



Built-in Flood Risk: the Intertwinement of Flood Risk and Unregulated Urban Expansion in African Cities

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Abstract

Urban flood risk is significantly shaped by ground conditions and the built environment, which are constantly modified and transformed by human actions. This paper examines the intertwining of flood risk and unregulated urban expansion processes in three selected sites in Accra's expanding periphery. All three sites have been included in Accra's urban extent since the 1990s, but differ with regard to the timing of development and socio-economic characteristics of residents. The research illuminates how flood risk is produced and "built-in" to the urban fabric through widespread practices associated with unregulated urban expansion processes, especially the persistent encroachment on water retention areas, wetlands and riparian zones and the highly fragmented provision of transport infrastructure in emerging residential areas in the periphery. Such harmful development practices are neither confined to homebuilders from poorer segments of the urban population nor spatially concentrated in low-income areas. The research highlights how the actions and inactions of a wide range of social groups and actors engaged in urban land administration and development contribute to flood risk in various ways, making flooding an increasingly alarming issue of citywide concern. Different stakeholders highlight fragmented urban governance as an underlying root cause for the obstruction of sustainable land and water management. Overall, the study calls for a more robust recognition of spatial planning and transport infrastructure provision in flood risk mitigation and highlights the urgent need for planning and governance practices that challenge the existing fragmentation of urban governance systems.

Keywords Urban expansion · Informality · Flood risk · Spatial planning · Land governance · African cities

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Introduction

Floods cause significant disruption, property damage and loss of lives in cities of the Global South. Globally, floods account for approximately 5000 deaths, 10 million internally displaced persons and USD 40 billion in economic losses each year (CRED, 2020; IDCM, 2020). Within African cities, floods are responsible for major disruptions with widespread implications for economic activities, livelihoods and access to services (Douglas, 2017). The adverse impacts are also often felt far away from where actual floods occur and manifest through disruptions to daily mobility, increasing congestion, prolonged travel times and higher costs of transportation (Akyelken, 2020; Andreassen et al., 2022; Eichhorst et al., 2011; Friedrich & Timol, 2011). Urban flood incidents may have wider impacts on national economies due to the concentration of economic activities and critical infrastructure in cities (Adelekan, 2016; Douglas, 2017).

This paper examines the intertwinement of flood risk and unregulated urban expansion processes based on in-depth research in Accra's sprawling periphery. Existing research suggests that urban flood risk intersects with large-scale land-use changes associated with urban expansion processes (Duy et al., 2018; Gupta & Nair, 2011; Lee & Brody, 2018; Remondi et al., 2016; Saraswat et al., 2016; Vachaud et al., 2019). Urban expansion has become a persistent feature of contemporary urban transformations in Africa, where sprawling new residential developments incessantly spread into surrounding peri-urban and rural areas (Africapolis, 2022; Atlas of Urban Expansion, 2020). Urban land cover in Africa will likely triple in the coming 20 years (Angel et al., 2011), while urban populations are "only" expected to double (UNDESA, 2018). Climate change is anticipated to amplify urban flood risk in the future due to the increasing frequency and intensity of extreme weather events and sea-level rise. While most climate scenarios for the West African region generally foresee a relatively modest increase in total precipitation, the frequency and intensity of heavy precipitation events are likely to increase (IPCC, 2014a, b).

The city of Accra is the capital city and largest urban centre of Ghana. In recent decades, Accra has experienced significant spatial growth and largely unregulated and unplanned expansion processes, which have resulted in sprawling and discontinuous forms of development characterised by poor accessibility (Akubia & Bruns, 2019; Atlas of Urban Expansion, 2020; Benza et al., 2016; Doan & Oduro, 2012; Møller-Jensen et al., 2012, 2020). Accra is highly exposed to flooding due to geophysical factors such as riverine and deltaic location, low elevations and exposure to storm surges and tidal waves. Heavy precipitation is the primary trigger of flood events in Accra, especially in the rainy season in May–June, causing flash floods and overflow from the numerous rivers and streams flowing from the Aburi mountains and crisscrossing through the city towards the Gulf of Guinea (Asumadu-Sarkodie et al., 2015; Korah & Cobbinah, 2019; Rain et al., 2011). Flooding in coastal locations can also be triggered by storm surges (Frick-Trzebitzky et al., 2017). Flooding is highlighted as the top priority hazard in Accra's recently formulated resilience strategy (Accra Metropolitan Assembly

2019). While Accra has a longstanding history of recurrent flooding, floods have become more frequent and destructive in the past decade (Asumadu-Sarkodie et al., 2015; Songsore, 2017; Government of Ghana, 2017; Møller-Jensen et al., 2022). A highly destructive flood event occurred on June 3, 2015, when the Ghana Meteorological Agency recorded heavy downpours of between 89.8 and 169.4 mm (Graphic Online, 2015), and resulting floods caused over 50,000 displaced people and 150 casualties (Government of Ghana, 2017).

This paper examines how flood risk is produced and “built-in” to the urban fabric through widespread and harmful development practices associated with unregulated urban expansion processes, especially the persistent encroachment on water retention areas, wetlands and riparian zones and the highly fragmented provision of road infrastructure in emerging residential areas in the periphery. The paper presents insights from recent research in three selected sites in Accra’s areas of recent urban expansion. In order to move beyond a conventional focus on urban flood risk in marginal areas inhabited by poor urban dwellers, this research includes three peripheral sites, which are developed and inhabited by a wide range of different social groups.

Linking Flood Risk and Urban Development Practices

Within the literature on climate change adaptation, risk is commonly conceptualised as the potential for consequences, where something of value is at stake. Risk is shaped both by the probability of a hazard occurring and the potential impacts if such a hazard should occur (IPCC, 2014a, b). Flood risk depends on the exposure to hazards, shaped by geo-physical factors and climate change-related trends, but anthropogenic factors are also crucial (IPCC, 2014a, b). In urban contexts, flood risk is significantly shaped by characteristics of the built environment and ground conditions, including surface materials, dimensions of water ways and various obstructions to water movements. Such ground conditions are produced and constantly modified by human actions (Douglas, 2017).

