Multifunctional Landscape Transformation of Urban Idle Spaces for Climate Resilience in Sub-Saharan Africa

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Abstract

Poor physical and land use planning underpin the chaotic evolution and expansion in cities and towns in sub-Saharan Africa. This situation amplifies urban vulnerability to climate change. Worse, urban landscapes are rarely considered part of the discourse on urban development in sub-Saharan Africa, let alone in climate change adaptation. Yet, landscapes are known to play crucial roles in social, economic, and cultural resilience in cities and towns. Hence, designing basic forms of appealing and functional urban landscapes that support multiple

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ecosystem services is essential to the drive towards resilience, which relates to the ability to maintain or improve the supply of life support services and products (such as food and water) in the face of disturbance. In this chapter, the idea of transforming idle urban spaces into multifunctional edible urban landscapes is introduced and explored as instrumental for cost-effective adaptation and resilience to climate change in cities and towns in sub-Saharan Africa. *Multifunctional edible urban landscape* is defined here as a managed landscape that integrates food production and ornamental design, in harmonious coexistence with other urban structures to promote or provide targeted, multiple services. These services include food security, scenic beauty, green spaces for active living and learning, jobs and livelihoods support, environmental protection, climate adaptation, and overall urban resilience. This approach constitutes a triple-win multifunctional land use system that is beneficial to landowners, city managers, and the general community. This chapter explores the benefits, challenges, and prospects for practically transforming urban idle spaces into multifunctional edible urban landscapes using an example project from Ghana. The chapter shows that multifunctional edible urban landscape transformation for resilience is practically feasible, and sheds light on the possibility of the food production component paying for landscaping and landscape management. It concludes with thoughts on actions required across sectors and multiple scales, including mobilizing stakeholders, laws, policies, and incentives, to actualize multifunctional edible urban landscapes as key transformational components of resilience in sub-Saharan Africa.

Keywords

Urban landscape · Multifunctional land use · Resilience · Green spaces · Food security · Ecosystem services · Climate change adaptation

Introduction

The Challenges of Urbanization, Climate Change, and Resilience in Africa

Urbanization has its promise and value in terms of concentrating resources and capital to improve physical development and human well-being; but it has its perils too as it increases the demand for basic necessities of life (such as food, water, shelter, employment, and recreational opportunities) and the complexity of managing the resources and the socioecological processes that underpin ecosystem services and quality of life. Urbanization creates and alters landscape attributes and functions, which in turn affect the environment and quality of life in urban areas. Compared to the rate of urbanization in other regions, Africa is said to have achieved an urbanization miracle (Lwasa 2014). Africa has experienced an unprecedented rate of urbanization in the last two decades, resulting in the emergence of several megacities

(Lwasa 2014; Güneralp et al. 2017). From the year 2010, African urban population has increased at an average rate of 3.2% per year, compared to global average of about 1.2% (African Union 2020; UN DESA 2012). Africa currently has 43% urban population and, together with Asia, will account for about 90% of the projected increase in the world's urban population by 2050 (UN DESA 2019). By mid-century, more than half of Africa's population is expected to live in urban areas. Sub-Saharan Africa will host most of the largest cities that will arise from the projected population growth in Africa, most of them in coastal areas (Di Ruocco et al. 2015). These underscore the challenge and importance of sustainably managing the quality and resilience of urban environment and life by maintaining and enhancing the integrity and functionality of the systems that underpin resilience, particularly food systems (Russo et al. 2017; Haberman et al. 2014).

Already, cities and urban communities in Africa face formidable challenges, including high levels of food insecurity, unemployment, poverty, and environmental degradation (African Union 2020; Lwasa 2014; Güneralp et al. 2017). Provision of livable urban spaces, including green and recreational spaces, has proved particularly challenging and elusive. Increase in food production in Africa has substantially lagged behind the rate of population growth, resulting in protracted food insecurity (African Union 2020). The number of hungry people in Africa is estimated at 256 million and the continent might not meet key global targets on malnutrition or eliminate hunger by 2030 (FAO, ECA and AUC 2020). Projections suggest that an increase of about 112% in food production (over 2015 baseline) will be required to meet the food demand of sub-Saharan Africa alone in 2050 (African Union 2020). Urbanization will not only increase the quantity of food demanded, but also alter the composition and patterns of food consumption, with likely increase in demand for fresh fruits and vegetables. At the same time, urbanization will increase competition with agriculture for land and water which underpin food production.

Climate change presents an additional developmental burden and complicates existing challenges for all regions. However, Africa is considered a highly vulnerable continent to the adverse impacts of climate change (IPCC 2007; Chapman et al. 2017), and the continent is already experiencing the impacts of climate change, through highly frequent and severe episodes of droughts and floods (African Union 2020; Batchelor and Schnetzer 2018; Van Rooyen et al. 2017; Lwasa 2014; Armah et al. 2011). This vulnerability stems partly from Africa's poor physical planning and environmental degradation, and overreliance on agriculture, which is hypersensitive to climate change (IPCC 2007). These challenges raise the imperative for exploring several response options, including the planning, evolution, development, and uses of urban landscapes for reducing vulnerability and enhancing resilience (Russo et al. 2017).

Evolution of Urban Landscapes and Idle Spaces in Africa

Urbanization can be instrumental in amplifying vulnerability or enhancing resilience. Unfortunately, urbanization in Africa is rapid, unplanned, unregulated, and

chaotic (Lwasa 2014; Güneralp et al. 2017), a situation that will compound vulnerability. Especially in sub-Saharan Africa, physical development and land use are poorly planned (if at all). Weak land administration and poor municipal services add to the challenge of discontinuous expansion and poor-quality urban landscapes and environments (Mensah 2014). Urban landscape planning and management are rarely considered important in the discourse on sustainable and resilient development (Yawson 2020). Urban landscapes have, therefore, evolved organically and chaotically with urbanization, and are poorly managed. This poor planning and management of urban landscapes has resulted in the degradation of the biophysical and sociocultural significance of urban communities and diminished the overall resilience to environmental shocks. If this trend remains unaddressed, it can substantially amplify urban challenges and vulnerability to climate change (Di Ruocco et al. 2015). One visible result is the considerable proportion of land surfaces poorly covered by either natural or man-made covers (Mensah 2014). Consequently, very dusty, bushy, and unsightly land surfaces are visible in both the urban core and the periphery, resulting in high exposure to dust during the dry season and mud or sediment transport during the wet season, and other unhealthy elements (Yawson 2020). These have consequences for resilience and sustainability in both the short and long term. For example, long-term exposure to $PM_{2.5}$ (dominated by dust) can contribute to ischemic heart disease, cerebrovascular disease, lung cancer, and respiratory diseases (Health Effects Institute 2019). The number of deaths associated with $PM_{2.5}$ in Ghana and Nigeria in 2017 were 5,190 and 49,100, respectively (Health Effects Institute 2019).

