

Final Project Report for

2011 START Grants for Global Change Research in Africa

The Role of Urban and Peri-Urban Agriculture in Enhancing Food Security and Climate Change Resilience in East and West African Cities

Abstract

This research report is a synthesis of both peer-reviewed and grey literature on Urban and Peri-Urban Agriculture and Forestry (UPAF) in eight East and West African Cities. The research is premised on the understanding that considerable research on UPAF in Africa has been conducted since the 1990s but not synthesized to garner knowledge on its role in building resilience in urban areas. Evidence suggests that UPAF has transitioned from a coping measure to now enhancing resilience as well as adaptation to and mitigation of climate change. This research provides knowledge and information with respect to how UPAF can contribute towards food security, improving urban livelihoods and enhancing ecosystem services as well as its limitations. Evidence suggests that the strategies for climate change mitigation and adaptation must be integrated into a multi-sector approach, but the role of UPAF in sustaining eco-system services has not been given adequate attention. The research analyzed secondary data combined with selected field and ground verification visits in two of the eight cities in order to draw generalizations from micro- to meso-scale ecosystem service provision through UPAF in African cities. The focus areas are: supporting ecosystems services; provisioning services; and regulatory ecosystem services.

Project Information

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The project duration was one year starting in September 2011 and ending September 2012. The total project funding was **US$44,930**, forty four thousands nine hundred and thirty USD

1.0 Introduction

1.1. Background

Discourse on the impacts of climate change at various scales indicates that the development deficit in developing countries coupled with exposure to climate risks will exacerbate vulnerability to the risks in the coming decades (Satterthwaite 2003; Satterwaite et al. 2007; Mkwambisi et al. 2011; Rogerson 1996). Although cities occupy a small percentage (4%) of land globally, cities now are habitats for over half the global population and regionally differential urbanization is characterized by fast paced urbanization in Global South, particularly Africa (Potts 2012b; Seto et al. 2011). Characterized by the historical mix of urban development pathways, African cities are described as having grown in pseudo manner with ruralization of urban lifestyles, particularly with respect to agriculture in cities (Maxwell 1999; Binns & Lynch 1998; UN-Habitat 2009). Resilience studies and urban poverty studies now contend that urban agriculture has a role to play based on experiences of contributing towards alleviation of poverty, but also enhancing resilience in view of climate change risks. This literature exists in scattered reports - many of which are grey and has not been synthesized to assess the potential of UPAF in enhancing food security

and building resilience in cities. This report is a synthesis of literature including field verification data assessing the potential of UPAF in building resilience and enhancing food security in eight African cities. Drawing from the multiplicity of literature sources and a multi-disciplinary team, the assessment is aimed at providing evidence of where UPAF is working, how it is working, how it can be scaled up and its limitations in building urban resilience to climate change risks.

1.1.1 Urban vulnerabilities

Climate change is now considered the most serious environmental threat facing humankind (Agbola 2011; Boko et al. 2007; Cohen et al., 2008). It affects all aspects of human activities. Climate change effects such as droughts, floods, forest fires and heat or cold waves have become more frequent (Zoellick 2009), impacting agriculture, cities, biodiversity, tourism and other sectors in Africa (UNFCCC 2007). As the people of Africa strive to overcome poverty, the development deficits and gaps threaten to increase vulnerabilities[1], while climate change risks are likely to erode hard-won gains, and seriously undermine prospects for development (Zoellick 2009). Wilbanks *et al*. (2007) notes that the two factors that contribute to vulnerability are largely determined by; a.) the development context, which has such a strong influence on households' income, education and access to information, and on the quality and extent of provision for infrastructure and services; and b.) People's exposure to environmental hazards in their homes and workplaces. Cities are exposed to global climate change and the impacts can range from sea level rise, floods, droughts and damage to infrastructure (Rosenzweig et al. 2011; Grimm et al. 2008). In urban areas, vulnerability is highly influenced by the extent and quality of infrastructure, public services, economic conditions and institutional or political factors (Satterthwaite 2007; Keivani et al. 2001; Debra Roberts 2008). The differentiated impacts of climate change at the global scale are also reflected by uneven distribution in cities and towns, as some groups are impacted more severely than others. The most vulnerable group to climate change impacts is the urban poor - women, the elderly and the young (Adejuwon 2006; UN-HABITAT 2006). The city structures, access to services and institutional setup shape the exposure to risks for much of the urban population (UN-HABITAT 2006; Adelekan 2009). Adelekan (2009) noted that the urban poor face a worsening situation as the effects of climate change including floods arising from increasing frequency of storm surges, and heavy rainfall of long duration or high intensity become more severe in cities. Flooding as a result of excessive rainfall, droughts, heat waves, cold waves and sea level rise are the key climate change risks that the assessed cities face(Niang et al. 2002; Rosenzweig et al. 2011; Maddison 2007). The exposure and levels of vulnerability differ between the cities of Kampala, Addis Ababa, Dar es Salaam, Douala, Ibadan, Nairobi, Dakar and Accra. But within cities there is even marked differentiated vulnerabilities associated with the social structures of the cities. The urban poor are the most vulnerable (Action Aid 2006; Frayne et al. 2012; Douglas et al. 2008).

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[1] *The Intergovernmental Panel on Climate Change (IPCC) (2007) has defined vulnerability as the extent to which a natural or social system is susceptible to sustaining damage from climate change. Vulnerability is a function of the sensitivity of a system to changes in climate and the ability to adapt the system to changes in climate.*



Cities of focus

2.0 **Contextualizing the research**

Literature indicates a surge in Global Environmental Change Research on Africa, the majority of which is conducted at micro- to meso-scale, testing and understanding the dynamics of local process that relate to global change processes with linkages to social and economic transitions. This research is a meta-analysis focused on food security in urban and peri-urban areas in African cities and how the provision of food within peri-urban and urban areas affects, and is affected by, climate change. Extreme climatic events in Africa are becoming increasingly more frequent and are now linked to climate change. These changes will most likely affect Urban and Peri-urban Agriculture and Forestry (UPAF), possibly in net positive or negative terms. Rapid urbanization implies an increased demand for urban services including food and water supply, and waste management - triggering significant transformations of peri-urban environments through to rural hinterlands, as the ecological footprints of urban areas increase. Food security in urban and peri-urban areas remains a challenge in Africa with disproportionate expenditure by the urban poor and also the middle and high-income groups, due to high sensitivity of food systems to price fluctuations and

natural events induced by climate change at local to global scales (Mkwambisi et al. 2011; Abdulsalam-Saghir & Oshijo 2009; Atkinson 2000).

Now that climate change impacts are a reality across the African continent (Conway 2009; Denton & O'Neil 2008), Africa's vulnerability has been highlighted and impacts differentially distributed across the continent with differing degrees of magnitude and severity (IPCC 2007). The urban population of Africa is approximately 40% (UN-HABITAT 2009), but with a high rate of urbanization of-between 4% and 10% annually - a small proportion of which is attributed to climate-induced migrations. The future urbanization trajectory poses both challenges and opportunities. Although climate change impacts have been felt and documented in rural Africa, urban and peri-urban populations are also experiencing serious climate change-induced impacts that are now documented. Climate impacts on the population of African cities have accentuated poverty and have added a layer to their inherent development challenges (Jerneck & Olsson 2008; Leichenko & O'Brien 2008; Satterthwaite et al. 2007; Simon 2010; UNDP 2007; UN-HABITAT 2009, 2010; Wakhungu 2005). The 'urban bias' has left majority urban populations in abject poverty effectively reducing their resilience to increased vulnerability (Prasad & Ranghieri 2009). Urban poverty has exacerbated vulnerability to climate change risks with differing degrees along the urban-rural gradient and peri-urban areas. The relationship between poverty and UPAF has been investigated by several studies across Africa in search for adaptation to and mitigation of climate change impacts. The linkages between urban and peri-urban food systems, with the rural hinterland connected to urban systems, also play important roles in sustaining the balance of food supply, livelihoods and provision of ecosystem services along the urban-rural gradient. UPAF has a potential for mediating climate change impacts and poverty on one hand and the provision of micro-level ecosystem services on the other, which can have a cumulative impact at the macro-scale (Grimm et al. 2008; Grimm et al. 2008; Lwasa et al. 2009; Padoch et al. 2008; Swalheim & Dodman 2008).

This research synthesized published and grey literature to evaluate the role of UPAF in enhancing food security and building climate resilience. The synthesis highlights progress in UPAF as a mediating activity that will not only enhance eco-system services, but also contribute towards food security in urban and peri-urban areas of East African and West African cities. Through extensive review of literature on African cities complemented by field visits to selected cities in East and West Africa, the multi-disciplinary study has generated knowledge to better our understanding of UPAF's role in earth systems processes, identifying limits and entry points for policy.

2.1 Scientific Significance

There has been considerable research on UPAF in Africa since the 1990s with supporting evidence of its role in enhancing food security, sustaining livelihoods and supporting municipal authorities in managing wastes. These studies however have received critique with respect to its associated social, economic and environmental risks and benefits (Novotny & Brown 2007; Prain, Karanja, & Lee-Smith 2009). From food security, nutrition enhancement, incomes and shrift farming, the discourse has transitioned from urban farming as a coping measure to facets of natural resource management and to 'productive greening', with the latter denoting multiple uses of UPAF including environmental mitigation of hazards (DPU 2006; Lwasa et al. 2009;

McGregor et al. 2006; Prain, Karanja, & Lee-Smith 2009; Veenhuizen 2006; Yusuf et al. 2008). The critiques have been shaped by the professional and historical orientation in urban development as determined by planning policy frameworks (Watson 2007). Municipal ordinances and regulations towards UPAF in Africa vary greatly. While it is still considered illegal in many cities, UPAF is tolerated in several cities and has been more recently encouraged as part of poverty reduction and sustainable livelihood strategies (Mkwambisi et al. 2011). Nevertheless, there has been increased research in the last 15 years in Africa (see for example Lock & Zeeuw 2003; Veenhuizen 2006). The scientific significance of this research is its focus on the integrated nature of UPAF in addressing livelihoods including issues of food security, its potential in revitalizing urban economies and potential for provision of regulatory and supporting ecosystem services.

Recent research has expanded to investigate the relationship between UPAF and climate change mitigation and adaptation, along with UPAF's role in sustaining eco-system services including flood attenuation in rainfall intensive areas, carbon sequestration, micro-climate moderation to reduce urban heat island effects and the reduction of GHG emissions from landfills by the uptake of wastes for recycling (Novotny & Brown 2007; Piracha & Marcotullio 2003; Albert 2010). This research analyzes these potentials to draw generalizations on issues of food supply balance, food security and the contribution to livelihoods in African cities. This is placed in the context of dynamic processes along the urban-rural gradient in terms of population-environment relationships, economic opportunities/constraints, demographic dynamics, social networks and material/resource flows (Sengendo 2005). The motivation for this assessment is that cities are key in environmental change mitigation due to their strategic position as centers of knowledge, innovation and creativity (Denton & O'Neil 2008). In many cities, urban ecological systems have been stretched to the limits or to tipping points where the ecosystem services of provisioning, regulation and cultural services are diminishing (Grimm et al. 2008; MA 2005). Enhancement of such services for urban ecological resilience is important, but less understood is the spatial-temporal scale at which the potential benefits of UPAF in reinstating some of the ecological services in cities across Africa exist. This is due to limited syntheses of research outcomes on UPAF in Africa. Most UPAF research is at micro-level and is utilized at the local city scale, but this study analyzed the literature to produce macro-scale generalizations that can inform policy interventions across the diverse African cities.

2.2 Research Objectives

The aim of this research is to conduct an assessment and evaluation of UPA's contribution to food security and enhancement of eco-system services for climate change resilience in African cities.

Specific Objectives

1. To analyze from completed studies the contribution of UPA to livelihoods and food security
2. Assess eco-system services derived from and/or enhanced by UPA in urban and peri-urban areas

3. Synthesize the contribution of UPA towards climate change mitigation and adaptation in African cities
4 Identify possible pathways for UPA's role in urban ecological resilience to climate change in different environmental settings of African cities

3.0 Activities Conducted

3.1 Literature assessment

The methods of study involved extensive review of both peer reviewed and grey literature on UPAF and urban ecological services published in the last 15 years. Grey literature was carefully treated through triangulation to minimize error propagation in the analysis; and a matrix depicting comparative indicators on the contribution of UPAF to urban livelihoods, food security and ecological services for each of the focus cities was developed. A total of 213 papers, reports and policy documents were collected and integrated into a database. This literature was reviewed following the guiding thematic areas of project focus. Owing to its strong linkage with UPAF, the urban ecological service analysis framework in Piracha & Marcotullio (2003) that focuses on supporting, provisioning and regulatory services from urban ecosystems was utilized. UPAF has been assessed with respect to some of the supporting services like nutrient recycling and its role in conditioning soils for production in urban ecosystems. On the other hand, UPAF strongly relates to provision in terms of food, and lately has been evaluated with respect to flood attenuation and utilization of waste water and nutrient recycling of organic waste in urban areas (Buechler & Devi 2008; Hide, Kimani, & Thuo 2001; Wahab et al. 2010). In all three focus areas UPAF apparently has an important role in ecosystem service enhancement, but the assessment expanded the services listed in the Millennium Ecosystem Assessment report to include potential for enhancing food security and livelihoods.

In the extensive review of literature, we prioritized studies that have utilized the systems analysis approach to urban ecology to examine the linkages between the regulatory, provisioning and supporting services of urban ecosystems and social systems. This helped in drawing generalizations about the relationships between the intertwined ecological and social systems This analysis was supported by analysis of evidence about material flows and urban metabolism including in-system production and reproduction sub-systems focusing on biomass, nutrients, urban sinks for urban generated pollution and exportation of pollution to peri-urban and rural hinterlands, expanding the analysis to the urban-rural gradient. The materials flow analysis covered the flow of nutrients to and from urban areas along the gradient and how this can potentially contribute to the enhancement of ecosystem services. This analysis also addressed the natural science issues. Tables 1 and 2 present summaries of both the assessed peer reviewed and grey literature.

Table 1: Summary of reviewed UPAF literature on four East African cities

FOCUS CITY	THEMATIC FOCUS	TYPE OF REVIEW		
		Peer-reviewed	**Grey**	**Total**
Kampala	Livelihoods	Jac Smit 1992; Atkinson 1995; Maxwell 1995; Maxwell 1999; Armar-Klemesu 2000; Gina 2003; Nabulo et al., 2006; Bukusuba et al., 2007; FAO 2008; Leonard et al., 2008; De Bon et al., 2009; Lee-Smith 2010; Katongole et al., 2011; Sabiiti 2011	Ellis 1999; Nabulo et al 2005; Dubbeling and Merzthal 2006; Tirado et al., 2009	18
	Vulnerability	Atkinson 1995; Nabulo et al., 2008; Amodu 2011; Makhoka et al., 2011	Nabulo 2002; Diamond et al., 2005; Nabulo et al., 2006; Cofie et al., 2003; Brown et al., 2012	9
	Adaptation/Mitigation	Parkinson and Tayler 2003; Mbabazi et al., 2010;	Ellis 1999; Satterwaite et al., 2007;	4
	Policy studies	Lavy 1992; Maxwell 1999; Simon 2012;	Mougeot 2000; Castillo 2003; Dubbeling and Merzthal 2006; Dubbeling et al., 2010	7
	Total	**22**	**17**	**39**
Dar es Salaam	Livelihoods	Briggs 1991; Jac Smit and Nasr 1992; Atkinson 1995; Armar-Klemesu 2000; Gina 2003; De Bon et al., 2009; Drechsel and Dongus 2010; Lee-Smith 2010	Lee 1993; Ellis1999; Dubbeling and Merzthal 2006; FAO 2008; Heaven et al., 2008; Tirado et al., 2011	13
	Vulnerability	Atkinson 1995; Nabulo et al., 2006; Amodu 2011	Cofie et al., 2003; Diamond 2005; Action Aid 2006; Brown et al., 2012	7
	Adaptation/Mitigation	Parkinson and Tayler 2003; Ricci 2012	Ellis 1999; Mkwela and Banyani 2008;	4
	Policy studies	Maxwell 1995; Lavy 1999;	Mougeot 2000; Action Aid 2006; Dubbeling and Merzthal 2006; Dubbeling et al., 2010;	6
	Total	**14**	**16**	**30**

Nairobi	Livelihoods	Jac Smit and Nasr 1992; Memon and Lee-smith 1993; Armar-Klemesu 2000; Atkinson 2006; Gina 2003; De Bon et al., 2009; Drechsel and Dongus, 2010; Lee-Smith 2010; De Zeeuw et al., 2011	Mwangi 1995; Ellis 1999; Wambui 2005; Action Aid 2006; Dubbeling and Merzthal 2006; Wambui 2007; FAO 2008; Schmidt 2010; Tirado et al., 2011	17
	Vulnerability	Amodu 2011; De Zeeuw et al., 2011	Atkinson 1995; Cofie et al., 2003; Ayaga et al., 2005; Diamond 2005; Action Aid 2006; Wambui 2007; UN-Habitat 2007; Brown et al., 2012	10
	Adaptation/Mitigation	Parkinson and Tayler 2003; De Zeeuw et al., 2011	Ellis 1999; Satterwaite et al., 2007; Wambui 2007;	5
	Policy studies	Lavy 1999; De Zeeuw et al., 2011	Mougeot 2000; Ayaga et al., 2005; Action Aid 2006; Dubbeling and Merzthal 2006; UN-Habitat 2007; Dubbeling et al., 2010;	8
	Total	**14**	**26**	**40**
Addis Ababa	Livelihoods	Jac Smit and Nasr 1999; Atkinson 1995; Lee-Smith 2010; Maes et al., 2010	Ellis 1999; FAO 2008;	6
	Vulnerability	Atkinson 1995	Diamond 2005	2
	Adaptation/Mitigation	0	Ellis 1999	1
	Policy studies	0	Dubbeling and Merzthal 2006 ;	2

			Dubbeling et al., 2010;	
	Total	**5**	**6**	**11**
	Overall total	**55**	**65**	**120**