Urban flood risk has been linked with large-scale land-use changes associated with urban expansion processes, namely, the increase in impervious surfaces and the reduction of vegetation cover and natural water retention areas, which may combine to reduce ground infiltration and increase surface run-off rates within urban watersheds (Duy et al., 2018; Gupta & Nair, 2011; Lee & Brody, 2018; Remondi et al., 2016; Saraswat et al., 2016; Vachaud et al., 2019). Harmful development practices may, for instance, alter or impede natural water flows by narrowing or blocking rivers and streams, encroaching on wetlands and clogging of channels by sediments and waste (Amoateng et al., 2018; Douglas, 2017; Shatkin, 2019). Flood risk is further amplified if valuable developments are allowed to concentrate in areas with high exposure and insufficient flood protection measures (Duy et al., 2018; Harwitasari & van Ast, 2011; Rodriguez & Santos, 2018; Su, 2017). Despite being logically connected, flood risk mitigation is often neglected in urban spatial planning (Chan et al., 2018; Su, 2017; Weinstein et al., 2019) or significantly undermined by inefficient enforcement of spatial plans and development control measures (Amoateng et al., 2018; Echendu & Georgeou, 2021;

Rodriguez & Santos, 2018). Therefore, research on urban flood risk needs to engage with broader urban governance issues, especially concerning land ownership and administration, spatial planning and infrastructure provision.

The links between flood risk and harmful development practices are well-known within the literature on urban flooding. However, the bulk of scholarly attention has focused on the encroachments of the poor on marginal and hazardous lands in naturally flood-prone areas. Previous studies have examined causes, impacts and local responses to flooding in notorious “slum” areas encroaching on wetlands, coastal estuaries and swampy areas in cities such as Lagos in Nigeria (Ajibade & McBean, 2014), Cape Town in South Africa (Drivdal, 2016; Jordhus-Lier et al., 2019; Musungu et al., 2016) and indeed also in Accra (Aboagye, 2013; Abu & Codjoe, 2018; Amoako, 2018; Amoako & Inkoom, 2017; Frick-Trzebitzky et al., 2017; Owusu et al., 2019). Numerous studies have examined similar issues in infamous “slum” areas encroaching on river embankments in cities such as Mumbai in India (Chatterjee, 2010), Dhaka in Bangladesh (Braun & Aßheuer, 2011), Jakarta in Indonesia (Padawangi & Douglass, 2015), Durban in South Africa (Williams et al., 2018), Accra (Twum & Abubakari, 2019) and various medium-sized cities in Pakistan (Rana & Routray, 2018), Malawi (Kita, 2017; Manda & Wanda, 2017), South Africa (Ogundeji et al., 2013) and Ghana (Danso & Addo, 2017). Commonly, these encroachments of the poor on marginal lands are perceived as illegal by urban authorities and residents typically face threats of or actual execution of evictions, demolitions and resettlement measures in the name of public safety (Ajibade & McBean, 2014; Alvarez & Cardenas, 2019; Amoako, 2016; Carrasco & Dangol, 2019; Goh, 2019; Kita, 2017; Padawangi & Douglass, 2015).

The preoccupation with the encroachments of the poor tends to depict flood risk as spatially and socially concentrated in marginal urban areas. This obscures the links between flood risk and wider urban development practices, which have been demonstrated in studies based on GIS-based modelling, remote sensing, hydrological models and other quantitative methodologies (Duy et al., 2018; Lee & Brody, 2018; Remondi et al., 2016; Rodriguez & Santos, 2018; Vachaud et al., 2019). Recent in-depth case studies suggest that flood risk may be linked with harmful development practices in urban fringe areas (Amoateng et al., 2018) and also augmented by development practices of middle- and high-income groups (Batubara et al., 2018; Harwitasari & van Ast, 2011; Weinstein et al., 2019). Furthermore, such practices are not necessarily confined to informally developed areas (Culwick & Patel, 2017; Fatti & Patel, 2013). This paper offers insights on how flood risk is produced through persistent encroachment on water retention areas, wetlands and riparian zones and fragmented infrastructure provision in three selected sites in Accra’s areas of recent urban expansion. These sites are developed and inhabited by a wide range of social groups, but none of them can be conceived of as typical “slum” settlements. As such, we go beyond “the usual suspects” within the literature on urban flooding and highlight how the actions and inactions of a wide range of social groups and actors engaged in urban land administration and development contribute to and exacerbate flood risk in various ways.

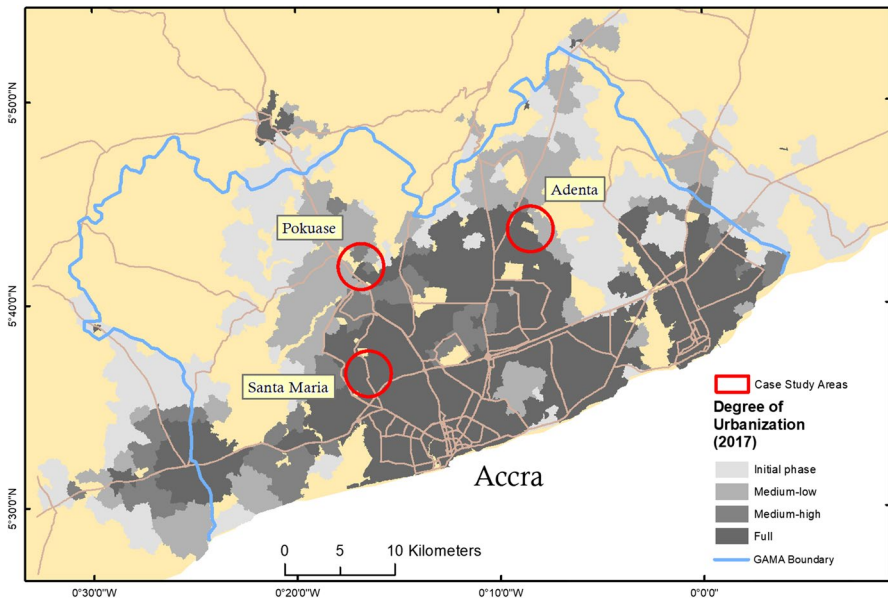


Fig. 1 Location of case areas and delineation of the built-up area of Accra 2017. Delineation of the built-up area of Accra in 2017 is produced following a methodology described in-depth in Møller-Jensen et al., 2020

