Building Urban Resilience

Assessing Urban and Peri-urban Agriculture in Dar es Salaam, Tanzania

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Building Urban Resilience

Assessing Urban and Peri-urban Agriculture in Dar es Salaam, Tanzania

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Preface

Food production in and around cities is an integral part of the urban fabric in much of the developing world. In these regions, urban and peri-urban agriculture (UPA) plays an important role in diversifying urban diets and providing environmental services in urban and peri-urban areas. As such, there is growing interest in UPA as a strategic component of urban resilience and climate change adaptation planning. However, advocacy for UPA in this capacity is outpacing the body of evidence regarding important stressors and drivers that act on UPA. Such knowledge is especially critical in the developing world where urban areas are experiencing rapid growth and transformation. In these regions, UPA is facing intensifying pressures from urban encroachment, waste disposal, pollution, and climate change that may undermine the sector's long-term viability.

The need to better understand these critical sustainability dimensions provided the impetus for city-level knowledge assessments of UPA, whose main findings are contained in nine underlying assessment reports including this one. The assessed cities were Dakar (Senegal), Tamale (Ghana), Ibadan (Nigeria), Dar es Salaam (Tanzania), Kampala (Uganda), Addis Ababa (Ethiopia), Dhaka (Bangladesh), Kathmandu (Nepal) and Chennai (India). All of the reports and the synthesis report can be found at *http://start.org/programs/upa*. The assessments were conducted in 2012, with initial stakeholder engagement beginning in 2011. The assessments were led by city-based teams, the composition of which varied, with some of the teams being comprised predominately of researchers and other teams comprising of a mix of researchers, city officials and urban NGO representatives.

The assessments seek to better understand the changing nature of UPA systems, and the critical interactions at the land-water-climate nexus that influence resilience of UPA in rapidly growing developing-country cities. The audience for these assessments includes national and city-level policymakers, sectoral experts and city planners, the research community, and non-governmental organizations (NGOs) that interface with urban farmers and other actors within the broader UPA sector.

The UPA assessments are part of a larger project on strengthening understanding of critical links between climate change and development planning in West Africa, East Africa and South Asia. The premise for the project is that progress towards undertaking effective action to address climate change risks in these regions is hindered by low levels of awareness of global climate change, lack of understanding of the findings of the Intergovernmental Panel on Climate Change (IPCC) and other sources of scientific information, lack of location and sector specific knowledge, and the need for strengthening capacities to undertake integrated assessments that support decision making. This multi-year project has been a collaborative effort between the World Meteorological Organization (WMO), the United Nations Environment Programme (UNEP), START, the University of Ghana, the University of Dar es Salaam, and the Bangladesh Centre for Advanced Studies (BCAS).

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The overall project and the associated UPA assessments were made possible in large part thanks to funding provided by the European Commission (through project ENV/2008/149690 '*Understanding the Findings of the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report "Climate Change 2007"—Integrating Climate Change Adaptation and Mitigation in Development Planning*'), as well as by the United Nations Environment Programme (UNEP), and the Global Climate Change Programme at the US Agency for International Development (USAID). The editors of this series wish to thank these organizations for their financial support.

In addition to the numerous authors listed in each of the separate reports, we are grateful to the following people for providing useful insights and feedback during the early conception of the knowledge assessment, and helpful review comments on the various manuscripts: Rafael Tuts, Anna Skibevaag, Stephen Twomlow, Elizabeth Migongo-Bake, Trang Nguyen, Volodymyr Demkine, Jane Battersby, Marielle Dubbeling, Anna Kontorov, Richard Munang, Jesica Andrews, Fatoumata Keita-Ouane, Jacqueline McGlade, Keith Alverson, Stuart Crane, Martina Otto, Robert Yennah, Beverly McIntyre, and Tom Downing. We would also like to express our sincere appreciation for the generous support of colleagues at the University of Cape Town's *Climate* Systems Analysis Group who with the climate projections for six African cities.

Acronyms and abbreviations

CIDA	Canadian International Development Agency
CMIP5	Coupled Model Intercomparison Project Phase 5
DSM	Dar es Salaam City
DAWASA	Dar es Salaam Water and Sewage Authority
ENSO	El Niño–Southern Oscillation
FAO	Food and Agriculture Organization (of the United Nations)
FGD	Focus group discussion
GCCP	Global Climate Change Partnership (of the United Nations)
GTZ	Gesellschaft für Technische Zusammenarbeit (German Technical Cooperation Agency)
IDRC	International Development Research Centre (Canada)
ILO	International Labour Organization (of the United Nations)
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Inter-Tropical Convergence Zone
MLHHSD	Ministry of Lands, Housing and Human Settlements Development (Tanzania)
MKUKUTA	Mpango wa Kupunguza Umasikini Katika Taifa (*National Strategy for Economic Growth and Poverty Reduction, Tanzania*)
NGO	Non-government organization
NRCA	National Research Council of Academies
RCP	Representative Concentration Pathway
RUAF	Resource Centres on Urban Agriculture and Food Security
SCINAP	Sustainable Cities International Africa Program
SCP	Sustainable Cities Programme
SDP	Sustainable Dar es Salaam Project
START	global change SysTem for Analysis, Research, and Training
TMA	Tanzania Meteorological Agency
UA	Urban Agriculture
UNEP	United Nations Environment Programme
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations Office of Disaster Risk Reduction
UPA	Urban and Peri-urban Agriculture
URT	United Republic of Tanzania
WHO	World Health Organization of the United Nations
WMO	World Meteorological Organization

List of local terms

Daladalas	Minibuses and minivans
Lishe	A protein fortified *Amaranthus spp.*
Matembele	Sweet potato leaves sold as a green leafy vegetable
Masika	Long rains
Mtaa	Sub-ward
Vuli	Short rains

Contents

Executive summary

This report presents the findings of a knowledge assessment on urban and peri-urban agriculture (UPA) for the city of Dar es Salaam, Tanzania that was conducted in 2012. It examines the state of UPA in the city through the lens of intensifying urban pressures and increasing climate risks with the objective of identifying how these and other drivers potentially interact to affect the long-term sustainability of UPA, and what response options are needed to address existing and emerging challenges. The assessment is intended to:

1. describe the dominant characteristics of urban and peri-urban agriculture, and identify key knowledge gaps in these UPA systems;
2. explore the array of stressors that contribute to vulnerability of UPA systems to climatic and other environmental changes; and
3. identify critical areas for strengthening policies and institutional capacities that contribute to sustaining the UPA sector within the larger context of resilient cities and food systems.

Urban and peri-urban agriculture contributes to Dar es Salaam's food basket, constituting an important source of the city's green leafy vegetables, eggs, poultry and dairy products. The characteristics of the city's UPA sector are quite variable, reflecting an engagement of low-, middle- and high-income groups. In recent years, high-income groups have become increasingly involved in UPA through the production of high-value crops and livestock products in urban and peri-urban areas, thus reflecting the fact that UPA is neither merely a survival option for the urban poor nor a rural remnant within the urban space.

The UPA sector faces many challenges stemming from increasing population pressure, environmental degradation of the land and water resource base, and urban encroachment that leads to loss of agricultural land. Access to suitable land and water for UPA is a particular concern for the sector's long-term sustainability. Farmers in both urban and peri-urban areas are experiencing significant insecurity about their present land holdings, and have few resources to protect themselves against rising pressures to convert farmland to urban uses. The extent of built-up areas in metropolitan Dar es Salaam has increased five-fold between the late 1970s and early 2000s, and given population growth projections, this trend is very likely to intensify in the coming few decades. The informal land market in peri-urban areas, characterized by high levels of land speculation, exerts pressure on agricultural land for conversion to settlements, which peri-urban agriculture is facing difficulty withstanding. Open-space vegetable farming on marginal lands within urban areas also faces land insecurities; given that access to land for open-space farming is tenuous. Moreover, these areas face high exposure to flooding and residual standing water that prevents timely crop establishment.

These land and water challenges are playing out against a backdrop of an increasing warming trend in the city and changes in rainfall characteristics that could potentially exacerbate stress on the resource base. For example, competition for water resources between agricultural and non-agricultural users

is very likely to intensify in the future given the city's population-growth trajectory. Furthermore, expected impacts of climate change, such as heat waves and saline intrusion into aquifers from sea-level rise, will lead to increased demand for fresh water. However, knowledge is lacking as to how climate change may intensify water shortages.

Despite its official recognition in policy frameworks, the UPA sector in Dar es Salaam suffers from a general lack of supportive policies and the policy enforcement mechanisms needed for its long-term viability. Urban and peri-urban farmers in Dar es Salaam contend with a high degree of climatic and non-climatic risks to their production systems. The degree of exposure to these risks by the city's UPA farmers is influenced by patterns of unplanned urban growth, competition for water with non-agricultural users, and haphazard waste disposal and pollution. In the case of open-space vegetable producers in urban riverine areas, flood risks are influenced by poor drainage networks and increased upslope concretization of surfaces, which increases the prevalence of flooding. The viability of these and other flood-prone areas for vegetable production could decline as heavy rainfall events become more common with future warming of the atmosphere.

Urban farmers who were engaged through this assessment clearly perceive changes in weather and climate, which they expressed in terms of excess heat that has shortened the period for vegetable production and an increased incidence of flooding and drought. The extent to which exposure to these

hydro-meteorological hazards is a result of a changing climate or to some combination of climatic factors and shifts in non-climate factors that exacerbate vulnerability to hazards is unclear. While farmers have established strategies for coping with the climatic vagaries, these coping strategies may not be sufficient under climate change, particularly in rapidly changing urban environments where transformation of land surfaces, competition for land and water resources, and abundant waste streams bring unique risks to urban and peri-urban farming.

There are several viable entry points for managing risks to UPA systems that can help foster adaptive capacities. These entry points include access to relevant and actionable seasonal climate forecasts and weather forecast bulletins, inputs that allow for timely establishment of crops in order to take better advantage of opportune windows for cultivating crops, access to credit that can help encourage diversification away from an overreliance on agriculture, and access to markets, including transport, and opportunities for value-added processing that increases profitability, and thus strengthen the asset base, of agriculture.

These actions may contribute in a small way to bolstering risk management and adaptive capacities, though alone they will not make a dent in altering the fundamental drivers of marginality facing urban and low-income peri-urban farmers, which include lack of a secure land base for agriculture, diminished access to adequate water for crop production, and low visibility in the policy realm. Motivating stronger recognition in policy and planning that leads to more secure access to land for agriculture is a critical first step for addressing these systemic drivers of vulnerability. In this regard, proactive land-use policies and strong enforcement mechanisms are needed to address systemic corruption and abuse of power in land acquisition and to ensure the continued viability of UPA, particularly where urban boundaries are extending into peri-urban land.

1 Introduction

Dar es Salaam's urban and peri-urban agriculture (UPA) systems are quite diverse, involving a range of socio-economic classes, from very poor, landless groups to those in the middle and even high incomes. One of the interesting features of the city's UPA is the increasing involvement of high-income residents in livestock keeping and cash-crop farming in peri-urban areas. This provides further evidence of the complexity and variability of UPA, which should not be solely thought of as a livelihood activity of recent immigrants from rural areas.

In their present form, agricultural activities in urban and peri-urban areas often conflict with formal and informal vestiges of urban planning. In some cases agricultural activities are conducted in fragile environments or hazardous areas resulting in land degradation and water pollution. In other cases agricultural activities are carried out in areas that are affected by industrial pollution, posing health risks to urban consumers.

Access to land is a critical concern for urban farming in Dar es Salaam. The outward physical expansion of the city has transformed peri-urban areas, with evidence of constriction of food production in favour of housing-related land uses. Land prices in peri-urban areas have increased sharply, placing pressure on agricultural activities and further intensifying land tenure and usufruct insecurity for farmers. Losing ownership of land and moving further to the peripheral areas, or moving to more agriculturally marginal lands within existing areas, appears to be increasing. Short of a major policy intervention to protect UPA or the development of new practices for substantially intensifying UPA, the present land-change dynamic appears likely to continue. In addition there are a number of environmental risks associated with food production in Dar es Salaam and similarly rapid growing and poorly regulated cities, which include heavy metal deposition on crop productivity (Othman, 2001; Bahemuka and Mubofu, 2002), food safety associated with use of wastewater for irrigation, and flooding that disrupts food production, transport, and storage.

