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Climate change: Crosscutting report

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Abstract

Urban Africa is highly vulnerable to climate change impacts. This report synthesises the research conducted by the African Cities Research Consortium (ACRC) in 12 African cities across eight “domains” (key areas of urban power, policy and practice): housing; informal settlements; land and connectivity; structural transformation; neighbourhood and district economic development; youth and capability development;

health, wellbeing and nutrition; and safety and security. The report focuses on climate-change-related findings across these domains, highlighting the importance of participatory approaches and inclusive planning to address the impacts of climate change on a range of complex urban challenges.

Urban growth often outpaces infrastructure and service delivery in African cities, including the provision of decent and affordable housing, leading to sprawling informal settlements and fragmented, poorly connected urban landscapes – heightening urban vulnerability to climate-related risks. To adapt to climate change and enhance resilience in urban areas, it is critical to upgrade informal settlements, strengthen land tenure and build affordable, low-emission, climate-resilient housing. Integrated solutions need to simultaneously address the challenges of security and the wellbeing of vulnerable populations. To improve food and nutrition security in the face of climate change, greater investment is needed in domestic food production and distribution, alongside findings ways to enhance the resilience of the agriculture and fishery sectors whilst reducing their emissions. Climate change disrupts urban economies by affecting productive infrastructure, livelihoods, key services and supply chains. Informal economies not only provide essential services and goods to urban residents, but also bolster cities' adaptive capacity to environmental changes. Urban development strategies need to harness the informal sector's potential for sustainable growth, enhancing millions of livelihoods and strengthening resilience to climate-related risks. Economic development and structural transformations should leverage low-carbon technologies to position African cities as global leaders in climate-resilient development. Empowering young people through education, training, economic development, entrepreneurship and technology access is also vital. The city cases examined in the report emphasise the importance of locally led actions, such as building coalitions which advocate and lobby for the informal sector. They suggest the need for integrated and multisectoral approaches, collaborative governance arrangements, and the ability to access and/or unlock finance.

Keywords: Urban resilience, climate adaptation and mitigation, informal settlements, housing and infrastructure, youth and inclusivity, participatory planning, economic development, sustainable urban governance, food security and nutrition

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Executive summary

This report synthesises key findings and insights emerging from the African Cities Research Consortium's (ACRC's) crosscutting climate-focused research conducted in 12 African cities across eight domains. Domains refer to fields of power, policy and practice that are relevant to solving particular problems and/or advancing specific developmental opportunities in relation to cities. They consist of: 1) housing; 2) informal settlements; 3) land and connectivity; 4) structural transformation; 5) neighbourhood and district economic development; 6) youth and capability development; 7) health, wellbeing and nutrition; and 8) safety and security.

Drawing from studies conducted in each city case, key findings from the analysis are that:

- **Growth of informal settlements with inadequate risk-reducing infrastructure and services, as well as profound political marginalisation, remains a rising challenge for all the ACRC study cities**. Informality leaves many residents exposed to precarious living and working conditions that exacerbate their vulnerability to a range of risks, including climate-related risks. Participatory planning processes that bring the voices of local residents and civil society into planning and policy decisions around urban development are one solution for building resilience to climate risks.
- **Decent and affordable housing offers increased resilience for vulnerable groups to climate-related risks, while also contributing to crime prevention, linking to the safety and security domain**. However, limited access to affordable housing options and housing finance means that low-income communities predominantly live in low-quality housing located in low-cost neighbourhoods, increasing their exposure and vulnerability to climate-related risks. Widespread lack of tenure security also affects people's ability to invest in their property and/or neighbourhoods, which interrelates with the land and connectivity domain. There is a need to better understand the factors hindering access to finance; to demonstrate that affordable housing finance can positively impact decent housing; and to develop standards and building codes for decent, affordable housing that is climate resilient and has a decreased carbon footprint, whilst keeping the cost of housing down.
- **Addressing the issue of mitigation within the land and connectivity domain is imperative, given the transport sector's significant contribution to greenhouse gas emissions**. Transport microenterprises (such as rickshaw taxis) play a critical role in moving goods and people to markets and workplaces not served by public transport. Coordinated training, proper identification of riders, institutional regulation, planned integration of transport microenterprises within the public transport system, and incentives to transition existing transport modalities to more environmentally friendly ones (such as bike taxis) are possible interventions for neighbourhood and district economic development, which could also enhance security and efficiency in cities.
- **Widespread insecurity, worsened by climate change, demands community-led security solutions**. This could start with hybrid community security structures, wherein people protect their community with support from relevant authorities (such as the police). Many of the case cities highlight the role of youth in crime and violence – both as perpetrators and victims.

Therefore, involving marginalised youth in hybrid community structures may contribute towards their empowerment, while also improving security. Education on the links between climate-related hazards and safety and security risks is key to increasing understanding amongst both residents and the authorities in order to mitigate spikes in these risks.

- **Within the youth and capability development domain, examination of the case studies highlights how youthful populations in African cities present significant opportunities for economic and social development**. However, a range of risks influence this potential, including inadequate education and high youth unemployment, among others. The cases suggest the need to invest in education, training, economic development, entrepreneurship and technology access for youth; this investment should be conducted in a way that 1) would allow youth in African cities to position themselves at the forefront of nascent green economies, and 2) can solve critical problems, such as waste management.
- **Climate change has major implications for food and nutrition security and yet, there are few linkages made in cities between urban nutrition issues and the diversity, quantity and quality of food production under climatic changes (which affects both food and nutrition security)**. Greater investment in domestic food production and distribution is likely necessary and further consideration needs to be given to how the resilience of the agriculture and fishery sectors might be affected by climatic changes, how these sectors affect greenhouse gas (GHG) emissions, and what can be done in this regard.

Overall, one of the common denominators of the ACRC city cases is the high proportion of low-income residents, particularly those who reside in informal settlements, who are most at risk from climate change. Poverty alleviation through local job creation/employment is critical to reduce exposure and vulnerability to climate-related risks, and efforts to improve labour productivity in African cities must explicitly address the challenges and opportunities of climate change. The nexus between incremental housing production, building materials and the local employment and skills development of youth presents a significant opportunity, offering considerable potential for upscaled training and education in environmentally friendly, energy-efficient and climate-resilient housing construction which is both decent and affordable. In order to simultaneously meet poverty alleviation, adaptation and mitigation goals in urban Africa, the role of micro- and small-scale goods and service providers – particularly in the informal sector – cannot be overlooked. These goods and services can be highly relevant to the climate change sphere, as is exemplified, for instance, by the case of the informal waste sector.

The ACRC cases highlight how cities' planning needs to incorporate participatory and inclusive processes to effectively address their priority complex problems (understood as the processes that are blocking or preventing the achievement of poverty reduction and/or economic development, and/or exacerbating the climate emergency) as well as the implications of climate change on these problems. The cases also highlight the importance of locally led actions, such as building coalitions that can advocate and lobby for the informal sector. Furthermore, the cases suggest the need for integrated and multisectoral approaches, as well as the need for collaborative governance

arrangements. City governments and residents cannot always resolve the challenges they face alone. Addressing the priority complex problems of cities also requires access to and/or unlocking finance, for example, to improve neighbourhoods, supply necessary infrastructure and incrementally upgrade low-quality units to improve the housing sector.

The report concludes by presenting some key avenues for future research that could enhance urban resilience and sustainable development across the key domains:

1. Investigating the efficacy of integrated multisectoral intervention;
2. Exploring joint approaches to systems and domains;
3. Exploring the success, challenges and scalability of resilient strategies in informal settlements;
4. Examining how climate action intersects with socioeconomic development;
5. Assessing the strategic role of diverse institutions in climate resilience;
6. Examining regulatory frameworks in the context of urban resilience;
7. Conducting further research into sustainable building materials and practices;
8. Researching climate-resilient urban food systems; and
9. Investigating the gaps and emergent issues in climate education.

1. Introduction and overview

1.1. Context

The latest Intergovernmental Panel on Climate Change (IPCC) report indicates that global average temperatures are already 1.1°C above pre-industrial averages, and that these increases are expected to reach 1.5°C and beyond (IPCC, 2023). Africa is highly vulnerable to climate change impacts under all climate scenarios, with varying effects across the continent (IPCC, 2023). The trajectory of Africa's future socioeconomic development is therefore intertwined with climate change, which poses a threat to achieving the Sustainable Development Goals (SDGs) and the Africa Union's Agenda 2063. According to the IPCC, the vulnerability and exposure of urban areas in Africa to climate change are increasing, with medium to high confidence levels (Trisos et al., 2022). Although this vulnerability is influenced by patterns and characteristics of urban settlements and housing, approximately 70% of African cities are highly vulnerable to climate-related events. In urban areas, global temperature increases and changing precipitation patterns will be associated with more frequent and intense heatwaves, droughts, sea-level rise and storm surges (for coastal cities), and increased rainfall intensity contributing to flooding events (IPCC, 2023).

Beyond future impacts, African cities are already experiencing the impacts of changing climatic systems and associated impacts on various elements of urban life, spanning urban ecologies, infrastructure, households, businesses and resource flows. For example, during 2015-2017, three consecutive winter droughts in the Western Cape Province of South Africa significantly threatened Cape Town's freshwater supply, leading to the potential in 2018 of reaching "day zero" – an event in which water pipes could run dry. The resulting crisis, and the associated responses employed by the City of Cape Town Metropolitan Municipality (the City), had far-reaching impacts, including the following:

1. Reduced agricultural productivity, food quality and exports, which led to considerable losses in revenue and jobs and potentially threatened long-term urban food security (Pakhathi, 2018; Roux, 2018).
2. Public awareness campaigns and associated water restrictions and fines, which, while largely effective, entrenched existing socioeconomic inequalities in access to and consumption of water (Roberts, 2018).
3. Potential threats to public health, particularly the increased prevalence of waterborne diseases in areas with already-compromised water and sanitation infrastructure.
4. Marked declines in international arrivals relative to previous years, with knock-on effects on tourism-dependent sectors of the economy (Dube et al., 2022).

This example from the city of Cape Town provides a snapshot, illustrating how interconnected localised factors, such as socioeconomic conditions, public health and urban planning, influence climate vulnerability. However, as indicated throughout this report, African cities are highly diverse, each facing unique challenges and opportunities shaped by their distinct histories, ecosystems and development

trajectories that interact to shape vulnerabilities to climate change. Cape Town's experience highlights issues that share certain commonalities across the continent, while underscoring the need for tailored, context-specific strategies to address the multifaceted impacts of climate change in African urban centres.

It remains a challenge to attribute specific small-scale events to anthropogenic climate change. However, recent evidence based on large, high-resolution data ensembles strongly indicates that anthropogenic climate change will directly increase the overall probability of similar droughts in south-western South Africa by a factor of three (Otto et al., 2018) or even as high as a factor of five to six, depending on the severity of future GHG emissions scenarios (Pascale et al., 2020). The impacts of this drought serve as a critical example of the sensitivity of African cities to already present climatic shifts and an indication of the impacts of increasingly likely future climate change, as well as the political, socioeconomic and governance considerations in addressing such impacts, which require critical attention.

Despite having the lowest regional GHG emissions (and thus contributing the least to global warming), Africa faces systemic risks to economies, infrastructure, water and food systems, public health, agriculture and livelihoods, threatening to undo development gains and exacerbate extreme poverty (IPCC, 2023). The impacts of extreme climate events are likely to affect disadvantaged populations the most. For example, higher temperatures increase both mortality and morbidity from a range of diseases and health conditions, and the health impacts of high and extreme temperatures are particularly severe for people living in informal settlements. These areas have characteristics that increase the exposure and sensitivity of residents to heat, such as dense settlement patterns, where air cannot circulate, and poor-quality, uninsulated housing (for example, Pasquini et al., 2020). As a further example, informal settlements across diverse African contexts are often located in areas exposed to flooding, including coastal areas, low-lying areas, floodplains, and near rivers and waterways; the lack of adequate sanitation structures in informal settlements exposes residents to contamination of water sources, homes and living environments during floods, leading to significantly increased infectious disease burdens during and after flooding events (for example, Hambrecht et al., 2022). Residents of informal settlements are not only more exposed to the impacts of climate change, but typically have higher vulnerability, due to a range of factors, such as higher levels of poverty and lower levels of availability and access to state services like health clinics. Other effects of climate change, including on water availability and food security, will also disproportionately affect those who already face struggles meeting their basic needs (Dodman et al., 2019; Satterthwaite et al., 2020).

At the same time, responses to climate change also have uneven implications. Responses to climate change generally fall either under the umbrella of adaptation, or of mitigation. Adaptation refers to efforts that anticipate the adverse effects of climate change and try to prevent or minimise the damage they can cause, or take advantage of opportunities that may arise as a result of climatic changes. An example of an

adaptation measure might be a large-scale infrastructure project, such as building defences to protect coastal settlements against sea-level rise (for example, a sea wall). Mitigation refers to efforts to prevent or reduce the emission of greenhouse gases into the atmosphere to make the impacts of climate change less severe; an example might be retrofitting old buildings to make them more energy efficient. Both mitigation and adaptation policies and projects have the potential for negative consequences for marginalised groups if they are not developed with an explicit focus on addressing existing and possible future vulnerabilities (Anguelovski et al., 2016; Eriksen et al., 2021). This includes considering tenure insecurity, gender, race/ethnicity, age, caste, sect and creed in terms of income, assets and employment opportunities, which can exacerbate vulnerabilities and inequalities. For example, a sea wall built to protect high-value properties in one area can increase flooding in another area, which may not have flood protection measures because of being a lower-income area. Finally, it is worth noting that effectively addressing the challenge of climate change can be enhanced by integrating responses that link and have co-benefits for mitigation and adaptation.

In African cities, climate risk is a consequence of both exposure to climate-related hazards, and vulnerability of residents and urban systems. Risk may be associated with location – for example, riverine and coastal flooding will be most severe in cities adjacent to rivers and the sea. Other climate change impacts will be more widespread, including from higher temperatures, drought and extreme rainfall. Vulnerability is driven by high levels of poverty; limited municipal and national resources to invest in risk reduction activities; and inadequate, out-of-date and poorly maintained infrastructure. In terms of mitigation, it has also become clear that alternative energy sources can offset the increasing energy demand and dependence on biomass and harness opportunities for low-carbon development (Birkmann et al., 2022; UNDRR, 2019; Fujii, 2016).

1.2. Purpose and methodology

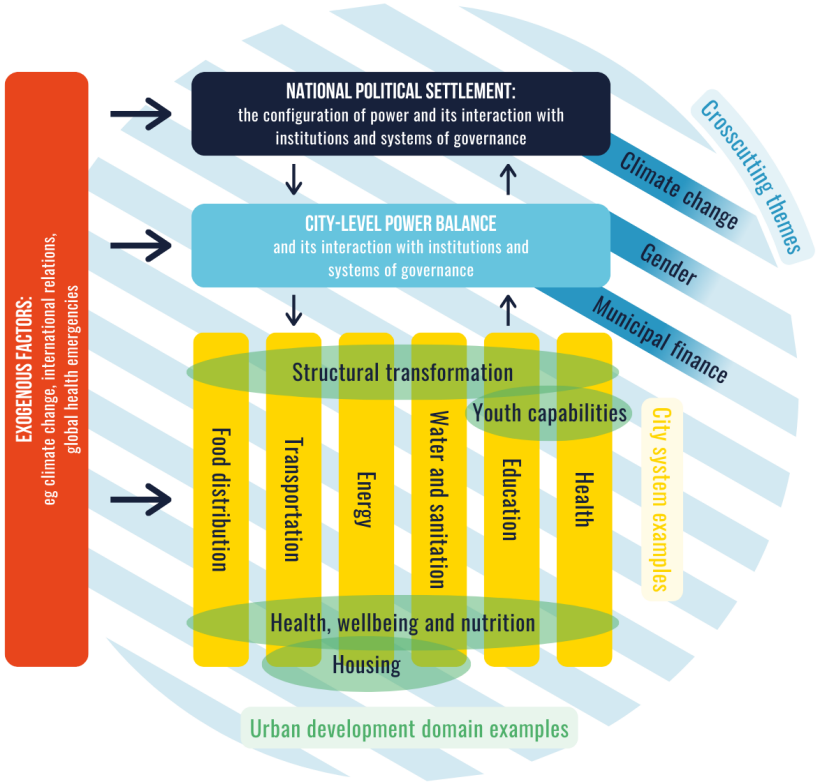
1.2.1. Research domains

Against this backdrop, this report synthesises key climate change-related findings and insights emerging from the African Cities Research Consortium's (ACRC's) crosscutting climate change research and studies conducted in 12 cities across the following eight domains: 1) housing; 2) informal settlements; 3) land and connectivity; 4) structural transformation; 5) neighbourhood and district economic development; 6) youth and capability development; 7) health, wellbeing and nutrition; and 8) safety and security. These domains refer to fields of power, policy and practice that are relevant to solving particular problems and/or advancing specific developmental opportunities in relation to cities. They enable a detailed exploration of sub-city processes, relations and institutions, recognising that the political economy and systems failures vary across domains (Kelsall et al., 2021). The ACRC's analytical framework (see Figure 1) uses the concept of urban development domains to transcend both sectoral and

traditional systems-based thinking. The domains are categorised into three sets (Kelsall et al., 2021):

1. **Built environment domains** that also play important economic and social roles (housing, informal settlements, land and connectivity).
2. **Economic domains** that focus primarily on income and asset generation (structural transformation, neighbourhood and district economic development).
3. **Societal domains** that affect all citizens and their efforts to secure health, wellbeing and socio-economic opportunities (youth and capability development, health, wellbeing and nutrition, safety and security).

Figure 1: ACRC's conceptual framework



Climate change intersects in complex ways with social, political, cultural and economic issues. While most domains did not have an explicit climate change focus or directly consider related issues in detail, considerable climate change mitigation- and adaptation-related insights can be drawn from the ACRC's research findings across the diverse cities and domains. It is also important to note that there are many intersections and areas of overlap between the different domains, such that examples discussed under one domain can be equally relevant to others, as will become apparent throughout the report. For instance, in the context of the ACRC cities, the housing domain intersects significantly with the informal settlements domain, which is unsurprising, given that informality is the dominant mode of contemporary urbanisation

in the majority of the world (UN-Habitat, 2022). This report is aimed at a wide audience, including policymakers, practitioners and academics.

