Building Urban Resilience

Assessing Urban and Peri-urban Agriculture in Addis Ababa, Ethiopia

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Building Urban Resilience

Assessing Urban and Peri-urban Agriculture in Addis Ababa, Ethiopia

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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

AACA	Addis Ababa City Administration
AACBPCD	Addis Ababa City Beautification, Park and Cemetery Development
AACMP	Addis Ababa City Master Plan
AACTIDB	Addis Ababa City Trade and Industry Development Bureau
AAWSSA	Addis Ababa Water Supply and Sewerage Authority
BTI	Bureaus of Trade and Industry
CBCD	City Beautification Agency and Cemetery Development
CBOs	Community-Based Organizations
CMIP5	Coupled Model Intercomparison Project Phase 5
CIP	Climate Information Portal
CPP	Consumer Purchasing Power
CSA	Central Statistical Authority
CSAG	Climate Systems Analysis Group
DPPA	Disaster Prevention and Preparedness Agency
EHNRI	Ethiopian Health and Research Institute
EPA	Environmental Protection Authority
ETB	Ethiopian Birr (currency)
EU URGE	European Union Urban Green Environment
FAO	Food and Agriculture Organization (of the United Nations)
FEACC	Federal Ethics and Anti-Corruption Commission
FEWS-Net	Famine Early Warning Systems Network
FGD	Focus Group Discussion
GCMs	General Circulation Models
GDP	Gross Domestic Product
GHASP	Galveston-Houston Association for Smog Prevention
GTP	Growth and Transformation Plan
IADB	Inter-American Development Bank
ILRI	International Livestock Research Institute
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
LADA	Land Administration and Development Authority
MoA	Ministry of Agriculture
MSE	Micro- and Small-Enterprise
NAIC	National Artificial Insemination Centre
NAPA	National Adaptation Programme of Action
NGO	Non-Governmental Organizations
PLWHA	People Living With HIV/AIDS
START	System for Analysis, Research, and Training
UACP	Urban Agriculture Core Process
UNEP	United Nations Environment Programme
UPA	Urban and Peri-urban Agriculture

Contents

Executive summary

This report presents the findings of a knowledge assessment on urban and peri-urban agriculture (UPA) for the city of Addis Ababa, Ethiopia, 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 Addis Ababa's food basket, constituting a major source of the city's green vegetables, eggs, poultry and dairy products. The sector also contributes to economic vitality within the urban food system, particularly by providing livelihoods for the urban poor, though the extent to which this group engages in UPA is not well quantified.

Despite the benefits of UPA, the sector faces many pressures stemming from urban encroachment that contributes to the loss of agricultural land and forests, environmental pollution and flooding. Moreover, UPA suffers from a general lack of supportive policies and policy enforcement mechanisms needed to ensure its long-term viability despite the presence of an urban agricultural office within the city government and other measures within the policy arena that are designed to strengthen it.

This assessment examines the major features of urban expansion in Addis Ababa, environmental and climatic issues, policy and socio-economic characteristics, and the role of UPA in urban food production and supply, livelihoods and economic activities. The assessment is intended to reach policy makers as well as government institutions, development agencies, researchers, urban producers, non-governmental organizations (NGOs), and private organizations concerned with agricultural production, food security and the urban environment. As the Addis Ababa city government is currently developing a UPA policy framework, the assessment is intended to inform that process.

The team that conducted the assessment consisted of senior professionals with extensive experience in UPA, agricultural sciences, urban geography and climate studies. They are from the Addis Ababa Office of Urban Agriculture, Addis Ababa University, and a locally based NGO, the Institute for Sustainable Development.

The assessment draws on a mixture of primary and secondary data analyses. The assessment team amassed secondary material from the Central Statistical Authority, the Ministry of Agriculture, the Ethiopian Institute of Agricultural Research, the Bureau of Trade and Industry, the Addis

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Ababa Environmental Protection Authority, the Addis Ababa Micro- and Small-Scale Enterprises Development Bureau, the City Beautification Agency and NGOs. This information was combined with primary data collected through surveys of 400 urban producers and interviews with government officials and representatives of farmers' cooperatives.

Key findings

Urban encroachment threatens the long-term viability of UPA. Urban encroachment and the development of road networks are contributing to increased land scarcity for agriculture. 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 develop agricultural land.

Given urban growth trajectories for Addis Ababa, these pressures are sure to intensify. 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.

As part of land-use planning, the city government's efforts to more fully commit itself to green development through a green-frame approach to urban planning, as stipulated in the city's master plan, would help to alleviate this threat. There is also a strong need to address the wide gap in institutional and professional capacity in the area of land management and governance. While the city administration considers urban agriculture as an important activity, policy frameworks to enable it are hindered by:

- low awareness amongst policy makers about of the importance of urban agriculture;
- limited leasing periods of five years for urban agriculture;

- legal and informal encroachment on peri-urban farmers' land; and
- lack of institutional coordination for UPA within other sectors.

Risks associated with climate change will become more prominent in the future. When considering the variety of drivers and stressors currently acting on UPA in Addis Ababa, climate change is not an important factor. However, climate change is likely to become more prominent in the future given projections of increased temperature and shifts in the seasonality of rainfall. Decadal analysis of climate trends preliminarily indicates evidence of potential climate change manifested through an increase in maximum temperature, increasing rainfall during the *Kiremt* (long) rains and decreasing rainfall during the *Belg* (short) rains. Additionally, the incidence of heavy rainfall events during *Kiremt* months has increased over the past several decades. These findings corroborate observations of increased flood risks and untimely rains that farmers are experiencing.

The sensitivity of UPA systems to climate risks is amplified by environmental degradation linked to rapid urban growth. Farmers in Addis Ababa are increasingly contending with the effects of extreme climatic events, particularly untimely rains and floods. The increased sensitivity to these risks is strongly shaped by non-climatic factors, such as increased siltation of rivers and urban encroachment, rather than by changes in climatic conditions *per se*. However, to the extent that extreme events become more prevalent with climate change, there is potential for heightened vulnerability of UPA farmers and production systems.

Several potential entry points exist for better managing climate risks to UPA that could help foster adaptation to climate change. These include availability of early-warning forecasts of floods, inputs that allow for the timely establishment of crops and thus reduce the time that crops are in the field and potentially vulnerable to flooding, access to credit that can encourage diversification away from an overreliance on agriculture, and improved farmer access to markets and opportunities for value-added processing that enhances agriculture's profitability. Moreover, securing the use of land for agriculture is critical for underpinning strong adaptive capacity.

Protecting urban food systems from climate extremes and other disruptions requires integrated city planning. While UPA plays an important role in ensuring diverse diets for city residents, the bulk of Addis Ababa's food supply comes from an area that encompasses more than one-third of the land area of Ethiopia. Given the precarious nature of food production in Ethiopia and the high risks the region faces from the effects of long-term climate change, more effective coordination is needed between city and national governments to ensure food security for Addis Ababa that does not, at the same time, undermine food security elsewhere.

One option would be for the city government to create a central office that oversees management of the city's food supply. Such an office could gather data on the city's food system and advise city and national officials on issues related to urban food security. An important mandate of this office could be to develop and initiate stronger spatial planning for flood and drought preparedness. The establishment of such an office would provide city administrators with a better means of monitoring the food demand/supply situation, and could lead to better food security for the city's residents.

1 Introduction

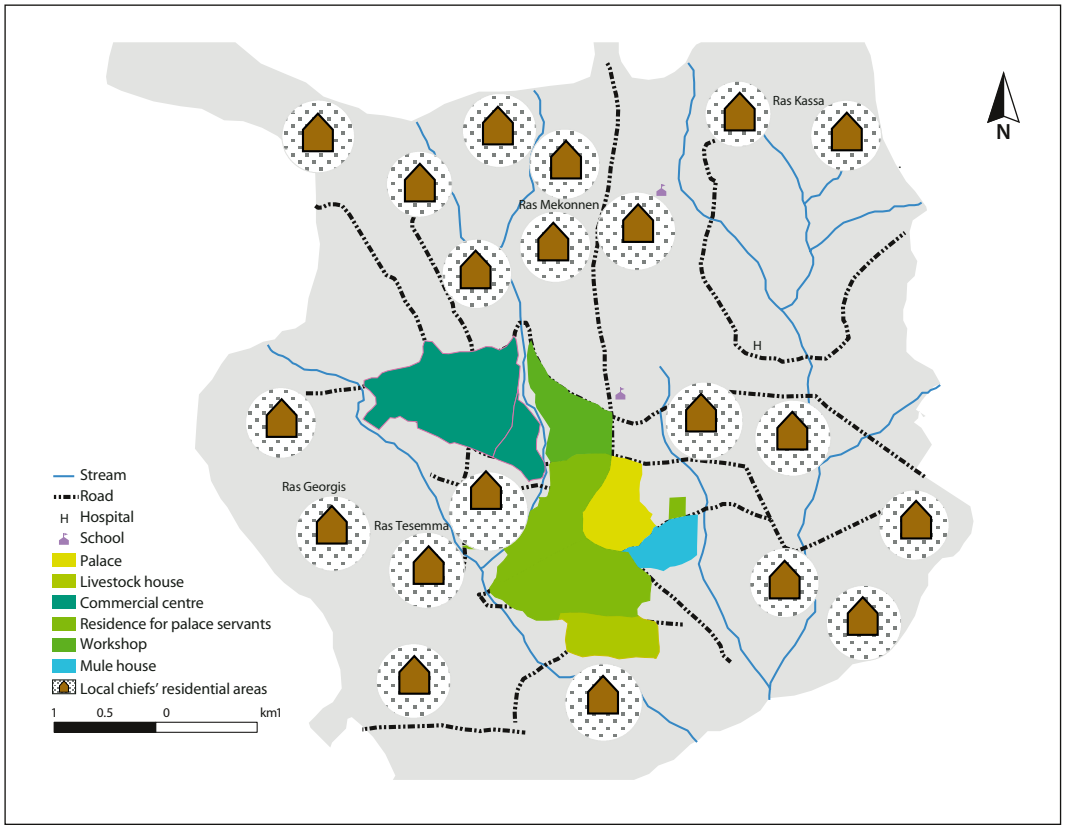
Addis Ababa was founded at the end of 19th century by Emperor Menelik at the geographical centre of Ethiopia. Its physical landscape is a mixture of undulating and rugged topography in the northern and central parts of the city, while relatively gentle morphology and flat areas characterize the city's southern reaches (Yirgalem, 2008).

After temporarily settling at the top of the rising slope of Entoto Mountain, Menelik moved southwards to a place called *Finfinnee*[1] where the emperor's chiefs and their entourages established residential

View of Addis Ababa from Entoto Mountain © B. Dereb / iStock

1. A place in the vicinity of a hot spring that existed prior to the establishment of Addis Ababa.

FIGURE 1.1
Original settlement of Addis Ababa
Source: Yirgalem, 2008



sites. Although Addis Ababa was founded relatively recently, it has experienced considerable change with respect to its demographic, socio-economic and physical development. Following the pattern of early Ethiopian cities, Addis Ababa started to grow around three nodes—a political centre, the palace; a church, St. George; and a market. In time, scattered large settlements began to sprawl from these nodes (Figure 1.1).

Today, Addis Ababa is the capital of Ethiopia and the country's largest urban centre. The 2007 census shows that the population of Addis Ababa had reached 2.7 million, with an annual growth rate of 2.1 per cent and UN-Habitat estimates the 2010 population was approximately 3 million. The city constitutes approximately 28 per cent, of Ethiopia's urban population. The accelerated growth of Addis Ababa can be attributed to natural increase, boundary expansion and rural-urban migration.

The physical development of the city (Figure 1.2) has been influenced by periods of sporadic growth, with inefficient land use and costly infrastructure development. This pattern of settlement has encouraged land speculation and corruption in the process of land administration and management. The municipality is estimated to have a total area of 540 km², of which 18.2 km² are considered rural.

The land base will continue to experience significant pressures as the city's population grows over the next few decades. Urban population growth in Addis Ababa and other urban centres in Ethiopia is far outpacing economic growth, resulting in large slum and squatter settlements—UN-Habitat (2008) estimates that between 50 and 80 per cent of houses in Addis Ababa are informal ones—bringing concomitant environmental degradation (Matheos, 2005; Yntiso, 2008).

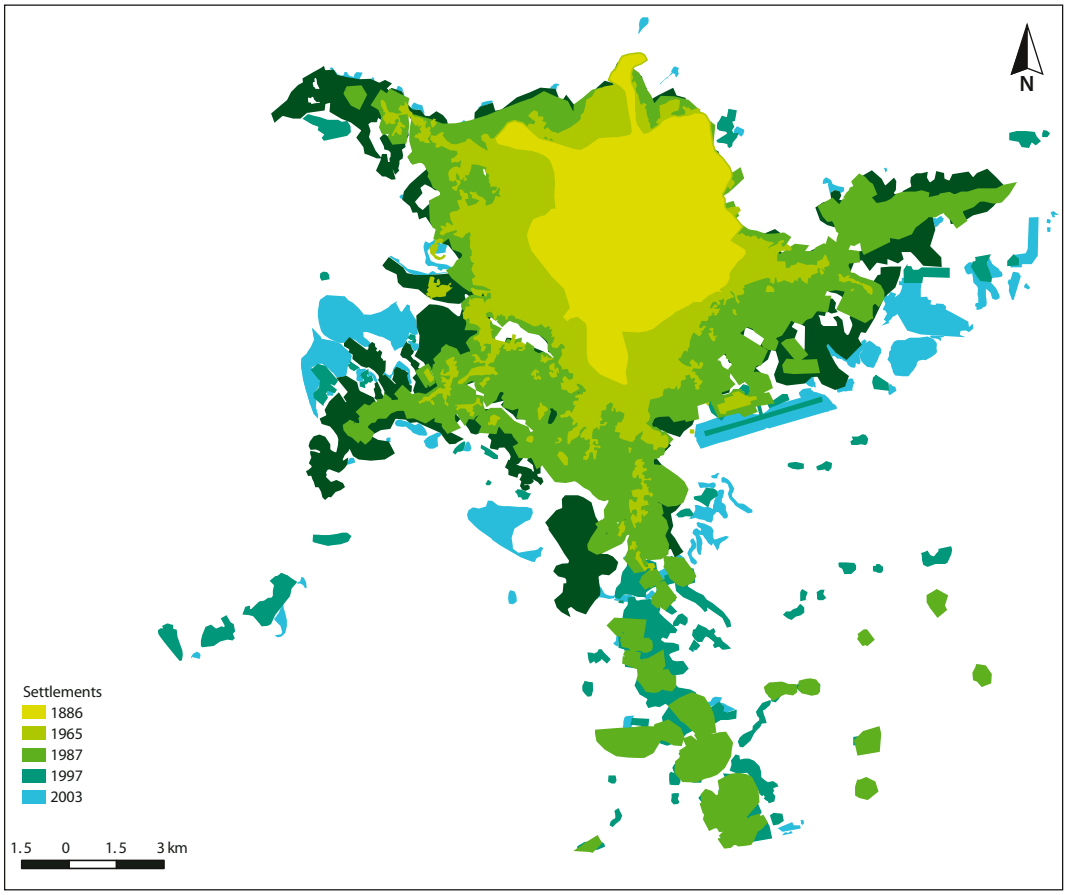


FIGURE 1.2
Physical development pattern of Addis Ababa, 1886-2003
Source: Yirgalem, 2008

Another aspect of rapid urban development in Ethiopia, and particularly Addis Ababa, has been a systematic displacement of low-income households from the inner city to resettlement sites on its fringes and a disruption of informal networks critical to the coping capacities of the poor (Yntiso, 2008). These circumstances have ultimately reduced the resilience of the urban poor, who make up a considerable proportion of the population.