Table 2: Summary of reviewed UPAF literature on four West African cities

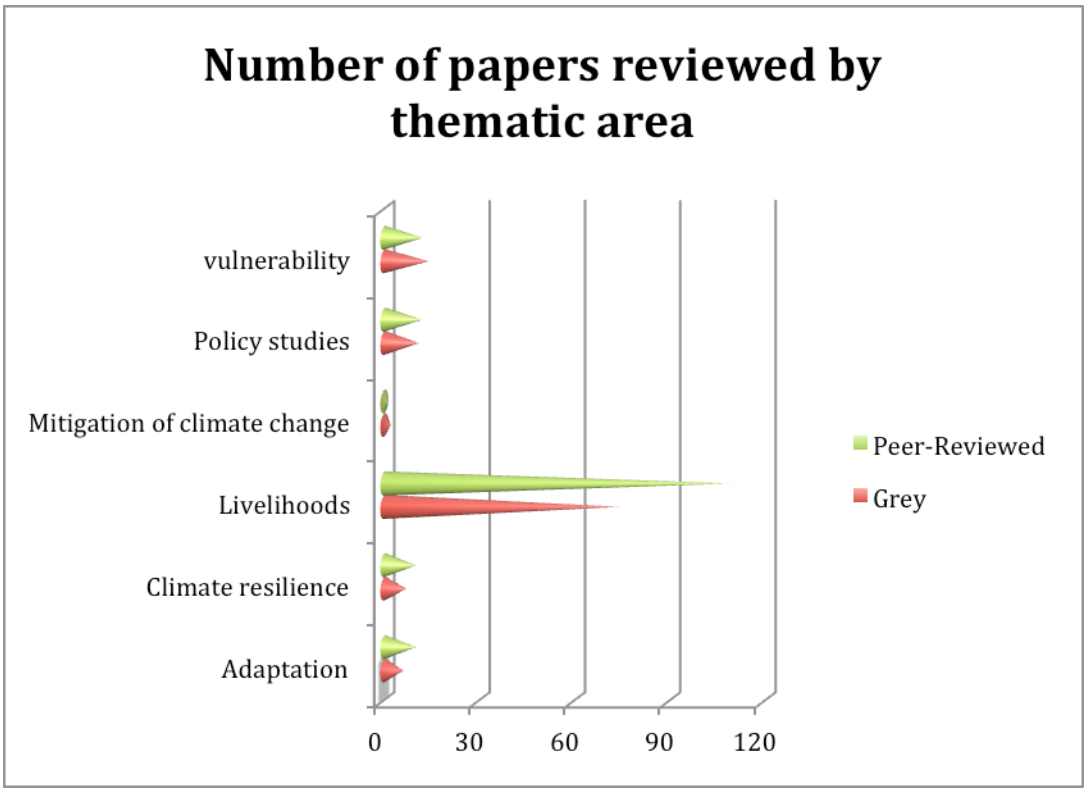
FOCUS CITY	THEMATIC FOCUS	TYPE OF REVIEW		
		Peer-reviewed	**Grey**	**Total**
Ibadan	Livelihoods	Gbadegesin, 1991; Adekoya, 2002; Akinbile, 2002; Smith, 2002; Cofie *et al*., 2003; Ogunyemi *et al*., 2003; Odebode, 2004; Akinlade *et al*., 2005; Yakubu *et al*., 2005; Akinbile, 2006; Odebode, 2006; Adesehinwa, 2007; Ayoola and Makinde, 2007; Fawole and Odebode, 2007; Olagunju *et al*., 2007; Yusuf *et al*., 2008; Adeola and Ayoade, 2009; Ojo *et al*., 2009; Olajide-Taiwo *et al*., 2010; Adelekan, 2010; Wahab *et al*., 2010; Cofie *et al*., 2010; Alli *et al*., 2011; Adeola *et al*., 2011; Ifeoluwa *et al*., 2011; Imran *et al*., 2011; Ogunniyi and Omoteso, 2011; Olajide-Taiwo *et al*., 2011; Olowogbon, 2011 **29**	Action Aid, 2006; Oyejide, 2006; Adeoti *et al*., 2010; RUAF, 2010; Afolabi, 2011; USAID, 2011 **6**	**35**
	Vulnerability	Adejuwon, 2006; Ajewole and Iyanda, 2009; Agbola, 2011 **3**	NEST, 2004; NEST and Tegler, 2011 **2**	**5**
	Adaptation/Mitigation	Adejuwon, 2006; Sanusi, 2011 **2**	Cohen *et al*., 2008; Adeniji and Ogundiji, 2009; NEST and Tegler, 2011 **3**	**5**
	Policy studies	Gbadegesin, 1991; Agbola, 2001; Smith, 2002; Oluokun *et al*., 2005; Fabiyi, 2006; Omole *et al*., 2006; Amoa *et al*., 2007; Yusuf *et al*., 2008; Ogunniyi, 2009; Oriola, 2009; Akinbile and Alabi, 2010; Gbadegesin *et al*., 2010; Ogedengbe and	RUAF, 2005; Ayorinde *et al*., 2007; Okubadejo, 2007; Oyedipe, 2009; RUAF, 2010; USAID, 2011	

		Akinbile, 2010; Adebisi-Adelani *et al*., 2011; Badmus and Yekinni, 2011; Eludoyin and Wokocha, 2011; Olabode *et al*., 2011; Oladele and Oladimeji, 2011; Olajide-Taiwo *et al*., 2011; Yahaya and Gbadebo, 2011 **20**	**6**	**26**
	Total	**54**	**17**	**71**
Accra	Livelihoods	Maxwell, 1999; Smith, 2002; Cofie *et al*., 2003; Cofie *et al*., 2010; **4**	Egyir *et al*., 2006 **1**	**5**
	Vulnerability		Egyir *et al*., 2006 **1**	**1**
	Adaptation/Mitigation		Cohen *et al*., 2008; Brown *et al*., 2012 **2**	**2**
	Policy studies	Maxwell, 1999; Danso *et al*., 2002; Smith, 2002; Drechsel *et al*., 2006; Egyir *et al*., 2006 **5**	RUAF, 2005; Cofie, 2009; Cofie *et al*., 2011; **3**	**8**
	Total	**9**	**7**	**16**
Douala	Livelihoods	Smith, 2002; **1**		**1**
	Vulnerability			
	Adaptation/Mitigation			
	Policy studies	Smith, 2002; **1**		**1**
	Total	**2**	**0**	**2**
Dakar	Livelihoods	Cofie *et al*., 2003; **1**		**1**
	Vulnerability			
	Adaptation/Mitigation		Cohen *et al*., 2008; **1**	**1**
	Policy studies	Beauchemin and Bocquier,	Cofie, 2009;	**2**

		2010; 1	1	
	Total	**2**	**2**	**4**
	Overall total	**67**	**26**	**93**

A summary graph of the reviewed literature is below. Papers and reports on livelihoods were the majority, followed by policy studies and vulnerability assessments. Papers focused on adaptation, climate resilience and climate mitigation are fewer. This points to the inadequate coverage during the time of the research literature on UPAF as a measure for adaptation and mitigation of climate change. This gap is what this research tries to fill.

Figure 1: Graphic Illustration of Reviewed Literature



3.2 Workshops

3.2.1 Methodology and training workshops

The team organized and conducted two workshops aimed at bringing all team members together to discuss and develop the research objective and methodology. These workshops were held in Kampala, February 2012 and in July 2012 in Ibadan. The first workshop in Kampala focused on familiarizing the team with the research concept, proposed methodology and approach to the study. Because the study is based on secondary sources, team members were trained on systematic review methodologies, and tools and techniques for systematic reviews. A data collection and

analysis matrix was developed and agreed upon during the Kampala workshop. A tool for collecting literature and collating it was also part of the training and systematic review techniques discussed at length to ensure that team members are grounded in the research concept and approach to the study. Two graduate students from Makerere University joined the workshop in Kampala for training in climate change research and systematic review. The student David Mukungu was closely involved with the project, and Peter Kasaija had a lesser association to the project but is conducting climate research and joined the workshop to gain skills in systematic reviews and collecting secondary literature, and utilizing online tools for data collection such as Google scholar, web of knowledge and Scopus peer reviewed catalogues. In Ibadan, the team met to further conduct training on the synthesis of literature as well as on the analysis of data from spreadsheets to generate the data and information to be included in the report and synthesis. Adesoji Adeyemi, the graduate student attached to the project in Ibadan, attended the Ibadan meeting.

3.2.2 Stakeholder workshops

Stakeholder workshops were held in both Ibadan and Kampala. The stakeholder workshops were meant to garner information regarding the policy and practical issues around UPAF. In Kampala, a stakeholder workshop was held in January 2012 involving several individuals from various organizations of civil society, municipality, research organizations and academia to garner information about what has been implemented in regard to UPAF in the context of climate change. In Ibadan a similar workshop was organized in May 2012 to garner information in respect to policy issues and challenges of UPAF in the city. The locations of the two workshops were selected out of the eight cities due to accessibility. The data collected was transposed to other cities through telephone conversations with informants from those cities. In Dakar and Dar es Salaam, key informant interviews were held over telephone to gain insight on how the findings in Ibadan and Kampala converge or diverge on UPAF. The individuals contacted were Cheikh Mbow and Wilbard Kombe, both of whom have extensive research experience in the cities.

3.2.3 Field verification and assessment

Two city-specific field verification exercises were conducted by the team. In addition to training, team members utilized the meeting in Kampala to conduct ground verification of UPAF. Visits were made to practicing UPAF farmers and entrepreneurs, integrated aquaculture-livestock-crop systems and nutrient recycling sites for UPAF in Kampala. The visit in Ibadan highlighted the importance of institutions in promoting and supporting UPAF especially in context of providing space for its practice. Farms were visited as well as hotspots for flooding risk to UPAF in Ibadan.

3.2.4 Teleconferences

A total of 7 teleconferences were held during the project implementation period. These were held to cover issues regarding the conceptualization of the research and the approach to the study. Emerging issues and questions were also discussed with respect to methodology, geospatial analysis and student participation in the project for capacity development. Graduate students from Uganda, Nigeria and the state of

Arizona in the United States joined the teleconferences and were able to exchange ideas and raise questions, which were discussed among the team members in regard to the project goals.

4.0 Outcomes and Products

4.1 Understanding UPA

Urban and Peri-urban Agriculture and Forestry (UPAF) is defined as agricultural (including livestock) production, and processing and distribution activities within and around cities and towns, with the main motivation being personal consumption and/or income generation, and which competes for scarce urban resources of land, water, energy and labour that are in demand for other urban activities (Gündel 2002). UPAF includes small- and large-scale activities in horticulture, livestock keeping, fodder and milk production, aquaculture, and forestry - where several activities may be carried out within one enterprise (Urban Harvest 2005).

UPAF and related activities have been receiving increased attention in recent years as a dimension of urbanization worldwide and as a means to alleviate poverty and improve diets in urban and peri-urban areas (Egyir & Ackah-Nyamike 2006). Thus, the changes in relationships between institutions and communities to promote food security that is being called for must not be limited to the rural areas alone. Indeed, as urban populations grow, empowering UPAF so as to contribute more to urban livelihoods is needed. As such, the links between the people involved in UPAF, the people they serve and the institutional framework that ought to support its growth must be well understood in order to fully explore the potential of UPAF (Egyir & Ackah-Nyamike 2006).

In recent times, UPAF has gained importance especially in developing economies. This is basically because it has been discovered to be a viable intervention strategy for the urban poor to earn extra income and therefore reduces their reliance on cash income for food by growing their own food, which in turn manages poverty (May & Rogerson 1995; Ayorinde et al. 2007; RAUF 2010). It is a major component of the urban food system in that it provides the diversity needed to ensure dietary quality - an important aspect of food security for several households (Egbuna 2001, 2009).

4.2 Contribution of UPA to livelihoods and food security

4.2.1 UPAF and urban livelihoods

UPAF has traditionally provided livelihood benefits for urban dwellers (Atkinson 2000; Mkwambisi et al. 2011). Though much literature contends UPAF's role in provisioning of food for the urban poor, this synthesis highlights evidence of middle income and high income groups in urban areas that have their food supplemented by UPA either directly as they engage in UPAF or through connections with urban producers of food (Masashua et al. 2009; Ricci 2012). Evidence from the literature also contends that the competition between space-confined technologies and space requirements for urban built up uses is stiff and affects productivity of urban ecosystems in terms of food provisioning (Kitha & Lyth 2011). But there is general agreement in the literature that as urbanization progresses, the space-confined technologies and crops/livestock that utilize limited space will have an edge over the space requiring crop systems (Masashua et al. 2009; Maxwell 1995). For example,

high-value vegetables, high-nutritious crops and high-productive livestock have increased in the cities where the assessment was focused. Evidence also suggests that UPAF has secondary livelihood strategies associated with it or that spin offs of UPAF exist. The recycling industry, nurseries for high-value crops and livestock breeding are some of the co-benefits of UPAF (Fall et al. 2000; Abutiate 1995; Olajide-Taiwo et al. 2010). In addition, integrated systems including crop-livestock systems, aquaculture-livestock-crop systems and integrated crop-forestry systems are paying off to some degree in terms of livelihood benefits to urban dwellers. As evidence of scaling up, institutions such as FAO and UNEP are now promoting ecosystem-based adaptation in African cities focusing on food production and improvement of food systems in urban and peri-urban environments as one component in addition to other eco-system services (UNEP 2010; FAO 2012).

Evidence also suggests that the urban population, largely older residents and lower-middle income groups, has a sizeable proportion of their livelihoods complemented by UPAF (Danso et al. 2002; Mwangi 1995; Bartlett et al. 2009). Production ranges from high-value nutritious crops to livestock such as poultry, but also to fruit and herbal trees - all of which supplement food intake as well as incomes of the urban population. Evidence in Ibadan, Kampala, Dakar, Addis Ababa, Dar es Salaam is overwhelming with respect to UPAF's role in contributing towards livelihoods (Ayalew n.d.; Tolossa 2010; Prain et al. 2010; Malick, Gaye, & Diallo 1997) High-value crops such as vegetables, tomatoes, poultry products, fruits and herbal crops top the list of UPAF enterprises that provide up to 15% of household incomes to the urban population(Sawio 1993). In Kampala and Dar es Salaam, the linkage of producers to big outlets such as supermarkets and chain stores through contractual arrangements has enabled urban farmers to maintain their incomes and sustenance from UPAF (Crush & Frayne 2011). UPAF is still an important livelihood strategy with respect to food provisioning and has the potential to contribute towards food security in urban areas.

4.2.2 Food systems structure and production in cities

The United Nations Development Program (UNDP) estimated in 1996 that 800 million people are engaged in urban agriculture worldwide. Of these, 200 million are considered to be market producers employing 150 million people on full-time basis. Urban agriculture contributed 15% of world food production in 1993 and this was expected to grow to 30% by 2005 (Smit et al. 1996). If peri-urban agriculture were included, the figure would even be higher which would translate to more food being available to city residents. Urban and peri-urban farming activities can be found everywhere, behind houses or along roadsides, on roofs or in the middle of roundabouts, along and between railway lines, in parks, along rivers, under power-lines, etc. Often we only have to train our eyes to see that in all kinds of private or open public spaces crops are cultivated and animals like goats and chicken roam about (Cofie 2005; Odebode 2006). Urban agriculture is seen to address the short- and medium-term food security and livelihoods needs by ensuring availability of and access to food, complement the supply from rural agricultural production, especially for food insecure zones, act as a coping mechanism against the negative effects of climate change on agricultural production, and as a strategy to reduce vulnerability among the urban populace. These would be achieved through a co-ordination mechanism that would provide a basis and framework for improved co-

operation/consultation among partners, and enhanced information dissemination and transparency in agriculture and food security initiations (Mougeot 2000; Castillo 2003; Dubbeling & Merzthal 2006; Dubbeling et al. 2010; Simon 2012).

Diversification of urban food production systems has proved to enhance household food and nutrition security among urban and peri-urban farmers (Njogu 2005). The results of a study of a diversified urban agriculture system among the farmers in Kamae peri-urban area of Nairobi city by Njogu (2005) indicated an improvement in the socio-economic status, in food production and consumption among the farmers. In addition, an increase in food production and nutrition knowledge was observed to increase households' food consumption. Urban farmers engaged in various farming practices including monoculture (cultivation of only one variety of crops); mixed cropping; livestock farming and mixed farming (cultivation of crops and rearing of animals on the same piece of land). UPA provides indirect social benefits from the economic gains, such as providing extra income used to pay school fees, acquiring more household assets and paying for better health care and livelihoods support for farming households in Ibadan (RUAF 2010). It offers the opportunity for the farmers to purchase agricultural inputs, fertilizers, tools and seedlings for the next planting season, thus ensuring sustainability of UPA from season to season in the city. It is an important livelihood and food security resource in parts of Ibadan (Oyejide 2006; Ayorinde et al. 2007; Adelekan 2011).

In Nigeria, urban agriculture plays an important role in enhancing urban food security since the cost of supplying and distributing food to urban areas based on rural production and imports continue to increase, and do not satisfy the demand, especially of the poorer of the population. The rate of migration from rural to urban areas in developing countries has led to emergence of cities. The increasing demand for food and the high rate of unemployment has further worsened the city situation. Traders, civil servants and artisans are finding it increasingly difficult to cope with the high cost of living and the stagnant income in the urban areas; these have promoted agricultural production within the vicinity of the city (Olayioye 2011). Next to food security, urban agriculture contributes to local economic development, poverty alleviation and social inclusion of the urban poor and women in particular, as well as to the greening of the city and the productive reuse of urban wastes (Oyedipe, 2009).

In Accra, exotic vegetables were grown in the gardens around castles and forts by Europeans and local merchants. In the 1890s, Aburi botanical station near Accra became an important vegetable growing centre with a bi-weekly supply into Accra on Mondays and Fridays (Cofie 2005; Drechsel et al. 2006). Between the First and Second World Wars (1914-1945), there was more extensive and outstanding vegetable production to meet the demand of American and British forces during the war. After the war until 1950, there was a reduction in production due to in the reduced war demand. From 1950 to present, there has been a gradual increase in production of exotic vegetables with 160ha in Accra and about 300ha in Greater Accra including Tema (Cofie 2005). In Douala, about 16% of the households are active in urban and peri-urban agricultural practices involving both crop and animal productions (Cofie et al. 2003).

4.3 **Cities and adaptation in Africa**

As climate change risks continue to manifest, a new layer to the existing challenges in African cities has been added. Consequently, adaptation to climate change has now become high on agenda in combination with development. Adaptation is necessary to build resilience of cities' response to climate change. Inland, coastal and mountainous cities face different climate risks ranging from storm surges, droughts, excessive rainfall, heat waves and cold waves. The impacts also range from flooding, storm surges, water scarcity, health impacts and landslides with social and economic implications in cities. The urgency of climate change adaptation promises to revitalize urban management to build resilience in cities. Adaptation of cities to climate change will have to couple with development to bridge both the urban development deficit and adaptation gap. Investing in resilient urban infrastructure and human settlements is a key aspect of building resilience in cities of Africa. Building on early and scalable adaptation measures is paramount to enable communities, institutions, urban authorities and different actors to become climate ready, while addressing the inherent challenges.

4.4 Mitigation, trends and opportunities

In terms of the UN Framework Convention on Climate Change (UNFCCC), its Kyoto Protocol and the international geopolitical negotiating positions surrounding its successor, and recognising the historical responsibility of the Annex 1 countries for the bulk of greenhouse gas (GHG) emissions, they are held primarily responsible for implementing GHG mitigation activities. By contrast, non-Annex 1 countries should concentrate on adaptation actions to cope with environmental change. This dichotomised approach is increasingly artificial and unhelpful, emphasising structural differences rather than shared global responsibilities in a world where many of the most acute GHG emission hotspots are in key cities of the global South (Simon 2012). Moreover, in recognition of this, a growing number of Southern countries and individual cities are adopting and implementing plans that represent a blend of mitigation and adaptation measures appropriate to their circumstances. Indeed, there is welcome movement away from such dichotomised thinking and policy, since it is now understood that they are not mutually exclusive and that some well-tailored and targeted measures can address both mitigation and adaptation simultaneously. Within the study area of this project, metropolitan Lagos represents perhaps the highest profile example, where a combination of road and drainage rehabilitation and expansion, along with traffic interventions such as bus priority lanes and new public transport, as well as urban greening aims to improve traffic flow, reduce congestion and hence GHG emissions and pollution, thereby improving public health while also stimulating economic growth (Rosenzweig et al. 2011; Lagos State Government 2012).

UPA represents a good example of a multifaceted strategy that can promote both mitigation and adaptation, while also providing employment and – under appropriate circumstances – sustainable livelihoods. The increase in food production and hence urban self-reliance and food security represents adaptation as outlined in the previous section. However, policies to encourage and expand the area under UPA will increase the food crops' carbon sequestration capacity, certainly relative to open or waste ground and other urban land uses. Clearance of urban or peri-urban forest patches for cultivation may actually represent a reduction in biological productivity and hence carbon sequestration capacity, depending on the relative biomass and species mix, so should not be advocated from a mitigation perspective (or that of biodiversity and soil

conservation). Crops differ in their sequestration capacity, which also rises as crops grow and their biomass increases, and then falls in the final stages of maturation. UPAF's carbon sequestration capacity therefore varies through the growth cycle of individual crop species as well as seasonally, so that the aggregate effect in a given urban area depends on the diversity and relative proportions of the different crops concerned. Up to certain thresholds, increased atmospheric CO_2 concentrations are associated with increasing productivity, especially of C_3 crops, although C_4 crops may be adversely affected since prevailing CO_2 levels are more or less optimal for them (see Section 1.1.1, pp.5-6).

