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AfricaInteract: Enabling research-to-policy dialogue for adaptation to climate change in Africa

Review of Research and Policies for Climate Change Adaptation in Urban Areas in Southern Africa

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AfricaInteract is funded by the International Development Research Centre (IDRC) and coordinated by the West and Central African Council for Agricultural Research and Development (CORAF/WECARD) under the auspices of the Forum for Agricultural Research in Africa (FARA). The regional focus of *AfricaInteract* is based on the Regional Economic Communities in the four sub regions of sub-Saharan Africa. Focal organizations coordinating regional activities are as follows: The Association for Strengthening Agricultural Research in East and Central Africa (ASARECA) – East Africa; Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN) – Southern Africa; Commission des Forets d'Afrique Centrale (COMIFAC) – Central Africa; and Energie-Environnement et Developpment (Enda) – West Africa.

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Table of Contents

Acronyms and abbreviations

COMESA	Common Market for East and Southern Africa
CSO	Civil society organisation
EAC	East African Community
IDRC	International Development Research Centre
IPCC	Intergovernmental Panel on Climate Change
LDC	Least Developed Country
NAPA	National Adaptation Programme of Action
NEPAD	New Partnership for Africa's Development
NGO	Non-governmental organisation
SADC	Southern African Development Community
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change

Executive Summary

This paper provides results for a review of climate change adaptation research and polices in the Southern African urban sector, focusing in particular on water resources management and use and gender relations. The review was conducted to identify gaps in research and policymaking for climate change adaptation in the urban sector, with the aim of improving evidence-based policymaking that can enhance food security and protect populations vulnerable to climate change. The review largely focused on critical and focused literature review of various documents including scientific and grey literature such as government and selected agencies' articles/ books, peer-reviewed journal articles, research (working) and published papers covering the past 15-20 years, as well as interviews with selected key informants. The study focused on Southern Africa using Malawi, South Africa and Zimbabwe as case studies.

Southern Africa remains the most urbanised region of Africa, with the country having the largest (61.5 percent) urban population, while Malawi is the fastest urbanising country in the world. Projections show further increases in urban population, suggesting that population growth in the region is becoming largely an urban phenomenon. Additionally, rural-urban migration is resulting in an increase in the proportion of poor population in the urban areas. Due to low capacity of local governments, the poor population lives in slums mushrooming on marginal land, without social amenities and highly vulnerable to natural hazards. Climate change is expected to worsen the vulnerability of these communities through impacts on water availability and quality leading to water stress, energy crisis, food insecurity, human health problems and sea level rise in coastal cities as well as destruction of infrastructure. The most vulnerable are the poor and especially women due to gendered division of labour and power relations. Urban populations with high adaptive capacity are less vulnerable to effects of climate risks.

The review suggests a need to support and enhance capacity of the most vulnerable through supporting urban based adaptation initiatives. However, current national policies as well as research activities are predominantly rural focused. Overall, research activities on adaptation are few in Zimbabwe relative to other countries and none of the documented projects directly address urban areas. In Malawi, out of 20 documented research or project activities, only one project focuses on urban adaptation. It addresses urban-rural linkages. In addition, empirical information is inadequate for informed policy due to lack of technical capacity and unavailability of data. This is exacerbated by lack of capacity to integrate urban adaptation into local government plans. However, the picture is different in South Africa where five research projects and initiatives are urban focused. Climate adaptation has been mainstreamed in the national framework for climate responses, and urban policies and research findings from city based climate risk assessments have been used to influence policy.

Opportunities for development of sustainable adaptation strategies exist through collaboration with various actors and partners. The actors involved in research and policymaking on climate change adaptation in urban areas include international, multilateral and bilateral organisations, the different tiers of government, grassroots groups and local communities, private enterprises and institutions, non-governmental and civil society organisations, networks and individuals. These shape adaptation policies and interventions in various ways including through information gathering and dissemination, resource mobilisation and allocation, skills development and capacity building, leadership and networking with other decision-makers and institutions. Stakeholder involvement can be improved through facilitation of multi-stakeholder collaboration in planning and implementing activities, production of reliable products (which can help to get donor support) and regular meetings.

In view of the above findings, the following recommendations are suggested:

Recommendations for research

There is need for 1) detailed vulnerability assessments of all urban areas to show which areas and groups of people are most vulnerable to current and future climate risks; 2) rigorous downscaled modelling of climate data for localised assessments of all urban areas to ensure availability of locally based information; 3) research on political economy or policy processes to improve uptake of unbiased and credible evidence; and 4) detailed assessments of rural-urban linkages and impacts of climate change.

Recommendations for policy

There is need to provide an appropriate institutional framework that forms a strong basis for mainstreaming adaptation into urban planning. This can be done through integration of urban adaptation to climate change into national climate change policies, where the local municipalities and authorities are clearly mandated. This approach will ensure integration of urban adaptation in municipal or city integrated development plans and budgets. Least Developed Countries (LDCs) including Malawi and Zimbabwe should ensure that National Adaptation Programmes of Action (NAPAs) are deliberately targeted at vulnerable groups in specific localities. Southern African countries should also adopt a more holistic approach to climate change focusing on both rural and urban areas' vulnerability and adaptation to climate change. Thus the development of national climate and development policy frameworks should

integrate complementary and differentiated urban and rural strategies.

Governments that are yet to recognise urban vulnerability to climate change should consider developing ongoing food security programmes that enhance adaptation of the urban poor as well as rural producers. This approach may make both rural food producers and urban poor resilient regardless of occurrence of climatic extreme events. The governments should consider developing policies that encourage peri-urban agriculture as an adaptation strategy away from human settlements. Additionally, as rural-urban migration continues, Southern African governments should consider integration of climate change management in both urban and rural areas with social safety nets that enhance adaptation. They should also ensure that there is a compromise between the increased land demands of urbanisation, partly resulting from climate change, and protection of agricultural land. This implies developing a policy that aims to protect high value agricultural areas in peri-urban areas, because without a law prohibiting sales, farmers are attracted by financial offers from urban developers. A change of valuable agricultural land to urban land uses such as settlements may reduce rural food crop production and consequently urban food security. Additionally, countries such as Malawi should consider promoting compact development in addressing land pressures resulting from urbanisation, in contrast to extending development into peri-urban agricultural land.

Southern African countries should promote policies that include climate change education and research. This will ensure development of a resilient population and competent research centres. Governments including South Africa should develop policies through which research centres and universities are mandated to sustain production of high quality empirical information on climate change for informed policy. Southern African governments should also increase provision and uptake of unbiased and credible evidence in policy processes to strengthen adaptation strategies of their vulnerable communities.

1 Introduction

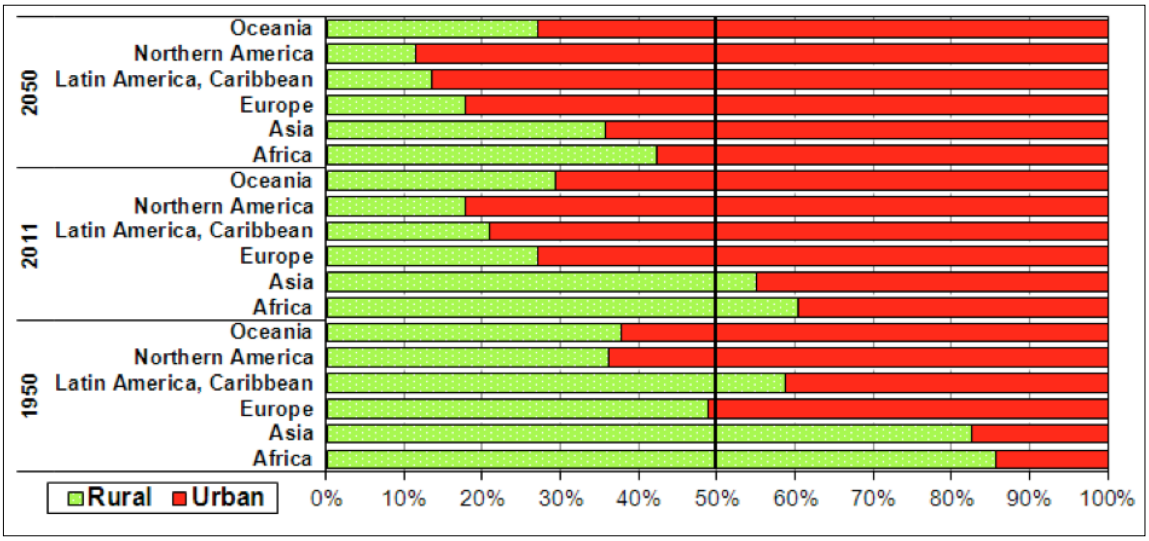
Climate change refers to a 'change in the state of the climate that can be identified (e.g. by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer' (IPCC 2012: 3; Pachauri and Reisinger 2007: 30). Africa is most vulnerable to the impacts of climate change and variability, mainly because of high dependence on ecosystem services, rain-fed subsistence agriculture and high levels of poverty (European Union 2011). Observed climate trends and projections for countries in Southern African Development Community (SADC) show an increase in temperatures (especially minimum temperatures) and inter-annual variability of rainfall events (Brown et al. 2012; Anderson et al. 2010; McSweeney et al. 2008; Christensen et al. 2007). These changes affect the health of fragile ecosystems, which support livelihoods of poor communities both in rural and urban areas, and hence expose insecurities in the food and water supply chain, exacerbating poverty and health risks. In this regard, the region's resilience to the impacts of climate change is a key development issue. However, the pace and extent of climate change and its impacts vary spatially. Hence locally generated adaptation approaches and active participation of local actors bring relevance to climate change adaptation programmes.

Currently, almost all countries in the region have performed a stock-taking of impacts on livelihoods associated with climate change and variability, with the United Nations Framework Convention on Climate Change (UNFCCC) funding the Least Developed Countries (LDCs, e.g. Malawi). These LDCs have developed climate change policy frameworks called National Adaptation Plans of Action (NAPAs). Most of the NAPAs are generally inadequately designed and implemented and a regional perspective of climate change adaptation is not yet clear. Additionally, urban adaptation is least recognised (Brown et al. 2012). However, there is a growing interest and support for research in adaptation to climate change in Africa. It is important that the results of the research activities inform the development of policies relevant to adaptation to climate change. Therefore, a stock-taking, synthesis and review of research results from relevant sources (peer-reviewed papers, theses and grey literature) and the way these feed into policies for climate change adaptation in the agricultural, health, water and urban sectors is needed.

It is critical that the sector policies are appropriately informed by the existing body of knowledge on climate change and variability generated from the scientific research. These policies should enable the respective sectors to build resilience against climate change and climate variability through adequate adaptation strategies and contribute to mitigation of climate change through use of improved and innovative technologies and management practices. In this context, this paper provides results of a review of climate change adaptation research and policies in the Southern African urban sector, focusing on water resources management and use, rural-urban linkages and gender relations. The focus is on the urban sector because of growing recognition of cities' potential vulnerabilities and roles in addressing climate change (UN-Habitat 2011a; UN-Habitat 2010). Levels of urbanisation are expected to rise considerably in the least urbanised regions of Asia and Africa, with about two-thirds of the population living in urban areas by 2050 (Figure 1). In Africa, over 50 percent of the population will be urban by 2030 (Figure 1; UN-Habitat 2008), doubling Africa's urban population from 373.4m to 759.4m. The changes in urban population are attributable to both natural increase and rural-urban migration.

The review was conducted to identify gaps in research, policy and their linkage for improved knowledge-based adaptation policies to effectively protect populations vulnerable to climate change and variability.

Figure 1. Urban and rural population in various development regions for 1950, 2011 and 2050, as a percentage of total population (Adapted from UN DESA 2012)



This paper is divided into eight sections. Section 1 introduces the scope of the review and its significance. Section 2 provides background to the review and methodology employed. Sections 3 through 7 provide detailed findings of the study, which are summarised and discussed in section 8. The paper provides an overview of urbanisation and climate change trends and associated implications in urban areas of Southern Africa. It further assesses implications of urban-rural linkages and impacts of climate change on food, energy, water, sanitation and health. The following key questions guided the review:

1. What is the role of climate change challenges in the context of the multiple challenges and opportunities facing urban areas in the region?

2. What is the current state of knowledge on adaptation to climate change in urban areas in the region? (section 4)

3. What is the current state of knowledge on whether and how research findings are integrated in urban area policies in the region? (section 5)

4. What are the major gaps in research on adaptation to climate change in urban areas? (section 6)

5. What is needed to ensure that research findings are better integrated into urban area policies? (section 6)

6. What is the current state of knowledge on the stakeholders involved with research and policy on adaptation to climate change in urban areas in the region, and how stakeholder involvement could be improved? (section 7)

In addition, the review was guided by a set of key crosscutting considerations including (i) social differentiation and gender implications, (ii) implications for water resources and (iii) cross-scale interactions (national, sub-national and local).

2 Background and methodology

2.1 Scope of the review

This review was commissioned by *AfricaInteract*, a project funded by the International Development Research Centre (IDRC) and coordinated by the West and Central African Council for Agricultural Research and Development (CORAF/WECARD). *AfricaInteract* aims at providing an appropriate forum for interaction among a broad range of African stakeholders, including civil society, researchers, policymakers, donors and the private sector working on adaptation to climate change in the agricultural, health, water and urban sectors. The review addresses the output of the project of establishing and promoting climate change information and knowledge systems, focusing on the Southern African urban sector.

The main objective of the review was to contribute to the building of a knowledge base and support research-based policy formulation for climate change adaptation in the Southern African urban sector. Specifically, the review was carried out to:

- Review climate change adaptation research and policy pertaining to the urban sector including the relationship with water resources, rural-urban linkages (focusing on rural-urban migration) and gender in a specific sub-region.

- Identify gaps in (a) climate change adaptation research and policy in the urban sector; and (b) the way research informs policymaking.

- Identify key stakeholders and opportunities for improving the climate change adaptation research-policy nexus in the urban sector.

However, due to limited availability of data on urban vulnerability and adaptation in Southern Africa, there is little coverage of gender implications.

2.2 Defining adaptation to climate change, resilience, coping and rural urban linkages

This review adopts the recent Intergovernmental Panel on Climate Change (IPCC) definition of adaptation viewed in two perspectives: human and natural systems. In human systems adaptation is defined as 'a process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities,' whereas in natural systems, it refers to the 'process of adjustment to actual climate change and its effects' – facilitated by human interventions (IPCC 2012: 3). Successful adaptation reduces vulnerability by building on and strengthening existing coping strategies.