Climate change-induced warmer temperatures, more extreme rainfall and more prevalent drought pose significant challenges for UPA in Dar es Salaam. As examined in Section 3, the metropolitan area has experienced an increasing trend in maximum and minimum temperatures over the past few decades, while mean annual rainfall has decreased, particularly in the short rains that occur between October and December. These observations were confirmed in focus group discussions where farmers reported decreased rainfall and diminished water in the rivers and springs, contributing to inadequate supplies of water for domestic and agricultural uses.

Floods are another important climate risk. Recent flooding in Dar es Salaam, which has been associated with strong *El Niño* episodes, particularly impacts unplanned settlements with inadequately

maintained storm drainage and poor waste disposal systems. Such settlements, as in the Msimbazi Valley, tend to flood even in the absence of heavy rainfall due to clogging and structural interference along the course of the Msimbazi River.

This remainder of this report describes the results of an assessment of the city's UPA in the context of rapid population growth, urban expansion, climate change, and other social and environmental stresses.

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2 Objectives and methods

This assessment examines UPA in Dar es Salaam in a multi-stressor context of rapid urban growth, climate variability and change, and environmental degradation. This assessment focuses on urban and in particular peri-urban environments of the city, and the farming systems—food crops, livestock and aquaculture—within them. The assessment's conceptual framework illustrates the key drivers and stressors, development factors and peri-urban products and services. The assessment framework is presented in Figure 2.1.

In compiling this report, the assessment team combined a review of relevant secondary literature with primary information gathering, which was accomplished through a combination of a stakeholders' workshop, focus group discussions and surveys, and interviews with individuals relevant to UPA in Dar es Salaam. The stakeholders' workshop to initiate the assessment was held in May 2011 with participants drawn from government representatives, urban planners, researchers, non-governmental organizations (NGOs), urban farmers and civil society organizations from the municipalities of Ilala, Kinondoni and Temeke.

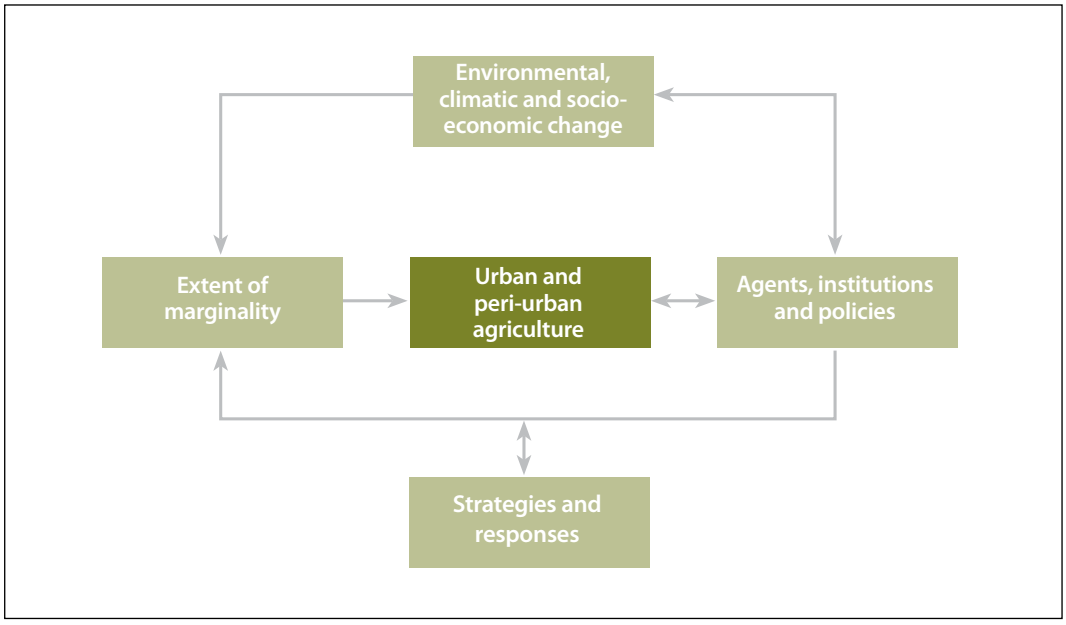


FIGURE 2.1
Conceptual framework

The objectives of this assessment are to:

- assemble and synthesize knowledge on agricultural activities in urban and peri-urban areas of Dar es Salaam;
- identify where insufficient knowledge exists and highlight where additional research and assessment efforts are needed to support policy planning and decision-making at the city level; and
- strengthen capacity within the research community to undertake assessments, and foster networks of regional technical expertise, and to encourage stronger "communities of practice" engaged in the topic of urban food production and climate change.

Secondary data collection involved gathering grey literature from libraries of Sokoine National Agricultural Library, the University of Dar es Salaam and Ardhi University libraries, relevant departments, the municipalities of Ilala, Kinondoni and Temeke and other city report sources. Graduate students were employed in collecting secondary data. Further, the team also consulted relevant recent peer-reviewed literature. Climate information was derived from the Tanzania National Meteorological Agency, the University of Cape Town's Climate Systems Analysis Group, and secondary sources.

Focus group discussions (FGDs) were held in the *Bonde la mchicha* valley of the Kimanga River and Kivule and in Kitunda and Tabata Segerea wards in Ilala municipality. The groups were composed of representatives of the farming community, belonging to different socio-economic groups as identified by ward leaders in collaboration with agricultural extension staff for the area. Each FGD featured both men and women; the elderly and young people; and farmers, livestock keepers and traders of agricultural products. The mix was regarded as important for capturing different perceptions of the issues by different members of the communities, thus enriching the study findings.

A list of open-ended questions was prepared to guide the discussion, during which participant's views and attitudes were documented. The key issues discussed included the history of the location in terms of settlement and livelihood activities; the opportunities and stresses facing UPA, and the communities' perceptions of climate change and variability, including the associated impacts.

Additionally, household surveys were carried out in eight wards of Kinondoni municipality, eight wards of Ilala and nine wards of Temeke. In Kinondoni, respondents were sampled from the urban wards of Ubungo, Kimara, Makumbusho, Msasani and the peri-urban wards of Mbezi, Bunju, Wazo, and Kimamba. In Ilala, a sample was drawn from urban wards of Buguruni, Kipawa, Kiwalani and Vingunguti, while the peri-urban sample came from Chanika, Kitunda, Segerea, and Ukonga. Lastly, in Temeke municipality a sample involved the urban wards of Miburani, Kurasini, Yombo Vituka, and Charambe, while the peri-urban wards were Chamazi, Kibada, Toangoma and Pembemnazi. A total 281 respondents were surveyed.

3

Description of Dar es Salaam

Dar es Salaam is located on the eastern part of the Tanzanian mainland, and consists of three municipalities with a total area of 110 850 ha. Of this area, 52 000 ha are in Kinondoni, 45 000 ha in Temeke and 13 850 ha in Ilala. The city is divided into three ecological zones (Figure 3.1): the upland zone comprising hilly areas to the west and north; the middle plateau; and

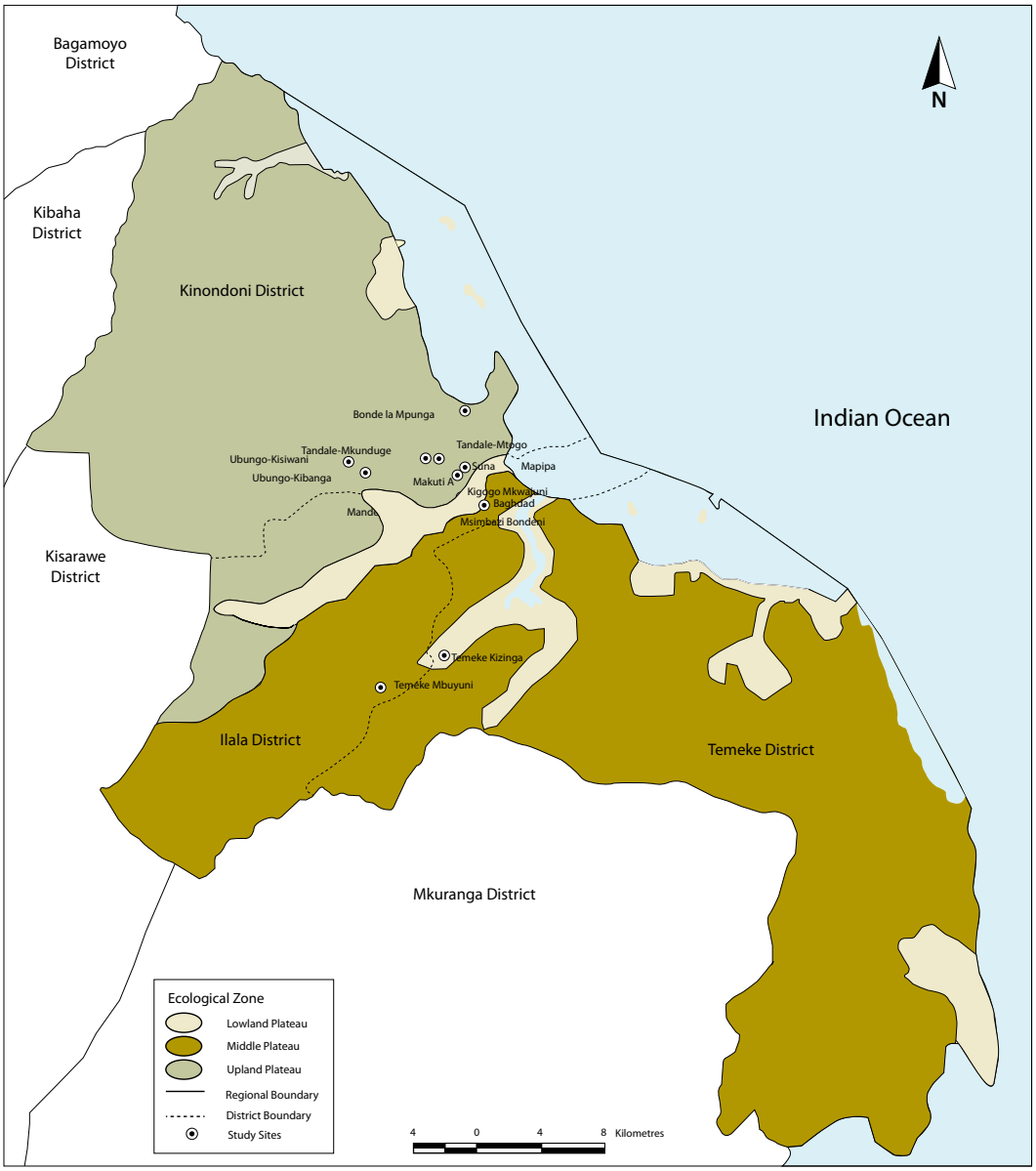


FIGURE 3.1
Dar es Salaam districts and ecological zones

Source: Institute of Resource Assessment Cartography Unit, Univ. of Dar es Salaam, 2010

the lowlands, which include Msimbazi Valley, Jangwani, Mtoni, Africana and Ununio areas. Natural vegetation mainly includes coastal palm groves, coastal shrubs, miombo woodland, coastal swamps and swampy mangrove trees and reeds. Prolonged human interference has reduced the diversity of woodland and scrub.

Dar es Salaam typifies the rapid and unplanned urban growth of coastal cities in Africa. With a growth rate of 5.6 per cent between 2002 to 2012, it is among the fastest-growing cities in sub-Saharan Africa with a 2012 population of 4.36 million (National Bureau of Statistics, 2013). The city's population is projected to reach 6 million by 2025 (UN-Habitat 2012); however, given the current results of the 2012 census, these projections are underestimated (Figure 3.2). UN-Habitat (2010) estimated that 80 per cent of Dar es Salaam's population lives in unplanned settlements. An important consequence of high population growth has been rapid spatial expansion into peri-urban areas, characterized by expansion of settlements into agricultural lands (Figures 3.3 and 3.4).

