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Assessing climate vulnerabilities of urban food systems and institutional responses: the case of Bulawayo, Zimbabwe

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The 21st century has witnessed a notable surge in global urbanization, particularly impacting African cities like Bulawayo, Zimbabwe. However, urban development in these regions has brought about challenges such as rising urban poverty, governance gaps, and service delivery issues. Compounded by climate change threats, urban food systems like those of Bulawayo face heightened vulnerabilities. This study delves into the specific climate vulnerabilities of Bulawayo's urban food system, evaluating the effectiveness of existing institutional frameworks and policies in addressing these challenges. Employing qualitative methods including key informant interviews and policy document analysis, the research highlights critical gaps in the current institutional response to climate-related food system vulnerabilities. Drawing insights from global case studies like New York City and Bangkok, the study provides valuable policy recommendations to enhance the resilience of urban food systems in Bulawayo and similar African cities to climate change impacts. Key findings reveal a robust national institutional framework guiding local authorities, yet there exists a disconnect between policies and climate-sensitive agricultural practices in Bulawayo. However, proactive initiatives by NGOs and the national government show promise in promoting climate resilience. The study underscores the urgent need to bolster agricultural extension services, scale up climate-smart agriculture initiatives, integrate urban agriculture into broader climate adaptation strategies, enhance institutional coordination, and secure sustained funding to fortify urban food systems in Bulawayo against climate vulnerabilities.

KEYWORDS

climate change, vulnerability, urban food systems, adaptive, governance, institution, Bulawayo, Zimbabwe

Introduction

Globally, there has been a phenomenal increase in urbanization (Baeumler et al., 2021; UN HABITAT, 2022a) so much so that the United Nations, Department of Economic and Social Affairs, Population Division (2019) identifies urbanization as one of the four mega-demographic trends of the 21st Century. A significant proportion of urbanization is being experienced in Africa, with the UN-Habitat highlighting that in 1950 Sub-Saharan Africa and Oceania were the least contributors to world urbanization but "…[t]hese two regions—together with Northern Africa and Western Asia—are projected to experience the biggest increase in the city population share in the future" (UN HABITAT, 2022a, p. 40). Similarly, Baeumler et al. (2021, p. 9) opine "…seven of the ten countries with the fastest projected urbanization rates between 2018 and 2050 are located in Africa." Whilst urbanization presents prospects for socio-economic advancement for African cities, developments on the ground also point to many negative developments linked to it. Several studies have highlighted that

urbanization in Africa has not been matched by concomitant economic development (Blekking et al., 2022; Haysom, 2014). This mismatch has led to serious negative ramifications such as rising urban poverty levels (Obeng-Odoom, 2017) and governance deficits resulting in challenges of service delivery and growing levels of informality being the defining features of the African urban scape (Resnick, 2014; UN HABITAT, 2014). This urban development trajectory is worrisome when one considers that urbanization, if uncontrolled and unplanned has the potential to increase vulnerability to a plethora of external shocks with a likelihood of negatively affecting the livelihoods of especially the urban poor. This is a point underscored by UN HABITAT (2022a, p. 9) which argues that "… millions of city dwellers in different parts of the world will continue to live in a future that is unfolding without the necessary scaffolding against the many threats to humanity that eclipse their dream of a better urban future." Climate change and variability are part of such threats.

The relationship between climate change and urbanization is a symbiotic one, with urban areas on one hand accounting for 70% of greenhouse gas emissions (GHG) whilst on the other hand being the much more exposed to the vagaries of climate change (UN HABITAT, 2022b). This relationship much more precarious for urban areas experiencing high levels of population growth (most of which are in Africa and Asia). According to Verisk Maplecroft Climate Change Vulnerability Index (2018), 86 of the 100 fastest growing cities are in Africa. Significantly, 79 of these cities face extreme exposure to the impact of climate change according to the Climate Change Vulnerability Index (Versik Maplecroft, 2018). There is therefore a clear danger posed by climate change to urban populations and infrastructure in Africa. Studies by several scholars and institutions attest to this existential threat by opining on the vulnerabilities of African cities to climate change and literature is abound with cases of how the phenomenon is likely to impact, and in some cases is already affecting African urban areas in diverse ways. For instance, some cities are noted to be experiencing increased frequency and intensity of cyclones and flooding (Salami et al., 2017; Zehra et al., 2019; UN HABITAT, 2022a; Kareem et al., 2020); whilst others have to contend with increased frequency and intensity of droughts (Kareem et al., 2020; African Development Bank, 2022); and yet others are faced with increased incidences of fires and heatwaves (Ngoungue Langue et al., 2023; Li et al., 2022; Ranasinghe et al., 2021).

The threat of climate change to African cities is even much more perilous if one also factors the downstream impacts of its resultant extreme climatic events already highlighted in the foregoing. This is largely because whereas African cities are threatened by climate change, this threat is increased because African cities are the epicenters of the continent's economic activities (African Development Bank, 2022). For example, climate change poses a serious threat to urban food systems in the continent. Notwithstanding the challenges bedevilling African cities highlighted in the foregoing, there is growing consensus that there is scant attention in the body of knowledge on urban climate change in the African continent (McQuaid et al., 2018; Pasquini, 2019). Furthermore, research on climate change and food security has tended to focus on the impact of climate change on food production to the detriment of other aspects of food systems. In this regard, Trisos et al. (2022, pp. 1349–1,350) point out "[a] significant knowledge gap, therefore, exists around the complex ways in which climate change will interact with broader components of African food systems, and strategies for making these systems more resilient…." In addition, most of what constitutes the body of knowledge on food systems in Africa has historically taken a rural dimension, a development justified by the population distribution dynamics and modes of food production then (Blekking et al., 2022; Maphosa, 2022; Zimmer, 2022). On the governance side, Zievergol (2022) opines that African cities have been sluggish in coming up with adaptation and mitigation policies and practice, yet the UN HABITAT (2022a) argues that at the core of climate action in future cities should be the building of appropriate governance and institutional structures. The importance of governance, more so the institutional element is apparent in its recognition in major multilateral agreements meant to build resilience against external shocks such as climate change. Some of these frameworks include the Sendai Framework for Disaster Risk Reduction (DRR), the Sustainable Development Goals (SDGs) and the Paris Agreement on Climate Change.

In view of the knowledge gaps highlighted in the foregoing, the current study contributes to the broader academic understanding of the relationship between climate change and urban food systems in African cities. The study broadens our understanding of the challenges and solutions related to climate vulnerabilities in urban food systems by assessing institutional readiness and effectiveness of responses to climate change related vulnerabilities affecting or likely to affect the city of Bulawayo in Zimbabwe. Thus, the specific objectives of the study are to: (1) identify and assess the specific climate vulnerabilities faced by urban food systems in Bulawayo, Zimbabwe; (2) investigate the existing institutional framework and policies aimed at addressing climate vulnerabilities in urban food systems in Bulawayo; (3) analyze the effectiveness of institutional responses in mitigating climate vulnerabilities and enhancing food security in Bulawayo and (4) Provide policy recommendations for enhancing the resilience of urban food systems in Bulawayo and similar African cities to climate change.

In terms of organization, after this introduction, the paper proceeds to reflect on the analytical framework where both theoretical and conceptual frameworks governing the study's approach to climate change, urban food systems and governance is established. The methodological path charted in the study is discussed next. The presentation and discussion of the study's findings follows guided by the thematic approach as informed by the study objectives followed.

The climate change-urban food systems nexus: an analytical framework

To gain a deeper understanding of the relationship between climate change and food security, it is much more helpful to employ the food systems lens. Using this lens helps to better understand the many elements, including their complex interactions, contributing to the observed food security outcomes. In addition, a food systems aids "…to effectively understand and identify vulnerabilities that may contribute to food insecurity and hunger" (Zimmer, 2022, p. 9). The utility value of the food systems approach is apparent in the conceptualization of a food system itself. FAO (2016, para. 1) points out that food systems:

> encompass[ing] the entire range of activities involved in the production, processing, marketing, consumption and disposal of goods that originate from agriculture, forestry or fisheries, including the inputs needed and the outputs generated at each of these steps. Food systems also involve the people and institutions that initiate or inhibit change in the system as well as the socio-political, economic and technological environment in which these activities take place.

A food systems approach therefore allows for the interrogation of multiple factors affecting food security including but not limited to activities, actors and different kinds of environments (such as policy, socio-political, economic) that shape the food system. The interactions of these different elements leading to particular food security outcomes is schematically represented in Figure 1.

Figure 1 effectively summarizes the interconnections between climate change and food systems. The figure illustrates that environmental factors, including climate change, constitute one of the key drivers of food systems. Consequently, any adverse alterations in the natural environment are likely to lead to negative outcomes in food security due to reduced productivity levels. This analysis does not consider potential interventions by various actors within the food system that could modify anticipated outcomes. These interventions represent a secondary tier of food system drivers, which may involve advancements in technology and infrastructure, shifts in socio-cultural norms and processes, and changes in the political and economic landscape. Therefore, the secondary layer of food system drivers has the capacity to either amplify or mitigate the influence of primary food system drivers. For instance, the implementation of policies promoting climate-smart agricultural practices in response to escalating risks posed by extreme weather events could alter anticipated trajectories if such interventions are not implemented.