1.2.2. Overview of ACRC cities

The 12 cities covered by the ACRC research in its first phase are as follows: Freetown (Sierra Leone), Accra (Ghana), Lagos and Maiduguri (Nigeria), Addis Ababa (Ethiopia), Kampala (Uganda), Bukavu (Democratic Republic of the Congo; DRC), Nairobi (Kenya), Dar es Salaam (Tanzania), Lilongwe (Malawi), Mogadishu (Somalia) and Harare (Zimbabwe). Of these cities, Lagos, Addis Ababa, Kampala, Nairobi and Dar es Salaam have been highlighted among the cities most at risk of climate change in global risks advisory firm Verisk Maplecroft's Climate Change Vulnerability Index (Verisk Maplecroft, 2018), which includes exposure, sensitivity and adaptive capacity. Across the remaining seven ACRC cities, significant evidence exists to confirm that they are at considerable risk from climatic changes and related climatic hazards.

Freetown released its first climate action strategy (2022-2030) in January 2023 (IIED, 2024). Climate analyses shows that both Freetown's average daily temperature and annual rainfall patterns are likely to increase as global emissions rise, which will likely result in more frequent and intense heatwaves and more intense periods of rainfall with associated flash floods and landslides (Freetown City Council, 2023).

In the context of **Accra**, historical analyses of the Greater Accra Region show that the region has warmed substantially in the past four decades (Ankrah et al., 2023), and different studies project increases in both minimum and maximum temperatures for the future (Ankrah et al., 2023; Siabi et al., 2023). Rainfall indices have not shown any significant changes over historical analyses, except for a significant decrease in consecutive dry day duration (Ankrah et al., 2023). However, projections for rainfall differ by study. For example, Ankrah et al. (2023) project a general increase in rainfall in the future in the area, whilst Siabi et al. (2023) project a general decrease in rainfall. Despite this discrepancy, in all cases rainfall is projected to become more variable. Therefore, Greater Accra is expected to experience both more droughts and floods, alongside heat-related hazards (see also Siabi et al., 2024).

In **Maiduguri**, and northern Nigeria's wider Borno state (of which Maiduguri is the capital), historical temperature and rainfall analyses have shown increases in temperature, increases in water shortages and droughts, as well as increases in the occurrence of urban floods (Abdulkadir et al., 2018; Bello et al., 2023; John et al., 2018). Climate projections suggest temperature increases across Nigeria by the end of the century, with greatest increases across the interior and northern parts of the country. Rainfall trends are less clear, but the expectation is that extreme rainfall events are likely to increase, resulting in flooding; under a high emissions scenario of RCP8.5, rainfall is expected to decrease significantly in the northern areas (World Bank Group, 2021). The Borno State Government released a Borno State Climate Action Plan 2014-2030, in which the key extreme weather events tied to climate change are identified as droughts, floods and heatwaves (Borno State Government, 2024).

Bukavu is the capital city of the South Kivu province in the DRC and one of the two main cities in the Lake Kivu basin (Sher Consult, 2020). While quantitative climate analysis is difficult because of the inadequacy of meteorological records over the entire catchment area of Lake Kivu (Sher Consult, 2020), historical temperature analysis within South Kivu shows an increase in annual average temperatures (Batumike et al., 2022). With respect to climate projections for the Lake Kivu basin, projections show annual rainfall tending to increase slightly across 16 climate scenarios by 2050, with most of the scenarios showing a drastic increase in rainfall through November-January (Sher Consult, 2020). Floods and flash floods linked to torrential rains have become particularly frequent and devastating in eastern Kivu (where Bukavu is located), and their frequency and intensity are intensifying due to climate change, urbanisation and land degradation (Sher Consult, 2020). Across the DRC in general, rainfall is projected to become substantially more variable, resulting in an overall increase in the frequency and intensity of both droughts and floods (World Bank Group, 2021; 2023a). Regarding temperature, projections across 16 climate models of the Lake Kivu basin indicate a significant increase by 2050 (Sher Consult, 2020); this aligns with projections for the DRC in general, in which heatwaves, hot days and hot nights are all projected to increase (World Bank Group, 2021; 2023a).

While climate analyses are not readily available for **Lilongwe** specifically, Malawi is highlighted as one of the most vulnerable countries in the world to the effects of climate change (Warnatzsch and Reay, 2019; World Bank Group, 2022). Since the 1970s, temperatures have risen, but historical data to assess historical precipitation changes are sparse (World Bank Group, 2022). In the last few decades, the country has experienced multiple severe droughts and flooding events, which have had a significant impact on key sectors such as agriculture, infrastructure and on livelihoods (Warnatzsch and Reay, 2019; World Bank Group, 2022). In the broader Lilongwe District, projections indicate that mean monthly temperature is expected to increase in the future under climate change, while mean annual precipitation is expected to decrease. However, mean monthly precipitation patterns exhibit an increase and decrease in different months and time periods (Msowoya et al., 2016). Urban areas in Malawi in particular are expected to face increasing climate change impacts (World Bank Group, 2022), and Lilongwe has already experienced heatwaves and floods (Alcayna et al., 2021).

Climate analyses for **Mogadishu** are also not specifically available; however, Somalia is also highlighted as extremely exposed and vulnerable to climate-related risks (World Bank Group, 2023b). Historical analysis shows that average annual temperatures have risen over the period for which records are available; by the end of the century, average temperature in Somalia is likely to exceed that experienced by any nation now or across all of human history (World Bank Group, 2023b; see also Ogallo et al., 2018, for climate projections). There is less clarity with precipitation trends, but since the 1980s the Gu rains (the main rainy season) have been declining in many parts of the country; projected rainfall trends are uncertain, with a moderate increase in rainfall being the most likely outcome over the course of the century (World Bank Group,

2023b; see also Ogallo et al., 2018, for climate projections). If this outcome (moderate increase in mean precipitation) does occur, once increased rainfall variation and evapotranspiration potential are factored in, it is likely that the incidences of both extreme flooding and droughts will increase (World Bank Group, 2023b). These changes occur against the backdrop of Somalia already facing a range of climatic hazards which have enormous impacts on the country's population and economy (World Bank Group, 2023b); the main causes of the vast majority of weather-related disasters are droughts and floods, which are the largest cause of Somalia's ever-increasing internal displacement crisis. Rising temperatures will also increase heat stress.

Finally, the Upper Manyame sub-catchment, in which **Harare** is located, has experienced statistically significant rising trends in temperature parameters from the 1970s onwards (Masimba et al., 2019; Mubaya et al., 2020). In contrast, historical precipitation analyses have shown a statistically insignificant falling trend (Masimba et al., 2019), with high variability in rainfall (Mubaya et al., 2020). Residents, and stakeholders in the water and climate sectors, of the city of Harare have reported a noticeable increase in temperatures over the years, resulting in frequent heatwaves, decreases in rainfall coupled with delays in the onset of the rainy season, and an increase in the frequency of floods (Mubaya et al., 2020). Climate projections indicate further increases in temperature in the future (Masimba et al., 2019; Mubaya et al., 2020). Downscaled precipitation projections have not shown a consistent increase or decrease in all the projected time periods; however, results suggest a decline in the amount of precipitation during the onset of the summer season (the period in which significant precipitation typically occurs), increased duration of the mid-season drought, and an earlier end of the summer season (Masimba et al., 2019). Masimba et al. (2022) specifically assessed potential climate change impacts on the streamflow and reservoir inflows in the Upper Manyame sub-catchment; their results suggest a future reduction in available surface water in the Upper Manyame sub-catchment, exacerbated by increases in the rate of evaporation from increases in mean temperature. This reduction in available surface water is expected to impact negatively on the water supply to the residents of greater Harare.

1.2.3. Key report sources and structure

The core focus of this report is on the synthesis of insights emerging from ACRC research and publications from the foundation phase – principally its suite of city and domain reports and linked relevant resources – and extrapolating their implications for future climate change impacts, adaptation and mitigation. Beyond this, the report also draws on multiple primary and secondary sources from the wider literature to substantiate key points and provide further detail. These written sources have also been supplemented with a series of four online engagements ("deep dives") held in February 2024 with ACRC city and domain leads, responsible for overseeing and coordinating research in their respective cities and domains. However, there are limitations to coverage for each domain and city in terms of the availability of some

reports and limited climate change-related detail in reports. Several reports were in draft form at the time of writing, and some cities and domains had limited representation during the deep dives.

Thematic climate change discussions are centred around the aforementioned ACRC domains, whereas city-specific insights and considerations are framed by priority complex problems (PCPs), in line with the consortium's overall approach. These PCPs can be understood as processes that are blocking or preventing the achievement of poverty reduction and/or economic development, and/or exacerbating the climate emergency. Specifically, PCPs are related to the political economy and associated system failures, particularly those related to a lack of systems integration, such as between hydrology and the spatial planning of settlements (Degenhardt et al., 2023). ACRC uses a "political settlements analysis" to understand the political economy of African cities. This analysis goes beyond formal governance to explore the underlying power dynamics and political factors that shape institutions and their functioning (Hickey, 2021).

This approach helps to clearly present findings across domains as well as their key implications and lessons for specific cities, and aligns with the recommendations of ACRC city and domain representatives consulted in the writing of this report. As such, it forms the basis for the structure of the document. Section 2 considers the connections between climate change and the eight urban development domains. Thereafter, Section 3 unpacks the implications of climate change across the focal cities and their respective PCPs, thereby also exploring potential solutions and adaptation pathways for cities to follow.

2. Implications of climate change for urban development domains

2.1. Housing domain

As noted, the housing domain is closely connected to the informal settlements domain. Housing is fundamental for social and economic development, aligning with Goal 11 of the 2030 Agenda for Sustainable Development. This includes target 11.1, "safe and affordable housing", focusing on achieving adequate, safe and affordable housing for all. The housing domain research drawn on in this report focused on seven African cities: Accra, Addis Ababa, Dar es Salaam, Freetown, Lagos, Lilongwe and Nairobi. Research under this domain combined in-depth case studies with political and historical analyses. This methodology involved a systemic examination of housing production ecosystems, including value chain analysis to identify bottlenecks and inefficiencies. Research also explored the power dynamics and political settlements influencing housing policies and practices in these cities, providing a nuanced understanding of the challenges and opportunities in the housing sector. While climate change issues were not a central focus in the housing domain research undertaken, there are several critical issues that emerged, as discussed below.

Climate risks related to housing are associated with both the construction of dwellings and surrounding infrastructure, and connections to citywide infrastructure networks. There are multiple intersecting factors that influence housing risk and vulnerability, such as adequacy of storm water drainage and green spaces for absorbing water runoff and reducing temperatures. Climate-resilient housing is critical to the ability of formal and informal settlements to withstand, adapt to and recover from the effects of climate change and associated disasters. However, buildings are also a significant source of global GHG emissions, which must be addressed through climate change mitigation. The pressing demand for land and buildings will continue to escalate as Africa's urban population continues to grow. The African buildings sector accounts for a significant proportion of final energy use and energy-related carbon dioxide (CO_2) emissions (IEA, 2021). Decarbonisation of the building and associated construction sector is thus urgently required for sustainable urban development in African cities (Rogelj et al., 2018). Decarbonising buildings across their entire life cycle requires a drastic transformation of both these sectors. Indeed, reaching net-zero operational and embodied carbon emission buildings is possible, but will require clear and ambitious policy signals to drive a range of measures, such as passive building design, material efficiency, low-carbon materials and highly efficient lighting and appliances (GlobalABC/IEA/UNEP, 2020).

Across the African continent, even modest formal housing units, constructed using basic materials, are beyond the financial reach of the majority of urban residents, highlighting a critical gap in affordable housing provision (CAHF, 2023; King and Virsilas, 2016). The high cost of construction poses a critical challenge to developing affordable housing. These costs are linked to the cost of building materials as well as inappropriate building codes and regulations adopted by national and subnational governments (King and Virsilas, 2016; McKinsey Global Institute, 2014). The latter are often imported from other parts of the world or of colonial heritage, preventing the use of available local building materials as well as the use of more cost-effective and environmentally friendly construction technologies (UN-Habitat, 2020).

There are currently a range of barriers to more environmentally friendly and climate-resilient housing, including the following:

- Limited communication and awareness raising, as well as limited supply of environmentally friendly and climate-resilient construction design, materials and technologies.
- Limited information dissemination about existing research and innovations in alternative building and materials technology, especially within the African city context.
- Blockages by existing elite interests and parties within the housing sector can hinder progress, as these groups may prioritise traditional building practices that conflict with newer, "green" building codes.
- High production and material costs; for example, many environmentally friendly building blocks are more expensive than fired earth blocks and hence not preferred by low-income households.

- Slow systems of accreditation and registration by materials testing and regulating agencies, which stall research and developments in energy-efficient, and/or eco-friendly construction materials.
- Consumer resistance to adopting new technologies, due to complexities such as societal attitudes, cultural perceptions and ideas of modernity (Maina et al., 2024).

The increasing uptake of “green” building standards in urban African contexts often faces resistance, due to mismatches with local realities. Imposition without careful consideration can exacerbate existing issues by not aligning with local economic conditions, cultural norms and the availability of materials, leading to delays and additional costs that may prove unaffordable and inappropriate for low-income urban residents. Such a sudden shift could potentially worsen housing shortages and increase living costs for urban residents on low incomes (Addy et al., 2021; Zhang et al., 2019; Iyer-Raniga et al., 2021).

Significant barriers to adopting green technologies include a lack of market demand and the high costs associated with these technologies. In environments where economic conditions are constrained and traditional construction practices prevail, the enforcement of green standards without adequate support mechanisms can further burden low-income urban residents. Additionally, the economic sustainability of these practices is crucial; they must offer viable financial returns and be resource-efficient to be genuinely sustainable. Moreover, aligning these practices with cultural norms and local community expectations is essential to ensure their acceptance and successful implementation (Addy et al., 2021; Zhang et al., 2019; Iyer-Raniga et al., 2021). The Office of the High Commissioner for Human Rights (OHCHR, 2023) has increasingly highlighted the necessity of incorporating housing rights within the broader context of climate change responses, prioritising adaptation measures for communities vulnerable to climate-related hazards. These guidelines also recommend thorough analyses of climate displacement and the promotion of environmentally sound housing construction to ensure housing rights amid climate challenges (OHCHR, 2023). UN Human Rights’ Key Messages on Human Rights and Climate Change encapsulate the responsibilities of states and other duty-bearers to mitigate climate change, adapt to its impacts, ensure accountability for climate-related human rights harms, and foster international cooperation and equity in climate action. These directives serve as a foundation for developing holistic, human-rights-based approaches to urban housing development that are both sustainable and resilient to climate change, emphasising the importance of protecting the most vulnerable and ensuring their active participation in shaping their living environments (OHCHR, 2023).

Furthermore, research undertaken across various ACRC domains and wider literature (for example, Odu and Adebayo, 2018) suggests that in relation to regulatory, planning and policy mechanisms, housing sectors across diverse African contexts often have insufficient strategies or goals, and implementation thereof, to address climate change, including a lack of construction and building standards and codes that adequately consider mitigation and adaptation issues. The deep dive discussions held with ACRC

city research leads underscored these issues, revealing the critical need for enhancing building regulations and promoting sustainable construction practices in contextually appropriate manners. These discussions pointed to the need for a shift towards more sustainable and climate-resilient housing policies across Africa, stressing the importance of skilled workmanship, education on the use of alternative materials, and environmental awareness.

A critical challenge across these efforts is the lack of comprehensive data on housing market performance, which is crucial for informing policy and investment decisions related to sustainable construction and innovation in the housing sector. However, there have been recent significant attempts to address this. For example, the Centre for Affordable Housing Finance in Africa (CAHF) is helping to address these issues by producing data and insights that underscore the necessity for a multifaceted approach to addressing housing challenges in African cities; one that is sensitive to the realities of rapid urbanisation and the climate change impacts exacerbating these challenges (Rust, 2020; CAHF, 2023). The focus on small-scale, localised projects and the development of finance products that cater to the informal sector and incremental housing construction offer promising pathways towards more resilient and inclusive urban housing solutions and can help to address challenges outlined above.

Insights from deep dives also emphasised the need for a re-evaluation of housing strategies across the African continent, focusing on climate adaptability and sustainable construction practices, as well as settlement design, particularly at the neighbourhood level. The discourse has also brought to light the urgent requirement to rethink building designs that leverage natural ventilation, aiming to accommodate the vast majority residing in informal settings. Building on these insights, Cavan et al. (2014) demonstrate the crucial role of urban green infrastructure in regulating temperatures, which can mitigate the urban heat island (UHI) effect and increased temperatures due to climate change. In cities like Addis Ababa and Dar es Salaam, informal and traditional housing areas using mud and wood construction with more green spaces provide better temperature regulation compared to other residential types, highlighting the need for sustainable urban planning that retains and enhances green spaces to combat heat stress.

However, while traditional residential forms, such as mud and wood houses, in Addis Ababa initially exhibit lower surface temperatures, due to their construction materials and green space coverage, these forms can be susceptible to rapid overheating over time (Mulatu and Desta, 2023). This rapid increase in temperature, particularly in peri-urban areas of Addis Ababa, exacerbates the urban heat island effect and raises concerns about the sustainability of traditional housing forms under intensifying urbanisation pressures (Mulatuand Desta, 2023). Beyond construction materials, two additional factors – elevation and land cover – play a crucial role in influencing surface temperature variations across different residential forms. Consistent with previous research, it has been observed that areas with higher elevations and greater green cover tend to exhibit lower surface temperatures (Mulatu and Desta, 2023). Traditional

residential forms, typically constructed using locally sourced materials such as bricks, mud and wood, benefit from these materials' favourable thermal properties, which help to mitigate climatic extremes. In contrast, modern houses built with concrete are more likely to generate higher indoor and outdoor temperatures. The design elements of traditional houses, including building shape, orientation and urban density, further contribute to temperature reduction. These findings illustrate the significant impact of elevation and green cover, alongside construction materials, on the observed disparities in surface temperature. Given these findings, the type of housing plays a vital role in insulation and temperature-related mortality. However, additional studies are necessary to reach more conclusive insights on the long-term sustainability of these housing forms in the face of changing climatic conditions.