In this context, vulnerability is defined as the propensity or predisposition to be adversely affected (IPCC 2012). It is mostly viewed as a 'function of both system's exposure and sensitivity to stress and its capacity to absorb or cope with the effects of these stressors' (Eakin and Luers 2006: 366). Vulnerability to climate change results from diverse historical, social, economic, political, cultural, institutional, natural resource and environmental conditions and processes (IPCC 2007b).

Exposure refers to the presence (location) of people, livelihoods, environmental services and resources, infrastructure, or economic, social, or cultural assets in places that could be adversely affected by physical events and which, thereby, are subject to potential future harm, loss, or damage (IPCC 2012).

Coping strategy refers to a temporary response to historically familiar climatic disturbance or change aimed to manage a transient threat. Effective adaptation

leads to resilience, the ability to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions (IPCC 2012).

Rural-urban linkages generally refer to the two-way flow of public and private capital, people, goods, technology, information and ideas between rural and urban areas (Tacoli 2006; Lynch 2005; Gaile 1992). These linkages include energy flows; flows of agricultural and other commodities from rural based producers to urban markets, both for local consumers and for forwarding to regional, national and international markets; and, in the opposite direction, flows of manufactured and imported goods such as farm inputs, groceries and clothes from urban centres to rural settlements. The linkages also include flows of people moving between rural and urban settlements, whether commuting on a regular basis, for occasional visits to urban-based services (such as hospitals, schools and banking facilities) and administrative centres, or migrating temporarily or permanently.

Flows of information between rural and urban areas include information on market mechanisms – from price fluctuations to consumer preferences – and information on employment opportunities for potential migrants. Many studies analyse these flows as a result of migration and find that these relations emanate from the complementary nature of the rural and the urban (Tacoli 2006; Gaile 1992). This suggests that rural and urban areas are highly interdependent; hence, wellbeing of one spatial system relies heavily on the other. Linkages operate in positive (spread) and negative (backwash) forms that impose differential development between the rural and urban.

The nature and scope of rural-urban linkages or interactions vary temporarily and spatially (Joshua et al. 2010; Tacoli 2006). For example, poor rural catchment management of a river that supplies hydro-energy and drinking water to urban communities may lead to siltation and consequently energy crisis and water shortages in urban areas. Low or poorly distributed rainfall during the cropping season in rural areas may lead to low crop yield and consequently food shortages or high food prices in urban markets which may result into urban food insecurity. Timely flow of reliable climate information from meteorological centres (located in urban areas) to rural farmers may help farmers to make informed decisions on farming practices such as selection of right crops and cropping patterns (Joshua et al. 2011). This may sustain or improve crop yield and consequently reduce urban food insecurity and related health challenges such as malnutrition.

2.3 Definition of 'urban areas'

There is no universal definition of urban areas. Urban areas may be defined on the basis of administrative boundaries of settlements, population census and socio-economic characteristics of the population (FAO 2005). An urban area is therefore generally characterised by a high population density and degree of specialised land use and wide variety of social and economic structures.

In Malawi, all areas that are designated as cities, municipalities, townships, town planning areas and growth and district centres under the Town and Country Planning Act, the Local Government Act or integrated rural development planning, are considered urban areas (UN DESA 2012). In South Africa, classification of urban centres is based on a dominant settlement type and land use, such that settlements including cities, towns, townships and suburbs are considered urban. Enumeration areas comprising informal settlements, hostels, institutions, industrial and recreational areas and smallholdings within or adjacent to any formal urban settlement are classified as urban (UN DESA 2012). In Zimbabwe, designated urban areas as well as places with at least 2,500 inhabitants whose population resides in a compact settlement pattern and where more than 50 percent of the employed persons are engaged in non-agricultural occupations are considered urban (UN DESA 2012).

2.4 Methodology used for review

The review focused on the SADC region, using South Africa, Zimbabwe and Malawi as case studies. Figure 2 below presents a map of the SADC region showing the location of the three countries under study.

Figure 2. Map of SADC showing locations of Malawi, Zimbabwe and South Africa

Source: sadcreview.com

The methodology employed in this paper largely focuses on critical review of various literature and interviews with selected key informants. The reviewed literature included scientific and grey literature such as government and selected agencies' articles/books, peer-reviewed journal articles, research (working) and published papers covering the past 15-20 years. The aim was to capture the scientific and indigenous knowledge as well as policies related to climate change adaptation and the possible gaps that will form the basis for further research and policy formulation. The documents used were identified in various sources including reliable publishers (such as ScienceDirect), government sources, non-governmental organisation (NGO) sources and donor project libraries through systematic review, keyword searches and content analysis. Qualitative data was categorised into major emerging themes and quantitative data was analysed in Excel where necessary.

3.0 Overview of the region's urbanisation profile

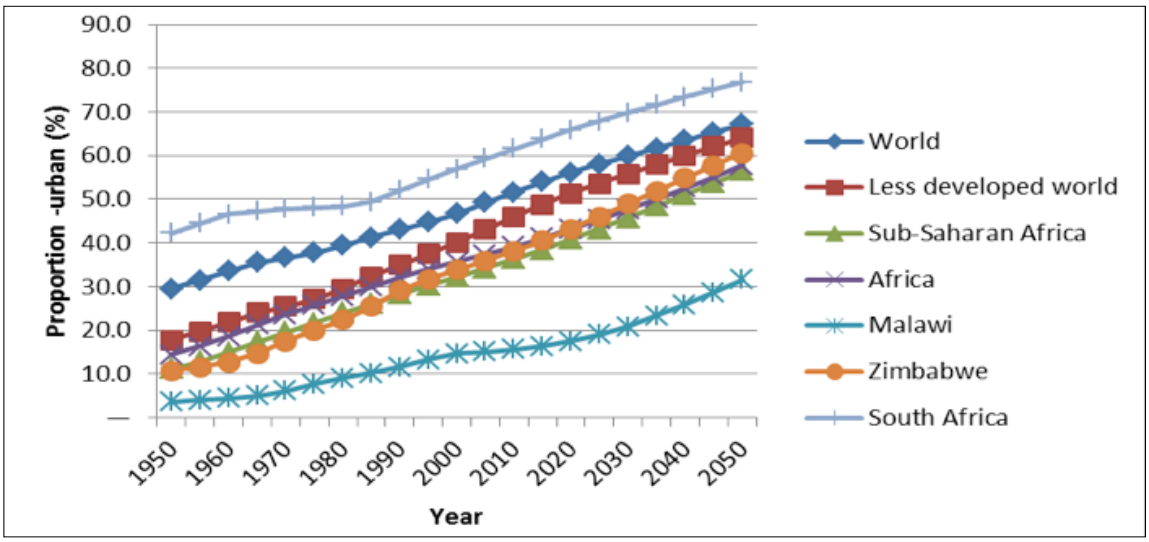
3.1 Key facts for urban areas in the region

Urbanisation generally refers to the proportion of total population living in urban areas or the rate at which this urban proportion is increasing over time (UN DESA 2012). In this paper, urbanisation refers to the proportion of people living in urban areas, whereas change of this proportion over time is termed the urbanisation rate. Overall, Southern Africa remains the most urbanised region in Africa, a position it reached in the decade 2000-2010. This high urbanisation is due to rural-urban migration and high population growth rates. Migration results from pull factors of urban centres, such as perceived job opportunities and better infrastructure and services, in addition to push factors from rural areas, such as land shortages and declining benefits from agriculture-based livelihoods (Meyer-Ohlendorf 2009).

Urbanisation has increased from 53.8 to 58.7 percent over this decade and is expected to reach about 66 percent by 2025 (UN-Habitat 2010). According to UN-Habitat, decade-interval urbanisation growth rates in Southern Africa peaked in the period 1990-2000 at seven percent, during which time the region also passed the 50 percent urbanisation mark. Currently the urbanisation rate depicts a declining trend to 4.9 percent for 2000-2010, and is expected to slow down further to 2.1 percent in the 2040-2050 decade (Ibid). However, the urbanisation rates of individual countries in the region for the same period vary significantly.

Malawi is one of the least urbanised nations in Southern Africa, with less than 20 percent of the population living in areas classified as urban, whereas South Africa is the most urbanised nation in the region at 61.5 percent. It is estimated that 77 percent of the South African population will be urban by 2050 (Figure 3). However, Malawi was categorised as the fastest urbanising country in the world in 2004, with three times the global rate and nearly twice Africa's rate of 3.5 percent per annum. Currently, the urbanisation rate is at 5.2 percent per annum, the fifth highest in Africa, and approximately 25.1 percent of the national population is projected to live in urban areas by 2020 (Joshua et al. 2010). Despite this, it remains one of the least urbanised countries in Africa (Figure 3). However, this does not imply that Malawi's government should ignore urbanisation challenges such as potential climate change vulnerabilities and solutions. For Zimbabwe, urbanisation rates have remained relatively constant since the 1970s at between two and three percent increase per year (Figure 3).

Figure 3. Proportion of urban population in study sites, 1950-2050



Source: UN DESA 2012

At the current rate, the Malawian and Zimbabwean urban populations are expected to double by 2030 and 2043, respectively. For all the three countries, the average growth rate for urban areas is consistently higher than the population growth rate (the difference of births and deaths) (Tables 1 and 2). The average annual urban population growth rates are also higher than rural rates (for the period: 1950 to 2010) (Table 2). Therefore, population growth is becoming largely an urban phenomenon over the years (UN DESA 2012; Satterthwaite 2007). Such development may have significant implications on climate change issues such as causes, impacts, vulnerability and adaptation which require special attention in policy discourses.

Table 1: Population in urban areas and proportion of urban compared to rural

Indicator	Country	1950	1960	1970	1980	1990	2000	2010
Rural population (thousands)	Malawi	2 780	3 370	4 257	5 675	8 296	9 588	12 585
	Zimbabwe	2 454	3 279	4 302	5 659	7 434	8 287	7 778
	South Africa	7 905	9 286	11 744	14 996	17 647	19 296	19 278
Urban population (thousands)	Malawi	101	155	274	565	1 084	1 641	2 316
	Zimbabwe	292	473	904	1 631	3 035	4 223	4 793
	South Africa	5 778	8 110	10 758	14 081	19 146	25 464	30 855
Percentage urban (%)	Malawi	3.5	4.4	6.1	9.1	11.6	14.6	15.5
	Zimbabwe	10.6	12.6	17.4	22.4	29	33.8	38.1
	South Africa	42.2	46.6	47.8	48.4	52	56.9	61.5

Source of data: UN DESA (2012)

Table 2: Average annual growth rates of urban compared to rural areas

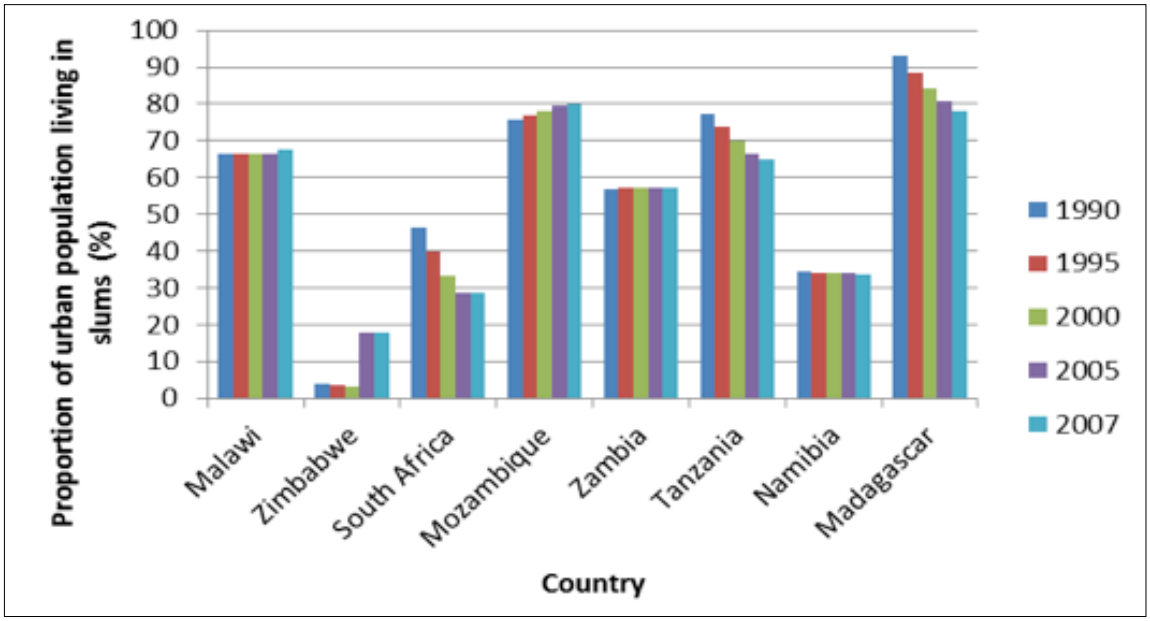
Indicator	Country	1950-1960	1960-1970	1970-1980	1980-1990	1990-2000	2000-2010
Rural annual growth rate (%)	Malawi	1.93	2.34	2.88	3.8	1.45	2.72
	Zimbabwe	2.9	2.72	2.74	2.73	1.9	-0.64
	South Africa	1.61	2.35	2.45	1.63	0.89	-0.01
Urban annual growth rate (%)	Malawi	4.27	5.72	7.23	6.53	4.14	3.45
	Zimbabwe	4.82	6.48	5.9	6.21	3.31	1.27
	South Africa	3.39	2.83	2.69	3.08	2.85	1.97

Source of data: UN DESA (2012)

Poverty rates remain high in the SADC region, with about 45 percent of the population living in abject poverty (SADC 2008). In general, high poverty rates are prevalent among the rural population. However, in Malawi, the proportion of the poor in urban areas (65 percent) is now greater than in rural areas (60 percent) (Government of Malawi 2012). The increase is attributed partly to rural-urban migration (Government of Malawi 2010a) and other factors such as low recognition of urban vulnerabilities, e.g. to food insecurity (Joshua et al. 2010). For Zimbabwe, poverty rates changed from 45 percent to 61 percent and 57 percent to 71 percent of the population in the urban and rural areas, respectively, in the period between 1995 and 2003. The increases in poverty are attributed to the economic crisis that the country went through (Government of Zimbabwe 2010). For South Africa, the percentage of people living in absolute poverty (under US$1 a day) declined from 11.3 percent to five percent in the period 2000 to 2006. However, since South Africa is classified as a middle income country, the poor population is described as those living under US$2.5 per day. In this regard, the poor population declined from 42.2 percent to 34.8 percent in the same period (Government of South Africa 2010).