Addis Ababa suffers from fragmented institutional arrangements and overlapping mandates with confusing duties and responsibilities; a situation that hampers the ability of city leaders to address critical socio-economic and environmental challenges. A general lack of clear and effective urban land-use policies during most of its history, and poor governance in carrying out those policies that do exist, are key factors behind environmental degradation. Action is needed to address the wide gap of institutional and professional capacity in the area of land management and governance, which is manifested in land-related corruption and abuse of power.

In Addis Ababa, UPA is estimated to meet a substantial portion of the city's demand for eggs, poultry, dairy and green vegetables. Poultry, animal fattening, dairy, beekeeping and vegetable production are predominantly done in urban core areas, while mixed farming of cereal crops, primarily wheat and teff (*Eragrostis tef*), and livestock production is practiced in peri-urban areas.

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Food production in and around Addis Ababa is an important livelihood resource for those urban poor who engage in agriculture, though there have been no recent, comprehensive studies to estimate the extent to which the urban poor engage in UPA activities. Lee (1997) and Egziabher (1994) stated that the livelihoods of many urban citizens in Ethiopia are dependent on urban farming though neither source provides estimates of how many. Duressa (2007) reported that two-thirds of household income is derived from farming for those residents of Addis Ababa engaged in urban farming, though he does not report on the extensiveness of urban farming in the city.

The favourable climate of Addis Ababa provides suitable conditions for UPA, however it has to compete for scarce resources—land, water, energy and labour—that are in demand for other urban activities. Urban areas also face emerging risks associated with climate change, which exacerbate vulnerability and are compounded by the existence of multiple stressors caused by uncontrolled urban expansion, poverty, pollution and inadequate urban infrastructure. The extent to which climate change presents an added burden to UPA is explored in this assessment.

This report is divided into seven sections. The introduction (Section 1) provides the overview of key issues facing UPA. After describing the study's objectives and methods in Section 2, the report then details the characteristics of UPA producers and farming systems in the urban core and in the peri-urban zone (Section 3), and the policy landscape in which UPA occurs and where opportunities and discontinuities in policy affect UPA (Section 4). Sections 5 and 6 explore core sustainability issues affecting UPA stemming from urban encroachment, environmental degradation and climate variability and change. The report concludes with a series of recommendations (Section 7) for city leaders that can help to ensure a viable future for UPA in Addis Ababa.

2 Objectives and methods

Objective of the study

This assessment assembles knowledge on the state of UPA in the city through the lens of urban growth, increasing climate risks and their interactions. The assessment is structured to provide credible information to support policy planning and decision-making at the city level with respect to UPA. Through this process, the assessment aims to raise awareness among stakeholders and policy makers of the importance of urban agriculture as a strategy to enhance urban food security, help reduce urban poverty, improve urban waste management and contribute to overall urban development. Lastly, the assessment sought to identify areas for which insufficient knowledge exists and highlight where additional research and assessment efforts are needed.

The assessment's conceptual framework illustrates the key drivers and stressors, development factors and urban and peri-urban products and services. The assessment framework is presented in Figure 2.1.

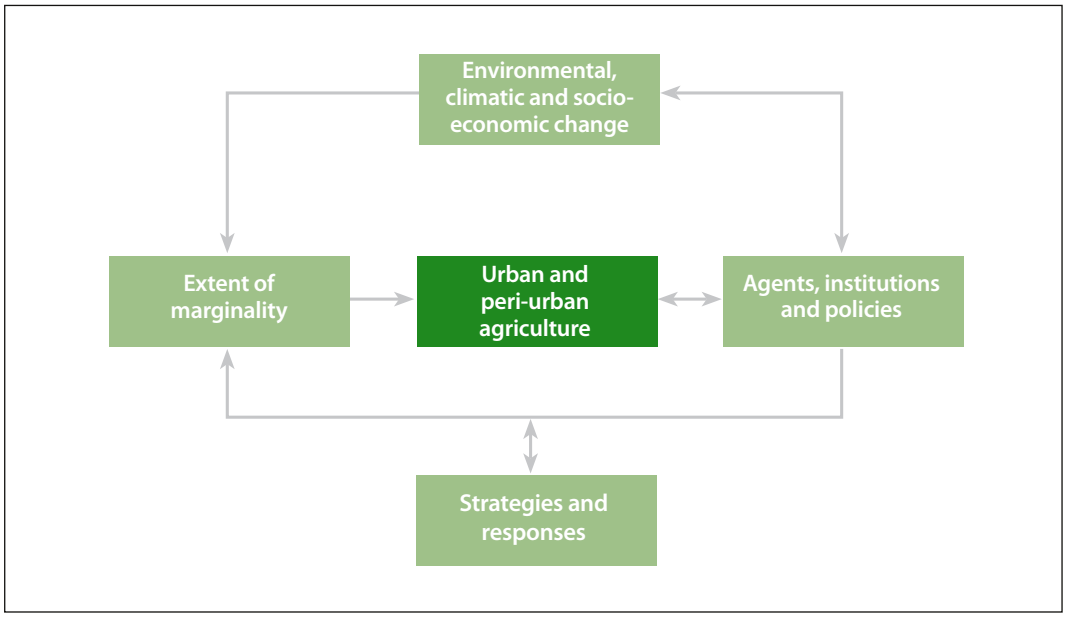

FIGURE 2.1
Conceptual framework

Description of methods

The information on which this assessment is based was obtained from both primary and secondary sources. Primary information collection occurred through several methods, including a stakeholders' workshop, focus group discussions, surveys of both male and female producers in urban and peri-urban areas, and interviews with urban producers, extension workers, cooperative members and individuals from selected NGOs and community-based organizations (CBOs).

To initiate and help frame the assessment, the team initiated an inception workshop in Addis Ababa in April 2011 involving an array of stakeholder groups including urban producers, NGOs, government institutions and departments, CBOs, service providers, city administration officers and agriculture extension agents. The main objective of this workshop was to gather input from a diverse audience and agree on priority themes to be considered as well as any other relevant aspects deemed important by the stakeholders.

The participants in the focus group discussions (FGDs), carried out over the course of the assessment, came from several districts of Addis Ababa's 10 sub-cities where urban production of vegetables, cereals and livestock is widely practiced: eight sub-cities for FGDs concerned with urban animal production (dairy, poultry, beekeeping and fattening) and five sub-cities for FGDs concerned with vegetable and cereal production. The urban producers included both men and women who had extensive experience to draw from and reflect on regarding changes in the production environment over the past decade and more.

A survey of 400 sample households was undertaken in UPA areas to gain a better understanding of land holdings, owned assets, labour availability and use, farm production and income, marketing, and access to basic services. The participants consisted of 152 mixed crop farmers, 61 vegetable producers, 114 dairy farmers, 55 poultry farmers, 11 beekeepers and 7 owners of animal fattening units.

The fieldwork was backed by secondary data collection, which involved an extensive review of peer-reviewed and grey literature, progress reports of projects and policy documents on the status and evolution of UPA in Addis Ababa. The document review targeted literature on UPA and its contribution to livelihoods, as well as documents pertaining to land and water resources and climate, relevant to UPA. The review revealed a lack of empirical research in this area in general, and particularly on the relationship and interaction of climate change and UPA in Addis Ababa.

The Addis Ababa assessment team held a stakeholders workshop in May 2012 after the preparation of the initial draft report. Its objective was to share the key findings with the participants—about 100 participants from different sector offices in Addis Ababa's city administration, urban producers, personnel from several NGOs, and extension staff working from different parts of Addis Ababa.

3

Urban and peri-urban agriculture and the urban food system

Systems of production

Urban and peri-urban agriculture plays an important role in Addis Ababa's economy, food and livelihood systems. Broadly speaking, UPA in the city involves livestock keeping, predominantly dairy cows, sheep and chickens; egg production and the cultivation of rainfed and irrigated crops, mainly vegetables but also cereals and pulses, on land adjacent to homes, river banks, on school and hospital land and in open fields. The UPA sector in Addis Ababa comprises individual farmers as well as farmers organized in micro-enterprises and cooperatives.

The contribution of farm products to the city from UPA producers is significant. According to a Central Statistical Authority (CSA) report (2007), 30 per cent of vegetables including 60–70 per cent of leafy vegetables, 60–70 per cent of milk and 40–60 per cent of eggs consumed in the city are supplied by UPA. Approximately 62 tonnes of honey is produced in Addis Ababa each year, with an average of 40 kg of honey obtained annually per improved beehive. This output is approximately double that of rural parts of the country where only 15–20 kg per beehive per year is harvested.

The contribution of UPA to total employment for Addis Ababa is quite low (3 per cent) compared with other economic activities, with more than half of household heads engaged in service sectors, and nearly 40 per cent engaged in manufacturing and repair and construction sectors (CSA, 2007). While the share of households directly engaged in UPA is low compared with other sectors, the economic benefits of UPA extend beyond the producers themselves to include other groups involved in the urban food chain who depend on agriculture, such as those in marketing, transport and processing. According to CSA (2003) the composition of those working directly in UPA production accounted for about 45 per cent and those dependent on UPA was 55 per cent. Studies are needed to update estimates on the total direct and indirect beneficiaries of UPA in the city.

Agriculture is one of the land-use categories in the Addis Ababa city plan, which categorizes it as either temporary or permanent. The temporary areas are located along river banks, at the perimeter of forest reserves and in open spaces within the city, while those considered as permanent are in peri-urban expansion areas. However, urban encroachment means that those lands categorized as permanent are increasingly taking on features of temporary urban agriculture, as discussed in Section 5.

Description of urban agricultural systems

Urban farming takes place in all Addis Ababa's 10 sub-cities. According to estimates from the Addis Ababa Urban Agriculture Office obtained by the assessment team, vegetables are produced on more than 300 ha; there are 6 454 vegetable producers and 5 765 livestock/dairy owners, with one livestock and nine vegetable cooperatives. There are 461 micro- and small-enterprises of farmers, particularly women, youth and elderly people engaged in livestock, vegetable and mushroom micro-enterprises.

The urban vegetable farmers surveyed for this assessment widely use a combination of mineral fertilizer, compost and manure to improve the fertility of their land. They reported having good access to extension support and that engagement in UPA increased their food security. The major constraints expressed by the farmers were a shortage of labour, pests, and insecurity of land holdings.

Poultry production is an important activity in the urban and peri-urban areas. According to 2002 estimates (Tegegne *et al.*, 2002), there are nearly 3 million chickens in the metropolitan area that are kept for egg and meat production. Poultry rearing is a significant part-time occupation for low-income households, though the proportion of the urban poor who are poultry keepers has not been adequately quantified. According to Tegegne, the urban poor use the income generated from the sale of eggs and chickens for school fees and other household expenses. There are also a few very large units that produce eggs, such as ELFORA, which in 2002 produced 18 million eggs annually from 340 000 chickens.

There are approximately 31 000 dairy cattle in urban areas of Addis Ababa. Nearly three-quarters of the urban dairy farmers surveyed for this assessment have only about 200 m^2 of land holdings on which to keep cows. As a result, they have little or no access to traditional continuous grazing systems, but rather follow confined management practices using purchased hay, crop residues and industrial by-products. Most of the dairy-cattle holders sell milk and milk products directly to consumers living close to the dairy, and most have good access to micro-credit services.

Urban dairying is an important component of agriculture in the city. Of the approximately two-thirds of milk supplied to the city by UPA, more than three-quarters of it comes from urban dairy farmers (Table 3.1). Much of these milk sales are very localized given the lack of cold storage. Constraints to dairy-cattle keeping include the shortage of and poor access to land, the high cost of inputs and particularly feed costs, shortage of space to grow feed resulting in high feed prices, poor milk storage facilities, low farm-gate prices for milk and inadequate facilities for proper waste management.

TABLE 3.1
Composition of milk production by different sources

Producer	Litres per annum	Total milk supplied (per cent)
Urban dairy farmers	34 649 450	79
Dairy Development	4 513 625	10
Peri-urban dairy farmers	4 684 600	11
Total	**43 847 675**	**100**

Source: Agricultural Development Bureau of the Addis Ababa City Administration

Farmers have access to technical support from extension services and to credit from micro-finance institutions. Poultry producers are also engaged in non-farm activities such as casual labour, and the preparation and selling of *injera* bread and homemade alcoholic beverages. The major constraints identified by the participants include the high cost of chicken feed and the shortage and insecurity of land holdings.

Urban producers are also engaged in beekeeping and animal fattening in the urban areas. Tegegne *et al.* (2003) estimated that more than 1 000 beekeepers and between 3 000 and 5 000 beehives exist in Addis Ababa of which more than 1 500 are improved hives (Tegegne, 2004). Fattening of cattle, goats and sheep,

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primarily for meat, is done for both domestic consumption and export. The city authority has provided land for animal fattening for about 10 years. Major constraints include high feed costs, shortage of land and marketing problems.

Description of peri-urban agricultural systems

In the peri-urban areas, mixed farming is practiced with crop and livestock production complementing one another. According to the surveys and focus group discussions, there are an estimated 36 000 local-breed and crossbred cattle in the peri-urban areas, while Tegegne *et al.* (2002), estimate 58 000 cattle in urban and peri-urban areas. Crops grown in the peri-urban areas include cereals, pulses, oil and horticultural crops, which are produced as staple food crops and, in the case of horticultural crops, for income generation. Most of the mixed farming is located in the five sub-cities of Akaki Kaliti, Bole, Kolfe Keranyo, Nefas Seilk and Yeka. Mixed farming is practiced on more than 7 700 ha with production largely dependent on rainfall. There are more than 3 300 mixed farmers in the peri-urban areas of the city. Mixed farming in peri-urban areas is practiced on a larger scale than in the urban areas, given that farmers have larger plots, typically more than 2 ha. Farmers use oxen and family labour but hire additional labour for harvesting.