Available fragmentary evidence and biological principles suggest that inter-or multicropping of different species with different heights, canopy cover, CO_2 utilisation and soil nutrient requirements will maximise carbon sequestration just as it maximises total crop output and spreads income or food supply and reduces risk by having different crops mature at different times, and reduces the risk from pest damage. We found no evidence from the literature in the study regions or the limited field verification work in Kampala and Ibadan to corroborate this, so detailed assessment would be an appropriate subject for future research. Even the otherwise comprehensive Healthy City Harvests report (Cole et al. 2008), which advocates a broad eco-health approach rather than simply focusing on human health, does not address this issue

In the course of our field survey to confirm the practices of urban and peri-urban agriculture in Ibadan, we visited a number of farms (livestock and crops) with the UPA farmers providing useful information relevant to our study. For the livestock farms, we encountered both domestic and the domesticated animal pens. Our findings are presented in the following sections:

4.5 **Thresholds, potentials and limits**

In the development of human settlements, a primary motivation for regulating or forbidding practices of food production has been concerns about human health, from infections to accidents (Furedy & Chowdhury 1996). The focus of attention in health risks is on humans. Urban agriculture however, includes animal rearing and waste water usage, additionally concerning the ways in which animals' health may be affected by problematic practices and injuries from sharp objects in garbage, and so on. Urban ecosystems have both health risks and economic and environmental benefits for producers and consumers (Katongole et al. 2011). Agriculture is a key part of the eco-system, generating risks through use of toxic inputs in densely populated areas and vulnerable at the same time to becoming a pathway for biological and chemical contaminants in the ecosystem, directly via soil or water to producers and indirectly facilitating the passage of contaminants into urban food systems (Amoah et al. 2005).

4.6 Urban ecosystem services derived from and /or enhanced by UPA

4.6.1 Regulatory and provisioning services of UPA

Ecosystem Services of UPA

Urbanization in sub-Saharan Africa is altering traditional livelihoods strategies and displacing agricultural land uses in many areas(Adeboyejo et al. 2007; Angel et al. 2011). Urban and peri-urban agriculture may however offer an array of ecosystem services that are locally and globally important (Alberti & Marzluff 2004; McDonnell et al. 1997). Agricultural lands are often associated with tradeoffs in ecosystem services, but some outcomes are local, depending on existing conditions and specific land management strategies. In urban areas and their immediate vicinity, agriculturally productive lands may offer distinctive benefits over carte blanche urbanization (Lovell & Johnston 2009). Some of the ecological functions of agriculture provide immediate benefits to producers, most notably food production, while other benefits are realized off-farm, and do not necessarily affect land managers, e.g., flood regulation or carbon sequestration. Here, we consider opportunities for agriculture to support ecosystem services, particularly provisioning, regulating and supporting services. We also discuss the role of UPA in supporting biodiversity, as this is increasingly recognized as a critical element of maintaining the resilience of social-ecological systems and the sustainable provision of many ecosystem services (De Zeeuw et al. 2011; Roberts et al. 2011).

Provisioning Services

The provisioning services provided by agricultural lands are among the most immediately important for human wellbeing. Provisioning services include the production of grain, livestock, produce, fuel, and forage (MA 2005). For millennia, humans have transformed the Earth's surface to enhance the capacity of ecosystems to provide provisioning services (Turner et al. 1990), often compromising other services to optimize outputs of food, fuel, and fiber production (DeFries et al. 2004; Foley et al. 2005). Despite these tradeoffs in ecosystem services, human wellbeing seems to be most closely tied to these increases in provisioning services, at least at national and global scales (Raudsepp-Hearne et al. 2011).

Food, Fuel, and Fiber

As urban populations grow in sub-Saharan Africa, provisioning services from urban landscapes will become increasingly important. Urban areas already produce some 15 to 20% of the world's food (Armar-Klemesu 2000; Drescher 1998), with UPA providing an even higher proportion of food supplies in many African cities. For example, production in Dakar meets 60% of the city's demand for produce and an estimated 70% of Senegal's total poultry demand (Mbaye & Moustier 2000). Similarly, Kampala produces some 70% of the poultry consumed in the city, and Accra's UPA regularly provides 60 to 90% of its perishable vegetables (Oboubie et al. 2006). As these examples illustrate, UPAF is particularly important for providing a diversity of perishable items such as dairy, meat, or produce (Mougeot 2000). In this manner, UPAF often increases the diversity of foods consumed, providing an important source of nutritional diversity (Davis et al. 1994). In Kampala, urban agriculture is positively associated with both food security and child nutritional status (Maxwell 1995; Maxwell, Levin, & Cseste 1998). In some instances, urban agriculture enhances food security directly as a source of food, but it often provides entitlements in the form of income from sales of agricultural products. Niang et al. (2006), for example, found that urban farmers in Dakar that grew lettuce for sale were able to generate incomes well above the poverty level(Niang et al. 2002; Ricci 2012).

The benefits from the sale of agricultural products and reduced household expenditures on food thus make an important impact on local food security.

Along with food production, agroforestry in urban and peri-urban environments can also support growing demand for wood fuel, which continues to be an important source of energy in much of sub-Saharan Africa (Baudoin & Drescher 2008). Sale of timber products and surplus food supplies additionally provide a source of income for urban households, and may increase incomes well above the national average (Veenhuizen & Danso 2007; Pottinger & Burley 1992). Sustainable management of timber and non-timber resources from forested lands offers a particularly promising approach to simultaneously cultivate an array of other ecosystem services, as noted in the sections below. The integration of urban forestry as part of provisioning ecosystem services underscores the importance of fruit and herb trees that can grow in urban areas utilizing space available with multiple benefits.

Regulating Services

In addition to directly providing consumable goods, UPAF provides benefits that may improve human wellbeing by regulating environmental processes. Concerns exist over the contributions of agriculture to global environmental change, and also for health threats at local scales, but appropriate practices may beneficially regulate local climate, water supplies, and disease. Specific practices can be implemented to improve ecosystem services on agricultural lands (Gliessman 1999), and the discussion below focuses on the benefits realized through such best practices.

Climate Regulation

Urbanization has major local climatic effects, primarily driven by increases in impervious surfaces and reductions in vegetation. This so-called urban heat island (UHI) effect is characterized by higher temperatures and less variation in nighttime and daytime temperatures. Nairobi, for example, has displayed a trend of increasing temperatures in urban areas and a persistent UHI effect (Makokha 2012). UPAF can help to regulate local microclimate (Tidball & Krasny 2006), and offset UHI effects by increasing the amount of green space in and near urban areas. The relatively lower albedo, as compared to impervious surfaces and other built features, reduces the sensible heat flux. While reducing the absorption of solar radiation, agricultural lands and urban gardens also increase evapotranspiration, thereby lowering temperatures through evaporative cooling. Fruit crops and agroforestry also provide shade, which can reduce land surface temperature, facilitating more rapid cooling at nighttime. Certain types of UPAF may support climate regulation at global scales by providing carbon sequestration. In particular, agroforestry has minimal carbon emissions because the soil is left intact, and also stores carbon in the structure of the trees. Properly managed rangelands provide similar carbon sequestration benefits (Havstad et al. 2007), though the scale of production may not be feasible for many urban settings because of limited land.

Storm Protection

Along with changes in local temperatures, urban environments are subject to increasing wind intensities, partially due to losses of vegetation. Areas of vegetation

can provide windbreaks that absorb the energy of strong gusts, and provide buffers between large structures. Nonetheless, urbanization often simplifies landscapes and removes such features along with their storm mitigating benefits. In Ibadan, vegetation cover reduced from 92% of the total land area to just 38.9% of land area by 2003 (Adelekan et al. 2010; Oluseyi 2006). Alongside this trend, the frequency of windstorm events is also on the rise (Adelekan et al. 2010). Increasing tree cover through agroforestry and providing breaks between built-up areas may reduce the frequency of these events and their damage. Similar strategies that utilize hedgerows and shade trees have been successfully implemented to reduce wind damage in agricultural lands of Tanzania and Kenya (Stigter et al. 2002).

Flood Regulation

Increases in impervious surfaces associated with urbanization reduce soil infiltration and increase surface runoff during storms. As a result, flooding is common in dense urban developments that lack adequate drainage systems as found in Ibadan. Kampala illustrates this challenge, where increased runoff has caused greater frequency of flooding, due to drainage of swamps, poor soil management practices, and urbanization (Matagi 2002). Shifting rainfall patterns, coupled with expanding urban settlement have similarly increased flooding hazards in Dakar (Mbow et al. 2008). Urban agriculture may provide one economical approach to address this growing need to alleviate flooding hazards by reducing surface runoff. Management practices, including appropriate crop cycling, that enhance soil structure and soil permeability (Swift et al. 2004) increase infiltration and provide water storage (Dubbeling et al. 2009). Permacultures and agroforestry can particularly reduce flooding and landslides by creating extensive root structures that hold soil in place and draw excess water from the soil through transpiration. Rice paddies and aquaculture may also provide areas that offer water storage during storms.

Coastal flooding hazards result from different conditions, but may benefit from some similar solutions. In the case of coastal flooding, agroforestry may again help to mitigate this hazard. Mangrove forests play a particularly important role for suppressing coastal inundation during extreme events (Badola et al. 2005). Douala, for example, experienced major coastal flooding during the 2000 hurricane season. In recent years, Douala has experienced extensive loss of mangroves to development and logging for fuel-wood (Din et al. 2008). A survey of loggers in Cameroon's Wouri estuary indicates that many (60%) consider sale of mangroves to be their primary source of income (Atheull et al. 2009). Efforts to improve coastal flood control must thus consider the economic incentives and provisioning services provided by this ecosystem. Examples of sustainable mangrove management creating win-win scenarios elsewhere, most notably in the Philippines, reveal the potential of maintaining flood regulating and provisioning benefits of this land cover.

Erosion Control

Changes in rainfall patterns due to climate change are likely to contribute to landslide hazards in many areas. Increasing frequency of major rainfall events, coupled with overall decreases in precipitation will have a destabilizing effect on steep terrain. In Kampala, these effects will be coupled with denudation of the land for urban expansion. Residential development often expands into hilly terrain that surrounds the

city (Matagi 2002), and residents remove vegetation, weakening the soil structure in the process. Some cities that have faced similar challenges have sought to prevent soil loss and landslides by paying farmers to maintain production on steep slopes (e.g. Perez 2005). Extensive root structures, from permaculture in particular, help to stabilize the terrain and to reduce erosion. In coastal areas like Douala, mangroves provide similar benefits, protecting against erosion during storms and may actually support land gains over time.

Water Regulation and Purification

While reducing runoff, more porous land surfaces also support recharge of water tables and increases groundwater flows. The steady recharge of water tables and surface water supplies by infiltration often plays a critical role in supporting water supplies. Natural movement through the water cycle through infiltration helps to purify water supplies and reduces contamination from surface runoff in urban areas. The value of ecosystems, particularly wetlands for purifying water supplies is increasingly recognized, and the restoration of wetlands is now often considered as an economical alternative to traditional industrial water treatment solutions (e.g., Chichilnisky & Heal 1998). University of Dar es Salaam research has shown that this approach to be highly efficient at filtering wastewater (Mashauri et al. 2000). The research shows that in a period of one month, filtration rates ranged from 0.27 m/h and 2.3 m/h and treatment effectiveness was evaluated with a high mean removal of 80% for Suspended Solids (SS), 66% for Chemical Oxygen Demand (COD), 91% for faecal coliforms (FC) and 90% for total coliforms (TC) at a low filtration rate (Mashauri et al. 2000). This evidence applies to constructed wetlands having natural species but there is agreement that even cultivated wetlands can have significant removal of organic pollutants (Sarmento et al. 2012). Ecological management of water purification may provide a useful strategy to address the challenges of water purification in many African cities. In Addis Ababa, only a fraction of wastewater is treated. The water supply-demand gap is estimated at 49% for Accra and 69% for Addis Ababa. Currently, only 7% and 30% of wastewater can be treated in Accra and Addis Ababa respectively (Rooijen et al. 2009).

In Douala, groundwater contamination was observed as high. In particular, flooding during spring months may contribute to overflowing latrines in informal settlements, which in turn contaminate shallow aquifers (Takem et al. 2009). This scenario illustrates the relationship between flood regulation and water regulating services, as well as the need for adequate water treatment infrastructure. Urban agriculture may help to alleviate both of these issues. In some cases, wastewater can also be applied directly to agricultural fields, preventing discharge of wastewater into rivers and reducing pollution (Buechler et al. 2006). Some forms of agriculture, such as floriculture and tree crops, can use effluent for irrigation with minimal risk of contamination (WHO 2006) because the edible portion of the crop rarely comes in contact with the water itself. However, some studies have shown that there is a potential for transfer of contaminants from root through stem and leaf tissue (Drechsel et al. 2008; Mbabazi et al. 2010). When used in this manner, wastewater is diverted from natural water bodies, reducing pollution and the land itself serves to filter the water.

Disease Control

Agriculture is often discouraged in urban environments because animals and standing water from irrigation provide breeding ground for vectors. Of particular concern for many cities in Africa is the increased incidence of Malaria due to creation of habitat for mosquito breeding. While this poses a legitimate concern, the linkages between urban agriculture and incidence of malaria are not always clear (Klinkenberg et al. 2005, 2008), and depend upon specific farming practices (Dongus 2009). When designed to enhance flood regulation, agriculture may actually provide a second-order service of disease regulation by reducing the extent of floodwaters that serve as vectors for disease. In other cases where urban infrastructure provides habitat for vectors of disease, UPAF can provide buffer areas. Given this complex interaction, policy-makers will have to consider the specific context and form of agriculture in making policies that address public health concerns. Recent work in Kampala provides an example of officials working directly with stakeholders to identify legitimate threats from UPAF and to develop strategies to reduce the health risks (Cole et al. 2008).

Pollination

Diverse agricultural lands in urban areas can provide habitat for pollinators, which immediately benefit urban producers, but also support natural ecosystems. The presence of a network of vegetated lands facilitates the travel of pollinators between forest fragments, as well as agricultural lands. While pollinators clearly provide an important service to growers, the honey produced by bees offers yet another valuable benefit that contributes to the incomes of many urban households. In Ibadan, for example, honey harvesting is a profitable endeavor that many residents use to supplement household income (Adeola et al. 2011).

Supporting Services

The Millennium Ecosystem Assessment recognized that certain ecosystem services are necessary to enable the provision of others (Scholes & Biggs 2004). These services are designated as supporting services, and often can be thought of as intermediary benefits. In the context of agriculture, these services create the environmental conditions necessary for food production. Farmers often replace or complement these services with chemical or mechanical supplements.

Nutrient Cycling

Nutrient cycles are more open in urban systems with nutrients imported (as food and other commercial products) and then exported as waste. Urban agriculture has demonstrated capability for nutrient cycling through maintenance of soil biota and by recycling urban wastewater (Drechsel & Kunze 2001; Troschinetz & Mihelcic 2009). As noted above, strategies for wastewater management can incorporate agricultural lands, including the production of fuel wood and tree crops (Smit, Rattu, & Nasr 1996). Composted solid waste can also be applied to fields in urban and peri-urban areas, closing nutrient cycles. Some 67 to 77% of solid waste produced in Accra is organic, and much of this is disposed in streams and open spaces (Asomani-Boateng

& Haight 1999). Agricultural lands could benefit from soil amendments from this organic waste, while providing an important service to the city (Asomani-Boateng 2002).

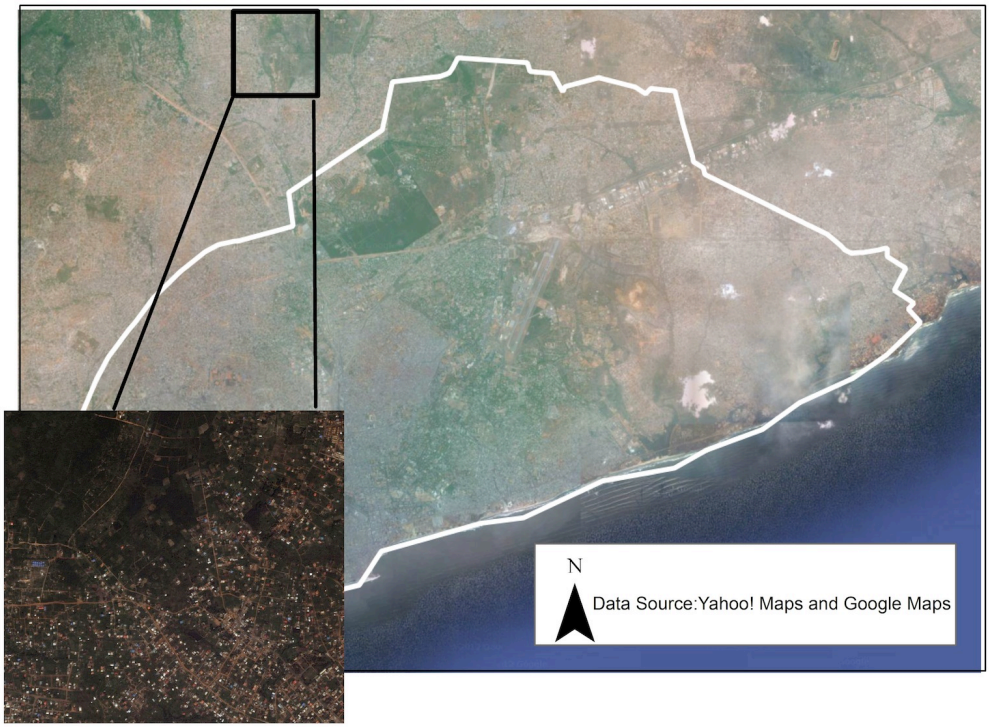
Biodiversity

The potential for biodiversity to improve human wellbeing remains largely unknown, despite nearly two decades of work to illuminate this relationship. The prominent thesis in much of the biodiversity research holds that biodiversity increases ecosystem functioning (Tilman et al., Loreau et al.), which in turn supports ecosystem services that contribute to human wellbeing (Cardinale 2012). Increasing evidence supports the idea that biodiversity increases ecosystem functioning, but the relationship between services and wellbeing remains unknown (Raudsepp-Hearne et al. 2011).

Nonetheless, there is evidence that biodiversity can support human wellbeing in at least three ways (Fischer et al. 2006; Swetnam & Reyers 2011). The existence value of certain species is valued by people around the world, as indicated by the extensive investment in global conservation efforts. Biodiversity also presents options value for future uses, often yet to be discovered, of the world's genetic diversity. Finally, biodiversity may also enhance livelihoods and reduce vulnerability to economic and environmental shocks especially in regard to payment for ecosystem services through species that can increase CO_2 sequestration and terrestrial carbon stocks (Pearson et al. 2010; Townsend-Small & Czimczik 2010). Studies have shown and agree highly that different urban surfaces with trees and ornamental plants can sequester organic carbon of up to 140 g C m^{-2}/y^{-1} (Fields 2009; Townsend-Small & Czimczik 2010). Agro-biodiversity, including genetic, functional, and species diversity, can serve to diversify household nutritional and livelihoods portfolios under an array of changing conditions. Such diversity may be particularly important for adaptation of agricultural practices under climate change. UPAF can support in situ conservation of plant genetic diversity (Trinh et al. 2003; Eyzaguirre & Linares 2004), particularly of indigenous varieties (Drescher 1998).