One illustrative example is Mozambique's coastal cities, such as Pemba and Quelimane, where climate-resilient housing is helping to address the challenges posed by climate change, including sea-level rise and frequent intense storms. Initiatives like the Coastal City Adaptation Project (CCAP) (António et al., 2018) have focused on developing housing that can withstand these impacts, employing strategies like community engagement for resilient design, training local artisans in resilient construction techniques, and emphasising affordable solutions. These efforts aim to improve the housing sector's resilience, reduce vulnerabilities and foster social and economic development amidst the growing threats of climate change.

Box 1: A spotlight on Nairobi, Kenya's housing crisis

In Nairobi, rapid urbanisation has led to high demand for land and housing, leading to the growth of informal settlements. These areas, home to approximately 60% of Nairobi's population, are characterised by varying levels of density, housing quality and environmental risks, making them particularly susceptible to climate-related hazards facing the city, including heatwaves, increased rainfall, more frequent floods and altered wind patterns (Abuje et al., 2020; Nairobi City County, 2022).

In Nairobi, the most affordable newly constructed formal housing unit – a 15 m^2 bedsitter on the city's outskirts – was priced at USD11,200 in 2018 (Rust, 2020). Theoretically, this is affordable to 51% of the urban Kenyan population when considering prevailing mortgage rates; however, it is likely that many of those working in the informal sector would not receive mortgages because of the reluctance of financial institutions to lend without the ability to do payroll deductions (Rust, 2020).

This affordability gap has led to the proliferation of informal settlements and housing typologies. In Nairobi, 70% of residents rent single-room accommodation, split relatively evenly between smaller "shacks" and larger tenement buildings, predominantly located in broader informal residential areas (Mwau and Sverdlik, 2020; Nakamura and Avner, 2018). Structures typically comprise one- or two-storey structures constructed from materials like wood, mud and iron sheets. These homes are typically small, with many measuring just 9 m^2, and lack access to essential utilities like water (Nakamura and Avner, 2018; Andersen et al., 2021; Nairobi City County, 2022). Tenements refer to multi-storey residential buildings with shared utilities. These have recently received considerable attention for substandard building practices and structural failures, in some cases leading to casualties (Mwau and Sverdlik, 2020). In addition to these,

much of Nairobi's formal housing stock – a mix of various private dwellings and aging public housing – has seen informal additions (Mwau and Sverdlik, 2020). Despite high rental rates, home ownership is uncommon, with 60% of residents lacking land ownership rights and access to basic services (Nairobi City County, 2022; Talukdar, 2018).

The Nairobi City County Climate Action Plan 2020-2050 highlights heat as a critical climate hazard, particularly affecting the residents of informal settlements. These communities face heightened risk because of factors like insufficient knowledge of heatwave occurrences, poor ventilation, limited cooling facilities and inadequate healthcare access (Nairobi City County, 2022).

Beyond heat, poor urban residents, attracted by lower rents to hazardous, flood-prone areas, face greater risks resulting from projected increases in rainfall intensity, storms and flood events, such as displacement (Thorn et al., 2015; Mulligan et al., 2017; Nairobi City County, 2022). Studies have drawn a direct correlation between poverty, informality and increased flood exposure and vulnerability, emphasising the disproportionate impact of climate change on low-income households facing tenure insecurity (Talukdar, 2018; Mulligan et al., 2020). Furthermore, urban migration and densification place additional strain on the city's inadequate sanitation systems, exacerbating the health-related impacts of flood events, especially in areas located along waterways (Mulligan et al., 2020; Andersen et al., 2021).

Crucially, climate change impacts are also compounded by the practices of Nairobi's recent boom in formal urban development and construction. The loss of green open spaces and shift to glass building facades is associated with an increase in surrounding air temperatures, intensifying the urban heat island effect. Additionally, encroachment on riparian corridors, the conversion of natural green spaces to impermeable surfaces decreases stormwater infiltration and increases surface runoff, further exacerbating flood risk (Mulligan et al., 2017; Abuje et al., 2020; Nairobi City County, 2022). However, even though these practices are driven outside of the context of informality, the vulnerabilities outlined above mean that their impacts are felt most severely within informal settlements.

2.2. Informal settlements domain

Rising populations across African cities have led to the rapid growth of informal settlements, as formal urban planning systems and housing supply markets struggle to meet the growing demand for land and affordable housing (Maina et al., 2024; McKinsey Global Institute, 2014). In sub-Saharan Africa, approximately 56% of the urban population lives in such informal settlements, a rate far higher than the average in other developing regions (UN Habitat, 2022; Fox and Resnick, 2022). Informal settlements are typically characterised by a combination of insecure tenure, inadequate access to basic services and infrastructure and, frequently, housing that fails to meet standard building codes and regulations (Ouma et al., 2024). The domain of informal settlements thus intersects strongly with those of housing (Section 2.1) as well as land and connectivity (Section 2.3).

Climate change interweaves with a myriad of factors driving rural-to-urban migration (Mpandeli et al., 2020; Weinreb et al., 2020), contributing to the expansion and densification of informal settlements (Tietjen et al., 2023) as well as increased conflict over land and resources, as explored in Section 2.8. The diverse spatial forms of

informal settlements, shaped by unplanned and rapid urbanisation, significantly influence their vulnerability and capacity for adaptation to climate change impacts (Ouma et al., 2024). These settlements are often located in areas prone to environmental hazards, on customary land or in areas tacitly approved by local authorities, necessitating tailored strategies for climate adaptation and mitigation (Pelling and Wisner, 2009; Hambati and Yengoh, 2018; Ouma et al., 2024). The physical location of these settlements, frequently found in African cities' most vulnerable areas – such as hillsides, riverbeds or coastal zones – exposes them to various climate-related hazards, including floods and landslides. This geographical exposure, coupled with the informal nature of these settlements, escalates the potential for climate events to turn into disasters, altering the physical landscape and amplifying existing hazards and risks (Pelling and Wisner, 2009; Hambati and Yengoh, 2018; Ouma et al., 2024).

Apart from geographical location and exposure, informal settlements are also highly vulnerable to the impacts of climate change because of low adaptive capacity, stemming from lack of access to basic services and infrastructure, as well as the frequently poor quality of their housing stock. Many informal dwellings are made from low-durability materials (such as cardboard, hardboard and corrugated iron) or traditional materials (like wattle and daub). Such materials have a direct impact on the degree to which households experience climate-related hazards, such as extreme rainfall or intense heat. The deep dive discussions for this domain demonstrated how low-quality construction materials, with high heat emissivity values, exacerbate the urban heat island effect in major African cities, a phenomenon yet to be adequately addressed in building codes and more widely across policy realms. Concurrently, the removal of vegetation cover to enable settlement expansion leaves these informal areas even more prone to flooding (by reducing groundwater infiltration) and extreme heat (by reducing local cooling; see Williams et al., 2019). Furthermore, by existing outside the purview of formal planning frameworks and contravening building regulations, informal settlements may lack access to the adaptation support measures that may well exist in formal urban policies, such that insecure tenure further increases their vulnerability to climate change.

The geographical location of informal settlements, their unplanned nature and the low quality of their built structures combine to exacerbate their overall vulnerability to climate-related hazards. This is already evident in various African cities, where these settlements are often most affected by extreme weather events. For instance, ACRC research and deep dives reveal that, in Harare, the impacts of climate change are most acutely felt in informal settlements. These areas grapple with flooding, the impact of which is exacerbated by their proximity to low-lying regions along water bodies and a lack of adequate stormwater drainage systems.[1] Due to water shortages and challenges with infrastructure provision and maintenance, the city also struggles to meet the water needs of its populace.[2] ACRC research in Harare emphasises that

1 Harare city lead, city lead deep dive discussion 1.
2 Ibid.

inadequate investment in infrastructure, particularly in drainage and roads, combined with insecure tenure and the constant threat of evictions and demolitions, significantly limits the capacity of residents in informal settlements to engage in resilience-building activities (ACRC, 2023).

Residents of informal settlements often lack the capacity to cope with climate risks, due to low incomes, fewer assets and limited governance participation, necessitating tailored policy interventions that recognise the heterogeneity within these communities (Sverdlik et al., 2019). Low-income and marginalised households residing in informal settlements, often in low-cost housing constructed from substandard and non-durable materials, such as corrugated iron sheets, untreated wood and makeshift materials, face significant vulnerability to climate-related hazards, such as fires, floods and high/extreme heat events, and their knock-on effects, such as recurrent outbreaks of waterborne diseases (Hambati, 2013; Williams et al., 2019). As illustrated in Box 1, the impact of heat on informal settlements is particularly concerning, with heatwaves becoming more frequent, yet their gradual onset is often not prioritised by disaster management policies. This lack of recognition and prioritisation in policy frameworks means that the severe consequences of heatwaves are not adequately addressed, leaving vulnerable communities without the necessary support and interventions.[3] These communities endure considerable losses from climate events, leading to profound development challenges. The escalating frequency, intensity and duration of these hazards systematically erode the resilience of these informally settled and low-income households, which are already exposed to higher levels of risk (Satterthwaite et al., 2019; Williams et al., 2019).

Access to energy and clean cooking is critical for daily life and economic activities, and remains a key challenge for inhabitants of informal settlements. To support mitigation, it is critical for energy systems to shift from traditional fossil-fuel-intensive pathways of energy generation to renewable sources. For instance, at least 1,500 informal settlement households and microenterprises in Freetown will be provided with clean cooking solutions through the Enabling African Cities for Transformative Energy Access (ENACT) project, implemented by ICLEI Africa and Energy4Impact, with support from the Freetown City Council. This initiative merges clean cooking technologies with an energy risk reduction education programme to ensure access to adequate, safe, reliable, clean and affordable energy in informal settlements. This is highlighted in Box 2, which showcases the transformative impact of the ENACT project.

3 Harare city lead, city lead deep dive 1.

Box 2: Case study: Transforming urban livelihoods through clean cooking

Implemented by ICLEI Africa, with support from Energy4Impact Mercy Corps, the Enabling African Cities for Transformative Energy Access (ENACT) project serves as a compelling example of how enhancing access to clean cooking can foster inclusive economic development in cities, particularly in urban informal settlements and slums.

ICLEI Africa is working with local partners in Freetown and Kampala to implement tailored clean cooking interventions for households and small businesses (predominantly those engaged in cooked food vending), in target informal settlements. The current phase of the project aims to provide clean cooking access to up to 3,000 households and businesses, while creating sustainable jobs, building capacity and awareness, and improving the livelihoods of the community dwellers. Through ENACT, wholesalers and retailers of charcoal and firewood within the community are being converted to become retailers and marketers of the clean cooking products being introduced. Cooked food sellers also receive training on how to effectively use the clean cooking products to save time and money, thereby empowering them to enhance profitability in their businesses.

To amplify the impact, influential members of the community are recruited as “clean cooking champions” and are remunerated for their services. This multifaceted approach showcases how ENACT is not only promoting clean cooking, but also creating economic opportunities and empowering local communities in the process (ICLEI Africa and Clean Cooking Alliance, 2023).

Use of shared canister model by a cooked food vendor in Susan Bay, Freetown. Implemented by Afrigas Sierra Leone through ENACT funding. Photo credit: ICLEI Africa (February 2024).

Upgrading informal settlements is pivotal in enhancing urban resilience and implementing climate change adaptation measures (Satterthwaite et al., 2018). Such upgrading efforts include installation of solar-powered streetlighting, improvement of solid waste management, expansion of green spaces and promotion of cooler housing designs, mixed-use development, pedestrianisation and increasing cycling. These interventions help reduce climate change impacts and foster socioeconomic development through the enhancement of livelihoods, gender equity, community pride,

social cohesion and environmental quality (Sverdlik et al., 2019; Collado and Wang, 2020). This approach aligns the objectives of upgrading with disaster risk reduction and climate adaptation, highlighting the necessity of quality urban infrastructure and housing. The conservation of low-carbon features within densely populated informal settlements is possible through the improvement of infrastructure, services and secure tenure. Furthermore, Satterthwaite et al. (2018) advocate for effective land use management as a cornerstone for resilient, low-carbon urban environments. This entails increasing the supply and reducing the cost of land for housing with infrastructure and services, ensuring adequate public space, implementing land value capture strategies and supporting compact city development to manage ecosystem services. These strategies are crucial, along with the provision of formal, affordable, incremental improvements to self-build housing as an alternative to informal settlements. The transition to efficient, cost-effective and less polluting urban development paths, especially within informal settlements, is critical for adaptation strategies. Reconciling the varied urban agendas – including economic vitality, poverty alleviation, disaster risk reduction, alongside climate change adaptation and mitigation – requires acknowledging their shared focus on pinpointing and addressing local risks and underlying causes. Evidently, there are critical overlaps between the housing and informal settlements domains, as well as several others.

For decades, African city governments have adopted various responses to informal settlements, ranging from denial and neglect to eviction and demolition (Nyiti and Genes, 2022). In Harare, authorities often opt for eviction in the face of climate change challenges within these settlements, neglecting opportunities for informed mitigation and adaptation strategies.[4] However, there is increasing evidence across African cities such as Nairobi of increasingly progressive approaches, such as ongoing upgrading and growing protection of informal settlement dwellers. Satterthwaite et al. (2018) suggest leveraging upgrading efforts to enhance climate resilience, encouraging proactive financing for multifaceted benefits, and creating financing mechanisms that intertwine settlement upgrading with urban resilience strategies. It is critical for policymakers to prioritise inclusive urban development and scalable programmatic interventions that address the growing needs of informal settlement populations (Sverdlik et al., 2019). Such interventions must be context-specific, appropriately scaled and sensitive to local risks, avoiding blanket approaches that fail to address the unique challenges faced by vulnerable residents (Sverdlik et al., 2019).

Beyond the Kenyan and Tanzanian contexts discussed above, ACRC research revealed that in Harare, the intricate interplay of governance and power within informal settlements significantly impacts climate change adaptation processes. Multifaceted governance structures, which include formal, informal and customary layers of authority, are crucial in implementing climate adaptation measures. It underscores the need for governance models that are inclusive and considerate of the perspectives and necessities of those living in informal settlements. The political and economic

4 Harare city lead, city lead deep dive 1.

landscape of these areas is tightly knit with the broader political economy of climate change, shaping their exposure to climate-related vulnerabilities.[5] Community efforts toward climate adaptation are underway, yet there remains a substantial need for support and resources.[6]

Policymakers in Harare are encouraged to develop a data-driven approach to validate that key challenges in informal settlements are linked to geographical settings and wider structural and political economic factors, amongst others. Collecting comprehensive data to develop improved understandings of the issues is a crucial step toward collaborative solution-building.[7] A key pilot project in Harare mentioned during deep dive engagements aims to address these issues with a climate-focused perspective, recognising the current policy gap that favours rural over urban climate strategies. It is essential for the city to establish its climate policies, learning from national frameworks and customising them to meet urban needs.[8]

In the absence of comprehensive, city-level climate policies in Harare, community-led initiatives, which are often informal in nature, have emerged to tackle its related challenges. These include infrastructural approaches to minimising physical vulnerability, such as sandbag barriers and tree planting to mitigate flooding impacts. Re-evaluation of building materials and construction techniques is also in progress, to ensure that housing within informal settlements is more likely to be able to withstand climate change impacts, emphasising the need for robust drains and effective waste management systems.[9] Beyond infrastructure, communities also have strong capacities in developing a range of formal and informal socioeconomic systems that leverage existing social networks to address other aspects of vulnerability and protect their livelihoods. However, city-specific examples remain underrepresented in the ACRC and other publications drawn upon for this report and require further research to fully understand their relationship to formal climate policy.

In African cities, managing waste collection in unplanned and informal settlements presents a significant challenge. The dense layout of these communities often prevents municipal vehicles from accessing narrow, poorly maintained streets, leading to infrequent waste collection. Because of this, residents often resort to open dumping and burning, contributing to air pollution through the release of carbon dioxide and methane, which in turn contributes to greenhouse gas emissions and exacerbates environmental degradation (Zohoori and Ghani, 2017; Abubakar et al., 2022). Inadequate drainage systems compound the problem, intensifying flooding risks and the proliferation of bacteria, posing further health risks – further emphasised in the case of Dar es Salaam discussed in Section 4 (Zohoori and Ghani, 2017; Abubakar et al., 2022; Williams et al., 2019). Improving water service provision in terms of both quality

5 Harare domain researcher, city lead deep dive 1.
6 Ibid.
7 Ibid.
8 City lead from Harare, city lead deep dive 1.
9 Ibid.

and quantity is vital, particularly as these areas are also impacted by the health and wellbeing challenges of high and extreme heat events (Williams et al., 2019).

To illustrate through a city specific example, Harare's capacity for climate action is hindered by several systemic barriers, as reported by city officials. The absence of a dedicated department to address climate issues reflects a broader institutional weakness in resource mobilisation and a lack of clear strategic direction for climate responses.[10] Moreover, outdated data on vulnerabilities and past climate responses pose a critical gap in planning and action.[11] There is a pressing need for enhanced institutional support to empower agencies and stakeholders to effectively address and adapt to the emerging challenges of climate change.[12]

2.3. Land and connectivity domain

Land and connectivity are critical issues in African cities, where urban growth often outpaces infrastructure development, leading to sprawling informal settlements (with obvious interconnections with the informal settlements domain) and fragmented urban landscapes. Although often overlooked, land tenure is an important variable impacting vulnerability to climate-related disasters, particularly in Africa, where the rapid expansion of informal settlements has heightened urban vulnerability, as reviewed in Section 2.2 (Twerefou et al., 2011; Chagutah, 2013). Effective land tenure systems can mitigate this by enhancing land market efficiency and reducing volatility, thus attracting sustainable investments and reducing disaster risk (Byamugisha and Dubosse, 2023). Systems of land tenure, especially granting of appropriate forms of tenure to low-income urban residents, are crucial for addressing disaster vulnerability in informally settled areas (Twerefou et al., 2011; Byamugisha and Dubosse, 2023).

The studies within this domain focused on six African cities: Accra, Bukavu, Harare, Kampala, Maiduguri and Mogadishu. The research under this domain employed a mixed-methods approach, combining quantitative data from surveys and censuses with qualitative insights from key informant interviews and focus group discussions. This approach supported the development of a nuanced understanding of the unique challenges and opportunities faced by residents in such urban contexts, providing valuable insights for developing effective strategies for land tenure reform and connectivity enhancement (Goodfellow et al., 2024).

