated in the interview. Since it is a qualitative study of communities sharing common socio-demographic characteristics and flood experience, the sample is adequate to provide a contextual perspective of the causes of floods. Besides, 9 key informants, who were heads of the various institutions were purposively selected for in-depth interviews. These institutions included NADMO, Metropolitan, Municipal and District Assemblies (MMDAs), Town and Country Planning Department (T&CPD), Ghana Meteorological Agency (Gmet), Hydrological Services Department (HSD), Water Resources Commission (WRC) Department of Parks and Gardens (DP&Gs) and Traditional Authorities (TA). These informants were selected because they offered expert views on the flood phenomenon being investigated. Interviews covered natural and human factors that underlie the rising flood incidence in Kumasi and specific ways to address them. While household interviews were conducted in the local dialect *twi*, English was mainly the medium of interviews with the key informants. It took between 35 and 40 min to end one interview session. All interviews were audio-taped with a digital voice recorder and supplemented with an interviewer's field notes. Direct observation

was also employed as a method for data collection using observation checklist.

The qualitative data obtained from the various categories of interviewees were analysed thematically (Nowell et al. 2017). Several steps were involved. First, transcription of all tape recordings into English was done and the transcript exported to NVivo 9 analytical software. At this point, data were coded both deductively and inductively. Coding went on until a theoretically saturated point was reached, where no new concepts emerged from further coding of data. Next, all coded data were developed into themes, which were defined and named. Themes and associated stories were identified and analyzed. To ensure the rigor of the findings as Miles et al. (2014) noted, the preliminary findings were shared with the study participants to gain their inputs, clarification and feedback. This helped in refining the results reported. Some of the qualitative results have been presented as direct quotations to illustrate relevant themes.

Direct observations of floodplain intrusion, choked drains, the nature and state of storm drains, waste collection practices and real flood situations were made to support data obtained from interviews. All observed phenomena were captured with a digital camera and presented in this work as pictorial evidence.

Ethical issues

Ethical clearance for fieldwork was secured from the Committee on Human Research, Publications and Ethics (Ref: CHRPE/AP/548/17). Besides, participation in the study was made voluntary. Participants were not coerced into providing information. The purpose of the research was also clearly communicated to the participants. Verbal and written informed consents were sought from all participants. Further, participants were informed that they had the right to withdraw at any point in the interview process if they felt so. To conceal the identities of participants, the analysis and presentation of data used only pseudonyms. Participants were assured that the information they provided would be kept in strict confidentiality.

Results and discussion

Flood incidence and household experience in Kumasi

Every year, floods occur in Kumasi after and during moderate and heavy rains, destroying properties and dislodging many people in the process (Amoateng et al. 2018). Evidence shows that the number of flood cases and the number of victims keep increasing. In 2012, the study area registered 7 flood cases and an estimated number of 391 people affected. In 2017, the number of cases and affected people increased to 38 and 3236 respectively (NADMO-Kumasi 2017). Figure 1 shows flood cases and the number of people affected from 2004–2017.

In Kumasi, floods occur in a socially unequal setting in which land ownership and development compel marginalized households to live in flood prone areas. Land in areas that are less prone to floods is highly priced often beyond the average Ghanaian income earner. These areas are sites of elite housing complexes or other large-scale projects oriented toward affluent users and consumers. Given this, the city poor are forced to live in urban locations that are environmentally unsafe or prone to floods. The vulnerable conditions in which these lower-income households find themselves not only keep them in perpetual fear of floods but also forced eviction or relocation by city authorities as a presumed necessity for attenuating the flood menace.

All the participants in the field interview agreed that they had previous flood experience and continue to face risks of floods during the rainy season. Respondents indicated that floods have serious negative socio-economic effects on them. These effects range from loss of personal belongings and collapse of buildings (Fig. 2) to the physical and psychological outcomes. Inundation of compounds and rooms by floodwater were widely reported by participants as an annual occurrence (Fig. 3). While some households were rendered homeless, others were forced to relocate temporally. In situations where households were unable to relocate due to financial constraints, they had to live with the floods. The number of days affected households lived under flood conditions reportedly ranged from 14 to 64 days. Campion and Venzke (2013) however found that it took twenty days for floodwater to dry up in some suburbs of Kumasi while