Land ownership in Ghana can be used to illustrate the evolution of urban idle spaces in urban landscapes in sub-Saharan Africa. In Ghana, just as in almost all sub-Saharan African countries, urban expansion occurs largely through private action in an informal context. There are two broad types of land ownership in Ghana: customary and state ownership, accounting for 78% and 20%, respectively of total land (Larbi 2008; Yawson and Armah 2018). The remaining 2% are vested lands (split ownership between the state and customary authorities). Customary lands are owned by traditional authorities (stools and skins), clans and families, with chiefs and clan/family heads as the custodians and supported by principal elders of the given community or family (Larbi et al. 2004). The government of Ghana can apply the power of eminent domain to acquire land for national development or security purposes. It is believed that this system of land ownership constrains effective land administration, land use planning and management, and is a major driver of informal land transactions and development. It also partly accounts for the numerous intractable land disputes and conflicts from parcel, through community to tribal scales. Although the Town and Country Planning Department is responsible for physical planning, chiefs or owners of large tracts of land are expected to make and present a parcelled plan of their lands to the Lands Commission for the purposes of registration and titling. However, this is not mandatory or enforced. This means parcelling and layout of residential areas largely evince from landowners, independent of infrastructural and municipal service planning, delivery, and management. This results in incoherent physical development, with scattered pattern of settlements

in developing areas. Due to weak property markets, insecurity of tenure of residential or commercial properties, and weak financial support system for rapid development of individual properties, there is inordinate pressure on land for low-density housing and other commercial activities in urban areas. As a result, persons buy parcels of land and slowly develop these, or simply leave the parcels of land idle until they are financially capable of developing the land. Some also buy land out of speculation, with the view to selling the land later at higher prices. Undeveloped parcels of land do not attract property taxes and there are no mechanisms to ensure management regimes fit for the landscape or the environment. As a result, and partly due to informal planning of space, there are several open spaces and undeveloped or partly developed but idle parcels of land that are poorly managed (if at all) in both the urban core and periphery. These, together with poor infrastructural planning, management, and municipal services, diminish the natural, cultural, and scenic beauty of urban landscapes and escalate vulnerability.

These idle parcels do not only detract from the urban beauty and landscape services, but are also sites for a range of activities, both positive and negative. In some cases, these parcels are used by itinerant farmers for food production, occupied by petty traders or informal settlers (squatters), or simply left bushy or bare and exposed to the erosive forces of water and wind (dust generation and transport). In most cases, these parcels are used for nefarious activities such as littering, defecation, and criminal activities, or habitat for vermin. However, these spaces can be sites for urban greening and human production to transform the landscape to support multiple environmental and developmental goals such as jobs or income generation, food security, environmental protection, and scenic beauty, and thereby contribute to overall urban resilience and well-being.

Multifunctional Edible Landscape Approach to Resilience

Resilient development and adaptation planning have become more urgent for social groups, ecological systems, and geographic regions for which there is high certainty of vulnerability (Stern and Treasury 2007). Resilience has been conceptualized as the capacity of a dynamic system to maintain its structural and functional integrity, or change for the better, in the face of disturbances that threaten the viability, functioning, or development of that system (Masten 2014). Urban resilience, from a socio-ecological perspective, removes constancy and introduces flexible, adaptive, and multilevel approaches for responding to persistent or short-term threats and stresses across the entire urban space. The scale of challenges outlined in section “[The Challenges of Urbanization, Climate Change and Resilience in Africa](#)” constitute a major source of disturbance that threatens the viability, functioning, and development of urban landscapes and communities, deserving resilient, multilevel responses. Globally, landscape-based approaches are being promoted, in both policy and academic circles, as an integral component of the responses to urban sustainability challenges (Säumel et al. 2019; van Noordwijk et al. 2014; Russo et al. 2017; Panagopoulos et al. 2016; Matsuoka and Kaplan 2008).

Landscapes can have different meanings for different persons or professionals (Fischer et al. 2016; Scott et al. 2009). However, in the urban context, landscapes can be considered as the physical environment shaped by human-nature interaction. The “nature” component comprises the biophysical cover of the land surface that underpin ecological productivity, while the “human” component comprises man-made surfaces and structures such as houses, roads, and other infrastructure (Grêt-Regamey et al. 2015; Panagopoulos et al. 2016; Russo et al. 2017), together with human action on nature. These components are intertwined and provide reciprocal services and or feedback effects on each other. Landscapes, therefore, provide first impressions of the complex processes and interactions between social and ecological components that underpin the provision of ecosystem services, which, in turn, underpin human well-being and resilience (Yawson 2020). These ecosystem services are classified as provisioning (e.g., food, herbs, and clean water or air), supporting (e.g., nutrient, energy, or material cycling), regulatory (e.g., flood, erosion, and climate control), and cultural (e.g., heritage, spirituality, visual aesthetics, and recreational opportunities) (Grêt-Regamey et al. 2015). A landscape reflects the status of cultural sophistication, development, and well-being, as well as the vulnerability of its inhabitants or users to a given external or environmental shock (Yawson 2020). Landscapes that are subject to unsustainable management practices can be very vulnerable to shocks and, in turn, deepen the vulnerability of its inhabitants or users to environmental shocks.