Jones et al. (2022: 292) note that the empirical evidence linking tenure security directly to specific development outcomes such as vulnerability reduction is "thin and mixed". This highlights the complexity of such linkages, which can vary widely, due to local context-specific factors, such as access to credit and market conditions, necessitating careful consideration of these variables in impact evaluations (Twerefou et al., 2011). For low-income households, insecure land tenure and the constant threat of eviction discourage investments in home safety improvements, such as drainage and terracing

10 Ibid.
11 Ibid.
12 Ibid.

to reduce flood susceptibility (Finn and Cobbinah, 2023). However, where tenure security is established, communities are more likely to invest in robust, incremental structures, enhancing community resilience to climate change (Chagutah, 2013; Mitchell et al., 2015).

Conversely, climate-related disasters can lead to new forms of tenure insecurity, or further exacerbate existing insecurity (Oteng-Ababio et al., 2024; Kamana et al., 2023). Indeed, land slides caused by extreme rainfall may simply remove entire urban neighbourhoods. Consequently, land cannot be accessed for production or for housing purposes. Garibay et al. (2010) identify key mechanisms through which a disaster could exacerbate insecurity of tenure as follows: destruction of physical evidence of property boundaries; relocation or death of community members and other individuals with detailed memories of property boundaries; and conflicts over land tenure heightened as a result of a disaster, such as tensions over inheritance of land rights. Land grabbing and poor building practices can occur in resettlement areas, where there are unclear property rights or there are no appropriate procedures in place to avoid it. Additionally, land grabbing practices, influenced by climate change policy and impacts, aim to secure agricultural production in anticipation of future climate-related losses, adding another layer of complexity to tenure security issues (Cotula et al., 2009). These practices are not only about the immediate acquisition of land but also involve securing water resources for agriculture, which are often overlooked yet critical for sustaining the projected productivity of these lands (Woodhouse and Ganho, 2011). Another predominant way in which disasters often exacerbate tenure insecurity is through the destruction of land tenure records, such as land title deeds and land registry records (Garibay et al., 2010). In relation to the latter point, the digitisation (for example, digital documentation) of land systems and services – an area that is seeing rapid change in Africa, as highlighted in the land and connectivity domain report (Goodfellow et al., 2024) – is critical to mitigate the destruction of land tenure records by climate-related disasters.

In terms of connectivity, unfettered and unplanned sprawl are prominent features of contemporary urban growth, particularly in the form of informal settlements and backyard dwellings. Consequently, emerging property developments, particularly residential areas in peri-urban locations, have limited connectivity and poor access to socioeconomic opportunities, which are largely concentrated in established historical core areas of cities. It is well established that many informal settlements are established on land that is environmentally unsafe for occupation because of its proximity to socioeconomic opportunities (Nassar and Elsayed, 2018; Kekana et al., 2023).

The impact of transport and connectivity infrastructure on urban development and climate resilience is profound. Infrastructure such as roads and public transportation systems not only significantly improves access to services and economic opportunities but also influences land values and urban growth patterns (Webster and Muller, 2009). However, the development of such infrastructure can have unintended consequences,

including land speculation and the displacement of vulnerable communities. This dynamic highlights a crucial aspect of urban planning: the need for strategic integration of climate adaptation measures. Extreme event attribution aims to elucidate the link between global climate change, extreme weather events and the impacts experienced on the ground by people, property and nature. It therefore allows the disentangling of different drivers of extreme weather from human-induced climate change and hence provides valuable information to adapt to climate change and to assess loss and damage (Clarke et al., 2022). Box 3 highlights how road network connectivity enhancements, while critical to urban development, have also increased climate-related risk. The increase in impermeable surfaces, such as road networks and the surrounding built environment catalysed thereby, lead to higher rates of surface runoff during rainfall events. Additionally, the alteration of natural waterways and drainage systems exacerbates the accumulation of water, further increasing the risk of flooding. Recurrent flooding disrupts transport, damages property and hinders various urban processes. Therefore, new infrastructure developments can lead to an increased risk of flooding, highlighting the need for flood-resilient urban planning. Box 3 emphasises the urgent need for climate-resilient urban planning that is conscious of such environmental impacts and engages the community in its approach to building sustainable infrastructure.

Importantly, several of these hazards fall along different parts of the causal chain that stretches from the sources of anthropogenic climate change to its impacts; each was selected as an appropriate intersection between attribution science and impact-relevance (Clarke et al., 2022). Specifically, the expansion of infrastructure in areas susceptible to climate-related disasters, like floodplains or landslide zones, underscores the importance of considering climate risks in development projects. These areas, often characterised by “growth without access”, due to inadequate infrastructure, present a complex challenge – balancing development with climate resilience (Goodfellow et al., 2024). Moreover, the role of customary tenure and informal land markets complicates the equitable distribution of infrastructure benefits, further emphasising the need for careful planning to ensure that development initiatives do not exacerbate vulnerabilities in the face of climate change.

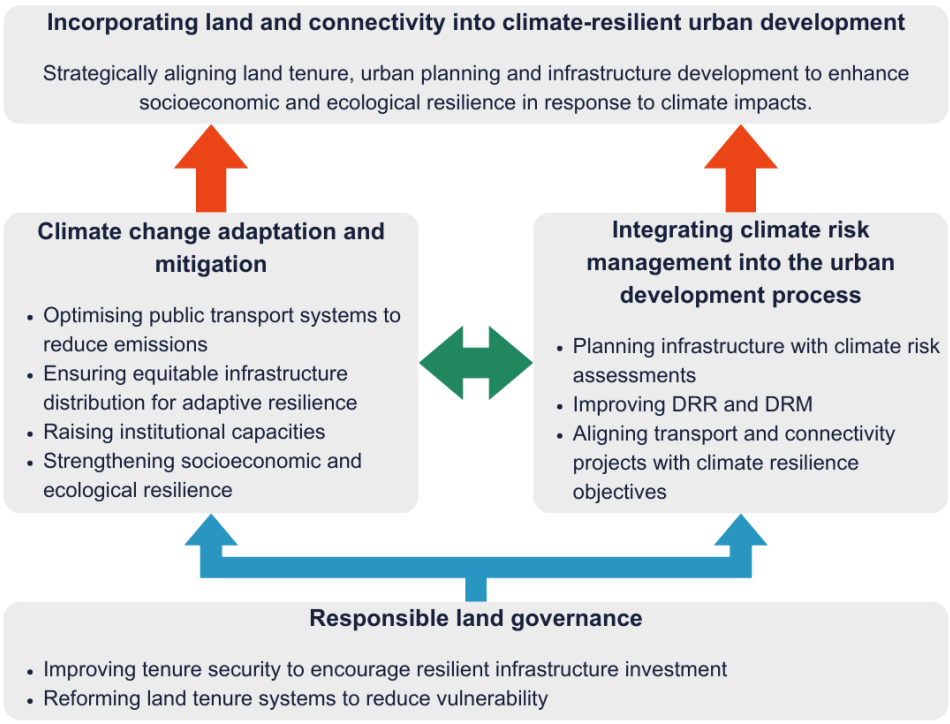
Overall, public transport coverage and accessibility is low across the rapidly increasing number of suburban and peri-urban areas of African cities (Bryceson et al., 2003; Sietchiping et al., 2012; Melbye et al., 2015; Campbell et al., 2019). The informal transport sector addresses major gaps in public services and limited access to private vehicles through servicing many areas throughout African cities, but has limited access in dense informal settlements, as well as areas far from the city’s economic hubs. These factors have important implications for the optimisation of public transport systems (see case studies in Section 2.4), which is crucial for the reduction of GHGs. Furthermore, the growing populations and sprawling suburban and peri-urban expansion of many African cities pose threats to the integrity of the continent’s ecosystems and biodiversity, which ultimately support adaptive capacity in the face of

many challenges, including the impacts of global climate change (Güneralp et al., 2017).

The sustainability of compact cities has been discussed and demonstrated in various studies (for example, Bibri and Krogstie, 2017; Bibri, 2021). Compact cities are typically defined by three characteristics: 1) land use densification, increasing the use of horizontal and vertical space per unit area; 2) land use diversity, increasing the mixture of activities per unit area; and 3) spatial connectivity, accessibility and public transportation (Bibri, 2021; Dehghani et al., 2022). Combined, land use densification and diversity result in land use intensification. Increasing the efficiency of existing resource use and infrastructure through these three actions is one of the core sustainable development strategies (Elmqvist et al., 2019). A key rationale behind the compact city is the efficient utilisation of existing infrastructure by increasing the density and connectivity of spaces (Dehghani et al., 2022). Compact cities are championed as more sustainable because they reduce travel distance; shorten commute times; decrease car dependency; lower per capita rates of energy use; limit the consumption of building and infrastructure materials; mitigate pollution; promote a diversity of workplace choices, public services and facilities, and social interactions; and limit the loss of biodiversity and ecosystems (Bibri et al., 2020). The sustainability benefits of the compact city model include lowering energy consumption and emissions in transportation, conserving agriculturally productive land and biodiversity and reducing infrastructure costs while increasing labour productivity (Bibri et al., 2020). However, the compact city model also presents potential challenges, such as increased ecological footprints, due to higher resource consumption per unit area; larger income gaps; housing affordability issues; living conditions for low-income groups; decreased access to green spaces; increased traffic congestion (Bibri et al., 2020).The shift to more compact cities must therefore be considered with caution, addressing the dangers of remaining locked into forms of urban development that are high in emissions and could exacerbate existing inequalities, while also avoiding creation of new inequalities. These complexities must be considered, to ensure that policies do not overlook the multiple needs of urban populations (Chihambakwe and Moyo, 2024).

As African cities evolve, the integration of strategic land use and improved connectivity within urban planning becomes crucial to building resilience against climate change. Figure 2 illustrates how incorporating land tenure, optimising public transport, and responsible land governance contribute to climate-resilient urban development. These interconnected strategies highlight the necessity for a multifaceted approach that addresses both the mitigation of and adaptation to climate impacts in urban settings (See Figure 2).

Figure 2: Enhancing climate resilience through land and connectivity strategies



Adapted from Mitchell et al. (2015).

Box 3: Urban infrastructure and resilience in Mogadishu

Road network connectivity is being expanded in Mogadishu to improve urban areas. The infrastructure's expansion is integral to the city's growth, introducing vital arteries that promise better connectivity. However, this development is met with complications, due to recurrent flooding, which disrupts transport, damages property and hinders the city's functionality as a result of mobility impediments and development. Therefore, new infrastructure developments can lead to an increased risk of flooding (Mohamed, 2022), thereby reiterating the significance of flood-resilient urban planning. The link between land development and environmental management can be seen in the city's struggle with flooding. This necessitates the incorporation of flood resilience into infrastructure projects, as stated in ACRC's land and connectivity report (Goodfellow et al., 2024), so that the role of road networks in supporting the city without increasing its vulnerability may be realised.

Climate-resilient infrastructure cannot be achieved without community involvement and civil society engagement in decisionmaking. Mogadishu's context, according to the domain report, requires participatory planning towards a more resilient city, less prone to natural disasters that threaten its citizens' safety and livelihoods (Mohamed, 2022). Such participatory planning processes are vital for integrating diverse community perspectives into urban development plans, thus addressing the complexities of urban flooding and its socioeconomic consequences (Mohamed, 2022; Ouma et al., 2024). The dual challenges of rapid urbanisation and recurrent flooding in Mogadishu require a resilient approach to urban planning, focusing on sustainability and adaptability. This approach must be underpinned by a comprehensive understanding of the urban fabric and a commitment to enhancing the city's resilience against climate-induced flooding.

2.4. Structural transformation domain

In African cities, where rapid urbanisation coexists with sprawling informal settlements, structural transformation presents a unique set of challenges and opportunities. Structural transformation refers to the movement of workers from low-productivity, primary economic sectors, such as agriculture, to more diverse and high-productivity secondary and tertiary sectors, such as industry and services, respectively, leading to increased job creation, improved labour productivity and poverty reduction (Danquah et al., 2024).

The ACRC studies drawn upon in this domain focused on six African cities: Addis Ababa, Dar es Salaam, Harare, Lagos, Nairobi and Accra. The underpinning research employed a mixed-methods approach, combining quantitative data from national surveys, such as labour force surveys and census data, with qualitative insights from key informant interviews and focus group discussions. This approach provided detailed insights into the challenges and opportunities faced by these cities in achieving structural transformation, highlighting the spatial distribution of economic activities and the influence of political settlements on economic change.

The push for structural transformation in African cities is inextricably linked to climate resilience. Infrastructure development is the main element of the transformation from agrarian-based economies to more diverse and productive urban-based industrial and service economies. However, such a transition demands a climate-resilient approach to ensure that new industrial zones and service networks can withstand and adapt to climate-related disruptions, and that such investments do not exacerbate climate risks. Such challenges have been observed in Mogadishu, where new infrastructure development, such as road network expansions, has led to increased flooding risks, highlighting the need for flood-resilient planning and climate adaptation measures in urban infrastructure projects (as discussed in Section 2.3).

The prevalence of informal enterprises in urban economies necessitates strategies that bolster their adaptive capacities, enabling them to thrive amid the challenges posed by a changing climate. By harnessing emerging technologies, cities have the potential to leapfrog unsustainable industrial development paradigms (such as those that predominate in Western nations) to more efficient and environmentally sustainable economic systems that reduce carbon emissions and promote economic growth, aligning with climate mitigation goals. However, there are concerns over limited access to such technologies, further exacerbating the disadvantages faced by low-income, frequently marginalised residents and microenterprise owners.

Improving labour productivity while addressing the challenges and opportunities of climate change is critical to ensure that, through structural transformation processes, African cities do not enter into or expand industries that will lead to stranded assets and stranded workers, who have been drawn into industries that are no longer favourable within regional and global markets. For example, economic and policy signals at global, regional and national scales clearly show that fossil-fuel-based industries, such as oil

and gas, coal mining and oil equipment and services, are on the decline, and will continue on this trajectory, due to economic and policy levers linked to the global just transition (Plantinga and Scholtens, 2021). It is thus essential, on a continent where population growth and urbanisation are occurring rapidly, that economic development and structural transformations are undertaken utilising low carbon technologies and setting African cities up as global leaders in climate-resilient development. Africa cannot afford to be left behind in this global transition. The structural transformation domain report (Danquah et al., 2025) emphasises that understanding the connections between cities and structural economic change is critical for efforts to strengthen the New Urban Agenda (NUA) that promotes economic transformation, inclusive growth and prosperity. Strengthening understandings of the connections between structural transformation and climate change in ACRC research is a key priority.

From a climate change mitigation perspective, this means that energy provision in African cities needs to increasingly be based on renewable sources (Nyiwul, 2019; Tietjen et al., 2023). The just energy transition is a major topic of concern globally and regionally. Transitioning to cleaner and lower carbon energy sources has multiple benefits from health (for example, less air pollution and respiratory illnesses), socioeconomic and environmental perspectives, but there are also concerns about job losses, as those currently employed and/or involved in the fossil fuel and associated industries may struggle to find opportunities in the low carbon energy provision sector (See Box 2).

In terms of climate change mitigation, it is important to understand the role of urban spatial planning in shaping how enterprises are spatially distributed within African cities, which directly impacts energy use, emissions and overall urban sustainability. The ACRC structural transformation domain report (Danquah et al., 2025) points to spatial disparities of economic activities in African cities, particularly in sectors like informal manufacturing and services, as a key challenge to climate action (Danquah et al., 2025). Furthermore, the report finds that in cities such as Accra and Nairobi, economic activities, especially in services and informal manufacturing, are predominantly located in central business districts (CBDs) and a few other hubs, resulting in high traffic congestion and increased pollution levels (Danquah et al., 2024). This concentration creates environmental stress, due to the high demand for transport services, leading to increased emissions from vehicles that are necessary to support these economic hubs. Additionally, this centralisation of economic activities can strain urban infrastructure and limit the potential for sustainable growth. Likewise, from a climate change adaptation perspective, it is crucial to thoroughly assess climate impacts during the construction of infrastructure, ensuring resilience against disaster risks and climate change impacts such as flooding and sea-level rise.

Building on this foundation of sustainable urban development, the integration of health co-benefits into urban climate change adaptation strategies emerges as a crucial element of structural transformation in African cities. As elucidated by Sharifi et al. (2021), prioritising investments in climate-resilient infrastructure is vital for mitigating

costs and economic losses attributed to climate-induced health risks. Key co-benefits include reducing heat stress and improving air quality through nature-based solutions such as urban greenery, which also contributes to lower incidences of respiratory and cardiovascular diseases (Sharifi et al., 2021). This strategic approach dovetails with the overarching need for African cities to evolve from their agrarian roots towards a mosaic of industrial and service sectors, with climate adaptation ingrained in every step of this journey.

A key component of this is the expansion of renewable energy, which serves the dual purpose of climate mitigation and the promotion of public health through improved air quality. Energy is a key driver of sustainability and is crucial for raising living standards across Africa. As a result, energy has become a vital resource in African cities, profoundly influencing their economies and environmental impact (Koh and Lim, 2010). Africa's energy sector is currently in a transition period, with the aim of shifting towards a sustainable, clean energy-based economy. Recent data indicates that power outages and high electricity costs remain significant challenges in sub-Saharan Africa. Addressing the needs of the 570 million people who lacked electricity in 2019 highlights a crucial juncture in Africa's development (International Energy Agency, 2021). This energy poverty exacerbates human poverty, severely affecting critical outcomes in education, health and income (Jessel et al., 2019). The choice of energy solutions – rapid and cost-effective fossil fuels versus the slower implementation of sustainable sources – poses a fundamental challenge. This choice is not simply about providing energy; rather, it is about advancing sustainable energy solutions that are consistent with the continent's path to growth and its goals for climate resilience.

In this light, the role of workforce development initiatives becomes crucial, especially as African economies progress towards a greener future. Specifically, in West Africa, the International Renewable Energy Agency (IRENA) has made significant strides to bolster renewable energy skills among professionals. Through the ECOWAS Renewable Energy Entrepreneurship Support Facility, IRENA has backed over 80 enterprises, facilitating access to more than USD 1 million from local financial institutions. This support has not only propelled the adoption of green construction practices and renewable energy technologies but has also enhanced the capacity for sustainable agriculture techniques, showcasing the intricate link between workforce development and the transition to more productive and climate-resilient economic sectors.