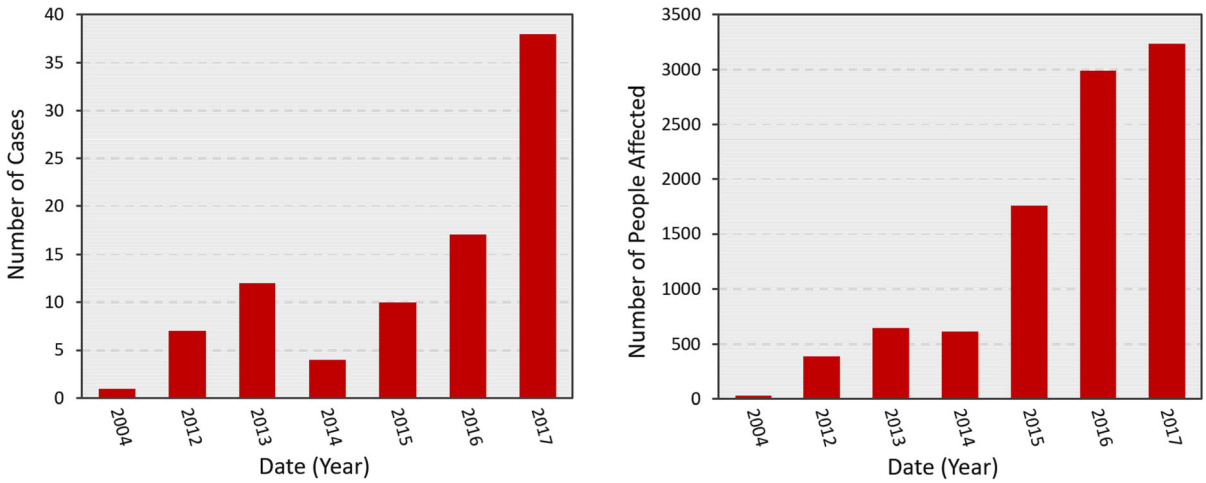

Fig. 1 Plot of the number of cases (left-hand side graph) and the number of persons affected (right-hand side graph)

Fig. 2 Relics of floods (Old Tafo)

Fig. 3 Residential facility within a wetland, Dichemso

it took a month in some cases for floodwater to recede. At Atonso S-line, a discussant had this to say:

> I remember two years ago our compound got flooded while we were all away. It rained so heavily that almost everybody's compound became flooded. The floodwater got to the window level and it took more than a week for the water to recede. Almost everything in my room got soaked and destroyed. Nothing was spared but the most painful and irreparable loss was damage to the school certificates of two of my children and my wedding pictures. (Male, IDI)

Another participant had this to say:

> My brother, look at the three buildings there. Don't you see they are similar in design as the one we are occupying now? We had to abandon them because of floods. The building still stands but can't be used by anybody. This is a huge investment that would have been earning us income through rental charges. We've simply toiled in vain. (Male participant, IDI)

Notwithstanding households' previous flood experience and risk awareness, It was found that they remained inadequately prepared for future flood occurrence. This concurs with the findings of earlier studies (Salami, 2017; Salami, et al., 2018) which observed no significant association between risk awareness and the level of preparedness to flood disaster.

Natural factors and rising flood incidence in Kumasi

Relief and soil

Analysis of the relief of the study area shows a generally undulating topography, with the greater part of the landscape characterized by highlands separated by lowlands. Elevations range from 206 to 315 m above sea level, with generally gentle slopes (Fig. 4). All the communities studied were observed to be low-lying. The low and flat land could partly explain the persistence and severity of floods in areas such as Atonso S-line, Dechemso, Anwomaso, Breman and Old Tafo.

Forest Ochrosols is the major soil type in the study sites. Its high clay content and the presence of nearly impermeable sub-surface layer lead to high runoff rate (Adjei-Gyapong and Asiamah 2002). Topography and soil conditions influence exposure to and incidence of flash floods since they affect the quantity and extent of overland flow (Amoateng et al. 2018; Okyere et al. 2012). While not discounting their role in flood intensity and persistence, interviews with both household heads and key informants suggest that topographic and edaphic conditions of the study areas have not changed in a way that could cause a rise in flood events. This was what the Metro Engineer said:

> No doubt, both the relief and soil characteristics can change with time through natural and human activities thereby having a localized impact on floods. But I will not link the worsening flood situation in the city to these physical factors. The problem is human-induced. (Male participant, IDI)

This concurs with the findings of previous studies (Owusu-Ansah 2016; Okyere et al. 2012) that physiographic features play little role in flood incidence and vulnerabilities in Ghanaian cities.

Climatic factors

It is evident from the trend analysis that annual rainfall has seen a marginal increase in the past thirty-six years (1980–2016), with several variabilities (Fig. 5). While a positive marginal trend in rainfall is recorded, it is not significant at an alpha level of 0.05 ($P = 0.084$) as shown in Table 1. The monthly rainfall for June, which is noted as the peak rainfall month, also revealed an insignificant increasing trend ($p = 0.844$) (Fig. 6). Although flood occurrence in Kumasi always