FIGURE 3.2
Dar es Salaam City population, 1978–2012
Source: UN-Habitat, 2010 and National Bureau of Statistics, 2013

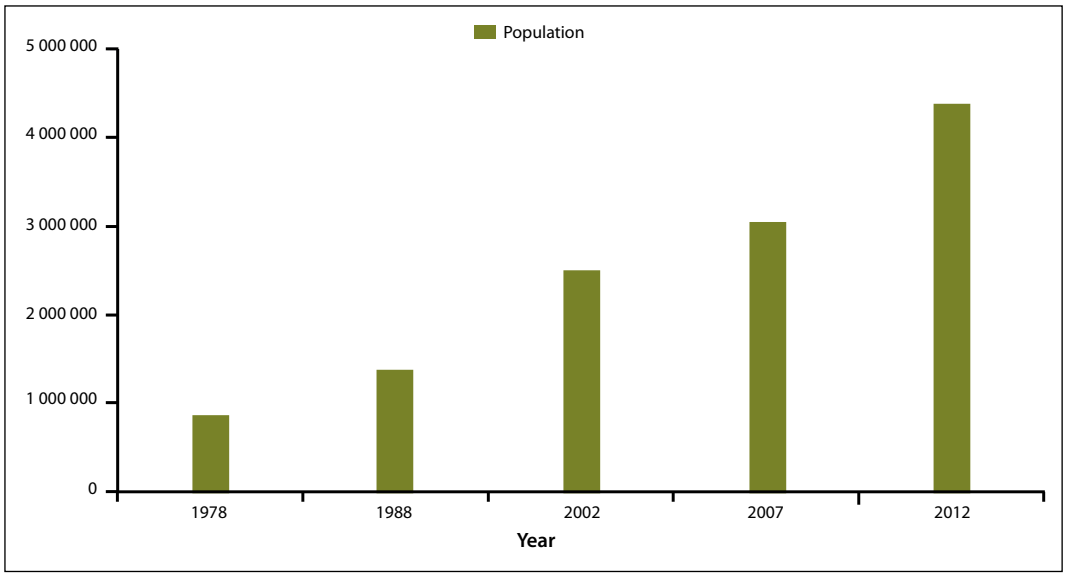
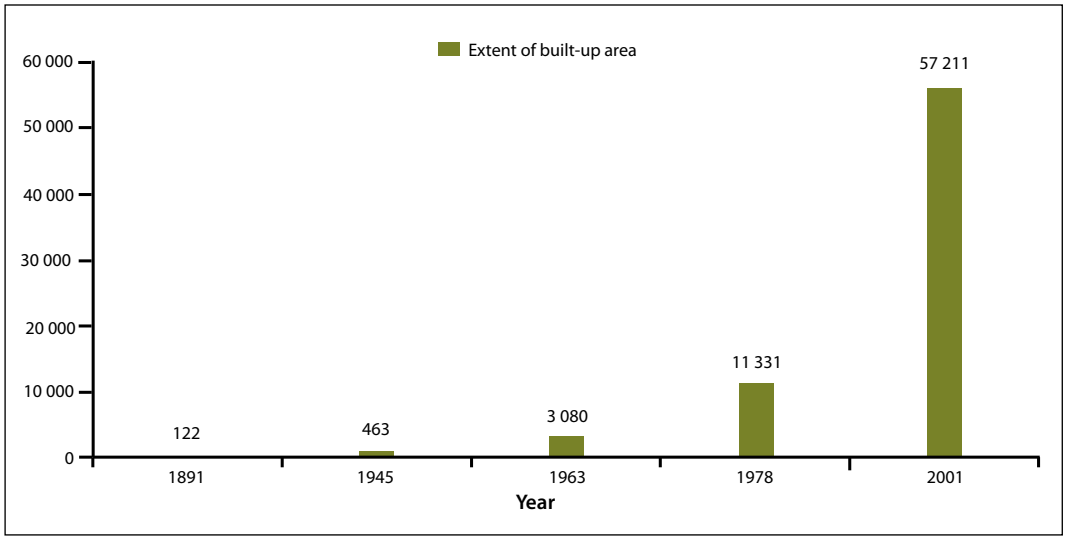


FIGURE 3.3
Spatial expansion (ha) of built-up areas in Dar es Salaam (1891–2001)
Source: Lupala, 2002 and Lupala et al., 2011



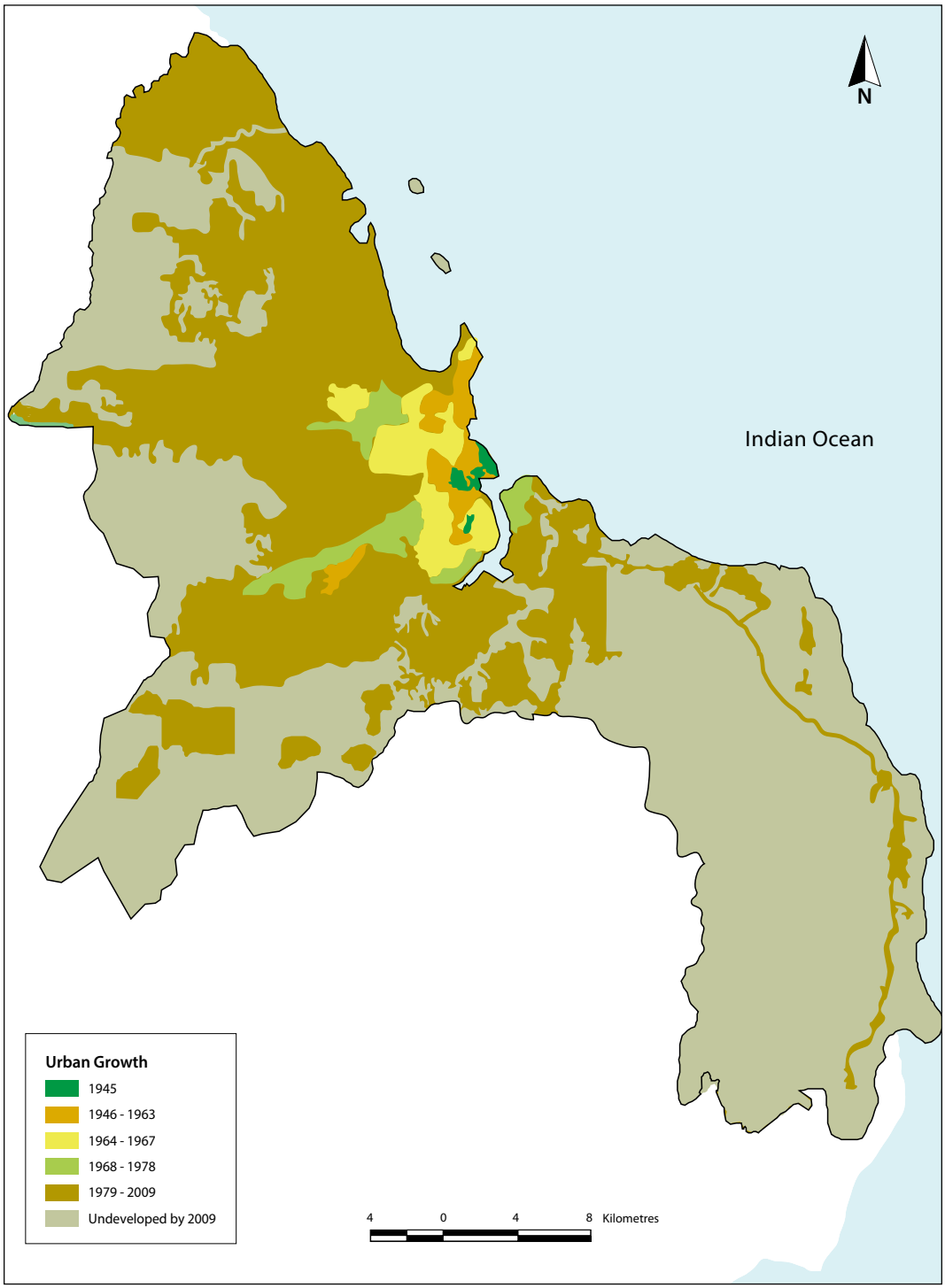


FIGURE 3.4
Urban spatial expansion of Dar es Salaam since 1945
Source: UN-Habitat, 2010

4 Climate trends and projections

Dar es Salaam receives over 1 000 mm of rainfall per year and has a bimodal rainfall distribution associated with southward and northwards movements of the Inter-Tropical Convergence Zone. The long rains (*masika*) occur from mid-March to the end of May, and the short rains (*vuli*) from mid-October to late December. Although June to September is typically a dry season for most parts of the country, coastal areas tend to receive a small amount of rainfall over this period. Dar es Salaam has a mean annual maximum temperature of 31°C and a mean annual minimum temperature of 21°C.

Temperature and rainfall trends

Analyses of maximum and minimum temperatures recorded at the Dar es Salaam International Airport (Figures 4.1 and 4.2) indicate a strong warming trend over the past four decades, particularly for maximum temperatures (START, 2011).

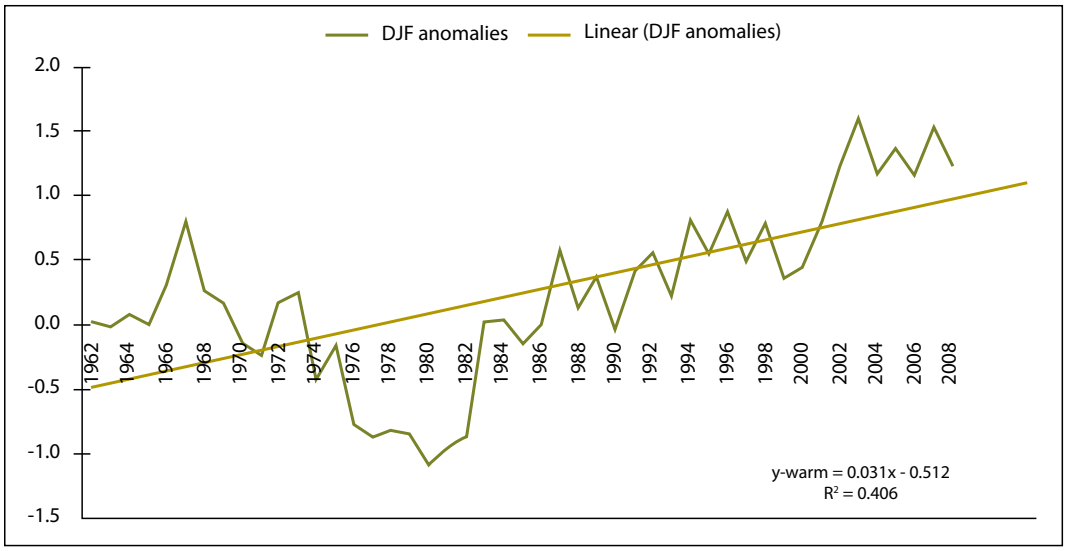


FIGURE 4.1
Trend of mean maximum temperature during the warmest months (December–February) at Dar es Salaam International Airport
Source: Tanzania Meteorological Agency, START, 2011

Mean annual rainfall over Dar es Salaam has decreased slightly over the past five decades. The characteristics of the rainy seasons have changed as well, with the number of rain days per year decreasing over the past five decades (Figure 4.3). Further, the number of consecutive dry days has increased and number of consecutive wet days decreased (Figure 4.4). Figure 4.5 shows a high incidence of heavy rainfall events, those exceeding the 95th percentile, in April with an average of 4.5 days of heavy rainfall during that month. The decadal trend analysis of heavy rainfall events (Figure 4.6) suggests a shift in occurrence from April to May with a possible decreasing trend in April and December and an increasing trend in May and November. However, confidence in these trends is fairly low, as indicated by the wide spread around the zero line.