Methods

This paper draws on insights from in-depth research in three selected sites in Accra's periphery. Two sites are newly developing settlements (Pokuase and Adenta North), which were gradually incorporated into the built-up area of Accra from the 2000s and onwards, while the third is a consolidated settlement (Santa Maria) relatively closer to the centre, which was incorporated into the built-up area of Accra already in the 1990s. The locations of study sites are indicated in Fig. 1. The selected areas differ in relation to the extent of on-going consolidation processes, the coverage of networked infrastructure, the socio-economic profile of homebuilders, the type and quality of housing they develop and the various ways in which these sites are affected by recurrent flooding during heavy precipitation events.

- **Adenta North:** an attractive and well-serviced area developed by middle and high-income homebuilders on low-lying riverine land
- **Santa Maria:** a consolidated and very dense area developed by low- and middle-income homebuilders on low-lying riverine land and surrounding hills
- **Pokuase:** emerging residential areas developed up-hill and down-hill around an old village and busy market site by a mixture of social groups

Data collection was carried out during two rounds of fieldwork in January and November–December 2019. In all three sites, key informant interviews were conducted with a wide range of local informants (Adenta North $n=12$,

Santa Maria $n = 18$ and Pokuase $n = 24$). Informants include municipal planning officers ($n = 4$), officers from the National Disaster Management Organisation (NADMO) ($n = 8$), members of the municipal assemblies (either elected or running for election) ($n = 4$), representatives from traditional authorities ($n = 5$), representatives from local residents' associations ($n = 22$) and representatives from local branches of transport unions such as Ghana's Private Road Transport Union (GPRTU) ($n = 11$). A total of 54 key informants have participated in formal interviews across the three sites.

The selection of key informants sought to ensure inclusion of different perspectives on and experiences with flooding within the study sites. Municipal planners and NADMO officials were selected based on their professional positions as civil servants and their specialized knowledge on urban planning and flood risk mitigation. Elected and aspiring members of municipal assemblies were selected based on the political positions they occupy (or wish to occupy) and provided insights on the political priorities of their local constituencies, the relative weight given to recurrent flooding and the range of solutions proposed to mitigate flood risk. Representatives from traditional authorities were selected based on the formal, ceremonial positions they hold as chiefs, queen mothers and "gonggon beaters" within the traditional authorities laying claim to land in the study sites and provided insights on land administration, land subdivision processes and the relative weight given to preservation of water retention areas. Selection of residents' associations sought to ensure coverage of all the active residents' associations organizing individual landowners within the study sites. Representatives from residents' associations were selected based on the voluntary positions of trust they hold as elected chairmen, vice-chairmen or community organizers and provided insights on their members' experiences with flooding and their priorities for community development. Selection of local branches of transport unions sought to ensure coverage of all the active associations organizing bus and taxi drivers operating and servicing local populations within the study sites. Representatives from local branches of transport unions were selected based on the positions of trust they hold as elected chairmen, vice-chairmen and station masters and provided insights on their members' experiences with flood impacts on local roads and the implications for the operation of transport services.

Informants do not appear under their own names and recognisable details have been altered to ensure anonymity. All interviews were recorded and transcribed and when necessary translated from local languages to English. The interview material was analysed in QSR Nvivo through an open coding process with the purpose of systematically analysing data for themes and concepts. Data collection also included extensive field observations, collected independently and accompanied by relevant local informants, to document characteristics of the physical environment. The research team conducted transect drives/walks with NADMO officials in all three sites to identify local flood hotspots regularly inundated during heavy precipitation events. Field observations were systematically recorded with GPS track logs, photos and field notes. Field-based data collection is complemented by insights from a recent study (Møller-Jensen et al., 2020), which documents the gradual extension and development of the built-up area of Accra based on analysis of satellite images.

In the subsequent analysis, we draw on these data to explore local perceptions of causes and impacts of heavy precipitation and recurrent flooding in the three selected sites in Accra and situate the specific historial, material and social dimensions of urban expansion in the three sites. Before doing so, the next section provides an overview of city-wide urban expansion process in Accra and how these spatial transformations take place in the context of and contribute to a fragmented urban governance system.

Rapid Urban Expansion in a Context of Fragmented Urban Governance

Accra is the capital city and dominant urban centre of Ghana in political, economic and cultural terms (Gaisie et al., 2019; Yankson & Bertrand, 2011). The city is located within the Greater Accra Region, which accommodates roughly a sixth of Ghana's population (GSS, 2012) and produces about a fifth of the total GDP (Accra Metropolitan Assembly, 2019). In 2020, an estimated 4.7 million people¹ lived within the part of the region commonly referred to as the Greater Accra Metropolitan Area (GSS, 2020). The population increased from 3.8 million people in 2010² (GSS, 2013) and 2.5 million people in 2000 (Accra Metropolitan Assembly, 2019), yielding average annual population growth rates of 3.2%. Accra has experienced significant spatial growth over the past decades, with the built-up area expanding at much faster pace than the population. Different sources suggest that urban expansion rates have been around 5–6% per year, with recent estimates ranging from 6% per year in the 1990–2015 period (Agyemang et al., 2017), 5.3% in the 2000–2014 period (Atlas of Urban Expansion, 2020) to 5.9% in the 2008–2017 period (Akubia & Bruns, 2019). The current extent of the built-up area is estimated to 1340 km² in 2017, though measurements differ significantly due to differences in objectives and methods (Møller-Jensen et al., 2020).