This study demonstrates the complex relationships between climate change and urban food systems through global case studies, such as New York City, Bangkok, Lima, and Antananarivo, which reveal different approaches to climate adaptation in urban settings. The case of New York City demonstrates how extreme weather events, such as hurricanes and storms, severely impact urban food systems by disrupting food supply chains, transport, and communication networks (Centre for Climate and Energy Solutions, 2017; New York City, undated). In response to these disruptions and in line with its Paris Agreement commitments, New York launched the 'Cool Neighborhoods' initiative, which mandates green roofs with solar panels and vegetation to combat the urban heat island effect, promoting resilience and energy efficiency (Appel, 2020; New York City, n.d.). This adaptive approach illustrates how urban centers can protect food security amid climate challenges. New York's experience is relevant to Bulawayo, highlighting how innovative governance can mitigate climate impacts on urban infrastructure and food systems.

Bangkok offers another example of adaptive governance, particularly in response to increased flooding caused by climate change and urbanization (Chandran, 2019; Nair et al., 2014). Following severe floods in 2011 that submerged a fifth of the city, Bangkok promoted rooftop and vertical farms as climate adaptation strategies, including the 22,000-square-meter Thammasat University rooftop farm, which mimics rice terraces to manage floodwaters (Beroske, 2022; Pratama et al., 2023). These green roofs are part of an approach to counteract urban expansion impacts and human ecological disruptions. Bangkok's integration of green infrastructure provides a model for other urban centers, underscoring how urban agriculture and resilient design can mitigate climate risks—a lesson applicable to Bulawayo's food system.

Lima, situated in a desert ecosystem, faces intensified water scarcity due to climate change. Projections indicate a 20–30% rainfall reduction along the coast and a temperature rise of 0.4°C by 2030, threatening agricultural productivity and food security (Bossio et al., 2022; Sara et al., 2017; Siña et al., 2016). Lima has addressed these challenges by supporting local food production through community gardens, rooftop farms, and vertical farming, reducing dependence on distant food sources (Dubbeling et al., 2019; FAO, n.d.; Santandreu,

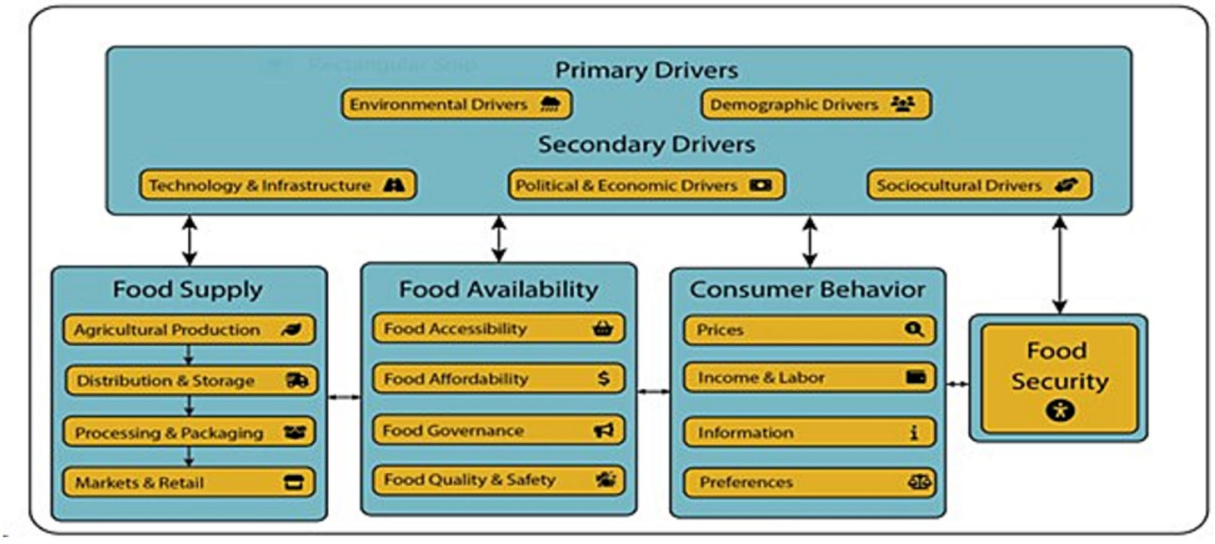

FIGURE 1
Conceptual framework of food systems for diet and nutrition. Source: Copyright Zimmer (2022, p. 10). Reproduced with permission.

2018). Furthermore, Lima allocates 5% of water revenue to green infrastructure projects, employing wastewater reuse, fog nets, and water harvesting to meet urban agriculture's water needs (Sonneveld et al., 2018; Merzthal and Bustamante, 2008; NaturPhilosophie, 2016). This emphasis on water management strategies offers insights for Bulawayo in building water-resilient urban food systems.

Lastly, Madagascar, despite its minimal carbon emissions, ranks among the countries most vulnerable to climate change impacts (Capper, 2021; USAID, 2023; World Bank, 2021). Antananarivo's food system faces disruptions from climate-induced hazards, such as cyclones and floods, affecting crop storage, food prices, and supply routes (FAO, 2021; FEWSNET, 2022). In response, the city's 2015 urban agriculture program supports local food production, especially for low-income households and school gardens, to reduce dependency on distant sources (FAO, 2018). These adaptive measures highlight the role of urban agriculture in enhancing food resilience in climate-affected regions.

The case studies of New York City, Bangkok, Lima, and Antananarivo illuminate the intricate interplay between climate change and urban food systems, revealing diverse adaptive governance strategies implemented to mitigate these challenges. These examples highlight the pressing need for cooperative and pre-emptive measures to adapt to climate change and ensure food security in urban areas globally. Given the significance of these interconnections, this study seeks to contribute to the body of evidence aimed at comprehensively understanding these dynamics through the case of Bulawayo. This is because there is need to explore how different urban contexts respond to climate change impacts on food systems. Other cities in the Least Developed Countries can draw lessons from the cases reviewed in the foregoing. These lessons center on adaptive governance, implementing innovative urban agriculture projects, such as rooftop and vertical farms, to enhance local food production and reduce dependence on external food sources. Furthermore, they include investing in green infrastructure, collaborative approaches and prioritizing climate resilience measures.

To better understand the context of the research it suffices to briefly describe the city of Bulawayo. The description of the city is nuanced to flag climate change issues and how they have been affecting the city's food system.

Materials and methods

Description of the study area

Established in 1893 by the British South Africa Company during the era of Southern Rhodesia's colonization, Bulawayo (Bulawayo 20°9′0" S; 28°35′0″ E) stands as the second-largest city in Zimbabwe, following the capital city of Harare. Renowned for its historical significance, Bulawayo has long been a prominent industrial and commercial hub within the country, earning the moniker 'Manchester of Rhodesia.' Its landscape was dotted with a plethora of heavy industries, encompassing textiles, clothing, engineering, food processing, and automotive sectors (Parliament of Zimbabwe, 2011; Ranger, 2006). To further cement its position as a nerve center of the country's economy, the city also served as the country's railhead (Ranger, 2006). Therefore, it held a pivotal position in shaping Zimbabwe's economic landscape, notably during both the colonial and post-independence epochs. Some scholars have partially attributed the city's economic decline to the persistent droughts it has faced (Madonko, 2016; Musemwa, 2006).

Bulawayo has a total population of 665,952 people where 307,871 are males and 358,081 being females (ZIMSTAT, 2023). The average household monthly income within the city was USD216 against a national average of USD232 (ZIMVAC, 2023). Poverty levels are high within the city as the latest poverty figures from the country's statistical agency, Bulawayo's household poverty prevalence stood at 22.3% in 2017 against a national average of 60.6% (ZIMSTAT, 2019). With respect to labor force participation amongst the economically active group, 42.1% of economically active people in Bulawayo were participating in economic activities (ZIMSTAT, 2023). However, 6.4% of people in Bulawayo were employed at the time of the 2022 national census and strict unemployment rate was at 14.5% (ZIMSTAT, 2023).

Administratively, the city is run by a local authority, the Bulawayo City Council (BCC) and is divided into 29 administrative wards. The city is run by elected councillors who are the policy makers, most of which have since the turn of the millennium been from the opposition parties. These councillors elect a ceremonial mayor who heads the Council. In terms of the Urban Councils Act (cap 29:15), BCC like other local authorities makes its decisions through standing committees. These include the General-Purpose Committee, Finance and Development Committee, Environmental Management and Engineering Services Committee, Audit Committee, Municipal Procurement Board, Town Lands and Planning Committee, Health, Housing and Education Committee, Business Committee and the Future Water Supplies and Water Action Committee (BCC, 2024). The last committee was inspired by the incessant water challenges mainly attributed to drought that have historically confronted the city. The other administrative arm of the city is that of the secretariat which is basically headed by the management committee comprising the heads of the following departments: Chamber secretary, the Department of Engineering Services, City Treasurer, Department of Health services and Department of Housing & Community Services who all report to the Town Clerk who leads the Town Clerk's Department (BCC, 2024).