Countries like Senegal, Ghana and Nigeria, under the auspices of the ECOWAS initiative, exemplify how targeted investments in renewable energy skillsets can catalyse broader structural economic transformation. IRENA's forward-looking analysis suggests that amplifying the renewable energy sector's share by 2030 could substantially elevate the global gross domestic product while potentially creating employment opportunities for over 24 million individuals worldwide. This projection underscores the multifaceted benefits of aligning workforce development with climate resilience strategies, ensuring that the economic restructuring not only fosters high

productivity but is also responsive to the imperatives of a climate-resilient economy (IRENA, 2020). This strategic alignment is particularly pertinent as African nations navigate the complexities of ensuring energy access amidst the global shift towards sustainability and low carbon development paths.

The informal sector is the economic foundation of most African cities (Guven and Karlen, 2020). Those operating within this sector will be deeply affected by climate change impacts, due to constraints in adjusting activities impacted by climate change and capacity to deliver their services or sell their goods, due to lack of readily accessible capital. Of paramount importance is that structural transformation occurring in African cities is undertaken in such a way that those working within the informal sector are provided with opportunities and safety nets that take account of increasing environmental uncertainty. These safety nets include cash transfer programmes, which provide direct financial support to households, helping them cope with income losses due to economic shifts. Social insurance schemes, such as health and unemployment insurance, protect individuals from economic shocks and ensure they can adapt to structural changes (Kangasniemi et al., 2020). Public works programmes offer temporary employment, stabilising income during transitions. Active labour market programmes (ALMPs) enhance employability through training and job search assistance, facilitating worker transitions into new sectors (Kangasniemi et al., 2020). Additionally, subsidies or financial support for small enterprises sustain businesses and maintain employment during economic changes, ensuring the process is inclusive and mitigates risks for vulnerable populations (Kangasniemi et al., 2020).

A further critical issue to explore is where and how structural transformation leading to economic growth is positive from the point of view of reducing consumption, natural resource pressure, carbon emissions and increasing “quality of life” and “standards of living” (rather than narrowly focusing on incomes or GDP, or on notions of standards of living/quality of life tied to material growth). The structural transformation domain report (Danquah et al., 2025) indicates that structural transformation has been associated historically with a shift from agrarian to industrial economies linked to urban areas, which play a critical role in economic growth and poverty reduction through hosting enterprises that create jobs and facilitate labour productivity. However, industrial economies have also generated more GHG emissions, been less environmentally sustainable, and led to widening inequality gaps – and thus require critical consideration for African cities. It is further highlighted in the report that countries of the West, China and Southeast Asia are examples of “successful structural transformation”. However, of central importance for African cities is to consider whether these countries (and their urban areas) are examples of environmental sustainability and the nuances in ensuring that structural transformation is in line with climate change (and other environmental) outcomes. A particularly pertinent area is the shift to green economies. The domain report notes that investing in firms and value chains linked to natural resources in African countries can enhance the transition to productive green jobs. Related to green growth, McMillan and Headey (2014) observe that it is important to consider the implications of structural transformation, specifically leapfrogging

development (economic transition from agriculture to services jumping the manufacturing stage) for the sustainable growth of African cities.

Lagos deep dives revealed that the growing recognition amongst urban and national governments of climate change impacts has been a catalyst for increased grant funding applications for green infrastructure projects. However, current efforts primarily target foreign investments, highlighting the need for stronger local-community–state collaborations. Effective climate responses require not only building governmental capacity but also improving governance structures to facilitate inclusive decisionmaking processes that engage local communities and leverage research insights.

2.5. Neighbourhood and district economic development domain

The neighbourhood and district economic development domain refers to the analysis and enhancement of economic activities at the local level, particularly in informal sectors such as household microenterprises (HMEs). This domain is important for sustaining livelihoods, especially in African cities where a significant portion of the urban workforce is engaged in informal employment. Climate change will affect urban economies directly through impacts on productive infrastructure and livelihoods, and indirectly through disruption to the provision of key services and supply chains, with considerable implications for neighbourhood and district economic development. At a household level, climate change impacts have complex consequences for livelihoods and HMEs. At the larger urban scale, climate change has the potential to disrupt economic networks and supply chains. For example, climate-change-related disruptions of critical infrastructure, such as electricity and water supplies, will have knock-on effects on the productivity of a range of urban sectors. Many African cities rely on hydroelectric power for electricity, and changing rainfall patterns have the potential to decrease generation potential. Similarly, severe droughts can contribute to widespread water shortages, affecting both households and industries, as happened in Cape Town in 2017-2018 during the drought crisis. Notably, this is as much a matter of governance as of absolute water scarcity (Ziervogel, 2019). In unpacking these connections, this section draws principally on insights from deep dive engagements with ACRC city and domain leads, related ACRC research outputs (including the associated domain report yet to be published) and the broader literature.

In cities across the continent, the informal sector emerges as the backbone of neighbourhood and district economies. On average, it accounts for 76.3% of the labour market in urban areas (versus 88.3% in rural areas), spanning diverse trades and services (Bonnet et al., 2018). This significant proportion underscores the critical role of informal employment in sustaining urban livelihoods, encompassing a broad spectrum from self-employed individuals in unregistered enterprises to those engaged in unprotected employment relationships (Chen, 2012). The informal sector represents a particularly vital source of livelihoods for a significant number of women, who are disproportionately represented in the lowest-earning forms of informal work (Chen, 2012).

Within this vast segment of urban economies, HMEs play a pivotal role. These entities, often run by individuals or multiple family members, navigate the challenges of limited capital, constrained access to markets and vulnerability to environmental and economic fluctuations. Despite these obstacles, HMEs contribute significantly to local economies, providing essential goods and services and sustaining livelihoods for a substantial portion of the urban population. Within HMEs, home-based workers span a broad range of occupations, from textile and garment production to craftwork and assembly jobs. The International Labour Organization and Women in Informal Employment: Globalizing and Organizing (ILO and WIEGO, 2017) estimate that a significant proportion of informal workers in urban settings are engaged in home-based activities, underscoring the necessity of recognising and supporting these labour segments. Challenges such as inadequate workspaces, unhealthy and unsafe working conditions, poor access to markets, inconsistent income and a lack of social protection are common, highlighting the need for targeted policy interventions.

In Accra, street vendors emerge as a vital force within the urban economy, offering an array of goods and services that cater to the diverse needs of the city's residents.[13] Anyidoho (2013) highlights the critical contribution of vendors in Accra, as evidenced by the Informal Economy Monitoring Study (IEMS), in not only upholding urban livelihoods but also enriching the wider economic structure of the city. A critical review of the data reveals that a majority of these entrepreneurs engage in the sale of food products and clothing, with notable distinctions in the types of goods sold by gender and location. For instance, women predominantly sell food items, while men deal more in clothing and higher value goods. This gendered dynamic in trade offerings underscores the complex interplay of socioeconomic factors that shape the vending landscape in Accra (Anyidoho, 2013).

Despite the pivotal role that informal sectors play in bolstering urban and national economies, their contributions often go unrecognised by governmental bodies, leading to punitive measures that not only overlook the economic value of informal workers but also exacerbate their vulnerabilities (Chen, 2014). Most informal enterprises face comparable constraints to residents of informal settlements. This includes being fined or arrested for contravening regulations. Many informal enterprises also lose income because of unreliable electricity, water supplies and waste disposal and thus require urgent upgrading and improvements. The informal economy often has large roles in service provision in informal settlements and usually includes many home-based workers (mostly women).

Despite the challenges they face, informal workers have demonstrated resilience and innovation, forming membership-based organisations and engaging in cooperatives to advocate for better working conditions and rights (Bonner and Carré, 2013). The adaptability and economic contributions of informal sector enterprises are particularly notable, as they often develop close to key urban infrastructures, contributing significantly to the labour force and the informal economy's diversity. However, the lack

13 Deep dive discussion.

of essential services further constrains these enterprises, highlighting a crucial area for intervention to not only recognise but also support and integrate informal economic activities into broader urban economic development plans (Farouk and Owusu, 2012). Satterthwaite et al. (2018) underscore the intricate dynamics of informal economies, where home-based workers, street vendors and waste pickers navigate the challenges of limited access to formal markets and vulnerability to urban environmental pressures. These informal economies not only provide essential services and goods to urban residents but also contribute to the adaptive capacity of cities to environmental changes. Box 4 highlights the crucial role of the informal waste sector and waste pickers in urban economies, especially in sub-Saharan Africa. It explores the contributions of these workers to environmental sustainability and the urban economy, despite the challenges they face, including societal stigmatisation and operational hazards. The box emphasises the importance of recognising and supporting these workers to enhance their economic security and integrate their roles more effectively into urban waste management systems.

Box 4: The informal waste sector and waste pickers

An estimated 19-24 million individuals worldwide earn their livelihoods through collecting and recycling waste, with 80% of waste pickers operating within the informal economy (Fair Circularity Initiative and Systemiq, 2024). However, these numbers are very likely to represent an underestimate, as reliable data on the informal waste sector are difficult to produce for a range of reasons, such as the invisibility of this work (Gutberlet, 2023). Waste workers are nonetheless expected to represent a significant proportion of the urban population in developing country cities (Gutberlet, 2023). For instance, Mbah et al. (2019) reference the figure of 1 million waste pickers in Nigerian cities, which they state constitutes about 0.6% of Nigeria's urban population and they characterise as quite a significant part of the urban labour force. For South Africa, estimates suggest that there are between 60,000 and 90,000 waste pickers (Godfrey et al., 2016), while in Ghana estimates are for between 7,788 and 9,440 waste pickers (Baah-Boateng and Vanek, 2020).

Informal waste workers make a significant contribution to waste management systems and are instrumental in local recycling efforts, collecting 60% of the plastic recovered for recycling (Fair Circularity Initiative and Systemiq, 2024). For instance, in South Africa, an estimated 80-90% (by weight) of paper and packaging is recovered by informal waste pickers (Godfrey et al., 2016). The work of the informal waste sector not only adds value to the industry but also yields multiple other benefits, increasing the urban quality and liveability of cities worldwide (Gutberlet, 2023). These benefits including savings for local governments, job creation, reduced greenhouse gas emissions, decreased reliance on fossil feedstock, reduced landfill waste and mitigation of environmental leakage (Gutberlet, 2021; Pholoto and Chitaka, 2022; Fair Circularity Initiative and Systemiq, 2024; Tasaki et al., 2024). For example, informal waste pickers are estimated to have saved municipalities in South Africa between R309.2 and R748.8 million in landfill airspace (in 2014), at little to no cost, by diverting recyclables away from landfill, at ± 16-24 tonnes/picker/annum (Godfrey et al., 2016). For another example, the population of waste pickers in Durban, South Africa, not only engages in the collection of a diverse array of recyclables – such as cardboard, plastics and metals – but also adds value through the creation of products like cupboards and tables. Furthermore, their economic activities foster strong forward linkages to the formal economy, with most collected waste sold to

formal enterprises, indicating an essential yet undervalued contribution to the urban economy (Mkhize et al., 2014). The role of waste pickers has received international recognition, with a United Nations Environment Assembly resolution recognising “the significant contribution made by workers in informal and cooperative settings to the collecting, sorting, and recycling of plastics in many countries” (UNEA, 2022).

The significance and contribution of the informal waste sector in urban Africa is stark, considering that in many parts of Africa, the collection of household waste is chronically underfunded and mostly covers central and high-income neighbourhoods, while informal settlements, where the majority of the urban population lives, do not have a regular waste collection system (Gutberlet, 2023). On the African continent, more than 90% of waste is inadequately managed and ends up in uncontrolled landfills, is burnt or leaks into the environment (UNEP, 2018). Because of the relatively recent population transition from rural to urban, it is expected that countries in Africa will continue to undergo dramatic social and economic transformations with continuous rapid urban growth, which will also bring changes in lifestyle and consumer habits, purchasing of packaged goods, throwaway items and items made of plastic; these trends will also lead to further exponential growth in waste generation (UNEP, 2018). City administrations are not prepared for dealing with these demands, putting immense strain on existing waste management services and infrastructure (Gutberlet, 2023).

Despite the fact that the informal waste sector plays an essential role in managing city waste, and that the actors within it participate actively in urban economic systems, they face societal stigmatisation, operational hazards and low remuneration (ILO and WIEGO, 2017; Pholoto and Chitaka, 2022); they remain the workforce that has the highest exposure to social, economic and health risks without any social or occupational protection (Pholoto and Chitaka, 2022). For example, waste pickers in Durban, South Africa, are primarily own-account workers (99%), who navigate a challenging economic environment to sustain their livelihoods. Their monthly earnings average R1,565.50 (approximately USD 119), underscoring the financial precariousness of their work, despite an average 40-hour work week (Mkhize et al., 2014). Further, waste pickers are largely unacknowledged and unrecognised in policy and local mandates, and face significant systemic challenges including restricted access to waste (exacerbated by city policies), and increased competition from both formal companies and other informal workers, putting their economic stability and growth at risk (Mkhize et al., 2014; Pholoto and Chitaka, 2022). Moreover, the lack of basic and supportive infrastructure further compounds their operational difficulties (Mkhize et al., 2014).

Recognition and support for waste pickers at the local scale can enhance their economic security and contribute to more effective urban waste management systems. Thus, it is critically important that the significant role of the informal waste sector be acknowledged within African cities; there is therefore a crucial need for inclusive urban planning and policy acknowledgment of the vital role of the informal sector in waste management and recycling systems, and in the development of the local (and regional) circular economy, as advocated by others (for example, Pholoto and Chitaka, 2022; Gutberlet, 2023).

2.6. Youth and capability development domain

Youth constitute a large segment of urban populations across the African continent. Over 70% of sub-Saharan Africa’s population is under the age of 30, with many living in urban centres (UN, 2024). As such, young people can play a potentially significant role in the socioeconomic development of Africa’s cities in the coming decades, provided

that opportunities for economic growth and innovation are recognised and young people are fully empowered to embrace them. However, young people also represent the majority demographic in under- and unemployment rates in cities with fast-growing populations, shrinking formal economies and resulting in acute dependence on “making do” in informal and often precarious forms of work (Potts, 2013; Mastercard Foundation, 2020).

The studies drawn upon in this domain focused on five African cities: Addis Ababa, Addis, Kampala, Freetown, Maiduguri and Mogadishu (Homonchuk et al., 2024). The research for this domain employed a mixed-methods approach, combining quantitative data from surveys and censuses with qualitative insights from key informant interviews and focus group discussions. Findings from these approaches provide valuable insights for developing effective youth empowerment strategies (Homonchuk et al., 2024). Significantly, the presence of a youth and capability development domain (alongside the structural transformation and other domains) supports holistic thinking and approaches about the interaction between politics, political economy and systems in the context of labour markets and youth.

Homonchuk et al. (2024) highlight how experiences of precarity and insecurity related to finding and maintaining work are central to the experience of youth across the five cities. In this context, opportunities to obtain skills relevant to the labour market are of particular concern to young people. Across ACRC cities, young people report that the government-funded education systems provide education that does not enhance youth capabilities to facilitate transition into secure employment (see also Datzberger, 2018; Musika et al., 2019; Mukhaye, 2023). Climate change is still an emergent topic within government-funded African education systems (for example, Rwobusiisi et al., 2021), which therefore begs the following questions: a) to what extent will such education systems be equipping youth with skills necessary for entering a green economy, which is the only viable direction for the future of economic systems to meet global environmental challenges, key amongst which is that of climate change? And b) to what extent will such education systems be equipping youth with the skills and information necessary to undertake both mitigation and adaptation actions?

The ACRC cases also revealed that formal and informal technical and vocational education and training (TVET) programmes for young people – which in theory could address some of the gaps in government-funded education systems – are plagued by many challenges that limit their effectiveness (Homonchuk et al., 2024). One of the core challenges hampering the effectiveness of youth TVET programmes is the significant misalignment between the skills taught and the rapidly evolving demands of the job market. This misalignment will also be seen in the context of climate change and the green economy. For instance, many programmes still focus on traditional industrial skills, while neglecting emerging sectors such as renewable energy technologies and sustainable (urban) agriculture practices (Ouma et al., 2024). However, and linked to the structural transformation domain, interventions to upskill youth in green economy skills must be matched by interventions to shift economies

towards a green economy, otherwise there will be an extensive mismatch between skills development and the needs of the labour market.

On the one hand, the sections above have highlighted how educational systems are not going to be preparing youth for future green economy job markets, and are not going to be equipping youth with the knowledge and skills for mitigating and adapting to climate change. On the other hand, climate change impacts significantly undermine educational systems, which in turn hampers the ability of young people to develop into productive and resilient adults. For example, extreme weather events, such as floods and droughts, can damage schools, disrupt lessons and lead to prolonged school closures, thus interrupting educational attainment and limiting future opportunities for youth (Bennell, 2021). This decline in educational quality occurs against a backdrop of diminishing educational investments by many African governments, exacerbating the situation (Bennell, 2021).

The ACRC cases also highlighted how access to both government-funded education as well as private education and vocational training programmes is often out of reach for the most disadvantaged populations, given their high costs (Homonchuk et al., 2024; see also, for example., Mpyangu et al., 2014). Thus, a lack of access to education and training opportunities will further contribute to the low adaptive capacity of disadvantaged communities, particularly youth, which increases their vulnerability to climate change impacts (Striessnig et al., 2013; Muttarak and Lutz, 2014; Birkman et al., 2022; Ngcamu, 2023).

In addition to facing a precarious financial future, as highlighted by the ACRC cases (Homonchuk et al., 2024), youth face worsening impacts of climate change in coming decades, despite having contributed the least to the problem. Added to these injustices is the fact that children, in particular, are often the most vulnerable to a range of climate-related impacts. For instance, as mentioned in Section 3.7, children are most sensitive to the impacts of malnutrition, or to the disease outbreaks associated with urban flooding in informal settlements, as in the case of Dar es Salaam (see Section 4). Moreover, the voices of children and young people, particularly girls and young women, are often inadequately represented in decisionmaking forums on climate policies, despite their considerable vulnerability to climate impacts (UNECA, 2017; Kayizzi-Mugerwa, 2019). The underrepresentation and systematic exclusion of these groups not only heightens their risks but also curtails their ability to shape policy responses that are attuned to their needs (Awiti, 2022). To redress these disparities and build climate resilience, it is imperative to generate more gender-disaggregated data that can inform the crafting of gender-responsive strategies (Awiti, 2022).