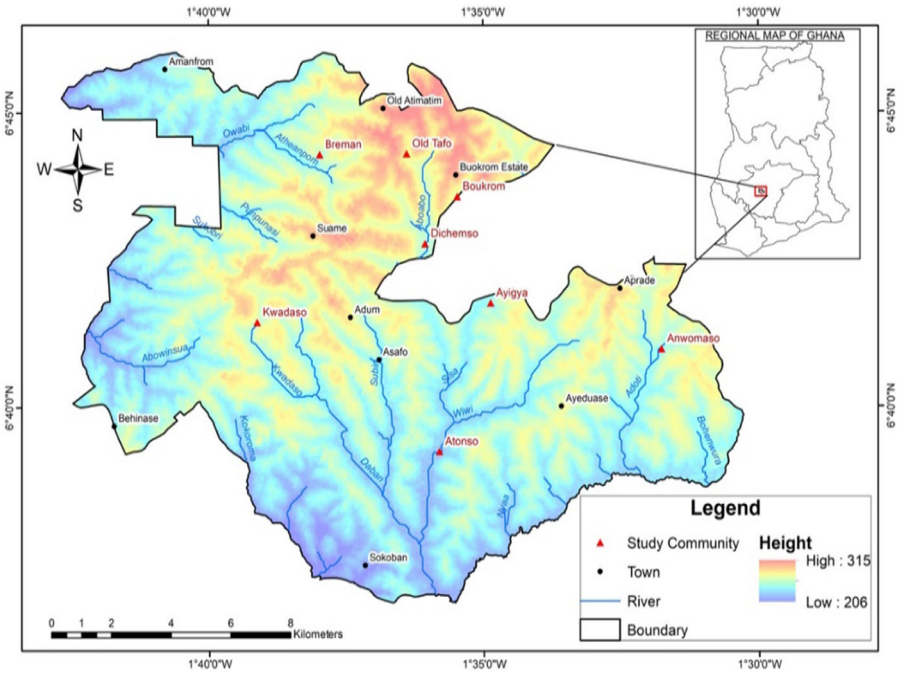

Fig. 4 Relief and drainage characteristics of Kumasi

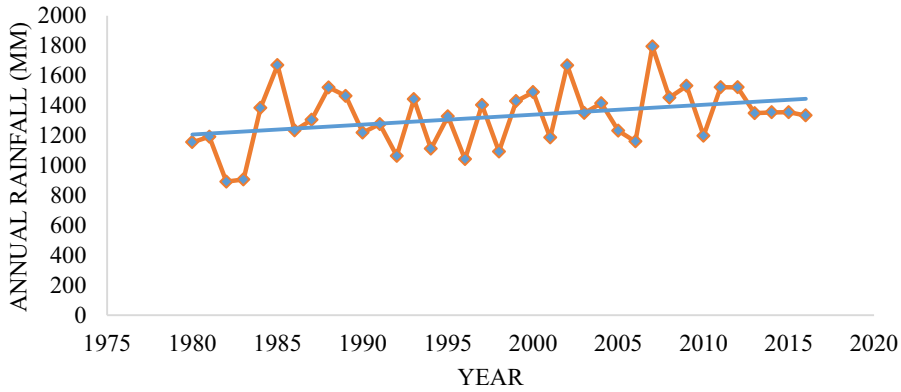

Fig. 5 Annual trend in rainfall in Kumasi (1980–2016)

Table 1 Mann–Kendall trend statistics for annual rainfall and mean annual temperature in Kumasi

Description	Rainfall statistics	Temperature statistics
Kendall's tau	0.203	0.327
Mann–Kendall statistics (S)	128.000	206.000
p-value (one-tailed)	0.084	0.998
Alpha	0.05	0.05

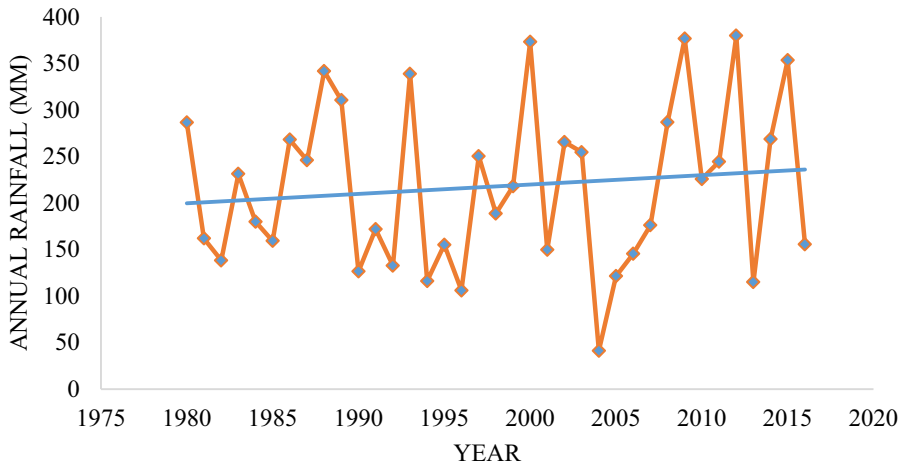

Fig. 6 Rainfall events for June in Kumasi (1980–2016)

coincides with the rainy season, the rising incidence of floods could not be linked to a climate-induced increase in rainfall as shown in the trend analysis (Figs. 5 and 6). Interestingly, a key informant had a different view. He put it this way:

> The worsening flood situation could be due to climatic factors. These days, the rain comes heavy and lasts for several hours in most cases. (Male participant, NADMO)

He was however quick to add that anthropogenic factors such as noncompliance with building regulations and improperly planned spatial development are the main causes of the flood problem.