Urban agricultural especially tree planting[2] (Stoffberg et al. 2010) can reduce emissions. Although this study calculates estimates of CO_2 sequestration of the street trees, the urban green surfaces covered with multiple functional plants and trees have a high potential to sequester CO_2 in cities. The structure of the landscape mosaic is thus important; canopy cover in agroforestry plots and the relatively less intensive uses of field crops can shape the climate resilient urban landscapes (Perfecto & Vandermeer 2010). Payment for ecosystem services through urban forestry has the potential to defray the impacts of land competitions and urban expansion that diminishes agricultural land as well as ecosystem services.

[2] The City of Tshwane Metropolitan Municipality provided a strategy in 2002 to plant 115,200 indigenous street trees in the period 2002–2008.. over a period of 30 years, this study estimates that tree planting will result in 200,492 tonnes CO_2 equivalent reduction and that 54,630 tonnes carbon will be sequestrated.



Despite being less vulerbale to sea levele rise, Accra's biodiversity loss is huge but less gentrification creates opportunities for increased productive UPA

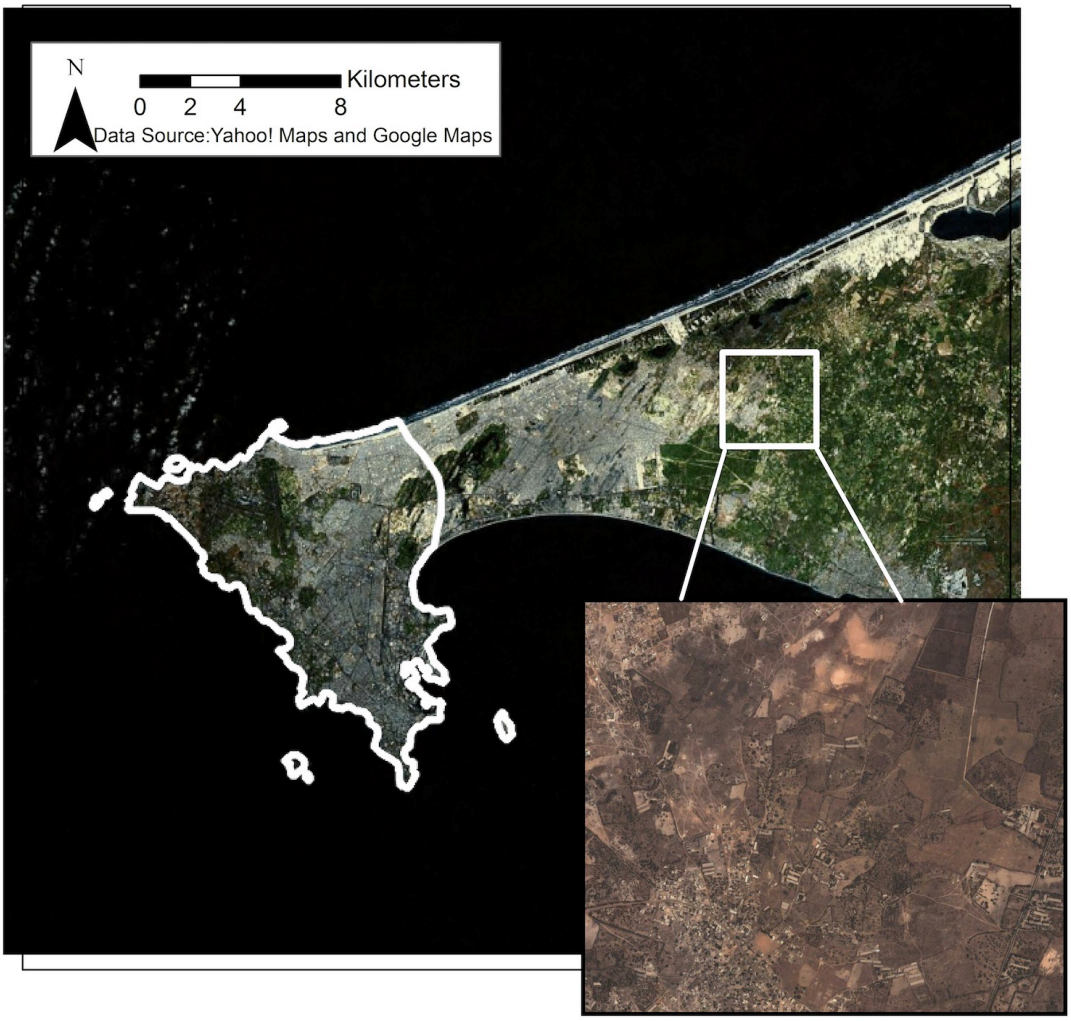
4.7 Scaling ecosystem services

The potential for ecosystem services of provisioning, regulatory and supporting services in the assessed cities is substantive, but many of the studies indicate that piloting and validation of UPAF is still largely at micro level (Arbesman et al. 2009; Sovacool & Brown 2009). It is necessary to bring UPAF to a level that would have city-wide impacts and build resilience. Scaling up has received less attention due to policy and institutional impediments (Ayaga et al. 2005; Carmin et al. 2012). In many of the cities assessed, UPAF is widely practiced but is still not officially accepted in city ordinances and regulations. Despite the wide promotion by CSOs and supporting institutions, UPAF struggles to make an impact on the majority of people in the low-income groups. Even where it is vigorously promoted, adoption by those who would benefit from its services is low. Many lean towards industrial and secondary employment sources, especially the service sector, rather than joining the sometimes despised occupations in UPAF. In the context of urban resilience, policy that targets the promotion of meso- to city-wide scale UPAF should be well thought through with respect to ecosystem services is important. A number of scalable UPAF strategies and activities exist and offer lessons for promoting wide-spread adoption of UPAF (Lwasa et al. 2009). The support of municipal and city authorities will be crucial in enabling the promotion that contributes to building resilience. Though outside the cities of

focus, Durban in South Africa has demonstrated that through UPA, poverty, biodiversity conservation and adaptation to climate change can be achieved.

4.8 Thresholds, opportunities and limits

Agricultural practices are traditionally known for negatively impacting ecosystem services, i.e., trade-offs exist between provisioning services (e.g., food and wood products) and most often the regulating and cultural services (e.g., nutrient cycling, flood regulation, and opportunities for recreation) associated with agriculture (Raudsepp-Hearne et al., 2010). However, the benefits are becoming more widely recognized in the literature. For example, nutrient runoff from agriculture can be reduced through a variety of means such as minimizing fertilizer use, using conservation tillage, or maintaining riparian zones without affecting food production and at the same time can enhance other services such as landscape beautification, wind protection, water quality, biodiversity, and crop production - increasing the benefits provided to society (Tallis et al., 2008; Foley et al., 2005). As the Millennium Ecosystem Assessment suggests, it is important that efforts be put into identifying not only the tradeoffs but also the synergies that exist among ecosystem services at different scales (Raudsepp-Hearne et al., 2010). Such research could help uncover policies and management approaches that could help improve the provision of multiple ecosystem services across landscapes (Lovell & Johnston, 2009). Recent research points to the benefits of creating multifunctional landscapes where multiple environmental, social, and economic functions are provided (Wiggering et al. 2003). In cities, urban agriculture and forestry can assist in the development of multifunctional landscapes through sustainable food production, biodiversity conservation, protection of ecosystem services, and poverty alleviation (McNeely & Scherr 2003). The benefits of UPAF far outweigh the risks if they are managed properly. Thus, it is important to understand the complex interactions that exist between UPAF and ecosystem services and associated limits and thresholds below which there will be negative consequences for human wellbeing.



Cities such as Dakar have limited land patches for greening

4.9 Challenges and limitations of UPA

The extent to which UPAF is successful, particularly in enhancing food security and ecosystem services in the context of climate change mitigation and adaptation largely depends on how it is perceived by city officials and how well integrated it is into other urban polices related to ecosystem management, water and wastewater management, and landscape management policies. Much of the negative sentiments surrounding the practice of UPAF stems from concerns about health risks to humans as well as the environment. For example, UPAF incorporates the use of easily accessible resources such as organic municipal waste, sewage and market refuse in crop production, which have often been found to cause microbial and heavy metal contamination of produce (Keraita & Drechsel 2004; Amoah et al. 2005; Akegbejo-Samsons 2008). Livestock and poultry manures have also been reported as sources of pathogen contaminations mainly of fecal origin (Güendel 2002; Sonou 2001; Drechsel et al. 2006). Unfortunately, these risks including other health concerns associated with improper management of livestock on urban farms (e.g., noise, odor, animals crowding nearby streets and residences) have resulted in the disregard of UPAF as a formal land use by city officials and the development of prohibitive or restrictive UPAF policies in cities of East and West Africa. Although UPAF is still

widely practiced due to poor implementation of these policies, the result is that public and ecological health is negatively impacted further (de Zeeuw et al. 2011).

In densely urbanized areas, particularly in slum and squatter settlements, one of the major limitations for UPAF concerns the space for food production, which is further complicated by its lack of incorporation in city planning and conflicts of land tenure. Resultantly, cultivation of UPAF often occurs on land located near busy roadways, near railroads, or in vacant lots or brownfields, which are often contaminated with heavy metals such as cadmium (Cd) and lead (Pb) (Nabulo 2002; Amoah et al. 2005). Concerns over soil contamination are real, where in this case vegetables grown in urban wetland soils become contaminated by polluted floodwaters from (Mbabazi et al 2010). Additionally, inappropriate usage of contaminated water supplied from rivers or canals to irrigate crops is a concern particularly in cities where treatment is unavailable. Crop contamination is particularly high in West Africa due to overhead irrigation techniques such as the frequent use of watering cans that are filled from contaminated surface water sources (Drechsel et al. 2008). In Antananarivo, Madagascar rice production often ceases when the organic content of the lowlands water where it is grown exceeds a certain threshold – this is because of urban wastewater which collects in the basin. Alternatively, farmers choose to cultivate watercress which thrives under these conditions and can actually clean the water downstream. However, this is often at the expense of public health, as contamination levels are high for human consumption, creating complex challenges for urban planners when considering sustainability at various scales (Aubry et al. 2012). UPAF has also been accused of increasing the incidence of malaria by supporting malaria vectors. For example, Stoler et al. (2009) report that in Accra, Ghana the odds of self-reported malaria are significantly higher for women living within 1 km of University of Accra (UA) compared with all women living near an irrigation source (the association disappearing beyond this distance), and that malaria prevalence is often elevated in communities within 1 km of UA despite more favorable socio-economic characteristics than communities beyond 1 km.

4.9.1 Opportunities

Opportunities exist by recognizing that agriculture is a key part of the socio-ecological system and through the promotion of good agricultural practices (GAPs) which aim to reduce the contamination from soil, agricultural inputs, harvesting and storage, etc. (Hoornweg 2008), to allow for the benefits that largely exist from UPAF to ecosystem services (e.g., provision of food, microclimate mediation, carbon sequestration, nutrient recycling, and recreational opportunities from multifunctional urban green spaces) (de Zeeuw et al. 2011). These GAPs underscore the need to identify the potential human and environmental health risks individually on a case by case or city or by city basis, and to develop and implement evidence-based policies with multiple stakeholders to eliminate these risks or reduce them to acceptable levels. In Kampala, Uganda, for example, regulations have been developed for urban livestock and aquaculture sectors through cooperation amongst researchers, policy-makers, urban planners, health officials and direct stakeholders (Cole et al. 2008). Furthermore, extension programs providing education and training on these risks including alternative measures to be taken (e.g., the WHO/FAO's Safe Guidelines for the Safe Use of Wastewater for Agricultural Production) (Hoornweg 2008) and on farming practices that are more ecologically sound will increase the capacity of UPA

to enhance and not degrade urban ecosystem services and to increase their functioning and resilience (Fischer et al. 2006).

5.0 Synthesizing the contribution of UPAF towards climate change mitigation and adaptation in African cities

5.1 UPA and adaptation to climate change

Evidence exists on how UPAF has been promoted and adopted to adapt to climate change (Lwasa et al. 2009; De Zeeuw et al. 2011; Roberts et al. 2011). The climate risks ranging from floods, heat waves, sea level rise and scarcity of water are some of which cities in Africa face. UPAF has been tested in adapting to flooding by a range of enterprises from productive greening strategies involving fruit trees, herbal shrubs, high-value vegetables, and on hill slopes and in valleys to increase water infiltration and reduce the time lag for flood occurrence. UPAF is also supportive of the earth dams and infiltration ponds on hill slopes to slow down runoff and contribute towards reduced flooding. The harvesting of rain water and run off has a potential for providing water for all year production of crops in cities. With respect to sea level rise, the rehabilitation of mangrove swamps by replanting and enabling regrowth is one of the adaptation measures that has been tested in Dakar, coupled with urban forestry in species that can take the excess water that causes flooding related to high water tables. The co-benefits of contributing to income and reducing some of the effects of flooding promise to bring UPAF on the adaptation agenda. Increased UPAF also has adaptation potential with respect to heat waves by moderating microclimates. During the hot seasons, temperatures tend to be high, but when neighborhood and city level productive greening involving trees is practiced, this has a potential for reducing high temperatures and effects of the urban heat island. Although provisioning potential is not as high as regulatory, UPAF can also help households of the urban poor supplement food supplies, thereby adapting to changes that might affect distant hinterlands that are the supply regions for food into the city.

5.2 UPAF and mitigation of climate change

Past global efforts at dealing with the problem of global warming concentrated on mitigation, with the aim of reducing and possibly stabilizing green house gases (GHGs) concentrations in the atmosphere(Cohen et al. 2008; Chintan 2009;). As progress in the area of mitigation has been slow, focus has grown on adaptation strategies for reducing vulnerability to the anticipated negative impacts of global warming (Frayne et al. 2012; Maddison 2007). It is increasingly becoming realized that mitigation and adaptation should not be pursued independently of each other, but as complements. This has resulted in the recent calls for the integration of adaptation and mitigation strategies. Hundreds of millions of urban dwellers in East African cities are at the risk from direct and indirect impacts of climate change. Without effective local adaptation, there will be serious consequences for urban residents and for their national economies. Satterthwaite et al. (2007) argue that there are limits to the damage or devastation that adaptation can prevent and also that there are very serious deficiencies in the institutional capacities for urban adaptation in low- and middle-income nations. However, Adger et al. (2009) examine the assumptions underlying current notions of limits to adaptation and the associated concept of thresholds and challenge the implicit assumption that successful adaptation to climate change will be bound by limiting factors beyond which adaptation will not be

possible. Their finding shows that any limits to adaptation depend on the ultimate goals of adaptation underpinned by diverse values; adaptation need not be limited by uncertainty around future foresight of risk. Social and individual factors limit adaptation action and systematic undervaluation of loss of places and culture disguises real, experienced but subjective limits to adaptation.

Eriksen et al. (2011) presents four normative principles to guide responses to climate change and illustrate the significance of the 'sustainable adaptation' concept through case studies from diverse contexts. The principles are: first, recognize the context for vulnerability, including multiple stressors; second, acknowledge that differing values and interests affect adaptation outcomes; third, integrate local knowledge into adaptation responses; and fourth, consider potential feedbacks between local and global processes. They argue that fundamental societal transformations are required in order to achieve sustainable development pathways and avoid adaptation funding going into efforts that exacerbate vulnerability and contribute to rising emissions.

The interactions between urban development and global environmental change processes in Dar es Salaam have been studied (Ricci 2012) and found to be crucial for reducing the impacts of climate change together with the challenges of rapid urban growth are identifying environmental change impacts that undermine efforts to achieve sustainable development. The study illustrates the livelihood strategies and environmental management practices used by peri-urban dwellers, while underlining challenges and opportunities for adaptive capacity. It also focuses on natural resource systems upon which peri-urban households depend and looks at the vulnerability of human–environment systems.

5.3 Linkages between adaptation, mitigation and ecosystem services

Adaptation is described as an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC 2001a). Adaptation could be anticipatory or reactive; private or public, and autonomous or planned (Adejuwon 2006). It involves trying to live with the ongoing effects on the environment and the economy from global change (Agbola 2011). At the core of mitigating global warming is the reduction of green house gas emissions through reducing energy and switching to cleaner energy sources. Adaptation, on the other hand, comprises of any measure to reduce the negative effects of climate change (Agbola 2011).

As Agbola (2011) observes, climate change will have substantial impacts on the lifestyles and livelihoods of indigenous peoples because of the effects on the variety of wild and remote areas where they live and the natural ecosystems. For instance, it might reasonably be assumed that the choices people make between cropping and keeping livestock in agro-pastoral areas are related to some extent to the risk of cropping season failure. As the probability of complete crop failure increases as result of climate change, shifts to livestock keeping, and/or more dependence on livestock keeping, are increasingly likely. Jones et al. (2010) suggested that under even a moderate greenhouse-gas emission scenario for the coming decades, there are likely to be substantial shifts in the patterns of African cropping and livestock keeping to the middle of the century. Southern coastal Kenya is one such potential livelihood transition zone, where maize production is likely to become increasingly risky (Thornton et al., 2010). In general, poverty rates in many of these transition zones are

already higher than average. For these areas that are relatively close to large human settlements, there may be options for integration of livestock systems into the market economy and for off-farm employment as an adaptation strategy to climate change (Thornton et al. 2010). In cases where crops and livestock are integrated to some degree, there are issues related to the production and utilisation of crop residues in the systems.

Individual and societal adaptation to climate is nothing new, neither as an empirical reality nor as a theoretical construct. The resource irregularities offered by different climates and the precariousness, which emerges from the vicissitudes of climate, have both acted as significant stimuli throughout human history for social and technological innovation (Adger et al. 2009). Irrigation, insurance and weather forecasting are just three of the many human institutions which have been prompted and shaped by the interactions between our physical and perceived encounters with climate. They are examples of how we have adapted our social practices in the face of variable climates (Adger et al. 2009).

In a new, deliberative and self-conscious way, however, adaptation to climate change has now become part of the contemporary discourse about the politics and economics of global climate change. It has been enshrined in the policy debate through its appearance in Article 2 of the United Nations Framework Convention on Climate Change (UNFCCC), where the ultimate objective of the Convention concedes that adaptation to climate change in relation to food production, ecosystem health and economic development can and will occur (Adger et al. 2009). Although much of the earlier international climate policy debate in the 1990s and early 2000s was pre-occupied with mitigation, the past decade has seen a growing attention given to adaptation - both its practice and its politics (Parry et al. 1998; Pielke et al. 2007).

Notwithstanding the potential insights offered by historical antecedents of change in human societies and their environment (e.g., from Huntington, 1915, 2001; to Diamond 2005), the contemporary discourse of climate change adaptation has two quite distinctive foci. First, how can adaptation to climate change be facilitated and enhanced, given that there are at least several generations in the twenty-first century which will experience progressively changing climates? Second, given that efforts at mitigating further global climate change are contested (in desirability, effectiveness and feasibility), are there limits to adaptation by society beyond which politically or ethically undesirable outcomes occur? This latter question is bound up in the discourse of ‘dangerous climate change’, where the implication is that adaptation by society is limited, in some way, once climate change crosses some danger threshold (Adger et al. 2009). An important policy discourse, explicit for example in the policy position of the European Union, suggests that such a threshold is 2^0C of global warming above pre-industrial levels (Adger et al. 2009). This target is, in effect, chosen to induce urgent action, given the high likelihood that this threshold will be crossed in coming decades (Schellnhuber et al. 2006).