Bulawayo together with Harare are the two metropolitan provinces in Zimbabwe. Despite the provisions in Zimbabwe's 2013 constitution for decentralization of power to various administrative centers, including Metropolitan Councils (Government of Zimbabwe, 2013), the actual establishment of these Metropolitan Councils has not yet occurred. However, representatives appointed by the central government, such as the Minister of State for Provincial Affairs and Devolution, Permanent Secretaries, and District Development Coordinators, are currently overseeing and implementing central government initiatives within the City/Province (Mapuva and Miti, 2019; Nyikadzino and Vyas-Doorgapersad, 2022). This institutional set-up has implications on policies that impact climate change, food systems and the general administration of the local authority. This is more so because central government agencies and departments that originate and implement these policies are superintended by these appointees. For instance, some of the landmark policy initiatives and developments that have or are likely to impact Bulawayo and other local authority's food systems have been originated by the central government, or at least its agencies. Cases in point include the development of the National Development Strategy 1 which is the country's macro-policy blueprint for the period 2021–2025. In addition, some of the initiatives and programs include those affecting

land reform especially as it affects land use changes within the city and its precincts where in some instances urban agriculture is practiced. In this respect some studies, such as that by Sithole et al. (2024, p. 15) have established that "[f]rom 1984 to 2022, the built-up areas [in Bulawayo] increased from 36642.81 ha to 21789.36 ha, representing a significant increase of 15,146 ha or 227%." Sithole et al. (2024, p. 22) go on to highlight the implications of these developments:

> In Bulawayo, urban sprawl has resulted in the loss of urban green spaces and agricultural land as most of the agricultural, vegetation and bare land has been converted to built-up development. In the context of climate change, this could lead to increased flood risks through increased water runoff and loss of aquatic and terrestrial biodiversity.

Ecologically, the city is classified as agro-ecological region 4 which is characterized by average to low annual rainfall. As such, the city is prone to droughts, which have been increasing in intensity and regularity of late and have been debilitating to the economy of the city and livelihoods of the residents in general (Nel and Berry, 1992). For instance, while 91% of households are connected to the Bulawayo City Council's water reticulation system, only 3% of the households indicated receiving water supplies for 7 days in a week (ZIMVAC, 2023). Most households (79%) indicated that they have access to water for between 2 and 4 days in a week (ZIMVAC, 2023). Furthermore, 78% of the households were dissatisfied or very dissatisfied with the reliability of council's water supply (ZIMVAC, 2023). Other than the impact of these ecological conditions on water supply, some studies have highlighted their detrimental effects on crop and livestock production levels. As an example, Dube et al. (2021) investigated how the practice of peri-urban agriculture in Bulawayo was adapting to climate change. Their study showed that farmers were employing a myriad of strategies to adapt to climate change such as watering crops during the night, renting space for livestock in farms with better water supplies and planting several times amongst others. Similarly, Maphosa (2022) found that water demand management strategies used by BCC such as water shedding and rationing negatively affected urban agriculture as households tended to forego especially backyard vegetable gardens which are key in ensuring household food self-sufficiency especially in the low-income areas. However, these studies did not delve into institutional readiness of the city deal with climate change in so far as it affected the food system.

In terms of energy usage within the city, the majority of Bulawayo's population is reliant on electricity as a source of energy. For instance, 87.1% of the households use electricity as the main source of cooking energy and 84.7% for lighting (ZIMVAC, 2023). Nonetheless, the city and the country in general have been facing electricity supply challenges with long periods of power outages being experienced. Of interest, is that Kariba hydroelectric plant, one of the country's major sources of electricity is projected to be negatively by climate change-induced alterations in precipitation patterns and evaporation (Hamududu and Killingtveit, 2016). Hydro-electric power generation is already facing challenges. Resultantly, together with the dire socio-economic profile described in the foregoing, many households find themselves physically and financially unable to access electricity. They end up resorting to alternatives which mainly include fuelwood (Ngulani and Shackleton, 2022). Interestingly, the poor urban households which are mainly domiciled in the high-density suburbs used a lot of fuelwood whereas their public green spaces produced little of fuelwood. In the affluent low-density areas, a reverse scenario obtained (Ngulani and Shackleton, 2022). Other studies, for instance, Mushore et al. (2022) used multispectral optical data for the period spanning 1990–2020 to observe changes in Bulawayo's local climatic zones. Some of the notable changes, which they partly attribute to a myriad of human activities include the fact that the "… replacement of natural covers, especially vegetation and water with built LCZs [Local Climatic Zones], increases heat absorption capacity of the city, which warms the air as it moves over these areas, thereby resulting in increased air temperatures (Mushore et al., 2022, p. 11). Furthermore, the same study showed a decrease and a potential long-term decrease in temperatures in parts of the city where there is densification of vegetation. Interestingly, food security-energy nexus studies seem to point out that poverty and energy challenges affect food preparation processes and ultimately food choices. Generally, they point out that poor households tend to shun foods that require longer preparation times and will tend to buy fresh foods on as per need basis because of lack of facilities such as refrigerators (see Ballantine et al., 2008; Battersby and Haysom, 2019a; Battersby and Haysom, 2019b; Maphosa, 2022).

The comprehensive analysis of Bulawayo sheds light on the intricate interplay between socioeconomic factors and climate change, offering valuable insights for policymakers and stakeholders. This understanding can inform the development of specific interventions aimed at strengthening food system resilience and alleviating the negative effects of climate change on food security in Bulawayo. In essence, the historical, economic, demographic, and institutional dynamics of Bulawayo intersect with climate change impacts, shaping its food systems. Recognizing these implications is essential for crafting tailored policies and strategies to bolster climate resilience and food security not only in Bulawayo but also in comparable urban settings in Zimbabwe and globally. It is this respect that after the methods section, the article interrogates the robustness of institutional responses to the climate change related vulnerabilities of Bulawayo's food system.

Methods

The methods presented in this section are part of a broader methodology employed in a bigger study that was conducted to critically analyze the interactions between urban food systems, urban governance and household food security using the case of Bulawayo (see Maphosa, 2022). The fieldwork was initially conducted from March to May of 2021 and a follow-up exercise meant to bolster aspects of this article was conducted between April and July of 2023. Methodologically, the bigger study employed a convergent mixed-methods approach where qualitative and quantitative approaches were used in a complementary manner. The qualitative dimension of the study sought to gain the views of social actors pertaining the food system whereas the quantitative aspects sought to understand how governance processes and structures shaped household food security. In this article, aspects of findings derived through the qualitative approach are presented.

The focus of this study is on Bulawayo for two primary reasons. Firstly, being the second-largest city in Zimbabwe situated in a semi-arid region, it confronts various climate change-related challenges, as discussed in the foregoing. Secondly, Bulawayo stands out as the first city in Zimbabwe to establish an urban agriculture policy, making it an ideal candidate for an institutional evaluation. It is assumed that Bulawayo boasts the most advanced institutional framework concerning food systems.

This study utilized secondary data from various published sources, including peer-reviewed journals, reports from local and international organizations, UN agencies, and government bodies, with data primarily sourced online using search engines such as Google Scholar and databases subscribed to by Rhodes University and the University of Fort Hare. The literature search was conducted in a phased approach, starting with broad keywords like 'food system' and 'urban governance' 'climate change' and progressively narrowing down to more specific concepts. Additionally, the snowballing technique was employed to identify related sources. The literature review was essential for understanding the climate vulnerabilities of Bulawayo's food system and institutions which can potentially deal with those vulnerabilities. The review was also instrumental in informing the study's methodology and framing its theoretical context. However, primary data gathered through fieldwork was needed to complement these findings, which is discussed hereunder.

This research adopts a qualitative approach, employing key informant interviews and qualitative content analysis. The latter method was utilized to scrutinize policy documents, legislation, regulations, and other written materials pertaining to climate vulnerability and urban food systems. This analytical process yielded crucial insights into the formal structures and institutional responses concerning climate vulnerability and food systems. Such insights were instrumental in comprehending the policy landscape, identifying gaps, assessing policy efficacy, and formulating informed policy recommendations.

The study scrutinized key national and sub-national institutional documents, including but not limited to the national constitution, the National Climate Change Policy, the National Climate Change Response Strategy, the Bulawayo Urban Agriculture Policy, and the Bulawayo Master Plan. Additionally, key informant interviews (KIIs) were conducted with a purposefully selected (with the guidance of city council and government authorities) cohort of participants who were 9 in total. Key informant interviews were conducted with participants from sectors pertinent to the configuration of urban food systems and climate governance. They comprised BCC officials (3), central government officials (3) and representatives of Non-Governmental Organizations (3). While engaging with a broader range of local officials would have been ideal, additional interactions would likely not have significantly enhanced the study, as climate action at the local level remains limited. This is consistent with the findings from the preceding institutional analysis, which shows that climate initiatives are largely directed by national government rather than local authorities. This also explains the limited engagement of this study with other activities of the food system such as the distribution and processing elements. Key informants could not provide information on how they thought climate change was affecting these two elements. The limited engagement in these sectors underscores the utility of a targeted, in-depth approach, focusing on participants with the most relevant experience and authority. Using a small number of purposefully selected interviews is well-justified in qualitative research, particularly when the study aims to capture in-depth insights from key stakeholders with specialized knowledge. Creswell and Poth (2018) argue that qualitative research prioritizes data richness over sample size, as the goal is to gain a comprehensive understanding of complex, context-specific phenomena, which can often be achieved through a few, targeted interviews. This approach is especially effective when investigating institutional dynamics, where only certain officials or stakeholders possess the expertise and access needed to provide informed perspectives.