Farmers use fertilizers and improved wheat, teff and vegetable seeds. Farmers stated that extension staff provide technical support particularly during ploughing and planting times. Farmers use chemical, traditional and mechanical pest-control methods, plant pest-resistant varieties and seeds and exercise early or late planting practices. Similar to urban farmers, the major constraints faced include the inadequate supply of improved seeds, a shortage of feed for livestock, shortage of land and a feeling of insecurity about their present land holdings because of urban encroachment.

Characteristics of urban and peri-urban farmers

In urban and peri-urban areas, both men and women are engaged to varying degrees in agriculture (Table 3.2). Results on gender composition generally indicate a higher proportion of male farmers, with women mainly active in poultry, dairy and vegetable farming. Women are typically involved in processing and selling, activities that can readily be combined with their other household responsibilities.

TABLE 3.2
Proportion of male and female farmers in Addis Ababa

Farm Activity	Farmers (per cent)	
	Males	Females
Dairy	68	32
Poultry	50	50
Beekeeping	86	14
Animal fattening	100	-
Vegetables	67	33
Mixed farming	82	18

Source: Assessment survey

According to the surveys, the majority of urban and peri-urban farmers are married (79 per cent) and the majority in each category except mixed farming, have had some formal education (Table 3.3). Dairy farmers tend to be older than poultry and vegetable farmers indicating the difference in capital and land resources required.

TABLE 3.3
Level of education of urban and peri-urban farmers

Farm activity	Education		
	None	Informal/religious	Formal
Dairy	25	11	64
Poultry	8	15	77
Animal fattening	-	17	83
Vegetables	34	8	58
Mixed farming	48	11	41

Source: assessment survey

Beyond UPA—key aspects of urban food dynamics in Addis Ababa

The Addis Ababa food shed

While UPA makes an important contribution to dietary diversity for the city, its contribution to the overall urban food basket is relatively minor. The food shed of Addis Ababa is estimated to cover a large portion of the eastern and central regions of the country. The food sheds for poultry and eggs, milk and a significant portion of vegetables, however, are largely confined to Addis Ababa and its closest hinterland, including the Shewan plateau, while that for meat covers very large areas of the country (Figure 3.1c). The largest supply of pulses and cereals are pooled from the large-scale state

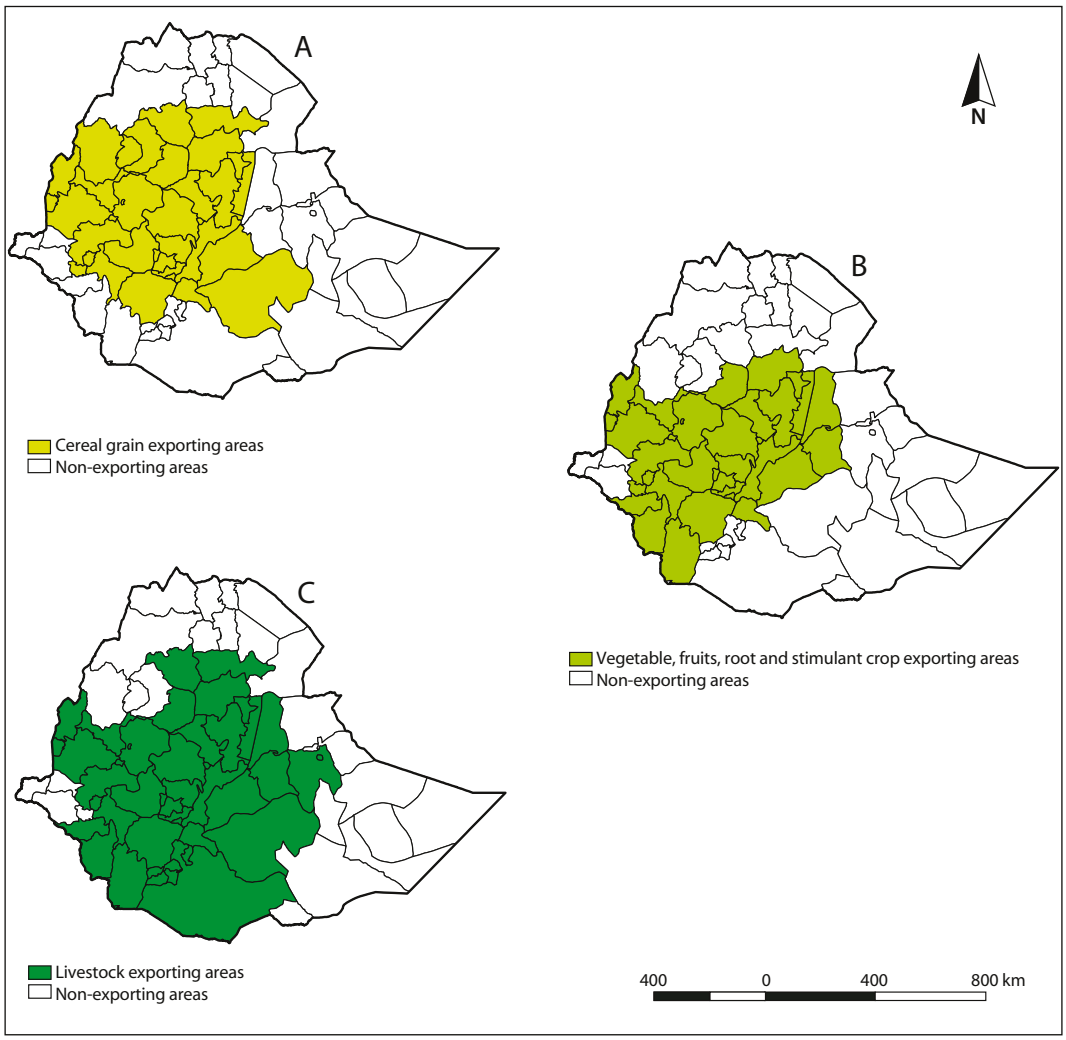


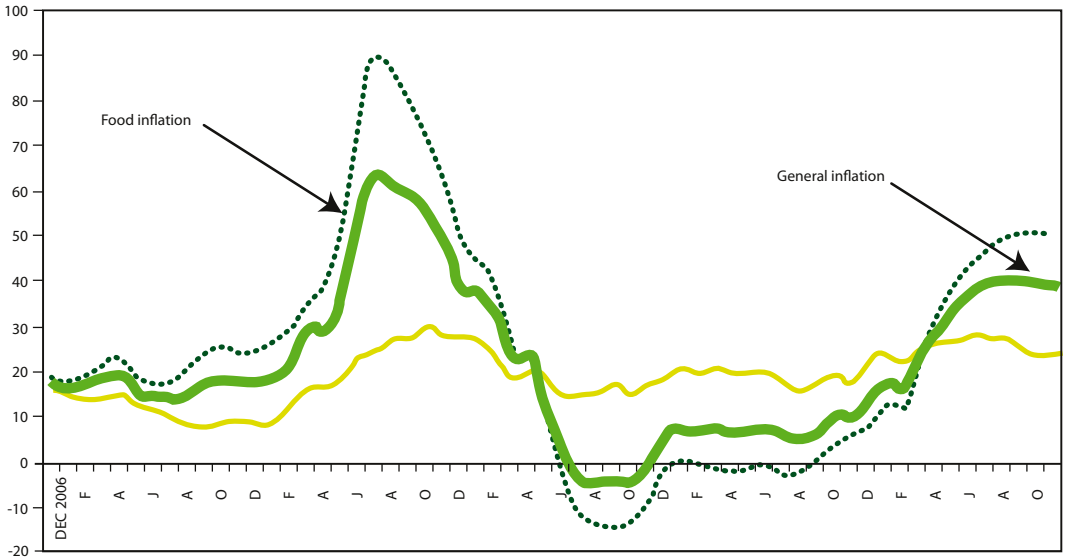
FIGURE 3.1
Food shed of Addis Ababa: (A) cereal grain, (B), vegetable, fruits, root and stimulant crops (C) and livestock including milk and poultry
Source: Central Statistical Authority, 2007

and commercial farms and private small-scale farms (see Figures 3.1a, b & c). Khat (*Catha edulis*) and coffee are pooled to Addis Ababa both for domestic consumption and export from the west, east and south of city (Figure 3.1b). Kocho, a pancake-like bread made from fermented enset (*Ensete ventricosum*) starch, is pooled from Gurage Zone, West Shewa Zone, Southwest Shewa Zone, Sidama Zone and Wolita Zone.

Access to food, and consumer purchasing power

The food habits of both urban and rural Ethiopians are still predominantly traditional, with most households acquiring unprocessed and raw food items and doing their own, often time-intensive, processing and cooking. However in Addis Ababa and other African cities, the increasing prominence of modern shops, supermarkets and other stores, with their orientation towards more processed foods, is beginning to change how food is accessed. While these new food outlets are quite visible, the extent of their influence, and their potential for value-added processing of locally produced agricultural products, is not well understood. The availability of commodity supplies and the infrastructure for distribution, in this case transportation, storage facilities and market places, as well as the purchasing power of consumers, are critical for gaining access to UPA products and other food sources.

FIGURE 3.2
Consumer price index inflation in Ethiopia, December 2006–November 2011
Source: CSA, 2011



As with other African cities (Crush *et al.*, 2012), Ethiopia's urban populations are highly dependent on purchased foods, and are thus quite vulnerable to food price swings. Data obtained from the Central Statistical Authority (CSA, 2011) indicates that consumer purchasing power (CPP) of those living in Addis Ababa was considerably eroded by the 2007–2008 food-price crisis and subsequent food-price volatility. Rising food and non-food consumable commodity and service inflation was accentuated by the depreciation of the Ethiopian Birr by about one-third in September 2010. Indicative of the erosion of food purchasing power is the new expression "five-eleven", wherein breakfast and lunch are merged at 5:00 a.m. and lunch and dinner merged at 11:00 p.m.

The CSA (2011) data showed that inflation indices for food and non-food commodities were about 50 per cent and 24 per cent, respectively, while the general consumer price index inflation was approximately 40 per cent at the end of 2011 (Figure 3.2). However, food, non-food and the general consumer price index inflation attained maximums of 90 per cent, 30 per cent and 62 per cent, respectively, in 2008. Although lower today, inflation remains very high and, in real terms, the purchasing power of both urban and rural populations in Ethiopia has been appreciably eroded (IMF 2011).

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4

Addis Ababa policy frameworks

Policy on urban and peri-urban agriculture

Although UPA is beginning to garner recognition within Ethiopia's policy community, the existing policy and legislative frameworks do not encourage it sufficiently. For example, UPA is not included in the 2010–2014 Growth and Transformation Plan (GTP), which is designed to support agriculture in playing a lead role in the growth and development of Ethiopia's economy. Indeed, the sector faces many problems that require policy support, including availability of land and security of tenure; access to clean water for irrigation; adequate supplies of inputs and credit services; weak farm organizations; low productivity, and long marketing chains.

In 2011, Ethiopia launched its five-year (2010/11–2014/15) national Growth and Climate Resilient Green Economy by 2025 plan that established the Addis Ababa green frame. This covers almost 41 per cent (22 000 ha) of the land area of the city, and involves four different urban land-use categories—green areas along riverbanks, forests and woodlands, urban agriculture, and recreational open spaces, botanical gardens, zoological parks, and natural and street parks.

Built-up surface occupies about 37 per cent of Addis Ababa's land area and 22 per cent is designated for urban expansion. Of this expansion area, 67 per cent is currently used for cultivation and a further 16 per cent as grazing land. Clearly, urban agriculture is an important part of green frame; however, enforcement of urban agricultural areas from encroachment and other uses remains a challenge (Section 5).

One of the main purposes of the office charged with greening the city is the development and maintenance of the recreational resources—green areas and parks. In an interview in January 2012, the deputy manager of the office of Addis Ababa City Beautification, Park and Cemetery Development (AACBPCD) reported that it preserves the main features and beautiful sites of the city to provide a worthy setting for the capital and, above all, give inhabitants pleasant, convenient and healthy surroundings in which to live and work.

The city government has traditionally focused much of its environmental enhancement efforts on establishing a few parks and roadside tree plantations (Eyob, 2010) and not on the multi-functionality of green spaces for reducing environmental risks to the city, such as from flooding. For example, no serious effort has been made to expand the spatial extent of the city in a planned manner that would allow the city to acquire adequate green space along with growth. The availability of green space is rapidly diminishing because of poor management of existing spaces and weak governance (Alamerew, 2002).

Encouraging urban and peri-urban agriculture

An urban agriculture policy framework currently being developed for the city of Addis Ababa provides a tangible measure for achieving greater visibility of urban agriculture within urban planning. The policy sets out a sound framework that promotes UPA in an effort to improve food security, income and employment in an environmentally friendly, socially inclusive and gender-sensitive manner, while reducing environmental degradation and pollution through the sustainable utilization of natural resources and the environment.

The policy framework, which the city government is in the process of developing, comprises five major elements—access to land and water, health and environment, UPA services, gender and social issues, and institutional and operational frameworks. Implementation of the policy will be shared by public, private and producer/NGO sectors. The following section summarizes the institutions involved and the roles each are expected to play.

Public sector

A number of ministries play an important normative role in promoting UPA despite not having a direct organizational link to Addis Ababa's UPA unit. The *Ministry of Agriculture* (MoA) for example, through its extension directorate, facilitates the dissemination and supply of improved technologies including semen by the *National Artificial Insemination Centre*.

The *Urban Planning Institute* coordinates urban land-use planning including the UPA land uses and develops maps of land allocated for UPA. The *Office of Land Administration and Construction* certifies UPA land allocations, which are currently restricted to micro- and small-enterprise use. The *City Council of Addis Ababa* formulates development policy, allocates the budget for municipal development activities, and provides political leadership to ensure effective implementation of activities in line with national and city priorities.

The *Bureaus of Trade and Industry* (BTI) issues UPA-related investment permits and licenses private service providers and producers. The Cooperative Organization and Promotion Process under the BTI registers and supports the sustainable development of cooperatives, and monitors and audits their financial integrity. The Addis Ababa *Environmental Protection Authority*, under the city council, is responsible for promoting environmentally sustainable development, and the city's health bureau has a stake in promoting eco-friendly UPA as it evaluates new and monitors existing agricultural enterprises, focusing mainly on hygiene and environmental health.

The Addis Ababa Micro- and Small-Scale Enterprises Development Bureau (MSE) is also key, working with organized and legally recognized groups of urban farmers to promote vegetable growing; silk, dairy and poultry production; beekeeping; and livestock fattening. The MSE provides services such as business development, training, credit, land and market links to the existing 461 micro- and small-enterprises engaged in UPA. Formal extension services, organized at the district (*woreda*) level, are provided by 58 agricultural officers.