Among the factors imposing limitations on adaptive capacity, the most significant is existent poverty which signifies lack of the resources necessary for adapting to climate change (Sperling 2003). In addition, there are disabilities such as poor health that could undermine labour availability for the farming activities both in quality and in quantity. Relatively low levels of educational attainment could also constrain the ability to acquire the technological capacity for combating the negative consequences of climate change (Adejuwon 2006). The rates of population increase, which stands at 28 per thousand could increase the rates of child dependency, increase

pressure on social infrastructure, and constrain the capacity to cope with the negative impacts of climate change (Adejuwon 2006).

Widespread poverty has been cited as the main cause of a low capacity to adapt to climate change in Africa (IPCC 2001a). Poor persons, poor communities and poor nations do not have enough of these resources, hence their low adaptive capacity. A low capacity to adapt to climate change automatically implies vulnerability. Hence, existent or pre-impact poverty connotes vulnerability. The summary of the results from the National Integrated Survey of Households 1995 (FOS 1996c) showed that practices that could boost the adaptive capacity of the peasant households were still being constrained by lack of funds at the individual household level. However, there was a significant difference in the incidence of poverty between households engaged in UPA and households with occupation in the other sectors. With the dominant role played by UPA in the provision of employment, it is not surprising that most of the poor were found in the farmlands (Adejuwon 2006).

The rapidly expanding population is exerting increasing pressure on the social and economic infrastructure of Nigeria. Schools, hospitals, and houses become inadequate almost as soon as they are completed (Adejuwon 2006). Similarly, electricity, water and waste disposal facilities designed for a given population are being made to serve much more than the population that existed when they were commissioned. Existing facilities are being put to a higher rate of usage than they were designed for.

The youthfulness of the population is directly responsible for the high rate of child dependency burden in the country. The South West has the least burden followed by the South East and the North West. The main consequence of this at the household level is that each pair of hands has to strive to provide for many more persons than it can conveniently cater for. In countries with such high proportions of children, relative to the proportions of the working age population, high percentages of national income is expended on consumable goods for these children (Adejuwon 2006). The higher the percentage of income expended on these consumables, the lower the percentage of income left for savings and investments (Adejuwon 2006). The capacity to cope with any additional stress in the form of negative consequences of climate change will also be lower in situations with high dependency burden because the first inclination would be to care for children rather than to prepare for a future under a changed climate.

Education will definitely enhance personal, community and national capacity to respond to external stresses placed on human livelihood and well-being. Therefore, inadequate or substandard education is a measure of the vulnerability of human exposure units to expected negative impacts of climate change (Adejuwon, 2006). It is easy to appreciate the fact that education is one of the means for achieving the goals of better health, higher labour productivity and more rapid GDP growth; all of which are required as the need arises to anticipate, manage or adapt to a worsening climatic factor (Hulme, 1996; WMO, 2000).

Climate is one of the major factors influencing the incidence of diseases in Nigeria (Adejuwon 1978). In general, disease agents do better when the temperature is high, under conditions of optimum water supply. The climate has long been identified as the fundamental cause of the low state of human health in the Tropical World (Adejuwon 2006). With ample justification, Gourou (1961: 529) contended that, “the steady, high temperatures, the high humidity of the air, the many water surfaces fed by rains, are necessary for the maintenance of pathogenetic complexes in

which man, insect and a microbe are closely associated". For instance, heavy rainfall quickly fills small surface depressions and abandoned containers with water in which mosquitoes find suitable conditions for breeding (Adejuwon 2006). About forty different types of human diseases are known to be transmissible by mosquitoes (Brown 1955). The most widespread include malaria, filariasis and yellow fever (Adejuwon 2006).

The most seriously affected states in Nigeria included Plateau, Sokoto and Kaduna in the north as well as Lagos in the south (FOS 1996a). There are other diseases such as measles, chicken pox, small pox, pneumonia and meningitis whose incidences attain epidemic proportions during hotter parts of the year (Adejuwon 2006). One cannot avoid the conclusion that the occurrences of these diseases are related to the changing seasonal weather. Incidences of measles, chicken pox and small pox tend to be high during the hot and dry seasons. On the other hand, pneumonia, which ranks third after malaria and diarrhoea, with respect to mortality rates, is significantly associated with the middle of the rainy season in Southern Nigeria. Cerebro-spinal meningitis is a virus killer-disease, well-known in the drier, northern parts of the country (Adejuwon, 2006).

The roles of urban and peri-urban agriculture in food security, income generation to the farmers, provision of employment opportunity and environmental services are closely linked to climate change adaptation and mitigation in that UPA reduces pressure on environmental resources, which otherwise would have been inadequate in the absence of UPA. Also, land protection and careful land use in upstream peri-urban areas can help reduce flooding in urban areas (Zakri 2003).

According to Agbola (2011), vulnerability to climate change is closely linked to a lack of assets (sources of livelihood, sources of income, employment generation, etc.). Conversely, the greater the erosion of these assets, the greater the insecurity of people, and consequent predisposal to climate change (Agbola 2011). For instance, In Ibadan, a large percentage of farmers was able to increase their basic farm assets from income generated through their UPAF activities (Adeoti et al. 2010).

Compared to rural settings, cities are more heavily regulated and experience more intensive competition among a wider range of stakeholders for resources. Urban agriculture has in the past been at best ignored and at worst restricted or prohibited by local governments in the developing world. As many cities have already shown, agriculture can become an integral part of good environmental management of urban space. Cities and their inhabitants need green space to survive, and this is offered by urban agriculture (Urban Harvest 2007). Studies in the developed world have shown the importance of integrating agriculture into urban planning and development, and by so doing, making cities more sustainable places (Urban Harvest 2007).

Cities take in natural resources, process them, and in some way or the other create pollution. The open-loop polluting system of the city is closed through improved municipal solid waste systems in connection with urban agricultural activities. However, to make these systems sustainable, they have to be designed in economically viable, environmentally sound and socially uplifting ways (Holmer 2001). In many cities, private or municipal initiatives exist to collect household waste and organic refuse from vegetable markets and agro-industries in order to produce compost manure or animal feed for improved urban agricultural production.

Recycling waste and sewage sludge reduces the difficulty of disposing of solid wastes, replaces the use of expensive chemical fertilizers and prevents soil degradation and erosion in the agricultural areas thereby improving environmental quality and ecosystem service functions (Holmer,2001).

Urban and peri-urban agriculture is part of, in some cases, an integrated environmental policy, with its main benefit being the greening of the city, the raising of the awareness of the citizens towards nature. It is a part of the urban ecological system and plays an important role in the urban environmental management. The fast growing cities produce more and more wastewater and organic wastes. For most cities the disposal of wastes has become a serious problem. Urban and peri-urban agriculture has contributed to solving such problems by turning urban wastes into a productive resource (Konijnendijk, 1999). For instance, UPA in Ibadan, is integrated into the urban economic and ecological system: this integration includes the use of urban residents as labourers, use of typical urban resources (like plant residues, organic waste as compost and urban wastewater for agriculture, direct links with urban consumers, direct impacts on urban ecology (Agbola 2001).

Urban agriculture has positive impacts upon the greening of the city (May & Rogerson 1995; Konijnendijk 1999), improves the urban micro-climate (wind breaks and dusts reduction) (Heisler et al. 1995) and maintains biodiversity - which are all key factors in reducing the effects of climate change (Rees 1997). It also contributes to cleaning of the city by turning derelict open spaces into green zones. Degraded open spaces and vacant land are often used as informal waste dumpsites and a source of crime and health problems. When such zones are turned into productive green spaces, not only an unhealthy area is cleared, but also the neighbours will passively or actively enjoy the green area. Such activities may also enhance community self-esteem in the neighbourhood and stimulate other actions for improving the community livelihood (Konijnendijk 1999).

Urban and peri-urban agriculture may also take on an important role of providing recreational opportunities for citizens (recreational routes, food buying and meals on the farm, visiting facilities) or having educational functions (bringing youths in contact with animals, teaching about ecology, etc.). It contributes to the reduction of a city's ecological footprint by reducing the amount of energy used for transport, packaging, cooling, etc., by producing fresh foods close to the consumers (Konijnendijk 1999).

In Ibadan, there is a Waste Management Authority Edict of 1997, which delegated the functions of the 11 Local Government Councils in Ibadan under the 1979 Nigeria Constitution with respect to collection, transfer and disposal of solid waste to the Authority in order to ensure a good and clear environment (Ayorinde et al. 2007). Besides this primary function, other functions of the Authority include registration of Private Refuse Contractors in the City; maintenance of landfill sites around Ibadan; enforcement of all regulations concerning refuse collection, disposal and any other sanitation laws and preparation of management information on sanitation and environment (Ayorinde et al. 2007). Of interest to UPA is the offences regulations part of the Ibadan Waste Management Authority Edict under section (xv) and (xvi) where draining of wastewater from any premises in a manner likely to cause harm to health or public property, and birds or animals to stray onto roads or public places is not allowed (Ayorinde et al. 2007).

Another notable Environmental Planning and Management project implemented in Ibadan is the Sustainable Ibadan Project (SIP). It evolved as a result of the request of the Oyo State Government in 1991 to participate in the Sustainable Cities Programme (SCP) of the United Nations Human Settlements Programme (UN-HABITAT) and it effectively commenced in 1994. The implementation agencies of the project are the Oyo State and the eleven (11) Local Governments in Ibadan with technical and financial supports from UN-HABITAT and UNDP (Ayorinde et al.

2007). The Project (SIP) has both technical and physical outputs. The technical output is in form of improved capacity for environmental planning and management. The physical output is comprised of various capital development projects which are being implemented to solve identified prioritized environmental problems of concern in the city focusing on three (3) priority issues: Waste Management; Water Supply and Institutionalisation of the Environmental Planning and Management (EPM) process (Ayorinde et al. 2007). The Sustainable Ibadan Project has contributed to the promotion of UPA in the city through advocacy and pilot project demonstration. It facilitated the establishment of pace-setter organic fertilizer plant in Bodija market and the Ayeye community-based compost project both of which produce organic fertilizer for farmers' use in the city. It also organised demonstration sessions to city farmers (male and females) on the application of the compost on vegetables and food crops.

Urban greening through the use of trees, shrubs, flowers and grasses have important environmental and ecological roles, especially recreational and aesthetic benefits in Ibadan city (Cofie 2010). Trees and grasses absorb excess rainwater, help to avoid flooding, and improve the micro-climate of the city. They also provide fruits and other items for family nutrition (e.g. fruit trees and medicines). However, city authorities need to consider the concept of open spaces in the cities. Some initiatives in West Africa have created open spaces, parks and gardens (Cofie 2010). Other open spaces include the green areas between roads, recreational parks and gardens.

Urban and peri-urban agriculture and Forestry is important in environmental management. The link between UPAF and environmental sanitation is highly significant both for positive and negative reasons (Cofie 2005). On the positive side, in addition to supplementing rural agriculture in food supply, UPAF creates an avenue for recycling readily available urban organic wastes, thereby improving the productivity of farming systems as well as environmental health. It facilitates the recycling of waste such as poultry manure, cow dung, market/household waste, human waste etc. In and around cities in West Africa, use of waste for agriculture is well established and has been practised for centuries. Lewcock (1995) reported that in the 1960s 25% of fertilizer needs in the peri-urban environment of Kano were met by reuse of municipal waste. By the 1990s, the area in which waste was used had increased (Cofie 2005). Household wastes are usually generated in the largest proportion however, market wastes are more readily accessible for composting and have very high organic content coupled with a low potential of metal contamination. A study carried out in Ghana showed that farmers are positive and interested in using compost to ameliorate the soil and as a source of plant nutrients, provided it is of good quality and effective (Danso et al. 2003). In Kumasi, many farmers prefer to use poultry manure for crop production due to its high nutrient value (up to 2% N) and low price (only transport costs paid by farmers). In particular, there is high demand for municipal compost by estate developers and ornamental growers in Ghana (Cofie 2005). In the 1990s, it was reported that 90% of collected night soil in Tamale was used as fertilizer by farmers as an alternative to imported chemical fertilizer (Owusu-Bennoah & Visker 1994). This situation has not changed much after 10 years. Some farmers in Tamale and Bolgatanga reported to have used human waste to cultivate cereals (their major staple) around the cities for up to 30 years (Cofie et al. 2005). Usually, faecal sludge is applied by spreading it on the soil surface, or stored and dried in pits during the dry season and later incorporated into the soil at the onset of rainy season. The high temperatures of the savannah climate and long period of drying caused the sludge to be handled easily and to be relatively safe if properly

handled. Through this practice, significant amounts of nitrogen (N), phosphorus (P) and potassium (K) are returned to the soil. In addition, the organic matter level of soil gradually increases.

6.0 Possible pathways for UPAF's role in urban ecological resilience to climate change in different environmental settings of African cities

Scalable policy responses

Some sub-Saharan African cities are facing high rates of growth through combinations of natural increase and net in-migration that are outpacing their economic growth and ability to adequately manage the environment and provide the most basic services for millions of urban residents (e.g., adequate housing, food security, access to clean water, employment and education). Others are growing slowly but also lack adequate employment and welfare provision (cf. Cissé et al. 2005; Potts 2012a, 2012b). UPAF has the potential to ameliorate some of these concerns through the creation of jobs, enhancing food security and livelihoods, and acts as a mediating sub-system between climate change impacts and poverty on one hand and the provision of micro-level ecosystem services on the other, which can have a cumulative impact at the macro-scale (Grimm et al. 2008a; Grimm et al. 2008b; Lwasa et al. 2009; Padoch et al. 2008; Swalheim & Dodman 2008). Although the majority of UPAF research in Africa focuses at the micro-level or city scale, the intent of this project is to synthesize this research and formulate generalizations that can inform policymaking in cities of East and West Africa, and to also contribute to chapters outlined in the IPCC AR5 – Urban Areas and Human Settlements. Here we discuss policy responses from our case study cities which have the potential to be "scaled-up".

Formal recognition of UPA in land-use policies

Barriers to successful UPAF practices are widespread throughout East and West African cities. They include issues of insecure access to land, inappropriate or unclear land tenure arrangements, and a persistent failure to incorporate UPAF into urban planning policies because of its perceived inappropriateness in terms of outdated modernist planning norms (Schmidt 2012). Cities have begun to take steps to review bylaws and regulations which restrict or limit UPAF practices and that, in effect, do not allow for proper integration in city planning. For example, colonial zoning bylaws have been revised to allow for specific production systems in specific zones in Kampala, Uganda and Kumasi, Ghana (Atukunda 1998; Abutiate 1995). Agriculture has been incorporated into urban expansion plans for Kinshasa, Dar es Salaam, Dakar, Bissau and Maputo (Mougeot 2000). In Lagos and Ibadan, state governments have embarked on aggressive urban greening programmes which involve tree planting and grassing in strategic public open spaces including road medians and road setbacks and roundabout. The aim is to promote city aesthetics and also serving as a response to climate change. Furthermore, there are efforts underway by many municipal governments to reduce the amount of bureaucracy involved with securing land titles and to provide options for leasing public land and promote community engagement in UPAF (Bakker et al. 2000). Recognition of UPAF as a formal land-use is a first step towards including urban agriculture and livelihoods incorporating it into more

comprehensive and tailored city strategies to reduce their overall ecological footprint and increase resilience to climate change.

In this context, scalability can best be achieved through dissemination of individual city experiences and good practice guidelines derived from these and from the literature as reviewed in this study, as well as possible model regulations. The most appropriate dissemination routes would be via relevant NGOs and NGO coalitions, the various national and regional urban planning associations and networks, and international agencies like UN-HABITAT (which has a particular remit pertaining to urban shelter, planning and climate change mitigation/adaptation in low- and middle income countries) and the CGIAR's International Water Management Institute (IWMI), which has been active in the UPAF field, and bilateral and multilateral donor agencies.

Integrated systems

In many cities where waste collection services are scarce or inefficient, a decentralized or community-based approach to the recycling of organic waste is a practical solution. This not only helps to keep the city environment cleaner, (i.e., a large part of cities' garbage is organic, but is often simply dumped or illegally burned) (Bakker et al. 2000; Simon 2012b), but it also reduces the need for chemical/inorganic fertilizers, offers livelihood strategies for producing and marketing compost, and enhances soil fertility. McGregor et al. (2011) note that integrated organic waste recycling (IOWR) is a highly practical option in the peri-urban interface of Kumasi, Ghana, and that "the combination of methods at appropriate scales of intervention means that a range of strategies designed for local geographical contexts can be implemented." Waste recycling for crop production is widely used by farmers in Ibadan, Nigeria and Kampala, Uganda. The West African office of IWMI has been directly involved in IOWR promotion and experimentation with sterilization of human and animal faecal waste to make it suitable for use in UPAF. They and comparable agencies represent the most appropriate promoters of scalability of these lessons learned.

Based on ground-truthing and field verifications, four integrated systems that utilize nutrients, alternative sources of energy and closing the loop in flows are possible pathways for UPAF's contribution to building urban resilience.

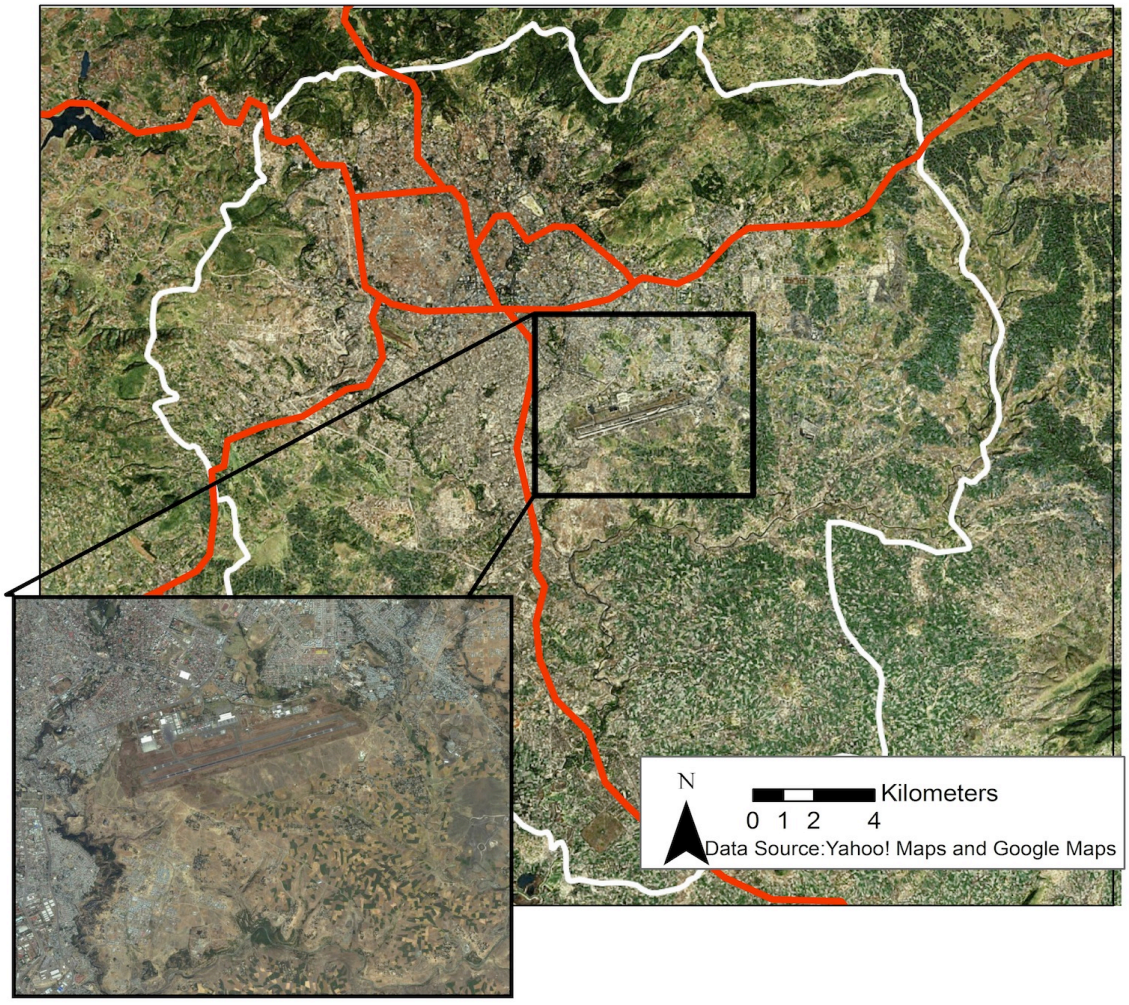
Integrated crop-livestock systems; in all cities assessed, there is evidence of this type of UPAF system practiced with benefits of enhancing food production and security but also nutrient recycling. The climate mitigation potential lies in reduced carbon footprint associated with long distance overhaul of food. While nutrient recycling and flows has a potential to reduce emissions associated with dumping organic wastes at landfills.