The above trends in urbanisation and poverty have social, economic and environmental knock-on effects on national, subnational and local governments and all relevant stakeholders. Local governments have limited capacity to provide employment opportunities, affordable housing and social services for the growing population. Additionally, access to suitable land for housing is highly bureaucratic and too expensive for the poor. The poor therefore meet their housing demands through informal market structures which usually lead them to occupy marginal urban lands that are typically

Figure 4. Proportion of urban population living in slums in selected SADC countries



Source: UN-Habitat 2010

below local authority minimum development standards and do not comply with environmental regulations. These factors lead to considerable growth of slums, informal settlements and overcrowding conditions (UN-Habitat 2010). A slum household is one that lacks one or more of the following facilities: durable housing, sufficient living area, access to improved water, access to sanitation and secure land tenure (Government of Malawi 2010a).

Malawi has a much higher proportion of slum dwellers, with limited access to water and sanitation, than Zimbabwe and South Africa (Figure 4; UN-Habitat 2010; WHO/UNICEF 2010). In Malawi, the proportion of slum dwellers has not significantly changed in the period between 1990 and 2007 (66 to 68 percent); however, the actual population of slum residents increased from 725,000 to 1,722,000 due to the growth of the urban population (Zulu et al. 2011; UN-Habitat 2010). For South Africa, the official figures show that the proportion of slum dwellers has fluctuated in the period between 2002 and 2009, and it was estimated to be at 13.4 percent in 2009 (Government of South Africa 2010).

In general, the proportion of slum dwellers has been kept low due to national and provincial housing policies and programmes such as the Upgrading of Informal Settlements Programme and Breaking New Ground (also known as the Sustainable Human Settlements Programme) (Government of South Africa 2010). The proportion of slum dwellers in Zimbabwe (18 percent) is the least among the three countries (UN-Habitat 2010). However, this rate is a dramatic rise from 3.4 percent in 2001 (Brown et al. 2012; UN DESA 2012; UN-Habitat 2008) due a significant decrease in public and private funding for low cost housing since 1999 (Government of Zimbabwe 2010). The actual population of slum dwellers rose from about 142,000 in 2000 to about 879,000 in 2007 (UN-Habitat 2010). Slums mushroom on marginal land, without social amenities and highly vulnerable to natural hazards such as floods and landslides. Climate change is therefore expected to worsen the vulnerability of these communities.

3.2 *Overview of responses to climate change in Southern Africa*

Over the past decade, all governments in Southern Africa have developed national climate change frameworks that seek to balance mitigation and adaptation policies, and at the same time promote climate change-resilient, low-carbon economies and societies. In this context, with the exception of Angola, all the LDCs in Southern Africa have developed NAPAs to guide adaptation at the national level (Brown et al. 2012). These countries have submitted their NAPAs to the UNFCCC, in accordance with Article 4 of the Convention, to provide the basis on which they could apply for adaptation funds in the future (Chagutah 2010). South Africa and Zimbabwe do not have NAPAs because they are categorised as developing countries and are not required to submit NAPAs to the UNFCCC. According to the UNFCCC framework, these countries 'do not commit to undertake any mitigation actions but [are] voluntarily supposed to notify the convention on their climate change mitigation actions' (Nzuma 2010: 32). However, although Zimbabwe is not officially categorised as an LDC, its Human Development Index (HDI)[1] rank in 2013 was two steps below Malawi, suggesting that it qualifies to be an LDC. Its exclusion from the LDCs may have implications for its adaptive capacity.

The climate change policy responses in the three case studies (Malawi, South Africa and Zimbabwe) are the responsibility of the national ministries responsible for agricultural, environmental and water affairs (UN-Habitat 2010). More often, the daily activities are delegated

to relevant departments and committees under the ministries, who will have personnel at national and local levels (GFDRR/World Bank 2011; Government of Zimbabwe 1998). In South Africa, climate change policies and platforms include the urban sector (UN-Habitat 2010) through frameworks such as the International Council for Local Environmental Initiatives (ICLEI) and United Cities and Local Governments (UCLG). However, in most countries such as Malawi and Zimbabwe national initiatives largely take place outside urban local government (UN-Habitat 2010). Hence, urban authorities and local stakeholders are passive or less active in key climate change debates, implying that urban climate change issues receive limited attention by policymakers.

3.3 Climate change challenges in different parts of the region

Climate scenario projections for the Southern Africa show a rise in temperatures of about 3°C (almost 1.5 times the global mean response) up to the year 2099 (Anderson et al. 2010; Christensen et al. 2007). There are also changes expected in the intensity and frequency of extreme rainfall events (storms) and the rainfall season patterns (e.g. onset, cessation and length) (Brown et al. 2012). Projections show increasing frequency of below-normal rainfall years, extreme dry years for Southern Africa (Lasolle 2012) and cyclone activity in

Table 3: Summary of climatic challenges, vulnerable sectors and vulnerability context by country

Feature		Country		
		Malawi	South Africa	Zimbabwe
Climatic challenges	Increase in temperature			
	Increased incidence of droughts			
	Decrease in rainfall			
	Seasonal shifts of rainfall			
	Localised floods			
	Decreased/varying river flow			
	Sea level rise			
	Salt water intrusion			
	Landslides in mountains			
Vulnerable sectors	Water scarcity			
	Biodiversity loss/tourism			
	Health/disease outbreaks			
	Hydropower			
	Coastal ecosystems, islands and cities			
	Infrastructure			
	Fisheries			
	Agriculture and food security			
	Livestock			
Vulnerability context	Urbanisation			
	Spread of cash crops			
	Shifting pastoralism and cultivation into drier areas			
	Conflict/post conflict/insecurity			
	Inequitable land distribution			
	Low education			
	Poor infrastructure			
	Gender inequality			
	Dependence on climate-sensitive resources			
	Poor health status			
	HIV/AIDS			

Source: Adapted from Eriksen et al. (2008)

the South West Indian Ocean region (IPCC 2007a). The region is expected to experience a median decrease of precipitation of about four percent, particularly in winter (June, July and August) and September, October and November (Anderson et al. 2010; Christensen et al. 2007).

For South Africa, scenario projections show a broad reduction in summer rainfall in the range of five to ten percent in the eastern part of the country, whereas the western part is projected to experience a marginal increase in early winter rainfall (Government of South Africa 2011; 2004). It is further predicted that by 2050 the coast will warm by around 1-2°C and the interior by around 2-3°C. For Zimbabwe, average rainfall across the country shows a declining trend of five percent between 1900 and 2000, with the 1980s and 1990s as the driest periods (Government of Zimbabwe 2010). The country has experienced rising daily minimum and maximum temperatures by approximately 2.6°C and 2°C, respectively, over the last century. If greenhouse gas emissions continue as predicted, the temperatures are projected to rise by 0.5-2°C by 2030 and 1-2°C by 2070 (Government of Zimbabwe 2010). In Malawi, there is increasing uncertainty and variability of climatic trends, with greater inter-annual rainfall variability and temperature increases (Ngongondo et al. in press McSweeney et al. 2008). Generally, observed temperature shows that mean annual temperature has increased by 0.9°C between 1960 and 2003 (Government of Malawi 2010b; McSweeney et al. 2008).

Assessment of climatic trends presented above shows some similarities and differences between countries, especially regarding climatic challenges, vulnerable sectors and vulnerability context. Table 3 below provides a summary of these characteristics by country. Some variations are due to social and economic differences among the countries (e.g. education and infrastructure for Malawi, but not Zimbabwe or South Africa); as well as physical location of the countries (e.g. sea level rise and salt water intrusion in South Africa).

3.4 Overview of the range of possible impacts of climate change in urban areas in the region

Global warming poses major challenges to humanity across the region, affecting agriculture, water, health and other key socio-economic sectors. Increases in intensity and frequency of rainfall events and storms will cause increase in runoff, erosion and destruction of infrastructure and crops, aggravating provision of food, shelter, health, water and sanitation services (Brown et al. 2012; Farrel 2010; Joshua et al. 2010; Dodman et al. 2009). On the other hand, a projected decrease in precipitation is expected to affect river discharge and groundwater recharge which consequently result in reduced water availability, leading to worsened water stress (in countries such as South Africa and Zimbabwe which are already water stressed) (UN-Habitat 2011a; Government of South Africa 2010; Cornway 2009; Kruger and Shongwe 2004). This drying condition is expected to significantly affect human health, performance of agriculture, other water-intensive economic sectors including mining and electricity-generation as well as environment status in general (Government of Zimbabwe 2013; Kruger and Shongwe 2004).

Agriculture is a dominant source of livelihoods for rural people. Low agricultural production will lead to shortages of raw materials for urban agro-based industries and decreases in local supplies and local farmers' income that support urban economies (Satterthwaite et al. 2007: 56). Additionally, low yields will lead to increased rural-urban migration in search of non-farm livelihoods, resulting in growth of slums, more pressure on already limited resources and shortages in food supplies in urban areas, which predominantly rely on rural production (Joshua and Namphande in press; Brown et al. 2012; Government of Malawi 2010b; Joshua et al. 2010; Meyer-Ohlendorf 2009; Eriksen et al. 2008; Joshua et al. 2008; Barrios et al. 2006). Shortage of water will add an extra burden on women due to gender division of labour.[2]

Although gender roles are less significant in many urban areas across developing countries, in Southern Africa the role of fetching potable water is seen primarily as a woman's job even in poor urban households. FAO/WFP (2008) argue that women principally shoulder the responsibility of food preparation and ensuring sufficient supply of water in their households. When potable water is not available on the premises, the burden of water collection rests on adult women above 15 years of age (Sorenson et al. 2011; UN DESA 2010; WHO/UNICEF 2010). This means that those households that have no improved water source on the premises, or when there is water shortage due to drying up of the source, the main water fetchers become women. During water shortages women therefore may resort to unsafe sources of water or spend more time in fetching potable water. Households that cover long distances or spend over 30 minutes round trip in fetching potable water fail to meet household drinking water requirements (WHO/UNICEF 2010). Quality and quantity of water drawn may have implications for food preparation and consumption in households. For example, in an attempt to economise insufficient water, households may miss some meals or inadequately clean raw foods – leading to health implications such as malnutrition and diarrhoea among children.

Increasing temperatures will result in heat waves, sea level rise, increased occurrence and severity of forest fires, water stress and heat stress (UN-Habitat 2011a). Sea level rise and storm surges will adversely affect the coast and coastal infrastructure through coastal erosion and saline intrusion. Saline intrusion in aquifers will limit people's access to potable and fresh water from groundwater supplies in coastal cities (Satterthwaite et al. 2007). Heat waves are a particular health concern to urban populations because their impact is amplified by urban 'heat islands' (Brown et al. 2012; Meyer-Ohlendorf 2009). Increased heat stress will demand higher energy

consumption due to increased use of air conditioning. Strong winds provide potential for wind power and ocean power while high temperatures provide a good source for solar energy (UN-Habitat 2010) for residential water heating and lighting. Hence, the strong winds are an opportunity arising from climate change that may be utilised by SADC countries in addressing the energy crisis in part contributed to by climate change. South Africa has moved a step ahead in promoting these renewable resources because its policy is well informed.

However, the magnitude of severity in specific urban areas, for example in Malawi and Zimbabwe, is not clearly known because most assessments have a rural focus. Thus the scale and depth of climate hazards and impacts are inadequately documented at city level. Despite this limitation, available information shows that the most vulnerable groups are the low income urban communities, children, the elderly, women and female-headed households (GFDRR/World Bank 2011; Farrell 2010; Richardson 2010; WHO/UNICEF 2010). Water scarcity would increase the workload for women and children because they have to cover long distances to fetch decreasing amounts of water (Brown et al. 2012; Dodman 2010; McMichael et al. 2005).

In summary, impacts of climate change are expected to affect urban areas differently depending on differences in vulnerability. However, the poor, especially those living in slums, are most vulnerable. Women are particularly vulnerable due to their socially constructed gender roles and inequities, which need to be addressed. It is worth noting that continued urbanisation in all South African urban areas is expected to grow further with increased rural urban migration, exacerbated by the effects of climate change. The majority of the migrants are the economically active men or youth whose needs have to be integrated into urban plans to reduce their vulnerability as well as vulnerability of the young and old left in their home villages.

3.5 Overview of the key causes of vulnerability in urban areas in the region

Vulnerability to the impacts of climate change varies at spatial and social scales. Risk from climate change impacts such as extreme events – both now and in the near future – is high in low lying coastal areas and countries that are less developed due to high sensitivity and low adaptive capacities. This situation is particularly notable in slums (where the poor are hit hardest) and among women in areas which are less responsive to climate change impacts (Dodman 2011; IPCC 2007a).

Populations in poor urban areas are vulnerable to the impacts of climate change because of high exposure and low coping or adaptive capacity, both through their physical and socio-economic setting, to climate-related hazards. The urban poor population mainly lives in crowded slums that mushroom in hazard-prone areas, such as coastal areas, flood plains and steep slopes, usually without land-use controls or building standards that are meant to reduce risks and stop developments in unsafe areas (CLACC 2009). Many shelters are poorly constructed from wood, mud or old iron sheets and are not able to withstand storms or floods (Brown et al. 2012; CLACC 2009). Lack of resilient assets, insurance, legal status and capability to relocate during a disaster mean that they have low coping or adaptive capacity (Dodman and Satterthwaite 2008; Satterthwaite et al. 2007).

In most cases, the slums do not have formal services such as drainage systems, sanitation, water supply or waste management. This is due to lack of capacity in local governments to cope with rapid urbanisation and sudden movements of people into the city due to adverse effects of climate risks or conflicts in surrounding areas (Meyer-Ohlendorf 2009; Satterthwaite et al. 2007). In all Southern African countries except South Africa, informal settlements are illegal and therefore under constant threat of eviction, leaving thousands homeless (Brown et al. 2012; Brown 2011). However, recently there is shift towards pro-poor policies, exemplified by five-year slum upgrading programmes in Zimbabwe (Brown et al. 2012), Malawi (Brown 2011; Government of Malawi 2010c; Manda 2007) and South Africa (Farrell 2010).