Moreover, Guest et al. (2006) found that data saturation—the point at which no new themes or insights emerge—can often be reached within a relatively small sample (as few as 6–12 interviews) when participants are selected based on their relevance and depth of knowledge. In policy-oriented studies, Patton (2015) supports the use of key informant sampling to ensure that participants have significant involvement in decision-making processes. This approach is particularly relevant to studies like this one, where the scope of local-level climate action is limited, and a few interviews with highly knowledgeable officials are more effective than a larger, less-focused sample. Thus, the study's selection of nine key informants aligns with established qualitative methods that emphasize depth, expertise, and relevance over breadth in sampling.

In spite of the limited number of interviews, these were instrumental in eliciting qualitative data regarding policy perceptions, effectiveness, impact, and areas necessitating improvement. To ensure consistency, standardized semi-structured KII guides were employed for all interviews. With the consent of the respondents, all interviews were audio-recorded and transcribed to facilitate reference and data citation during the analysis phase. Additionally, notes were taken during the interviews to provide clarity and elaboration where necessary. The researcher employed a thematic analysis approach to examine the qualitative data transcripts. This involved a thorough process of reading and re-reading the data to identify emerging themes. During this process, the researcher coded the data with a focus on the study's objectives and analytical framework. As key issues of interest aligned with these objectives, they were categorized into named themes. This method followed the six-step approach outlined by Braun and Clarke (2006), which includes familiarization with the data, generating initial codes, searching for and reviewing themes, defining and naming themes, and finally producing the report by contextualizing the findings within the study objectives and existing literature This methodology facilitated a comprehensive exploration of policy issues from diverse viewpoints.

Findings and discussion

The review of literature findings indicates the presence of a legal framework supporting the establishment of a strong institutional structure to deal with climate change by sub-national governing bodies, such as local authorities or the Metropolitan Councils overseeing the country's two metropolitan provinces of Harare and Bulawayo. The national constitution, with its paramount authority as articulated in sections 1 and 2, sets the guiding principles (Government of Zimbabwe, 2013). Section 1 establishes the Constitution's supremacy by deeming any law, practice, custom, or conduct conflicting with it invalid to the extent of the inconsistency.

Section 2 further imposes responsibilities on every individual, as well as on government entities including the executive, legislative, and judicial branches at all levels. It underscores that these responsibilities must be met by all pertinent government institutions and agencies (Government of Zimbabwe, 2013).

Section 73 of the constitution outlines environmental rights, stating that every person has the right to an environment that is not harmful to their health and to have the environment protected for the benefit of present and future generations through measures that prevent pollution, promote conservation, and ensure ecologically sustainable development. Additionally, the State is mandated to take reasonable legislative and other measures, within its available resources, to progressively realize these environmental rights (Government of Zimbabwe, 2013). In addition, Section 77 of the constitution guarantees every person the right to safe, clean, and potable water as well as sufficient food, and mandates the State to take reasonable measures to progressively realize this right within its available resources (Government of Zimbabwe, 2013). Therefore, through these constitutional provisions, there is a sufficient institutional framework at the national level for the local authority and its partners in Bulawayo to build a robust institutional framework at the local level to deal with climate related vulnerabilities of the food system. The constitutional provisions provide a framework emphasizing the right to a healthy environment, the necessity for sustainable practices, and the guarantee of sufficient food.

The Government of Zimbabwe has formulated policies at the macro level which also provide the necessary foundations for climate change management in the country. This is facilitated by the fact that laws like the Urban Councils Act of 1995 establish guidelines for local governance. This law ensures that local planning and development activities align with national objectives and respect constitutional rights. The current macro policy blueprint, the National Development Strategy 1, prioritizes food and nutrition security and environmental protection and climate resilience amongst other 14 national priorities (Government of Zimbabwe, 2020). In addition, the government has also formulated climate change management policy frameworks. These include the Zimbabwe National Climate Change Response Strategy and National Climate Change Policy. The Zimbabwe National Climate Change Response Strategy is highly relevant to the management of urban food systems as it provides a comprehensive framework for enhancing climate resilience. By promoting sustainable agricultural practices, improving water management, and addressing food security, the strategy directly supports urban food systems in adapting to climate impacts. It also encourages institutional coordination of the "…climate change response governance framework at national, provincial, district and ward levels" (Government of Zimbabwe, Ministry of Environment, Water and Climate, n.d., p. ix). The strategy also calls for the mainstreaming of "…climate change into urban and rural planning, infrastructure, investments and service delivery" (Government of Zimbabwe, Ministry of Environment, Water and Climate, n.d., p. ix).

The Zimbabwe National Climate Change Policy is crucial for managing urban food systems as it outlines strategic actions to mitigate climate impacts on agriculture and food security. It emphasizes the adoption of climate-smart agriculture, improved water management, and enhanced disaster risk reduction measures (Government of Zimbabwe, Ministry of Environment, Water and Climate, 2017). This policy ensures that urban food systems are resilient, sustainable, and capable of adapting to climate change, thereby securing food availability and safety for urban populations.

The Zimbabwe Climate Change National Adaptation Plan (Government of Zimbabwe, 2023) identifies key sectors affected by climate change. For the urban areas such as Bulawayo, these include the water sector. The Plan notes that the sector is likely to be exposed to climate hazards such as droughts and floods amongst others. It argues that these are likely to lead to water infrastructure damage and a decrease in the quality and quantity of water for human consumption. The Plan also identifies the agricultural sector as being vulnerable to climate change hazards with a negative impact on productivity levels and food security levels. Finally, for the human settlements and infrastructure development sector, climate change hazards are amongst other things leading to damage of key infrastructure such as road networks, railway lines and telecommunication. To counteract these challenges the National Adaptation Plan establishes an institutional framework to guide adaptation processes. It mandates the local authorities to deal with climate change as it says: "…Urban Local Authorities implement climate change related programs using locally generated resources and devolution funds in accordance with decisions made at the local level" (Government of Zimbabwe, 2023, p. 27). The Zimbabwe Climate Change National Adaptation Plan highlights significant vulnerabilities in key sectors such as water, agriculture, and infrastructure, which are directly relevant to Bulawayo's urban food system. However, the Plan's reliance on local authorities to implement climate adaptation programs using locally generated resources and devolution funds raises concerns about institutional effectiveness. In Bulawayo, where resource constraints and inadequate infrastructure already challenge climate-smart agriculture initiatives, this approach risks overwhelming local institutions that may lack the capacity or funds to effectively address climate hazards. The reliance on local-level decision-making without sufficient support from national institutions may hinder the timely and effective response to climate vulnerabilities.

The Zimbabwe Climate Change Gender Action Plan (GAP) provides a comprehensive framework that integrates gender considerations into climate resilience strategies (Government of Zimbabwe, Ministry of Environment, Climate, Tourism and Hospitality in Industry, Ministry of Women Affairs, Community, Small and Medium Enterprises Development, 2023). Rooted in Zimbabwe's national climate policies and influenced by global mandates such as the Paris Agreement and the UNFCCC Gender Action Plan, the GAP addresses gaps in gender representation and decision-making in climate policies. It highlights that climate vulnerabilities disproportionately affect women due to existing socio-economic inequalities, emphasizing the need for inclusive policies that empower women and promote their active participation in climate adaptation processes. This approach not only enhances climate resilience but also aligns with the National Development Strategy, which seeks gender equality in all socio-economic activities, including urban food systems.

A key focus of the GAP is mainstreaming gender within four priority sectors: Energy, Industrial Processes, Agriculture, Forestry and Other Land Use (AFOLU), and Waste. In the AFOLU sector, for instance, the GAP proposes actions to enhance women's roles in sustainable agriculture practices and advocates for inclusive participation in decision-making processes regarding land and resource management. These gender-responsive strategies are critical for cities like Bulawayo,

where climate vulnerabilities in urban food systems intersect with gender disparities. By promoting women's leadership in climate action, cities can leverage diverse perspectives that contribute to sustainable and resilient urban food systems. The GAP's emphasis on a gendered approach to climate vulnerabilities provides a foundation for analyzing how institutions can foster inclusive climate resilience strategies that account for the unique challenges and contributions of women in urban food security. Thus, at the national level a foundation has been made for the local level to develop robust and gender sensitive institutional framework to deal with food system vulnerabilities to climate change.