Integrated crop-forestry systems; this type of UPAF system can occur in two forms - First, with planting multi-purpose trees and shrubs that can produce food but also sequester CO_2. Evidence of the surfaces associated with this type suggests that this is a strong option for mitigation of climate change. The second is the form that can be practiced in peri-urban zones with a little more space for production. There is also evidence around agriculture's potential in

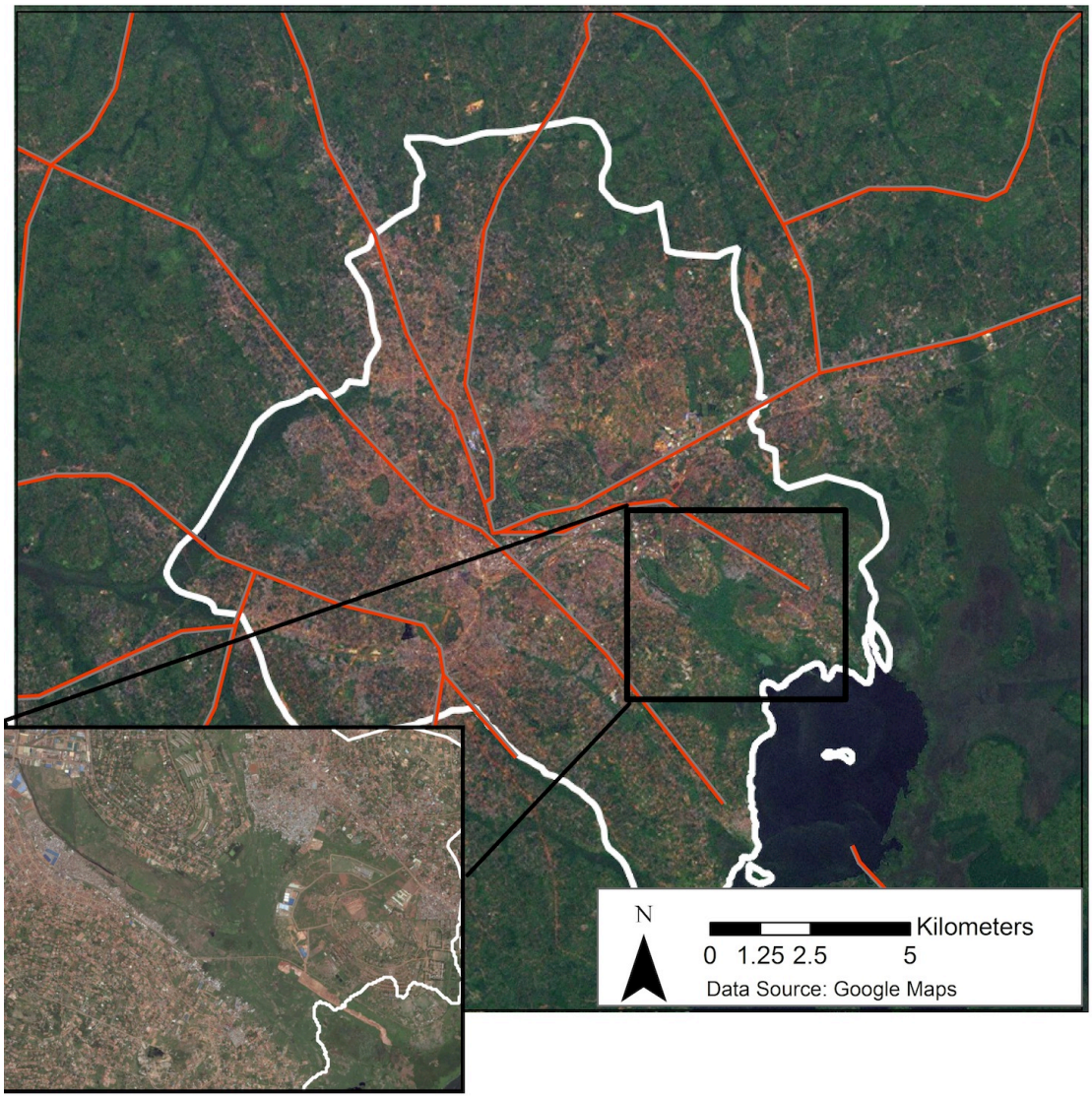
sequestering CO_2. The adaptation potential for this type to buffer climate change impacts like floods is also high, as exemplified in many of the neighborhoods of the cities assessed.

Aquaculture-livestock-crop systems; that which hinges around nutrient recycling and utilization and has a potential to reduce organic wastes that would otherwise emit GHGs. This type has a high potential to contribute toward food security and enhance livelihoods while mitigating climate change.

In cities with extensive peri-urban green zones or institutional land patches, *crop systems* still have a high potential to contribute significantly toward food security. Urban crop systems of a wide range of crop types can play a significant role in addressing the urban heat island, coastal erosion and flood control.



Addis Ababa's greenness has potential for mitigation and adaptation.



Kampala's greenness is a springboard for adaptation to floods but also mitigate urban heat island

7.0 Urban Policy and response to climate resilience

Up until recently, urban authorities within many sub-Saharan African cities have generally shared rather negative views regarding the practice of UPAF, mainly due to the perceived public health and environmental risks. Although research has shown that UPAF has many benefits and potential for addressing complex problems within cities of sub-Saharan Africa, political constraints remain problematic and its incorporation into planning is very often neglected. Much of this stems from long-standing restrictive policies, laws, and regulations due to the "illegal" status of UPAF, confusion surrounding land tenure and property rights as well as a lack of support for agricultural services, and organization and representation of urban farmers (Deelstra & Girardet 2000). Nowadays, the political mind frame in many East and West African cities is more neutral or tolerable of UPA; the majority of policies which do exist have implicit goals of alleviating poverty or enhancing food security. The IDRC, Resource Centres on Urban Agriculture and Food Security (RUAF) and Urban Harvest have supported both research and policy development in many African countries and across the world, as has the Urban Management Programme (UMP) and several agencies of

the UN (Lee-Smith, 2010). However, more effort must be put into wider acceptance and integration into, for example, ecosystem and landscape management, and waste and wastewater management policies. This is particularly important given effects of global environmental change, including climate change, which will create new environmental, economic, and social challenges for urban areas and exacerbate many of the problems they already experience - affecting to a greater extent and the urban poor and other vulnerable groups (de Zeeuw & Dubbeling 2009). The UN Populations Fund (UNFPA) indicates that climate change disproportionately affects people 'who live in slum and squatter settlements on steep hillsides, in poorly drained areas, or in low lying coastal zones' (UNFPA 2007). A step in the right direction requires the recognition of UPA as an integral part of the urban socio-economic and ecological system and a key component in comprehensive strategies for building resilience to climate change within the urban area (Mougeot 2000; de Zeeuw et al. 2011).

Despite the effects of climate change which include irregularities in the rainfall pattern as well as extreme weather events such as thunderstorms, heat waves, heavy winds, and floods – all of which devastate farmlands and can lead to food shortages due to crop failure, a number of pathways exist for UPAF to improve the urban ecological environment in cities and to become more resilient. UPAF is a means to keep areas that are vulnerable to flooding or landslides free from construction and to maintain their natural functions (enhancing water storage and infiltration; reducing run off) resulting in less floods and reduced impacts of prolonged and heavy rainfall as a result of climate change (Dubbeling et al. 2009). To this end, policies in Dar es Salaam, Tanzania reserve temporarily flooded areas for UPAF, and urban agriculture is commonly practiced in valleys, plains and hillsides of cities within Kenya and Nigeria (Hoornweg 2008).

Urban and peri-urban forestry and greening (UPFG) has unfortunately received little attention on political agendas (Knuth 2005) despite its ability to enhance/preserve local biodiversity and vegetative cover particularly through the maintenance of green open spaces. However, Pretoria, South Africa has incorporated UA into the management of its urban open spaces and has allotted various sections of land within the city to UA (Bakker et al. 2000). Policy in Dar-es-Salaam allows for virtually unregulated backyard farming (for the better-off) and open-space farming (for the poor). The cultivation of UPAF including urban forestry in these areas helps improve the urban micro-climate, minimizing the effects of the urban heat island and reducing energy use and the emissions of greenhouse gases through shortening the distance of food transport from the rural to the urban setting (de Zeeuw et al. 2011).

Recycling and reuse of wastewater reduces the demand for fresh water supplies and pollution caused by the discharge of wastewater into rivers and streams, and leakage into aquifers (Buechler et al., 2006). Urban wastewater can also be recycled for use as irrigation of horticultural crops as well as forested plantations that serve to combat desertification and provide energy through the burning of fuel wood and charcoal; these plantations can create the types of green spaces noted above that benefit low-lying areas and steep slopes (de Zeeuw et al., 2011). Health and environmental risks associated with the use of untreated wastewater and polluted surface water can be reduced through measures outlined in the World Health Organization guidelines for the safe use of excreta and wastewater (WHO 2006). These guidelines are extremely useful in cities which do not have the water treatment options.

Furthermore, the composting of organic materials eliminates wastes in landfills and provides nutrient-rich material, conserving and enhancing soils, and offering alternatives for livestock feed (Deelstra & Girardet 2000). In Ibadan, Nigeria and Accra, Ghana wastes are commonly converted to organic fertilizers for improved crop production. Farmers who have been involved in waste recycling in Ibadan understand the interwoven character of UPAF and environmental management in that it keeps the city clean and also and also provides jobs for residents. Reduction/reuse of solid waste is a strongly promoted urban waste management strategy in the region. Additionally, Katongole et al (2011) assessed household level factors underlying the use of market crop wastes as feed in Kampala, Uganda, in which they established that nearly half of the animal workers have at some time used these wastes to feed animals and improve soil fertility. These activities would be further encouraged if municipal policies are developed to support depots for livestock waste for use in co-composting, and for food and other organic waste for livestock feed and co-composting (Lee-Smith 2010).

The World Meteorological Organization (WMO) suggests that urban and indoor farming should be incorporated into strategies for building more resilient cities (de Zeeuw et al. 2011). Urban agriculture is a complex area for policy, potentially involving several different policy goals such as poverty and hunger alleviation; economic growth through value addition; and ecological urban management. The potential for win-win solutions are there, but require a comprehensive framework for assessing the potential solutions as well as tradeoffs during the design phase (Lee-Smith, 2010). In order to realize the potential of urban agriculture, particularly in the case of urban ecological resilience to climate change, much more must be done that what is currently happening in many East and West African cities. Integrating policies that focus on the social dimensions of UPAF (i.e., food security and poverty alleviation) and the economic (job creation and income generation) with those that take an ecological perspective (de Zeeuw et al. 2011) highlighting the multi-functionality of urban agriculture as previously discussed (reduction of GHG emissions through local production, maintenance of green spaces, reuse of urban wastewater, etc.) will be a critical in this regard.

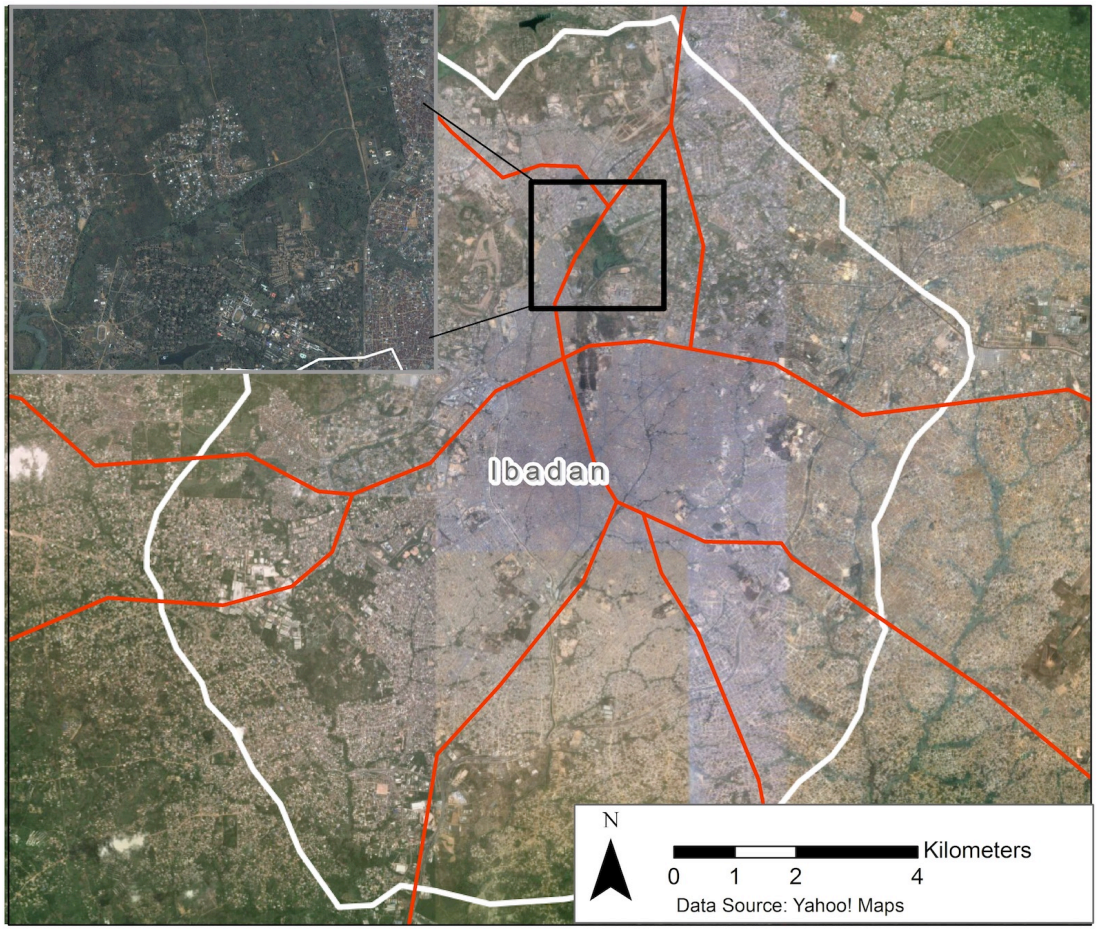
3.3.1 Policy Action and leverage of adaptation and mitigation funds

National policies, integrated planning and policies, financial incentives (e.g., taxes, subsidies), research and development policy, standards and regulations that incorporate climate change considerations, integrated land use planning and, most often, linkages across policy sectors and to 'sustainable development' are some of the policy frameworks cited as relevant to enabling climate change mitigation and adaptation (Dovers & Hezri 2010; Hussey & Dovers 2007; IPCC 2007). The presence of the necessary institutional framework and the existence of such policy structures is important element for a country's potential to access climate change financing. Such institutions provide supportive frameworks for the government to make decisions on climate change priorities, and fully integrating climate change issues into national policies as clear signals for project developers (public and private sector promoters, NGOs, communities) and local authorities on potential areas for mitigation and adaptation activities. Utilizing the Initial National Communication (INC) and National Adaptation Programme of Action (NAPA) to the UNFCCC, cities can play a leadership role in building resilient systems. For example, with the expansion of

CDM to urban projects, well designed UPAF projects have the potential to support access to adaptation funding (Coninck et al, 2007; UNCCD 2009). However, the established urban specific institutional framework to support the development of mitigation and adaptation projects is still requiring. Many of the project ideas relate to the agricultural land-use, forestry, and renewable energy sectors. More specifically, this involves activities that focus on urban agriculture and urban forestry. However, the lack of clarity observed in some of these key documents raises concerns as to the degree that mitigation and adaptation priorities have been identified and incorporated into national and urban specific policies 2009; URT, 2007).

8.0 Future Directions

This research synthesizes literature and has identified possible pathways, opportunities and limitations of Urban and Peri-Urban Agriculture as well as Urban Forestry. There are two areas in which future research would consider focusing. The first area is the assessment of thresholds for mitigation of climate change such as GHg emissions reduction for different scenarios and pathwys. The data synthesized in this report identifies city-specific thersholds but urban areas both between and iwthin are characterized by differences in surfaces as well as urban fabric that influences mitigative potential. Thresholds at various scales of urban development will be useful in translating the potential into policy. The second issues are in respect to adaptation to climate change in African cities. The co-benefits of adaptation will require more indepth assessment to translate into policy. Policy directions will benefit from indepth assessments and adaptation of theidentifed pathways for building resilience. The greenness of the assessed cities differes but provides a basis for future assessment.



Greeness of Ibadan and the roel of institutions like military that occupy arge pieces of land can be a basis for adaptation and mitigation

9.0 Conclusion

Reviewed literature has evidenced that Urban Peri Agriculture and Forestry (UPAF) has supported urban populations as a livelihood strategy, enhanced food security and enhanced urban ecosystem services. Though challenges and risks of UPAF exist, studies also indicate that if well managed, different UPAF activities of crop systems, crop-livestock integrated systems, crop-forestry systems and aquaculture-livestock-crop integrated systems have a high potential in promoting adaptation to climate change in cities. The role in mitigating climate change is also evident through reduction of carbon footprint of food systems but also recycling nutrients and energy sources to reduce emissions. Urban Climate resilience is largely an unchartered field with the uncertainties around climate change trajectories as well as responses to the risks. Although there are several studies and reports focused on challenges and means of building climate resilience, its not clear at city-scales how these generic strategies can translate into practical solutions that cities need to mitigate and adapt to climate change. From the synthesis of literature and field verifications, building urban resilience will require three main broad set of activities at city-regional and global scale. First is addressing the development deficit in the cities of East and West Africa. Filling the development deficit in cities will support adaptation to threats but building long-term resilience with support infrastructure. Second is the reform of institutional architecture and policy to support urban landscapes that are multi-functional within

which UPAF and other climate sensitive activities can be encouraged and supported. Thirdly urban resilience will require broad international support through sharing of knowledge and other resources that can help scale out and scale up best practices. These three broad set of activities have a high potential and likelihood to mainstream UPAF as one of the mediating processes for adaptation and mitigation of climate change.