4.0 Research related to climate change adaptation in urban areas

4.1 Vulnerability and adaptation of people in urban areas in the region

Most of the research activities or projects in the region have focused on rural areas (see Appendices 1, 2 and 3), despite the economic importance and associated vulnerabilities of urban areas (Brown et al. 2013; 2012; Adaptation Partnership 2011; UN-Habitat 2011a; Chagutah 2010; Zvigadza et al. 2010). This subsection provides an overview of urban research related to climate change adaptation in the three case studies.

In Malawi, only one out of the 20 adaptation projects or programmes implemented in the past ten years (Adaptation Partnership 2011) focused on urban areas. The study explored implications of urban-rural links on vulnerability and identified coping and adaptation strategies of communities in Blantyre and three smaller towns through participatory action research (Joshua et al. 2011; 2010) (See Table 4 and Appendix 1 below). The Malawi study identified vulnerabilities and coping or adaptation strategies that were spatially and socially differentiated, suggesting that when planning for urban adaptation, plans should integrate such dimensions to produce effective outcomes. In particular, women, children, youths, the elderly and the poor are among the

Table 4: Research activities and projects on vulnerability and adaptation in urban areas of Southern Africa

Name of project/ research	Type of adaptation programme	Funded by	Years	Implemented by	Priority area	Geographical focus
Building the capacity of urban project teams in participatory action research	Capacity building; knowledge communication	DFID-IDRC CCAA Programme*	2008-2010	UK Department for International Development (DFID)	Urban areas	Urban
Reducing disaster from wildfire hazards associated with climate change	Capacity building; policy formation and integration	Special Climate Fund	2011-2014	United Nations Development Programme (UNDP)	Disaster risk management; fire management	South Africa (Western Cape, Eastern Cape, Freetown Province)
Five-city network to pioneer climate change adaptation in sub-Saharan Africa	Capacity building; policy formation and integration	DFID-IDRC CCAA Programme	2009-2012	International Council for Local Environmental Initiatives	Urban areas	Mauritius, Mozambique, Namibia, South Africa (Cape Town), Tanzania
Strengthening the role of civil society in water governance in African cities: Durban, Maputo, Nairobi	Research; capacity building	DFID-IDRC CCAA Programme	2010-2013	York University (Canada)	Fresh water supply; civil society; urban areas	Kenya, Mozambique, South Africa
Urban-rural interdependence and the impact of climate change in Malawi and Tanzania	Participatory action research and capacity building	DFID-IDRC CCAA Programme	2009-2012	University of Dar es Salaam in collaboration with the Universities of Malawi and Greenwich	Agriculture; urban areas; rural areas	Malawi and Tanzania

* Climate Change Adaptation in Africa, a joint programme of the UK Department for International Development and the International Development Research Centre

Source: Adaptation Partnership (2011)

most vulnerable groups to the impacts of climate change and climate variability. Their adaptation is weak due to limited capacity, institutional support and access to relevant information for informed decisions and actions.

To cope with food and water shortages, people diversify their livelihood strategies. High income households can afford high prices during shortages or move to other places in search of food, whereas low income households often go hungry. For water shortages, the poor turn to unsafe water sources such as unprotected wells and rivers. In times of food shortages, coping strategies for low income households include small scale vending, charcoal making, irrigation, prostitution, migration, brick-making, remittances, begging, casual labour, reduced number of meals, changing diets and petty theft. However, most of these coping strategies are not robust enough for effective adaptation. Additionally, their vulnerability is least recognised by local authorities, who associate food security of urban households with market supplies or stocks, ignoring the differences in purchasing power between the poor and high income people. Furthermore, research least covers urban adaptation in other equally important sectors such as water, health and infrastructure development. However, current national disaster risk programmes may have implications on urban adaptation (GFDRR/World Bank 2011). These initiatives are also common in the other SADC countries including Zimbabwe and South Africa.

In Zimbabwe (Appendix 3), a study conducted in the rural area of Chiredzi showed significant exodus of young people to urban areas in Zimbabwe and neighbouring countries, which has adversely affected agricultural production. This rural-urban migration increases vulnerability of the urban poor as well as the rural poor (McDevitt 2009). Famers are advised to grow resilient crops in order to cope with declining rainfall. To address water challenges in Bulawayo, the local authority charges high tariffs to other cities obtaining water from its area of control, prohibits use of hosepipes for irrigation and rations water during critical water shortage periods. The

local authority has also drilled boreholes in Bulawayo, especially in high density areas. The water points are used for domestic use as well as urban farming. Similar initiatives are promoted in Malawi's cities. However, in times of critical water shortages, urban farmers in Bulawayo use polluted stream and drain water for irrigation. Most crops (such as vegetables) produced in this way are likely to be contaminated with pathogens (Sithole et al. 2012). This may pose health risks to consumers. Promotion of rainwater harvesting technologies is therefore ideal to address the problem. Other studies also advocate for expansion of formalised use of treated wastewater in industrial plants as well as in homes (e.g. for sanitation and gardening) (Thebe and Mangore undated) to reduce water demand on available resources.

South Africa (Appendix 2) is one of the few countries that have taken steps to address urban adaptation guided by reliable climate and local vulnerability assessments, in some cases in collaboration with other cities within the region (UN-Habitat 2011a). Two cities, eThekwini (Durban) and Cape Town, have led the way in establishing adaptation policies and plans which currently guide adaptation action (Ziervogel and Parnell 2010). For the City of Durban, an assessment of the projected impacts (through 2100) of climate change suggests negative economic and health implications of the future climatic risks (see Carmin et al. 2012; Farrell 2010; Satterthwaite et al. 2007; Naidu et al. 2006). The City Council has moved to integrate the risks posed by climate change into planning and development (Carmin et al. 2012; Satterthwaite et al. 2007), through its Municipal Headline Adaptation Strategy (Roberts 2010; Satterthwaite et al. 2007). This is an integrated adaptation strategy to the projected impacts of climate change and includes responses in human health and safety and infrastructure for water and sanitation, coastal line protection and transport (Carmin et al. 2012; Farrell 2010; Satterthwaite et al. 2007). Recognising the diverse effects of climate risks necessitates the involvement of all relevant stakeholders in the development of the plan, generating a Municipal Adaptation Plan (MAP) which addresses cross-cutting issues that require coordination across line functions.

The Department of Environmental Planning and Climate Protection conducts community level adaptation pilot projects using Danish bilateral funding. The department has been testing methodologies for community risk assessment and for enhancing food security and rain water harvesting in low income settlements. In addition to other actions which are underway, the department has also established a Climate Change Partnership for ongoing dialogue with multiple stakeholders including civil society groups, academics and businesses. The aim is to generate inputs for actions that aim to support city-wide climate resilience objectives. Similar activities are coordinated in Cape Town and other cities by the Environmental Resources Management Department (Farrell 2010; Ziervogel and Parnell 2010).

The cities work collaboratively with the universities in generating downscaled models that are localised for a specific city. Climate projections in Durban are based on research undertaken by the Universities of Pretoria, KwaZulu Natal (Pietermartizburg campus) and Cape Town, using a regional downscaling model.. Durban City also accesses data from the South African Navy to project possible sea level rise as part of the Global Sea Level Observing System project (Johnson and Breil 2012). Researchers use the physical indications from modelling and four integrated scenarios for the future development of the cities to generate results that are communicated for informed decision-making. Although this collaboration has a few shortfalls (including limited institutional support and legal mandate), it provides high quality scientific climate models that can enhance cities adaptation to climate risks (Johnson and Breil 2012). Currently, the city of Durban is collaborating with the Tyndall Centre for Climate Change Research in the UK to develop a model that is expected to 'enable the simulation, evaluation and comparison of strategic urban development plans within the context of climate change' (Satterthwaite et al. 2007: 56). This aims to enhance an understanding of effects of climate change risks in Durban, including on greenhouse gas emissions, and to improve the city's plans with 'model-based assessment of the effectiveness of alternative strategic approaches to mitigation and adaptation' (Satterthwaite et al. 2007: 56).

Similarly, in 2009 the city of Cape Town 'established a climate change knowledge think-tank regrouping academics and scientists to undertake reviews and assessments of the effects of climate change on the city' (UN-Habitat 2010: 228). This research is expected to guide the city in its response to climate change (UN-Habitat 2010). The University of Cape Town's Climate Systems Analysis Group (CSAG) has developed downscaled climate change scenarios that use global circulation models linked to local station data (Ziervogel et al. 2010: 100). Researchers use these scenarios to interpret some of the expected changes, for example on water resources and vulnerabilities for the Western Cape. The Civil Engineering Department at the University of KwaZulu Natal provides expertise on urban water management to the local government (Ziervogel et al. 2010).

4.2 *Options for reducing vulnerability, strengthening adaptive capacity and supporting different urban groups*

Most urban adaptation strategies that are already adopted by cities, as well as those suggested in the relevant literature, fall into the categories of technical adaptation (hard infrastructural or soft non-structural); land use and contingency planning; education and awareness; and research and monitoring (Johnson and Breil 2012). These offer opportunities for mainstreaming climate change mitigation and adaptation (Johnson and Breil 2012; Brown 2011; Farrell 2010). For example, the compact city model that integrates climate risk concerns

is a recommended model for most cities in Malawi (Brown 2011). This will protect agricultural land and forest cover and minimise further vulnerability for both rural and urban communities. In the City of Durban, there is a shift from being responsive to preventive in disaster management to reduce losses arising from extreme events and increase resilience. The city has adopted a sector-by-sector adaptation approach beginning with the water, health and disaster management sectors. Water and health sectors are prioritised in part due to their vulnerability to climate change and importance to the city's development agenda. The sectors require adaptations that involve multiple actors and cover a spectrum of risks and threats (Johnson and Breil 2012; Roberts 2010).

The water sector adaptation plan focuses on improving water and sanitation, coastal, storm-water and catchment management and coastal policy (Johnson and Breil 2012). Water and sanitation adaptation options include modifications to landscape designs to ensure increased water absorbing capacity of the urban landscape; improvements to drainage systems; increasing the height of natural shoreline stabilisation measures utilising storm-water retention/detention ponds and constructed wetlands; adjusting storm-sewer design; and land-use planning and zoning to avoid locating structures/ buildings in risky areas (Satterthwaite et al. 2007).

The health plan covers clinical health, environmental health, communicable disease control, social development and food security (Johnson and Breil 2012). Human health is expected to be managed through public education that enhances community responses, e.g. promoting more shade provision and increased efficiency, and to develop an extreme-climate public early-warning system, as well as research and training for environmental health (Satterthwaite et al. 2007). Other interventions aimed at improving institutional capacity are included in the disaster management plan. These include implementation of the disaster risk management framework, comprehensive city-wide assessment, recruiting additional staff for the Disaster Management Unit, revisions of contingency plans for key risk areas and hosting a disaster management summit (Johnson and Breil 2012).

Similarly, Cape Town has adopted integrated water resource planning approach to manage changing water demands and address the effects of climate variability, population, economic growth and stresses on the supply of water. The city has adopted demand-side as well as supply-side management responses to deal with growing projected water demand and the future intermittent shortages that will be brought about by climate variation (Mukheibir and Ziervogel 2007; 2006). However, demand-side management interventions are preferred to supply-side options because climate change trends may make the latter inappropriate in the short term. With successful institutions, demand-side management interventions can delay the need for augmentation because they lead consumers to use water sustainably (Ziervogel et al. 2010).

Demand-side management strategies include water restrictions for some activities to specific times and bans on other activities to reduce the demand on the limited water resources; water tariffs to lower the water demand, conserve water and consequently increase both the robustness and resilience of the water supply system; reducing leaks through the upgrading and improvement of water supply lines to reduce losses to within acceptable limits as well as treatment and distribution costs; pressure management to reduce leaks by lowering the off-peak water pressure in the pipes; and awareness campaigns to reduce the consumption of domestic water (Mukheibir and Ziervogel 2007; 2006).

Supply-side strategies include establishment of additional water schemes; promoting reuse of grey water in households and re-use of effluent through incentives that encourage industries and other wet-processing systems to recycle their wastewater; promotion of water harvesting (Ziervogel et al. 2010; Mukheibir and Ziervogel 2007; 2006) through the installation of rainwater tanks in homes and commercial buildings for use in gardens, swimming pools and sewerage, using incentives; modification of catchment vegetation with high water demand and high transpiration; desalination; and improved integration of climate variability information into decision-making, with water resource managers integrating information about climate variability on an annual timescale in order to better manage resources given the expected seasonal variation (Mukheibir and Ziervogel 2007; 2006).

The city has also focused on urban design and planning to create more green buildings and more efficient means of cooling and heating buildings. This adaptation option is part of the City's Green Building Guideline that aims to ensure that all new property developments use solar heating and consequently are able to withstand changing weather patterns and more frequent extreme weather conditions. Other adaptation interventions are seen in the municipality's policy of retrofitting ceilings in houses that did not have these, in order to maximise the heating and cooling of such homes – mostly belonging to the category of social housing (Mokwena 2009). For example, the Kuyasa Fund in Cape Town provides microfinance lending for housing, targeting the most vulnerable groups, in particular women. About 16 percent of the funds went into thermal efficiency of houses (Alber 2011). These adaptation strategies may be applicable to all cities experiencing similar climate challenges.

However, selection of adaptation options should relate to particular vulnerabilities of people and areas, which requires good governance – 'improved competency, capacity and accountability within city and municipal governments' (Satterthwaite et al. 2007: 59). The exposure to risk of the poor urban population may be reduced through provision of affordable land or housing in safer, legal locations (Satterthwaite et al. 2007). Partnerships between local government and slum and shack dwellers may reduce their vulnerability to storms and floods while improving housing conditions and infrastructure provision at minimal cost (Satterthwaite

et al. 2007). Examples of such partnerships include a slum upgrading programme by the Homeless People's Federation, Dialogue on Shelter and the City of Harare (Brown et al. 2012) and similar initiatives in Malawi (Brown 2011; Manda 2007). In South Africa, a Reconstruction and Development Programme provided capital subsidies and subtracted housing arrangements to low income dwellers living in informal settlements in 1994. This policy graduated into Breaking New Ground in 2004, under which houses are constructed depending on owner requirements, in contrast to the former arrangement where all houses were standard fit for a single family (Farrell 2010). If slum upgrading programmes or policies integrate climate risks such as trends in temperature, rainfall and extreme weather events in housing designs, adaptive capacity of the low income residents will be enhanced.