Multifunctional edible urban landscapes are being promoted as instrumental for sustainably intensifying the production of ecosystem services and products, improving livelihoods, and optimizing the use of limited land resources as opposed to straight intensification of farming and commercial forestry (Säumel et al. 2019; Panagopoulos et al. 2016; Fischer et al. 2016; Bustamante et al. 2014; van Noordwijk et al. 2014; Santika et al. 2015). Multifunctional edible urban landscape refers to a managed landscape that integrates food production and ornamental landcover, in harmonious coexistence with other urban structures to promote or provide targeted, multiple services such as food, erosion and flood control, scenic beauty, and recreation. A multifunctional edible urban landscape approach, thus, helps generate ecosystem goods and services to meet the basic but multiple demands of urban communities while limiting expansive use of land. It helps reconcile competing interests and goals that put urban land under constant and intense pressure. Multifunctional edible urban landscapes will arise from and be enhanced by land use planning approaches and innovative transformations that harmonize the functions of landscape components in order to derive multiple benefits across varying spatial and temporal scales. Multifunctional edible urban landscapes have considerable promise to contribute to urban resilience and long-term sustainability or adaptive capacity if the structure and functions of components are well aligned, interconnected, and harmonized to generate specific products and services (Säumel et al. 2019; Panagopoulos et al. 2016; van Noordwijk et al. 2014). This implies urban planning should be deliberate in shaping multifunctional landscape performance in order to derive optimal outcomes from every inch of ground. This can be enhanced or constrained by land use intensity and the scale of opportunity for landscape

innovations in existing urban zones. It could be argued that several aspects of landscapes are multifunctional in nature. However, developing countries require special attention for multifunctional landscape planning to impose desirable landscape structure with increased capacity to contribute to addressing the multiple challenges in urban communities in the short term, while enhancing resilience and adaptive capacity in the long term.

Increasingly, this realization has given rise to the calls for expanded urban green infrastructure as a nature-based solution or ecosystem-based approach to resilience and climate change adaptation (Russo et al. 2017). Urban greenspace or cover can contribute to food security, urban aesthetics, thermal regulation, air quality (by suppressing dust and removing pollutants), water quality, and mitigate against flood and erosion (Wolch et al. 2014; Eschobedo et al. 2011; Thompson 2011; Nowak et al. 2006). A review by Laille et al. (2014) showed a strong evidence for contribution to physical and psychological health, biodiversity, thermal regulation, and urban attractiveness. In fact, poor access to urban greenspace could be associated with increased mortality (Coutts et al. 2010) and other adverse health outcomes (e.g., Villeneuve et al. 2012; Thompson 2011; Barton and Pretty 2010). This emerging evidence supports the view on the value and utility of urban green cover to strengthen resilience and adaptation to climate change (Dai 2011). Accordingly, research interests in green infrastructure, ecosystem services, or nature-based solutions have increased substantially as options for strengthening urban sustainability and resilient response to climate change (Haase et al. 2014). While a large body of literature has emerged from this research interest, these studies are largely conducted in isolation without considering the need for integrated systems that include food production and general landscape management in urban contexts (Russo et al. 2017). Critically, in developing countries, the role of human production activities as part of green cover in urban landscapes to support multiple goals, including support for livelihoods, food security, environmental protection and aesthetics, and provision of recreational and learning opportunities, needs to be emphasized (Yawson et al. 2019).

Elsewhere, there have been calls for embedding multifunctionality into agriculture and other land use sectors in rural landscapes (Mander et al. 2007; Nair and Garrity 2012). Even though interest in urban agriculture has been increasing substantially (Csortan et al. 2020; FAO 2012; Urban Agriculture 2009), this has often been studied or articulated in isolation from general landscape management goals. In Africa, the need for deliberately incorporating human production activities in urban landscapes to serve multifunctional purposes is urgent and critical due to increasing urban poverty, food insecurity, and poor-quality landscapes (FAO 2012). Due to poor urban planning, landscapes evolve chaotically with urban development and are hardly managed (Lwasa 2014; Mensah 2014). Poor financial resources and land administration combine to raise the challenge of creating and managing curated landscapes to preserve the scenic beauty and improve the social, economic, environmental, and cultural significance of urban zones. A way out is mobilizing policies, regulations, incentives, and stakeholders to adopt landscape management approaches that permit a sensible balance between economic activities and

profitability on one hand, and ecological functionality and productivity on the other hand, so that the latter is maintained by the former and, together, support overall urban well-being and development goals. In other words, producers become landscape entrepreneurs and managers whose obligation include the maintenance and management of ecological productivity and functionality, profitability, and scenic beauty. In this case, the scenic beauty, which is a desirable public good or non-commodity output, for example, is paid for by the economic production which is private activity (Mander et al. 2007). This twin system can be applied to multifunctional landscapes where food production supports urban food security, jobs, and poverty reduction, while general landscape management, as part of the production obligations, provides ecosystem services such as scenic beauty, environmental protection, and recreational opportunities.

In Africa, innovations in existing urban spaces are required to improve livability and overall resilience and human well-being, through increased capacity for intensive delivery of multiple ecosystem services. Because land is finite and the value of urban land parcels increases rapidly, preserving spaces for a single purpose is extremely difficult (Säumel et al. 2019; Güneralp et al. 2017; Mander et al. 2007). This difficulty is heightened by poor land administration, speculation, informal land transactions, and urban expansion. Additionally, the constraint of funding makes it difficult for African governments to invest in the development and maintenance of curated landscapes to improve the scenic beauty of the urban space and contribute to resilience and well-being. As a result, improving landscape contribution to resilience would require approaches that balance or optimize ecological productivity through human production, economic profitability, and scenic beauty or delivery of other ecosystem services which are public goods. To this end, it is important to adopt innovative approaches to impose specific multifunctional landscape character in existing urban spaces, and multifunctional land use planning for the future. Multifunctional landscape approaches that include human production are promising options for enhancing resilience in poorly planned urban zones in Africa (Säumel et al. 2019). Particularly, food production integrated in properly designed and managed landscapes to support multiple development goals, including food security and jobs, would be crucial. This is particularly important since land is finite, urban land has high value and is constantly under intense pressure from competing interests and goals. Multifunctional edible landscape approach provides opportunity for balancing competing interests and goals, both ecological and socioeconomic, in the African urban space. However, a multistakeholder mobilization of policies, resources, and regulatory and financial instruments will be required to ensure inclusivity, broad-based acceptance, and long-term sustainability (Yawson et al. 2019). The purpose of this chapter is to illustrate the workability and utility of this innovative approach to urban landscape transformation, and the requirements for scaling out, for resilience in Africa using a case study from Ghana.