Reviewed publications

SOURCE	TITLE	AUTHOR(S)	FILE URL	FILE TYPE	PUBLICATION TYPE
1	**Innovative Spatial Planning in Mitigating Climate Change-Related Vulnerability in Nigerian Urban Centres.**	**Sanusi, Y.**	**http://www.corp.at**	**Pdf**	**Conference paper**
2	**Urban Agriculture in Ilorin, Kwara State**	Olayioye, J.T.		Hard copy	Dissertation in the Department of Urban and Regional Planning, University of Ibadan
3	**Grasscutter Rearing as an Urban Agricultural Practice in Ibadan Metropolis**	Akinbile, L.A.		Hard copy	Article in a Journal
4	**Beekeeping as an income generating activities: A case study of honey bee Farmers in Ibadan Metropolis**	Adekoya, A.E., Ahmed-Akinola, A.A. and Fashola, A.A.		Hard copy	Article in a Journal
5	**Contribution of Home Gardening to Household Food Security in Egbeda LGA, Oyo State**	Akinbile, A.A.		Hard copy	Conference paper
6	**Explaining the Implications of Climate Change and the Associated Farmers' Risk Preferences in Nigerian Agricultural**	Salman, K.K.	http://www.americanscience.org	Pdf	Article in a Journal

	Economy				
7	**Urban Agriculture for Green and Productive Cities**	René van Veenhuizen	www.ruaf.org.	Pdf	Book
8	**Marketing of Cassava Products among Women in Oyo State, Nigeria**	Fawole, P.O. and Odebode, S.O.		Hard copy	Article in a Journal
9	**Gender Participation of Melon Framers in Ibarapa Area of Oyo State, Nigeria.**	Odebode, S.O.		Hard copy	Article in a Journal
10	**Assessment of the Practice of Home Gardening in Egbeda Local Government Area, Oyo State**	Afolabi, S.A.		Hard copy	Dissertation
11	**Perceived health and environmental related factors associated with urban agricultural activities in Ibadan metropolis**	Okubadejo, O.O.		Hard copy	Dissertation
12					
13	**Climate Change and Poverty in Nigeria.**			Hard copy	Article in a Journal
14	**Sustainable Urban Agriculture in Developing Countries:A Review**	De Bon H, Parrot L, Moustier P	www.agronomy-journal.org	Pdf	Journal article
15	**Dynamics and Sustainability of Urban Agriculture: Examples from sub-saharan Africa.**	Drechsel P, Dongus S		Pdf	Journal article
16	**Resource Use Efficiency in Urban and Peri-urban Sheep, Goat and Cattle Enterprizes**	Diogo R.V.C, Buerkert A, Schlecht E		Pdf	Journal article

17	**Market Mechanisms, Efficiency, Processing and Public Health Risks in Peri-urban Dairy Products Markets: Synthesis of Findings from Ghana and Tanzania**	Omore A, Staal S.J, Osafo E.L.K, Kurwijilla L, Barton D, Mdoe N, Nurah G, Aning G	research.dfid.gov.uk	Pdf	Technical Report
18	**Environmental Lead Pollution and Food Safety around Kampala City in Uganda.**	Leonard R. Mghweno, Anselimo O. Makokha, Happy S. Magoha, John M. Wekesa, Amina Nakajugo	www.biosciences.elewa.org	Pdf	Journal article
19	**Potentials, Problems, and Policy Implications for Urban Agriculture in Developing Countries**	Erik Bryld	www.springerlink.com/index/p208q4158p3q4122.pdf	Pdf	Journal article
20	**Urban Agriculture in Low Income Households of Harare: An Adaptive Response to Economic Crisis**	Kutiwa S, Boon E, Devuyst D		Pdf	Journal article
21	**Urban and peri-urban Agriculture in Developing Countries Studied Using Remote Sensing and In Situ Methods**	Kwasi Appeaning Addo	www.Mdpi.com/journal/remotesensing	Pdf	Journal article
22	**The role of Urban Agriculture in building Resilient Cities**	De Zeeuw H,Van Veenhuizen R, Dubbeling M		Pdf	Journal article
23	**Heavy Metal Contamination in Vegetables Cultivated on a Major Urban Wetland Inlet Drainage System of Lake Victoria, Uganda.**	Mbabazi, J., Wasswa, J., Kwetegyeka, J., Bakyaita, GK	http://www.tandfonline.com/page/terms-and-conditions	Pdf	Journal article
24	**Farming as a Livelihood Source for the Urban Poor of Nakuru, Kenya**	Dick. W.J. Foeken, Samuel O. Owuor		Pdf	Journal article
25	**Climate change, urban flooding and the rights of the urban poor in Africa**	Action Aid	http//www.actionaid.org	Pdf	Technical Report
26	**Understanding vulnerability of coastal communities to climate change related risks**	Dolan A. H. and I. J. Walker		Pdf	Article in a Journal
27	**RUAF in Ibadan-Nigeria**	Adeoti, A., Hope L. and Cofie, O.	http//ruaf.iwmi.org	Hard copy	Article a Magazine
28	**Assessment of the Benefits and Constraints of Home Gardening in the Neighborhood of the National Horticultural**	Olajide-Taiwo, F.B., Adeoye, I.B., Adebisi-Adelani, O.,		Pdf	Article in a Journal

	Research Institute, Ibadan, Oyo State	Odeleye, O.M.O., Fabiyi, A.O. and Olajide-Taiwo, L.O.			
29	**Assessment of irrigation systems for dry season vegetable production in urban and peri-urban zones of Ibadan and Lagos, Southwestern Nigeria.**	Ojo, O.D., Connaughton, M., Kintomo, A.A., Olajide-Taiwo, L.O.		Hard copy	Article in a Journal
30	**Urban and Peri-urban agriculture in Ibadan. Characteristics, Challenges and Prospects. A Policy narrative:**	Resource Centres on Urban Agriculture and Food Security, RUAF	http//www.ruaf.org	Pdf	Technical Report
31	**Urbanization and Extreme Weather: Vulnerability of indigenous**	Adelekan, I.O.		Pdf	Conference paper
32	**Vulnerability of Poor Urban Coastal Communities to Climate Change in Lagos, Nigeria**	Adelekan, I.O.		Pdf	Paper presented at a symposium
33	**Food Security Initiative in Nigeria: Prospect and Challenges**	Arthur E. D		Pdf	Article in a Journal
34	**Ensuring Food and Nutrition Security in Rural Nigeria: An assessment of challenges, information needs and analytical capacity**	Akinyele, I.O.	www.ifpri.org	Pdf	Background paper
35	**Urban agriculture and food security, nutrition and health**	Armar-Klemesu, M.		Pdf	Conference paper
36	**The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones**	McGranahan, G. Balk, D., and Anderson, B.		Pdf	Article in a Journal
37	**Executive summary of five multi-sector surveys on nigeria's vulnerability to climate change.**	The Nigerian Environmental Study/Action Team (NEST)	www.nest-interactive.org	Pdf	Article on the internet
38	**Climate Change Adaptation Strategy**	NEST & Tegler, B.		Pdf	Technical Report
39	**Urban and Peri-urban agriculture in Ibadan. Characteristics, Challenges and Prospects. A Policy Narrative:**	Resource Centres on Urban Agriculture and Food Security (RUAF)	www.ruaf.org.	Pdf	Technical Report
40	**Planning for Climate Change. A Strategic, Values-based Approach for Urban Planners.Version 1: for field testing and**	UN-Habitat		Pdf	Book

	piloting in training				
41	**Industry, Settlement and Society**	Wilbanks, T. and Lankao, P.R., Bao, M., Berkhout, F. and Cairncross, S.			Book
42	**Agricultural trade liberalization and food security in Nigeria**	Abdullateef, U. and Ijaiya, A.T.	http://www.academicjournals.org/JEIF	Pdf	Article in a Journal
43	**Migration and urbanization in francophone West Africa: a review of the recent empirical evidence**	Beauchemin, C., Bocquier, P.		Pdf	Technical Report
44	**Migration and urbanization in francophone West Africa: a review of the recent empirical evidence**	Beauchemin, C., Bocquier, P.		Pdf	Technical Report
45	**Annual report and statement of accounts**	Central Bank of Nigeria			Annual Report
46	**Rural Livelihoods and Diversity in Developing Countries**	Ellis, F.		Pdf	Book
47	**"To subsidise my income". Urban farming in an East African town.**	Foeken, D.		Pdf	Book
48	**Multi-spatial livelihoods in sub-Saharan Africa: rural farming by urban households – the case of Nakuru, Town, Kenya.**	Foeken, D. and Owuor, S.O.		Pdf	Article in a Journal
49	**Farming as a livelihood source for the urban poor of Nakuru, Kenya.**	Foeken, D.W.J. and Owuor, S.O.		Pdf	Article in a Journal
50	**Migration and urban survival strategies in Windhoek, Namibia**	Frayne, B.		Pdf	Article in a Journal
51	**Policies on managing risk in agricultural markets**	Larson, D., Anderson, J. and Varangis, P.	http//wbers.oxfordjournals.org/	Pdf	Article in a Journal
52	**Alleviating transitory food crises in sub-Saharan Africa**	Lavy, V.	http//wbers.oxfordjournals.org/	Pdf	Article in a Journal
53	**Framework for Food Security and Poverty Reduction in Nigeria**	Oriola, E.O.		Pdf	Article in a Journal
54	**Improving Food Security through Environmental Management in Ibadan**	Wahab, B., Sridhar, M.K.C and Ayorinde, A.A.	www.ruaf.org.	Pdf	Article in Urban Agriculture magazine
55	**Introducing Urine as an Alternative Fertiliser Source for Urban Agriculture: Case studies from Nigeria and Ghana**	Cofie, O., Adeoluwa O. and Amoah, P.		Pdf	Article in Urban Agriculture magazine

56	**Urban Agriculture and food security in Abuja: An Enquiry**	Egbuna, E.N.		Hard copy	Ph.D Thesis
57	**Effects of Gender Differences on Access To Technologies Among Farmers In Ibadan/Ibarapa Agricultural Zone Of Oyo State, Nigeria**	Adeola, R.G. and Ayoade, A.R.		Pdf	Article in a Journal
58	**Farming in the Urban Environment of a in a developindg nation- a case study from ibadan metropolis, nigeria**	Gbadegesin, A.			article in journal
59	**Economic Analysis of Swine Production in Nigeria: A Case Study of Ibadan Zone of Oyo State**	Ogunniyi, L. T. and Omoteso, O. A.		Pdf	Article in a Journal
60	**Economic Viability of Cat Fish Production in Oyo State, Nigeria**	Olagunju, F. I., I. O. Adesiyan and A.A. Ezekiel			Article in a Journal
61	**Effect of Capacity Building on Production of Safe and Profitable Leafy Vegetables among Farmers in Ibadan City of Nigeria.**	Olajide-Taiwo, L.O., Cofie, O., Odeleye, O.M.O., Olajide-Taiwo, F.B. Olufunmi Y. Adebayo, O.S. and Alabi, O.O.		Pdf	Article in a Conference Proceedings of First All African Horticultural Congress
62	**The Political Economy and Urban food security in sub-saharan Africa.**	Maxwell, D.	systems		Article in a Journal
63	**National Food Crisis Response Programme**	Oyedipe, E.O.	www.fao.org	Pdf	Technical Report
64	**Assessment of Poverty among Urban Farmers in Ibadan Metropolis, Nigeria**	Yusuf, S. A. Adesanoye, A. O. and Awotide, D. O.		Pdf	Article in a Journal
65	**Poverty and Sustainable Cities in South Africa: The Role of Urban Cultivation**	May, J. and Rogerson, C.M.		Pdf	Article in a Journal
66	**Approaches and actors in urban food security in developing countries**	Atkinson, S.J.		Pdf	Article in a Journal
67	**The political economy of urban food security in Sub-Saharan Africa**	Maxwell, D.	www.elsevier.com/locate/worlddev	Pdf	Article in a Journal

68	**Understanding the terrain: assets and food security. In Frayne, B., Moser, C. and Ziervogel, G. (eds.) Climate Change, Assets and Food Security in Southern African Cities.**	Frayne, B., Moser, C. and Ziervogel, G.		Pdf	Book
69	**Urban Food Security and Climate Change: A system of flows. In Frayne, B., Moser, C. and Ziervogel, G. (eds.) Climate Change, Assets and Food Security in Southern African Cities.**	Battersby, J.		Pdf	Book
70	**The Informal Food Economy in a Peripheral Urban District: The case study of Bandim District, Bissau**	Lourenco-Lindell, I.		Pdf	Article in a Journal
71	**Adapting to climate change: Agricultural system and household impacts in East Africa**	Thornton, P.K., Jones, P.G., Alagarswamy, G., Andresen, J and Herrero, M.	www.elsevier.com/locate/agsy	Pdf	Article in a Journal
72	**Climate Change 2007: Impacts, Adaptation and Vulnerability. Summary for Policy Makers.**	IPCC, Intergovernmental Panel on Climate Change	<http://www.ipcc.cg	Pdf	Technical Report
73	**Ecosystem Services in Southern Africa: a Regional Assessment. Millennium Ecosystem Assessment**	Scholes, R.J. and Biggs, R.	<http://www.millenniumassessment.org>.	Pdf	Technical Report
74	**Attributing physical and biological impacts to anthropogenic climate change**	Rosenzweig, C., Karoly, D., Vicarelli, M., Neofotis, P., Wu, Q., Casassa, G., Menzel, A., Root, T.L., Estrella, N., Seguin, B., Tryjanowski, P., Liu, C., Rawlins, S. and Imeson, A.		Pdf	Article in a Journal
75	**Urban and Peri-urban Agriculture: Towards a better understanding of low-income producers' organizations**	Egyir, I.S. and Ackah-Nyamike Jnr., E.E.		Pdf	Technical Report
76	**Are there social limits to adaptation to climate change?**	Adger, W.N., Dessai, S., Goulden, M., Hulme, M., Lorenzoni, I., Nelson , D.R., Naess, L.O., Wolf, J. and Wreford, A.		Pdf	Article in a Journal
77	**Collapse: how societies choose to fail or survive**	Diamond, J.		Pdf	Book
78	**Urban Agriculture as a Poverty Reduction Strategy in Nigeria; the Case of Ibadan, Oyo State**	Oyejide, O.T.		Hard	dissertation

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79	**Review and Analysis of Policies, Regulations and Legislative Frameworks on Urban and Peri-urban agriculture**	Ayorinde, A.A., Oyedokun, P.O., Oladele, J.O., Akinbobola, A.A., Adeniran, F.O., Olanrewaju, F.O., Tairu, T.T., Oladokun, M.O. and Oyeleye, O.S.		Har d co py	Technical Report
80	**Cost and returns in the marketing of**	Yakubu, F.B., Idumah, F.O. and Anamayi, E.S.		Pd f	Article in a Journal
81	**Why urban agriculture? Notes for the IDRC Development Forum on Cities Feeding People: A Growth Industry**	Rees, W.			Technical Report
82	**Avoiding dangerous climate change**	Schellnhuber H.J., Cramer, W., Nakicenovic, N., Wigley, T., Yohe, G.		Pd f	Book
83	**Nigeria Food Security Outlook**	USAID	www.fews.net/nigeria	Pd f	Short communication
84	**Regional Study on Agricultural Support, Nigeria's Case.**	Okolo, D.A.		Pd f	Technical Report
85	**Emerging Issues in Urban and peri-urban agriculture (UPA) in West Africa: Briefing Note**	Cofie, O.	www.ruaf.org.	Pd f	Brief note
86	**The Status of Greenhouses Utilization in Oyo State, Nigeria.**	Yahaya, M. and Gbadebo, I. O.	jeteas.scholarlinkresearch.org	Pd f	Article in a Journal
87	**Urbanization and Food Security in Sub-Saharan Africa**	FAO		Pd f	Conference paper
88	**Urban Agriculture for Green and Productive Cities**	René van Veenhuizen	www.ruaf.org.	Pd f	Book
89	**Comparative Analysis of Cassava and Sweet Potato Improved Processing Techniques in Nigeria: Rural Women Experience**	Odebode, S.O. and Fawole, O.P.		Har d co py	Article in a Journal
90	**Food potentials of snail in human nutrition**	Ebiloma, S.O.		Har d	Article in a Journal

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91	**Assessment of Home Gardening as a Potential Source of Household Income in Akinyele Local Government Area of Oyo State**	Odebode, S.O.		H ar d co py	Article in a Journal
92	**Acceptability of Sweet Potatoes Spari and Its Potentialn for Enhancing Food Security and Economic Empowerment of Rural Women in South-Western, Nigeria.**	Odebode, S.O.		H ar d co py	Article in a Journal
93	**Sustaining Urban Agriculture Requires the Involvement of Multiple Stakeholders. In Urban Agriculture for Green and Productive Cities. Cities Farming for the Future**	Dubbeling, M. and Merzthal, G.		Pd f	Book
94	**Urban Agriculture: Definition, Presence and Potentials and Risks**	Mougeot, L.J.A.		Pd f	Thematic Paper
95	**Nigeria Agricultural Growth, Poverty Reduction and Food Security: Past Performance and Prospective Outcomes.**	NFSP		Pd f	Technical Report
96	**Health and Safety in Agriculture and Food Security Nexus**	Olowogbon, S.T.		Pd f	Article in a Journal
97	**The household strategies of the urban poor: Coping with poverty and recession in Gweru, Zimbabwe.**	Rakodi, C.		Pd f	Article in a Journal
99	**Best Management Practices for Fish Farmers in Nigeria**	USAID	www.nigeria.usaid.gov	Pd f	Technical Report
99	**Impacts of urban agriculture**	Urban Harvest		Pd f	Book
10 0	**Urban Ecosystems Analysis: Identifying Tools and Methods**	Zakri, A.H.	http://www.ias.unu.edu	Pd f	Technical Report
10 1	**A livelihoods approach – conceptual issues and definitions. In: Rakodi, C., Lloyd-Jones, T. (Eds.), Urban Livelihoods: A People-Centred Approach to Reducing Poverty**	Rakodi, C.		Pd f	Book

102	**The state of the world's cities 2006/7**	UN-Habitat		Pdf	Technical Report
103	**Rural-urban interactions: A guide to the literature**	Tacoli, C.		Pdf	Article in a Journal
104	**Effect of irrigation amount and tillage system on yield and water use efficiency of cowpea**	Adekalu, K.O., Okunade, D.A.		Pdf	Article in a Journal
105	**Small Scale Fresh Water Fish Farming**	Assiah, Van Eer, O., Ton van Schie and Hilbrands, A.			Book
106	**The peri-urban interface: a tale of two cities**	Brook, R.M. and Dávila, J.D.			Book
107	**Urban Agriculture: A Strategy for Poverty Reduction in Nigeria**	Egbuna, E.N.	www.cbn.org	Doc.	Technical report
108	**Food Security, Climate Variability and Climate Change in Sub Saharan West Africa**	Adejuwon, J.		Pdf	Technical Report
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244	**Perception of Agricultural Information Needs by Small-Scale Maize Farmers in Isin Local Government Area of Kwara State**	Adebayo, O. O. and Oyetoro, J. O.		Pdf	Article in a Journal
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274	**Emissions of ammonia, nitrous oxide and carbon dioxide from urban gardens in Niamey, Niger**	Predotova, M., Gebauer, J., Diogo, R.V.C. Schlecht, E. and Buerkert, A.	www.elsevier.com/locate/fcr	Pdf	Article in a Journal
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Project-related Products (already out and still pending)

1. Simon. D., S. Lwasa., B. Wahab B., F. Mugagga., D. Mukungu., A. Adesoji., C. Griffith. (2012). Urban and Peri-Urban Agriculture: Transcending Poverty Alleviation to Mitigating Climate Change. Paper presented at the Royal Geographical Society (RGS)/IBG Annual Conference (Session on Adapting to Climate/Environmental Change: The Urban Challenge). 4th July 2012, University of Edinburgh, United Kingdom

APPENDICES

Appendix 1: Reports, including stakeholder workshop reports

STAKEHOLDER MEETING HELD AT HOTEL AFRICANA-KAMPALA, 6TH FEBRUARY 2012.