It is assumed that successful rural development helps to reduce rural-urban migration. In the context of climate change, this may be viewed as one option for reducing urban vulnerability. Although this may apply when considering negative effects of climate change-induced rural-urban migration, this assumption is based on a limited understanding of positive effects of rural-urban linkages. This happens when these spatial systems are considered as separate entities. Rural-urban migration remains significant despite successful rural development programmes (Brown 2011). Satterthwaite et al. (2007) argue that such condition increases rural-urban migration, as higher-value crops and higher incomes among the rural people increase demand for urban goods and services. Increased trade between these two spatial systems may therefore help reduce urban vulnerability. Policies that recognise the significance of rural-urban linkages to the wellbeing of each spatial system may therefore enhance positive linkages.

4.3 Documented adaptation by farmers in urban areas

Urban and peri-urban agriculture is recognised to contribute to urban food security, household income and environmental management (Mkwambisi 2009; Mutonodzo 2009; Satterthwaite et al. 2007). In many cities including eThekwini, Gaborone, Harare, Lusaka, Maputo and Maseru urban agriculture has developed significantly in the last decade (UN-Habitat 2010). Urban agriculture is an important livelihood activity for women, especially in female-headed households, in Malawi (Mkwambisi 2009). It is an important adaptation strategy for low income households in urban areas, whose promotion can help reduce vulnerability of women in particular (Joshua et al. 2012a). Many urban poor rely on self-produced food for household food security due to their low purchasing power. Hence, low crop yields make them vulnerable to food insecurity (Ibid).

However, water and land are important resources constraining the proliferation of urban agriculture. Both land and water are scarce in cities, leading to a spatial marginalisation of the poor, in particular women due to their economically and often legally disadvantaged situation (Alber 2011). A lack of tenure and legal status forces poor urban farmers to work on marginal lands with water of low quality, such as wastewater. Use of raw or poorly treated wastewater for irrigation poses a significant health risk to farmers, and hence its use is prohibited. Against this background SADC countries including Malawi, Swaziland, Tanzania and Zimbabwe signed the 2003 Harare Declaration committing to the development of urban agriculture. It is hoped that the initiative may encourage further expansion of sustainable agriculture in urban and peri-urban areas (UN-Habitat 2010). However, the Declaration little recognises the significant gender dimension in urban agriculture.

In male-headed households, unequal gender relations, division of labour and access and control over resources remain challenges in distribution of benefits. Although more women than men shoulder the responsibility of production and marketing, in Malawi women have limited control over household income generated from product sales (Joshua et al. 2012a). Similarly, in South Africa men tend to control finances and make most decisions in many households. Gender bias also features at the policy level, where women are under-represented, particularly in executive positions. This consequently leads to male bias in planning and decision-making which may lead to neglect of women's needs (Alber 2011) and consequently exacerbates their vulnerability to climate change. Gender mainstreaming is therefore recommended at all levels to address gender inequalities in benefits.

4.4 Lessons from adaptation projects and interventions in urban areas in the region

Recognising trends of urbanisation and climate change, it is necessary to promote strategies that integrate climate risks. For example, an integrated adaptation strategy to the projected impacts of climate change are appropriate for effective adaptation and this should include responses in all vulnerable areas including human health and safety, infrastructure for water and sanitation, coastal line protection, energy and transport (Carmin et al. 2012; Farrell 2010; Satterthwaite et al. 2007). Effective adaptation interventions should also integrate gender dimension and target the most vulnerable areas and social groups. This approach may ensure coordination across line functions and multidisciplinary participation of relevant stakeholders in addressing adaptation interventions.

Water is a non-substitutable environmental resource and perhaps the most vulnerable to climate change. Appropriate adaptation interventions are therefore required to sustain its diverse demands. Demand-side management interventions are more suitable than supply-side options because climate change trends may make the latter inappropriate in the short term. For example, declining rainfall trends may lead to drying of water reservoirs in some parts of Southern Africa.

Figure 5. Tower gardening for growing vegetables in urban areas

a) Vine preservation of sweet potato as a planting material – tower gardening

b) Pumpkin leaves in tower garden gardening

c) Mustard in tower garden at homesteads

d) Amaranth in tower garden

Source: Joshua et al. 2012a

Construction of new dams to address water shortages in such areas may therefore be cost-ineffective in the near future. With successful institutions, demand-side management interventions can delay the need for augmentation because they lead consumers to use water sustainably (Ziervogel et al. 2010). Appropriate tariff charges, promotion of water recycling and effluent re-use in households and industries are good examples of demand-side management interventions.

In urban agriculture there is need to promote technologies that require less water, less land and fewer inputs, and that addresses seasonality patterns of products (Joshua et al. 2012a). Vegetables form an important component of urban households' diets and incomes, especially for the poor. However, production and supply to households is seasonal. In a participatory action research project involving Malawian urban farmers and the local government, Joshua et al. (Ibid) identified high yielding and profitable vegetables as well as technologies that withstand high temperatures and low water supply. The farmers received training on effects of climate change on horticultural production, entrepreneurship and recommended in-field horticultural practices. A combination of sunken beds, mulching and use of organic manure were identified as best technologies in both Mulanje and Chikhwawa urban sites. The farmers also adopted staggered planting to retain market supply of vegetables and earn more income. While tower gardening failed in Chikhwawa due to very high temperatures, it was adopted well in Mulanje, which is cooler.

Tower gardening uses less water, land and can be practiced throughout the year, hence addressing seasonality patterns of vegetable production and supply in the urban areas. The technology is also friendly to vulnerable groups: the elderly, physically challenged and women. In Malawi, tower gardening is used for vine preservation of sweet potato as a planting material at Bvumbwe Agricultural Research Station (see Figure 5). Conservation of sweet potato planting material is a challenge where there is no access to water during the dry season.

Tower gardening also ensures a stable source of income to a farming household, which can be invested into a range of livelihood needs including household horticulture, better quality food, education, shelter and social support networks (Liwenga et al. 2012). In Chikhwawa, farmers are growing vegetables such as cabbage and onions which were previously thought not to be suitable for the area due to very high temperatures (see Figure 6). The Agricultural Office at the local government level has extended project activities to other areas with high potential for vegetable production to ensure sustainability.

The project showcased a multidisciplinary approach to adaptation programmes as an effective way to influence policy and upscale successful adaptation strategies. This was achieved by bringing key stakeholders within the urban-rural linked food and agricultural systems together.

South African cities offer key lessons for the Malawian and Zimbabwean cities in formulating and implementing

climate change adaptation and mitigation policies in the urban environment. These include the recognition of the role of local governments in addressing adaptation at urban level; capacity building (training) of local government staff on climate science and linkages with development, good governance and political support; reliable city level climate assessments for informed policy; mainstreaming (horizontal integration) of climate change concerns in city plans or development programmes for the results from city scale modelling and vulnerability assessments to serve the intended purpose; affordable financial systems that encourage adaptation; city-to-city networks for sharing of climate knowledge and experiences; and multi-stakeholder collaboration and dissemination of research results (see sections 4.1, 4.2 and 5.0; Farrell 2010; Satterthwaite et al. 2007).

4.5 Key documented barriers to adaptation in urban areas

Barriers to climate change adaptation in urban areas include climate information and data deficiencies; administrative and governance constraints; funding limitations; and the need to define progress indicators (Johnson and Breil 2012).

In Malawi, there is a paucity of information from climate modelling due to limited expertise in modelling and scanty network stations and equipment for downscaling regional climate data, which pose challenges for the provision of localised climate simulations (Joshua et al. 2011). This is exacerbated by low coverage of climate science at all levels of the education system (Joshua and Namphande in press; Government of Malawi 2010c). The National Education Sector Policy and Plan (NESP) contains no policy statements on climate change and environmental education and awareness (Government of Malawi 2008). Education can help to change current practices through behaviour modification, offering both medium and long term solutions to climate change challenges and building a more resilient population (Laure 2009; Pollier 2009; Young 2009). In addition, there is a general tendency to focus adaptation activities in rural areas at the expense of the urban sector (Joshua et al. 2010). Low recognition of the vulnerability of the urban sector means that there is low political support for adaptation programmes in that sector. Malawi lacks a national urban policy to support urban agriculture (Joshua et al. 2012a). In addition to policy gaps, Malawi's urban sector adaptation to climate change is challenged by weaknesses in political decentralisation and inadequate institutional capacity (Brown 2011).

In Zimbabwe, the main challenge to adaptation arises from inadequacies in the legal framework and governance. Adaptation research is heavily influenced by a rural policy agenda (Brown et al. 2012). Although this is recommended for reducing rural-urban migration, and indirectly urban vulnerability through rural-urban food, energy and water flows, neglecting climate change adaptation of urban areas constrains support to adaptation strategies at the urban level. Similar to Malawi, there is no policy framework that gives mandate to local authorities to manage urban adaptation (Ibid). For example, though urban agriculture is legally supported in Bulawayo, bylaws in Harare restrict it to marginal areas (Mutonodzo 2009). Current urban water demand management interventions are inadequate to address climate change-induced water shortages both in Malawi (Mulwafu et al. 2003) and Zimbabwe (Sithole et al. 2012) due to limited institutional support (Mulwafu et al. 2003).

In South Africa, research institutions and universities are not mandated to produce climate assessments for urban local authorities. Although the universities provide climate change assessments of high scientific quality, the lack of legal mandate threatens their continuity in provisioning of climate change information, updates and future elaboration of localised climate simulations (Johnson and Breil 2012). In addition, uncertainty of climate change impacts, operational constraints, slow uptake of new technologies and competition on the national budget with pressing development issues affect implementation of adaptation programmes (Johnson and Breil 2012; Farrell 2010). Furthermore, the local authorities are constrained by lack of technical knowledge and understanding of climate change issues (such as risks and impacts) and lack of institutional (guiding policy or mandate) and financial support (Ziervogel and Parnell 2010). However, most of the policy challenges for South African cities seem to now be addressed by the National Climate Change Policy (Government of South Africa 2012a), so it is important to build up the support systems that encourage and support local adaptation (Meyer-Ohlendorf 2009).

5.0 Policies related to urban issues with regard to climate change

5.1 State of knowledge on policies and strategies for climate change adaptation in urban areas

Development policies in most Southern African countries other than South Africa have paid little attention to urbanisation and climate change impacts on the urban sector. They have largely attempted to control urbanisation by promoting rural development, probably because urban growth is viewed as a problem and not an opportunity (Schensul 2012; Brown 2011; UN-Habitat 2010).

South Africa, Zimbabwe and Malawi are signatories to several multilateral environmental agreements, some of which directly address climate change issues, such as the UNFCCC and the Kyoto Protocol. In response to climate change challenges, the Government of Malawi has adopted two principal strategies for addressing climate change adaptation and sustainable

development, namely the country's NAPA[3] and the Malawi Growth and Development Strategy (MGDS) (Brown 2011; Government of Malawi 2011; 2006). The NAPA, a requirement of the UNFCCC, identifies and prioritises critically important adaptation activities for which further delay might increase vulnerability or lead to higher adaptation costs over the long term (Brown 2011). The NAPAs represent one important instrument that facilitates mainstreaming and implementation of adaptation (Meyer-Ohlendorf 2009).

The MGDS is an overarching development strategy for Malawi, which has attempted to translate the Millennium Development Goals (MDGs) to Malawi's localised context. The MGDS recognises the risks posed by climate change in achieving the MDGs (Government of Malawi 2011). In 2012, the Malawian Ministry of Environment and Climate Change launched the National Environment and Climate Change Communication Strategy which primarily aims at increasing public awareness and promoting positive behavioural change for sustainable development (Government of Malawi 2012). However, all of these documents focus on rural vulnerability and adaptation.

Currently, climate change issues are managed through environment-related sectoral policies such as water, forestry, agriculture and fisheries. However, the policies of the different sectors are not harmonised (Joshua and Namphande in press) and climate change is treated as a secondary issue in policy and therefore receives inadequate policy direction and resource allocation (Brown et al. 2012). Similarly, there are three key institutions which are working hand in hand in coordinating climate change in Malawi at the policy level (Ministry of Development Planning and Corporation; Climate Change and Meteorological Services; and Environmental Affairs Department). The Ministry of Local Government is, however, not among these three. This is a serious oversight and setback in terms of mainstreaming climate change adaptation in local government policy.

Zimbabwe's urban policy does not explicitly address climate change (Brown et al. 2012), probably due to the lack of a national climate change framework which could guide integration of climate change concerns in the urban policy. The National Climate Change Office is mandated to assist the government in designing climate change policies (Chagutah 2010) and is in a process of developing a 'Climate Change Response Strategy' (Brown et al. 2013; 2012). Currently, climate change is addressed by environmental legislation (mainly through the Environmental Management Act). However, it is widely recognised that such policies are insufficient in light of the projected impacts of climate change and the scale and scope of vulnerability. Climate change is widely treated as a secondary issue in policy and therefore does not receive adequate emphasis in terms of policy direction or resource allocation (Chagutah 2010).

South Africa represents a unique case in Southern Africa in that local governments have taken a proactive role in addressing climate issues at the local level, and the urban sector is not ignored. A number of cities have developed adaptation plans at both city and sectoral levels, which provide a framework within which local government departments, the private sector and civil society can prepare and implement their contributions to strategies for adaptation within development or investment plans (UN-Habitat 2011a).

In 2004, South Africa produced a National Climate Change Response Strategy aimed at integrating climate change response programmes across national and regional boundaries (Carmin et al. 2012; Farrell 2010; Government of South Africa 2004). A National Climate Change Response Policy was launched in 2012, which integrates urban vulnerability and recommended responses, and clearly stipulates the role of provincial and national government in addressing urban adaptation (Government of South Africa 2012a). In addition to this policy, the government has developed a national Strategic Plan which also addresses capacity gaps at all levels (Government of South Africa 2012b). The government has also integrated gender concerns into the climate change policy responses through a green paper that integrates and provides adaptation strategies in all major areas that concern women's vulnerability, including water, agriculture, human health, energy and transport (Gender CC/CGE/GENSA 2011).