Structure of the Chapter

Section “[Introduction](#)” above has provided background and contextual information about urban challenges and evolution of urban landscapes in Africa, as well as the utility of multifunctional edible landscapes for enhancing resilience. The rest of the chapter is organized as following. Section “[Multifunctional Edible Urban Landscape Transformation in Practice](#)” presents a case study of practical implementation of multifunctional edible landscape in existing urban areas in Ghana and the outcomes. Section “[Lessons and Insights for Scaling Up](#)” builds on the case study outcomes to provide lessons and insights on practical expansion of multifunctional edible urban landscapes in Africa. Finally, the chapter presents some conclusions and recommendations in section “[Summary and Conclusions](#)”.

Multifunctional Edible Urban Landscape Transformation in Practice

Promoting innovative landscape transformation can play a catalytic role in addressing urban challenges and enhancing resilience to climate change in Africa. Proceeding from the context and belief presented in the prior section, a practical example of an edible urban landscape transformation activity Ghana is presented in this section. This example is aimed at demonstrating the utility and practical approach to transforming idle spaces into multifunctional edible landscapes in existing urban areas. It also highlights key challenges and levers of change for wider implementation or adoption of this approach to support multiple development goals and enhance resilience. A question of interest inherent in this example was whether the food production component, from a multifunctional perspective, could incentivize and pay for maintenance of scenic beauty and management of landscapes in existing urban areas.

The practical example referred to is derived from a pilot project by the Agriculture for Food Security 2030 (AgriFoSe2030, theme 2) sponsored by the Swedish International Development Agency (SIDA) through the University of Gothenburg. The project, firstly, tested the idea of using vacant, idle parcels of land in the urban area to produce food, enhance the scenic beauty of the surrounding landscape with ornamental plants, while providing jobs for young people and women. This concept was referred to as multifunctional edible urban landscape (a managed landscape that integrates food production, ornamental aesthetics, and other urban structures in a harmonious coexistence to deliver targeted, multiple ecosystem services – Yawson et al. 2019). The edible urban landscape pilot project was conceived as a potential path to climate adaptation and resilience in urban centers in Ghana. The pilot project took place in the year 2018 in the City of Cape Coast in the Central Region of Ghana. Several idle parcels suitable for the project were identified in Cape Coast. Owners of the identified parcels were contacted to negotiate permission to use their lands for the pilot project. Other considerations for the final selection of sites included trust of landowner, safety of the project activities and assets (for e.g. safety from praedial

Fig. 1 A Google Earth screenshot of landscape view of part of Kwaprow community (one of the pilot project communities) in Cape Coast

larceny), access to water, and ease of monitoring by the researchers. Based on these, two sites were eventually secured at Akotokyer ($1^{\circ}17'36.28''\text{W}$, $5^{\circ}8'8.61''\text{N}$) and Kwaprow ($1^{\circ}18'7.02''\text{W}$, $5^{\circ}7'26.98''\text{N}$), two communities that border the University of Cape Coast.

The city of Cape Coast is the capital of the Cape Coast Metropolis (CCM) and the Central Region of Ghana. The CCM covers an area of 122 km^2 and is very urbanized as only 23% of its 169,894 inhabitants live in rural areas (Ghana Statistical Service 2013). The study communities are among several that border the University of Cape Coast and, together, make up the largest spatially distinct continuum of communities outside of the core of the city of Cape Coast which is densely built up and has limited space for new development. Due to the proximity to the University of Cape Coast, Kwaprow and Akotokyer are among the fastest-growing urban communities in Cape Coast as demand for facilities and services for students, staff, and the associated itinerant workers of the University of Cape Coast keeps growing. However, the communities lack planned physical development and so the physical expansion is haphazard and chaotic, with spatially scattered property development and several idle, unmanaged spaces contributing to undesirable landscapes. A section of urban landscape in Kwaprow is shown in Fig. 1. The communities have poor infrastructure and municipal services are vulnerable to floods and are highly exposed to dust pollution during the dry season. This situation presents an opportunity to generate evidence for the value and feasibility of landscape transformation to support multiple development goals and enhance resilience and well-being.

Implementation of the Pilot Project

The project goals and activities were explained to relevant stakeholders. The sites for the pilot project were bushy and unkempt (Fig. 2). The site at Akotokyer had sparsely distributed apartment buildings while the site at Kwaprow had neighboring low-density houses and amenities such as a school and a clinic. The sites were cleared, ploughed, and harrowed (Fig. 3).

A greenhouse, measuring 9×15 m, was installed at each site (Fig. 4). Solar-powered fans were used for ventilation and to control humidity in the greenhouses. Seedlings of the tomato genotype Eva Purple Ball were grown in pots in the

Fig. 2 Project site at (a) Akotokyer and (b) Kwaprow

Fig. 3 Site at Kwaprow (a) and Akotokyer (b) ploughed and prepared for greenhouse installation

Fig. 4 Greenhouses installed at sites with grasses and border plants grown around the greenhouses

Fig. 5 Young tomato plants growing in pots in the greenhouses

greenhouses and recommended agronomic practices on integrated production and protection (IPP) were used (Figs. 5 and 6). The area surrounding the greenhouses were planted with grasses and border plants (fruit trees for shade were planned but land lease terms did not permit this immediately) and maintained to improve the scenic beauty of the site, control erosion and dust, while providing recreational and educational opportunities for neighboring families (Fig. 4). Eight young people, four females, and four males aged between 18 and 35 years were employed to work in the greenhouses and to maintain the surrounding landscapes.

Fig. 6 Matured tomato plants in the greenhouses

Fig. 7 Degraded, idle backyard space (left) turned into a productive site for eggplant (right)

In addition, the project encouraged individuals to transform small spaces in backyards or urban areas into green, productive areas. For example, one woman turned a degraded, idle backyard space into a productive site for eggplants (Fig. 7).

When the tomatoes were ripe and partly harvested, a stakeholder engagement or dissemination event was held at the sites, involving the communities and other stakeholders, to showcase and discuss the relevance, challenges, and opportunities for scaling up the project (Fig. 8).