FIGURE 4.2
Trend of mean minimum temperature during the cool months (June-August) at Dar es Salaam International Airport
Source: Tanzania Meteorological Agency, START, 2011

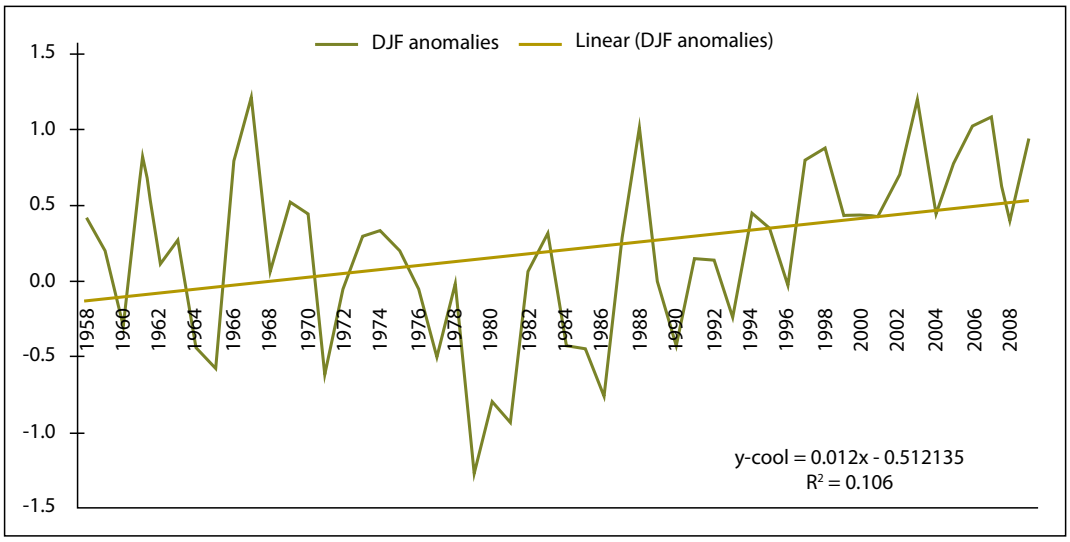
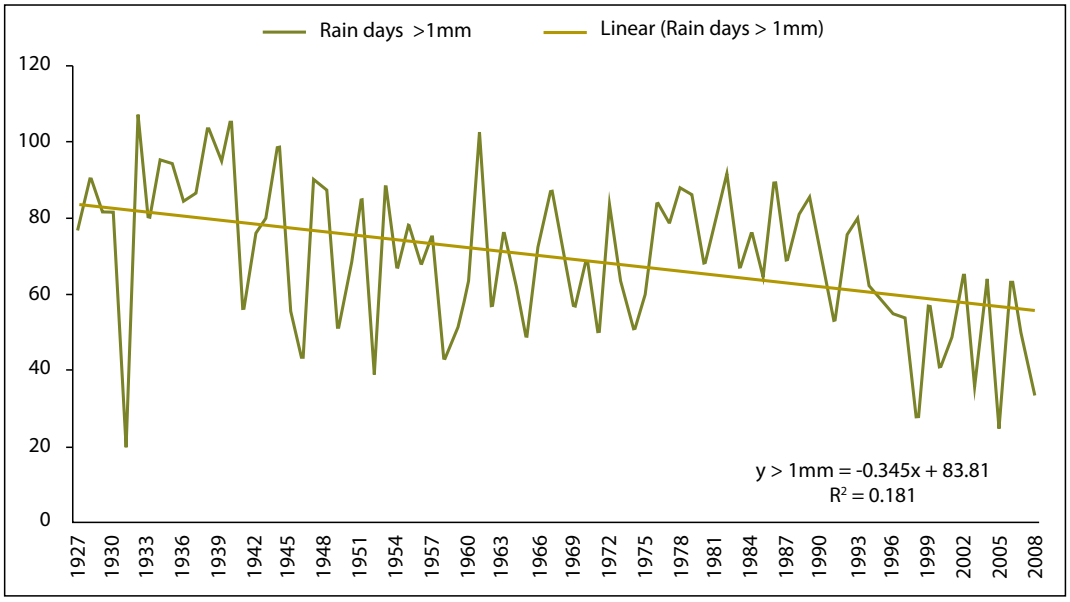


FIGURE 4.3
Number of rain days per year at the Dar es Salaam Chemical Laboratory (city centre)
Source: Tanzania Meteorological Agency, START, 2011



Temperature projections

The warming trend described above is expected to intensify over the course of this century, consistent with anthropogenic climate change. Figures 4.7 and 4.8 below show an envelope of projected temperature change derived from a suite of regionally downscaled climate model projections from CMIP5, under a future scenario of low greenhouse gas emissions (Representative Concentration Pathway [RCP] 4.5) and a future scenario of high greenhouse gas emissions RCP 8.5. The temperature projections are given as anomalies (i.e., how much the mean monthly temperatures for the projected period differ from historic mean monthly temperatures) for the 2040-2060 period relative to the observed period of 1958–2000.

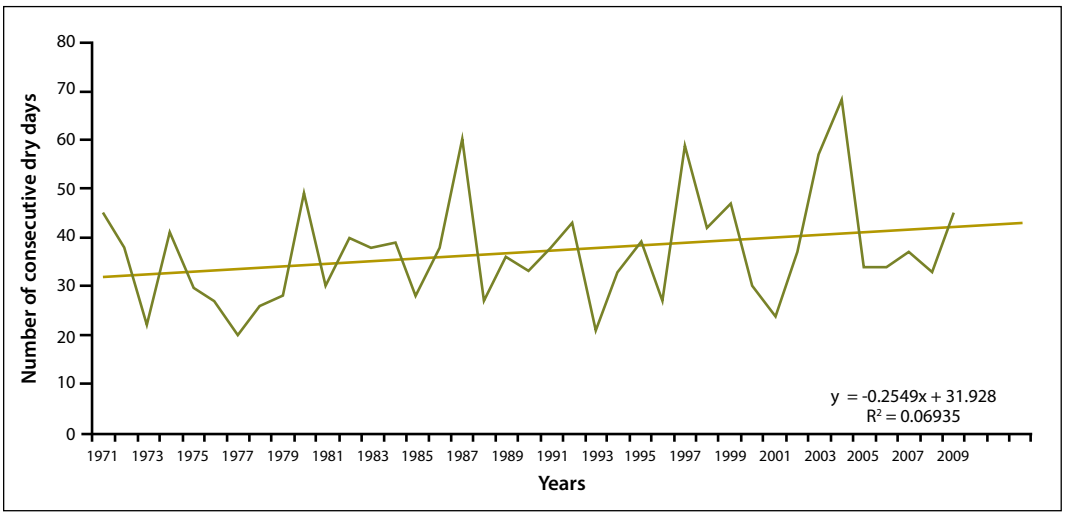


FIGURE 4.4
Trends in the number of consecutive dry days in Dar es Salaam

Source: Tanzania Meteorological Agency, START, 2011

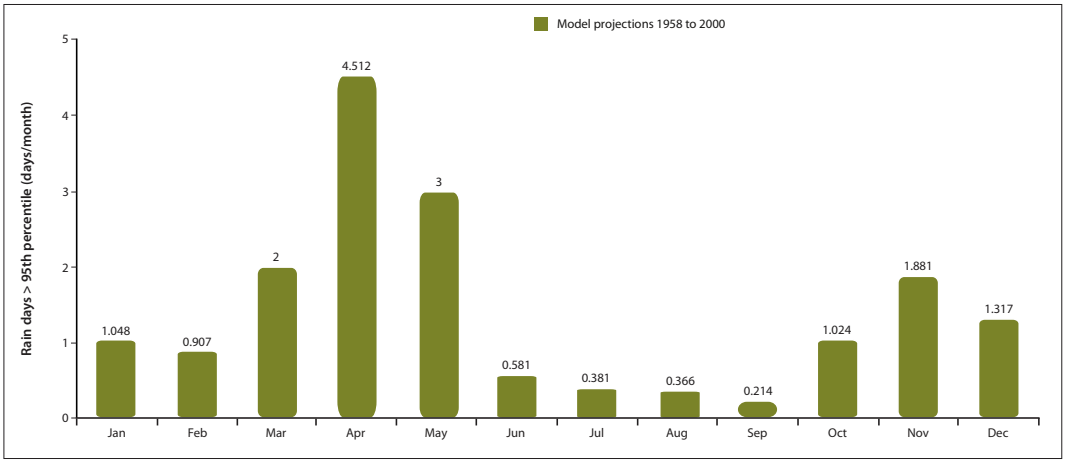


FIGURE 4.5
Number of rain days per year at Wazo Hill (north of city centre)

Source: Tanzania Meteorological Agency, START, 2011

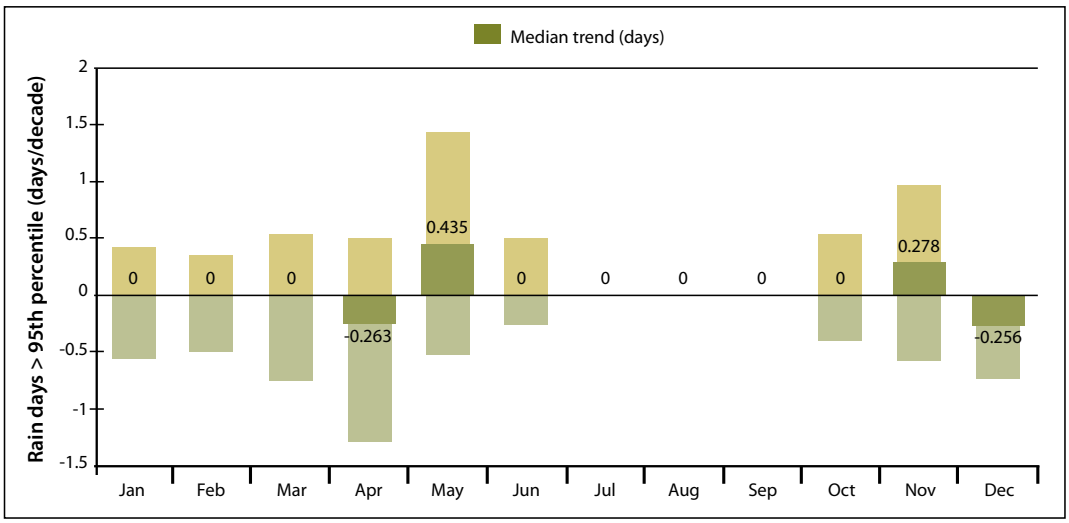


FIGURE 4.6
Change in the monthly distribution of heavy rainfall days, 1958–2000 (number of days per decade)