The driving force in Accra's expansion is the acquisition and development of land for residential purposes, primarily by private individuals, but also to some extent by private real estate developers and governmental housing providers (Yankson & Bertrand, 2011). Recent decades have seen a proliferation of housing developments in the periphery, where private individuals buy land and build houses, commonly without having either land titles or building permits in place (Gaisie et al., 2019). Both low-, middle- and high-income groups engage in such practices (Bartels, 2019; Gough & Yankson, 2000). The emerging residential areas in the periphery are often underserved or wholly un-served by networked infrastructure and characterised by poor accessibility and limited connectivity to other parts of the city (Møller-Jensen

¹ Population count for Greater Accra Region in 2020, excluding the four most eastern districts not commonly considered part of Greater Accra Metropolitan Area (Ningo Prampram, Shai Osudoku, Ada West and Ada East).

² Population count for Greater Accra Region in 2010, excluding the two most eastern districts not commonly considered part of Greater Accra Metropolitan Area (Dangme East and Dangme West).

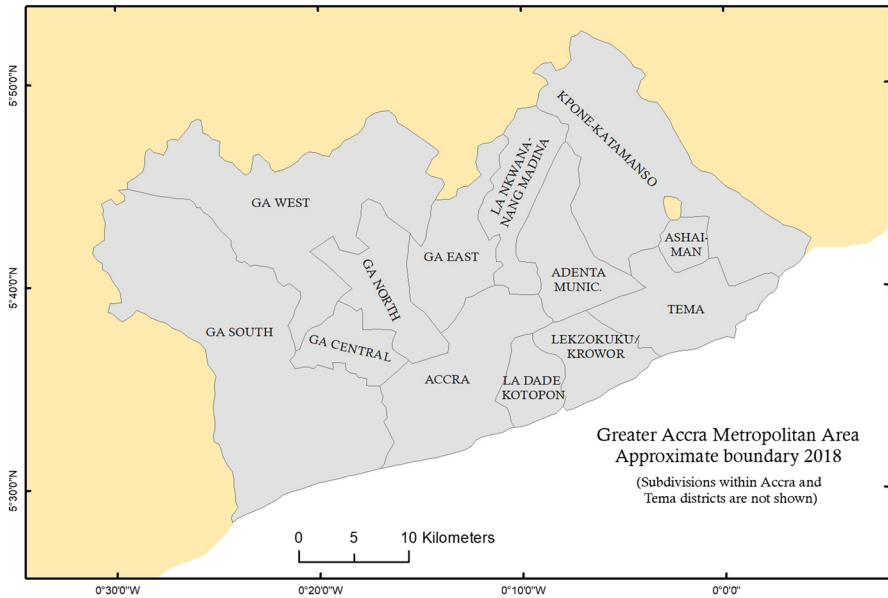


Fig. 2 Greater Accra Metropolitan Area. Delineations of local government entities within the Greater Accra Metropolitan Area are based on the newest available shapefiles (approximate 2018 boundaries). Accra and Tema Metropolitan Assemblies have subsequently been further subdivided, but shapefiles are not yet available for these subdivisions

et al., 2012). Despite this, there is strong functional integration between the rapidly growing fringe areas and the central areas, where key commercial activities and administrative functions are highly concentrated (Esson et al., 2016; Møller-Jensen et al., 2012). Accra Metropolitan Assembly (2019) estimates that roughly 2 million commuters move in and out of the central areas daily. Commuting times from emerging residential areas in the periphery are long due to widespread congestion and low travel speed, especially in major junctions and where limited access roads connect interior areas to main radial roads (Møller-Jensen et al., 2012).

The continuous transformation of rural and peri-urban land into urban residential purposes is taking place within a context of fragmented and overlapping urban governance systems. Currently, the Greater Accra Region is subdivided into a number of local government entities, either metropolitan, municipal or district assemblies, with primary responsibility for spatial planning and land-use management (Gaisie et al., 2019; Owusu, 2015). Importantly, the Greater Accra Metropolitan Area (GAMA) is not a political-administrative entity in itself, but refers to a collection of metropolitan and municipal assemblies commonly considered part of the functional city-region of Accra (see Fig. 2). Within the context of Ghana's decentralisation programmes, Accra has seen an ever-growing number of smaller local government entities (Owusu, 2015). The 2020 census projection lists 29 local government entities within the Greater Accra Region, of which 25 are commonly considered part of the Greater Accra Metropolitan Area (GSS, 2020). The relations between various assemblies are notoriously fraught with boundary disputes and

lack of cooperation (Owusu, 2015). The rescaling and fragmentation of urban governance have exacerbated challenges with regard to citywide spatial planning (Gaisie et al., 2019; Owusu, 2015). Urban governance in Accra is also influenced by the often comparatively better-resourced and more influential state agencies involved in matters relating to urban land governance and infrastructure provision, such as the Department of Urban Roads under the Ministry of Roads and Highways and the Ministry of Works and Housing. Until recently, there was no enabling legislation to foster cooperation and coordination between the many different local government entities. However, the Greater Accra Regional Spatial Development Framework established in 2017 is intended to foster citywide coordination (Gaisie et al., 2019).

Urban expansion processes in Accra are also shaped by ambivalent land governance systems, as is common in the West African context, characterised by legal pluralism and co-existing customary tenure systems and statutory acquisitions. Most land in the periphery of Accra remains under customary tenure, owned and controlled by traditional authorities, including chiefs and family heads, with authority to allocate or sell land to interested buyers (Bartels et al., 2018; Denchie et al., 2020; Gough & Yankson, 2000). These traditional authorities are legally recognised as custodians of customary land, though land use management and spatial planning are the jurisdictions of local government entities (Cobbinah et al., 2020; Owusu, 2015). The customary system has proven the source of many land disputes because of poor boundary delineations, lack of documentation for ownership and competing claims from different traditional authorities (Gough & Yankson, 2000). While customary tenure is in principle a collective possession, traditional leaders commonly act as private landowners controlling and distributing revenue from land transactions (Bartels et al., 2018; Gough & Yankson, 2000). Rivalling groups within the same stool or family may engage in double transactions or challenge acting leaders to gain control over revenue from such transactions (Bartels et al., 2018). As such, land ownership is not simply acquired through purchase but must be actively maintained through active development and settlement strategies (Bartels et al., 2018).