5.2 Reviews of climate change considerations in regional urban area policies and strategies

African Heads of State launched the Comprehensive Africa Agriculture Development Programme (CAADP) and Environment Action Plan (EAP) to address the pressing landscape and livelihood needs of the African continent. CAADP focuses on four pillars of action, including Sustainable Land and Water Management (Pillar 1), aimed at rapid improvement in productivity, competitiveness and development potential of African agriculture. The New Partnership for Africa's Development (NEPAD) Secretariat facilitates implementation of the CAADP agenda, but the major responsibility for implementation lies with regional economic communities including SADC, the Common Market for East and Southern Africa (COMESA), the East African Community (EAC) and their member countries.

In recognition of the significance of climate change to people's livelihoods and countries' development, the Secretariats of COMESA, EAC and SADC have jointly developed a comprehensive approach to address climate change: the African Climate Solution (Adaptation Partnership 2011; COMESA/SADC/EAC 2011; COMESA undated). This initiative highlighted the need to mainstream climate adaptation and mitigation into poverty reduction strategies and economic development plans. The African Climate Solution primarily aims at the promotion of sustainable agriculture and land-use

practices, biodiversity conservation, maintenance of environmental services, successful adaptation to climate change and improvements in rural livelihoods, in addition to the delivery of cost-effective and verifiable reductions in greenhouse gas emissions. The African Union, NEPAD, COMESA, EAC and SADC have also committed to active participation in the negotiations concerning future commitments under the UNFCCC and the post-Kyoto Protocol climate regime (COMESA/SADC/EAC 2011). However, a focus on rural areas may mean limited support to national or local initiatives for urban adaptation.

5.3 Review of key policy actors and networks involved with adaptation to climate change in urban areas

There is a wide variety of policy actors and networks that are responding to climate change in urban areas at international, regional, national and local level. These include international, multilateral, bilateral, regional, national, NGO and city-level actors, initiatives and networks.

The United Nations is the key climate change institution at the international level, acting through the UNFCCC and IPCC and keeping world governments informed of climate change issues such as trends and impacts. UN agencies such as the United Nations Development Programme (UNDP), Educational, Scientific and Cultural Organisation (UNESCO), Food and Agriculture Organisation (FAO) and Human Settlements Programme (UN-Habitat) are very active in addressing climate change adaptation in Malawi and Zimbabwe (UN-Habitat 2010). Multilateral institutions are sources of technical and financial assistance. These include the World Bank Institute, which is implementing several city-focused climate change initiatives (Ibid).

National governments have signed international agreements such as the UNFCCC aimed at mitigation and response to disasters (Johnson and Breil 2012; UN-Habitat 2010). They also negotiate development policy loans to support climate adaptation budgets, and climate change aspects are increasingly integrated into donor policies (Johnson and Breil 2012). Additionally, they are involved in coordinating adaptation measures at the national level. Cities and local governments are equally important in managing climate issues, especially in local context (UN-Habitat 2011a). They play a significant role in facilitating the exchange of information, ideas and learned practices related to climate change adaptation through knowledge sharing networks. These include the Africa Partnership on Climate Change Coalition, Climate Action Network Southern Africa, Africa Adapt, South African Cities Network (SACN), fellows of the Capacity Strengthening of Least Developed Countries for Adaptation to Climate Change (Adaptation Partnership 2011) and Fair Climate Network Africa.

Civil society organisations (CSOs) also play a critical role in climate change governance. They are involved in research and policy analysis, lobbying and advocacy, capacity building and knowledge sharing, adaptation initiatives, resource mobilisation and coordination, all of which influence policy formulation and implementation. For example, in Malawi the Civil Society Network on Climate Change (CISONECC) plays an important role in climate change governance and management. In Zimbabwe, a coalition of environmental CSOs lobbies the government for a participatory approach to climate change policymaking (Chagutah 2010). In Malawi and Zimbabwe, research centres and institutes also play a critical role in planning and implementing research programmes in projecting climate trends and climate change mitigation and adaptation (Joshua et al. 2012a; Adaptation Partnership 2011; Chagutah 2010).

5.4 State of knowledge on funding streams for policies and strategies on adaptation in urban areas at national and regional levels

A number of multilateral organisations, bilateral donors and foundations are actively financing Southern Africa's current adaptation projects (see Appendices 1, 2 and 3). Prominent ones include the Adaptation Fund, European Commission, Global Environment Facility (GEF), IDRC, Least Developed Countries Fund (LDCF), Special Climate Change Fund, Rockefeller Foundation and the governments of Denmark, Finland, Germany, Norway, Switzerland, the United Kingdom (DFID) and the United States (USAID) (Johnson and Breil 2012; Adaptation Partnership 2011; UN-Habitat 2010). Local sources can also play a role in funding urban adaptation. Additionally, Cities Alliance is particularly important in funding city network initiatives. It funds network activities such as launches and development of State of Cities reports.

5.5 Review of key barriers to uptake of research evidence for policy formulation and implementation

Firstly, structural barriers within governments and donor agencies and low sustainability of donor funded projects affect mainstreaming. For example, most projects or research activities are funded for a short period of time while climate change interventions require long time horizons to determine effect or impact of an intervention. Similarly, long term planning of climate issues is not compatible with the short term political and budgeting cycles at the local level (Johnson and Breil 2012; Ziervogel and Parnell 2010; Meyer-Ohlendorf 2009). This implies that an adaptation option that requires long term management may not fit short term budgeting cycles at the local level.

Secondly, local authorities are constrained because they lack technical knowledge and understanding of climate change issues (such as risks and impacts) and support (Ziervogel and Parnell 2010). For example, in Durban, the Office of Environmental Management initiated the process of climate risk assessment followed by development of the adaptation strategy after undergoing training in climate change science. Knowledge obtained from the training enhanced capacity to act. The third barrier relates to lack of available information on climate change that is relevant for informed policy. Not all important information can be projected, and downscaling of climate change projections is still a big challenge in most countries in Southern Africa due to lack of data (Joshua et al. 2011; Meyer-Ohlendorf 2009). Hence, there are uncertainties in climate change information to inform policy. In addition, lack of institutional (guiding policy or mandate) and financial support impedes efforts of policymakers to mainstream adaptation in their policies (Ziervogel and Parnell 2010).

Fourth, there are trade-offs between climate change and development objectives in light of operational procedures. Although climate change is multi-sectoral, some view it as an environmental, not a developmental issue, hence external to their mandate. This may bar other sectors from mainstreaming the issue in their policies (Farrell 2010; Meyer-Ohlendorf 2009). Climate change adaptation should be viewed by national and city governments as complementary to development agendas, otherwise it will remain ignored (Ziervogel et al. 2010; Satterthwaite et al. 2007). The fifth barrier is limited standing of local governments in international climate change negotiations, despite their potential role in adaptation and capacity building (Johnson and Breil 2012).

6.0 Gaps in climate change adaptation research and policy in urban areas

6.1 Key research gaps

Little research has been conducted on the urban spatial system in most parts of Southern Africa. Most research activities are heavily influenced by rural bias, neglecting urban vulnerabilities which are manifested in urbanisation trends and associated relationship with climate change risks. Additionally, local actors have low capacity (technical and financial resources) and no mandate to integrate urban adaptation into their plans. Hence most countries in Southern Africa, including Malawi and Zimbabwe, lack empirical evidence on urban vulnerability (Brown et al. 2012).

Most of the studies also focus on agriculture and freshwater resources. Several research areas remain underexplored. These include modelling of climate risks for specific urban areas to provide city or urban level relevant climate information and reduce uncertainties, assessment of vulnerabilities, coping and adaptation strategies of different urban areas and social groups; an understanding of urban-rural linkages and impacts of climate change; and assessment of the role and capacity building needs of local governments. While these gaps apply to all countries in Southern Africa, it is worth noting that South Africa has taken a lead in covering most of the gaps identified above. However, more detailed studies are needed, particularly on uncertainties in modelling and urban-rural linkages.

6.2 Key policy gaps

Climate change responses in the Southern African countries are rurally biased (Brown et al. 2012; Brown 2011), suggesting that urban areas are largely ignored in climate change policy debates. This is evident in the low recognition of urban vulnerabilities in National Communications to the UNFCCC from both Malawi and Zimbabwe (Government of Malawi 2010b; Government of Zimbabwe 1998). In Malawi, the NAPA also significantly aims at reducing rural communities' vulnerability (Government of Malawi 2006), ignoring the urban population. Additionally, NAPA guidelines promote urgent action instead of strategic development planning. Hence many NAPA projects ignore the importance of structural and institutional reforms that are needed to mainstream or integrate climate adaptation into national policy and planning as well as supporting adaptation capacity within local government (Meyer-Ohlendorf 2009; Satterthwaite et al. 2007). This is crucial, especially for urban areas where there is great need to strengthen capacities for planning and implementation, because all aspects of climate change risks and vulnerabilities have local context (Meyer-Ohlendorf 2009). The Malawi Growth and Development Strategy (Government of Malawi 2011) also largely ignores the vulnerability of urban areas despite their economic importance. Meanwhile, the National Physical Development Plan supports a policy of decentralised growth aimed at reducing urbanisation (Brown 2011). This suggests that there is lack of relevant policies that mandate local governments in urban areas to integrate adaptation into city or urban plans and budgets.

In addition, current environmental management legislation and policies are insufficient and outdated in light of the predicted severity of climate change effects and scope of vulnerability (Brown et al. 2012; Satterthwaite et al. 2007). For example, although the 1996 Environmental Management Plan for Malawi integrates climate change, urban vulnerability is given less importance. Additionally, although management of natural disasters is included in city/physical plans, predicted severity associated with climate change is not considered. The other challenge is low recognition of the role of local government in addressing adaptation. Both in Zimbabwe and Malawi climate change issues are coordinated by the Department of Environmental Affairs, located in the Ministry of Environment and Natural Resources Management and Ministry of Environment and

Climate Change Management, respectively. Hence, local governments view climate change adaptation issues as external. In Malawi, this situation is exacerbated by inadequacies in the Local Government Act, which does not include climate change adaptation. This shortfall is influenced by weaknesses in the Environmental Management Act.

While South Africa launched its National Climate Change Response Policy in 2012 (Government of South Africa 2012a), other countries in Southern Africa are yet to develop theirs. At the time of finalising this paper, Malawi and Zimbabwe were drafting their own national climate change policies (Joshua and Namphande 2013; Brown et al. 2012). Such a policy is supposed to clearly articulate the roles of local government to give them mandates; without policy support, the officers may be unwilling to integrate adaptation into their plans. However, it is not known if urban vulnerability and adaptation are integrated in these new drafts. The process calls for serious attention because lack of appropriate policy and legislation will delay urban adaptation planning and management.

6.3. Options and possible policy 'spaces' or opportunities for improved uptake of research findings

In view of the policy shortfalls, there is a need to downscale NAPAs 'to city and local level through the promotion of city adaptation programmes of action (CAPAs) and smaller scale local adaptation programmes of actions (LAPAs)' (Satterthwaite et al. 2007), especially for high risk areas. South Africa provides a good model of city-based adaptation plans – such as the CAPAs in Durban (Roberts 2009) and Cape Town (Mukheibir and Ziervogel 2009). This shift is likely to facilitate active participation at the local level for both researchers and policymakers, and enhance the process of locally adjusted adaptation (Meyer-Ohlendorf 2009). The UNFCCC remains a potential source of funding for Malawi and Zimbabwe to develop downscaled NAPA documents that integrate both rural and urban concerns (Brown et al. 2012).

International organisations such as UNDP, United Nations Environment Programme (UNEP), UN-Habitat, the World Bank, Metropolis and the International Union of Local Governments, along with other regional organisations, facilitate capacity building programmes for public officials responsible for urban and environmental planning and public works every year in LDCs and emerging economies. This is an opportunity for national governments to collaborate with the international and regional organisations and the scientific community. Capacity building programmes can produce effective short term outcomes if implemented collaboratively with local, national and regional universities and research institutions (Rodriguez 2009).

Another window exists through creation of linkages among CSOs, universities and research institutions to incorporate the dimension of climate change in their activities. For example, in slum upgrading projects these can link to integrate climate adaptation (e.g. selection of safe sites) which is often neglected (Ibid). In addition, applied research plays a fundamental role in informing the development of adaptation strategies that address spatial (both rural and urban) and social (e.g. women and men) difference in vulnerabilities (Brown et al. 2012). This type of research also contributes to raising 'climate change as a policy priority at all levels and in informing an integrated approach to future climate policy-making' (Ibid). However, in most countries, including Zimbabwe, adaptation research activities are small relative to the nature and scale of vulnerabilities. This suggests a need for great attention to adaptation research activities in each country. The other important option is the creation of city networks which improve knowledge generation, sharing and uptake by relevant stakeholders (as in the South Africa case study). However, this option should start with situation analysis to ensure that all necessary requirements are considered.

7.0 An analysis of stakeholders and opportunities for collaboration

7.1 Synthesis of key institutional actors involved with research and policymaking on climate change adaptation in urban areas

The actors involved with research and policymaking on climate change adaptation in urban areas include international, multilateral and bilateral organisations; the different tiers of government; grassroots groups and local communities; private enterprises and institutions; NGOs and CSOs; networks; and individuals. Actors involved in mitigation usually include those from the energy, transportation, forestry and agriculture sectors. On the other hand, adaptation includes a large variety of stakeholders with varied interests, including agriculture, tourism and recreation, energy, human health, water supply, coastal management, urban planning and nature (UN-Habitat 2011a). These shape adaptation policies and interventions in various ways, including through information gathering and dissemination; resource mobilisation and allocation; skills development and capacity building; leadership; and networking with other decision-makers and institutions (Agrawal et al. 2008). Major research institutions and policy actors are listed in Appendices 4 and 5.

7.2 Review of identified or inferred 'missing voices' in research and policy debates

Women and children are widely identified as the most vulnerable to hazards associated with climate change, especially in female headed households, because of their climate sensitive livelihoods and gender-based roles. Despite this, their vulnerability remains unrecognised in research and decision-making processes on climate change and disaster risk management (Brown et al. 2012; Adaptation Partnership 2011; Chagutah 2010). For example, in Zimbabwe environmental management policy frameworks only slightly integrate gender aspects (Brown et al. 2012; Chagutah 2010). In Malawi, adaptation activities conducted in the past ten years demonstrate an absence of gender aspects (Adaptation Partnership 2011). Results of an urban-rural interdependence project suggest further attention to women's needs. Although women participated actively alongside the men in the planning and implementation of the project (including production and sales of vegetables), the use of proceeds was strongly dictated by their husbands.