In terms of temperature, it is evident that the annual mean temperature time series has slightly increased in Kumasi over the past three decades spanning from 1980 to 2016 (Fig. 7). However, there is no significant trend in the annual temperature of the areas under consideration as shown in Table 1.

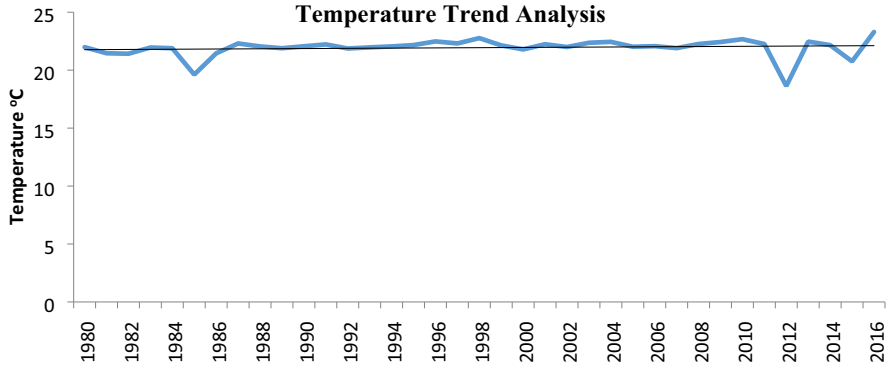

Fig. 7 Annual Mean Temperature Trend in the Kumasi (1980-2016)

Anthropogenic factors and perennial floods in Kumasi

Urban growth, land use/cover change and floods

One key dynamic factor that accounts for the increasing flood incidence in Kumasi is its rapid growth. The city has expanded in both numbers and spatial extent over the years. It is the most rapidly growing urban area in the country, having grown at 5.2% annually between the 1984 and 2000 intercensal years but at a much greater rate of 5.4% from 2000 to 2010 (Afrane and Amoako 2011; GSS 2014). A large number of newcomers from deprived rural areas often do not settle in the well-established parts of the city due to their low-income status. Rather, they settle in marginal and environmentally unsafe areas, open spaces and stream buffer zones. From whichever angle it is viewed, rural–urban migration resulting from the spatial imbalance in development in Ghana is the result of policy failure. In Ghana, the north–south divide in development dates back to colonial times, when the north served as a source of labor for the opulent south (Rademacher-Schulz et al. 2014). The capture of the state by post-colonial political elites, mismanagement and corruption may have widened inequality and created vulnerable groups in the north. The result is a continuous migration of labor from the north to cities in the south and the resultant increase in the population of these cities. Given their low-income status, this section of the urban population resort to illegal and makeshift structures for accommodation and this lays the foundation for the development of slums in the cities. From the political ecology theoretical point of view, the state bias and socio-economic marginalization of some segments of the population seem to partly explain the unplanned spatial development and different vulnerabilities to natural hazards.

Satellite image analysis of the study area by Abass et al. (2019) (Figs. 8a and b) shows that between 1986 and 2016 there was a remarkable increase in the extent of urban land use from 23.3 to 77.6%. The non-urban land surface, however, declined from 76.7 to 22.4% within the same period.

From the perspective of urban political ecology, flooding reflects the influence of human interventions in natural ecologies. The expansion of Kumasi has implications for flood incidence through land use and land cover changes. Impervious concrete surfaces such as roofs, roads and pavements have virtually taken over permeable surfaces. Field research shows that one major cause of floods in the city is human occupation of wetlands and building in waterways (Fig. 9). The use of such areas involves processes such as stream diversion and filling with loads of sand. Typical examples of the development of wetlands and riparian areas for residential purposes were found at Atonso S-line and Kwadaso Estate. In a key informant interview at Old Tafo for instance, the NADMO coordinator linked the problem of floods in the community to people building in waterways and inadequate storm drains. The NADMO officer summarizes it succinctly this way:

> People must stop building in waterways, marshy and waterlogged areas if we are to win the fight against floods in the city. If we block the natural course of a stream or river, it will hit back at us because water will always try to find its way. (Male participant, IDI)