Private sector

Private sector involvement in UPA features prominently in Addis Ababa, with a diverse range of actors, functions and services (Table 4.1). This is not restricted to Addis Ababa—some, such as the animal feed suppliers, mushroom seed laboratories, milk processing firms and agricultural input suppliers, have national mandates and play an increasingly significant role in the promotion of UPA in other Ethiopian cities. The existence of these heterogeneous actors and services, and the shift toward private-sector leadership within Addis Ababa, gives rise to untapped opportunities including, for example, the ability to influence public investments through strategic public-private partnerships.

TABLE 4.1
Private organizations, institutions and individuals providing UPA-related services in Addis Ababa

Actors	Functions and Services
Animal feed suppliers	feed processors and factories, feed retailers and hay suppliers
Animal health service providers	veterinary clinics, mobile clinics, chemists and veterinarians
Private and MSE livestock farms	supply of improved livestock breeds of dairy cows, pigs and poultry
Private mushroom seed laboratories	supply of mushroom seeds and agricultural inputs for production
Milk processing firms	milk collection and transport
Artificial insemination (AI) technicians	delivery of AI services
Financial institutions	micro-finance for UPA producers
Agricultural input suppliers	marketing of vegetable seeds, fertilizer, farm tools, irrigation equipment, sprayers, poultry cages and beekeeping equipment

Producer/NGO sector

There are around 25 NGOs and community-based organizations (CBOs) in Addis Ababa that are involved in livelihood promotion for urban poor and marginalized people. These organizations focus on UPA, HIV/AIDS and reproductive health activities—the UPA component focuses on the poor and marginalized groups specifically people living with HIV/AIDS (PLWHAs), women, orphans and vulnerable children and young people. The major areas covered include UPA technology promotion; environmental management, direct support for PLWHAs, technology transfer, solid waste management and business development. In addition, these NGOs/CBOs are actively engaged in the promotion of UPA and related waste management through public-awareness raising using exhibitions, developing manuals and the distribution of leaflets.

One of the strongest is the Hibert Dairy Producers and Marketing Cooperative in the Akaki Kality sub-city. Established in 2003, the cooperative, which has 134 male and 72 female members, currently provides feed, vaccinations, training, milk collection, processing and marketing services to members and non-members alike.

Typical hanging beehive used in Ethiopia © Guenterguni

There are other agriculture and related-sector producers, marketing cooperatives and associations based in Addis Ababa engaged in promoting market-oriented agriculture across the country—dairy, beekeeping, horticulture, mushroom growing, organic agriculture and feed production. Addis Ababa UPA producers could better exploit the opportunities provided by these associations, which are promoting pro-poor agricultural value-chain development, knowledge and information related services.

Very recently, some NGOs have taken initiatives to create UPA platforms to bring all actors together for learning and advocacy (e.g., UASNCW 2012). In February 2012, the Addis Ababa Urban Agriculture Core Process organized a stakeholders' workshop with more than 60 participants from the government, international organizations, and NGOs to discuss the launch of the Addis Ababa Urban Agriculture Stakeholders' Network, a platform for sharing knowledge and coordinating approaches to promote urban agriculture in the city.

5 Urban environmental change and UPA

Urbanization and population growth trends for Addis Ababa

Addis Ababa is growing rapidly beyond its legal and municipal boundaries, with attendant negative impacts on socio-economic conditions and the city's physical environment. Lack of good governance, unemployment, chronic shortages of housing and infrastructure, and poor environmental quality are priority issues expressed in the Addis Ababa five-year strategic plan (Addis Ababa City Administration, 2011). Governance within the city has suffered from corruption, lack of accountability, and the misuse and abuse of financial resources. Addis Ababa city is facing critical environmental problems emanating from rapid population growth and unrestricted economic activities. Such environmental challenges include poor green-area management, inappropriate solid waste disposal, deforestation, adverse land-use change in flood-prone areas, and severe pollution of streams and rivers.

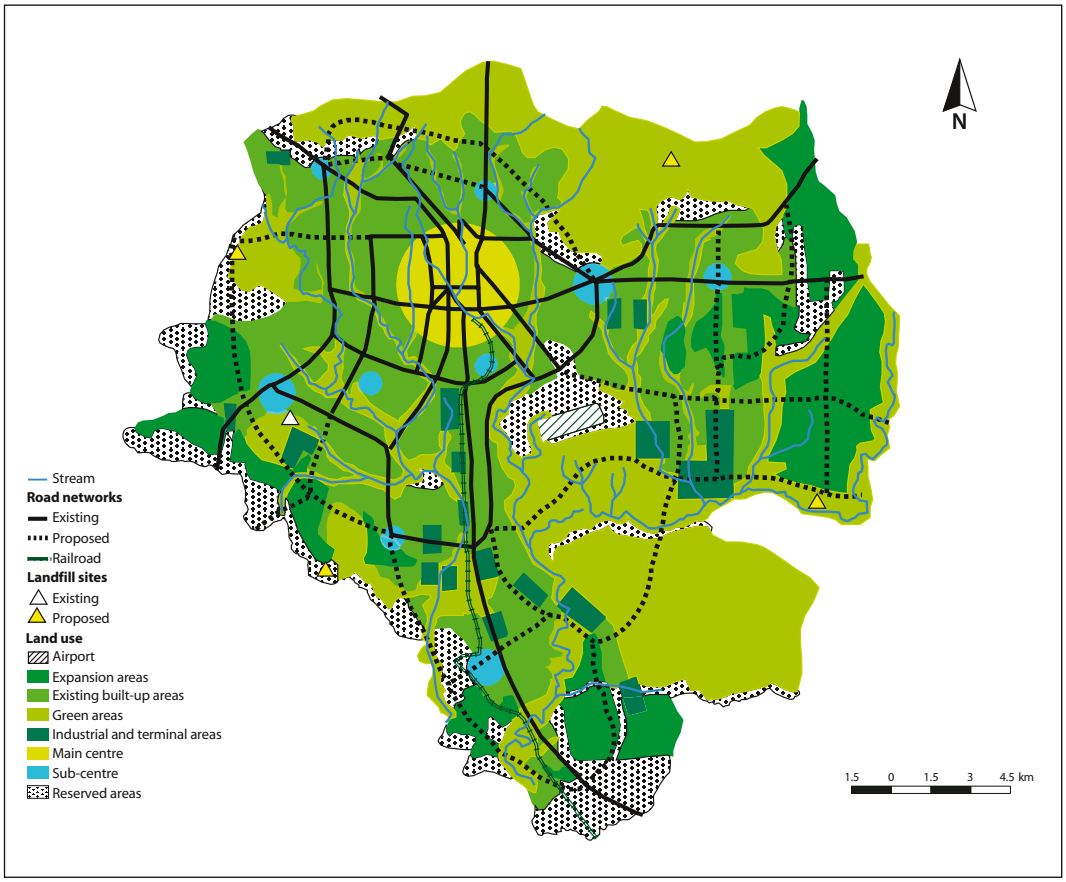
The city master plan, which is currently under revision, provides a general development guideline. Within its development framework, there are many area-specific local development plans. At present, most of the local plans are implemented in the form of urban redevelopment and renewal in the inner city. As a result, many households have been relocated to Addis Ababa's periphery, which is expanding both formally and informally, with no proper physical and social infrastructure in place. This rapid expansion has significant negative implications for biodiversity conservation and the preservation of prime agricultural land.

From its current population of more than 3 million, the population of Addis Ababa is projected to reach 3.3 million in 2015 and 4.7 million by 2025 (UN-Habitat, 2013). However, these figures are contested as being highly conservative. The recent decision of the Addis Ababa city and Oromiya regional state administrations to transfer eight satellite towns to Addis Ababa's city administration has added more than 500 000 residents to the city's existing population, potentially exacerbating socio-economic and environmental challenges. The current annual growth rate of the city is 2.1 per cent (Abdissa and Degefa, 2011).

Critical challenges

Rapid and unplanned urban growth: The major environmental challenges of the city, both now and in the future, are strongly linked to rapid population growth, inappropriate land-use management and uncontrolled physical expansion outpacing infrastructure development. Integrated infrastructure and housing development approaches are not common and, as a result, in most areas the provision for basic social and environmental infrastructure is either lacking or inadequate. Unplanned growth exacerbates existing environmental problems associated with poor solid waste management, inadequate sewerage systems and chronic surface water pollution. Moreover, many of the preconditions for successful environmental policy implementation, are weak at best (UNEP, 2013).

FIGURE 5.1
Master Plan guiding the development of the city
Source: Adapted from Yirgalem, 2001



A row of slum homes perches on a polluted riverbank in Addis Ababa. © Paul Myhill

Degradation of water resources: The rivers that flow through the city are severely stressed by habitat degradation and point- and non-point-source pollution from industrial effluents, sewage and household solid and liquid waste. Beyene *et al.* (2009), reported severe degradation of pollution-sensitive river fauna within and downstream of urban Addis Ababa indicating biological and chemical degradation of river water quality.

The Akaki River, an important source of irrigation water for vegetable production in the city, receives a significant portion of the wastewater generated in the city from the networks of streams that feed into the river and direct dumping of effluent from industries adjacent to it. The total irrigated area in Addis Ababa is 1 240 ha, serving 1 300 vegetable farmers (Van Rooijen *et al.*, 2010).

Poor water quality has important health implications for urban vegetable production given these systems' high reliance on surface-water irrigation. Weldegebriele *et al.* (2012), determined that concentrations of lead and cadmium in vegetables produced in Addis Ababa exceeded safe levels and that river water used to irrigate vegetables exceeded safety limits for cadmium, cobalt, copper, manganese and nickel. High reliance on irrigation with heavy-metal polluted water increases the risk of the accumulation of metals in soils, though the high alkalinity, clay content and cation-exchange capacity of soils in the study area may serve to limit this. However, more research is needed to better understand pathways of food contamination in these production systems, including from biological contaminants originating from solid waste.

Most UPA farmers surveyed about the source and quality of water they used stated that they have observed water-quality degradation and half noted a decline in the availability of water supplies (Table 5.1). Not surprisingly, the overwhelming majority of the respondents are of the opinion that environmental sanitation and the health situation in and around Addis Ababa has worsened over the past 20–30 years.

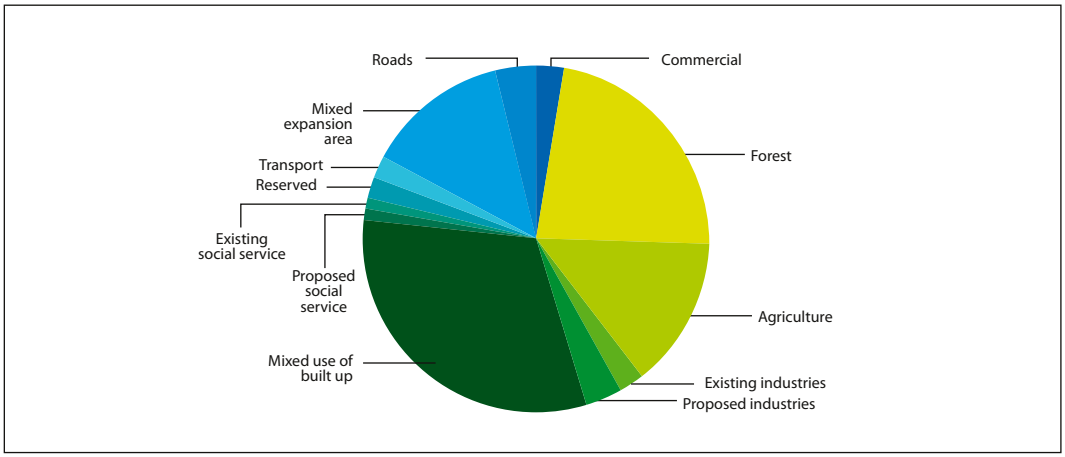
TABLE 5.1
Water supply and quality: perception of 400 UPA farmers

Main source of water for agricultural production	No.	per cent
Piped water supply	204	51
Direct extraction of river water	120	30
Rainwater	68	17
Well water	8	2
Change in water supply in the past 20–30 years	**No.**	**per cent**
Decreased water supply	196	49
No change in water supply	171	43
Difficult to determine	33	8
Change in the quality of water for agriculture	**No.**	**per cent**
Decreased water quality	330	83
No change in water quality	37	9
Difficult to determine	29	7
No reply	4	1

Land resource and population pressure: In rapidly growing urban areas, access to land is becoming more difficult as demand is rising simultaneously for housing, industry, commerce, infrastructure and transport, all competing with such demands as agriculture, open space and green areas (Figure 5.2). At present the only formal access to urban land is through the auctioning of leases, but high land prices coupled with a growing demand for housing have forced poor and middle income people to opt for informal land access in environmentally vulnerable areas within the city or in the nearby satellite towns. This situation leads to spontaneous informal-settlement development without proper infrastructure and on marginal lands close to industrial facilities that pollute, or areas susceptible to flooding or other natural hazards (Yirgalem, 2008).

Land is the major source of revenue for Addis Ababa's authorities. However, land resource development, use and management have been poor, haphazard and unsustainable. Although land allocations are supposedly based on the master plan of the city, spatial development has commonly preceded planning with plans only being implemented for renewal and upgrading. Indeed, the Land Administration and Development Authority has no formal links with service-providing agents to coordinate land subdivision and infrastructure development at the sub-city level. As a result, infrastructure-development agents usually act on their own plans and priorities, which may not be in harmony with those of the Land Administration and Development Authority. This lack of integration and coordination has hampered the development of infrastructure in newly developing areas, which lags behind house construction, often by several years.

FIGURE 5.2
Land-use categories in Addis Ababa
Source: Addis Ababa City Administration, 2009



In addition, land-related corruption is rampant, as noted in the significant increase in accusations of corruption especially within the past several years. Land administrators have been charged with illegally transferring plots of land from legal owners to other bodies for development purposes (Burns and Dalrymple, 2012). Ambiguous laws and unclear mandates for land allocation and ignoring of the city's master plan has enabled corruption in the city, as cited by the 2007 Federal Ethics and Anti-Corruption Commission report of five sub-cites in Addis Ababa (FEACC, 2008). The city administration has attempted to fight the corruption by tightening the regulation of formal access to land and reorganizing the land-administration system (Addis Ababa City Administration, 2009).

These land resource challenges manifest in environmentally significant areas. According to interviews with the Addis Ababa Environmental Protection Authority, 15 m buffer zones on each side of rivers are to be kept free from any interference for reforestation. However, the areas are used by unemployed youth producing concrete blocks and other materials for sale. Further, Eyob (2010) reported that about

90 per cent of the city's river buffers have been encroached by illegal settlers and by settlements constructed with legal permits from local (*kebele*) authorities, violating the stipulations of the master plan.