Causes and Impacts of Flooding in Accra's Areas of Recent Urban Expansion

Flooding is a recurrent hazard in all three sites, especially during the rainy season where heavy precipitation events are frequent and the soil is often saturated from past rain events. Across sites, local informants explain that heavy precipitation events routinely inundate certain segments of the housing mass, submerge low-lying road segments and transform interior access roads to slough. Flood risk mitigation is also perceived as an important priority for local development in all three sites. This section examines local perceptions of the causes and impacts of heavy precipitation and recurrent flooding in the three sites. The analysis will unfold the history of spatial expansion and consolidation, the nature of the emerging developments and the local explanations concerning flood risk and the experienced impacts of flooding.

Adenta North

The built-up area of Accra began expanding into the northern parts of Adenta municipality in the 2000s, with housing developments gradually spreading south-to-north and west-to-east from the Accra-Aburi highway. Housing development has only recently begun in the most interior areas furthest away from the highway. The northern parts of Adenta have attracted homebuilders mainly from middle and higher-income segments of the urban population, many of which are well-educated urban professionals and civil servants. Plot sizes are generous and houses predominantly rather large modern villas and bungalows, often outfitted with elaborate security measures and four-wheel-drive cars in the driveways. Adenta is widely perceived as an attractive and relatively well-planned and well-served area. The southern parts of Adenta contain several governmental housing estates built in the 1980s as well as many high-end private housing estates. The northern parts of Adenta are officially zoned for residential purposes, but developments on the ground rarely conform to formal spatial plans and many landowners build without having permits or titles to the land. There are also several on-going land disputes on large land tracts between traditional authorities, state agencies, large private developers and individual homebuilders.

Flood risk in Adenta is linked with the riverine location and relatively low elevations of the area. Adenta is criss-crossed by several streams flowing from the Aburi Mountains and converging within Adenta before reaching the University Dam and draining towards the Sakumono Lagoon west of the harbour in Tema. The streams are small and narrow most of the year, but commonly carry significant water volumes during the rainy season. Most local informants highlight the persistent encroachment on vegetated zones along the streams and water retention ponds from unregulated housing developments as a primary cause of flooding in the area. A growing number of houses are developed very close to streams (see Fig. 3). Most of the water retention ponds established in Adenta in the 1960s for irrigation purposes have been drained and the land sold to homebuilders. A traditional leader explained: “The current generation of young people has sold so many of our water bodies for housing development. When I observed this, I reported to the head of our stool [traditional authority], but so many things have changed because in the old days our ancestors were farmers and took good care of the environment.” During a transect drive, a NADMO official pointed out a large pond, which was recently drained following a loud blast that significantly altered and widened its western outlet. This was also mentioned by several other informants and subject to local dispute. While some informants consider it a result of intense pressure from exceptionally large water volumes, others are convinced the blast was orchestrated by landholders eager to drain and sell the land for development. Indeed, many large villas are under construction on the floor of the former pond (see Fig. 4). An Assembly member wryly remarked: “Everybody wants to have a piece of land and develop it without taking into consideration where the land is or what can cause damage to society when they put up a building or a wall. Someone from the Assembly may come and condone what is being built. Maybe they take some small money to allow it. Once it gets to a certain level, you cannot pull it down.”

Fig. 3 Housing developments too close to a stream in Adenta North. Source: authors' field-work, 2019



The northern parts of Adenta are regularly affected by overflow from streams during the rainy season and in case of heavy precipitation events locally or in upstream areas. Informants explain that this regularly causes inundation of houses built close to the streams as well as numerous flood hotspots affecting interior access roads. The interior areas rely on a limited number of rough gravel roads and unimproved dirt roads for access to Dodowa Road, which is the nearest all-weather main road connecting to the Accra-Aburi highway and onwards to central areas. The interior roads commonly become muddy and un-motorable even during smaller precipitation events. The minibusses providing public transport services throughout Accra, known locally as *trotros*, commonly withdraw their services when interior roads become too rough. The combination of muddy roads and inundated road segments means that interior areas can become effectively isolated during heavy precipitation events, as explained by an Assembly member: “If you are unable to hit the big roads like Aburi or Dodowa [main radial roads connecting Adenta to central Accra], trust me you cannot come out that day. If you are caught behind these roads before it rains, then you will have to wait for the water to recede.” Heavy precipitation commonly causes damage to road surfaces and creates potholes, compelling Adenta’s relatively resourceful residents’ associations to routinely organise and co-finance road grading after each rainy season. Many interior access roads within Adenta are abruptly blocked by streams or connected only by makeshift footbridges. Over the

Fig. 4 New housing developments on the floor of recently drained pond in Adenta North. Source: authors' fieldwork, 2019



past decade, municipal investments in bridges and culverts have improved accessibility for motorised vehicles within Adenta, though paradoxically, these investments have also exacerbated flood risk. Undersized and poorly constructed bridges and culverts are pointed out by NADMO officials and local residents as blockages for water, which cause local flood hotspots affecting interior access roads when it rains. Local informants speculate that either these structures were dimensioned incorrectly from the onset or water volumes have increased, possibly due to developments in upstream areas. A recent example suggests that shoddy construction work may be at least part of the explanation. During fieldwork in 2019, a new bridge was constructed in Adenta following extensive lobbying efforts and significant co-financing from a group of resourceful local residents. While the new bridge has improved passage for vehicles, the culvert is malfunctioning and disperses water flows in a way that has effectively transformed surrounding residential developments into wetlands.

Santa Maria

The built-up area of Accra began spreading into Santa Maria in the 1990s, where the affordability of land attracted many aspiring homebuilders, and later also many tenants. A high share of Santa Maria's residents is engaged in informal business and trading activities in central Accra. During the 2000s and 2010s, unregulated land subdivision processes have continued and a growing number of tenants have been accommodated by homebuilders. Housing types consist of a mixture of detached bungalows and single rooms for tenants of varying sizes and quality. At present, Santa Maria is a consolidated and very densely developed area, accommodating a wide range of low- and middle-income people. From the onset, the land market was highly contested with many double transactions and fierce land disputes within and between competing groups of traditional landholders. The land market in Santa Maria is associated with the presence of "land guards", a well-known phenomenon in Accra, where the widespread insecurity concerning ownership and transactions of

land induce larger landowners to employ informal security providers to protect and enforce ownership rights (Korah & Cobbinah, 2019). Formal spatial plans have had very little influence on the physical development of Santa Maria, as explained by a municipal planning officer from Ga Central municipality: “The Santa Maria area is historically known for the land guards. We do not really have full control over the land or its development, because it is more or less like the chiefs have already sold all the land. When it comes to settlement upgrading, even the municipal assembly finds it difficult to find land for development projects.”