Urban agriculture, both formal and informal, has a longstanding presence in Bulawayo. Despite this, a draft urban agriculture policy was only officially introduced in December 2002 and finalized in 2007 (Bulawayo City Council, 2007). This illustrates how Bulawayo's agricultural policy evolved in response to existing agricultural practices. However, it should be stated from the onset that in as much as the brief literature review in the foregoing reflected on how other urban centers have used urban agriculture to deal with climate change, this is not the case in Bulawayo. For instance, there is nowhere in the document where climate change is mentioned. This is understandable given that the policy was crafted when the discourse of climate change was not as dominant as it is now. Nonetheless, the fact that the policy has not been revised after such a long time points to an institutional set-up that is not adaptive and hence not responsive to current existential threats.

The implications of the absence of climate change considerations in Bulawayo's urban agriculture policy are significant in so far as managing the urban food system. Firstly, this disproportionately exposes the food system to climate change impacts. Without explicit considerations for climate change, urban agriculture practices may not be resilient to climate-related challenges such as extreme weather events, changing rainfall patterns, or temperature variations. This could lead to decreased productivity and increased food insecurity. Indeed, these fears were pointed out in a KII:

> *The absence of climate change considerations in Bulawayo's urban agriculture policy leaves the food system vulnerable to climate impacts, risking decreased productivity and heightened food insecurity in the face of extreme weather events and shifting climatic patterns. The city is prone to periodic droughts and with the current agronomic practices we experience a lot of crop failure and hence poor harvests. However, we have pockets of emergent climate sensitive agricultural practices within the city which are mainly supported by Non-Governmental Organizations. Some of these organizations are promoting climate-smart agricultural practices, mainly drip irrigation in community and nutrition gardens. Unfortunately, as a department, we are failing to fully offer technical backstopping services to such organizations because we are hamstrung in terms of resources. For instance, at the moment there are just two officers meant to cover the entire city of 29 wards. Thus, at times, we have staff from the neighboring Umguza district seconded to the city to ameliorate the challenges (Agriculture Extension Officer).*

By failing to integrate climate change considerations into urban agriculture policy, the food system becomes disproportionately exposed to the adverse effects of climate change. This exposure manifests in various challenges such as extreme weather events, unpredictable rainfall patterns, and temperature fluctuations. These factors collectively contribute to decreased agricultural productivity and heightened food insecurity, posing a significant threat to the city's food supply and the well-being of its residents. It is also apparent that the city of Bulawayo is susceptible to periodic droughts, a recurring challenge that significantly impacts agricultural practices and results in frequent crop failures. Some of the issues raised by the key informant are corroborated by secondary sources. For instance, the National Agriculture Policy Framework (2019–2030) points out that adaptive capacity of communities is curtailed by amongst other things poor resourcing of extension services and limited adoption of CSA practices amongst other things (Government of Zimbabwe Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement, 2018).

A lack of climate change considerations means missed opportunities for implementing adaptive measures within urban agriculture, such as adopting climate-resilient crop varieties, implementing water-efficient irrigation techniques, or integrating agroforestry practices to mitigate climate risks. For instance, in the city's agriculture policy it is stated that:

> The city has some 220 boreholes scattered throughout the city. These have been drilled and equipped as [a] standby supply of domestic water source[s] during shortage times. However, these boreholes can be used for community gardens when there is no serious shortage of water but they revert to domestic use during difficult times. Water conservation methods like drip irrigation are encouraged (Bulawayo City Council, 2007, p. 13).

The policy pronouncement indicates that climate-smart agriculture is not integrated as a core practice but is instead viewed as an additional initiative utilized opportunistically when water supply conditions permit. This indicates that the focus of authorities is primarily on water management rather than on addressing food security directly. This narrow approach leads to limited adaptive capacity of the residents in the face of climate change as noted here: "some contributing factors towards limited adaptive capacity include the low levels of investment in irrigation…" (Government of Zimbabwe Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement, 2018).

Notwithstanding these limitations in the city's institutional framework, it is encouraging as testified in the foregoing by an official from Agritex that some NGOs are actively pursuing CSA initiatives within the city.

> *In our ongoing efforts to promote climate-smart agriculture in Bulawayo, we have established training programs, nutrition gardens, and knowledge-sharing platforms for poor urban farmers. Our initiatives focus on agro-ecological practices and water-efficient farming methods. Challenges include resource constraints and the need for policy support to mainstream CSA into urban agricultural strategies. Despite these obstacles, our organization is dedicated to empowering farmers and building climate resilience in the city (Key informant Interview, NGO Official 1).*

> *We have introduced sustainable farming practices such as rainwater harvesting, micro-irrigation and soil conservation techniques. However, obstacles such as limited funding, insufficient technical support from our public sector partners, and farmers' lack of*

> *awareness regarding the benefits of CSA persist. In addition, there is no focal platform to coordinate the activities of the different actors promoting CSA within the city (KII, NGO Official 2).*

The above excerpts demonstrate that despite institutional limitations, there are encouraging signs of active engagement by NGOs in pursuing climate-smart agriculture (CSA) initiatives within the city. This indicates a potential source of resilience and innovation in addressing climate vulnerabilities in urban food systems. NGOs are employing diverse approaches such as training programs, nutrition gardens, and knowledge-sharing platforms to promote CSA among poor urban farmers. This suggests a comprehensive strategy aimed at enhancing climate resilience and sustainable food production in urban areas. Whereas NGOs play a crucial role in implementing climate-smart agricultural practices, their impact is however constrained by the localized scope of their interventions within their designated programming areas and for specific durations. In addition, their work is constrained by existing challenges facing the city of Bulawayo as shown in the following excerpts:

> *We are promoting hydroponics as a water-efficient farming technique, especially suited for urban environments like Bulawayo where climate change has intensified water scarcity. However, the projects face financial and infrastructural hurdles. The high costs of setting up hydroponic systems, coupled with the city's intermittent water supply, have slowed down progress. Without adequate policy support and investment in water infrastructure, scaling up hydroponics to benefit urban farmers remains a significant challenge. Yet, we continue advocating for policy reforms to better integrate these practices into urban agricultural frameworks." (Key Informant Interview, NGO Official 3).*

> *Our NGO has established community gardens equipped with solar-powered drip irrigation systems to support urban farmers in drought-stricken Bulawayo. These gardens promote climate-smart, water-efficient agriculture. However, we face significant challenges in maintaining the solar equipment. Theft and vandalism have disrupted several projects, highlighting the need for improved security and community ownership. We're actively working to engage the community and find solutions to safeguard this vital infrastructure." (Key Informant Interview, NGO Official 1).*

> *As part of our climate-smart agriculture initiatives, we have promoted mushroom farming in Bulawayo. This practice offers several advantages: it requires minimal land, energy, and produces low carbon emissions. It's particularly well-suited for urban farmers who face space and resource constraints. However, a major hurdle has been marketing the mushrooms. Farmers often struggle to find reliable buyers who offer fair prices, limiting the scalability of these ventures. To overcome this, we are actively working to establish stronger market connections and educate the public about the nutritional and economic benefits of mushroom farming (KII, NGO Official 2).*

The above excerpts further highlight the footprint of NGOs in promoting CSA in Bulawayo, with a particular focus on hydroponics, community gardens, and mushroom farming. While these efforts demonstrate a proactive response to climate vulnerabilities in the city's food system, they are hindered by challenges such as high initial capital requirements, infrastructural vandalism, and market constraints. This reflects a broader issue identified in the literature, where CSA adoption is frequently limited by institutional capacity and resource availability (Abegunde et al., 2022; Ogunyiola et al., 2022; Wakweya, 2023). In Bulawayo, as seen with the solar-powered drip irrigation systems, the lack of sound governance and maintenance mechanisms exacerbates the vulnerability of these projects to theft and vandalism. These challenges indicate a gap between policy formulation and implementation, which weakens the institutional effectiveness of the city's climate resilience strategies. This shows that the success of such initiatives is not contingent on technological solutions only but also robust institutional frameworks that foster local ownership and capacity building. To this end, some of the NGOs indicated that they have started trainings on governance to ensure sound management of the gardens and sustainability.

Additionally, the challenge of marketing mushrooms, despite their low land and energy requirements, underscores the need for stronger institutional linkages between urban farmers and markets. As highlighted in the literature, successful urban food systems depend on the ability of institutions to facilitate market access and integrate smallholder farmers into broader supply chains (Berti and Mulligan, 2016; Ma et al., 2024). Without effective market integration, the sustainability of urban agriculture projects remains in jeopardy, as evidenced in Bulawayo's mushroom farming initiative. The institutional shortcomings in building reliable market connections reflect a broader failure to fully address the socio-economic dimensions of climate vulnerabilities in Bulawayo's food system. This indicates that while NGOs are key players in introducing adaptive farming techniques, there is a pressing need for more coordinated institutional efforts to integrate these practices into the city's food system, ensuring long-term resilience.

A recurring theme in the above excerpts is that of limited coordination in the city's efforts to deal with urban food systems failings, especially those attributed to climate change. For instance, a city council official indicated that the city council used to have an Urban Agriculture Multistakeholder forum as provided for in the city's urban agriculture policy. However, the forum has been moribund.