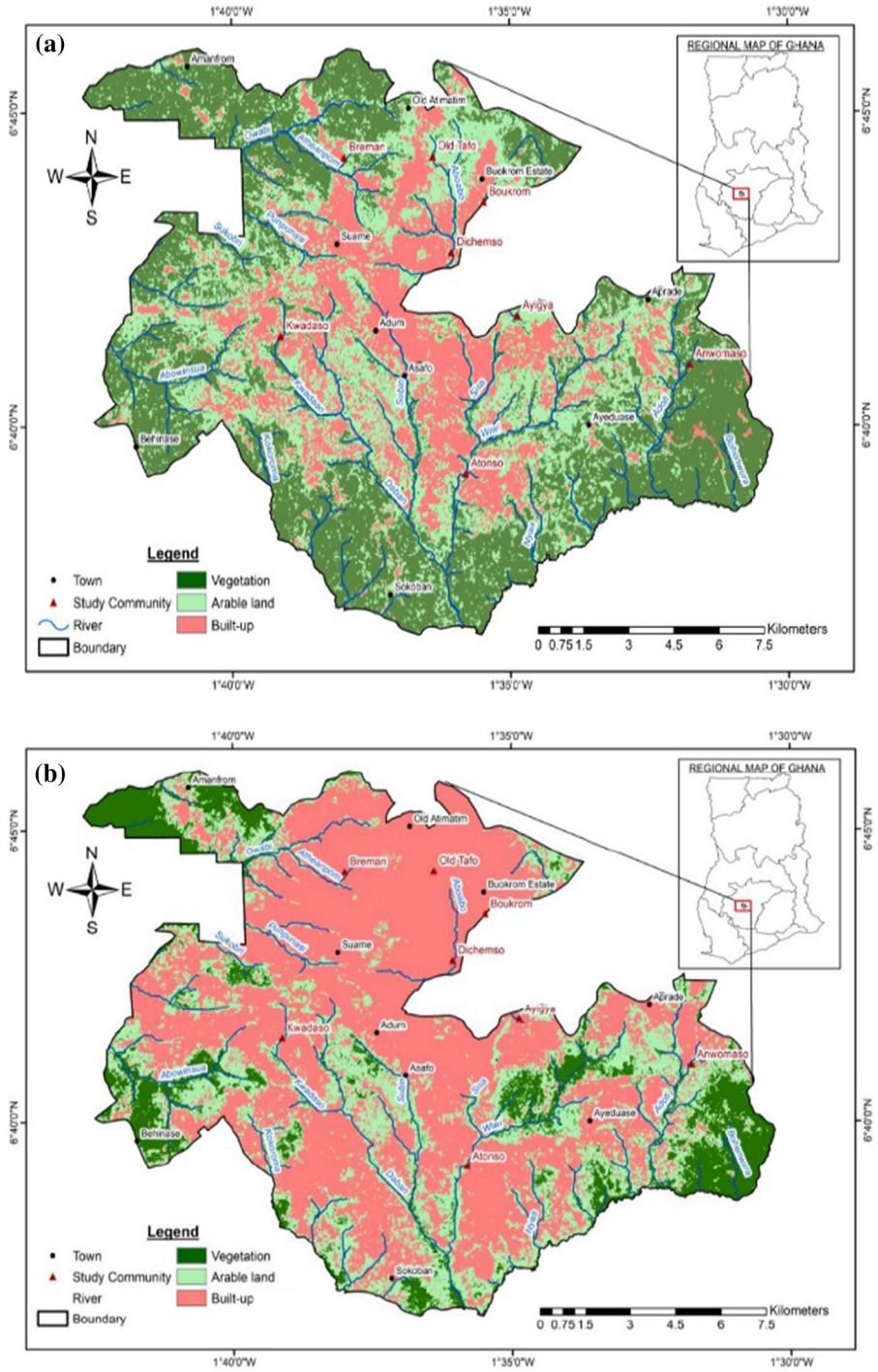

Fig. 8 **a** Classified Land Cover of Kumasi, 1986. **b** Classified Land Cover of Kumasi, 2016

Empirical evidence shows that progressive clearing of vegetative cover for urban infrastructure alters hydrological regime, increase surface runoff and river flow and results in greater flood risk (Ouellet et al. 2012; Tao et al. 2011). Urban floods, according to Douglas et al. (2008), are not only related to extreme climatic

Fig. 9 Abandoned buildings situated in a wetland, Atonso S-line

events but are also associated with transformations in the built-up areas themselves. It is to address this challenge and make a city livable that properly planned cities integrate green spaces into the city structure. Urban green infrastructure has been linked to surface runoff reduction and recharge of the aquifer (Gill et al. 2007) and acts as both buffers and natural stormwater drains during floods (Munang et al. 2013). This is however not the case in Kumasi. The continuous destruction of urban green and open spaces for urban land use forms may be indicative of increased risk of floods in the city.

Sanitation challenges, drainage infrastructure and floods

Related to urbanization is the poor solid waste management culture in Kumasi. Rapid urban growth has led to an increased and uncontrolled generation of wastes. With an estimated per capita daily municipal waste generation rate of 0.75 kg in the city (Miezah et al. 2015), the city authorities are overwhelmed by the volume of waste to be managed daily. As such, a substantial volume of waste often remains uncollected. In 1995, it was estimated that an amount of 600 metric tons of solid waste was generated in Kumasi per day. This increased to 1,000 metric tons per day in 2005, increasing to 1200 tons daily in 2008 and then 1500 metric tons in 2010 (Owusu-Sekyere et al. 2013). This has been compounded by the mushrooming of new settlements that fall sometimes outside the radar of city authorities.