Source: Climate Systems Analysis Group, University of Cape Town, 2014

FIGURE 4.7
Change in maximum temperature, RCP 8.5

Source: Climate Systems Analysis Group, University of Cape Town, 2014

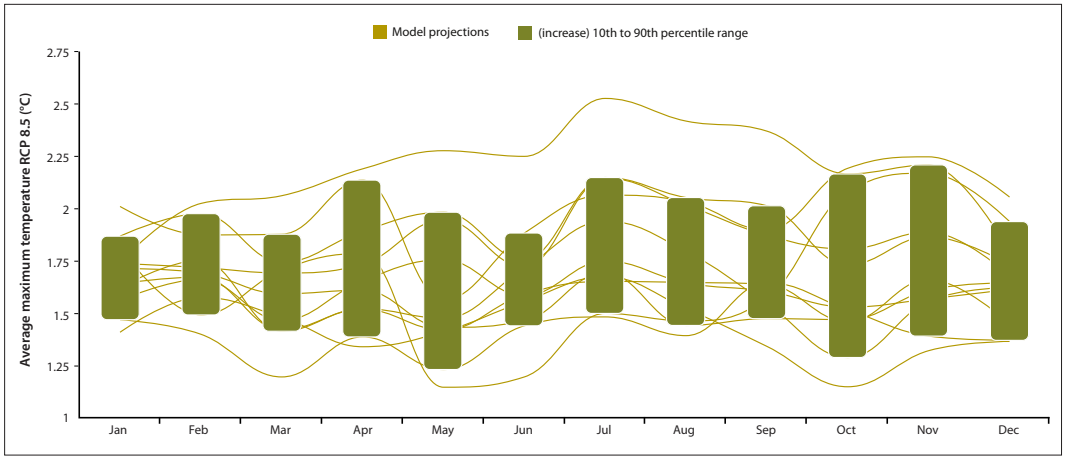


FIGURE 4.8
Change in minimum temperature, RCP 8.5

Source: Climate Systems Analysis Group, University of Cape Town, 2014

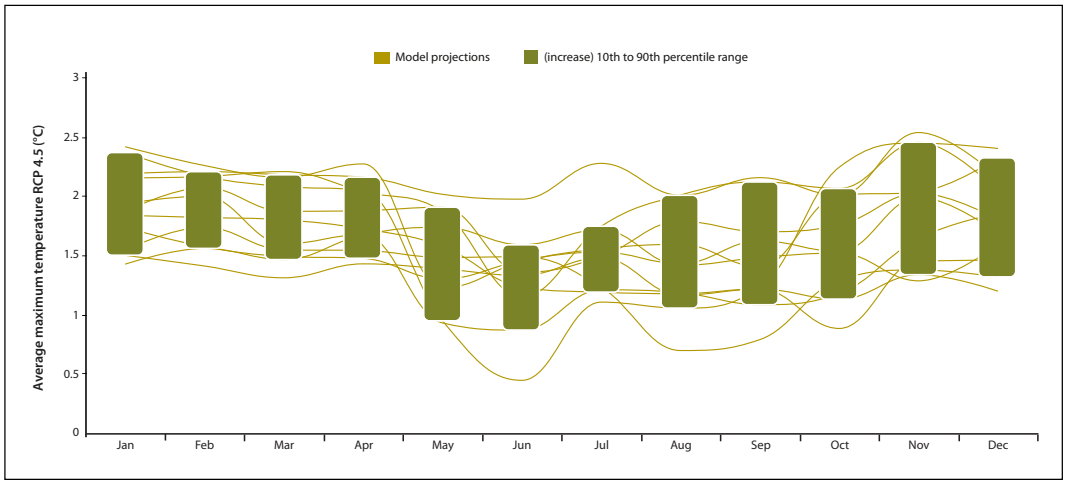
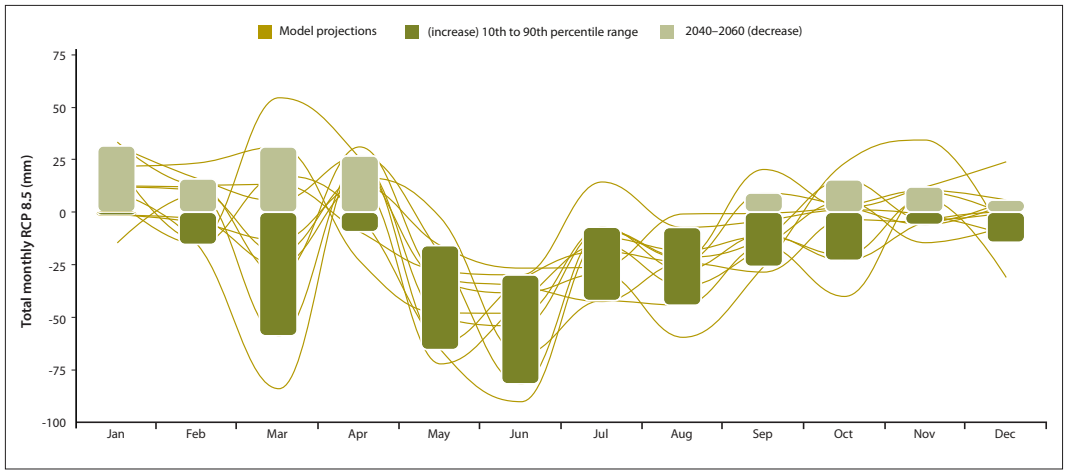


FIGURE 4.9
Change in mean monthly rainfall, RCP 8.5

Source: Climate Systems Analysis Group, University of Cape Town, 2014



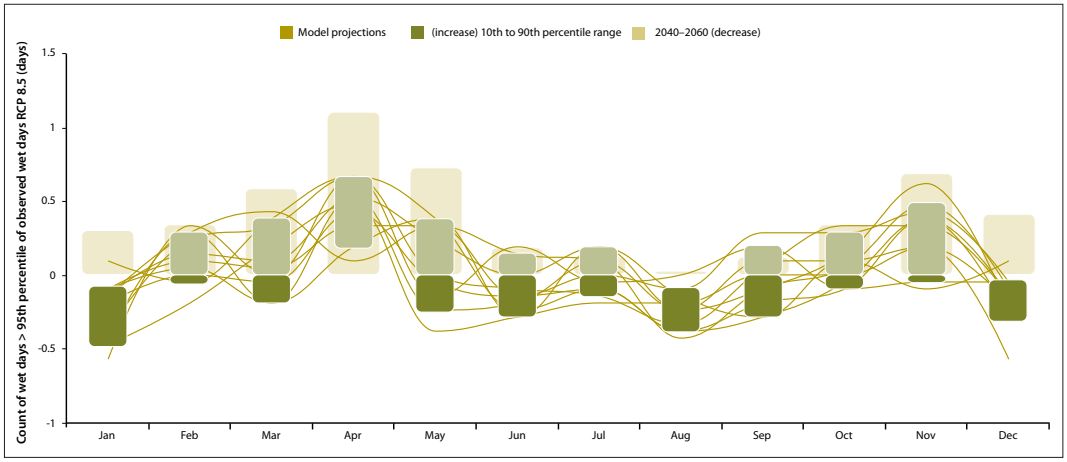
Vegetable gardens recovering after the December 2011 floods © Mlozi 2011

The green bars represent the range of temperature change, and the lines represent the different models that were used to derive the bars. Short bars indicate close agreement between the model projections, and thus relatively greater certainty, while tall bars indicate a wide spread of the model results and less overall certainty as to the amount of change. Thus, for example, in Figure 4.7, projections for the months of January and June show close agreement between the models, indicating a higher level of certainty as to the magnitude of projected temperature change, whereas October and November have a much wider band of projected temperature change, indicating relatively greater uncertainty as to the magnitude of temperature change relative to months such as January and June.

Rainfall projections

Figure 4.9 shows an envelope of projected precipitation change for the 2040–2060 period compared with the historic baseline period of 1958–2000. The figure was derived from a suite of regionally downscaled climate model projections from CMIP5, under a future scenario of (RCP 8.5) greenhouse gas emissions, and was obtained from the University of Cape Town's Climate Information Portal. The blue bars represent positive anomalies (increased rainfall), and the green bars negative anomalies (decreased rainfall) relative to historic monthly means. The brown lines represent the individual model results. As explained above, the height of the bar indicates the degree of model agreement; the shorter the bar, the greater the degree of agreement of rainfall projections between models, and thus the higher degree of relative certainty with respect to the future. The distribution of the bars is also important. Bars that are distributed predominately in one direction relative to the zero line indicate

FIGURE 4.10
Change in rain days exceeding the 95th percentile
Source: Climate Systems Analysis Group, University of Cape Town, 2014



agreement between the models regarding either increasing rainfall (the bar is mostly above the zero line) or decreasing rainfall (mostly below the zero line). Bars that evenly straddle above and below the line show poor agreement as to the direction of future rainfall, as is the case in Figures 4.9 for the month of February.

Rainfall projections for mid-century (2040–2060) under both high and low emissions scenarios indicate that the long rainy season (March–May) could become drier overall while the short rainy season (October–December) could become slightly wetter overall. The direction and magnitude of the projections are fairly consistent across the low and high emissions scenarios. Projections of changes in heavy rainfall events for the 2040–2060 period (Figure 4.10) show a similar pattern of behaviour across the models, and indicate an increase in heavy rainfall occurrence during the months of March, April and November.

5

Urban and peri-urban agriculture in Dar es Salaam

Description of UPA production systems

Urban agriculture

Agriculture in urban core areas occurs on both publically and privately owned land in planned and unplanned high-density areas. Medium- to low-income households exist in these areas; houses are rented and the population often contends with inadequate and poorly planned infrastructure. Open-space farming is a common form of agriculture in these high-density areas, and occurs on undeveloped (hence, "open space") lands adjacent to roads or railways and on land unsuitable for construction, such as under power lines or in river valleys. Open-space vegetable production is primarily carried out for commercial purposes, and leafy green vegetables predominate. Other crops include tomatoes, okra and eggplants, and to a lesser extent cassava, rice, maize and cowpeas, bananas, pineapples, coconuts and oranges. Open-space farming in Dar es Salaam is quite extensive; Dongus (2001, in McLees, 2011) estimated that in 1999 about 650 ha in the city were used for open-space farming. Updated estimates of the scale of open-space vegetable farming are needed given the rapid growth of the city over the past decade.

Livestock rearing features prominently on government-owned lands, including on land used for housing of government workers. Dairy cattle are kept within housing compounds or in temporary livestock sheds. Open spaces between houses, along roads and fences, on old golf courses, and along beaches, hedges and streams provide pasture for livestock. Poultry, for the production of both eggs and meat, are also an important component of this type of agriculture. Nelson (2007) describes instances where government employees keep poultry as a means of buffering economic uncertainty.

Peri-urban agriculture

Food production in peri-urban areas is increasingly carried out by high-income groups who commute to farms on the city periphery or who have moved and reside there permanently. The construction of high-end housing in newly opened-up low-density areas, such as those in Kunduchi, Msasani, Mbezi, Mikocheni and Ukonga, are further attracting elites to engage in UPA, and they are more likely to have intensive contacts with agriculture and livestock extension agents. Extensive livestock rearing, dairying and egg production occur in these peri-urban areas. Fruits including oranges, mangoes, banana, pawpaw, pineapple and coconut, as well as cashew nuts, are also cultivated in the peri-urban areas. Remnants of smallholder traditional agriculture remain, though these are under pressure from development. Agriculture in these areas contends with poor infrastructure and theft of animals and crops.

Vegetable gardens in Mbezi Valley

Profile of UPA producers

In Dar es Salaam, UPA involves many people ranging from the very poor, the landless up to middle and high-income residents. The different social groups are involved in UPA activities for varying reasons. For high-income households, UPA has increasingly become a response to growing business opportunities in peri-urban areas, particularly for livestock and poultry/egg production, while for low-income, and some middle-income households engaged in vegetable production, UPA is an important livelihoods strategy. A household survey of 281 respondents from Ilala, Kinondoni and Temeke indicated that most farmers are from poor and middle-income households that generally lack formal employment, though some vegetable farmers also derive livelihoods from teaching, tailoring and petty trading. The surveys also revealed that about half of the people involved in UPA have a primary (and a few secondary) level education, and that women are more involved in cultivating vegetables than men.

The survey showed that the time farmers lived in Dar es Salaam varied greatly, with about half having lived in urban and peri-urban areas of the city for 6–20 years. The focus group discussions (see Section 8) noted that most longer-term farmers own land, while most newcomers rent fields and pay rent for cultivating vegetables. This confirms other studies (Jacobi *et al.*, 2000; Schmidt *et al.*, 2011) indicating that UPA farmers are not necessarily new arrivals from rural areas but rather are longer-term residents who have obtained sufficient resources, networks and other forms of social capital to engage in UPA.

According to the surveys, a substantial majority of small-scale vegetable producers sell their produce at the farm gate directly to consumers or to middlemen who deliver the vegetables to large and small markets. However, some UPA farmers transport their own vegetables to retail markets in nearby areas. A wide variety of vegetables, fruit, eggs and fodder are delivered into city markets using bicycle transport and in *daladalas* (minibuses). Eggs are mostly sold to chip makers and retail shops. Some large-scale producers sell eggs to wholesalers and large markets such as Kariakoo and Tandale. Most dairy farmers sell milk to their neighbours, while some sell to milk wholesalers, kiosks and government offices. Broilers are mainly sold to restaurants and bars. Pigs are sold to abattoirs and bars, which in turn, sell roasted pork to consumers. There is a more organized marketing system for pigs, where informal employment opportunities have been created for people transporting live pigs from the producers to urban abattoirs.

Contribution of UPA to the city's food basket

Urban and peri-urban agriculture contributes nutrient-dense foods to Dar es Salaam's food basket. Jacobi *et al.,* (2000) estimated that UPA supplies 90 per cent of the city's leafy vegetables, 50 per cent of which are produced in open-space farming on marginal lands (McLees, 2011), and 60 per cent of its milk. (The assessment was unable to locate estimates on how much peri-urban egg, poultry and livestock production, or cut-and-carry fodder to feed urban livestock, contribute to the city's food system though casual observation confirms that these are important features of UPA.) While the few available studies noted above point to an important role for vegetables and milk in the city, no recent studies have been done to estimate the contribution of various UPA components to the city's food system, in light of critical change factors such as high urban growth rates, the penetration of supermarket chains into the city, and the spike in and volatility of food prices. This is an important knowledge gap.

As with other African cities, livestock keeping in Dar es Salaam has increased substantially over the past decade or more, as indicated by Tables 5.1 and 5.2. While cattle are almost exclusively kept by medium- and high-income groups, either in peri-urban or low-density areas, goats and chickens are kept by all income groups. The rate of growth in livestock keeping is driven by such factors as the presence of nearby markets (Foeken *et al.,* 2004), economic insecurity of people living in urban/peri-urban areas that impels them to keep livestock for income stability, and the government's policy of encouraging urban dwellers to produce their own food. The focus group discussions mentioned that since the 1990s there has been an increase in livestock brought from up-country regions of northern and central Tanzania because of the relative abundance of water and grazing land near the city and access to the large market of Dar es Salaam.