> *The policy includes such a provision; however, in reality, the stakeholders are not highly active as a unified coalition. What I've noticed is a lack of cohesion in their efforts. Ideally, they should convene regularly as stakeholders, develop work plans, and review them periodically (KII BCC Social Services Section).*

This scenario indicates potential difficulties in mobilizing stakeholders efficiently, organizing regular meetings, and performing periodic reviews as outlined in the policy. It suggests a disconnect between formulating policies and putting them into action, resulting in a gap in achieving the desired objectives of advancing urban agriculture and involving stakeholders in a collaborative approach. Addressing this lack of unity and revitalizing the multi-stakeholder forum could be vital for improving the effectiveness and influence of urban agriculture initiatives in the city. Furthermore, this platform has the potential to guide future actions regarding the vulnerabilities of the city's food system to climate change.

The national government has also joined NGOs in rolling our CSA initiatives through its flagship program dubbed Intwasa/

Pfumvudza which is "…conservation agriculture concept, a crop production intensification approach under which farmers ensure the efficient use of resources on a small area of land in order to optimize its management" (Mavesere and Dzawanda, 2023, p. 3455). According to Mujere (2021) Intwasa/Pfumvudza is a Zimbabwean term signifying the sprouting of new leaves in spring. It embodies a sustainable farming method developed by the Foundation for Farming. This approach aims to ensure household food security by cultivating a small plot of land efficiently. Its key principles include minimal soil disturbance, permanent soil cover, crop rotation and intercropping. By adhering to these principles and practices, Intwasa/Pfumvudza empowers farmers to maximize yields and achieve food security, even on small plots of land.

TheIntwasa/Pfumvudza program is now called the Presidential Climate Proofed Input Scheme. Whilst this program started in 2020 with a rural inclination, it has now factored in urban communities. For instance, in 2020 the program sought to support 20,000 urban households in Bulawayo with inputs that included 10 kg maize, 5 kg, sorghum, 2 kg, pearl millet, 5 kg soya beans, 2 kg sunflower, or castor bean, 5 kg beans, cowpeas, or round nuts for each farmer (Paganga, 2021). In 2023, the scheme covered 500,000 urban farmers (Government of Zimbabwe Ministry of Lands, Agriculture, Fisheries, Water and Rural Development, 2023, p. 63). The integration of the Intwasa/Pfumvudza program into urban areas offers substantial benefits for enhancing urban food systems and food security, including increased food production, economic benefits, and environmental sustainability. The utility value of Intwasa/Pfumvudza in terms of increasing agricultural productivity and household food security has been established by some scholars (Mavesere and Dzawanda, 2023; Mujere, 2021). However, based on precedents, the initiative must navigate several potential drawbacks, such as resource constraints, pollution risks, selection bias and technical barriers, to achieve its full potential.

Food systems in Bulawayo are also being supported by initiatives of UN multilateral agencies working in cooperation with donors and implementing partners in the form of NGOs. For instance, one NGO official indicated that they are working with the UNDP, BCC and the Ministry of Local government in transforming food systems through for instance, the construction of a climate resilient wholesale fresh vegetable in Nkulumane. The key informant indicated that the market will provide a safe working space for informal food vendors who for a long time have been exposed to the harsh vagaries of weather through trading in open spaces. He indicated that this facility comes with climate control facilities to ensure a longer shelf life of vegetable produce hence reducing food waste which is characteristic of informal food vending in the city. Interestingly, even in terms of power supply, the NGO official indicated that they have gone green with the use of solar power to power the market. While the construction of a climate-resilient wholesale vegetable market in Nkulumane is a positive step towards mitigating food system vulnerabilities in Bulawayo, it may not fully address the broader challenges posed by climate change. The focus on infrastructure improvements and renewable energy is commendable, but additional efforts are needed to enhance urban agriculture practices and support local food production. Moreover, long-term success will depend on sustained funding, community engagement, and the integration of these initiatives into broader climate adaptation strategies.

Another development which shows the cooperation of development partners in dealing with climate-related food system challenges is that of the review of the Urban Agriculture Policy which is partly driven by the World Food Program in partnership with local NGOs. To this end, an NGO official in a KII indicated that:

> *This review is partly driven by the World Food Program in collaboration with local NGOs, including my organization. We aim to ensure that the policy not only focuses on production but also adopts a comprehensive, systemic approach to urban food systems, incorporating essential elements of climate resilience.*

Additionally, a BCC Town Planning Official indicated that they are formulating a Climate Resilient Urban Food System Policy with support from another development partner, HIVOS International. This new policy marks a shift from focusing solely on production-oriented urban agriculture to a more comprehensive and systemic approach to urban food systems, and it notably incorporates climate resilience into the city's urban food system. While the collaboration between development partners and local NGOs in reviewing the Urban Agriculture Policy and formulating a Climate Resilient Urban Food System Policy demonstrates proactive institutional responses to climate threats, it may face challenges in implementation due to potential resource constraints and coordination issues. Additionally, the shift from a production-oriented focus to a comprehensive, systemic approach is promising, but its effectiveness will depend on sustained support, community engagement, and the integration of these policies into broader urban planning and climate adaptation strategies.

Conclusion

This study investigated the institutional framework and policies addressing climate vulnerabilities in urban food systems in Bulawayo, analyzed the effectiveness of institutional responses, and provided policy recommendations to enhance urban food system resilience to climate change. The findings reveal a robust legal and policy framework at the national level, including constitutional provisions and strategic policies like the National Climate Change Response Strategy and the National Climate Change Policy. However, Bulawayo's urban agriculture policy lacks specific climate change considerations, leading to vulnerabilities in the urban food system. Despite these gaps, NGO-led initiatives and national programs like Intwasa/Pfumvudza show promising efforts to integrate climate-smart agriculture into urban contexts.

Recommendations

Allocate targeted funds to expand urban agricultural extension services by recruiting and training additional extension officers, ensuring each urban ward has dedicated support. Develop a structured training program on climate-smart practices, such as water-efficient irrigation, organic farming, and pest management, tailored to urban farming conditions. Establish a mobile or digital platform for extension officers to share timely updates, resources, and best practices, improving access and engagement with farmers across all urban wards. Align urban agriculture policies with national and regional climate adaptation

plans by establishing a formal urban agriculture policy group within climate adaptation planning bodies. Ensure urban food systems are recognized as essential for resilience by embedding them in city and regional strategies with clear targets for sustainability, food security, and greenhouse gas reduction. Coordinate urban agriculture initiatives with broader climate projects, such as water conservation and renewable energy programs, to create an integrated approach to climate adaptation. To resuscitate the urban agriculture multistakeholder forum, there is need to effectively engage a diverse range of stakeholders. Therefore, a multi-tiered approach should be followed. Firstly, community-level can be established to directly involve small-scale farmers, women's groups, youth associations, and climate-vulnerable populations. Simultaneously, a digital platform needs to be created to facilitate virtual participation and idea sharing. Quarterly or periodic stakeholder workshops can then be organized to bring together representatives from government, local authorities, NGOs, the private sector, and community members to co-create and refine urban food system related policies. To ensure inclusivity, special committees that focus on addressing the specific needs and challenges of women, youth and other vulnerable segments of the population need to be established. Finally, a robust feedback mechanism has to be implemented to gather community input and make necessary adjustments to policy implementation. To secure sustained funding, establish a dedicated urban agriculture and climate resilience fund that pools resources from government, international donors, and private sector partners. Create clear funding channels and incentives for private sector investment, such as tax breaks or co-financing opportunities for businesses that contribute to climate-resilient urban agriculture. Direct funds towards specific infrastructure projects, starting with pilot micro-irrigation schemes in high-need areas, upgrading market facilities to withstand extreme weather, and installing solar-powered water pumps for community gardens. Develop a transparent monitoring framework to track investments and demonstrate impact, which will help maintain ongoing support and attract additional donors.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by Rhodes University Human Ethics Committee and Bulawayo City Council. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

MM: Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. PM: Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Abegunde, V. O., Sibanda, M., and Obi, A. (2022). Effect of climate-smart agriculture on household food security in small-scale production systems: a micro-level analysis from South Africa. *Cogent Soc. Sci.* 8, 1–27. doi: 10.1080/23311886.2022.2086343

African Development Bank. (2022). Particularly exposed to climate shocks, African cities are turning to adaptation and resilience. Available at: https://www.afdb.org/en/news-and-events/particularly-exposed-climate-shocks-african-cities-are-turning-adaptation-and-resilience-56462 (Accessed May 29, 2024)

Appel, D. (2020). New York City Legislation to Foster Environmental Sustainability. Available at: https://www.nycfoodpolicy.org/nyc-legislation-to-foster-environmental-sustainability/ (Accessed March 27, 2024)

Baeumler, A., D'Aoust, O. D., Gapihan, A., Goga, S., Lakovits, C. C. P. R., and Terraza, H. (2021). Demographic trends and urbanization. Washington DC: World Bank.

Ballantine, N., Rousseau, G. G., and Venter, D. J. (2008). Purchasing behaviour as a determinant of food insecurity in Klipplaat. *J. Family Ecol. Consum. Sci.* 36, 1–8.

Battersby, J., and Haysom, G. (2019a). "Linking urban food security, urban food systems, poverty, and urbanisation" in Urban food systems governance and poverty in African cities. eds. J. Battersby and V. Watson (London and New York: Routledge), 56–67.