Attempts by the Addis Ababa City Administration to implement planned urban expansion programmes in the late 1990s resulted in displacement of occupants, predominately farmers, from peri-urban areas to peripheral and marginal agricultural and forest lands. Approximately 730 households, accounting for nearly 4 400 people, were relocated with limited consultation, although settlement packages were offered. The majority of affected households were involved in agriculture. In interviews by Abdisse and Degefa (2010), relocated people described their need to diversify livelihoods to day labour, alcohol production, and water vending but having little social and financial capital to support such changes.

The rapid horizontal expansion of Addis Ababa has increased urbanization pressures on agricultural land. As shown in Figures 5.3 and 5.4, urban encroachment onto agricultural land and ecologically sensitive areas is a serious threat to food production in peri-urban areas.

The shrinking land base is directly impacting UPA producers as access to land for agricultural use has become increasingly difficult. The overwhelming majority of the respondents (98.5 per cent) voiced concerns about the difficulty of securing land for residential purposes let alone for agriculture (Table 5.2). Land shortages are becoming especially critical where the city has spread beyond its administrative boundaries, particularly in the northeastern, southwestern and southern parts of the city (Chalachew, 2005).

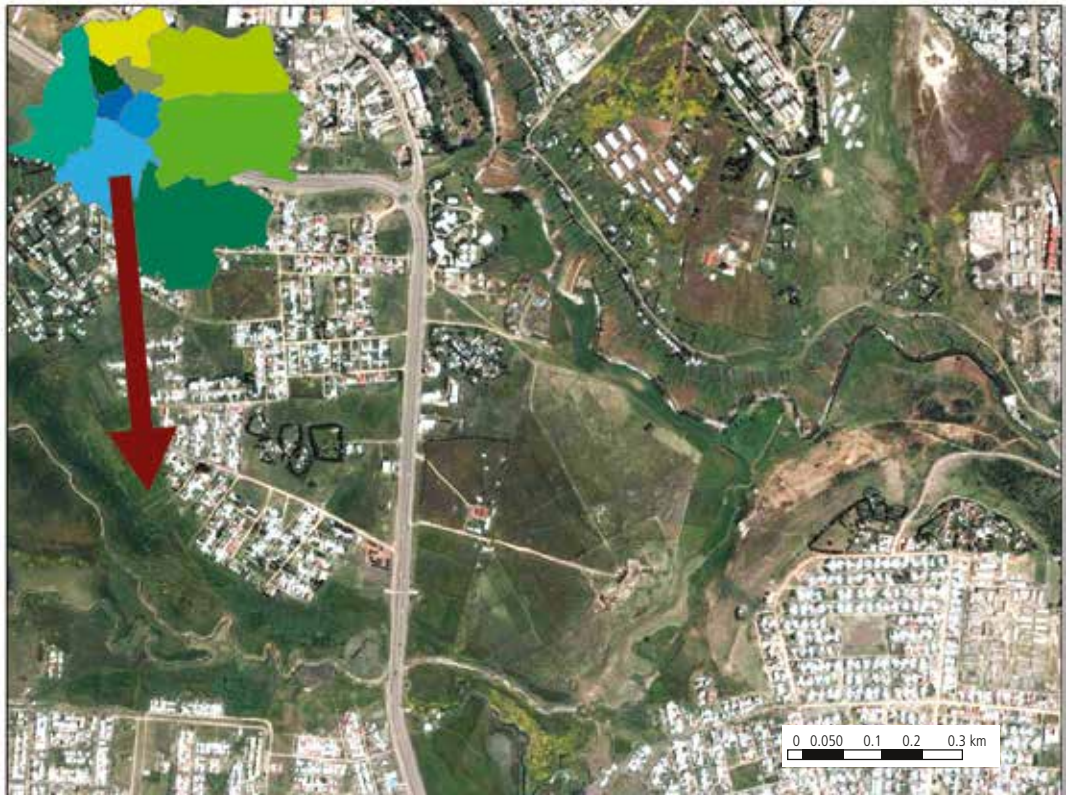


FIGURE 5.3
Settlement pressure on urban agriculture in Nefas-Silk Lafto sub-city
Source: Google Earth, 2009

FIGURE 5.4
Settlement encroachment onto ecologically sensitive areas, Yeka sub-city
Source: Google Earth, 2009

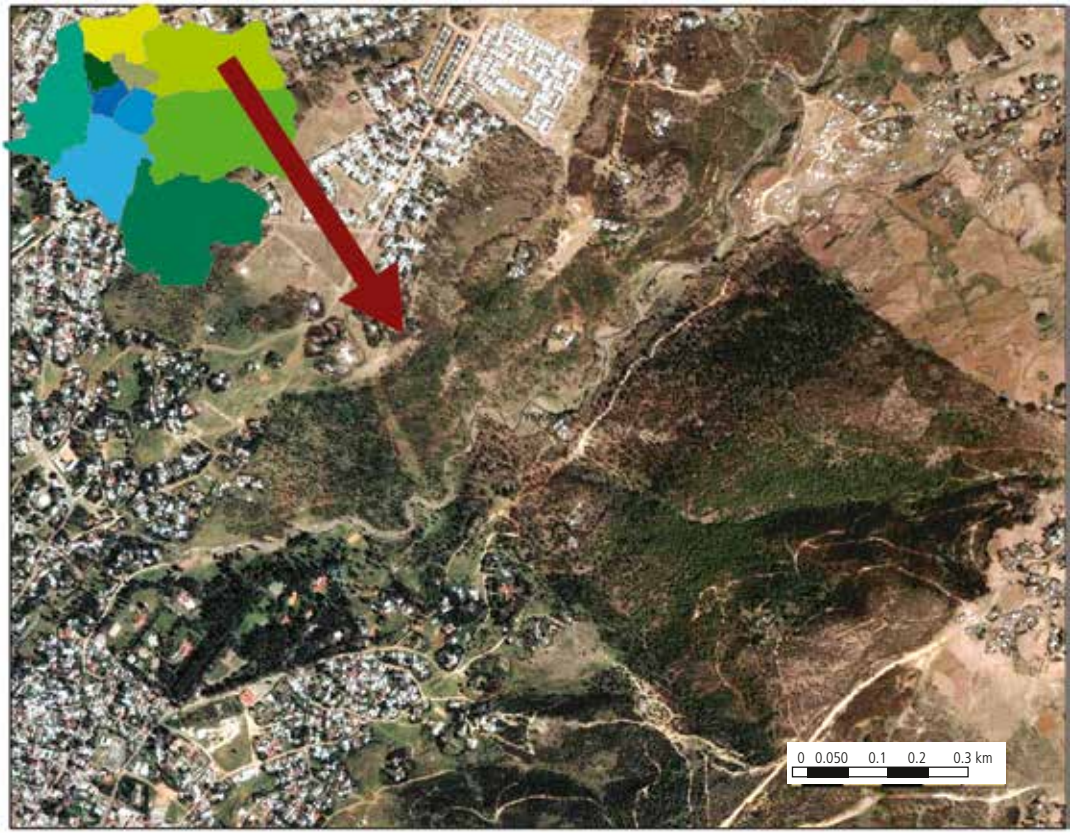


TABLE 5.2
Availability of urban land for agricultural production in Addis Ababa

How do you see availability of farmlands in Addis Ababa in the past 30–50 years?	No.	per cent	How do you see availability of farmlands in recent years?	No.	per cent
Readily available	37	9	Readily available	-	-
Moderately available	128	32	Moderately available	6	2
Scarce	235	59	Scarce	394	98
Total	**400**	**100**	**Total**	**400**	**100**

How do you evaluate the quality/productivity of land through time?	No.	per cent
High productivity	17	4
Moderate productivity	134	33
Low productivity	247	62
Not stated	2	1
Total	**400**	**100**

6 Climate risks and UPA

Floods

Addis Ababa's undulating topography and haphazard urban expansion create significant risks of flooding in the city. Recent major floods occurred in 1994, 1995, 1996, 2003, 2005, 2006, 2007 and 2008, causing considerable damage to Addis Ababa, though their full economic impacts have not been quantified (Table 6.1). Thus the data presented here is only partial. The most flood-prone areas in Addis Ababa include the middle reaches of the Little Akaki and Bantiyketu Rivers and the lower reaches of Kechene and Kurtume Rivers. According to expert interviews conducted in carrying out this assessment, intensive rainfall, steep slopes, deforestation of the mountains and the presence of houses and other buildings along riverbanks are the main causes of flooding in the studied sub-cities. In the event of heavy rainstorms in the upper basin, water levels in the middle- and lower-city reaches rise within two to three hours and can result in flash flooding.

Floods in Addis Ababa are exacerbated by inadequate urban drainage systems. The sewer lines collect runoff water and discharge it into nearby streams and rivers. The urban stormwater drainage network, however, has limited capacity due to the obstruction of pipes and street inlets with debris and sands (Wondimu and Alfakih, 1998), and most of the roads do not have drainage systems. According to a recent study by Belete (2011), major causes of flooding in Addis Ababa were found to be the blockage of urban stormwater drainage lines and poor integration between road and urban drainage infrastructure, which continues to lag behind the rapid urban population growth.

TABLE 6.1
Flood damage in Addis Ababa since 1994

Year	Damage
1994	10 052 people affected (loss of assets and income sources); 12 355 people displaced
1995	4 914 people displaced
1996	-
1998	1 300 people affected; 40 people killed; 21 people injured
2003	-
2004	8 300 people affected
2005	6 208 people affected
2006	-
2007	3 985 people affected
2008	282 people affected

Source: Disaster Prevention and Preparedness Agency (DPPA)

© Crocket

Table 6.2 shows the extent of property damages caused by floods in Addis Ababa since 1994. The greatest damage occurred in 1994 when residential property valued at more than ETB 31.3 million (approx. US$ 1.65 million) was destroyed in the city.

TABLE 6.2
Flood damages on houses and property in Addis Ababa since 1994

Year	Flood damage to residential property in Addis Ababa
1994	ETB 31 328 336 (approx. US$ 1 648 860)
1995	ETB 473 000 (approx. US$ 24 895)
2004	ETB 13 028 218 (approx. US$ 685 695)
2005	ETB 2 879 500 (approx. US$ 151 553)
2006	-
2007	25 houses destroyed
2008	14 houses destroyed

Source: DPPA

Climate impacts on urban agriculture

Key-informant interviews with environmental and agricultural experts in the city administration of Addis Ababa suggest that frequent flooding has caused significant damage to farms, grazing areas and conservation structures in the flood-prone, low-lying areas of the city. However, no data are available on crop damage. In addition to drowning and injuries, flooding impacts animal production by affecting the health of livestock and the availability and quality of feed and water resources (Aklilu and Alebachew, 2009). Livestock disease and poor feed availability are major concerns of urban

livestock keepers, as indicated in surveys carried out for this assessment. The importance of flooding to UPA is examined in more detail in Box 1.

Heavy rainstorms, strong winds and high temperatures constitute climate hazards with more subtle impacts. Heavy rainfall, in addition to being a major cause of floods, also damages houses, infrastructure and crops, even causes loss of life. In Addis Ababa, strong winds accompanying heavy rain, or occurring just before it, often damage poorly constructed shelters in slums and squatter settlements, which constitute a large portion of housing in the city (UN-Habitat, 2008).

The implications of drought in Addis Ababa are largely manifested through adverse impacts on energy supplies, water supplies, food availability and prices in markets, and social and environmental problems related to the influx of drought victims from other urban and rural areas. Drought-induced water shortages adversely affect public health and sanitation. The major source of electricity for the city, and the country at large, is hydropower. Though rain failure is not the sole reason for electric shortages, inadequate rain or drought can lead to power failures, which disproportionately affect urban centres. There is a generalized lack of information on how drought impacts food availability and access in Addis Ababa.

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Box 1. Vulnerability of UPA farmers in Addis Ababa

Focus group discussions (FGDs) on climate change and agriculture were conducted with two farmer groups engaged in mixed cereal, livestock and vegetable farming. Both groups were selected from Akaki Kaliti sub-city, *Woreda* 02 and 09. Those from *Woreda* 09 were mixed crop-livestock farmers, while the farmers from *Woreda* 02 were engaged in vegetable growing through a production cooperative. The purpose of the focus groups was to understand the underlying factors that contribute to the farmers' vulnerability and their experiences and perceptions of climate change.

When asked to describe the major challenges associated with agriculture, both groups described many common features associated with access to means of production, markets and extension (Table 6.3). They also noted changes in weather conditions.

TABLE 6.3

Sustainability concerns raised in farmers' focus groups

Mixed farming	Vegetable farming
• Inadequate supply of agricultural inputs (e.g. improved seed, fertilizer, pesticide, etc.) • Lack of access to information about improved practices and appropriate technologies • Lack of appropriate training for farmers • Lack of farmers organizations • Drainage problem in vertisol soils during the rainy season • Animal disease incidences and lack of veterinary service • Crop pests and frost incidence • Gradual temperature rise • Vegetation coverage reduction and soil erosion increment	• Lack of agricultural inputs and farm implements • Cost burden of land preparation and cultivation (tractor, oxen, labour, etc.) • Lack of transport to markets and interference from brokers • Crop losses from unpredictable rains that generate localized flooding, from March to May • Lack of early warning information on unpredictable rain that causes flooding • The deposition of solid waste, including plastic materials, on farmland by flooding that requires labour to clear • Frequent and extended pest incidence that cause yield losses

Farmers in both FGDs were asked if the weather was the same as in the past or whether it had changed. The mixed farmers noted that the rains had become more unpredictable, and that they had to contend with unseasonable rains during crop harvesting (December to January), which have increased post-harvest losses and the cost of labour involved in harvesting quickly following rains. Further, they reported that rust diseases and insect pests have increased, especially in September, and livestock diseases have also become more common, mainly during rainy periods.

The vegetable farmers described how they now experienced unpredictable rains that trigger flooding, particularly during the *Belg* rains, increasing crop losses. They lamented the lack of weather information (early warning) that would allow them to harvest crops early or remove those, such as garlic, that have been harvested but left to cure.

Box 1. Vulnerability of UPA farmers in Addis Ababa (continued)

According to the farmers, flooding has intensified due to siltation caused by erosion from farmland and solid waste dumping from upstream urban areas. In areas where floods are not a problem, three to four harvests are possible, including during the rainy season, boosting productivity and earnings. But at the Chelo vegetable farm, the floods that cover the farm during the rainy season do not drain immediately and the farmers have to wait until November to cultivate crops. This lack of timely access to land results in the farmers being able to produce two irrigated crops at most and sometimes only one during the dry season. Like the mixed cropping farmers, the vegetable farmers attributed increased damage from insect pests to changes in the weather—aphids are particularly difficult to manage and chemicals are no longer effective against these and other pests.

When asked how they could prepare themselves for the prospect of increasing flooding risks associated with climate change, the mixed crop farmers emphasized the need for fast-growing varieties, reducing exposure to damage from late season rains. In earlier times they cultivated slower-growing, higher-yielding local varieties, but nowadays, due to the short rainy season and declining soil fertility, they are implementing intensive agriculture through the utilization of improved seeds, adjusting sowing times and increasing their reliance on synthetic fertilizers and pesticides.