Fig. 8 Segments of stakeholder dissemination event

Project Achievement

Multifunctional Edible Urban Landscape

The association between urban greenspaces and environmental quality and human well-being is well established and the need for planning to incorporate greener spaces in urban areas is being actively promoted (Panagopoulos et al. 2016; Laille et al. 2014; Mensah 2014; Bratman et al. 2012; Matsuoka and Kaplan 2008). However, in Ghana, and largely across sub-Saharan Africa, outdoor landscaping is a private matter and overall management of public spaces and the general fabric or structure of the urban landscape does not feature in discourse on sustainable development or resilience. There is evidence that greenspaces in urban Africa is declining at an alarming rate due to neglect and poor land use planning and controls (Mensah 2014). Poor urban landscapes can diminish resilience as they can contribute to flooding and sediment transport, thermal stress, air pollution, garbage accumulation, and transmission of diseases. Landscapes expose most urban residents to environmental conditions that undermine health, well-being, natural resource sustainability, and overall resilience (Säumel et al. 2019). It has been reported that the informal, chaotic, and discontinuous pattern of urbanization in Africa, together with poor social services, is a mark of vulnerability to extreme events (Di Ruocco et al. 2015). Dust, for example, is a major component of particulate matter in the air. In most urban zones and rural communities in Africa, people live literally in dust arising not only from industrial or human activities but mainly from bare surfaces (including roads, see Fig. 1) due to poor physical, infrastructural, and landscape

planning and management. While the adverse health outcomes of exposure to dust are known and have been of considerable interest in some jurisdictions (Khan and Strand 2018), there is poor information on the contribution of dust to air quality and human health in West Africa, for example, where dust pollution and morbidity rates are higher (De Longueville et al. 2010) and over 20% of infant mortality is due to respiratory infections (Bryce et al. 2005; Morris et al. 2003). In the recent state of global air report, it was shown that annual death from air pollution (principally from PM_{2.5}) is on the rise in sub-Saharan Africa, reaching 5,190 and 49,100 for Ghana and Nigeria, respectively, in 2017, while others suffer various morbidities due to long-term exposure (Health Effects Institute 2019). Malaria is a major cause of morbidity in the case study communities. Africa remains the largest global hotspot of death from malaria, accounting for about 90% of all deaths from malaria in 2017 (WHO 2018). In addition, heat stress events would likely increase in intensity, frequency, duration, and spatial spread (Chapman et al. 2017) and humid tropical countries could have high sensitivity and exposure to these events. Enhancing resilience in urban communities implies taking verifiable steps to minimize the exposure of populations to these environmental stressors and hazards. Innovative landscape management approaches can help increase infiltration, reduce floods and sediment transport, and exposure to dust and vector-borne diseases such as malaria. These conditions are expected to be amplified by climate change; and taking remedial measures now through cost-effective landscape transformation or management approaches, as demonstrated in this example project, is a reasonable investment in achieving multiple development goals and enhancing resilience and long-term adaptive capacity.

Through their natural, cultural, and scenic beauty, urban landscapes provide a range of services (or disservices) that contribute to social, economic, and cultural resilience and overall quality of life. Landscapes embody and reflect the state of well-being and vulnerability of inhabitants to shocks. Hence, designing basic forms of appealing and functional urban landscapes that support multiple ecosystem services is essential to the drive towards resilience, which relates to the ability to maintain or improve the supply of life support services and products (such as food and water) in the face of disturbance. Just like many cities and towns in Ghana, the evolution of Cape Coast can be described as chaotic, contingent, discontinuous, and informal. Poor planning has combined with pressure on land for housing to create discontinuous physical expansion of the city, resulting in several vacant, idle parcels of land in the city. Several areas in both the core and periphery of the city are degraded, with visible signs of erosion, red-earth (iron-rich) dusty surfaces. Other places are simply covered by unmanaged bush, which becomes breeding grounds for mosquitoes and other vermin. Because of poor drainage systems, the project communities easily succumb to floods and sediment transport (Tham-Agyekum et al. 2019), and have conducive surfaces for breeding of mosquitoes. In the example project presented, the sites acquired for the pilot project were idle, bushy, and unmanaged (Fig. 2), detracting from the scenic beauty and ecological utility of the area, as well as posing physical and health hazards to residents and those who passed through the area, especially women, at night. Residents and those who pass through

the area harbored fear about the high probability of attacks from criminals and/or vermin. There were signs of nefarious use of the sites as litter, human faecal matter, and other vermin were observed during land preparation. This pilot project opened up the area, improved the ecological functions, safety, scenic beauty, and social utility of the area (Figs. 3 and 4). The landscaping around the greenhouses were generally part of the integrated preventive environmental strategy of beautifying and protecting the landscape, reducing environmental degradation by ensuring soil cover and increasing the delivery of ecosystem services, both directly and indirectly. The idea of the project was to maintain a beautiful landscape or urban aesthetics while producing food and supporting incomes for the landscape managers. In this way, food production and basic landscaping are integrated, in a multifunctional edible urban landscape perspective, to deliver multiple ecosystem services. The project sites became attractions to the residents, the communities, and others who simply passed through the area. The grassed surroundings were used for recreational purposes by families and for curiosity learning (especially by children). The project sites became the largest curated, managed outdoor area considered by residents as beautiful and safe space for recreation by children in the communities. Generally, residents and those who passed by were happy about the project as they realized that it is possible to produce so much food in a small area and, at the same time, maintain a beautiful landscape or communal outdoor space in hitherto idle, unmanaged urban areas. The experience from the pilot project reported in this chapter suggests that persons have innate desire for beautiful urban landscapes but are denied of these due to poverty of municipal services. It also suggests the existence of a desire for recreational opportunities in safe, well-kept urban landscapes due to the use of the site for recreational purposes. Some nearby residents were happy because the improved landscape also meant improved security and safety in the area. In all, the example project demonstrated the idea and utility of multifunctional edible urban landscape and the feasibility of achieving this through transformation of idle spaces in existing urban areas.