Battersby, J., and Haysom, G. (2019b). How Food Secure are South African Cities? Available at: https://idl-bnc-idrc.dspacedirect.org/server/api/core/bitstreams/fea12a66-0769-4d73-ae1b-45e6718d74b7/content (Accessed March 27, 2024)

BCC. (2024). Council Committees. Available at: https://www.citybyo.co.zw/About/CouncilCommittees (Accessed January 09, 2024)

Beroske, E. (2022). The sustainability of urban rooftop farms. MSc thesis sustainable development Programme. Utrecht University

Berti, G., and Mulligan, C. (2016). Competitiveness of small farms and innovative food supply chains: the role of food hubs in creating sustainable regional and local food systems. *Sustain. For.* 8, 1–31. doi: 10.3390/su8070616

Blekking, J., Giroux, S., Waldman, K., Battersby, J., Tuholske, C., Robeson, S. M., et al. (2022). The impacts of climate change and urbanization on food retailers in urban sub-saharan africa. *Curr. Opin. Environ. Sustain.* 55, 101169–101168. doi: 10.1016/j.cosust.2022.101169

Bossio, C., Coomes, O., and Ford, J. (2022). What motivates urban dwellers to adapt to climate-driven water insecurity? An empirical study from Lima, Peru. *Environ Sci Policy* 136, 136–146. doi: 10.1016/j.envsci.2022.05.009

Braun, V., and Clarke, V. (2006). Using thematic analysis in psychology. Qualitative research in psychology. *Qual. Res. Psychol.* 3, 77–101. doi: 10.1191/1478088706qp063oa

Bulawayo City Council. (2007). Urban Agriculture Policy. Available at: https://foodsystemsplanning.ap.buffalo.edu/wp-content/uploads/sites/68/2017/06/Urban-agriculture-policy-Bulawayo-Zimbabwe.pdf (Accessed April 2, 2020)

Capper, L. (2021). The impact of climate change on food Systems in Southeast Madagascar.Sustainable environment, education and development. Available at: https://madagascar.co.uk/blog/2021/11/impact-climate-change-food-systems-southeast-madagascar (Accessed January 9, 2024)

Centre for Climate and Energy Solutions. (2017). Resilience strategies for extreme heat. C2ES. Available at: https://www.c2es.org/wp-content/uploads/2017/11/resilience-strategies-for-extreme-heat.pdf (Accessed November 18, 2023)

Chandran, R. (2019). Biggest rooftop farm in Asia gets growing in Bangkok. Global Center on Adaptation. Accessed https://gca.org/biggest-rooftop-farm-in-asia-gets-growing-in-bangkok/ (Accessed March 18, 2024)

Creswell, J., and Poth, C. (2018). Qualitative inquiry and research design choosing among five approaches. *4th* Edn. Thousand Oaks: SAGE Publications, Inc.

Dubbeling, M., van Veenhuizen, R., and Halliday, J. (2019). Urban agriculture as a climate change and disaster risk reduction strategy. *Field Act Sci Rep* 20, 32–39.

Dube, T., Sibanda, S., and Chiwara, P. (2021). Adapting peri-urban agriculture to climate change in Bulawayo, Zimbabwe: a qualitative assessment. *Cogent Soc. Sci.* 7. doi: 10.1080/23311886.2021.1944486

FAO. (2016). Sustainable Food Systems: Concept and Framework. Available at: https://openknowledge.fao.org/server/api/core/bitstreams/b620989c-407b-4caf-a152-f790f55fec71/content (Accessed May 22, 2023)

FAO. (2018). Antananarivo: vegetable gardens for school canteens. Open Knowledge FAO. Available at: https://openknowledge.fao.org/server/api/core/bitstreams/5b70072f-b817-4aab-a1d1-2088aa1de475/content (Accessed March 12, 2024)

FAO. (2021). *Assessing risk in times of climate change and COVID-19: City region food system of Antananarivo, Madagascar*. Rome: FAO. doi: 10.4060/cb2899en

FAO. (n.d.). A case study on sustainable urban food development in Lima, Peru. Available at: https://elearning.fao.org/pluginfile.php/707811/mod_resource/content/2/Case%20study%20-%20Urban%20food%20development%20in%20Lima.pdf (Accessed March 11, 2024).

FEWSNET. (2022). Negative impacts of multiple droughts and cyclones driving high food needs this lean season. Available at: https://fews.net/southern-africa/madagascar/key-message-update/march-2022 (Accessed February 15, 2024)

Government of Zimbabwe (2013). Constitution of Zimbabwe amendment (No. 20). Harare: Government Printer.

Government of Zimbabwe. (2020). National Development strategy 1: January 2021–December 2025. Available at: https://faolex.fao.org/docs/pdf/zim203781.pdf (Accessed May 11, 2024)

Government of Zimbabwe (2023). Zimbabwe's climate change national adaptation plan. Harare: Government Printers.

Government of Zimbabwe, Ministry of Environment, Climate, Tourism and Hospitality in Industry, Ministry of Women Affairs, Community, Small and Medium Enterprises Development (2023). Zimbabwe climate change gender action plan. Harare: Government of Zimbabwe.

Government of Zimbabwe, Ministry of Environment, Water and Climate (2017). National Climate Policy. Harare: Government of Zimbabwe.

Government of Zimbabwe, Ministry of Environment, Water and Climate (n.d.). Zimbabwe's national climate change response strategy. Harare: Government of Zimbabwe.

Government of Zimbabwe Ministry of Lands, Agriculture, Fisheries, Water and Rural Development. (2023). Government of Zimbabwe (2023) agriculture, food systems and rural transformation strategy: 2023–2025. Unpublished draft policy manuscript.

Government of Zimbabwe Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement (2018). National agriculture policy framework (2019–2030). Harare: Government of Zimbabwe.

Guest, G., Bunce, A., and Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field Methods* 18, 59–82. doi: 10.1177/1525822X05279903

Hamududu, B., and Killingtveit, Å. (2016). Hydropower production in future climate scenarios; the case for the Zambezi River. *Energies* 9. doi: 10.3390/en9070502

Haysom, G. (2014). Food system governance for urban sustainability in the global south. Thesis, University of Cape Town, Faculty of Science, Department of Environmental and Geographical Science. Cape Town: University of Cape Town

Kareem, B., Lwasa, S., Tugume, D., Mukwaya, P., Walubwa, J., and Owuor, S., Byarugaba, D, et al. (2020). Available at: https://iopscience.iop.org/article/10.1088/1748-9326/ab7951/pdf (Accessed April 18, 2023)

Li, X., Stringer, L., and Dallimer, M. (2022). The impacts of urbanisation and climate change on the urban thermal environment in Africa. *Climate* 10, 1–21. doi: 10.3390/cli10110164

Ma, W., Rahut, D., Sonobe, T., and Gong, B. (2024). Linking farmers to markets: barriers, solutions, and policy options. *Economic Anal. Policy* 82, 1102–1112. doi: 10.1016/j.eap.2024.05.005

Madonko, V. (2016). Bulawayo: A faded Industrial Giant. Available at: https://www.urbanafrica.net/news/bulawayo-a-faded-industrial-giant/ (Accessed April 18, 2021)

Maphosa, M. (2022). A critical analysis of the urban food system, urban governance and household food security in Bulawayo, Zimbabwe. PhD thesis. Makhanda, eastern cape: Rhodes University

Mapuva, J., and Miti, G. (2019). Exploring the uncharted territory of devolution in Zimbabwe. *J. Afr. Stud. Dev.* 11, 12–20. doi: 10.5897/JASD2018.0527

Mavesere, F., and Dzawanda, B. (2023). Effectiveness of Pfumvudza as a resilient strategy against drought impacts in rural communities of Zimbabwe. *GeoJournal* 88, 3455–3470. doi: 10.1007/s10708-022-10812-3

McQuaid, K., Vanderbeck, R., Valentine, G., Liu, C., Chen, L., Zhang, M., et al. (2018). Urban climate change, livelihood vulnerability and narratives of generational responsibility in Jinja, Uganda. *Afr. J. Int. Afr. Institute* 88, 11–37. doi: 10.1017/S0001972017000547

Merzthal, G., and Bustamante, E. (2008). Using treated domestic for urban agriculture and green areas; the case of Lima. *Urban Agric. Magazine* 20, 5–7.

Mujere, N. (2021). *Assessing the potential contribution of Pfumvudza towards climate smart agriculture in Zimbabwe: a review*. 18. Available at: www.preprints.org (Accessed July 7, 2024).

Musemwa, M. (2006). Disciplining a 'dissident' City: hydro politics in the City of Bulawayo, Matabeleland, Zimbabwe, 1980–1994. *J. South. Afr. Stud.* 32, 239–254. doi: 10.1080/03057070600656119

Mushore, T., Mutanga, O., and Odindi, J. (2022). Understanding growth-induced trends in local climate zones, land surface temperature, and extreme temperature events in a rapidly growing City: a case of Bulawayo Metropolitan City in Zimbabwe. *Front. Environ. Sci.* 10, 1–14. doi: 10.3389/fenvs.2022.910816

Nair, S., Kai Wen, W., and Mei Ling, C. (2014). Bangkok flood risk management: application of foresight methodology for scenario and policy development. *J. Fut. Stud.* 19, 87–112.