Amid growing frustrations with the pace of change in climate change mitigation and adaptation, recent years have seen growing youth mobilisation to advocate for faster climate action as well as to offer innovative solutions (Apamaku et al., 2021; Roberts, 2023). For a concrete example of African youth activism in action, see Box 5. However, research also reveals that, given the extent of climate inaction across the continent, there is still significant untapped potential for youth mobilisation, activism and protest

when compared with other parts of the world (Zhanda et al., 2021). Tangibly involving youth in conversations and forums that determine climate action is vital to benefit from the energy, skills and ideas of young people, as well as to ensure that climate change mitigation and adaptation measures are contextually relevant (Benkenstein et al., 2020; Nkrumah, 2021; Shamiso et al., 2023).

Box 5: African youth climate activism: The case of Vanessa Nakate

The Rise Up movement, spearheaded by Vanessa Nakate, represents a significant force in African youth climate activism. As a Ugandan activist, Nakate has focused on the unique challenges faced by African communities due to climate change, including racial injustice and gender-based violence (Homonchuk et al., 2024). Her activism not only raises awareness but also pushes for policy changes that address these intertwined issues. Nakate's work is part of a broader wave of youth-led movements across the continent, calling for urgent and comprehensive climate action. This mobilisation demonstrates the potential of youth to drive significant environmental and social changes, even in the face of systemic barriers.

2.7. Health, wellbeing and nutrition domain

Access to healthy diets is essential to wellbeing and good health. Yet, in the five ACRC cities studied within the health, wellbeing and nutrition domain – Freetown, Lilongwe, Nairobi, Bukavu and Kampala – there has been a documented rise in food insecurity and a prevalence of non-communicable diseases (NCDs) associated with unhealthy diets (Tacoli et al., 2024). ACRC research identifies three major income and non-income drivers of food and nutrition insecurity in the five cities studied, two of which are particularly relevant in relation to climate change.

A key driver of food and nutrition insecurity is cost: consuming a healthy diet that includes fresh fruit and vegetables is expensive for urban residents, who depend on food purchases, and is especially so for low-income earners. This is exacerbated by the dependency of each city's country on international food markets, increasing their vulnerability to price increases. It is therefore necessary to consider what role climate change plays in decreasing the viability of national food markets – through its effects on crop yields and food quality – and what strategies can mitigate climate change effects on the agricultural sector (see Section 2.4). Encouraging urban, and particularly peri-urban, farming may also play a role in the provision of lower-cost fruit and vegetables, but crucially, must be resilient to climatic change. The health, wellbeing and nutrition domain thus has intricate links to the land and connectivity domain.

Beyond potentially increasing the availability of affordable fresh produce, urban agriculture also holds other possible benefits. Recent studies have shown that urban agriculture can also mitigate some of the negative impacts of climate change, such as urban heat islands, by increasing green spaces and improving air quality (Zezza and Tasciotti, 2010). Moreover, urban farming initiatives often provide valuable employment opportunities, especially for marginalised groups, including women and youth, thereby fostering social inclusion and economic empowerment (Mougeot, 2005; 2006). Highlighting the importance of innovative urban agriculture practices, the case study of

urban agriculture in Nairobi (Box 6) illustrates how these practices can effectively enhance food security and community resilience. However, while urban agriculture is widely recognised for its role in poverty reduction, food security, climate resilience and social inclusion of low-income urban residents and women, it has been extensively critiqued for not being economically or spatially feasible enough to make a sizeable impact on the overall food needs of African cities (World Bank, 2013; Specht et al., 2014).

Box 6: Urban agriculture in Nairobi, Kenya

In Nairobi, urban agriculture has emerged as a critical strategy to address food insecurity and enhance resilience to climate change. This practice involves cultivating crops and raising livestock within city limits, often in informal settlements, where access to affordable, nutritious food is limited. Urban agriculture provides a direct source of fresh produce for low-income households, reducing their dependence on expensive market-purchased food (Tacoli et al., 2024).

One notable example is the Kibera community, where local initiatives have transformed vacant lots into productive gardens. These gardens not only supply vegetables and fruits but also serve as educational hubs, where residents learn sustainable farming techniques. The impact of these initiatives is significant: participating households report improved dietary diversity and reduced monthly food expenses. Moreover, the communal nature of urban farming fosters social cohesion and collective action, which are vital for resilience against climate-related stresses (Tacoli et al., 2024).

Furthermore, urban agriculture in Nairobi contributes to the livelihoods of many households, with over 650 hectares of land under urban and peri-urban production (World Bank, 2013). However, the development of urban agriculture in Nairobi faces several challenges, including limited access to safe irrigation water, land tenure insecurity, credit and capital and the need for better integration into urban planning frameworks, which were all identified as constraints by producers in Nairobi (Tacoli, 2024). The average areas cultivated are small, especially for women-headed households, which limits the potential for large-scale food production (World Bank, 2013). Furthermore, container farming is common in densely built-up slum areas, highlighting the spatial limitations of urban agriculture in these settings (World Bank, 2013). Despite these obstacles, the success of initiatives in Kibera highlights the potential of urban agriculture to contribute to food security, health and wellbeing in African cities (Tacoli et al., 2024).

Amidst lingering uncertainties and scientific debate on the exact influence of climate change on African food security, there is evidence that rainfall plays a major, albeit regionally variable, role in agricultural productivity (Pickson and Boateng, 2022), while GHG emissions lead to an increase in malnourishment rates (Adesete et al., 2022). From a climate resilience perspective, the ability to import food and connect to a global supply system serves as a crucial buffering mechanism during times of localised climate stress. Although long supply chains are often criticised for their transport-related emissions, these emissions represent only a relatively small fraction of the overall impact on food systems. In Africa, emissions from pre- and post-production processes were significantly lower compared to other regions, totalling only approximately 0.4 Gt CO_2 eq. yr^{-1}, indicative of the agricultural and food processing

dynamics typical in regions with less developed agri-food industries (Tubiello et al., 2022). Moreover, between 1990 and 2019, while emissions from these pre- and post-production processes in Africa did increase, they continued to be a minor component relative to emissions from farming and land use changes. This indicates a gradual, albeit limited, rise in the impact of food system industrialisation and urbanisation, in contrast to more developed regions. Additionally, within the global context, Africa's emissions primarily stem from farm gate and land use changes, rather than from industrial or supply chain emissions, reflecting the less industrialised nature of its agri-food sectors (Tubiello et al., 2022).

More research is required to understand the link between climate change and the diversity, quality and quantity of food produced in Africa, which all play a role in overall food security and nutrition. To mitigate these impacts, nutritionally dense, climate-resilient crops (for example, drought-resistant varieties) must be prioritised, and barriers to enhancing the climate resilience of the agricultural sector need to be addressed. The contribution of the agricultural sector to greenhouse gas emissions, as well as unsustainable land-use change, cannot be overlooked. Addressing these issues requires incentivising and facilitating regenerative agriculture, agroecology and agroforestry.

Another driver of food and nutrition insecurity in cities studied by the ACRC is the pervasive incidence of water- and foodborne illnesses. Common afflictions such as cholera, dysentery and typhoid fever, often exacerbated by poor access to clean water and sanitation, are compounded by malnutrition and vulnerability to communicable diseases. This is particularly evident in dense urban neighbourhoods, where the convergence of malnutrition and diseases like malaria, tuberculosis (TB), as well as non-communicable diseases linked to pollution and poor diets, creates a compounded health crisis (Hambrecht et al., 2022). This is caused by inadequate access to basic water and sanitation infrastructure and housing, which has clear links to the informal settlements and housing domains (Tacoli, 2017). Climate change will increase the incidence of both water- and foodborne illnesses (Cissé, 2019). For example, increased air temperatures and El Niño events have been linked to a rise in the incidence of salmonellosis cases and diarrhoeal diseases, as food spoils more rapidly (Duchenne et al., 2021). The effects of this increase in foodborne diseases will be felt worst in parts of the continent without sufficient access to electricity to keep food fresh. Similarly, waterborne diseases have been shown to increase in prevalence during extreme climatic events, namely elevated temperatures, droughts and flooding, which often disproportionately affect children, as well as the elderly (Nichols et al., 2018).

While on average urban residents are less food-insecure than rural residents, residents of low-income, informal settlements are likely to be equally if not more food-insecure than their rural counterparts (Tacoli et al., 2024), which compounds their already high vulnerability to climate change. Good nutrition is a key component of healthy immune systems (Munteanu and Schwartz, 2022). By contrast, poor nutrition and weak immune systems translate to less resistance to infectious diseases likely to increase under

climate change (Katona and Katona-Apte, 2008). Poor immunity exacerbates the wide-ranging health impacts of climatic changes, including air quality impacts on respiratory health and infectious disease transmission (Van de Vuurst and Escobar, 2023). Children and youth are not only among the most vulnerable to malnutrition but also among the most vulnerable to a range of diseases and conditions that are likely to increase under climate change, such as cholera and malaria (WHO, 2023). Furthermore, as indicated in the ACRC's health, wellbeing and nutrition domain report (Tacoli et al., 2024), urban food retailers are increasingly exposed to increased variability and extreme weather events associated with climate change (Blekking et al., 2022; Tacoli et al., 2024). Informal food retailers in particular are impacted by slow-onset hazards together with sudden shocks, such as extreme rainfall or heat events, due to the precarity in the wider food system. Increased frequency and intense droughts may disrupt food supply chains on wider spatial scales (Blekking et al., 2022). The health, wellbeing and nutrition domain report (Tacoli et al., 2024) indicates that inadequate responses to climate change could lead to declining productivity as well as increasing food demands and prices, to which low-income urban populations are among the most vulnerable. Increased insights and understanding are required regarding how climate change intersects with food, health and nutrition issues in African cities (Tacoli et al., 2024).

Box 7: Strengthening urban food systems: The AfriFOODLinks initiative

The AfriFOODlinks project, coordinated by ICLEI Africa, emphasises the importance of peri-urban zones and local rural food-sheds over urban agriculture. This shift in focus is based on the understanding that protecting urban edges and ensuring the economic competitiveness of local rural farmers can have a more significant impact on food security and sustainability (ICLEI Africa, 2023). This involves protecting urban edges from development to shield productive agricultural sites from sprawl, ensuring that local food remains economically competitive against global imports through local-first public procurement guidelines, and maintaining local food distribution infrastructures. Moreover, shaping the type of food demand cities place on rural landscapes through advertising regulations, healthy food incentives and taxes on unhealthy foods can significantly enhance urban food environments (ICLEI Africa, 2023).

Fresh food trader at Lusaka's largest food market, Soweto Market.
Photo credit: ICLEI Africa (2024).

African cities face high rates of malnutrition, stemming from both undernutrition as well as rising rates of overweight and obesity (Tacoli et al., 2024). This is due to very rapid changes in the food system, especially the availability of cheap, ultra-processed foods and beverages, as well as major reductions in physical activity closely linked to sedentary urban lifestyles (Popkin et al., 2020). Furthermore, access to different forms of energy impacts cooking methods for households, thereby influencing the diets available to households (Battersby, 2019; Tacoli et al., 2024). As further discussed in Section 3.2 there are important links between the need for clean cooking solutions based on renewable/green energy and reduced climate change emissions and therefore mitigation that need to be considered in a holistic manner.

2.8. Safety and security domain

The safety and security domain is critically important for African cities, as these urban centres often experience high levels of insecurity, crime, conflict and violence, which have a profound impact on the lives of urban residents (Adzande et al., 2024). The safety and security domain research conducted by ACRC focused on six African cities: Nairobi, Bukavu, Freetown, Mogadishu, Lagos and Maiduguri. These cities were selected due to their distinct experiences with insecurity, shaped by factors such as political instability, conflict and socioeconomic challenges (Adzande et al., 2024). The studies employed a mixed-methods approach, incorporating interviews, surveys and community consultations to capture the lived experiences of residents. This methodology aimed to understand the nuanced and diverse perceptions of safety and security across different urban contexts and demographic groups (Kaganda Mulume-Oderhwa et al., 2023). However, the safety and security domain report did not surface climate-related issues specifically; therefore, this section draws upon findings from broader literature to discuss how climate change can aggravate safety and security issues in multiple ways.

Safety and security issues are exacerbated by rapid urbanisation, inadequate infrastructure, and weak governance systems (Adzande et al., 2024). Insecurity significantly impacts the daily lives of city dwellers, influencing their mobility, economic opportunities and overall wellbeing. Vulnerable groups such as women, children and the economically disadvantaged often bear the brunt of violence and crime, making the need for reform in this domain urgent to foster safer, more resilient urban environments (Kaganda Mulume-Oderhwa et al., 2023).

Environmental insecurity arises from climate-related events, such as fires and floods. Moreover, climate-related events have been linked to increases in violence. For instance, mental health issues stemming from climate and environmental shocks can lead to increased perpetration of violence against children, including domestic violence (Nicholas et al., 2020; Datzberger et al., 2023), with children already being particularly vulnerable to safety and security risks (as explained in the safety and security domain report: Adzande et al., 2024). While not a specific focus in the ACRC research under this domain, the intertwining of crime with climate change, alongside the cyclical relationship between poverty and urban crime, highlights how climate change-induced

poverty can escalate crime rates (Adzande et al., 2024). Increased aggression, violence and conflict between individuals in response to rising temperatures, especially in densely populated urban areas, have been well documented (Bollfrass and Shaver, 2015; Miles and Anderson, 2019; Memon, 2020). Conflict increases under climate change, with the displacement of people from rural to urban areas, and the displacement of people from one urban area to another, occurring wholly or in part as a result of climatic hazards (Burrows and Kinney, 2016; Brzoska and Fröhlich, 2016). For instance, flooding can displace people from one city settlement to another. The resultant pressure on land and resources can lead to conflict (Brzoska and Fröhlich, 2016). Displaced people – and particularly marginalised groups, such as women, children, those with disabilities and the elderly – generally face greater deprivation than other residents (Biesbroek et al., 2015), including very limited access to basic infrastructure and services, which heightens their vulnerability to a range of risks, from insecurity to climate change.

During deep dive engagements, the links between conflict and migration were highlighted as key issues for Lagos requiring further attention. Box 8 further crystallises the critical challenges faced in Lagos in the realm of safety and security as it intersects with the pressing issues of climate change. This box sheds light on the multifaceted impacts of environmental changes on urban safety, social cohesion and the profound effects on marginalised populations, notably women and girls.

Studies have also shown that climate change aggravates gender-based violence (Memon, 2020). For example, climate change heightens the erosion and destruction of WASH infrastructure, such as through extreme events, meaning women and girls have to travel further to access water and sanitation, which further aggravates their risk of exposure to violence (Memon, 2020). As climate change intensifies, it exacerbates existing vulnerabilities and inequalities, disproportionately affecting marginalised communities, including women and girls. Displacement, resource scarcity and economic instability due to climate-related events often heighten the risk of gender-based violence, as women and girls are subjected to heightened vulnerability in these situations (UN Women Watch, 2009). Additionally, traditional gender roles and power dynamics may exacerbate violence against women in the context of climate change, further restricting their ability to access resources, decisionmaking processes and support services.

Addressing gender-based violence in the context of climate change from a rights-based standpoint entails prioritising the fundamental rights of every individual, irrespective of gender. This includes ensuring access to safe and secure environments, equitable resource allocation and active participation in decisionmaking processes. The integration of gender perspectives into strategies for climate change adaptation and mitigation is crucial for addressing the underlying factors contributing to gender-based violence and advancing gender equality. By anchoring climate action in human rights principles, such as the rights to safety, dignity and non-discrimination, we can strive towards a future that is more equitable and sustainable for everyone.

The safety and security domain report also notes that a dominant theme emerging across all cities is that urban spaces are frequently sites of trauma as a result of lived experiences of insecurity (Adzande et al., 2024). Consequently, mental health is noted to be impacted, with post-traumatic stress a reality (Kaganda Mulume-Oderhwa et al., 2023). In this context, it is critical to note that climate change also exacerbates many social, environmental and risk factors for problems in mental health and psychosocial wellbeing (WHO, 2022). For instance, survivors of extreme climate-related events are at increased risk of post-traumatic stress disorder, suicide, depression and anxiety (Schwartz et al., 2015; Carleton, 2017; Burke et al., 2018; Silveira et al., 2021). Therefore, safety and security risks, and climate change risks, are likely together to heighten the mental health burden of vulnerable urban populations. In turn, mental health issues stemming from climate-related shocks can sometimes lead to increased aggression and violence, as noted in preceding paragraphs (for example, Datzberger et al., 2023). There are therefore likely to be complex interrelationships between trauma, mental health, climate change and safety and security challenges, though research still needs to systematically address these interrelationships.

As highlighted in Sections 2.1 and 2.2 of this report, the nexus between housing and security is undeniable – safe and secure housing is a critical underpinning of resilient communities. Quality dwellings and neighbourhoods with adequate infrastructure and services are not just shelters but provide refuge against disaster and other risks, thereby contributing to safety and security within urban ecosystems. The use of robust building materials and sound construction practices in informal settlements is crucial for protecting residents against extreme weather events. Inadequate housing materials, such as flimsy doors or roofing, can lead to heightened vulnerability, exacerbating the insecurities faced by informal settlement dwellers. Thus, reconfiguring shelter through climate-adapted and resilient design is imperative for safeguarding communities and promoting comprehensive urban safety and security.

Box 8: Insights from Lagos: Deep dive engagements on climate change urban safety and security

Deep dive reflections with domain and city leads from the safety and security domain in Lagos highlight the significant impact of climate change on urban safety and security, emphasising the need for integrated solutions that address the challenges of climate change, security and the wellbeing of vulnerable populations. Desertification drives nomadic communities towards urban areas like Lagos, escalating migration and conflict over scarce resources. This situation exacerbates safety, security and social cohesion challenges, contributing to the formation of new informal settlements. Additionally, flooding and infrastructure vulnerabilities in Lagos lead to contaminated water sources, causing disease and fatalities. The economic losses from climate-induced flooding severely impact small-scale businesses and can result in building collapses, due to weakened foundations. The human cost of displacement from flooding and other climate-related disasters is significant, affecting families and communities deeply, including the tragic loss of lives in major flooding events. Women and girls face disproportionate effects of climate change, impacting their livelihoods and exposing them to increased risks of violence. Moreover, the psychological and emotional shocks from insecurity, displacement and climate change trauma underscore the need for comprehensive support and interventions. These insights

underline the interconnectedness of climate change, urban safety, security and the disproportionate impacts on marginalised groups, advocating for a holistic approach that addresses the complex dynamics of climate change, urbanisation and social inequalities.