Urban Food Security and Livelihoods

Food insecurity, unemployment, and poverty are major developmental challenges in urban Africa. Urban poverty is increasing in Africa and so is food insecurity (African Union 2020) as urban areas rely on rural food supplies. With poor supply chains, fresh food deteriorates rapidly both in transit and in urban markets and food safety also becomes a concern. This constrains access to fresh food as availability and prices become affected. Tomato, for example, is a climacteric crop which is an essential ingredient in almost every Ghanaian dish. Tomato is produced under rainfed conditions and long-distance transport and storage under poor conditions result in high losses. Prices of tomato in the dry season can be as high as three to four times the prices in the rainy or main harvesting season. This raises the need for producing food close to urban markets or point of consumption. Although urban agriculture is practiced in Ghana, there are concerns about the safety of the food produced and its environmental impacts due to the quality of water, other inputs, and management practices used (FAO 2012; Redwood 2009). Because urban agriculture

has yet to gain a desirable level of quality and policy attention and thereby become mainstreamed in the urban landscape architecture, urban agriculture is practiced informally and in isolation from landscape management goals (FAO 2012), let alone from a multifunctional perspective. Just as with food, even where municipal services are available, poverty constrains access to these, resulting in increased vulnerability (Armah et al. 2018). Overall, there is a need to boost policy and operational or practical innovations for landscape transformation that integrates urban agriculture and landscape management goals in a singular, cost-effective framework to support resilience to climate change and better response to challenges in existing urban zones. These challenges include food security, jobs and income-generating activities, and aesthetic, livable, and recreational spaces. Embedding human production in the management of urban landscape and scenic beauty in this way is a useful integrative framework for landscape transformation and management as it can ensure that human production pays for the intangible ecological functions and services (such as scenic beauty) that are public goods while enabling a better response to development demands and climate change. This approach is consistent with recent calls for multifunctionality in agriculture, forestry, and other land use sectors (Russo et al. 2017; Nair and Garrity 2012; Mander et al. 2007).

Inherent in the pilot project was the idea of demonstrating the feasibility of twining human production and maintenance of beautiful landscapes such that the former (as a private good or activity) pays for the latter (as a public good) while supporting urban food security. The human production aspect was fulfilled by the production of high-quality tomato fruits in the greenhouses, with low external inputs such as water and pesticides. The system used in the pilot project produces 2000 kg (2 tonnes) tomato per cycle per greenhouse, and there could be at least three cycles per year. If properly planned with market access to high-end users (such as supermarkets, hotels, and restaurants), three cycles are enough to recover the full cost of installation and operation and generate profit. In this project, eight young men and women were employed for the duration of the project, to work in the greenhouses and maintain the surrounding landscapes. Their initial wages were part of the initial investment cost for the first cycle while payment of wages in subsequent cycles would be paid for by revenue from previous cycles. The initial idea was that these young persons work without wages but receive payment from the postharvest revenues. However, this idea was not acceptable to prospective workers, even those who were already in urban farming. So, in the end, their wages had to be worked into the initial investment cost. The tomatoes produced in the greenhouses were sold locally in the study communities, University of Cape Coast and beyond. Those young persons who worked in the greenhouses also had some tomatoes for their own household consumption. This possibility of paying for ecosystem services, as public good, by human production in urban landscapes to support multiple environmental and development goals was demonstrated during the dissemination event, to stakeholders including representatives from the Cape Coast Metropolitan Assembly, Ministry of Agriculture (regional office), town planning, chiefs and elders of the project communities, tomato retailers association in local markets, academics, and the general public. This approach was intensely discussed during the

dissemination event and the consensus was that if this approach is well planned for out- and up-scaling, it can considerably augment urban food security and environmental and human resilience. The members of the project communities indicated how the landscaping could help reduce floods or dust exposure in the communities and improve scenic beauty to bring them some dignity, happiness, and recreational opportunities for children. In all, the project shows a possible pathway for urban employment and livelihoods in food production, landscaping, and landscape management while supporting food security.

Projections suggest that urban food demand will increase substantially due to a combination of increase in population and incomes, increased awareness of food health and safety, and dietary shift (Alexandratos and Bruinsma 2012; Yawson et al. 2020, 2017). A resilient urban community should be food secure and have landscapes that minimize socioecological vulnerability. One way of addressing food safety and security concerns is local supply where the food is transparently produced and freshly supplied to consumers or retailers. Tomato, for example, is almost indispensable in Ghanaian dishes or diets. Tomato production is very seasonal and can be very expensive or simply unavailable during the dry season. Suppliers and market women travel to neighboring countries to bring tomatoes to urban centers in Ghana especially during the dry season. The same can be said of several other vegetables. Yet, there are idle, unkempt spaces in urban areas that currently pose risks and dangers to urban populations and substantially detract from the scenic beauty of urban landscapes. This project demonstrates the fact that a multifunctional edible urban landscape approach can be applied to transform these spaces to productive and livable landscapes to support the multiple goals of food security, jobs and poverty reduction, environmental quality, and human well-being. This approach is not only feasible but also cost-effective and presents a triple-win opportunity for landowners, landscape entrepreneurs and workers, and city managers. It improves landscape structure and ecosystem services to enhance resilience and well-being. In terms of adaptation to climate change, transformation of idle spaces in urban zones to multifunctional edible urban landscapes can be instrumental in strengthening resilience and adaptive capacity in the areas of food insecurity, incomes and livelihoods, and environmental quality.

Lessons and Insights for Scaling Up

Landscaping and maintenance of public outdoor spaces have traditionally been the responsibility of governments. In sub-Saharan Africa, this arrangement seems to be generally absent due to weak financial capability and poor physical planning, resulting in distasteful landscapes that amplify vulnerability to shocks. Although urban agriculture or farming has been practiced for a long time throughout the world, and there is a growing interest and worthy calls for its integration in urban planning (Redwood 2009), it does not necessarily and deliberately integrate landscaping for the purpose of scenic beauty, environmental protection, and recreational use. Similarly, the idea of edible landscapes has been around for a while and practiced in

different formats and context, including home or kitchen gardens and agro-parks. However, in Africa where poor financial capability weakens public landscape management, there is scope for exploring the requirements for creating edible landscape entrepreneurs who simultaneously produce food and maintain aesthetic landscapes, with the former paying for the latter. The practical example presented in this chapter tested this idea in parallel with the idea of transforming the idle spaces to multifunctional edible landscape. This project suggested that young persons would not easily defer payment for their work until revenue is generated from sales of produce. Perhaps, they did not consider the project as their own but only as workers, a situation worthy of further exploration. Nonetheless, on a balance, the project result showed that, with careful planning and successful harvest, it is possible to cover this cost from initial revenue and generate profit from the second or third cycle. Hence, the project gives indication that multifunctional edible landscape entrepreneurs can be developed to maintain idle and public spaces that are poorly managed (or not at all) by either the state or private owners due to inadequate resources. Further exploration of this idea would be useful for policy, practice, and research in multifunctional edible urban landscapes to help improve the general landscape character and resilience of urban zones in Africa.