The mixed crop farmers also prioritized the need for better water management through draining excess water from their vertisols (high shrink-swell clayey) during the rainy season and putting in place measures to harvest rainwater for dry season planting. Access to information and training on the use of improved agricultural practices and appropriate technologies, and increased education and awareness raising about climate change, were also noted as important.

Since flooding is a major concern for vegetable cultivation, the farmers have tried to reduce the risk of production loss by maintaining vegetable seedlings to transplant immediately after the land has drained following the long rains, so that they can plant a second crop. Also, since unpredictable rains occur during the second round of production, they favour cultivation of root crops such as carrots and beets that are relatively less prone to flood damage. The vegetable farmers, when asked how they could better manage climate risks, emphasized the need for access to weather forecasts so they could be better informed of the potential for unexpected flooding during the March to May period. The farmers also mentioned the need for greater availability of fertilizers so that they can produce crops more quickly. The lack of timely transport of vegetables to markets also increases vulnerabilities to flooding in that they cannot get their perishable produce to market quickly enough when floods are forecast.

The findings of these two FGDs are somewhat consistent with a broader survey of 400 farming households in the Addis Ababa sub-cities. The great majority (91 per cent) of the respondent farmers reported that adverse rainfall conditions and extreme events presently affect their production and are concerned it could worsen, though the risks associated with rainfall differed among the farmers surveyed. Nearly half (48 per cent) reported late-season rains causing lodging of crops near maturity and 59 per cent reported flooding as a major cause of crop and livestock losses. However, only 11 per cent of the large group surveyed reported a shift in the timing of the rains.

7 Climate trends and projections

Rainfall trends

The main rainy season for Addis Ababa is June to September (*Kiremt*) when up to 70 per cent of the city's annual rain falls; the second short rainy season is from March to May (*Belg*), which contributes nearly 24 per cent. The region has one distinct dry period from October to January. The annual average rainfall is 1 134 mm with a rather wide range—973 mm at the Akaki Station and 1 241 mm at the Addis Ababa Observatory. The peak months are July and August with an average rainfall of 260 and 270 mm, respectively.

Analysis of the *Belg* and *Kiremt* rainfall of Ethiopia indicates that overall rainfall has increased since the early 1980s over Addis Ababa, though the increase is not statistically significant (Figure 7.1). However, when analyzed seasonally rainfall during the *Kiremt* rainy season has increased (Figure 7.2) whereas rainfall during the *Belg* has decreased (Figure 7.3). The finding of decreased *Belg* rains is in general agreement with recent FEWS-Net analysis (2012) of rainfall trends across Ethiopia.

Trend analysis of heavy rainfall events—days per month exceeding the 95th percentile for rain days—shows that the greatest number of heavy rainfall days occurs during the main (*Kiremt*) rainy season, during July and August (approximately 3 days per month) (Figure 7.4). Decadal trend analysis (Figure 7.5) indicates that there has been a 1.4 days per decade increase in the incidence of heavy rainfall days during July, and 1.3 days per decade for August over the 1979 to 2000 time period.

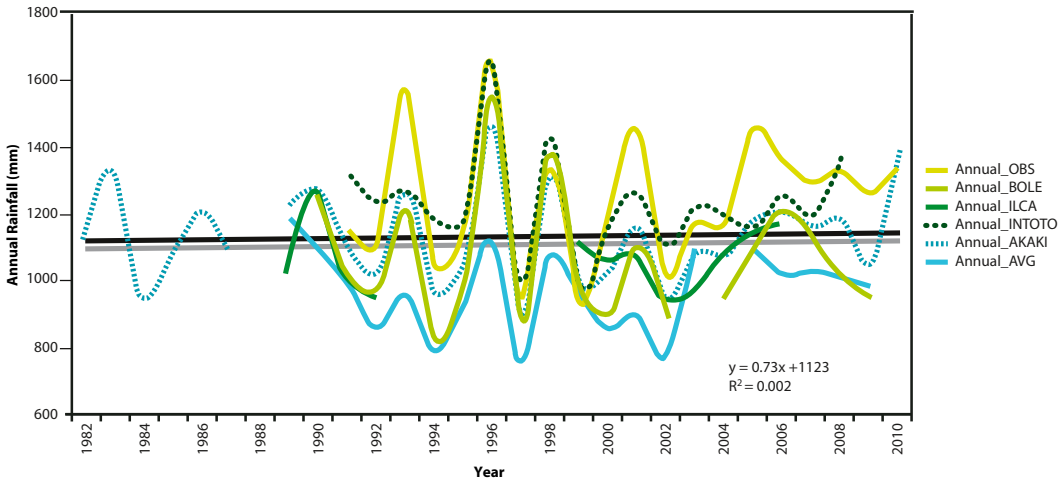


FIGURE 7.1
Trend of annual rainfall for five stations in Addis Ababa (1982–2010)
Source: National Meteorological Agency, 2012

FIGURE 7.2
Kiremt rainfall trend for five stations in Addis Ababa (1982–2010)

Source: National Meteorological Agency, 2012

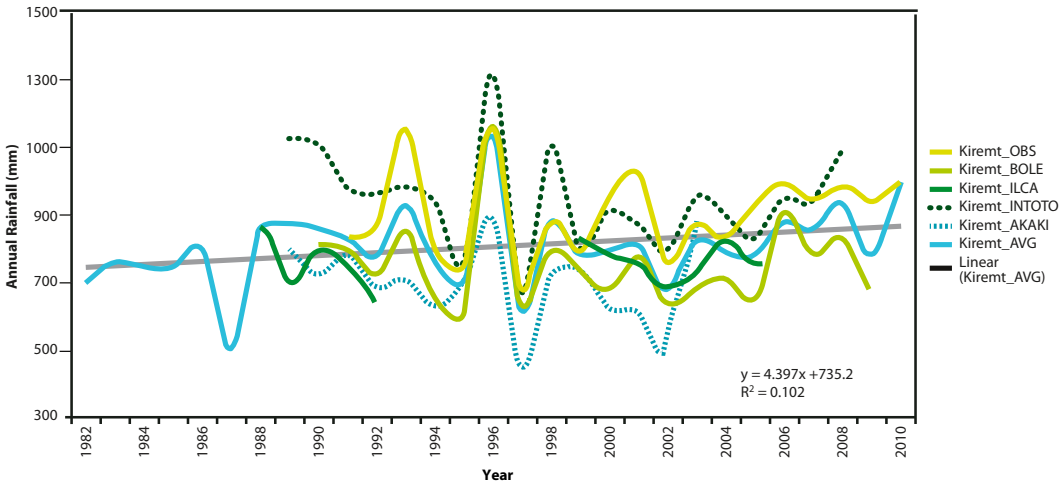


FIGURE 6.3
Belg rainfall trend for five stations in Addis Ababa (1982–2010)

Source: National Meteorological Agency, 2012

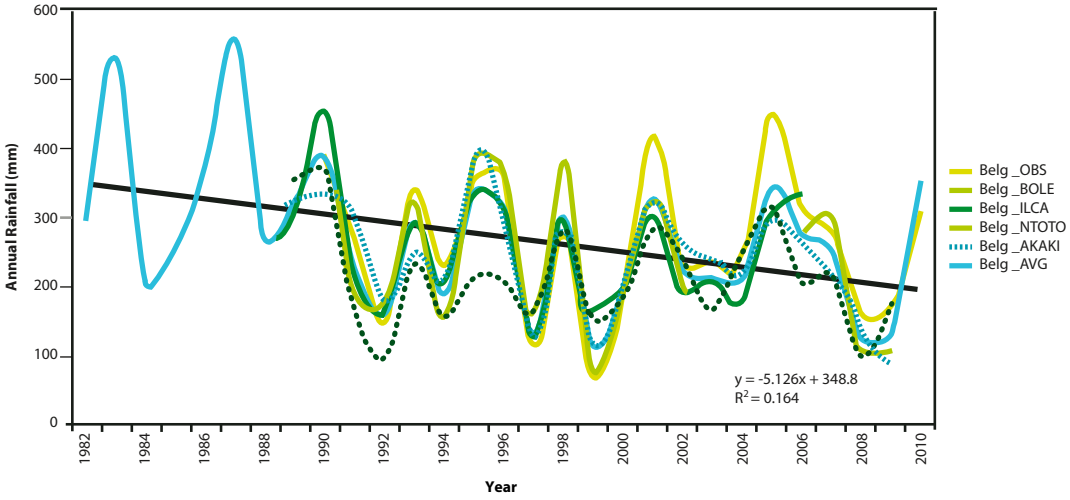
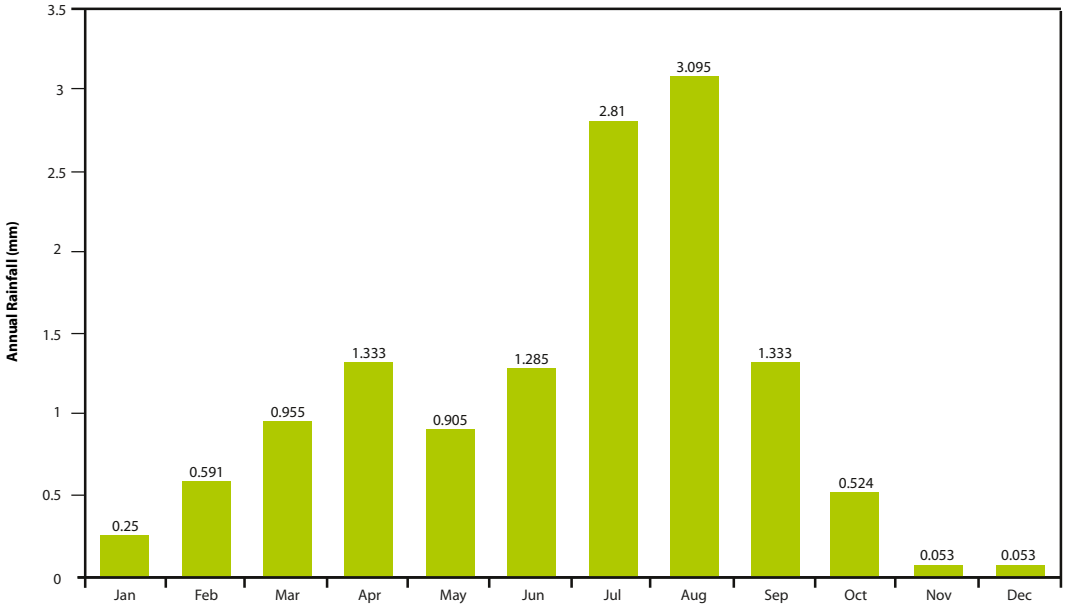


FIGURE 7.4
Number of heavy rain days, defined as those exceeding the 95th percentile (days per month), 1979–2000



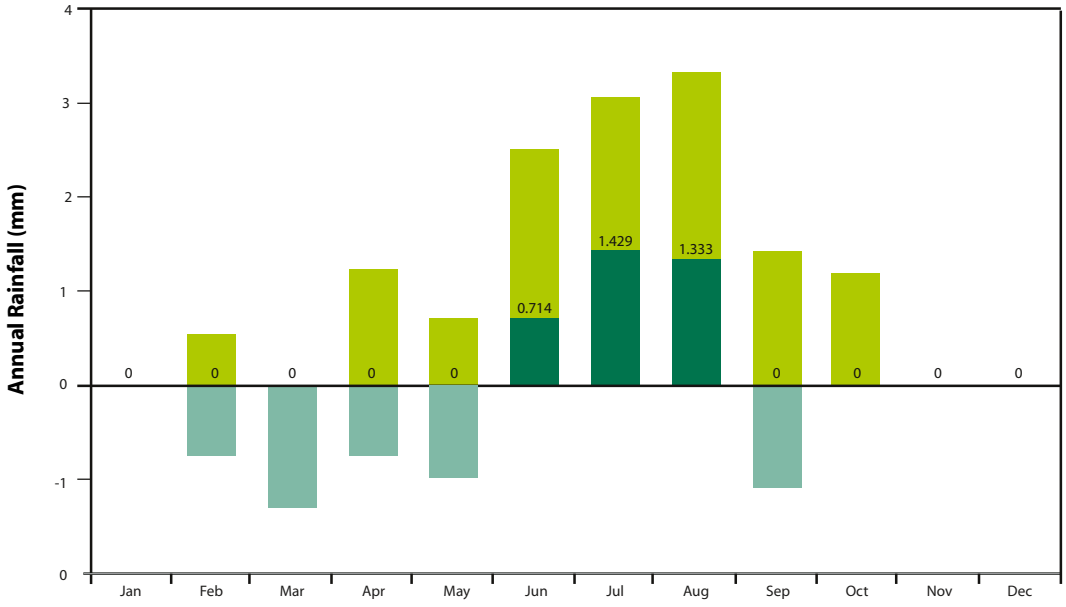


FIGURE 7.5
Change in the monthly distribution of heavy rainfall days (number of days per decade), 1979–2000

Temperature trends

The mean monthly maximum temperature over Addis Ababa has been increasing by 0.19° C per decade since the middle of the past century (Figure 7.6). The mean monthly minimum temperature has not increased over the study period (1990–2011). However, for the last ten years (2000–2011), there have been consistent minimum temperatures (Figure 7.7).