NaturPhilosophie. (2016). The Fog Harvesters of Lima, Peru. Availalbel at: https://www.naturphilosophie.co.uk/fog-harvesters-lima-peru/ (Accessed June 11, 2024)

Nel, E., and Berry, B. (1992). The problems of supplying water to third world cities: Bulawayo's water crisis. *Dev. South. Afr.* 9, 411–422. doi: 10.1080/03768359208439648

New York City (n.d.). Cool neighborhoods NYC a comprehensive approach to keep communities safe in extreme heat. New York: New York City Government.

Ngoungue Langue, C. G., Lavaysse, C., Vrac, M., and Flamant, C. (2023). Heat wave monitoring over west African cities: uncertainties, characterization and recent trends. *Nat. Hazards Earth Syst. Sci.* 23, 1313–1333. doi: 10.5194/nhess-23-1313-2023

Ngulani, T., and Shackleton, C. (2022). Fuelwood production and carbon sequestration in public urban green spaces in Bulawayo, Zimbabwe. *Forests* 13, 1–13. doi: 10.3390/f13050741

Nyikadzino, T., and Vyas-Doorgapersad, S. (2022). Decentralisation and central government control: experiences from the local government reform in Zimbabwe. *Afr. J. Governance Develop.* 11, 213–232. doi: 10.36369/2616-9045

Obeng-Odoom, F. (2017). Urban governance in Africa today: reframing, experiences, and lessons. *Growth Chang.* 48, 4–21. doi: 10.1111/grow.12164

Ogunyiola, A., Gardezi, M., and Vij, S. (2022). Smallholder farmers' engagement with climate smart agriculture in Africa: role of local knowledge and upscaling. *Clim. Pol.* 22, 411–426. doi: 10.1080/14693062.2021.2023451

Paganga, L. (2021). 20,000 Bulawayo urban farmers to receive govt farming inputs. Farmers Review Africa. Available at: https://farmersreviewafrica.com/20-000-bulawayo-urban-farmers-to-receive-govt-farming-inputs/ (Accessed October 21, 2024)

Parliament of Zimbabwe. (2011). Bulawayo Provincial Profile. Retrieved from Parliament of Zimbabwe. Available at: http://parlzim.gov.zw/component/k2/download/1248_f27bd883d1839e2cad0b1a4ac15c6223 (Accessed March 23, 2020).

Pasquini, L. (2019). The urban governance of climate change adaptation in least-developed African countries and in small cities: the engagement of local decision-makers in Dar Es Salaam, Tanzania, and Karonga, Malawi. *Clim. Dev.* 12, 408–419. doi: 10.1080/17565529.2019.1632166

Patton, M. (2015). Qualitative Research & Evaluation Methods: Integrating theory and practice. *4th* Edn. Thousand Oaks: SAGE Publications.

Pratama, H., Sinsiri, T., and Chapirom, A. (2023). Green roof development in ASEAN countries: the challenges and perspectives. *Sustain. For.* 15. doi: 10.3390/su15097714

Ranasinghe, R., Ruane, A., Vautard, R., Arnell, N., Coppola, E., Cruz, F., et al. (2021). "Climate change information for regional impact and for risk assessment" in Climate change 2021: The physical science basis. Contribution of working group I to the sixth assessment report of the intergovernmental panel on climate change. eds. V.

Masson-Delmotte, P. Zhai, A. Pirani, S. Connors, C. Péan and S. Bergeret al. (Cambridge: Cambridge University Press), 1767–1926.

Ranger, T. (2006). The meaning of urban violence in Africa: Bulawayo, southern Rhodesia, 1890–1960. *Cult. Soc. Hist.* 3, 193–228. doi: 10.1191/1478003806cs057oa

Resnick, D. (2014). Urban governance and service delivery in African cities: the role of politics and policies. *Develop. Policy Rev.* 32, 3–17. doi: 10.1111/dpr.12066

Salami, R., von Meding, J., and Giggins, H. (2017). Urban settlements' vulnerability to flood risks in African cities: a conceptual framework. *Jàmbá: J. Disaster Risk Stud.* 9, 1–9. doi: 10.4102/jamba.v9i1.370

Santandreu, A. (2018). "Urban agriculture in Lima metropolitan area: one (short) step forward, two steps backwards – the limits of integrating food into urban planning" in Integrating food into urban planning. eds. Y. Cabannes and C. Marocchino (London: UCL Press), 117–133.

Sara, L., Pfeffer, K., and Baud, I. U. (2017). "Unfolding urban geographies of water-related vulnerability and inequalities: Recognising risks in knowledge building in Lima, Peru" in Urban water trajectories. Future City. eds. I. S. Bell, A. Allen, P. Hofmann and T. Teh, vol. *6* (Cham: Springer).

Siña, M., Saldarriaga, E., Lawler, J., Zunt, J., Garcia, P., and Cárcamo, C. (2016). Understanding perceptions of climate change, priorities, and decision-making among municipalities in Lima, Peru to better inform adaptation and mitigation planning. *PLoS One* 11, 1–13. doi: 10.1371/journal.pone.0147201

Sithole, S. M., Musakwa, W., Magidi, J., and Kibangou, A. Y. (2024). Characterising landcover changes and urban sprawl using geospatial techniques and landscape metrics in Bulawayo, Zimbabwe (1984–2022). *Heliyon* 10:e27275. doi: 10.1016/j.heliyon.2024.e27275

Sonneveld, B., Merbis, M., Alfarra, A., Ünver, O., and Arnal, M. (2018). Nature-based solutions for agricultural water management and food security. Retrieved March 17, 2024, from FAO land and water discussion paper no. 12.: Available at: https://openknowledge.fao.org/server/api/core/bitstreams/818a9e85-12e7-415a-b005-05d37a33377d/content

Trisos, C., Adelekan, I., Totin, E., Ayanlade, A., Efitre, J., Gemeda, A., et al. (2022). "Africa" in Climate change 2022: Impacts, adaptation and vulnerability. Contribution of working group II to the sixth assessment report of the intergovernmental panel on climate change. eds. H. Pörtner, D. Roberts, M. Tignor, E. Poloczanska, K. Mintenbeck and A. Alegríaet al. (Cambridge: Cambridge University Press), 1285–1455.

UN HABITAT (2014). The state of African cities 2014: Re-imagining sustainable urban transitions. Nairobi: UN HABITAT.

UN HABITAT (2022a). World cities report 2022: Envisaging the future of cities. Nairobi: UN HABITAT.

UN HABITAT (2022b). Urban climate action. The urban content of the NDCs: Global review 2022. Nairobi: UN HABITAT.

United Nations, Department of Economic and Social Affairs, Population Division. (2019). *World Population Prospects 2019 Highlights.* New York: United nations.

USAID. (2023). Environment and biodiversity. Retrieved January 11, 2024, from USAID: Capper, L. (2021) 'The Impact of Climate Change on Food Systems in Southeast Madagascar'. Available at: https://madagascar.co.uk/blog/2021/11/impact-climate-change-food-systems-southeast-madagascar (Accessed January 11, 2024)

Versik Maplecroft. (2018). 84% of world's fastest growing cities face 'extreme' climate change risks. Available at: https://www.maplecroft.com/insights/analysis/84-of-worlds-fastest-growing-cities-face-extreme-climate-change-risks/ (Accessed March 22, 2023)

Wakweya, R. (2023). Challenges and prospects of adopting climate-smart agricultural practices and technologies: implications for food security. *J. Agric. Food Res.* 14:100698. doi: 10.1016/j.jafr.2023.100698

World Bank. (2021). Madagascar. Available at: https://climateknowledgeportal.worldbank.org/country/madagascar (Accessed March 22, 2023)

Zehra, D., Mbatha, S., Campos, L., Queface, A., Beleza, A., Cavoli, C., et al. (2019). Rapid flood risk assessment of informal urban settlements in Maputo, Mozambique: the case of Maxaquene. *Int. J. Disaster Risk Reduct.* 40, 101270–101212. doi: 10.1016/j.ijdrr.2019.101270

Zievergol, G. (2022). African cities: climate action plans could help address injustice, inequity. Available at: https://www.un.org/africarenewal/magazine/september-2022/african-cities-climate-action-plans-could-help-address-injustice-inequity (Accessed February 22, 2024)

Zimmer, A. (2022). Dynamics of rural-urban food systems in southern Africa. Doctoral Dissertation. Tucson, AZ, The University of Arizona

ZIMSTAT (2019). Zimbabwe poverty report 2017. Harare: ZIMSTAT.

ZIMSTAT (2023). Zimbabwe 2022 National Population and housing census report, vol. *1*. Harare: ZIMSTAT.

ZIMVAC (2023). Zimbabwe vulnerability assessment committee (ZimVAC) 2023 urban livelihoods assessment report. Harare: Food and Nutrition Council Zimbabwe.