The United Nations International Strategy for Disaster Reduction (UNISDR) Hyogo Framework for Action urges all countries to integrate the gender perspective into 'all disaster risk management policies, plans and decision-making processes, including those related to risk assessment, early warning, information management, and education and training' (UNISDR 2009 p10). Future planning of both urban research and policy frameworks should therefore give special consideration to gender aspects in urban areas while considering spatial differences.

7.3 Lessons from efforts to promote research-policy dialogues on adaptation in urban areas

A number of lessons are generated from various efforts that are applied to promote research-policy dialogues on adaptation in urban areas (Brown et al. 2012; Joshua et al. 2012; Liwenga et al. 2012; Brown 2011; UN-Habitat 2011a). Firstly, research-policy dialogues require multi-stakeholder participation because climate adaptation needs an integrated approach. This suggests that input from actors with varied interests needs to be considered in planning and implementing research as well as policy debates. The actors include international organisations, donors, different tiers of government institutions including city governments and networks, academia, the private sector, civil society and the grassroots (Brown et al. 2012; Joshua et al. 2012; Liwenga et al. 2012; Brown 2011; UN-Habitat 2011a). Secondly, city networks and partnerships play a fundamental role in promoting research-policy dialogues. They are significant in facilitating the exchange of information, ideas and learned practices related to climate change adaptation. Success stories from South Africa provide a good example (UN-Habitat 2011a). Lastly, activities of the civil society (NGOs, CSOs and networks) play a role in influencing policy formation and integration. For example, they can pressure governments to take a certain course of action based on empirical evidence such as projected risks (Brown et al. 2011; UN-Habitat 2011a; Chagutah 2010).

8 Conclusions and recommendations

The review set out to identify gaps in research and policymaking for climate change adaptation in the urban sector, and provide information and insights that can be used to bring researchers and policymakers together to improve evidence-based policymaking, enhance food security and protect populations vulnerable to climate change. The review has revealed results important for informing urban adaptation policy and interventions.

Overall, Southern Africa remains the most urbanised region in Africa. Within the region South Africa has the most urban population (61.5 percent), while Malawi is one of the least urbanised nations (less than 20 percent) but is the fastest urbanising country in the world. Between 1950 and 2010, average annual urban population growth rates were higher than rural rates in all the study countries, and projections show further increases in urban population. This suggests that population growth in Southern Africa is becoming largely an urban phenomenon. Rapid urbanisation has social, economic and environmental knock-on effects for national and local governments and all relevant stakeholders. The urban poor are forced to access land for housing in informal sites which are highly vulnerable to natural hazards and are poorly serviced by local governments. Climate change is therefore expected to worsen vulnerability of these communities.

The review has established that urban areas are highly vulnerable to these impacts of climate change, potentially leading to water stress, energy crisis, food insecurity, human health problems, destruction of infrastructure and, in coastal cities, sea level rise. However, vulnerability varies between cities due to differences in social, economic and environmental factors. Furthermore, within urban areas vulnerability is geographically, socially and economically differentiated. The most vulnerable will be the poor living on marginal lands such as flood-prone areas, and women because of gendered division of labour. Urban populations with high adaptive capacity are less vulnerable to the effects of climate risks. This suggests a need to build capacity of the most vulnerable through supporting urban-based adaptation initiatives.

Options to reduce urban vulnerability include mainstreaming adaptation into city plans, and supporting pro-poor programmes to reduce vulnerability of the poor. One way to achieve this is through the NAPA process. The NAPAs facilitate mainstreaming and implementation of adaptation. The other option is to have legislation that mandates urban authorities to act. Research work should also provide relevant empirical evidence for informed policy. However, the review has revealed that in Malawi and Zimbabwe, adaptation policies, programmes and research activities are biased towards rural areas, probably because of a predominantly rural population (over 80 percent for the Malawian case). In addition, urban legislature (policies and laws) in most countries are outdated to manage climate change effects. For example, although traditional urban development policies integrate management of climate risks such as hazards, they are not able to manage the recent and predicted severity of the risks and they do not integrate resilience.

In South Africa, cities have developed evidence-based adaptation strategies and also mainstreamed urban adaptation in their city plans and budgets. The cities have city networks which facilitate knowledge sharing and learning and consequently improve capacity of city managers to manage and solve city-based climate change problems. Government recognition of the significance of climate change for the urban economy and human wellbeing, as well as efforts by city managers, have provided the basis for South Africa's government to upscale the adaptation interventions. With significant political, financial and international support, the initiatives have enhanced the adaptive capacity of South Africa's cities.

8.1 Recommendations for research

There is need for 1) detailed vulnerability assessments of all urban areas to show which areas and groups of people are most vulnerable to current and future climate risks; 2) rigorous downscaled modelling of climate data for localised assessments of all urban areas to ensure availability of locally based information; 3) research on political economy or policy processes to improve uptake of unbiased and credible evidence; 4) detailed assessments of rural-urban linkages and impacts of climate change; and 5) dissemination of results to a wide audience using various media to increase uptake of credible evidence.

8.2 Recommendations for policy

Following best lessons from South Africa, Southern African countries need to provide an appropriate institutional framework that forms a strong basis for mainstreaming adaptation into urban planning. This can be done through integration of urban adaptation to climate change into national climate change policies, in which local municipalities and authorities are clearly mandated. This approach will ensure integration of urban adaptation into municipal or city integrated development plans and budgets.

LDCs including Malawi and Zimbabwe should ensure that NAPAs are deliberately targeted at vulnerable groups in specific localities. Southern African countries should also adopt a more holistic approach to climate change, focusing on both rural and urban areas' vulnerability and adaptation to climate change. Thus the development of national climate and development policy frameworks should integrate complementary and differentiated urban and rural strategies.

Many urban poor rely on self-produced food for household food security due to their low purchasing power. Hence, low crop yields make them vulnerable to food insecurity. Governments that are yet to recognise urban vulnerability to climate change should consider developing ongoing food security programmes that enhance adaptation of the urban poor as well as rural producers. This approach may make both the rural food producers and urban poor resilient regardless of occurrence of climatic extreme events. The governments should consider developing policies that encourage peri-urban agriculture as an adaptation strategy away from human settlements.

As rural-urban migration continues, Southern African governments should consider integration of climate change management in both urban and rural areas with social safety nets that enhance adaptation. They should also ensure that there is a compromise between the increased land demands of urbanisation and protection of agricultural land. This implies developing a policy that aims to protect valuable agricultural areas in peri-urban areas, because without a law prohibiting sales, farmers are attracted by financial offers from urban developers. A shift of valuable agricultural land to urban land uses such as settlements may reduce rural food crop production, and consequently urban food security.

Countries such as Malawi should consider promoting compact development in addressing land pressures resulting from urbanisation, as an alternative to extending development into peri-urban agricultural land. Southern African countries should promote policies that include climate change education and research. This will ensure development of a resilient population and competent research centres.

Governments including South Africa should develop policies whereby research centres and universities are mandated to sustain production of high quality empirical information on climate change for informed policy. Southern African governments should also increase provision and uptake of unbiased and credible evidence in policy processes to strengthen adaptation strategies of their vulnerable communities.

End Notes

[1] HDI is a composite index that measures average achievement of a country in three basic dimensions of human

[2] Gender division of labour refers to 'the socially determined ideas and practices which define what roles and activities are deemed appropriate for women and men. This results in context-specific patterns of who does what by gender and how this is valued.' (Reeves and Baden 2000: 8)

[3] All countries in Southern Africa have submitted National Communications to the UNFCCC and six have NAPAs. However, almost all have a rural focus.

[4] At the time this work was finalized, Cities Alliance had just started promoting city based assessments in Malawi

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Appendix 1: Research activities on vulnerability and adaptation in Malawi

Name of project/ research	Type of project/ programme	Funded by	Years	Implemented by	Priority area	Geographical focus
Participatory building of capacity for climate change adaptation in agricultural sector in Tanzania and Malawi	Participatory action research; capacity building	Rockefeller Foundation	2012-2014	University of Dar es Salaam in collaboration with the University of Malawi	Agriculture, rural areas	Malawi, Tanzania
Climate change adaptation for rural livelihood and agriculture	Community based adaptation; capacity building; policy formation and integration	Least Developed Countries Fund (LDCF)	2008-2013	African Development Bank (AfDB), Environmental Affairs Department (EAD) and Department of Irrigation	Agriculture	Rural
Legume diversification in tobacco systems: climate risk and market opportunities	Research; capacity building	International Development Research Centre (IDRC) Research in Tobacco Control	2009-?	International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)	Agriculture	
Malawi climate change programme	General support for the country's efforts to respond to climate change	UK Department for International Development (DFID)	2009-2011			
Kulera biodiversity and Mt Mulanje: Mountain biodiversity increases livelihood security project	Community based adaptation	US Agency for International Development (USAID)	2010-?		Agriculture; biodiversity	Mt Mulanje
Community based adaptation to climate change in Africa	Capacity building; field implementation; community based adaptation; research	DFID-IDRC Climate Change in Africa (CCAA) Programme	2008-2011	African Centre for Technology Studies	Multisectoral	African: Kenya, Malawi, South Africa, Sudan, Tanzania, Uganda, Zambia, Zimbabwe
Advancing capacity for climate change adaptation (ACCCA)	Assessment; capacity building; policy formation and integration; in Malawi, focuses on disaster management and health; bridges meteorological services and Red Cross work	IDRC, UK Department for Environment, Food and Rural Affairs (DEFRA), Swiss Federal Office for the Environment, NCAP, European Commission	2007-2010	UN Institute for Training and Research (UNITAR)	Multisectoral	Global: 17 countries in Asia and Africa including Malawi, South Africa
Integrating climate change risks and opportunities into national development processes and UN country program	Policy formation and integration	Spanish Government	2008-2010	United Nations Development Programme (UNDP)	Government	Global: Columbia, Cape Verde, El Salvador, Malawi, Nicaragua

Climate change adaptation and development initiative (CC-DARE)	Demand driven capacity building; knowledge communication; field implementation; 4 projects in Malawi: 1 rural, 3 on climate change mainstreaming in education, policy and districts	Danish Ministry of Foreign Affairs	2008-2011	United Nations Environment Programme (UNEP) and UNDP	Multisectoral	African: Benin, Ghana, Ethiopia, Malawi, Mozambique, Rwanda, Senegal, Seychelles, Tanzania, Togo, Uganda
Strategies for adapting to climate change in rural sub-Saharan Africa: Targeting the most vulnerable	Capacity building; community based adaptation; policy formation and integration	German Federal Ministry for Economic Cooperation and Development (BMZ)	2008-2011	International Food Policy Research Institute (IFPRI), Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN), Germany Potsdam Institute for Climate Impact Research (PIK) and German Leibniz-Centre for Agricultural Landscape Research (ZALF)	Rural areas; agriculture; government	African: Angola, Botswana, Malawi, Lesotho, Madagascar, Mauritius, Mozambique, Namibia, South Africa, Tanzania, Zambia, Zimbabwe
Ground water in sub-Saharan Africa: Implications for food security and livelihoods	Research; policy formation and integration	Alliance for a Green Revolution in Africa (AGRA)	2009-2011	International Water Management Institute	Fresh water supply	African: Burkina Faso, Ethiopia, Ghana, Kenya, Malawi, Mali, Mozambique, Niger, Nigeria, Rwanda, Tanzania, Uganda, Zambia
Linking African researchers with adaptation policy spaces	Research; policy formation and integration; capacity building	DFID-IDRC CCAA Programme	2009-2011	IDRC and Institute of Development Studies (IDS)	Civil society	African: 20 countries including Kenya, Malawi, Tanzania
Supporting integrated and comprehensive approaches to climate change adaptation in Africa (Africa Adaptation Programme, AAP)	Capacity building; policy formation and integration; knowledge communication	Japan International Cooperation Agency (JICA)	2008-2011	UNDP	Government	African: 20 countries including Lesotho, Malawi, Mauritius, Mozambique, Namibia

Urban-rural interdependence and the impact of climate change in Malawi and Tanzania	Participatory action research; capacity building	DFID-IDRC CCAA Programme	2009-2012	University of Dar es Salaam in collaboration with the Universities of Malawi and Greenwich	Agriculture; urban areas; rural areas	Malawi, Tanzania
Strengthening local agricultural innovation systems in less and more favoured areas of Tanzania and Malawi to adapt to the challenges and opportunities arising from climate change and variability	Participatory action research; capacity building	DFID-IDRC CCAA Programme	2007-2011	University of Dar es Salaam in collaboration with the Universities of Malawi and Greenwich	Agriculture; urban areas; rural areas	Malawi, Tanzania
Preparedness for climate change	Capacity building; policy formation and integration	International Federation of Red Cross and Red Crescent Societies (IFRC)	2006-2009	National Red Cross/ Red Crescent Societies	Disaster risk management	Global: 39 countries including Madagascar, Malawi, Mauritius, Seychelles, Zimbabwe
Zambezi River Basin Initiative	Capacity building; community based adaptation	IFRC	2009-2013	National Red Cross/ Red Crescent Societies	Disaster risk management	Regional: Botswana, Malawi, Mozambique, Zambia, Zimbabwe
Southern Africa regional climate change programme	Policy formation and integration	DFID, Swedish International Development Cooperation (SIDA)	2009-2014	OneWorld Sustainable Investments	Government; climate information services	African: Angola, Botswana, DRC, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia, Zimbabwe
Enhancing adaptive capacity to climate change impact through well managed water use for aquaculture integrated with small-scaled irrigation in the Chinyanja triangle	Assessment	BMZ	2010-2013	WorldFish Centre and International Water Management Institute	Freshwater fisheries	Regional: Malawi, Mozambique

Source: Adaptation Partnership (2011), Joshua et al. (2010; 2008)

Appendix 2: Research or project activities on vulnerability and adaptation in South Africa