The project used greenhouse system for crop production. This is expensive and could be unaffordable to potential multifunctional edible urban landscape entrepreneurs who would likely be resource-poor. As a result, some form of financial support or business case could be investigated to inform large-scale implementation of this system. While non-greenhouse-based production systems are viable, such as seen in conventional urban farms, the landscape beautification and opportunities for recreational and educational use might give cause for security concerns. Uncontrolled visit or recreational use of the site can expose the crops to unintentional damages. Prædial larceny could also be increased. In addition, because of the quality and safety concerns over vegetables from urban farms in Ghana (Redwood 2009), greenhouse production might be more acceptable to consumers. Finally, because greenhouse production is highly productive, it will not require large area of land to produce profitably and can be more suitable for small idle spaces or where only a small space can be used for food production while the rest of the land area is landscaped. As a result, the use of a greenhouse system as presented in the example project, or otherwise, should be informed by local circumstances, including security concerns.

While Africa is known to be highly vulnerable to climate change, the local-scale impacts of climate change in Africa is poorly understood (Di Ruocco et al. 2015). Cape Coast lies in the coastal savannah agroecological zone and so drought, water scarcity, and heat stress are persistent problems. Cape Coast is the capital of the Central Region, which is the fourth poorest region in Ghana. These challenges would be exacerbated by climate change, population growth, and urbanization. The urban challenges of Cape Coast might not differ significantly from other cities in Ghana. There are numerous opportunities for implementing multifunctional edible urban landscapes in Ghana and sub-Saharan Africa as the characteristics of urban landscapes tend to be similar. The project demonstrated the promise of a

multifunctional edible urban landscape approach to strengthening resilience through food production, land cover management, improving urban aesthetics, environmental protection, providing greenspace for recreational and educational opportunities, as well as jobs and livelihood opportunities in cities and towns.

Despite the huge potential of this concept of multifunctional edible urban landscape to contribute to resilience and adaptive capacity, there are success factors that need to be in place and challenges that need to be addressed to ensure success. These are discussed below to help identification of opportunities for innovation and mitigation of challenges and risks that might arise, and guide efforts at implementing or scaling up similar landscape transformation projects in similar contexts.

1) Trust and legitimacy: The first lever of change is developing a strong trust between city authorities (government), landowners, and landscape entrepreneurs. As indicated earlier, the land sector in Ghana is riddled with disputes, protracted litigation, and conflicts (sometimes violent conflicts) due to poor land administration and inordinate pressure on land for housing, commercial, and industrial activities. A parcel of land can be sold to two or more persons by the same or multiple parties. The courts are unable to deal with land disputes or litigation swiftly. Protecting a parcel of land can be more expensive than the cost of the land itself, and sometimes comes at a great cost to parties in a dispute or conflict. In the example project, though earlier verbal assurances were given by landowners to the researchers, the landowners later showed deep distrust and insecurities with releasing their lands for the project. Urban landowners feel insecure granting their lands for temporary projects as there might be limited or costly paths to peaceful recourse to their lands. The first step to successful implementation of this landscape transformation is, therefore, to establish an institutional framework that fosters and deepens a three-way trust between landowners, city authorities, and landscape entrepreneurs. This institutional framework should formalize and render transparent land transactions and use. This is necessary to legitimize the ownership of resources, the process of transformation, formal rights and responsibilities, and benefits sharing. Minimizing insecurities among landowners and strengthening tenure security of landscape entrepreneurs are key to freeing up the numerous idle spaces in existing urban zones for edible urban landscape transformation projects. This, in turn, will require a stronger connection with and improvements in the land administration system at local or national scale to guarantee the security of ownership and access to land by landowners without jeopardizing the tenure security of those who produce on and manage the landscapes.

2) Incentives: Beyond institutional arrangements for land ownership and tenure security, specific incentives can help ease the process of committing idle spaces to edible landscape transformation. As indicated earlier, idle lands do not attract any meaningful taxes and there are no management responsibilities enforced on landowners. There is a need for land management mechanism that encourages owners of idle parcels or spaces to actively manage their lands in a manner that fits the broad urban landscape and ecosystem or transfer such management responsibilities to edible urban landscape initiatives. As part of the institutional arrangements and improvements in land administration, policies and regulatory instruments that

impose and enforce land management and tax obligations on landowners would be essential. This needs to be tightly coupled with improvements in land administration structures and procedures to make the process of land registration and titling less cumbersome. In this context, incentives such as free land registration and/or titling, reduced or waving of land taxes, and transfer of land management responsibilities from landowners to landscape entrepreneurs can help catalyze freeing idle lands for multifunctional edible urban landscape initiatives. Neighbors would be supportive of edible urban landscape projects if they become aware of the numerous benefits it can generate to the public, landowners, and the edible landscapists, especially if neighboring residents know that the project would not lead to conflict over land, and that they can benefit from fresh food, recreational and learning opportunities, or aesthetic value of the project sites. The argument of neighborhood landscape improvement could also be made and used to derive small margin of revenue from neighboring properties whose owners or inhabitants could benefit from the aesthetics and the recreational and educational opportunities. A major incentive to landscape entrepreneurs would be a strong connection to markets: local residents, fresh produce retailers, supermarkets, hotels, restaurants, and processors. Local authorities or city managers could facilitate this as part of an integrated approach to serving the multiple goals of urban development demands, including food security, jobs and poverty reduction, and scenic beauty. This will also mean supporting private or individual developers to complete their housing or property development projects quickly to support the achievement of a desirable landscape as a whole.

3) Formal edible landscapes in urban planning: Beyond innovations of landscape transformation in existing urban zones, there is a need to arrest the current chaotic and informal evolution or growth of urban zones and landscapes. This calls for compact urban planning approach that opens up a zone for development at a time, reduces the preponderance of idle spaces, and formally integrates multifunctional edible landscapes in the urban fabric. In the interest of the challenges and threats posed by climate change, resilient cities need to have the capacity for resource efficiency, circular economy, and material transformation or flows. This formal incorporation of multifunctional edible landscapes into the development plan will amount to a formal recognition and practical articulation of the high capacity of urban agriculture for material cycling while supporting multiple socio-ecological services in urban areas (FAO 2012). When greenhouse production is chosen, landscape entrepreneurs might need support as the capital requirement might be high for some. To this end, support for formal access to financial resources and technical support would be helpful and a great incentive to landscape entrepreneurs.