Flood risk in Santa Maria is linked with riverine location and low elevation. The Lafa River flows through Santa Maria and several smaller streams flow from the hilly areas north of the settlement and join the Lafa before exiting under the Anyaa-Awoshie Road and draining towards the Densu wetlands west of the city centre. The northern parts of Santa Maria are characterised by hilly terrain, whereas the southern parts are characterised by very low elevation and effectively function as a “sink” in landscape. Local informants also highlight that flood risk is exacerbated by extensive encroachment on riparian zones from unregulated housing development. Throughout Santa Maria, landowners have built very close to the edge of streams, effectively narrowing the channels and in many cases creating awkward diversions, as explained by a local politician on election for the assembly: “It is because they have blocked the waterways. The municipality was supposed to have assisted them on where to build their houses, but because of the chiefs, the land guards and whatever, everybody wanted to sell their land to different people and they didn’t plan at all, so now when the population is increasing we are having severe flood problems”. NADMO officials also point out flood hotspots caused by undersized and/or mal-functioning bridges and culverts. However, most informants in Santa Maria highlight that flood problems cannot be solved without some demolition of buildings too close to the streams. Municipal authorities have attempted to demolish some of these structures, but have been largely unsuccessful. A local informant pointed out a particularly narrow stretch along a stream near his own house (see Fig. 5): “They are building a new bridge up there, and they also want to widen the channel, but some of those down there are trying to make it very difficult for them to break down the houses. The amount of water coming down from the uphill areas is so large, and that place is too narrow, so the water will flow to the surrounding areas.” Flood risk is further aggravated by the visibly large amounts of waste in the streams impeding the flow of water (see Fig. 6), as is also pointed out by several informants. There are no municipal waste collection services within the community and many low-income households are unwilling or unable to pay for private waste collection services. Consequently, households and business owners commonly dump waste in local streams. While municipal authorities routinely dredge waste and sediments from streams before the rainy season, they quickly fill with waste again.

Santa Maria is regularly affected by overflow from rivers and streams during heavy precipitation events. Informants report that this causes regular inundation of houses close to streams as well as numerous flood hotspots affecting interior access roads. The main outlet road, Kwashieman Road, which provides access to the Accra-Tema Motorway and onwards to central areas, is also impacted by overflow from streams. Even the busy trotro station in Santa Maria is regularly

Fig. 5 Extreme narrowing of stream channel in Santa Maria. Source: authors' fieldwork, 2019



affected by floodwater. Consequently, trotro and taxi operators commonly do not enter Santa Maria during heavy precipitation events. This constrains mobility of Santa Maria residents as well as many others, who need to pass through Santa Maria on their daily trips, as explained by a NADMO officer: “Last Stop [the trotro station] is very busy, so when it gets flooded, it actually affects many other communities, who need to pass through Last Stop. When it rains, that place is very dangerous, even when using a vehicle.” With the exception of Kwashieman Road, interior access roads within Santa Maria are predominantly rough gravel roads with only partial drainage, which are highly susceptible to erosion. In uphill areas, field observations indicate visible evidence of road erosion, with some houses having driveways located well above the current level of the road. The partial and ad hoc provision of drainage often aggravates road erosion and contributes to local flood hotspots, i.e. when homebuilders have developed small drains along their own local roads, which remain unconnected to larger drains and consequently spill onto other roads further downstream (see Fig. 7).

Fig. 6 Waste blocking a culvert in Santa Maria. Source: authors' fieldwork, 2019



Pokuase

The built-up area of Accra reached Pokuase around the early 2000s, as new residential areas began emerging on the outskirts of the old Pokuase village located along the Accra-Nsawam highway. In the early 2000s, a high-end private housing estate, known as ACP Estate, was built in the hilly areas east of the old village. The hilly areas have attracted many homebuilders from middle and higher-income segments, who gave their neighbourhoods aspirational names such as Windy Hills and Pokuase Ridge. The hilly areas are characterised by low densities, generous plot sizes and large villas and bungalows. Housing developments have only recently begun in the most interior hilly areas. The low-lying wetlands on the western side of Accra-Nsawam highway have attracted individual homebuilders of more modest means, who have filled up the wetlands with stone and sand and built bungalows of varying sizes. The old village area along the highway is now a busy commercial area and regional market for agricultural products. Pokuase is part of Ga North municipality, which was recently carved out from Ga West municipality.

Flood risk in Pokuase is related to roadside runoff from the large all-weather main roads as well as overflow from the two tributaries of the Densu River, the Nsaki and the Nsunkwa, flowing on the northern and southern side of Pokuase hills. Both streams are channelled under the Accra-Nsawam highway and

Fig. 7 Road erosion caused by partial drainage from uphill areas in Santa Maria. Source: authors' fieldwork, 2019



converge in the wetlands west of the highway before draining towards the Weija Reservoir. Flood risk is aggravated by unregulated housing development along river embankments as well as extensive encroachment on the wetlands on the western side of the highway, as explained by a representative from a residents' association in the area: "Some of the elders committed certain mistakes by giving out the lands to individuals like myself. The second mistake is committed by us individuals buying the land because this area used to be a wetland. People bought the plots and started filling them up so they could build. If you buy land here you have to fill it, or else the river will disturb you." A visibly frustrated NADMO official pointed out evidence of new buildings under construction in the wetlands and complained that no action is taken against such offenders (see Fig. 8): "The municipal assembly has the mandate to demolish, so we write a report, take pictures and inform the assembly. We advise them to demolish the buildings and stop the work because these are the developments that are causing flooding, but as you see, no action has been taken yet." These former wetlands receive much of the water draining from surrounding hilly areas, where unregulated housing development has also impacted surface run-off. Informants explain that water volumes can be significant at times and that downhill water flows are insufficiently channelled. Houses and walls commonly act as blockages and disperse water flows, as explained by a representative from a residents' association in a hilly area: "There

Fig. 8 Housing developments in former wetland area in Pokuase.
Source: authors' fieldwork, 2019



is a little bit of indiscipline on our part when people put up their buildings and they do not think of what happens when it rains.”