Field observations reveal that waste littering and indiscriminate waste disposal is a common scene (Fig. 10). Huge volumes of unmanaged solid waste are

Fig. 10 Waste-strewn Sisa Riverbank (Ayigya Zongo)

deposited in streams or rivers by surface runoff after heavy rainfall or are disposed into them deliberately by those living close to the drainage systems. Subin, Wiwi, Sisa, and Aboabo, have over the years received huge doses of wastes of all kinds. This phenomenon has led to widespread narrowing and choking of major storm drains. A careful perusal of NADMO records reveals waste-induced floods as the predominant cause of floods in the study area.

There is also evidence of collapsed bridges (Fig. 11) and incomplete construction of drains exacerbating the floods situation in the city. Generally, storm drains are inadequate to direct stormwater away from most of the flood-prone communities. In most cases, storm drains look poorly designed, too narrow and often choked with waste. As a result, most communities get flooded during heavy downpour. Supporting this are earlier studies which found that choked drainage is the cause of many urban flash floods (Lamond et al. 2012; Zambrano et al 2018). These concerns were affirmed by a NADMO officer during an in-depth interview.

Fig. 11 Stream erosion-induced Collapse Bridge (Kwadaso)

> One of the main causes of floods in the city is dumping refuse in the drains. When they dump waste into these streams, they get choked leading to floods. Some of the drains are so narrow that, they are unable to contain the volume of water flowing through them. This results in the streams overflowing their banks and spreading out into communities as floods.

He continued:

> Areas of much concern these days as far as flooding is concerned are the new sites, which are mostly not served with the requisite storm drains. They have no defined drainage system to contain surface water flowing through these areas. Also, due to lack of monitoring by building inspectors, people build anywhere including in the waterways. Some of the drainage channels have become shallow due to the accumulation of waste and sand. We need to dredge or de-silt them.

Another key informant from the Hydrological Services Department noted:

> We are responsible for designing urban storm drains and part of the team that supervises the project construction. The problem has always got to do with inadequate funds and poor supervision. You can present a good design to the assembly but if they fail to follow strictly what is captured on paper, the drains will surely be overwhelmed by the huge volume of water that runs through them and cause floods. (Male participant, IDI)

In an in-depth interview with a 57-year old resident at Kwadaso, he noted that the perennial flood problem is due to dumping of waste in the Kwadaso river and the bad state of the bridge which lies about 40 m away. Like many other respondents, he blamed city authorities for their woes. He failed however to accept as a problem the very decision to settle in his present location. He put it this way:

> Floods have been a perennial problem here. It has minimized somewhat these days due to the dredging of the mainstream. We cannot however predict what would happen since we have about five months to the end of the year. The truth is that people dump their refuse into the stream which leads to floods. But I will blame it on the bridge which is too narrow for the amount of water that passes through it. Look at the bridge; half of it has been washed away by the sheer force of the water and almost dividing the road into two. This is a failure on the part of city authorities and our Member of Parliament. Isn't it a pity? (Male participant, IDI)

At Atonso S-line however, respondents have different reasons for the persistence of floods. They were all unanimous in the exact cause of perennial floods in the area. While they indicated inadequacy of storm drains as a problem, they were all of the view that the problem of floods is a recent phenomenon, attributing it to the owner of the newly constructed school complex. A 35-year old female participant at Atonso S-line said this in an in-depth interview:

> I was born here and have been living here for 35 years now. This is my family house. The truth is that we were not experiencing floods those days. The whole problem started when the Joy Standard School was built. The owner of the school graded the whole area, sand filled his part of the land and diverted the course of the main stream. The topography of the land also changed in the process with our side becoming a low-lying area. Since then, we've never known peace. This has exposed us since then to perennial floods.

At Ayigya Zongo, a male participant said this during an interview:

> The flood problem started with the construction of this bridge. I have been living here for the past 40 years now and living in this same building; my building. We were not experiencing this in the past but the problem started with the construction of the bridge and the poorly constructed drains. As you can see, the river (i.e. Sisa) has changed its course. Rather than flowing through the main channel or the culvert constructed for it, it has taken a different course altogether. It sometimes gets flooded even when it does not rain here. The river has already eaten up part of my building and is still undermining it. I don't have the means to handle this. We need your help.