4) Recognition and articulation of landscape needs and services: The first challenge is the need for policymakers, regulators, and urban management authorities to recognize and strongly articulate the fact that the appearance and structure of landscapes in which people live are strongly connected to a sense or state of poverty, powerlessness, vulnerability, despondency, ill-health, and distrust of government (Scott et al. 2009). Urban landscapes can deter or facilitate nefarious or some criminal activities. Urban landscapes can confer confidence, dignity, and a sense of pride (or otherwise) in its inhabitants or users. Recognizing these fundamental

relationships between landscapes and people by public authorities is a prerequisite for moving towards policies and management decisions aimed at transforming landscapes to transform lives. People have landscape needs (Matsuoka and Kaplan 2008). These landscape needs are directly linked to the material and existential needs of the landscape inhabitants or users and, by addressing these needs, vulnerability can be reduced, and resilience enhanced (Yawson et al. 2015). A formal recognition and articulation of the linkage between landscapes and urban challenges or people's needs are a prerequisite for innovative planning and transformative approaches that enhance resilience and adaptive capacity. Next to this recognition is the need for political will to tackle the issue of integrated urban planning that can incorporate multifunctional edible urban landscapes, dignity and resilience considerations, or tackle land management in general in urban areas using the approaches or instruments proposed earlier in this chapter. While poverty and undesirable landscapes can have spatial delimitations, their impacts can be diffuse across sectoral, spatial, and temporal scales. The fabric and connectivity of landscapes in urban zones should, therefore, be considered holistically as to ensure broad-based resilience and adaptive capacity across the entire urban space or city. To this end, recognition and articulation of the role of urban landscapes to development and well-being would gain acceptance and support among urban residents and pave the way for mobilizing multiple stakeholders for transformational projects and implementation of planning measures adopted. In Ghana, for example, the Department of Parks and Gardens, which hitherto is responsible for public landscaping and landscape management, seems to be weakened and inactive. Recognizing the link between landscapes and urban resilience and human well-being would also mean revitalizing the appropriate units, such as the Department of Parks and Gardens, Environmental Protection Department, and Agricultural Extension Services, that can provide technical support to landscape entrepreneurs. For example, the Department of Parks and Gardens in Ghana can be a source of genetic or planting materials that helps design the edible landscapes and provides training to prospective landscapists. Context-specific arrangements would be necessary to respond to local challenges or needs. In this way, bottlenecks associated with production and technical assistance in the context of human production and landscape management entrepreneurship can be addressed during planning and operational phases of multifunctional edible landscapes for urban resilience.

Summary and Conclusions

Urban zones in Africa face considerable challenges, including floods, droughts, high rates of poverty, unemployment, food insecurity, and environmental degradation. Climate change, population growth, and urbanization would escalate these challenges. People's landscape needs, poverty, and vulnerability are directly interlinked. This chapter used evidence and insights from a pilot project to promote the feasibility and the instrumental role of a multifunctional edible urban landscape transformation approach that balances land productivity, economic profitability, and

human well-being to strengthen resilience and adaptive capacity in poorly planned or managed urban zones in Africa. The pilot project simply tested the idea and workability of incorporating food production into ornamental landscape design, so that the former pays for the latter while maintaining profitability and supporting urban food security, jobs, and livelihoods, and maintenance of scenic beauty and environmental protection to enhance resilience. The findings from the pilot project show that urban spaces which are hitherto idle, unmanaged, and unkempt can be successfully transformed into green, productive, and aesthetically appealing landscapes to support the delivery of multiple ecosystem services and, therefore, contribute to urban resilience. The example project demonstrated the possibility of producing fresh, quality tomato fruits from a small area using a greenhouse, providing jobs or income for young persons, and maintaining ornamentally landscaped surroundings that provide public goods (scenic beauty, safe space for recreational and learning opportunities, and environmental protection). This demonstrates the workability of this landscape transformation approach to resilience and adaptive capacity using spaces which are currently idle and unmanaged in poorly planned and managed urban zones in Africa. The chapter argues that the multifunctional edible urban landscape transformation approach presented in the example project is innovative, cost-effective, and a feasible avenue for green transformation of undesirable landscapes in sub-Saharan Africa to improve lives and well-being. The multifunctional edible urban landscape transformation in this chapter can be adapted and scaled in similar jurisdictions, where limited public funds constrain investment in landscape and scenic beauty management, so that human production (as a private activity) can pay for public goods or ecosystem services. This idea, which requires further exploration, makes multifunctional edible urban landscape transformation, as presented in this chapter, insightful and relevant for policy, practice, and research. The chapter also sheds light on challenges and levers of change critical for successful transition to multifunctional edible urban landscapes as a pathway to enhancing urban resilience in Africa. These include a formal recognition and articulation of the link between urban landscapes and a sense or state of poverty, powerlessness, and vulnerability of inhabitants. This recognition, coupled with political will and a genuine commitment to confronting the problem, can pave the way for building trust and legitimacy for transforming idle spaces, providing incentives for landscape transformation project, and formally incorporating multifunctional edible landscapes in compact urban development planning and processes. Achieving this will, in turn, require multistakeholder mobilization of policies, laws, and institutional arrangements that (i) ease access to idle or formally demarcated spaces in urban zones in a manner that protects or guarantees the security of ownership and tenure for both land owners and landscape entrepreneurs, (ii) incentivizes multifunctional edible urban landscapes in the context of urban planning and management for resilience and adaptation to climate change, (iii) provides support for access to productive and technical resources, and (iv) promote reliable market for produce from multifunctional edible urban landscapes to sustain the human production and the payment for the ecosystem services which are public. Altogether, the landscape transformation approach presented in this chapter demonstrates an innovative path that balances

ecological productivity and protection, scenic beauty, and socioeconomic profitability and well-being in existing urban zones, and constitutes a triple-win option for urban managers, landowners, and landscape entrepreneurs. If well planned and effectively managed, it can enhance urban resilience and contribute to long-term sustainability of urban zones in Africa. Hence, multifunctional edible urban landscapes should be integral to the suite of responses to the challenges of climate change.

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