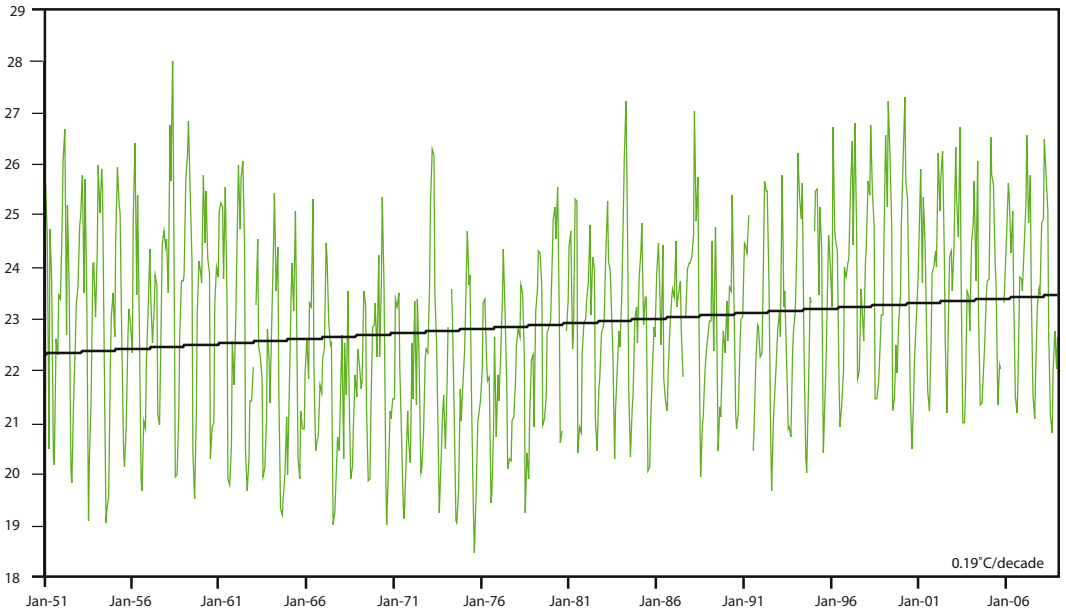
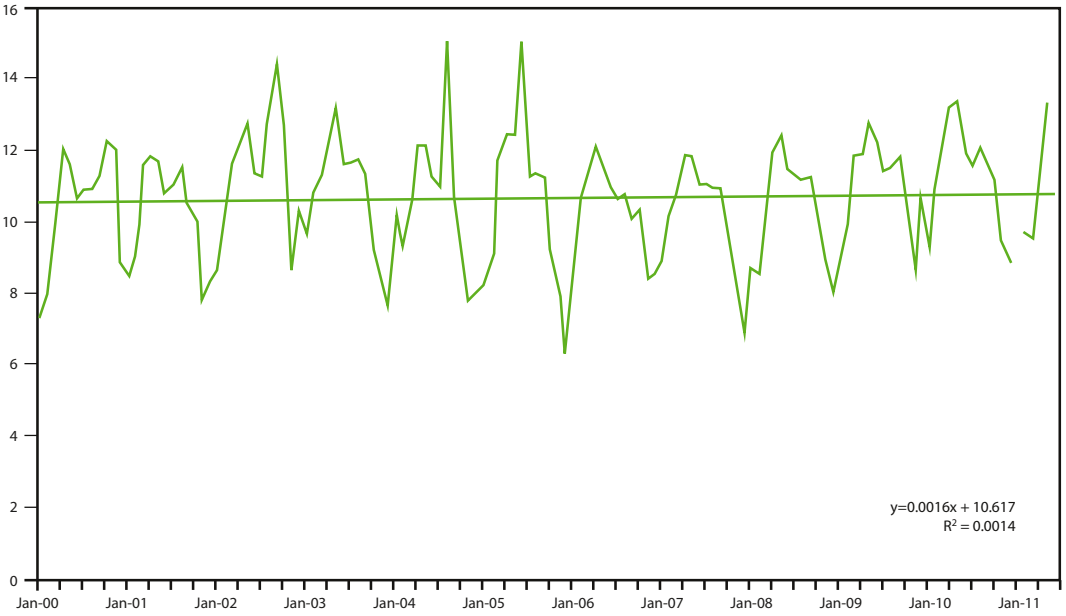


FIGURE 7.6
Trend of maximum temperatures at the Addis Ababa Observatory, (1982–2010)

FIGURE 7.7
Trend of monthly minimum temperature over Addis Ababa Observatory



Temperature projections

Future projections of temperature change for 2030, 2050 and 2080 were generated in the process of preparing Ethiopia's National Adaptation Programme of Action (NAPA 2007). The basis for the projection was an IPCC mid-range (A1B) emission scenario using an ensemble of 18 climate change general circulation models (GCMs). The analysis indicated that mean annual temperatures will increase 0.9–1.1°C by 2030, 1.7–2.1°C by 2050 and 2.7–3.4° C by 2080 above the 1961–1990 baseline temperature.

Projections of temperature change were further analysed using projections information obtained from the Climate Information Portal administered by the University of Cape Town's Climate Systems Analysis Group. That analysis shows an envelope of projected temperature change derived from a suite of regionally downscaled climate model projections from CMIP5, under future scenarios of high greenhouse gas emissions (RCP 8.5)[1] and low greenhouse gas emissions (RCP 4.5). Figures 7.8a and b and 7.9a and b depict predicted temperature change for Addis Ababa in mid-century, broken down by month and by maximum and minimum temperatures.

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 1979–2000. 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.

1 The emissions scenarios are based on the IPCC 5th Assessment Report scenarios. See http://sedac.ipcc-data.org/ddc/ar5_scenario_process/index.html

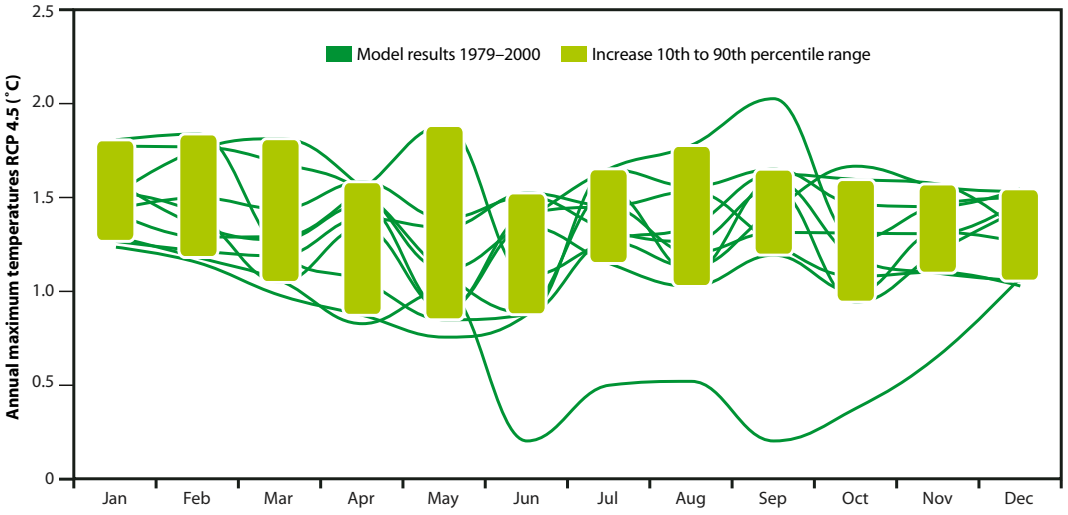


FIGURE 7.8a
Mean maximum monthly temperatures, RCP 4.5

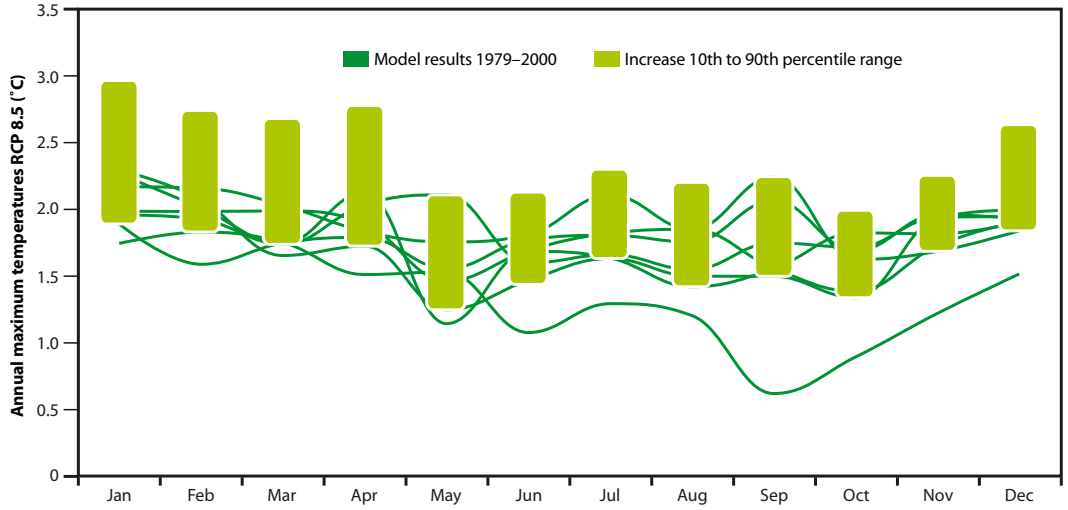


FIGURE 7.8b
Mean maximum monthly temperatures, RCP 8.5

The RCP 4.5 (low emissions) scenario indicates that maximum temperatures will increase within a range of around 1.0 to 1.7° C by mid-century over the 1979–2000 period (Figure 7.8a), and the RCP 8.5 (high emissions) scenario indicates that maximum temperatures will increase within a range of around 2.0 to 2.5° C (Figure 7.8b). Similar magnitudes of warming are projected with minimum temperatures (Figures 7.9a and b). The close agreement between the high and low emissions scenarios for maximum and minimum temperatures indicates that the likely rate of warming is well represented over a range of low to high future greenhouse gas emissions.

Rainfall projections

Analysis of future rainfall for Addis Ababa was derived from the aforementioned Climate Information Portal. Figures 7.10a and b show an envelope of projected precipitation change derived from a suite of regionally downscaled climate model projections from CMIP5, under future scenarios of low (RCP 4.5) and high (RCP 8.5) greenhouse gas emissions.

FIGURE 7.9a
Mean minimum monthly temperatures, RCP 4.5

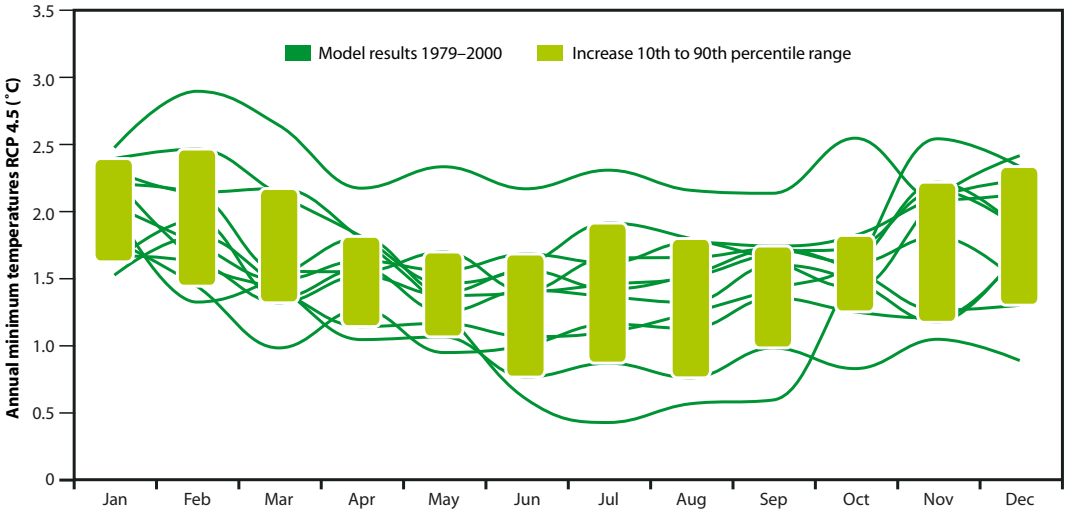
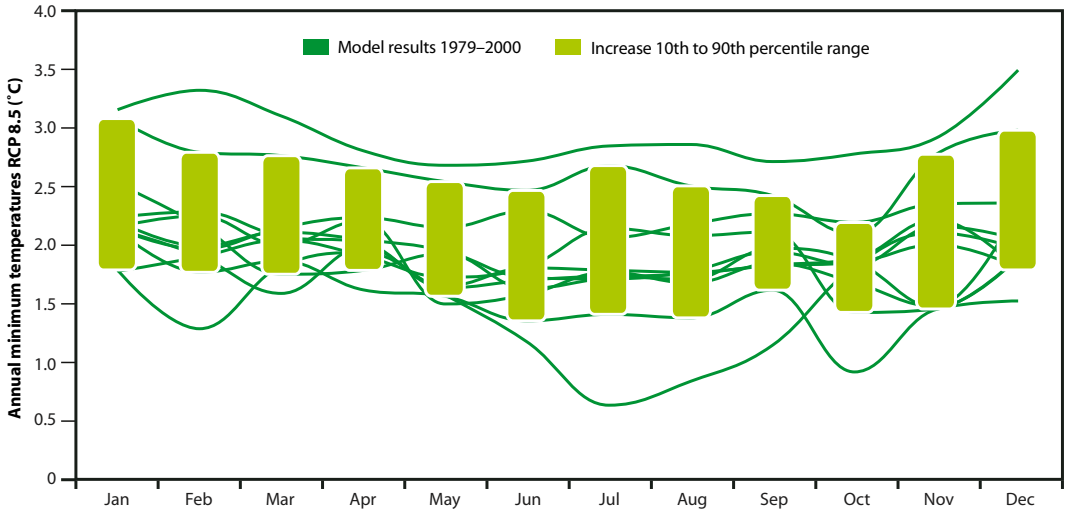


FIGURE 7.9b
Mean minimum monthly temperatures, RCP 8.5



The olive green bars represent positive anomalies (increased rainfall), and the light green bars negative anomalies (decreased rainfall) relative to historic monthly means. The horizontal green lines represent the individual model results. As explained previously, 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 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 for projections in the month of August in Figure 7.10a.

Rainfall projections for 2040–2060 under both high and low emissions scenarios indicate potential shifts in the distribution of rainfall during the *Kiremt* season, with June and July experiencing slightly less rainfall and September more rainfall, with August possibly more rainfall though the models

indicate a spread of increased and decreased rainfall. Rainfall anomalies for the *Belg* season indicate a potential for a slight reduction in overall rainfall. For heavy rainfall events, projected changes indicate increased incidence for the 2040–2060 period during both rainy seasons (Figure 7.11).

Implications of climate change on UPA

The climate data analysis carried out for this assessment shows evidence of a warming trend, and a shift towards decreased rainfall during the *Belg* rains and increased rainfall during the *Kiremt* rains, as well as an increase in heavy rainfall days during peak rainfall months. The warming trends reported in this study are consistent with findings of Conway *et al.,* (2004) who analysed long-term climate trends from the Addis Ababa Observatory data. Their analysis showed a 0.4° C per decade increase in minimum temperatures and a 0.2° C increase per decade in maximum temperatures for Addis Ababa for 1951–2002. However, they caution that the temperature series contains statistical anomalies that skew some of the results. Projections of future climate change presented in this report indicate an intensified warming trend for Addis Ababa, potentially resulting in temperature rise of around 2° C by mid-century, and indications of potentially increased monthly precipitation during the *Kiremt* rains.

There are important temperature dimensions of climate change. An increase in minimum temperatures could be favourable in terms of extending the growing season, though this favourable effect may dissipate as anthropogenic warming intensifies in the latter half of this century. The effect of high temperatures on critical biophysical thresholds, such as with human health and crop and livestock diseases is a significant knowledge gap.