3. Solutions to the implications of climate change for ACRC cities and their priority complex problems (PCPs)

The ACRC city cases exhibit many PCPs that intersect across multiple domains, and that are impacted by climate change in diverse ways that require increased attention. The implications of climate change on the PCPs of the city cases are set out below by domain, with a discussion on practical solutions for addressing the impact of climate change on city PCPs (with the exception of the structural transformation and neighbourhood and district development domains, for which, at the time of drafting this report, there was insufficient data available).

In the domain of informal settlements, growth of informal settlements with inadequate risk-reducing infrastructure and services, as well as profound political marginalisation, remains a mounting challenge for many cities, including all the ACRC study cities. In African cities, informality leaves many residents exposed to precarious living and working conditions that exacerbate their vulnerability to a range of risks, including climate-related risks (Ouma et al., 2024). For instance, the Dar es Salaam city case notes how the lack of basic services contributes, among other things, to poor sanitation that exposes residents to disease outbreaks (as does the Maiduguri example) (Pasquini et al., 2020; Mohamed, 2022). Flooding (which can be driven in part by changes in rainfall) frequently overwhelms or destroys WASH infrastructure in informal settlements (Williams et al., 2019), leading to disease outbreaks such as cholera, the risk of which also increases with increasing heat (Nichols et al., 2018; Cissé, 2019). In Freetown, a significant proportion of the population is at risk of flooding and landslides, due to rapid urbanisation and high cost of decent housing in formal areas, with more people settling in informal settlements along the risk-prone coastal areas or on the steep slopes of the city (Freetown City Council, 2023).

Building resilience to climate risks is therefore critical, and one solution is to use participatory planning processes. The Dar es Salaam, Freetown and Mogadishu cases highlight the importance of bringing the voices of local residents and civil society into planning and policy decisions around urban development plans to halt the densification and sprawling of informal settlements (Ouma et al., 2024). For example, the Freetown City Council has collaborated with interest groups to reduce exposure to disasters, hazards and vulnerability in coastal and hillside informal settlements. It is critical that participatory planning processes strongly account for climate change issues. For instance, by ensuring that settlements are planned in ways that protect critical open green space within and around the settlements, for both mitigation and adaptation purposes, ICLEI Africa's UNA Resilience project[14] demonstrates how a myriad of participatory methodologies, including photovoice workshops, were employed to

14 See cbc.iclei.org/project/una-resilience.

engage local communities and stakeholders in visually documenting their urban environments. These workshops revealed the challenges, solutions and inherent value of urban natural assets. Through this inclusive process, participants felt empowered to articulate their priorities and concerns to decisionmakers. Additionally, youth workshops fostered creative envisioning of the city's future, as evidenced by vibrant drawings and blueprints. This collective effort culminated in an exhibition,[15] serving as a poignant reminder of the imperative to preserve and conserve urban nature for a resilient future. By brokering diverse perspectives, this exhibition effectively integrates community voices into decisionmaking processes.

The ACRC Kampala city case presents a model for revamping existing sanitation facilities to create a more participatory and inclusive regulatory mechanism for scaling-up, extending and regulating an off-grid sanitation service delivery model, increasing service access and coverage, particularly to underserved communities (ACRC, 2025). The proposed model, including a sludge transfer tank and three-wheeler vehicle at Ggaba Market, aims to be scaled up and lead to a more collaborative working arrangement between the different market stakeholders, the Kampala Capital City Authority (KCCA) and National Water and Sewerage Corporation (NWSC). It aims to work towards creating a more participatory and inclusive regulatory mechanism for extending and regulating an off-grid sanitation service delivery model, increasing service access and coverage, particularly to underserved communities in Kampala (ACRC, 2025). In Lilongwe, collaborative strategies between residents and state agencies have been adopted specifically to mitigate climate change-induced vulnerabilities in informal settlements. The Lilongwe City Council, together with the Department of Disaster Management Affairs, has established and trained ward-level civil protection committees to be contact points for disaster risk management programmes (Ouma et al., 2024).

Within the housing domain, decent and affordable housing plays an important role in urban and national development, and in relation to climate change, offers increased resilience for vulnerable groups to climate-related risks. It can also contribute to crime prevention and therefore interrelates with the safety and security domain. Low-income communities predominantly live in low-quality housing. The Dar es Salaam and Nairobi cases in particular demonstrate that access to affordable housing finance is a major challenge to most home seekers and builders in the city. Due to a lack of affordable housing options and the difficulties in securing housing finance to enable housing costs to be repaid over a long time period, most households acquire housing through incremental construction, using low-quality materials and locating in low-cost neighbourhoods (which are often flood-prone). Further, the Lilongwe and Freetown cases highlight how widespread lack of tenure security affects people's ability to invest in their property and/or neighbourhoods, which interrelates with the land and connectivity domain.

15 See africa.iclei.org/preserve-conserve-tinker.

ACRC research for Dar es Salaam highlights that there is a need to better understand the key factors hindering access to finance and the scaling-up of existing financing options, and to demonstrate that affordable housing finance can positively impact decent housing. With regards to the Nairobi case, ACRC research highlighted that it is expected that reduced housing construction costs would also increase the supply of rental housing and reduced rental prices, leading to greater quality and quantity of rental housing. From a climate perspective, one solution to housing domain problems is that standards and building codes for "decent, affordable housing" be envisaged, keeping climate considerations in mind. It is crucial to recognise that "decent" means "climate-resilient", and that this will require greater innovation and experimentation around building design, materials and construction to increase resilience and decrease carbon footprints. However, there is a risk that such innovations would increase the cost of housing. Hence, experimentation will also be required to keep costs down and to overcome the barriers preventing new materials and technologies from being implemented on the ground. The Lilongwe case study proposes education and support for technical training in the production of sustainable building materials, such as cement stabilised earth blocks and concrete cement blocks, which require less energy to produce. There are several examples of emerging innovation in this sector that need to be harnessed and supported for upscaling. For example, the Nairobi-based start-up company "Gjenge Makers"[16] (founded by Nzambi Matee), developed a lightweight and low-cost building material composed of recycled plastic with sand to create bricks that are stronger than concrete material (UN SDG Action Awards, 2024).

With respect to the land and connectivity domain, addressing the issue of mitigation is imperative, especially given the transport sector's significant contribution to greenhouse gas emissions. Transport microenterprises, such as motorcycles and rickshaw taxis, play a critical role in Dar es Salaam and Maiduguri, moving goods and people to markets and workplaces not served by public transport. Coordinated training, proper identification of riders, and institutional regulation are proposed solutions for neighbourhood and district economic development in Dar es Salaam, which could enhance security and efficiency in the city. The Maiduguri ACRC case study highlights the possibility of transitioning rickshaw taxis to solar power and ultimately to solar-powered minibuses, but remains small-scale. However, such transitions will require addressing broader structural changes, including financing and production costs.

Box 9 exemplifies Rwanda's approach to the challenges at the intersection of urban development, transportation and climate change. While ACRC did not undertake empirical research in Rwanda, this provides an important illustrative example of key issues under this domain. Focusing on the moto-taxi sector, the case study details a collaborative effort to reduce emissions and improve livelihoods, which presents innovative solutions for enhancing urban mobility. To integrate transport microenterprises within the public transport system and avoid duplication, regulation must be carefully considered. Planning and regulating these systems to be

16 See www.gjenge.co.ke.

environmentally sustainable is crucial. For example, there is potential to replace motorcycles and rickshaw taxis with bike taxis, provided there are appropriate incentives. Of critical importance to note is that before regulation there is a need for the participatory planning of hybrid systems. Regulations are only one outcome of this participatory planning.

Box 9: NAMA case study

The government of Rwanda has reaffirmed its commitment to achieve its ambitious nationally determined contributions (NDC) goals, but it has also acknowledged that there are significant barriers to financing, market activation and functional ecosystems that are specific to the expansion and scaling up of e-mobility throughout public transportation (Mitigation Action Facility, 2024). The transport sector – specifically, the use of motos for public transport – is a pivotal focus of Rwanda's NDC commitments, as the majority of Rwandans in Kigali use moto-taxis. As petrol-operated motos, they emit a high level of carbon emissions. Given its strong underlying economic benefits (lower operating costs, doubling of operator income), the Rwandan e-moto sector provides a potential accelerator for the country's green economy.

In coordination with the Rwanda Green Fund (FONERWA), Development Bank of Rwanda (BRD) and Carbon Trust, and supported by GIZ through the NAMA facility, ICLEI Africa worked to develop a funding mechanism and support programme to upscale the e-moto market in Rwanda. This included a credit enhancement facility that provides first loss funding to banks, as well as a rebate scheme that provides selected low-income (and female) operators with subsidies to lower e-moto downpayments. Support will also be provided to facilitate public–private sector coordination and engage development partners for additional funding and risk mitigation support. During the project duration, the direct and indirect mitigation targets are 620,706 tCO_2eq and 46,089 tCO_2eq respectively and the project will provide many taxi drivers with clean mobility alternatives, transport services and potentially lower fares (Mitigation Action Facility, 2024). Other key outputs from the upscaling of the e-moto industry include improvement of waste management; increased female participation as operators, riders and employees; and advancement of policies, standards and national replication (Mitigation Action Facility, 2024).

The Mogadishu case study highlights further, within the land and connectivity domain, how the state of Mogadishu's roads stems from a failure of urban environmental planning and drainage management. Recurrent urban flooding – that can increase under climate change as well as other drivers, such as lack of waste management – significantly impedes urban mobility and damages the built environment. This increases the range of stresses on informal and low-income households, thereby increasing their vulnerability to a range of hazards, including climate-related hazards.

In relation to the safety and security domain, insecurity is pervasive in many of the case studies (for example, Freetown, Maiduguri, Mogadishu, Nairobi). As highlighted in Section 3.8, climate change increases safety and security risks. Reducing safety risks that arise in African cities as a result of their locations in areas prone to climate-related hazards and as a result of inadequate housing structures has already been discussed. The Freetown and Maiduguri cases both suggest that addressing safety and security at community levels can start with hybrid community security structures through which

people protect their community with support from the relevant authorities, such as the police. Many of the cities studied highlight the role of youth in crime and violence, as both perpetrators and victims; drawing on the youth for such hybrid community structures may thus go some way towards empowering marginalised youth, whilst improving security. Education to increase the understanding among community residents and the police of the links between climate-related hazards and safety and security risks is key to mitigating spikes in these risks. For instance, educating communities and the police about the links between floods and gender-based violence can help direct the effort allocations of security structures (whether these are police or hybrid security structures); for example, security structures could monitor flood warnings, in order to place a greater number of members on stand-by to monitor and respond to the incidence of gender-based violence. Highlighting risks in this way helps to bring to the fore the interconnectedness of climate change with pressing development and other issues and also not overburden communities with multiple demands on time through addressing issues in a separate manner. Education can also help security structures know, for example, where to refer victims of gender-based violence for support (for example, health facilities, women's centres). Interestingly, within the youth and capability development domain, the Mogadishu case study discusses using youth-led peer-support social healing processes to address the impact of trauma and facilitate social healing, as well as youth-led social justice, under which informal, community-level justice systems could be adopted. Such solutions can also be critical to addressing gender-based violence specifically. Similar solutions may also be helpful for addressing conflicts that may arise from competition for land and resources as a result of migration and displacement of people (both from rural to urban areas, and within different sections of urban areas) as a result of climate-related hazards and their impacts (for example, drought-induced migration of people from rural to urban areas, or displacement of people from one urban settlement to others as a result of urban flooding).

In the health, wellbeing and nutrition domain, the Kampala, Freetown, Lilongwe and Nairobi cases specifically discuss how unhealthy diets pose a major morbidity and mortality risk. For instance, in Freetown, unhealthy diets pose a greater morbidity and mortality risk than unsafe sex and alcohol, drug and tobacco use combined. Climate change has major implications for food and nutrition security, as reviewed in Section 3.7. A gap that is revealed by analysis of the health, wellbeing and nutrition domain report (Tacoli et al., 2024) – and the related recommendations for the cities – is the linkage between urban nutrition issues and the diversity, quantity and quality of food production under climatic changes, which affects both food and nutrition security. For example, the Freetown city research brief (ACRC, 2024) refers to Sierra Leone's agriculture and fishery sectors being undermined by powerful international and national interests, including the refusal to use locally produced content to supply public sector programmes, the failure to protect national fishing resources from international fleets, and large-scale imports of rice. It is argued therefore that greater investment in domestic food production and distribution, including in urban areas, is necessary. But

further consideration needs to be given to how the resilience of the agriculture and fishery sectors might be affected by climatic changes, how it affects GHG emissions, and what can be done in this regard.

In the youth and capability development domain, examination of the Freetown, Maiduguri, Mogadishu and Kampala case studies highlights how youthful populations present significant opportunities for economic and social development. However, as outlined previously, a range of risks influence this potential, including inadequate education, high youth unemployment, poor healthcare access, limited political representation of youth interests, and others. In this context, the Freetown case notes the need to invest in education, economic development, entrepreneurship and technology access for youth and capability development. It is suggested that this investment be conducted in a way that would allow youth in African cities to position themselves at the forefront of nascent green economies. Thus, the Freetown case study notes that the formal education system and other initiatives – including the creation of strong public–private partnerships – should be geared towards solving other critical problems, including waste management and the green energy transition. An example of such a model is provided by the Kampala case study. The Kampala study recommends co-creating a plastic waste actor coalition under the Kawenja Plastic Waste Entrepreneurship and Innovation Hub, composed of settlement and city forums with the support of the ACRC Kampala team. This would entail building a network of informal youth plastic waste collectors mobilised around a “plastic-preneurship” hub focused on developing their competencies and skill sets to become innovative “plastic-preneurs”, who can also lead lobbying and negotiation for better prices with industrial sector firms.

More generally, informal strategies to tackle deficiencies in state-provided basic services present avenues for income generation among adolescents and young individuals (Homonchuk et al., 2024), and this effect has been particularly observable in activities related to waste management, as the literature has noted (Oteng-Ababio, 2012; Adama, 2014) and as the Kampala case suggests (see also Box 4). The different city case studies also suggest that, given the challenges that African cities face in relation to housing, it is an area of opportunity to train and certify youth in climate-resilient housing design and construction.

In conclusion, in African cities, it is important to benefit from international expertise and good practice, but also to own and promote African expertise and leadership. African-led solutions to climate change, as a developmental challenge that overlays and interacts with the socioeconomic issues each city faces, are vital, due to the contextual differences on the continent as a whole, and within and between African cities.

4. Concluding reflections: Key findings, research gaps and implications for urban reform efforts and implementation

Climate change overlays and exacerbates many of the existing challenges for African cities, but the responses to existing challenges can also, more positively, address both

mitigation and adaptation issues facing urban Africa. This section presents concluding reflections on climate change challenges identified across the ACRC domains and the cities and their PCPs, in relation to implications for urban reform efforts and implementation. The final section outlines key avenues for future research that could enhance urban resilience and sustainable development across the key domains. As this report is aimed at a wide audience of policymakers, practitioners and academics, the focus of this concluding section is wide-ranging.

For over two decades, ICLEI Africa has been working with African cities on their sustainability journeys, particularly in tackling climate change. This work has focused on enhanced planning and pilot-scale implementation to achieve sustainability goals, in parallel with advocacy for the vital role that locally led thinking and action has in achieving any national and international sustainability objectives, as well as an increasing focus on unlocking scaled finance for action. ICLEI Africa's analysis of the ACRC research conducted to date in relation to climate change aligns with insights and experiences across our programming to date. These insights include:

- Subnational governments play a pivotal role in enabling sustainable development and, in particular, in uplifting and empowering Africa's poorest residents, as the tier of government closest to the people.
- Subnational governments cannot perform this critical role alone. National governments play an essential role in enabling their subnational governments, especially when mandates critical to local development are not held by subnational governments; for example, the provision of energy is often a nationally held mandate.
- In light of this, multi-level governance is critical, all tiers of government working in coherence and practising the principle of subsidiarity and ensuring that the tier of government where mandates, policy levers and resources are held is the most relevant tier for effective implementation.
- Subnational governments are collaborating with communities, research organisations and the private sector in various ways across diverse contexts to help ensure the scale of change necessary. However, in our experience, most subnational governments seek to enable such, but often lack the means and methods to follow through on their collaboration ambition.
- Finance is critical to moving from talk to action.

Crucial to all this work is the capacitation and resourcing of intermediary organisations and individuals that are skilled at bringing diverse stakeholders and sectors together to tackle challenges in integrated and systemic ways. When urban challenges are not tackled in such integrated ways, we risk causing unintended negative ramifications, which we can ill afford as African urban areas face urgent sustainability polycrises.

It is unsurprising that one of the common denominators of the ACRC city cases is the high proportion of low-income residents, particularly those that reside in informal settlements, who are most at risk from climate change. Poverty alleviation through local job creation/employment is recognised as an essential developmental need of urban areas in Africa and is critical to reduce the exposure and vulnerability of many city

residents to the impacts of climate change. As this report has discussed, efforts to improve labour productivity in urban areas in Africa must explicitly address the challenges and opportunities of climate change.

In this context, skills development to bring people into the local economy in a manner that meets mitigation and adaptation goals is critical. As the ACRC case cities have demonstrated, employment and skills development are most crucial for young people. The ACRC cases have highlighted how one area of significant opportunity for addressing cities' PCPs, whilst mitigating and adapting to climate change, exists at the nexus between incremental housing production, building materials and local employment and skills development of youth. There is considerable potential for upscaled training and education in environmentally friendly, energy-efficient and climate-resilient housing construction – particularly for the youth – thus meeting local employment needs and improving the delivery of affordable, decent housing that is compatible with both mitigation and adaptation goals. The delivery of this kind of intervention can be met by actors both within the private and public sector, and potentially also by NGOs at different levels.