These participants do not associate the flood problem with the poor waste disposal culture in the Ayigya area. When they were quizzed further whether they appreciate the link between the dumping of waste into the stream and the flood problem they face, this was the response from one participant:

> We deposit wastes into the stream to limit the effects of floods. The water cannot come here, the waste blocks it. That is why you were able to cross over to the other bank. We need more of the waste. The heaps of sawdust you see in the river bed were deposited there deliberately. But for this, our buildings would have collapsed long ago. (Male participant, IDI)

As Owusu-Ansah (2016) rightly noted, waste deposited into streams and drains inhibits stormwater flows, causing them to disperse and result in floods. In the urban areas of Ghana, safe management of solid waste is a challenge due to rapid population growth and constraint of finance arising from other competing needs (Oteng-Ababio 2011). With the projection that developing countries will experience rapid urban expansion and city authorities' inability to raise the needed resources for efficient waste management, waste management problem may get worse (Lamond et al. 2012). Studies have shown that inability to manage waste efficiently is a perennial issue in less developed countries, and a matter of concern for the management of flood risk (Lamond et al. 2012). For instance, poor waste disposal frequently results in choked drains and watercourses (Muñoz-Cadena et al. 2009), thereby reducing their capacity to store and convey water and this results in floods (Appiah 2012; Marfai 2011). Thus, efficient management of municipal solid waste emerges as an option for reducing flood risk (Jha et al. 2012). While the study participants are partly responsible for the flood problem due to their poor waste management practices, the state and its institutions take the ultimate blame. Informing this logic is the view that where communities are inadequately served with waste containers, waste littering may be inevitable.

Institutional and regulatory contexts of floods in Kumasi

A key element in the political ecology of floods is the role of the state and its institutions. Padawangi and Douglass (2015) noted that flooding in both its origin and consequences takes place in political spaces. Urban planning policy, as an instrument for minimizing the effects of flood risk, finds expression in flood areas zoning, discouraging physical development in floodplains and offering land use technical advice. As Minea and Zaharia (2011) pointed out, it is the responsibility of public institutions to stop development and human occupation of flood-prone areas and to ensure resettlement of already existing settlements. In the context of Ghana, and for that matter Kumasi, this is a failure.

The management and control of land use in Kumasi is a chaotic one. Notwithstanding the existence of planning regulations and institutions, land uses in the city do not conform to planning standards and in most cases, settlements are inadequately supplied with the requisite drainage infrastructure. Regulatory institutions such as Metropolitan and Municipal Assemblies, T&CPD, DP&Gs, Forest Commission, among others have failed to deliver on their mandate (Addo-Fordwuor 2014; Amoako and Adom-Asamoah 2017). Informing this are plethora of factors including their large number with duplicate and conflicting functions, poor co-ordination and collaborations (Addo-Fordwuor 2014; Amoako and Adom-Asamoah 2017), inadequate resources, political interference, poor law enforcement and lack of cooperation from the public (Amoako and Adom-Asamoah 2017; Stow et al. 2016). The National Building Regulations, 1996 (LI 1630) and Riparian Buffer Zone Policy jointly stipulate that physical developments must be 30 to 100 m away from river banks and wetlands. Besides, the Local Government Act (Act 462) mandates the Kumasi Metropolitan Assembly, the planning authority, to stop and demolish physical developments within the zone. However, law enforcement lax has led to housing development and human occupation of these areas causing floods. Problems of building in flood-prone areas and associated floods due to planning failure have been reported by newspaper reports and scholarly publications (e.g. Campion and Venzke 2013; Korah and Cobbinah 2017).

Institutional ineptitude also manifests in the issuing of building permits. Undue delays, frustrations and the cost in getting building permits sometimes push developers to start projects without the relevant permit. It is estimated that between 1990 and 2000, only 7.2% of buildings in Kumasi got the requisite

permits, with more than 80% of new buildings not having building and development permits from appropriate institutions (Botchway et al. 2014). Failure to ensure orderly spatial development through effective planning has been reported by other researchers (Cobbinah and Darkwah 2017; Korah et al. 2017; Yeboah and Obeng-Odoom 2010).

Also contributing to the problem is the land ownership and control in the region. In the Ashanti Region, traditional institutions control over 80% of lands, held in trust for their people (Abass et al. 2019; Amoako and Adom-Asamoah 2017). These traditional authorities decide who develops what and where without following an approved plan and this makes urban space planning and management more difficult. The consequence is the improper land use pattern evident in the city as it sprawls into the rural fringes. Land transaction is however a complex process that involves Kumasi Metropolitan Assembly, Land Commission and the Traditional Authority hence identifying any one of these actors as the reason for the poor management of the urban space may be simplistic. Interviews with key informants confirm this view when it was revealed that there are some powerful actors in the land allocation arrangement and therefore to blame one institution for the problems of unplanned physical development masks the true picture. An officer from T&CPD put it this way:

> The Department does not sanction developments that do not follow an approved plan. There are clear sanctions for those who breach the law but it is often difficult to enforce. However, we are not given the free hand to operate when culprits are connected to or have the backing of powerful people in society. This breeds impunity because people have come to understand that the laws exist only on paper. (Male participant, IDI)

He continued:

> For me, I will blame individuals who acquire land and put up buildings in flood-prone areas. What would the motivation be? Obviously because the land there is cheap. If you care to know, you will discover that most people living in such unsafe places, I mean flood-prone areas, have no permit to be there. KMA task force has on many occasions demolished many of such buildings, especially those built in waterways. Pull down these buildings today and you will find new ones emerged tomorrow on the blind side of city authorities. (T&CPD, IDI)