Economic role of UPA

Estimates of the number of households involved in UPA are sketchy and outdated, though the available estimates give some indication of its economic importance. Sawio (Veenhuizen and Danso, 2007) reported that 68 per cent of the city's households were engaged in some form of food production, and Mascarenhas (Lee-Smith, 2010) estimated that 36 per cent of the city's residents were involved in crop production in 1995. However, Hoogland (2003, in Schmidt, 2011) reported that nearly 35 000 residents practiced farming in the three districts of Dar es Salaam—Ilala, Kinondoni and Temeke—which, while not insignificant, is much lower than the other estimates.

Similarly, recent data on the contribution of UPA to household income and the urban economy are not available, though older studies from Dar es Salaam provide a rough estimate of the contribution of

TABLE 5.1
Livestock numbers in the three urban districts of Dar es Salaam in 1997/1998

Livestock type	District			Total number	Households raising
	Kinondoni	Ilala	Temeke		
Cattle	2 005	684	2 315	5 006	3 035
Goats	1 157	1 053	1 489	3 701	1 544
Sheep	36	0	0	36	12
Pigs	375	466	626	1 478	176
Poultry	3 573	2 203	4 430	10 221	4 767

Source: Mlozi, 2005

TABLE 5.2
Livestock numbers in the three urban districts of Dar es Salaam in 2011

Livestock type	Kinondoni	Ilala	Temeke	Total
Cattle	11 099	9 414	11 885	32 398
Goat	28 850	9 414	15 424	53 688
Sheep	19 572	682	633	20 888
Pigs	14 658	14 599	6 222	35 479
Poultry	299 559	623 125	288 696	1 211 380
Other	24 741	37 521	14 530	76 792

Source: Dar es Salaam City Council, 2011

UPA to livelihoods. Nyambaya (1991) estimated that the average annual farmer revenue from urban agriculture in 1991 was TSh. 241 300 (US $965) while the profit was TSh. 115 000 (US $460). At the time of this study, that income was 1.6 times more than what was considered to be a minimum salary—TSh. 72 000 (US $288). Nyambaya further reported that, in 1991, 10 229 urban agriculture enterprises in the city realized an annual gross output of TSh. 6.8 billion (US $27.4 million), and an annual value added of TSh. 2.8 billion (US $11.3 million). Mlozi and Hella's (2001) analysis of vegetable-grower earnings found that the annual average from cultivating amaranth was TSh. 115 815 (US $136).

Studies by Mlozi (2005) found that livestock keepers in Dar es Salaam made on average about TSh. 240 000 (US $500) annual profit, and that dairy herdsmen had earnings of TSh. 64 244 (US $75.80) per month, above the government minimum salary of TSh. 50 000 (US $58.80, Mlozi, 2005). The 2005 study also found that urban dwellers sold 80 per cent of their livestock and/or their products, and retained 20 per cent for home consumption, results that were similar to surveys of dairy farmers carried out by Kivaria *et al.* (2006).

These studies point to urban agriculture's potential importance but in the absence of updated estimates it is not possible with any confidence to scope UPA's contribution to household income and food security, and to the informal and formal economy of the city. Robust studies are needed to estimate the extent of the population's involvement in UPA, including those involved indirectly in UPA, such as in the areas of transport, processing, storage and marketing. Carefully designed quantitative studies that consider the full food system dimensions of UPA rather than solely its production would bring much needed clarity to UPA's relative importance to household food and livelihoods security in Dar es Salaam.

6 Policy and legal frameworks influencing UPA

Urban and peri-urban agriculture is relatively well represented in official policy, compared with other cities in Africa. The Land Act of 1999 No. 4, the Land Use Planning Act of 2006 and the Urban Planning Act of 2006 give power to relevant authorities to allocate land and stipulate procedures for applying and allocating land for urban farming. The National Human Settlement Policy of 2000 identifies UPA as one of the strategies that can be used to reduce urban poverty and requires the government to designate special areas within planned areas where people can be granted legal rights to engage in agricultural activities. The Agricultural and Livestock Policy of 1997 insists that the government should continue to regulate the conduct of UPA and ensure that it does not disrupt planned urban development. The National Livestock Policy of 2006 urges the government to strengthen technical support and encourage peri-urban livestock farming that is environmentally friendly. The National Land Policy (1995) requires the government to establish appropriate infrastructure to mitigate land degradation and water pollution, safeguard public health and reduce hazards in areas where UPA is permitted. These policies recognize that UPA is not a principal function of towns, but, when properly organized, it has the potential to provide employment income, and is a supplementary source of food for town dwellers; however, implementation of these policies has been limited.

Despite strong policy support for UPA at the national level, and stipulation by the Dar es Salaam City Council of the use of land for UPA in its development agenda, there are no areas officially demarcated for crop or livestock farming in the city. Township expansion through land declaration and acquisition, and the eviction of farmers by local city authorities is a common occurrence. This is driven by the view that urban agriculture is an informal and thus unregulated practice. Additionally, local and central government planning institutions are reluctant to include UPA in their land-use plans despite policy directives (Schmidt, 2012; Halloran and Magid, 2013). Urban planners still use traditional master plans that do not designate land for UPA or put special conditions on its treatment. Overcoming these policy biases is critical to creating a more sustainable pathway for UPA.

Since the 1970s, several research and development projects have engaged with urban farmers and city planners to integrate urban agriculture in planning and management through capacity building and stakeholder engagement, including supporting urban agriculture farmer groups (Figure 6.1). Within the past 20 years, several development agencies and non-government organizations have attempted to engage with the Dar es Salaam local government; however, efforts are often not sustained after project completion (Halloran and Magid, 2013).

FIGURE 6.1
Urban agriculture legitimization processes and stakeholders (1992–2012)
Source: Halloran and Magid, 2013

Legitimization	Year	Stakeholders
UN-Habitat initiated Sustainable Cities Programme (SCP) to build the capacity of local authorities in environmental planning and management through broad-based consensus with stakeholders in the public, private and popular sectors	1992	UN-Habitat SCP
UN-Habitat and IDRC join forces to create a new strategic urban development plan and policies for integrating urban agriculture, as well as support for local researchers	1993	SDP? IDRC?
Urban Vegetable Promotion Project (UVPP) project initiated to improve vegetable production in Dar es Salaam by upgrading extension services, strengthening the organizational capacity of urban farmers, conducting complementary studies and promoting cooperation with various stakeholders	1993	Urban Vegetable Promotion Project (GTZ)
Sustainable Dar es Salaam Project (SDP) comes to completion	2003	SDP
Baseline survey, stakeholder analysis and problem identification conducted; urban agriculture legitimization process commences	2010	SCINAP & CIDA
Formation of the Tanzania Food Garden Network urban agriculture advocacy group	2010	Tanzania Food Garden Network
Stakeholder consultations, action planning, capacity-building workshops	2010–2011	SCINAP
Strategic planning for urban agriculture zones and the creation of municipal strategic plans	2011	SCINAP, MLHHSD, DCC with municipalities
Municipal strategic plans submitted to the Dar es Salaam Master Plan 2012–2032 for approval	2012	MLHHSD
Implementation of strategic plans upon approval of the Dar es Salaam Master Plan 2012–2032	2012–?	Kinondoni, Ilala and Temeke municipalities

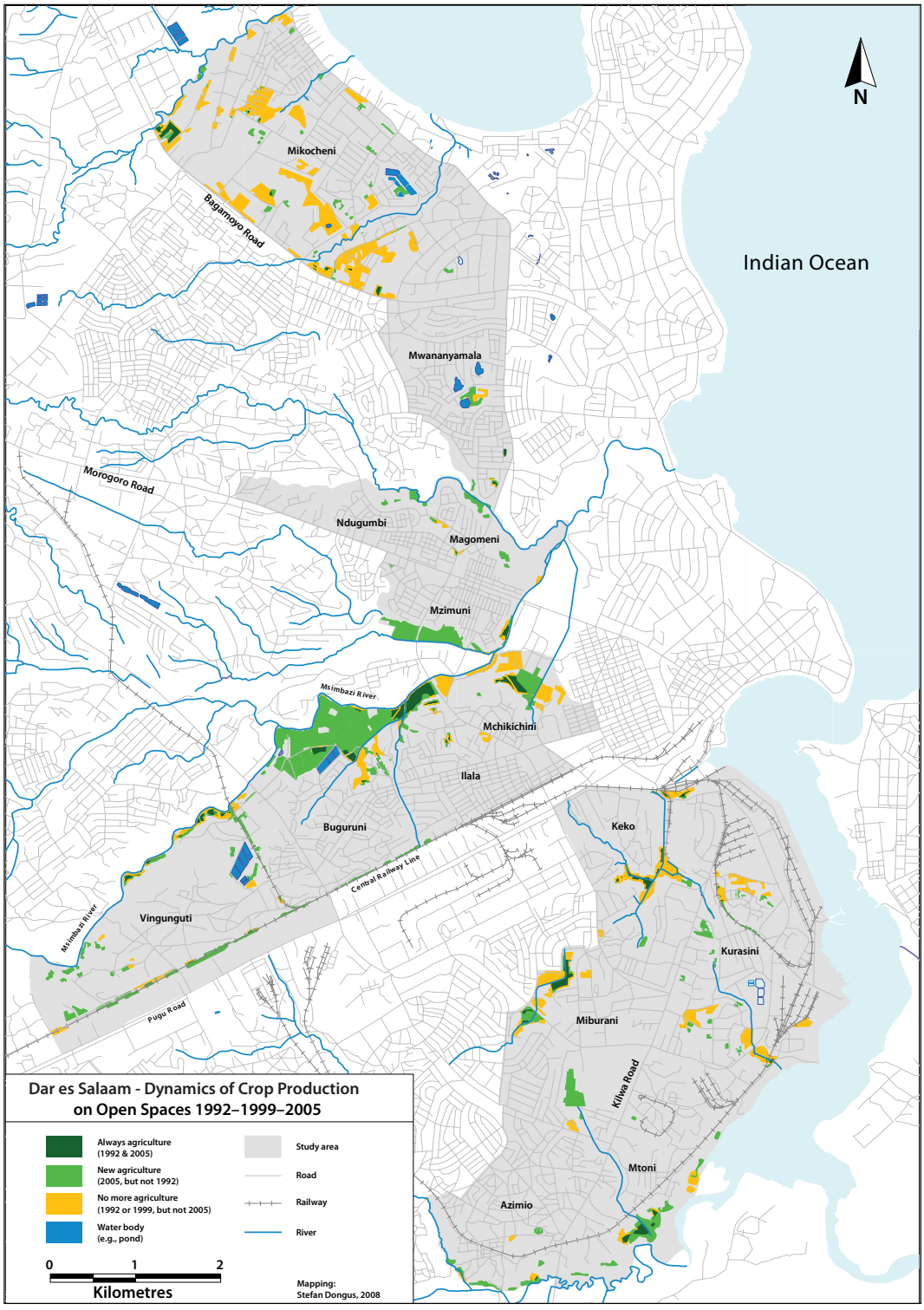
7 Urban environmental change and UPA

Urban encroachment and land-use change

Dar es Salaam is growing at a rapid pace, resulting in the emergence of an informal land market for housing in expansion areas at the edge of the city. Farmers are under pressure to sell their land to new settlers who want to construct houses or to speculators who are investing in land with the prospect of establishing settlements (Kahyarara *et al.*, 2002; Lupala, 2002; Nelson, 2007). Moreover, liberalization of the transportation sector, which allows for more systematic transport services into peri-urban areas, and housing subsidies for civil servants are helping to drive the peri-urban housing market for middle- and upper-income groups (Briggs and Mwamfupe, 2000, in Nelson, 2007). Amongst the surveyed farmers, 51 per cent indicated increased difficulty acquiring new land because of the increase in settlement encroaching on the land. An additional 44 per cent specified a land shortage overall and attributed that to the city's increasing population.

Vegetables and plantains growing in front/backyard of houses in Tabata Segerea

FIGURE 7.1
Spatio-temporal changes of cultivation of open spaces in Dar es Salaam, Tanzania (1992–1999–2005)
Source: Dreschel and Dongus, 2010



Cultivated open spaces, often public lands, for vegetable production have changed in the past two decades. Dreschel and Dongus (2010) found that the overall amount of cultivated spaces has remained the same, but has dramatically shifted to more marginalized land, particularly lowland areas around riverbanks which are prone to flooding (Figure 7.1).