Programme

Time	Activity	Facilitator
08:00 – 08:30	Arrival and registration	David
08:30 – 09:30	Debriefing and project overview	Shuaib and Frank
09: 30 – 10:00	Tea break	
10:00 – 12:30	Plenary discussion (Evidence-based) 1. Contribution of UPA to livelihoods and food security in Kampala city and environs (Discussion to focus on provisioning and sustenance services such as food production and supplies, health and nutrient provision, UPA's economic feasibility, UPA policy issues (incl. legalization, regularization in land use plans, support ordinances, etc)). 2. Ecological services derived and or enhanced from UPA in Kampala and environs (Regulatory services including nutrient recycling through waste recycling, soil formation, flood attenuation, micro climate moderation etc)	Frank and Shuaib
12:30 – 14:00	Lunch	
2:00 – 15:30	Plenary discussion (Cont'd) 3. Contribution of UPA to climate change mitigation, adaptation and ecological resilience in Kampala city and environs (Supporting services to GHG emission reduction, flood attenuation, micro climate moderation, etc)	Frank and Shuaib
15:30 – 16:00	Tea Break	
16:00 – 17:00	Wrap up and way forward	Frank and Shuaib

Prospective stakeholders and invitation status

	Stakeholder	Affiliation	Telephone contact
1.	The Director- Crop Resource	Ministry of Agriculture, Animal Industry & Fisheries	0772589642
2.	Faith Gubya (Mrs)	Agriculture Officer(Kampala Capital City Authority)	0712886637
3.	Justin Ssesanga	Agriculture Officer (Makindye	0772499825

	(Mrs)	Division)	
4.	Florence (Ms)	Agriculture Officer (Nakawa Division)	0712830190
5.	Sophie Musaana (Ms)	Plant Geneticist, Horticultural Program, NACCRI	0772665303/0712255205
6.	Muhammed Bukenya (Mr)	Lecturer - CAES, MUK	0772893233
7.	Nadiope Moses (Mr)	Urban Farmer	0712482492
8.	Betty Onek (Mrs)	Urban Farmer	0772407722
9.	Placid (Mr)	Urban Farmer	0772458128
10.	David Mukungu (Mr)	Graduate Research Assistant	0782949353
11.	Frank Mugagga (Dr)	Co – Principal Investigator	0772 968421
14.	Shuaib Lwasa (Dr)	Principal Investigator	0772 461727

PROGRAMME FOR FIRST TEAM MEETING (UPA PROJECT) HELD AT HOTEL AFRICANA, KAMPALA UGANDA, 18TH – 21ST FEBRUARY 2012.

Day and time	**Activity**
Friday 17 .02.12	Arrival of partners
09.10	Wahab arrives
22:10	Simon and Corrie arrive
Saturday, 18.02.12	
09:30 – 10:30	Getting refreshed about the Project (objectives, methods etc). What has been accomplished so far?
10:30 – 11:00	Tea Break
11:00 – 12:30	The draft research protocol and data entry matrix
12:30 – 14:00	Lunch (Hotel Africana)
14:00 – 15:30	The draft research protocol and data entry matrix (cont'd)
15:30 – 16:00	Tea Break
16:00 – 17:00	Wrap up of day one
19:00 – 20:00	Welcome Dinner????? Where? Kitobero Res
Sunday, 19.02.12	
11:00 – 12:30	Pick up from hotel
12:30 – 14:00	Lunch (Venue???)
14:00 – 17:30	Field visits
18:30 – 20:30	Dinner(Shuaib's Home)
Monday, 20.02.12	
09:30 – 10:30	Using ZOTERO (hands – on)
10:30 – 11:00	Tea Break
11:00 -12:30	The assessment procedure (agreement and confidence evaluation)
12:30 – 14:00	Lunch (Hotel Africana)
14:00 – 15:30	The assessment procedure (agreement and confidence evaluation) (Cont'd)

15:30 – 16:00	Tea Break
16:00 – 17:00	Working with the data collection matrices (Hands-on) (cont'd)
17:00 – 17:30	Wrap of day 3
18:30 – 20:30	Dinner (El Patio Restaurant)
Tuesday, 21.02.12	
09:30 – 10: 30	Working with the evaluation matrix (Hands-on)
10:30 – 11:00	Tea Break
11:00 – 12:30	Wrap up of the meeting and way forward
12:30 – 14:00	Farewell Lunch (Hotel Africana)

SPECIFIC POINTS OF ACTION AND TIMELINES ARISING OUT OF THE FIRST TEAM, FEBRUARY 18TH-21ST, 2012.

1. **Fieldwork in a Third Focus City**
   - Members noted the need for one of the Team Members to visit one of the focus cities as stated in the project proposal. This was however subject to budgetary amendments as air fare costs had lately risen, with serious implications on the project activities. No dates were agreed as to when the trip would be taken.
2. **Data entry into matrix**
   - Members were encouraged to continue uploading data onto ZOTERO and populate the matrix with the reviewed literature, initially working with their personal repositories until end of March 2012. A central matrix will then be uploaded onto the GoogleDocs platform onto which Team Members will transfer the data for synchronization before the Meta analysis starts by end of April 2012.

3. **Geospatial analysis**
   - All country Teams were urged to make efforts in securing imagery to aid in the Geo Spatial analysis. The following data sets were noted as being very instrumental to this analysis;
   - Political/administrative maps
   - Land use maps
   - Vegetation maps
   - Infrastructure maps
   - Hydrology maps
   - Population/Demographic maps
   - Drainage maps
   - Shuaib noted that he was in possession of 'Flood Risk Map of Africa layer' that would be helpful.

4. **Edinburgh Conference**
   - An abstract had been submitted and eventually accepted for oral presentation at the Royal Geographical Society/Institute of British Geographers' annual conference, Edinburgh, 3-5 July 2012. David Sr, being one of the conveners would ensure that the paper is presented, should other members fail to make it to the event.

5. **Second Team Meeting**
   - To be held in Ibadan, Nigeria within July 2012. Specific dates yet to be agreed upon. On top of 'Groundtruthing' UPA in Ibadan, the meeting will focus on progress made since the February 2012 meeting and drafting the final project report.

6. **Structure of final report**
   - It was noted the START Secretariat had not yet provided a format for the final report. To this effect, the Ugandan Team prepared a template for the draft final report and Team Members were assigned roles presented below;

2. Introduction (***Shuaib* CA**)
   2.1. Research Objectives
   2.2. Contextualizing the research (**African cities**)
3. Framing Climate Resilience (**Shuaib CA**)
   3.1. Urban vulnerabilities (**Wahab**)
   3.2. Understanding UPA (**Frank**)
   3.3. Cities and adaptation in Africa (**Shuaib**)
   3.4. Mitigation, trends and opportunities (**David Mukungu, ASU students**)
4. Method and Materials (**Michail CA**)
   4.1. Climate resilience assessment (**David Simon**)
   4.2. Literature assessment (**Frank, David Mukungu)**
   4.3. Field verification and assessment (**Wahab**)
5. UPA, Food systems and food security (**Wahab, CA**)
   5.1. UPA and urban livelihoods (**Shuaib**)
   5.2. Food systems structure and production in cities (**Frank**)
   5.3. Ecosystems services from UPA (**Michail/ASU**)
   5.4. Thresholds, potentials and limits (**Frank**)
6. Urban ecosystem services (**Shuaib, CA**)
   6.1. Regulatory, provisioning services of UPA (**Michail**)
   6.2. UPA and micro-ecosystem services (**David Simon**)
   6.3. Scaling ecosystem services (**Shuaib**)
   6.4. Thresholds, opportunities and limits (**ASU**)
7. UPA and Climate resilience (**Frank ,CA**)
   7.1. UPA and adaptation to climate change (**Shuaib**)
   7.2. UPA and mitigation of climate change (**Frank**)
   7.3. Linkages between adaptation, mitigation and ecosystem services (**Wahab**)
   7.4. Challenges and limits (**David Mukungu**)
8. Policy implications (**David Simon, CA**)
   8.1. Scalable policy responses (**ASU**)
   8.2. Urban Policy and response to climate resilience (**Michail**)
   8.3. Policy Action and leverage of adaptation and mitigation funds **(ASU, Shuaib)**
9. Conclusion (**David Simon, CA)**
   9.1. Synthesis of climate resilience
   9.2. Options for action

CA; Coordinating Author of a section

IBADAN STAKEHOLDERS' MEETING

Venue: Centre for Sustainable Development, University of Ibadan, Ibadan
20, Awolowo Avenue,
Bodija, Ibadan.

Date: Monday, 07 May, 2012

PROGRAMME.

Chair: ***Tpl Dayo Ayorinde, Project Manager, Sustainable Ibadan Project***

TIME	ACTIVITY	FACILITATOR
8.30-9.00am	Arrival of Participants and Registration	
9.00-9.30am	Introductions and Welcome-	Dr. Bolanle Wahab
9.30-9.45am	Chairman's Opening Remarks –	Tpl Dayo Ayorinde
9.45-10.30am	Overview of the Stakeholders' Meeting	Dr Bolanle Wahab
10.30-11.00am	Group Photograph/Tea Break	
11.00-12.30pm	Urban/Peri-urban Agriculture, Food Security and Climate Change Resilience in Ibadan: An Update-	Mr Soji Adeyemi & Dr. Bolanle Wahab
12.30-1.30pm	Stakeholders' Perspective of UPA and Climate Change in Ibadan- Plenary 1	Tpl Dayo Ayorinde
1.30-1.45pm	Comments on UPA & Forestry in Ibadan	Prof. Labode Popoola
1.45-2.45pm	Lunch	
2.45.3.45pm	Stakeholders' Perspective of UPA and Climate Change in Ibadan- Plenary 2	Tpl Dayo Ayorinde
3.45-4.15pm	Wrap-up and Closing Remarks-	Dr. Bolanle Wahab
4.15-4.30pm	Vote of Thanks	Tpl S. K. Ojolowo
4.30pm	Departure	

SECOND TEAM MEETING HELD IN IBADAN, NIGERIA (16th – 19th July 2012)

Venue: Centre for Sustainable Development, University of Ibadan, Ibadan

PROGRAMME:

Day One (Monday 16 July):

1. Review of work done since January meeting in Kampala
2. Report on Edinburgh Conference
3. Report of Ibadan Stakeholders' meeting
4. Review of contents of Google doc Final Matrix

Day Two (Tuesday, 17 July):

1. Review of contents of Google doc Final Matrix
2. Consideration of draft Project Report
3. Presentations on UPA in Ibadan by invited guests (women vegetable farmer, foodcrops grower, poultry farmer, feed-miller, compost makers, and policy-maker).
4. Dinner with Bolanle in his house

Day 3 (Wednesday, 18 July):

1. Consideration of draft Project Report
2. Visit to some UPA sites
3. Free evening

Day 4 (Thursday, 19 July):

1. Review of workshop proceedings
2. Way Forward & Plan of Action on Final Project Report
3. Identification of outlets for the publication of project output
4. Final wrap-up and closing

KEY NOTES FROM IBADAN TEAM MEETING (16TH TO 19TH JULY, 2012).

Day one (16th July, 2012)

Key points:

1. Started off with a brief from David about the Edinburgh conf. Paper well received, may be considered for publication in a special issue.
   Another paper could target next year's AAG/UGEC conf (Deadline, October, 2012). Drawing interest in UPA across the globe was well expressed from the audience as an intervention that transcends both the north and south blocks.
   Shuaib: To what extend can UPA contribute to CC A and M? What are the limits of UPA? These are some of the key issues to be considered in the final report.
2. Expressed the need to emphasize grey lit, drawing on one of the hypothesis in the proposal.
3. Graph in the conf paper to be broken further to be more representative, more specific and localized. The methodology used to generate the graphs needs to be clarified. Maybe change back to arithmetic scale and focus on the key parts of the range because the logarithmic scale compresses the differences.
4. Same to be done for other themes including UPA, adaptation and mitigation and Resilience/ECs.
5. Need to be careful not to draw conclusions that UPA as a panacea to CC, but rather a contributor/potential as is with other interventions (this addressing the policy objective of the project). Constraints need to be also highlighted.

6. Policy Briefs (PBs) to be developed and tasks to be divided, e.g. Shuaib and David to provide some examples from previous/related work. Style of writing to depend on the target audience/stakeholders (ref to the proposal for the target audience).

Bolanle: Ibadan Stakeholders meeting review;

1. Participants including several farmer groups Viz vegetable, fish, yam, poultry, horticulture, livestock: some of whom were involved in more than one enterprise: representatives from the Local Governments in Ibadan and Ministry of Agriculture and Natural Resources also participated. A total of 24 attended.

   David: need to make anecdotes from the farmers and integrate them in the report. E.g changing planting and harvesting seasons, changing varieties.
   Shuaib: Are the farmers doing some form of research? Are they linked with some researchers? What is the basis of their conclusions or stand points?
   Bolanle: Not really, however, some research is going on about what is observed by farmers and what is projected.
   David: Short reports on the Kampala and Ibadan Stakeholder meetings should be written and integrated in the report as appendices as evidence of activities that were undertaken and also to document the issues from the farmers.
   Corrie: what was the contribution from the Local/Govt reps in the stakeholders' meetings?
   Bolanle: Govt is implementing a 'Back to school Agric programme' encourages urban schools to revive school based agric programmes as used to be the case. It has a subsidized fertilizer programme and also facilitates farmers with credit, also allows farmers to access govt land to undertake farming activities in the designated land with increased security.
   David: Need to use these to write the specific PBs as agreed earlier.
   Bolanle: Dealing with smell arising from urban farmers will reduce resistance from other residents. A classical successful example (Hope Farms) to be visited during fieldwork.
   UPA is very important not only as livelihood enhancer but also as a quick access to the much needed resources, given the changing conditions
   Shuaib: Is it possible to get data on the Carbon footprint in UPA vis a vis its location outside of town? i.e How much in terms of tonnes of vegetable/food coming out of the cities? And how it relates to C emissions vis vehicle type? Fuel consumption?
   All is needed is being clear on assumptions . Otherwise, you may never get something very accurate, said Shuaib. Drawing on Soji's expertise, this could be a good venture to undertake.
   Shuaib: How integrated is UPA in Ibadan as compared to the Kampala situation? Bolanle cited the integrated farmer (Hope Farms) to be visited. That, these points could be integrated to justify presence of UPA, that has often been criticized as a source of nuisance in terms of noise, smell, etc.
   Bolanle: Limitations for each of the sectors need to be addressed e.g vegetable famers face problems of disease and pests; use Neem tree to control pests. These are some of the interventions that have to be undertaken. Such limitations and potentials have to be documented in the report. How do such

interventions relate to CCA and M??? Need to have these tabulated in the final report.

Bolanle: farmers expressed their desires to have more residents embracing UPA given its enormous contributions. Were worried about dangers from climatic vagaries e.g. Flooding and erratic rainfall. Such should be documented as anecdotes.

Skype with John Connors:

Corrie: Updated john about meeting in the first session.

John: updated us about ground covered as far as data collection for the spatial analysis.

Shuaib: will provide 'flood risk map' thru Corrie so that he can embark on the analysis.

Envisaged outputs:

1. Flood risk maps: what are the risks in the cities of focus?
2. Potential in terms of urban spaces available for potentials in UPA, can mapped at any scales/resolutions.

   Simon: cited examples from his recent visit to Dar es Salaam where he was able to zoom into some sites, using Google maps.

   John: challenge is the scale of data that he has been working with. Reference to Goggle maps would be the option; accessibility other maps is not very easy. However, this would require additional time input from John. Copyright issues also important to be remembered.

   Shuaib: Some work is ongoing by students from Kampala, a landuse map to be generated and to be shared as one of the case studies for the report. We will proceed with the case study approach, deriving on what is available from the focus cities.
3. Space for peri-urban forestry/greening: that can utilize coarse resolutions and can be expanded to cover zones out of city zones.

John: Are special study area maps needed for the report??

Shuaib: Yes, but thematically presented ones from the spatial analysis would suffice. The local expertise can work on the other ones as and when needed.

Corrie: proposed Wednesday, same time for the next meeting.

- GoogleDoc final matrix:_Shuaib

1. Suggested a data cleaning process be undertaken.
2. Corrie agreed to undertake the initial tasks.
3. Soji to update the 'Kampala matrix' with what is missing.

Next steps: Discussions to continue as to how to proceed with data analysis. Shuaib to take the Team through this process, come day three.

Day three (17 July 2012)

Key points from post-fieldtrip discussion (DS)

For our report, we need to balance individual UPA case studies and farmer profiles with the clear overall structural perspective of areas where UPA is undertaken and the issues pertaining there.

If possible, it would be excellent to be able to show on a map the areas where stream/river water is safe to use for UPA irrigation and where it is (likely to be) problematically polluted – especially from the industrial areas and by untreated sewage.

Superimposing maps of topography and land tenure would also be advisable if we can obtain these – in order to identify areas of potential for UPA or where slopes are too steep and are likely to erode under UPA.

Day three: Final Matrix and data analysis

Session kicked off with;

a. A review of Ibadan the thematic maps as prepared by Ibadan Team
   - It was suggested that all places visited during the Kampala and Ibadan ground truthing exercise be mapped and included as appendices in the final report.
   - Shape files for the Ibadan Peri-urban areas that were visited to be sent to John. These will include among others, topographic, drainage, population, vegetation, political/administrative etc

b. Shuaib presented a 'cleaned' data matrix and requested members to further look out for issues that still required attention.

c. Frank presented the report template (as required by START's format) to be followed by the Team members when writing the final report. Some additions were made thus;
   - A section on Policy Briefs and what they would focus on
   - Project outputs to include conference papers and PBs
   - ➢ Shuaib emphasized the need for members to clearly number sections when sending to Coordinating Authors to avoid mix-ups.
   - ➢ David urged members to constantly update and share literature with others as and when they come across it from the project database (matrix), as it may be impossible for all individuals to read all the literature in the remaining time. To this, Corrie, initiated a document sharing platform, 'DropBox' to which members will repost the documents being worked on.

d. A discussion about the timelines was started in view of the deadlines owing to the tight deadlines, as far as the project life is concerned. No conclusions were however reached. Final report is expected by end of 14th October, 2012.

e. The Policy Briefs:
   - David to draft the general one, focusing on all themes across the two cities.
   - Shuaib and Frank to draft the Kampala one
   - Bolanle and Soji to draft the Ibadan one
   - Shuaib to draft one focusing on adaptation and mitigation- giving it a general approach.

Courtesy Visit to the Vice Chancellor- University of Ibadan (UI).

- ➢ The Team paid a courtesy visit to the VC and briefed him about the project.
- ➢ The VC reiterated UI's commitment to supporting and fostering international research collaborations.
- ➢ The VC noted the importance of UPA in ensuring household food and economic security of urban and peri urban dwellers.

f. Visit to the UI Organic Farm

- The Team was taken to a tour of the UI organic farm, research and outreach venture between the University and surrounding communities.
- The Team was informed of the cordial relationship that has been fostered between the university and the community who were previously hostile towards the University ventures. Through this initiative, both the University and the community mutually benefit in such a way that the community are able to utilize University land to organically grow vegetable crops, while the University is able to undertake joint research using the same plots.

Day four (19.07.2012)

➢ Timelines, deadlines and tasks

- A teleconference to be scheduled to discuss outputs from John, first week of August was proposed.
- End of August, first draft (Zero order) to be received by the Kampala Secretariat. This therefore implying that members are expected to be feeding into the
- Final report to be completed by 30th September, 2012.
- The ASU Team will help in designing the outlook of the Policy Briefs.
- The Mit and AD Policy Brief to be out by mid September, 2012, others to come out after the submission.
- The project E-portal /website will be integrated into a bigger one on the Urban Knowledge Arena one that is under construction at Makerere University, an initiative of UN Habit.

- Glossary of Terms
- Include list of acronyms and abbreviations

➢ **Websites**

Still under development as part of an e-portal for the Urban Knowledge Arena with similar objectives as this research project.

➢ **Policy Briefs**

See separate documents attached to this report.