Name of project/ research	Type of project/ programme	Funded by	Years	Implemented by	Priority area	Geographical focus
Building the capacity of urban project teams in participatory action research	Capacity building; knowledge communication	UK Department for International Development (DFID) and International Development Research Centre (IDRC) Climate Change Adaptation in Africa (CCAA) Programme	2008-2010	DFID	Urban areas	Urban
Adaptation by small scale Rooibos Tea farmers in Wypperrthal and Suid Bokkeveld areas of Western Cape	Research; knowledge sharing	SouthSouth North	2008 -?	UN Environment Programme (UNEP)	Agriculture	Western and Northern Cape
Managing climate risk to agriculture	Research; knowledge sharing	DFID-IDRC CCAA Programme	2009-2011	DFID	Agriculture; fresh water supply; climate information service	South Africa
Community based adaptation to climate change in Africa	Capacity building; field implementation; community based adaptation; research	DFID-IDRC CCAA Programme	2008-2011	African Centre for Technology Studies	Multisectoral	African: Kenya, Malawi, South Africa, Sudan, Tanzania, Uganda, Zambia, Zimbabwe
Climate change support programme	Assessment	German Federal Environment Ministry (BMU)	2009-2012	Department of Environmental Affairs (DEA)	Tourism; health	
Strategies for adapting to climate change in rural sub-Saharan Africa: Targeting the most vulnerable	Capacity building; community based adaptation; policy formation and integration	German Federal Ministry for Economic Cooperation and Development (BMZ)	2008-2011	International Food Policy Research Institute (IFPRI), Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN), Germany Potsdam Institute for Climate Impact Research (PIK) and German Leibniz-Centre for Agricultural Landscape Research (ZALF)	Rural areas; agriculture; government	African: Angola, Botswana, Malawi, Lesotho, Madagascar, Mauritius, Mozambique, Namibia, South Africa, Tanzania, Zambia, Zimbabwe

Reducing disaster from wildfire hazards associated with climate change	Capacity building; policy formation and integration	Special Climate Fund	2011-2014	UN Development Programme (UNDP)	Disaster risk management; fire management	Western and Eastern Cape, Freetown Province
Food and water security under global change: Developing adaptive capacity with a focus on rural area	Assessment	German Advisory Service on Agricultural Research for Development	2007-2009	International Food Policy Research Institute (IFPRI)	Agriculture; fresh water supply	Ethiopia, South Africa
Advancing capacity for climate change adaptation (ACCCA)	Assessment; capacity building; policy formation and integration; in Malawi, focuses on disaster management and health; bridges meteorological services and Red Cross work	IDRC, UK Department for Environment, Food and Rural Affairs (DEFRA), Swiss Federal Office for the Environment,, Netherlands Climate Assistance Program NCAP, European Commission	2007-2010	UN Institute for Training and Research (UNITAR)	Multisectoral	Global: 17 countries in Asia and Africa including Malawi, South Africa
Southern Africa regional climate change programme	Policy formation and integration	DFID, Swedish International Development Cooperation (SIDA)	2009-2014	OneWorld Sustainable Investments	Government; climate information services	African: Angola, Botswana, DRC, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia, Zimbabwe
Five-city network to pioneer climate change adaptation in sub-Saharan Africa	Capacity building; policy formation and integration	DFID-IDRC CCAA Programme	2009-2012	International Council for Local Environmental Initiatives	Urban areas	Cape Town, Mauritius, Mozambique, Namibia, South Africa, Tanzania
Regional science service centre for adaptation to climate change and sustainable land management in Southern Africa	Research; capacity building; knowledge communication	German Federal Ministry of Education and Research (BMBF)	2009-2012		Ecosystem conservation	Regional: Angola, Botswana, Namibia, South Africa, Zambia
Strengthening the role of civil society in water governance in African cities: Durban, Maputo, Nairobi	Research; capacity building	DFID-IDRC CCAA Programme	2010-2013	York University (Canada)	Fresh water supply; civil society; urban areas	Kenya, Mozambique, South Africa

Southern Africa regional climate change programme	Policy formation and integration; research	DFID, SIDA	2009-2014	OneWorld Sustainable Investments	Government; climate information services	African: Angola, Botswana, DRC, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia, Zimbabwe

Source: Adaptation Partnership (2011)

Appendix 3: Research activities on vulnerability and adaptation in Zimbabwe

Name of project/ research	Type of project/ programme	Funded by	Years	Implemented by	Priority area	Geographical focus
Coping with drought and climate change in Zimbabwe	Capacity building; research; community based adaptation; field implementation	United Nations Development Programme (UNDP), Global Environment Facility (GEF)	2007-2012	Environmental Management Agency (EMA) in the Ministry of Environment and Natural Resources Management with support from UNDP	Agriculture	Rural
Lack of resilience in African smallholder farming: Exploring measures to enhance the adaptive capacity of local communities to pressures of climate change	Community based adaptation; policy formation and integration	UK Department for International Development (DFID) and International Development Research Centre (IDRC) Climate Change Adaptation in Africa (CCAA) Programme	2007-2011	University of Zimbabwe, IFPRI and the Soil Fertility Consortium for Southern Africa	Agriculture	African: Mozambique, Tanzania, Uganda, Zambia, Zimbabwe, Ghana, Mali
Building capacity to adapt to climate change	Knowledge communication; research; capacity building	DFID-IDRC CCAA Programme	2007-2010	Midlands State University and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)	Agriculture	Zambia, Zimbabwe
Community based adaptation to climate change in Africa	Capacity building; field implementation; community based adaptation; research	DFID-IDRC CCAA Programme	2008-2011	African Centre for Technology Studies	Multisectoral	African: Kenya, Malawi, South Africa, Sudan, Tanzania, Uganda, Zambia, Zimbabwe
An assessment of vulnerability and adaptation of maize production to climate change in Zimbabwe				Climate Change Office under the Ministry of Environment and Natural Resources Management	Agriculture	Rural

Strategies for adapting to climate change in rural sub-Saharan Africa: Targeting the most vulnerable	Capacity building; community based adaptation; policy formation and integration	German Federal Ministry for Economic Cooperation and Development (BMZ)	2008-2011	International Food Policy Research Institute (IFPRI), Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN), Germany Potsdam Institute for Climate Impact Research (PIK) and German Leibniz-Centre for Agricultural Landscape Research (ZALF)	Rural areas; agriculture; government	African: Angola, Botswana, Malawi, Lesotho, Madagascar, Mauritius, Mozambique, Namibia, South Africa, Tanzania, Zambia, Zimbabwe
Preparedness for climate change	Capacity building; policy formation and integration	International Federation of Red Cross and Red Crescent Societies (IFRC)	2006-2009	National Red Cross/ Red Crescent Societies	Disaster risk management	Global: 39 countries including Madagascar, Malawi, Mauritius, Seychelles, Zimbabwe
Support for strengthening national capacity for disaster management		UNDP	2004-2009	Department of Civil Protection and the Ministry of Local Government, Public Works and National Housing		
Zambezi River Basin initiative	Capacity building; community based adaptation	IFRC	2009-2013	National Red Cross/ Red Crescent Societies	Disaster risk management	Regional: Botswana, Malawi, Mozambique, Zambia, Zimbabwe
Southern Africa regional climate change programme	Policy formation and integration	DFID, Swedish International Development Cooperation (SIDA)	2009-2014	OneWorld Sustainable Investments	Government; climate information services	African: Angola, Botswana, DRC, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia, Zimbabwe
Enhancing adaptive capacity to climate change impact through well managed water use for aquaculture integrated with small-scaled irrigation in the Chinyanja triangle	Assessment	BMZ	2010-2013	World Fish Centre and International Water Management Institute	Freshwater fisheries	Regional: Malawi, Mozambique

Source: Chagutah (2010), Adaptation Partnership (2011)

Appendix 4: Major research institutions

Level/Country	Research Institution	Role/Reason
International	Intergovernmental Panel on Climate Change (IPCC)	Provides internationally coordinated scientific assessments of the magnitude, timing and potential impacts of climate change and proposed responses
	UN-Habitat	Analyses and studies human settlement patterns, and develops methods for controlled settlement to ensure preservation of the environment
	Food and Agriculture Organization (FAO)	Food security assessments
	United Nations Development Programme (UNDP)	Partners with people at all levels of society to help build nations that can withstand crisis, and drive and sustain the kind of growth that improves wellbeing. One way of fulfilling this is through research in several areas and produce reports for policy influence
Regional	International Federation of Red Cross and Red Crescent Societies (IFRC)	Disaster management studies
	WorldFish	Community based adaptation
Malawi	Natural Resources and Environment Centre (NAREC), University of Malawi	Multi-institutional, interdisciplinary and policy directed research experience on urban-rural linkages and impact of climate change. Experience with community based research in urban areas and technology transfer
	Geography Department, University of Malawi	Climate modelling, social, economic and ecological assessments. It has technical expertise to coordinate and monitor climate change adaptation research studies
	Environmental Affairs Department	Vulnerability assessments
	Leadership for Environment and Development, Southern and Eastern Africa (LEAD SEA), University of Malawi	Experience with community based research in urban areas and technology transfer
	Mzuzu University	Technology assessments and transfer in urban areas
	Bvumbwe Research Station and Co-ordination Unit for the Rehabilitation of the Environment (CURE)	Multi-institutional, interdisciplinary and policy directed research experience on urban-rural linkages and impact of climate change. Experience with community based research in urban areas and technology transfer
South Africa	Universities of Cape Town, KwaZulu Natal (Pietermaritzberg) and Pretoria	Climate risk assessment
	The African Centre for Cities, University of Cape Town	Urban research and policy centre
	The Gauteng City-Region Observatory	Urban research and policy centre
	International Council for Local Environmental Initiatives	Capacity building, knowledge sharing and policy formation
	York University	Urban research and capacity building
Zimbabwe	University of Zimbabwe	Climate modelling
	Institute of Environmental Studies, University of Zimbabwe	Multi-institutional, interdisciplinary and policy-directed research on environmental issues. It has in-house technical expertise to coordinate and monitor research studies
	Midland State University, World Agroforestry Centre (ICRAF) and African Centre for Technology Studies	Have experience in capacity building research and technology assessments

Source: Chagutah (2010), Adaptation Partnership (2011), UN-Habitat (2011a; 2010), Johnson and Breil (2012), Joshua et al. (2011), Joshua and Namphande in press), Brown et al. (2012), Cities Alliance (2013)

Appendix 5: Major policy stakeholders

Level	Geographic area	Stakeholder		Role
International	All countries	United Nations		Steers and coordinates climate change action worldwide. Works through the UN Framework Convention on Climate Change (UNFCCC) and Intergovernmental Panel on Climate Change (IPCC) to keep world governments informed of climate change issues, trends and impacts
			UN Educational, Scientific and Cultural Organization (UNESCO)	Climate change mainstreaming in school curriculum
			Special Climate Change Fund (SCCF) / Global Environment Facility (GEF)	finances projects related to adaptation, technology transfer and capacity building, energy, transport, industry, agriculture, forestry, waste management and economic diversification. Current research supported aims at capacity building, policy formation and integration
			Least Developed Countries Fund (LDCF)	Finances preparation and implementation of the National Adaptation Programmes of Action (NAPAs) of LDCs
			Green Climate Fund	Operating entity of the financial mechanism to support projects, programmes, policies and other activities in LDCs
			Adaptation Fund	This Fund was established by the Parties to the Kyoto Protocol of the UNFCCC to finance concrete adaptation projects and programmes in developing countries that are Parties to the Kyoto Protocol
Multilateral institutions	All countries	World Bank		Provides technical and financial (loans) assistance
Donors		Governments of Finland, Germany, Norway and Switzerland		Fund adaptation (and mitigation) projects in developing countries
	Malawi	UK Department for International Development (DFID), International Development Research Centre (IDRC), Cities Alliance[4]		Fund research activities and initiatives on urban adaptation. Current research work supported aims to build capacity, policy formation and integration and knowledge sharing
	South Africa	DFID, IDRC		Fund research activities and initiatives on urban adaptation. Current research work supported aims to build capacity, policy formation and integration and knowledge sharing
		Rockefeller Foundation, US Agency for International Development (USAID), Royal Danish Embassy		Fund city networks, e.g. formation and studies
		Cities Alliance		Funds city networks and production of State of Cities reports
International city networks and initiatives	All countries	ICLEI-Local Governments for Sustainability, C40 Cities Climate Leadership Group, Clinton Climate Initiative, World Mayors Council for Climate Change, United Cities and Local Governments, Climate Alliance, Asian Cities Climate Change Resilience Network, Covenant of Mayors		Facilitate city level social, economic and ecological assessments and improve knowledge generation, sharing and uptake by relevant stakeholders

Regional	All countries	Africa Partnership on Climate Change Coalition, Climate Action Network Southern Africa, Africa Adapt, Fellows of the Capacity Strengthening of Least Developed Countries for Adaptation to Climate Change	Forums for knowledge sharing
National	Malawi	All key line ministries (Local Government, Agriculture, Climate Change and Environmental Management, Economic Planning and Development, Water, Transport, Trade & Industry) and departments	Provide sectoral based information
	South Africa	Key line ministries (Local Government, Human Settlements, Transport, Public Works), National Local Government Association	Provide sectoral based information
		South African Cities Network (SACN)	Promotes good city governance and management; analyses the strategic challenges facing cities; collects, assesses and applies cities' experiences; and promotes learning partnerships between different spheres of government to support cities
	Zimbabwe	All key line ministries and departments	Provide sectoral information
City/ municipal level	Malawi	City councils and municipal offices	On adaptation - not clearly specified by National Climate Change Policy (2012)
	South Africa	Local government offices through City Networks, e.g. Think Tank in Cape Town created by the Environmental Resources Department	Facilitate knowledge generation, sharing and uptake by relevant stakeholders
Academia	All countries	Universities	Provide research results
Civil society	Malawi	Churches Action in Relief and Development (CARD), World Vision International, Co-ordination Unit for the Rehabilitation of the Environment (CURE), Centre for Environmental Policy and Advocacy (CEPA)	Climate change governance
		Centre for Community Organisation and Development (CCODE)	Slum upgrading
	South Africa	Indigo South Africa	Funds technology-driven projects to bring about social change, largely in African countries
	Zimbabwe	Coalition of environmental NGOs, Zimbabwe Environmental Law Association (ZELA), Practical Action, ZERO Regional Environment Organization	Climate change governance
Grassroots	Malawi	Malawi Homeless People's Federation (grassroots network of saving schemes of people living in poor communities)	Lobbies for cheap plots in cities and builds low cost but good quality houses for the poor in safer sites
	South Africa	Low income groups	Use subsidy to improve living conditions in informal settlements
	Zimbabwe	Homeless People's Federation	Lobbies for cheap plots in cities and builds low cost but good quality houses for the poor in safer sites

Source: Chagutah (2010), Adaptation Partnership (2011), UN-Habitat (2010; 2011a), Johnson and Breil (2012), Joshua et al. (2011), Joshua and Namphande (in press), Brown et al. (2012)

Appendix 6: List of interviewees and key informants

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