Much of the research conducted in the ACRC cities has also emphasised the primary role that micro- and small-scale providers do and/or can play across many critical domains (for example, housing, safety and security, land and connectivity, and so on) in providing essential goods and services, particularly those operating in the informal sector. These goods and services can be highly relevant to the climate change sphere, as is exemplified by the case of the informal waste sector. The informal sector contributes significantly to local economies, sustaining livelihoods for a substantial portion of the urban population. Meeting poverty alleviation goals as well as adaptation and mitigation goals through local job creation and employment cannot be achieved in urban areas in Africa without recognising and supporting the informal sector (and micro- and small-scale service providers) through urban development policies and programmes. Within this recognition and support, upskilling micro- and small-scale actors, including all genders, youth and persons with disabilities, is again critical. Training opportunities, however, do not have to be formalised. Beyond the role that private and public sector actors can play in training and upskilling, as well as NGOs, peer learning and neighbourhood apprenticeships can also be relevant here, paving the way for locally led interventions.

Recognising and supporting the informal sector, and micro- and small-scale service providers, must of course not be limited to training and upskilling. Integrated urban policies will need to recognise the informal/small-scale sector's role, support its integration into formal economic frameworks and strengthen its resilience to climate variability. These goals can be addressed by urban governments through participatory approaches and inclusive planning processes. These goals can also be addressed through actions that are more locally led, such as building coalitions that can advocate and lobby for the informal sector and micro- and small-scale service providers.

The ACRC cases have also highlighted how participatory approaches and inclusive planning processes are critical for cities to adopt in their planning processes more broadly, to effectively address their PCPs and the implications of climate change on their PCPs. For instance, within spatial planning, local residents and civil society can be brought into planning and policy decisions around urban development plans to halt the densification and sprawling of informal settlements and reduce exposure and vulnerability to climate-related events.

Examination of the PCPs of cities from a climate change perspective also suggests the need for integrated and multisectoral approaches, as well as the need for collaborative governance arrangements. City governments and residents cannot always resolve the challenges they face alone. For example, no single intervention, government level, sector or actor will be effective alone at addressing the upstream factors that enable healthy diets; the challenge demands coordinated action across sectors, scales and actors. Institutional and governance issues and challenges will arise around multisectoral and collaborative governance approaches. For example, issues around where responsibilities for addressing climate change are placed institutionally; for another example, how to manage the tensions and complementarities between formal and informal governance arrangements and their overlaps. However, more concrete suggestions and examples of how integrated, multisectoral and collaborative approaches might work in practice are required, and this will be part of the implementation phase of the ACRC.

Dealing with the PCPs of cities additionally requires being able to access finance/unlock finance (for example, for scaling up interventions); this finding is emphasised across ACRC domains and cities, but few practical solutions are offered in this regard. Box 10 below provides insights from ICLEI Africa's experiences as to how finance to support locally designed initiatives can be scaled. There are limited examples in the ACRC research of how accessing or unlocking greater finance can practically be achieved, despite the rising availability at a global level of climate finance. Some important considerations regarding this issue include: planning and investment in neighbourhood adaptation and resilience need to deploy diverse sources of finance, including climate financing, to improve neighbourhoods, supply necessary infrastructure, and incrementally upgrade low-quality units to improve the housing sector.

Box 10: ICLEI Africa spotlight on scaling finance to support locally designed initiatives

Finance is critical to moving from talk to action. The current global financial architecture is set up in such a way that direct access to significant finance – whether grant- or loan-based – for African subnational governments and communities is almost impossible in most contexts. Our work will continue to advocate for transforming the financial architecture in ways that better enable the flow of finance for sustainable development (which should be all finance) directly to those who bear the brunt of the challenges of the current and future sustainability polycrises, while being realistic and practical about not waiting for this transformation, and enabling local finance within currently available systems.

ICLEI Africa's sustainability finance journey has included the sourcing and co-development of urban project pipelines. Unsurprisingly, there has been an inundation of project ideas and concepts. Many of these project concepts struggle to attract finance, due to challenges such as:

- Lack of creditworthiness of the institutions requesting finance for these projects.
- Project ticket sizes being too small to be viable from a donor/development finance institution (DFI) transaction advisory perspective.
- The proposed projects not having the required financial and impact-related measures factored in and visible – sometimes due to those developing the projects not being aware that this is a donor/DFI requirement. If aware, those developing the projects often do not have the resources to develop a compelling case for financial viability and impact for their project(s). Where resources for this technical assistance are available, the data requirements are often not able to be met.

The crux of the issue with scaled urban finance is one of risk – the perceived risk of financing locally led projects.

In response to this, ICLEI Africa's Sustainable Finance Centre (SFC) has pioneered – with various partners, cities and donors – multiple programmes and projects, where via learning by doing we are uncovering opportunities, success factors and catalytic enablers for unlocking finance for urban sustainability. The SFC is doing this by playing the vital and often underresourced intermediary role needed to bridge divides between crucial stakeholders, ensuring that all actors involved in the project development value chain work in an integrated manner. This role is critical to increasing the chances of African urban projects reaching bankability and implementation.

The SFC performs the following activities:

- Project development support throughout the entire project development lifecycle, in partnership with all tiers of government, DFIs, multilateral development banks (MDBs), project preparation facilities (PPFs) and the private sector.
- Piloting of business models to support the private sector in the development and deployment of context-relevant sustainable technologies and solutions.
- Co-developing new and tailoring existing financial instruments for African urban projects, in partnership with MDBs, DFIs, PPFs and country-specific agencies.
- Capacity building and tool development on a variety of topics and sectors relevant to unlocking finance for local sustainability action.

A selection of SFC projects are described below, to depict this work:

1. Under the Alternative Finance for Municipal Embedded Generation (AFMEG)[17] project, ICLEI Africa worked with the Development Bank of Southern Africa (DBSA) to co-develop four renewable energy projects with intermediary cities in South Africa, with all four of these projects (the first four municipal projects to do so) having met the criteria and entered into the DBSA's PPF. Once implemented, these projects will unlock USD 114 million in climate finance and save over 36 million tonnes of CO_2eq.

   The AGMEG project has:

   - Created a pathway for municipalities in South Africa to unlock climate finance from DBSA's Embedded Generation Investment Programme (EGIP),[18]

17 AFMEG was funded by the UK government through UKPACT. See https://youtu.be/91vIZnrLJIA, www.ukpact.co.uk/country-programme/south-africa.
18 See www.dbsa.org/projects/embedded-generation-investment-programme-egip.

- Charted a course for other municipalities across the continent to enter DFI and MDB's PPFs (in multiple sectors) – increasing their chances of accessing climate finance, and
- Contributed to nuancing the discourse that finance for intermediate municipalities is too risky.

Project outputs include:

- Policy and capacity analysis with recommendations,
- A six-part capacity building programme,[19] and
- The development of pre-feasibility studies and financial models for each municipality.

2. Working with the Rwanda Green Fund, the Development Bank of Rwanda, GlobalDF and Carbon Trust, the SFC co-developed a financial mechanism that will accelerate the deployment of e-motos in Rwanda, successfully passing the DPP of the Mitigation Action Facility.[20] Once fully implemented, the project is expected to enable the deployment of 52,439 e-motos, mitigate 422,556 tCO_2e, and secure EUR 197 million in finance.
3. Working closely with FEICOM (Fonds Special d'Equipement et d'Intervention Intercommunale), the University of Yaoundé 1, the Cameroonian government (all tiers), and intermediary community-based organisations, the SFC is addressing knowledge-to-action gaps that are hindering locally led adaptation projects from being financed. The Brokering Innovation for Decentralised climate finance and Gender Equality (BRIDGE)[21] project is improving access to finance that enables locally led and gender-responsive climate change adaptation action in Cameroon, with learnings scaled to the central Africa region and beyond.

   Project outputs include:

   - An interactive mapping tool that improves transparency on adaptation finance flows in Cameroon and how locally led and gender-responsive they are.
   - Building the capacity of locally based intermediaries and knowledge brokers, to enhance their ability to improve access to gender responsive and locally led adaptation finance at the city scale.
   - Co-developing a set of GESI criteria with key roleplayers in the Cameroonian climate finance landscape.
   - Adjusting an existing financial mechanism to be more gender-responsive and locally led.
   - Co-developing city-scale projects that harness this adjusted financial mechanism and apply the GESI criteria.

4. As host of the Covenant of Mayors Sub-Saharan Africa (CoM SSA)[22] Secretariat, ICLEI Africa has worked with signatory cities (380+) and implementing partners – GIZ, Expertise France, AFD and AECID – to develop and conduct:

   - A pipeline of project activities derived from council-endorsed climate action plans,

19 See https://learnwithicleiafrica.org/courses/municipal-embedded-generation-toolkit.
20 The Mitigation Action Facility has various partners and donors. See https://mitigation-action.org/projects/rwanda-accelerating-the-deployment-of-electric-motorcycle-taxis-e-motos-and-e-buses.
21 BRIDGE falls under the CLARE programme, which is co-funded by the Ministry of Foreign Affairs of the Netherlands and the International Development Research Centre (IDRC). See https://clareprogramme.org.
22 CoM SSA is co-funded by the EU, BMZ and AECID, and co-implemented by AECID, Expertise France, AFD and GIZ. See https://comssa.org.

- A climate finance course[23] tailored to sub-Saharan African cities (undertaken by over 750 practitioners in French and English to date),
- Five project concept notes and two pre-feasibility assessments, with support provided to apply to relevant PPFs, and
- Significant capacity building with signatory cities, in collaboration with PPFs and DFIs.

5. The SFC has supported the Steve Tshwete Local Municipality (South Africa)[24] in developing a just transition chapter within its core development policy (its Integrated Development Plan), which is linked to a Just Transition Roadmap and a pipeline of just transition projects. This project involved assisting a municipality located within the heart of South Africa's coal belt navigate what the just transition means in its context and how to develop just transition criteria that can be applied to projects. Three of these just transition projects have been developed into concept notes with financial models. These projects were showcased at a high-level roundtable entitled: *Funding South Africa's Just Transition – The Municipal Opportunity*, where discussions were held on the development of a framework tackling how local just transition projects can attract finance, harnessing political, technical and financial levers in the South African landscape.
6. In Kenya, as part of the 100% Renewables Cities and Regions Roadmap (100%RE) project,[25] the SFC built the capacity of Kenyan national and subnational government officials in prioritising sustainable energy projects and developing them into concept notes that can be discussed with PPFs and DFIs for additional support. Four concept notes have been developed: a) solar mini grids in markets; b) solar-powered water-pumping systems; c) clean cooking in peri-urban areas; and d) e-mobility for two- and three-wheelers; as well as a pre-feasibility study for energy efficiency and renewable energy measures in eight Kisumu county hospitals. Each are now being discussed with potential PPFs and donor partners for further development.
7. The Enabling African Cities for Transformative Energy Access (ENACT)[26] programme is a high-impact, multi-country initiative that is transforming clean cooking access in informal settlements. Through policy advocacy, public sector capacity building, and the development of public finance mechanisms, the programme supports African governments to enable clean cooking ecosystems that can provide life-changing and environmentally impactful clean cooking access for the most vulnerable residents of African cities. Alongside support to the public sector to align policy and resource flows with national and global clean cooking targets, the ENACT programme applies catalytic grant capital and technical assistance in support of the development of market-led clean cooking access models by clean cooking companies, who have yet to unlock what is perceived as a limited market. There is huge potential for scale, and even in its early stages, ENACT has enabled improved clean cooking access to over 20,000 people, created 60 jobs, and contributed to local partner companies leveraging almost a quarter of a million pounds sterling in RBF and concessionary finance.

ENACT recognises the multidimensional impacts of improved access to clean cooking, not least the economic and opportunity cost savings, as well as the health and emissions abatement

23 See https://learningportal.comssa.org/courses/com-ssa-finance-course.
24 The recent work with Steve Tshwete Local Municipality has been funded by AFD, and builds on 12 years of collaboration via the UrbanLEDS programme, which was funded by the European Commission and jointly implemented by ICLEI and UN-Habitat.
25 The 100% RE project was implemented by ICLEI and funded by the International Climate Initiative (IKI), which is implemented by the BMWK (the German Federal Ministry for Economic Affairs and Climate Action) in close cooperation with the BMUV (Federal Ministry for the Environment and Consumer Protection) and the Federal Foreign Office. See https://renewablesroadmap.iclei.org, www.international-climate-initiative.com.
26 ENACT is funded by UK Aid's Transforming Energy Access (TEA) programme; ENACT in Uganda is funded by FCDO Uganda. See https://africa.iclei.org/project/enact.

potential of the clean cooking transition. ENACT has enabled new clean cooking markets to be activated in Sierra Leone and Uganda, with the flexibility that catalytic grant capital provides, and has most recently responded positively to an invitation from the government of Uganda, supported by FCDO Uganda, to scale the initiative within the Great Kampala Metropolitan Area (GKMA), a regional economic hub in Uganda.

In the coming year, the SFC will incubate the African Cities Clean Cooking Facility, to crowd in additional resources to further scale ENACT models of deployment.

An overarching conclusion from reviewing the ACRC research is that learning from innovation, experimentation and testing has considerable potential to underpin future policy and practice in African cities aimed at addressing their PCPs (and the related intersections of PCPs with climate change). There have been considerable favourable policy developments in recent years across African cities in support of climate change action and informal settlements. However, programming and practice require significant attention and cities must be open to continuous learning as they navigate their urbanisation challenges.

In light of the above, and based on key findings from a detailed review of ACRC outputs, engagements and secondary literature, several future research opportunities and gaps are identified below. The synthesis of findings under the ACRC climate change theme underscores the need for a comprehensive exploration of multisectoral interventions within the context of climate change resilience-building.

The final section below presents key (although not exhaustive) avenues for future research that could enhance urban resilience and sustainable development across the key domains.

Efficacy of integrated multisectoral interventions: Investigating how the interweaving of various urban systems, such as water, sanitation, hygiene (WASH), drainage, transport and clean energy, with informal settlement regularisation, housing and land-use planning can coalesce to strengthen climate resilience and promote health. Despite notable recent advancements, as evident in ACRC research across diverse cities, there remains an observed gap where there has been inadequate or limited engagement with climate change issues within the informal settlement and housing domains across the African continent. Detailed case studies should map out how these integrated approaches can be effectively employed, their benefits and the processes needed for successful implementation.

Joint approaches to systems and domains: Related to the above, for the future, ACRC will continue to benefit from holistic approaches to addressing key systems and domains to achieve substantial health and climate resilience benefits. Significant considerations include the practicalities of realising such benefits and identifying political barriers and policy opportunities that could be exploited. For example, investigating PCPs and coalition-building as mechanisms to drive such joint efforts, with a specific climate change lens. The implementation phase of ACRC will focus more strongly on climate change issues across the crosscutting domains.

Resilient strategies in informal settlements: There is a clear mandate to examine the factors that contribute to the success, challenges and scalability of participatory strategies in informal settlements, with more focus on initiatives such as sanitation innovations in Dar es Salaam and the upgrading of Mukuru in Nairobi. A key research area, and one that ACRC is committed to prioritising in the implementation phase, is to improve understanding of effective participatory models in varying urban contexts, even if the original initiatives are still small-scale or not fully operational.

Climate action and socioeconomic development: Critical aspects of ACRC's implementation phase include: consideration of how climate action intersects with socioeconomic development; and assessing how climate resilience can be interwoven with broader development goals, with a particular focus on practical and locally appropriate solutions. This could also involve identifying strategies to ensure sustainable urban development and how urban resilience contributes to the achievement of these goals.

Strategic role of diverse institutions in climate resilience: More research and insights are required to understand potential strategic roles for organisations in leading climate change mitigation and adaptation efforts within urban settings. Key areas of potential analysis include institutional capacities, potential funding models and frameworks for long-term climate action planning. These aspects have been strongly recognised and form part of the work being undertaken in ACRC's implementation phase.

Regulatory frameworks and urban resilience: A significant research avenue under ACRC's neighbourhood and city work on climate change is the examination of urban planning regulations, particularly in coastal cities like Lagos and Accra, which are currently insufficient for addressing coastal erosion and flooding. It is important for future research to consider how planning standards need to be updated and implemented, and what supporting mechanisms are required to effectively counter these issues. The gap in regulatory frameworks suggests an urgent need to develop and implement regulations that are robust enough to manage the escalating threats of climate-induced phenomena. It is critical to ensure that such studies are not detached from practice interventions and the realities on the ground, and that barriers and opportunities are centrally considered.

Sustainable building materials and practices: There is a noticeable discrepancy in building materials and construction practices, with a marked gap in discussions around carbon-neutral construction in African cities. The prevalent use of concrete and other cement-based materials contributes to GHG emissions, although these are minimal compared to emissions from other continents, such as Europe.

Climate-resilient urban food systems: Analysis of domain reports reveals a gap in the link between urban nutrition issues and the diversity, quantity and quality of food production under climatic changes. Future research should consider how climate-resilient food production systems that emit fewer GHGs can be incentivised and promoted in urban areas. This includes the integration of urban food systems planning,

such as school farming, in participatory processes for planning informal settlements. Additionally, it is vital to examine policies and planning in peri-urban and rural areas that supply food to cities. Research should extend to exploring agricultural systems that meet both adaptation and mitigation goals, focus on the production of more nutritious foods under climate change, consider market systems and remove barriers such as access to seeds for climate-resilient varieties. For example, the need for greater investment in domestic food production and distribution to improve resilience in sectors like agriculture and fishery in the face of climatic changes and GHG emissions is highlighted in the Freetown research brief. However, there is a lack of consideration on how to adapt these sectors to be more resilient to climatic changes – a key focus area for future research. The AfriFOODLinks project outlined in this report addresses several of these key gaps.

Emergent issues in climate education: The inclusion of climate change topics within government-funded African education systems is still nascent, raising critical questions about the preparedness of young people for the emerging green economy. There is a research gap in understanding to what extent current educational curricula are equipping youth with the necessary competencies for jobs in environmentally sustainable sectors. This gap is particularly pressing, given the inevitable shift towards green economic practices globally and the crucial role such jobs will play in addressing major environmental challenges, including climate change. As we explore the intersection of climate vulnerability and access to education, it is vital to scrutinise whether disadvantaged youth, who are also the most affected by climate impacts, are receiving the educational opportunities necessary to participate effectively in – and benefit from – a green economy. Investigating this relationship offers a pathway to enhance the adaptive capacity of disadvantaged communities and decrease their vulnerability to climate change.

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