Peri-urban agriculture is facing difficulties withstanding this transformation as farmers have to pay rents well above those for other land use (Lupala, 2002), and there appear to be few prospects for intensification or added-value activities sufficient to allow agriculture to compete in the informal land market. About half the farmers involved in the survey attributed difficulties in getting new land for UPA to the expansion of settlements onto arable land.

Farmers in urban core areas also face significant land-tenure and access constraints, as access to land for open-space farming is tenuous and prone to disruption. Analysis by McLees, (2011) illustrates several instances where farmers were pushed off of land to make way for commercial ventures. Insecure land tenure also influences farming practices and land use. According to McLees "*Leafy greens such as* mchicha*, pumpkin leaves, potato leaves and Chinese cabbage can be planted and harvested within four to six weeks. Many farmers explain that while these are also important vegetables in local diets, the other advantage is that if they find out that they will have to leave the land, they can ask for just a few more weeks to harvest their last crops and if they do not receive that permission, they will not lose too much investment. The lack of formal tenure also limits other investments that farmers can make… [O]pen-space farmers in Dar es Salaam are convinced that if they had formal tenure they would be able to deal with their second most difficult issue, which is access to consistent and clean water. The water table is not far below the surface in most of the city, but farmers need sealed wells to prevent contamination from polluted water during regular floods. … Without secure land tenure, farmers cannot invest their own money in digging deeper wells that can be sealed, or permanent drainage systems that do not have to be re-dug each time it rains.*"

The focus group discussions further elaborate on this issue of compound stresses originating from climate risks and poor land access by urban farmers.

Water and UPA

The provisioning of adequate water resources for UPA production is a critical concern. Surveyed farmers identified water issues as the most significant problem limiting their crop production (29 per cent). Important contemporary challenges to use of water resources include pollution of irrigation and drinking water sources from increased industrialization and from floods that flush waste and pollutants into river valleys and other low-lying areas where open-space vegetable farming is carried out. Irrigation water in the Msimbazi River Valley, an intensively farmed area, was found to have lead concentrations in irrigation water eight to ten times above WHO drinking water standards (Mwegoha and Kihampa, 2010). High concentrations of heavy metals, linked to environmental pollutants in water and soil, were found in vegetables produced in three wards of Dar es Salaam (Othman, 2001) and along the Sinza and Msimbazi rivers (Bahemuka and Mubofu, 2004).

Farmer access to tap water, which provides a modest source of water for urban agriculture in the city, is becoming increasingly tenuous. In a study of three wards in the city, Dongus *et al.,* (2009) found that 30 per cent of urban gardens were irrigated with tap water, although tap water is unreliable due to leaks in the system, scarcity during the dry season and high prices mandated by the privatized Dar es Salaam Water and Sewage Authority (DAWASA) (Jacobi *et al.*, 2000; Kjellen, 2006; Schmidt, 2011). DAWASA has, at times, limited or cut off access to water pipes for urban irrigation (Sawio, 1998). Alternative water sources include shallow wells and surface water; however, these sources are vulnerable to environmental pollution, as noted above.

Current water stresses will likely intensify in the future given demographic, climatic and environmental trends. Important influences on future water resources are population growth that increases competition for water between agricultural and non-agricultural users, increased demand for water to cope with warmer conditions, including heatwaves, continued environmental degradation of water bodies, and the growing risk of groundwater salinization (Box 1). In addition, there is poor understanding of other processes that could potentially further stress water resources for UPA, under a warmer and more variable climate, such as increased evaporative losses from crops and increased health hazards associated with the use of wastewater for irrigation.

Box 1. Sea-level Rise

Dar es Salaam residents are becoming increasingly reliant on groundwater for household supplies, which has led to widespread borehole drilling (UN-Habitat, 2010; Mtoni *et al.*, 2012). High rates of groundwater extraction have, in turn, increased the incidence of saline incursion into the aquifer that serves the city (URT, 2010; Mtoni *et al.,* 2012); the greatest risk of incursion occurs in the low-lying city centre (Mtoni *et al.,* 2012). Saline groundwater affects vegetable production. According to interviews carried out by Mtoni *et al.,* (2012), water that is too saline to drink is used for vegetable production but irrigation is stopped in late summer when groundwater salinity levels adversely affect vegetable production.

Saline incursion of groundwater, not to mention significant above-ground damage, is expected to increase with sea-level rise associated with a warming planet. Kebede *et al.,* (2010) report that a 1m sea-level rise would require an average of 400 m of landward retreat in Dar es Salaam. Loss of land to the sea, through erosion and submergence is not a distant threat. Kebede *et al.* estimated that "*in 2030 the coastal zones of Tanzania could experience a cumulative land loss of 7 624 km^2 to erosion and submergence, with approximately 1.6 million people per year anticipated being flooded, … leading to a total residual damage cost as high as US $42 million per year.*"

Watkiss *et al.*, (2011) estimated that currently 140 000 people in Dar es Salaam are below the elevation map's 10 m contour line, and more than 30 000 are highly exposed to a 1 in 100 year coastal flooding event. By 2070, the number of people exposed to such an event is estimated to increase approximately seven-fold under a mid-range (A1B) scenario for sea-level rise.

Adaptation measures involving building protection, beach/shore nourishment and the upgrading of dikes, combined with proactive spatial planning that reduces pressures on the city could partially offset, though not eliminate, the anticipated impacts (Figure 7.2) (Kebede *et al.*, 2010).

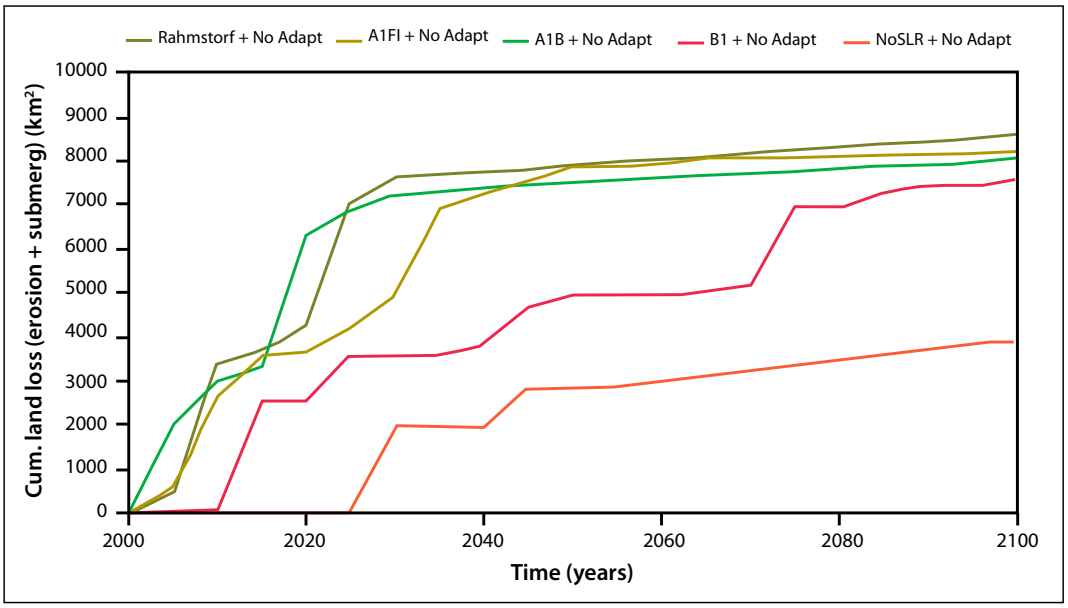
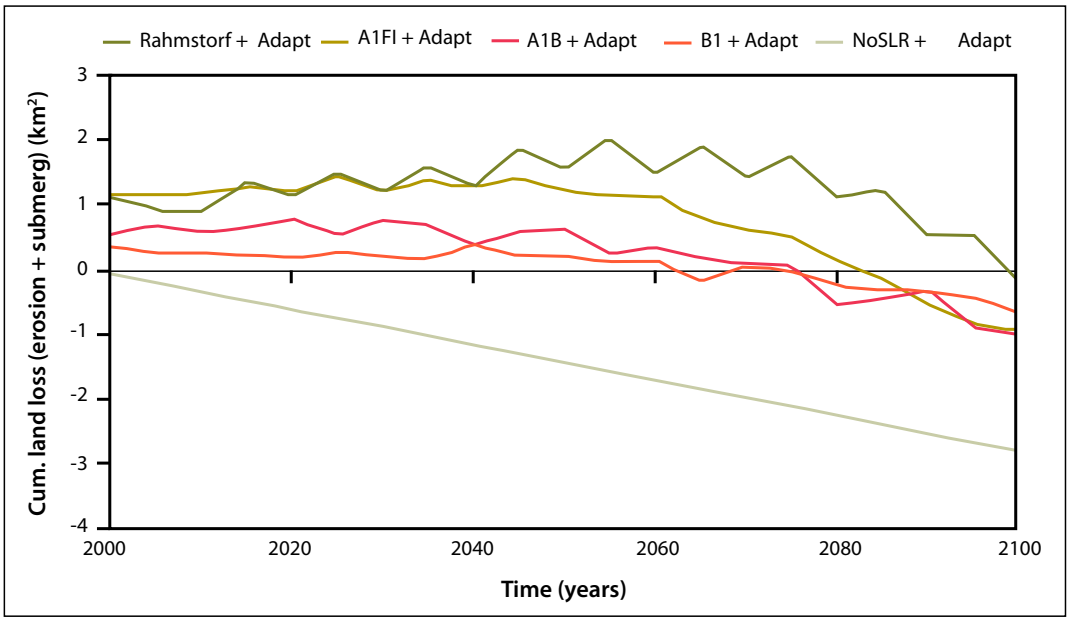


FIGURE 7.2
Cumulative land loss (erosion + submergence) due to sea-level rise from 2000–2100 for Tanzania according to simulations without adaptation
Source: Kebede et al., 2010

Amaranth is a common UPA crop

FIGURE 7.3
Cumulative land loss (erosion + submergence) due to sea-level rise from 2000–2100 for Tanzania according to simulations with adaptation
Source: Kebede et al., 2010



8

Urban and peri-urban agriculture and climate change

The climate trends described in Section 4 demonstrate that Dar es Salaam's climate is changing—maximum and minimum temperatures are increasing, the number of rainy days is decreasing and in some months rainfall intensity appears to be increasing. The climate model projections suggest that warming trends will intensify, the seasonality of rainfall could shift and heavy rainfall events could increase; however, there remain significant uncertainties around future rainfall projections.

Assessing the vulnerability of UPA systems and producers to climate extremes requires comprehensive understanding of the underlying contributors to vulnerability as well as the forces that shape the capacity of farmers to avoid or mitigate harm and adapt to longer-term change. In particular, it is important to understand the non-climate stressors that farmers face and how these interact with climate stressors.

Two FGDs, one in an urban setting, the other in a peri-urban one, were carried out to gain an understanding of the context in which farmers are vulnerable to climate risks. While in-depth studies are needed to more fully elaborate risks faced by UPA farmers in Dar es Salaam, these FGDs provide an entry point for understanding the range of climate and non-climate stressors that shape vulnerability.

Box 2. Focus Group Discussion 1: Urban Location
Kimanga River, *Bonde la Mchicha* Valley

Description of farming area
The *Bonde la Mchicha* is located in Dar es Salaam's Ilala district. There were 16 participants in this FGD, all of whom were men who had begun farming the river valley in the early 2000s. When the farmers first came to *Bonde la Mchicha*, they cultivated a variety of vegetables such as eggplant, leafy vegetables, cucumber and spices, but now they mostly cultivate amaranth, spinach, pumpkin and a little eggplant, which they are able to market nearby. The average plot size of the farmers is approximately 0.1 ha. Participants noted that most of the farmers in the Kimanga Valley moved there after being displaced from previous farming areas by urban encroachment. Participants noted that land availability is a problem, even for those who wish to rent it for short periods.

Men are the primary agriculturalists in this valley, though recently women, driven by a need to generate additional family income, have started to engage in crop cultivation in other valleys. The farmers produce vegetables from May to June just after the long rains but sometimes up to August, depending on water availability. When the water dries up, they do very little vegetable

production. In addition to constraints to water availability, participants noted that recent industrial development is polluting the water in most of the valleys, including theirs.
The major challenges and issues that these farmers face in producing vegetables include:

- water availability and poor quality water;
- urban encroachment into the valley where they farm, as well as competition for land from other residents who would also like to cultivate the valley;
- pollution from livestock kept within the vicinity of the valley by other farmers and sewage outflow from houses;
- solid waste disposal on their lands without their permission;
- periodic restrictions on cultivation imposed by the military;
- limited access to markets;
- poor accessibility of farmyard manure;
- limited availability of seeds and other agricultural inputs; and
- pests and pathogens that affect all types of vegetables.