Pokuase is affected by swelling streams in the rainy season and during heavy precipitation events, causing regular inundation of houses developed in the former wetlands and too close to the rivers. Several flood hotspots are also caused by overflow from roadside drains on low-lying segments of the large all-weather main roads, Kwabenya Road, Anyaa-Awoshie Road and Accra-Nsawam highway, which join each other in a large junction in Pokuase. The busy trotro station and the commercial areas around Pokuase junction are regularly affected by overflow from roadside drains. More severe precipitation events can bring traffic through Pokuase to a complete standstill, as explained by a municipal planning officer: “Most often, it causes traffic jams, when it rains, so that no one wants to risk driving. At times, you have to park for one hour or maybe 2 h, depending on the volume of water.” In the hilly areas, heavy precipitation causes considerable damage to the steep and rough gravel roads. Field observations reveal visible evidence of road erosion, mudslides and deep gullies (see Fig. 9). Some homeowners have experienced large volumes of surface run-off flowing through their houses and walls collapsing under pressure. Significant amounts of sediments are carried downhill when it rains, causing sedimentation of the drains along the large main roads. Several informants in Pokuase emphasise that drains along the main roads are too small and their function severely

Fig. 9 Road erosion caused by surface runoff in hilly parts of Pokuase. Source: authors' fieldwork, 2019



challenged by constant sedimentation, as a representative of a local GPRTU branch explained: “When the rains set in, you will see the drains overflowing, and after the rains all the drains are choked with sand. We did not have this issue until the hilly side was sold for people to build.”

The Intertwinement of Flood Risk and Unregulated Urban Expansion Processes

This section highlights key insights from across the study sites concerning the intertwinement of flood risk and unregulated urban expansion processes. Flood risk is effectively produced and “built-in” to the urban fabric through widespread and harmful development practices associated with unregulated urban expansion processes, especially the persistent encroachment on water retention areas, wetlands and riparian zones and the highly fragmented provision of transport infrastructure in emerging residential areas in the periphery.

The extensive encroachment on water bodies is identified as an underlying cause of flooding across the three sites. Flood risk is “built-in” to the physical environment as more and more aspiring homebuilders acquire land and build houses within wetlands, former ponds or too close to streams, effectively shrinking the space reserved

for water. Almost all informants interviewed highlight “buildings in waterways” as a primary cause of flooding and regard some extent of demolition and relocation necessary to solve local flood problems. This is consistently highlighted by municipal planners and NADMO officials, but perhaps more surprisingly also by many assembly members and representatives of residents’ associations, even though they represent some of the homebuilders, who would be targeted in potential demolition campaigns. However, such measures are also considered unfeasible by most informants, as they would require adequate compensation of current landowners. Small landowners commonly place a significant share of their household savings in their land and house (Andreasen & Agergaard, 2022).

The persistent encroachment on water bodies is facilitated by the fervent commercialisation of land by traditional landholders and the non-enforcement of development control by municipal planning authorities. The high demand for urban land offers irresistible incentives for traditional landholders to drain ponds, fill up wetlands and sell marginal land too close to streams. At least some aspiring homebuilders are willing to buy and develop such land; either because they lack knowledge of the hazards associated with the land or because they chose to tolerate such hazards in order to acquire affordable land in desired locations. More importantly, these harmful development practices are not sufficiently prevented by municipal planning authorities, who seem incapable of and/or unwilling to regulate housing development and protect water bodies from encroachment. Ultimately, it is the lack of development control that is to blame for the widespread encroachment on water bodies. Some informants suggest that demolition of consolidated housing would be highly controversial and politically unviable for municipal assemblies, even when such developments clearly exacerbate flood risk in surrounding and downstream areas. Others suggest that these practices persist due to mismanagement and corrupt practices among municipal planners, who may accept bribes for not reporting or acting on such issues.

Flooding has become a recurrent hazard in the rainy season, which affects houses close to water bodies as well as interior access roads and downstream housing developments. Across the three sites, heavy precipitation events are routinely associated with submersion of parts of the housing mass, inundation of low-lying road segments, retreat of public transport services and significant damage to roads. In some cases, residential areas may become effectively isolated during heavy precipitation events, as is evident in interior parts of Adenta. Such disruptions also impact many other urbanites, who may need to pass through a flood-affected access road. This is the case in Santa Maria and Pokuase, both of which are important nodes in the urban transport system. The impacts of flooding are aggravated by the general lack of redundancy in the road network, meaning that there are few alternative route choices if important access roads are affected by water. Further, such impacts are not necessarily caused by precipitation events that are particularly “extreme” in magnitude. “Every time it rains” was a common response from key informants when asked how often local roads within their neighbourhoods were affected by water. The significance of local flood hotspots affecting interior access roads suggests that flooding has much wider impacts on the daily lives of many urbanites living far away from water bodies and bearing no direct responsibility for the encroachment on these.