In a similar tone, a key informant from the Water Resources Commission explained:

> The flood issue is a disturbing one. Riparian Buffer Zone Policy clearly defines the limits within which development can take place with reference to waterbodies. For us as commission, our mandate is clear. We are not clothed with the power to arrest nor stop people from building very close to streams or rivers. There are institutions whose mandate it is to stop this lawlessness. (Female participant, IDI)

A key informant at the Department of Parks and Gardens suggested that the fight against floods in Kumasi may not be successful if the current land use trend continues. To him, the uncontrolled physical expansion and wanton destruction of green spaces is a worrying development. He emphasized the need to pay attention to a more robust green space infrastructure in the city as one of the measures for addressing the flood menace. The Metropolitan Engineer had this to say about physical development and the flood situation in the city:

> The city is expanding very fast and people need places to lay their heads. People put up buildings anywhere without a permit. River catchment areas are not spared and so are open and green spaces that are not zoned for development. The problem is caused by human beings. We are simply lawless. This is the root cause of the floods we are all witnessing. We need to change our attitude, I mean everybody. (Male key informant, IDI)

Besides, while the public and traditional institutions are to work in a coordinated manner, interviews show that they blame each other for the land use problems. Though strange, it may be a defense mechanism to deny their role in the improper management of the urban space. It is alleged that some public officials in collusion and connivance with some traditional leaders sell or allocate plots of land to private land developers without following the due process, a finding which has also been reported by Abass et al. (2019). A logical explanation is that as urban and peri-

urban lands acquire value, it is more profitable to convert any available idle space to urban use, taking the form of residential accommodation, industrial and commercial buildings (Abass et al. 2018; Afriyie et al. 2014). The unbridled sales of land not only pose a threat to sustainable urban land use but potentially make the fight against the perennial floods daunting and unending.

One major issue has been the nature of the legal regime for land use and regulation. Over the years, the legal framework that regulated planning practices and functions in Ghana were contained in different legislations with different procedures for plan preparation, approval and implementation. These made their concurrent operation both cumbersome and confusing (Abass et al. 2019). Besides, the many institutions involved in land use planning and management have duplicated and conflicting functions. However, Ghana's Land Use and Spatial Planning Act (Act 925), which came into force in 2016, is an intervention, which may help address the perennial flood situation in Kumasi.

A good flood disaster governance as noted by Marks (2015) would be exercising power to successfully and fairly reduce vulnerabilities and exposures to disasters. This will also require strict and non-selective application of the law. However, good governance required to make the city safe and reduce vulnerability to flooding in Kumasi is lacking.

Conclusion and policy recommendations

The paper analyzed the factors that underlie the worsening flood cases in Kumasi from the lens of urban political ecology. While the findings suggest that topographic and edaphic conditions explain the persistence of floods in some suburbs, they cannot be blamed for the general rise in the incidence and spread of floods in Kumasi. The study demonstrates that floods in the Kumasi normally coincides with the peak of the rainy season but it could not be established that the rising flood cases in the city are the results of climate change-induced increases in rainfall. Besides, the temperature has remained relatively stable over the years. It was evident that anthropogenic factors are the key driving factors. Rapidly expanding city, poor spatial planning, physical development into wetlands and watercourses, inadequate drainage infrastructure, improper disposal of waste, silting and choking of drains and non-enforcement of laws on building construction explain the frequency, persistence and spatial spread of floods in Kumasi.

In light of these findings, reengineering and expansion of drainage systems by city authorities to increase their capacity for storing and conveying high stream flows are needed**.** Regular dredging and desilting of urban stream/river channels by KMA in collaboration with the communities and traditional leaders is a measure that would help improve drainage and reduce the likelihood of floods occurrence. Provision of adequate and accessible waste bins is good but regular emptying of waste receptacles by waste collection companies is of cardinal importance. Regular cleaning of choked gutters through the mobilization of community labor would yield a desirable outcome. Waste re-use and recycling must be given a priority attention. In addition, sustained public education through the most accessible media on the ills of indiscriminate waste disposal and dangers of building in waterways and wetlands should be pursued by the MMDAs, NADMO and traditional leaders. Further, maintaining urban green spaces and conserving vegetative cover can be a useful intervention in controlling floods. In communities where trees have been cleared, replanting can be undertaken. Adopting a smart growth policy is a viable intervention to limit further horizontal expansion of the city and make it a safe and livable place for all. To ensure a positive outcome, it is important that land use regulations are strictly enforced by the city authorities.

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Compliance with ethical standards

Ethical approval To gain entry into the communities the research team paid courtesy calls on Chiefs and elders of each research community to inform them of our mission and to seek their permission. Informed written and verbal consents were obtained from all research participants. Participants were requested to sign or thumbprint a written informed consent form. Oral consent was sought from those who felt uncomfortable with either the thumb printing or signing. Participants were assured of strict confidentiality and anonymity of the responses they provided.

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