Climate stressors
Farmers in this area contend with significant climate-related risks. Flooding is common, and causes major losses from rotting and from crops being washed away. The farmers noted that high temperature periods are beginning earlier, and that the excessive heat constrains their ability to produce vegetables into September. Drought conditions also result in low vegetable productivity, which is why they cultivate from May to July. After this period, they experience very dry conditions and the water becomes saline, rendering it unsuitable for irrigating crops. The farmers attribute drought conditions to the presence of very high temperatures. They also noted that winds have become stronger, causing wilting of their vegetable crops.

The farmers explained that these climate risks are increasingly affecting production. For instance, they reported that floods have become more frequent in the past few years, which they partly attribute to increased congestion of residents and settlements, resulting in fewer channels for water to be disbursed. In the past, water in the valley would flow well and remain for reasonable periods, but now the water does not last and the river dries up quickly. Small holes that would capture water for long periods in the past have now disappeared. They also noted that water pollution is now more pronounced than before.

When asked about the periods in which they have noticed these changes and with what frequency, farmers indicated that most of the floods and excessive rains come in March and April. Interestingly, farmers noted that they are affected more by heavy unseasonable rains than the floods that occur during the normal seasonal rains in March and April, which they can plan for—for instance, unexpected storms and heavy rains took them by surprise in 1998 and 2011. While these kinds of flash floods do not occur with great frequency, when they do their impact is significant.

Flooding tends to cause total losses in this valley, forcing the farmers to restart cultivation once the floods abate. Sometimes water stagnates, so they may have to wait for a month or two for the water to recede. Households heavily affected by flooding sometimes return to their villages until the water has settled and they can resume farming. Others go temporarily to Morogoro, which is approximately 250 km from Dar es Salaam and which is more favourable for vegetable

gardening but where they also face stiff competition from other established vegetable farmers. Casual labour is also a common coping mechanism for the male farmers in Kimanga Valley. Women make buns for sale, which is not very profitable as they have to compete with big bakeries. Farmers also deplete household savings to cope with flood impacts. During droughts, they use very small amounts of fertilizer when vegetables become yellow, but only in small quantities and only in emergencies.

External interventions to help farmers cope better with climate extremes have been few. Farmers indicated that although there have been a number of institutions that have visited them and promised support, no concrete results have been forthcoming. Some of the external advisers brought pesticides that did not work because farmers were not properly trained on how to use them. When asked what measures they think would help them better manage risks, farmers highlighted the need for better access to water resources, such as through digging wells that can provide reliable water, the provision of irrigation pumping equipment, and enhanced support in marketing vegetables in order to increase profitability.

Box 3: Focus Group Discussion 2: Peri-urban Location
Kivule (Ilala municipality)

Description of farming area
There were 12 participants, 9 men and 3 women, who have lived in this area for about 20 years. Farmers in this peri-urban area mainly grow sweet potato, amaranth, radish, plantains and sugarcane and keep cattle, chickens, goats, sheep, doves, guinea fowl and ducks. When they first came to this settlement, the area was predominantly bush, and they were the ones who started farming there, having migrated from Kitunda and Kipungu in order to seek better livelihood and income-generation opportunities. Those who migrated from Kitunda commented on the lack of opportunities to cultivate vegetables and other crops there.

Participants indicated that, in the past, land availability was not a problem as the area was bush and it was lightly populated. Settlers could buy a fifth of a hectare for Tsh. 300 000–500 000 (US $200–300), whereas now half a hectare costs around Tsh. 12 million (US $7 500). Nonetheless, production has risen due to an increase in market opportunities and in the number of people engaged in vegetable cultivation.

In this area, all family members are involved in vegetable production, though women lead the activity. Men concentrate on livestock rearing, transport and marketing of vegetables. The major challenges and issues that these farmers face include:

- limited availability of farming equipment and inputs such as pesticides, mineral fertilizers and poultry manure. The decline in available manure is due to the fact that demand has grown as many people are now involved in vegetable production;
- limited water availability due to dry conditions and extreme heat;
- poor access to markets and low profitability;
- termites, other pests and diseases;

Climate stressors

Drought is an important risk in the area, which is magnified by increased settlements and the concomitant competition for water between farmers and residents and, in any case, during the dry season, the water becomes too saline for vegetable production. The majority do not farm during the rainy season, concentrating instead on livestock production. A few grow sweet potato and amaranth during this period as the crops can be quickly harvested. If they try to cultivate in the uplands during the rainy season, the crops are washed away.

Participants noted changes in weather patterns, which they believe are impacting their production systems. These changes include increased cloud cover, reduction in and late onset of rainfall from October to November, and more extreme heat in September and October, which causes wilting of vegetable crops. The farmers associate high temperatures with decreased milk production and decreased egg laying by hens. Livestock pests and disease also increase during the period when it is hot and some of the pests affect cattle and chickens, which get a disease called *gombolo*, causing high mortality when it is extremely hot. During drought periods, farmers have to dig down 10 m to get water for irrigation, unlike earlier times when water was more easily accessible. (Focus group discussions in Tabata Segerea and Kitunda also revealed concerns over increasing water shortages, which the farmers attributed to increased competition for water and changes in precipitation patterns.)

Participants indicated that they started noticing changes in the weather from around 2000. On probing as to how they have managed to identify the problem of cloud cover, participants highlighted that they realize the problem of pests and diseases, (particularly fungal diseases), when it is cloudy, which negatively affects vegetable production. They further explained that in the past the presence of clouds was only associated with rainfall, which is no longer the case.

To cope with drought, farmers feed low-market-value vegetables to their cattle and engage in casual- labour activities such as building or fetching water from distant places and selling it for construction. Men are mainly involved in construction while women are the ones who primarily fetch water for sale. The young follow this gender split in roles, (Ricci *et al.*, [2012]) described how farmers are switching from rice to cassava to cope with water shortages or moving out of crop production in favour of livestock keeping).

On average, each farmer can cultivate five plots of vegetables when conditions are good. If weather conditions are bad farmers reduce the number of plots to one or two. The vegetable farmers also market such products as eggs and milk for livestock keepers who can offer this work and who are less vulnerable to climate risks. When asked to highlight the socio-economic groups most vulnerable to climate risks, participants indicated women as they have to take care of children in hard times. Husbands and fathers can travel and feed themselves wherever they are, but it is more difficult for women who have to ensure that the family is fed. Women are also most affected because they are more dependent on income from vegetable production, which is climate sensitive.

Farmers buy livestock as a way of preparing themselves for future risks and to sell milk to reduce reliance on vegetable production. Income generation through farming, regardless of how little it may be, ensures a level of savings that can be drawn on to engage in petty trading and other income-generating activities during times of stress.

Participants noted that they have not received any external support until recently, when an extension worker provided technical advice on their farming activities. In the past, they had one officer who covered many areas, but for the past three months, they have had one specifically allocated to their area. As with the Kimanga group, farmers identified better marketing opportunities, for selling vegetables, eggs, and milk, and support for access to water, through water harvesting and well digging, as key measures for managing risks.

These two focus group discussions illustrated how development factors such as lack of access to markets, timely inputs and external technical assistance, combined with tenure insecurity, place low-income farmers in a precarious position. Addressing these obstacles in a way that increases the visibility and profitability of UPA would help to strengthen the farmer-asset base, thus helping them to better cope with disruptions brought on by extreme weather and other risks, and to build adaptive capacities for emerging challenges associated with climate change and intensified urban growth.

9 Recommendations

Promote proactive land-use planning for UPA. Although UPA is vital for contributing fresh, nutritious products to Dar es Salaam's food basket, access to land remains a major concern for practitioners in the face of the city's outward expansion, and increased pressure on open lands located within the present city boundaries. Despite national laws and ordinances that empower relevant authorities to stipulate procedures for applying and allocating land for urban farming, and the legal authority of the Dar es Salaam City Council to allocate land for UPA in its development agenda, no areas have been officially demarcated for crop or livestock farming. This is a major shortcoming that needs to be addressed within the policy-making realm. The Dar es Salaam City Council could consider the use of land for urban agriculture in its city land-use plans and the demarcation of areas specifically for UPA. In the absence of such actions, the increasing pace of urban expansion and spiralling land values for non-agricultural uses will likely further diminish UPA in Dar es Salaam. Together with the provision of specific areas for UPA, the government should also regulate and control UPA activities to ensure that they neither cause land degradation nor pollute the environment, and to safeguard public health.

Secure water resources for urban agriculture. Increased access to safe and adequate water resources for food production is a goal strongly expressed by farmers associated with this study. Achieving this outcome will be difficult given the array of current water stresses and the strong likelihood that they will intensify as Dar es Salaam's population grows, warmer conditions increase water demand, environmental degradation of water bodies continues and the risk of groundwater salinization increases. Additionally, the city's authorities will have to cope with pollution of irrigation and drinking water from increased industrialization and flooding that flush waste and pollutants into river valleys and other low-lying areas. Thus, finding a way forward to allocate specific water resources for farming will require navigating significant needs for non-agricultural water use while also dealing with stresses facing water resources. Solutions for securing water for food production may lie in allocation of resources for enabling efficient rainwater harvesting and for use of treated grey water produced by urban households, the latter of which entails significant health hazards that need to be understood and addressed by primary water treatment and careful monitoring as well as awareness raising to reduce exposure to chemical and biological hazards. Moreover, better understanding is needed of the physical positioning of urban agriculture in a hazard-prone landscape of urban flooding and, longer-term, sea-level rise.

Invest in research and capacity strengthening. As has been amply demonstrated in this assessment, there remain numerous and important knowledge gaps surrounding the efficacy and functioning of UPA in and around Dar es Salaam and the stresses it faces in the light of urban growth, diminishing water resources, and climate change. It is recommended that filling these knowledge gaps becomes a priority, especially in terms of better enabling sustainability of the urban agriculture enterprise.

Research on climate change and urban food production systems lags considerably behind research on staple crops and extensive livestock systems in rural areas. Among the issues for which research is needed in Dar es Salaam (and as identified in other cities associated with the UPA assessment) are:

- heat and water stress on horticultural crops and urban livestock keeping under climate change scenarios;
- how expected increases in temperature and humidity and changes in rainfall patterns due to climate change could influence existing or emerging pests and diseases of urban crops and livestock;
- potential interactions that affect horticultural crops, such as between high temperature and high salinity stress; and
- risks associated with using untreated wastewater for irrigation under warmer temperatures and more variable rainfall, in terms of activity of human pathogens and parasites.

New knowledge generation is also needed with respect to updating existing information about the changing nature of UPA in the city. While it has been widely reported that UPA fosters poverty alleviation and increases food and nutritional security in cities where it is actively practiced, there is little quantitative evidence to back this up, and those studies that do exist are outdated. For example, many of the studies cited in this report point to an important role of UPA for supplying vegetables and milk to the city, but these studies are few and severely outdated. Updated understanding of the contribution of various UPA components to the city's food system is needed in light of critical change factors such as high urban growth rates, the penetration of supermarket chains into the city, and the spike in and volatility of food prices.

There are also a number of institutional and governance issues that require careful analysis, such as those related to policy formulation and barriers to enforcement and uptake, the dynamics of informal land markets and pathways for creating stronger visibility and empowerment of farmers in urban planning processes.

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This report represents one from a series of nine city-level reports on urban and peri-urban agriculture (UPA), which together form a larger knowledge assessment. The knowledge assessment was carried out in Dakar (Senegal), Tamale (Ghana), Ibadan (Nigeria), Dar es Salaam (Tanzania), Kampala (Uganda), Addis Ababa (Ethiopia), Dhaka (Bangladesh), Kathmandu (Nepal) and Chennai (India). The nine reports and a synthesis report can be downloaded at: http://start.org/programs/upa

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This assessment report presents the findings of a knowledge assessment on urban and peri-urban agriculture (UPA) for the city of Dar es Salaam, Tanzania, that was conducted in 2012. The assessment examines the state of UPA in the city through the lens of intensifying urban pressures and increasing climate risks with the objective of identifying how these and other drivers potentially interact to affect the long-term sustainability of UPA, and what response options are needed to address existing and emerging challenges.

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