Flood risk is further “built-in” to the urban fabric through the highly fragmented and insufficient provision of road infrastructure in emerging residential areas in the periphery. Peripheral neighborhoods are commonly serviced by rough dirt or gravel roads for decades, even though traffic volumes and service areas may increase significantly over time. Interior access roads are rarely outfitted with comprehensive roadside drainage. Over time, roads are gradually widened and improved, but such improvements are limited by the economic capacity of local landowners and their collective ability to lobby municipal authorities. The substandard nature of interior access roads exacerbates flood risk because even smaller precipitation events can make roads un-motorable and unsafe to use. The lack of appropriate sealing materials also makes interior roads highly susceptible to erosion during heavy precipitation events. The relentless damage to roads is arduous for vehicles and necessitates regular maintenance of both. Residents’ associations spend a significant amount of resources on routine gravelling of interior roads after each rainy season, typically financed through contributions from members. While roadside drainage remains virtually non-existent along interior roads in Pokuase and Adenta, landowners in Santa Maria have constructed drainage along some of the interior roads. However, this partial and ad hoc provision of drainage by individual landowners is highly problematic and actually increase flood risk in downstream areas. Many small drains remain unconnected to larger drains and contribute to road erosion and flood hotspots in downstream areas. While roadside drains are provided along the large all-weather main roads, the efficient functioning of these is challenged both by irregular waste disposal and the continuous sedimentation of drains. Even larger infrastructural improvements undertaken by municipal authorities, such as bridges and culverts in Adenta and Santa Maria, seem to be constructed without due consideration of how new structures affect surrounding and downstream areas during heavy precipitation events.

Conclusions

This paper has presented insights on the intertwinement of flood risk and unregulated urban expansion processes, based on in-depth research in Accra’s areas of recent urban expansion. The research illuminates how flood risk is produced and “built-in” to the urban fabric through widespread practices associated with unregulated urban expansion processes, especially the persistent encroachment on water bodies and the highly fragmented provision of transport infrastructure in emerging residential areas in the periphery.

The research highlights that unregulated urban expansion processes are associated with extensive encroachment on wetlands, ponds and riparian zones, effectively reducing the space for water and obstructing existing water bodies. Importantly, such harmful development practices are neither confined to homebuilders from poorer segments of the urban population nor spatially concentrated in low-income areas. The diverse collection of study sites illuminates that a wide range of social groups build too close to water bodies, divert streams and drain water retention areas, and that these practices are an ingrained and widely normalised part of

unregulated urban expansion processes. It is well-known that central Accra has struggled with increasingly severe flood events in recent years (Asumadu-Sarkodie et al., 2015; Accra Metropolitan Assembly, 2019). Likely, part of the explanation may be found in the harmful development practices in upstream, peripheral areas documented through this research.

The research highlights the need to preserve space for water during urban expansion processes. At present, municipal approaches to flood risk management commonly aim to ensure efficient passage of water, e.g. through the dredging of streams within their jurisdictions. Quite likely, partial and uncoordinated dredging interventions simply “push” flood risk further downstream, effectively shifting rather than solving the problem. Emerging planning approaches on sustainable urban drainage systems and green-infrastructure-based stormwater management instead emphasize the reduction or delay of surface run-off through the preservation of water retention areas and increasing groundwater infiltration and could provide valuable inspiration for flood risk mitigation in Accra (Mguni et al., 2016). However, different stakeholders highlight that the fragmentation of urban governance undermines sustainable land-use planning and water management in Accra. This finding is in line with previous research in Kumasi (Amoateng et al., 2018) and central Accra (Amoako & Frimpong Boamah, 2015; Korah & Cobbinah, 2019). There is an urgent need to improve coordination and cooperation between traditional authorities, municipal planning authorities and national agencies involved in land administration, water management and urban infrastructure provision. Citywide planning mechanisms are needed to ensure oversight and coordination of land-use, effective development control and preservation of urban water bodies. Crucial to achieve this, is the proactive identification and designation of water bodies, which are of importance for urban water management and flood risk mitigation, long before formerly rural land is transformed into urban residential purposes. Ideally, this should be undertaken by higher levels of government than local government entities (i.e. regional or national level), as municipal and metropolitan assemblies are too many and geographically too small to ensure a comprehensive perspective on urban water management. They may also be more responsive to incentives or pressures from local stakeholders to allow encroachment on local water bodies, even though preservation of such areas would have significance for flood risk mitigation in a city-wide perspective. Aspiring homebuilders would likely benefit from information on how to avoid acquiring land in spaces designated for water, though the central actors to reach are traditional authorities and local government entities. Traditional authorities should be educated on the necessity of preserving space for water during urban expansion processes, while municipal and metropolitan assemblies should enforce swift and efficient development control, before emerging structures too close to water bodies reach completion and become much more difficult to remove.

The research also highlights the critical role of road infrastructure provision in relation to flood risk mitigation. Flood risk is clearly aggravated by the highly fragmented and insufficient provision of road infrastructure in emerging residential areas in the periphery. Heavy precipitation events are routinely associated with submersion of road segments and interior access roads transforming to slough, causing widespread disruptions to residents’ daily mobility patterns (Andreasen et al., 2022).

Such disruptions not only interfere with the daily lives of those living in peripheral and poorly accessible locations; there are likely adverse implications for the urban economy, when workers and business owners are routinely stuck at home or on the roadside during and after heavy precipitation events. Significant investments are needed in road infrastructure and comprehensive roadside drainage in emerging residential areas in the periphery. New infrastructure should, from the onset, be built to withstand the pressure and abrasion from the large water volumes flowing through Accra every rainy season and with due consideration of how new infrastructure affect water flows during heavy precipitation events. The routine gravelling and refilling of roads after each rainy season constitutes a significant waste of resources, which could have been used more productively on infrastructure improvements elsewhere. Likewise, the many undersized and poorly constructed culverts and bridges causing local flood hotspots represent a shamefully wasteful expenditure of public funds for infrastructural development.

Overall, the study calls for a stronger recognition of spatial planning and transport infrastructure provision in flood risk mitigation and highlights the urgent need for planning and governance practices that challenge the existing fragmented urban governance system, which is undermining sustainable land and water management. It is a cause of significant concern when insightful observers (Gaisie et al., 2019; Owusu, 2015) highlight that the rescaling and continuous fragmentation of urban governance causes significant challenges for citywide spatial planning and infrastructural development. For this reason, is necessary to rethink and improve the response of Ghanaian cities in relation to flood hazards. There is an urgent need for a more proactive approach to flood risk mitigation and effective preservation of urban water bodies. This research specifically highlights the urgent need for comprehensive, coordinated and citywide spatial planning concerning land-use, development control, water management and transport infrastructure.

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