When considering the variety of drivers and stressors acting on UPA in Addis Ababa, climate change is not currently an important factor; however, climate risks certainly are. Floods and untimely rains were identified as two key climate risks facing UPA farmers—flooding has made vegetable production more risky and marginal and untimely rains can endanger harvests. Farmers' perceptions are that these risks are increasing though that is not borne out by meteorological station data. However, that does not mean that farmers are incorrect in their perceptions. The increased exposure to these climate risks may be governed more by non-climate factors, for example increased siltation in river beds or changes in where farming is practiced due to urban encroachment that increase exposure to flooding. Moreover, systemic factors that reinforce poverty also increase vulnerability to extreme events that disrupt livelihoods that the urban poor derive from UPA and other sources.

The extent to which climate change may interact with important non-climate stressors is not entirely clear given uncertainties around the magnitude of future climate change as well as changes to livelihoods trajectories influenced by dynamic socio-economic and environmental conditions. However, basic understanding that warming of the planet will spawn more extreme events provides an entry point for examining risks to UPA. For example, the incidence of heavy rainfall events, predicted to increase with warming of the atmosphere, presents a critical challenge for the kinds of opportunistic farming that often take place in flood-prone urban landscapes.

This assessment clearly shows that urban encroachment into peri-urban areas and degradation of water resources are the largest physical stresses facing UPA in Addis Ababa. The projected future growth of the city and the demand this will place on land, water, energy and other resources is likely to

FIGURE 7.10a
Change in mean monthly rainfall, RCP 4.5

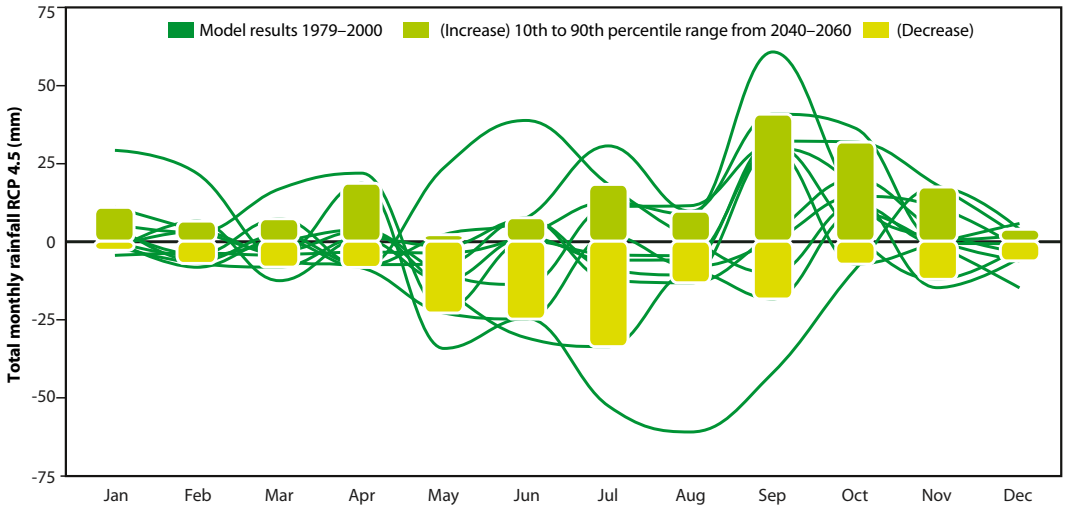


FIGURE 7.10b
Change in mean monthly rainfall, RCP 8.5

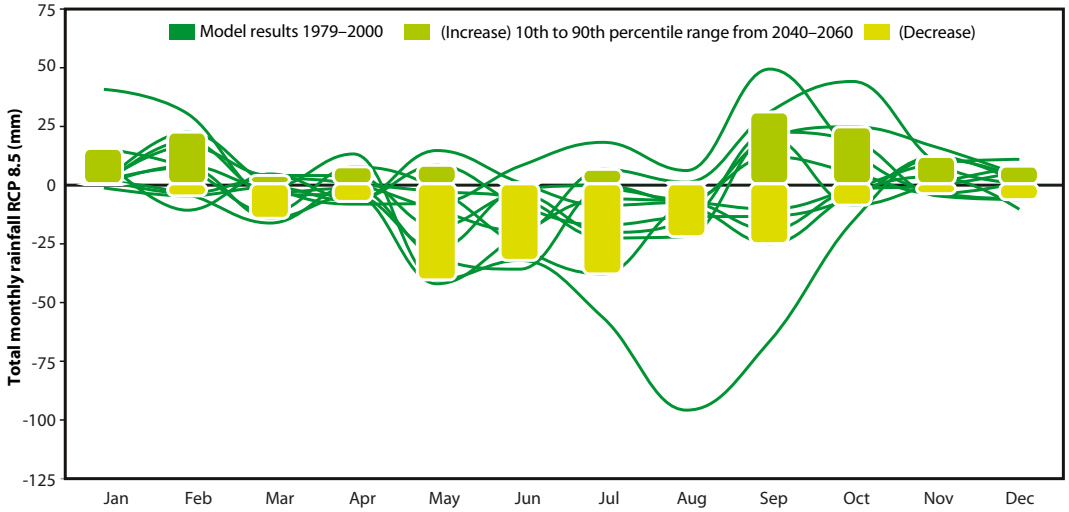
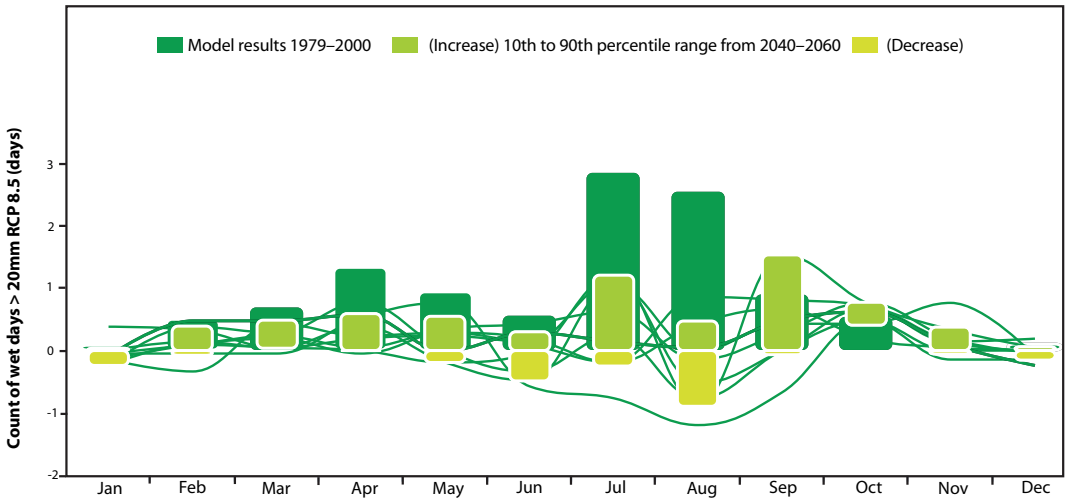


FIGURE 7.11
Projected change in heavy rain days, those exceeding the 95th percentile, for the period 2040 to 2060 compared with observed trends from the period 1979 to 2000



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further marginalize urban and peri-urban agriculture, in the absence of strong proactive measures to protect this sector. Spatial planning that considers agriculture in the landscape would serve to protect both agriculture and the environmental service that agriculture provides by maintaining permeable surfaces that act as a buffer against damaging runoff and flooding. A deeper understanding of the dynamics of UPA systems in the context of productive ecosystem services could be an important step towards establishing a baseline for evaluating the full potential of UPA; one that goes beyond food dimensions to consider UPA's potential to directly and indirectly mitigate some of the most intractable environmental problems (e.g., waste reuse and flood risk mitigation) that this urban area faces.

8 Recommendations

UPA provides a critical source of fresh, nutrient dense foods for the city's food basket, and is an important livelihood resource for those engaged in UPA. This assessment offers several recommendations to city planners, government officials, researchers, and other stakeholders to consider for ensuring the sustainability of this sector.

Proactive land use policies and strong enforcement mechanisms are needed to ensure the continued viability of UPA, particularly where the urban boundaries are encroaching into peri-urban land. Policies are required to delineate land for UPA, particularly dairy farming, and to encourage the temporary use of vacant space for agricultural production. Furthermore, the value and visibility of UPA needs to be increased through the inclusion of relevant research within the national strategy and through the promotion of more environmentally friendly and sustainable agriculture production practices. But to attract the necessary investment in these, UPA producers require more secure land tenure and access to credit and other production resources.

All this requires the harmonization of the mandates and responsibilities of different institutions/agencies within the Addis Ababa City Administration dealing with UPA, land issues, management of parks, waste management, health and the environment. The City Land Administration, Addis Ababa Urban Agriculture Office, and urban producers and their associations are all key actors. The new UPA policy being developed by city officials provides an important opportunity to address the historical policy marginalization of UPA.

One option would be to restructure the offices of the Environmental Protection Authority (EPA) and the City Beautification Agency and Cemetery Development (CBCD) so that consideration of UPA would fall under one office. This could result in better integration of activities related to environmental issues and avoid overlapping of duties and the inefficient use of limited resources. Another option could be closer collaboration between the city government and Federal Ministry of Urban Development and Construction with the aim of planting green buffer zones along the rivers that bisect Addis Ababa.

To enhance the local environment the city government could, additionally, commit itself more fully to the enforcement of UPA protection provisions within the 'green frame' as stipulated in the city's master plan. More attention should be given to the development of green spaces in parts of the city where urban renewal is taking place and where new roads are being built. The City Land Administration, Addis Ababa Urban Agriculture Office and the CBPCD are all important players if this is to be brought about.

New approaches to research, extension and training are needed that bring innovation to UPA production. Given the significant climate and land area pressures bearing down on UPA, new production systems could help to ensure that urban food production can be sustained and possibly

increased. Intensive production for UPA systems, with its small land holdings, will become increasingly important given increasing land constraints. Research that targets poultry and egg production, vegetable seeds, crop varieties, mushrooms, and improved milk production is needed. Challenges associated with intensive production on a restricted land area also require extension and other technical service providers to gain skills on new production practices and technologies for space-limited production, for low-input or organic production, and marketing.

Outreach aimed at farmers should include information on optimal crop selection, efficient irrigation methods, and safe handling of wastewater. Such training could significantly assist farmers in adapting to impacts of climate and environmental changes. Pest and diseases of crops and livestock were consistently noted as a serious concern among the cross-section of farmers surveyed for this study. Extension services to help address this threat are needed.

Greater attention towards value-addition of UPA products is needed to enhance its economic viability and in turn strengthen value chains. Improving post-harvest handling and marketing is also important for reducing food losses through spoilage, an issue that could take on increasing prominence in a warming environment. Activities to promote value addition could include access to micro-credit and creation of pilot programmes on small-scale agro-processing—milk processing and supplying frozen vegetable chips to retail/specialty markets. The city's poor, if given more favourable conditions to engage themselves in horticulture and dairy production within the metropolitan areas, can benefit if markets, transport and storage conditions are made more viable.

Improved liquid and solid waste management and pollution abatement are critical to ensuring food safety and environmental sustainability. As discussed in this assessment, farmers rely on heavily polluted water for irrigation of crops. The effects of industrial pollution on UPA and the environment could be minimized through the enforcement of environmental and social impact assessment processes prior to the approval of any new industrial development project. Other measures that could contribute include putting in place control technologies, environmental auditing, the issue of discharge permits and the enforcement of limits on the disposal of effluents into the environment. These broad-based measures would have obvious societal benefits well beyond the safer production of UPA crops.

However, UPA itself also pollutes, mainly through substantial quantities of livestock waste, which are released, untreated, into streams and other water sources. Better understanding is needed of how farmers manage liquid and solid waste productively—for soil improvement or biogas production, for example.

Embed climate risk management, particularly for flood risks, within a framework for climate change adaptation. Better management of climate risks and building adaptive capacities for climate change are becoming increasingly important. Rising temperatures, heavy rainfall and extreme events are becoming increasingly prominent features of sub-Saharan Africa's climate, including in Addis Ababa. Flood risk management measures identified by those consulted for this assessment included strategies to shorten the time that crops are grown in flood-prone areas, such as through access to credit that allows flexibility in agricultural investments, timely access to seeds and other productive inputs, improved links to markets for moving produce, promotion of short-duration varieties, and early warning systems for floods. Measures that could be undertaken to reduce flood risks include the construction of flood defences, complemented by land-use zoning and the establishment of buffer zones along rivers and streams free of settlements and development.

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The city government should create a central office dedicated to the city's food supply and distribution. Protecting the food supply from climate change extends well beyond UPA. It requires long-term spatial planning within the whole of Addis Ababa's food shed. There is a need to establish an office within the city governance structure to oversee and gather data on the city's food system to provide administrators with a better means of monitoring the food demand-supply situation and develop stronger spatial planning in the face of changing and extreme weather conditions.

Promote research and capacity building aimed at addressing key knowledge and capacity gaps with respect to climate change vulnerabilities and impacts, and adaptation responses. These include:

- cross-sectoral capacity to interpret, analyze and apply climate-model projections data to decision making and adaptation planning;
- greater understanding of how urban growth and the conversion of permeable surfaces—forests and agricultural lands—in Addis Ababa may exacerbate impacts of heavy rainfall and flooding, which is a key risk associated with climate change;
- greater understanding where potential vulnerabilities exist in urban crop and livestock systems to high temperatures, higher humidity and changes in precipitation patterns—heat stress of livestock and crops, pest and diseases of crops and livestock, and shelf life of UPA products under warmer and more humid conditions, for example;
- comprehensive assessments of farmers' coping strategies to help identify a suite of potential adaptation responses and to understand the challenges to current coping strategies that may impact future adaptation;

- enhanced capacity for instituting land-use practices that encourage reforestation of critical upland areas in order to dampen stormwater runoff and soil erosion risks; and
- analysis of vulnerabilities of the food supply-chain infrastructure—roads, bridges, markets, and processing, storage and market facilities, etc.—to extreme events.

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Mainstreaming adaptation action on climate change is vital to all sectors and decision makers both at the city and national level. Developing the necessary processes will broaden ownership of implementation. Involvement of NGOs and CBOs in climate change issues in urban contexts of Ethiopia is also needed. NGOs and CBOs can help to strengthen the interface between policy and practice, and complement adaptation action programmes.

In-depth studies are needed to fully understand and quantify the economic and food/nutritional security dimensions of UPA in Addis Ababa. This assessment and previous work have demonstrated that UPA in Addis Ababa fulfills an important role in contributing to the city's food basket, benefitting both producers and consumers. However, there remain important knowledge gaps with respect to the extent of the positive impacts of UPA to the city. Further in-depth studies that more fully quantify both direct and secondary benefits of UPA and analyse where the full potential of UPA is not being realized are needed. The city's UPA and health offices working in collaboration could undertake these studies to provide Addis Ababa's administration better management information to ensure food security for the residents.

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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 Addis Ababa, Ethiopia, 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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