



Economic Commission for Africa
Subregional Office for Southern Africa

“Climate Change and the Rural Economy in Southern Africa: Issues, Challenges and Opportunities”

Issues Paper



Economic Commission for Africa

“Climate Change and the Rural Economy in Southern Africa: Issues, Challenges and Opportunities”

Issues Paper

United Nations Economic Commission for Africa
Subregional Office for Southern Africa

Table of Contents

Foreword	v
Acknowledgements	vii
Acronyms	ix
Executive summary	xi
Introduction	1
1. The SADC rural economy: features and performance	4
2. Climate-change challenges to agriculture and food security	10
3. Climate change, water and sanitation and biodiversity: risks and vulnerability in Southern Africa	24
4. Climate change and human development in Southern Africa	39
5. Responding to climate-change effects on the SADC rural economy	47
Conclusion	57
References	59

Foreword

Global warming is already affecting Africa and other regions and is expected to worsen in the coming decades. The Southern African Development Community (SADC) subregion is among the most affected regions in the world. Rural economies in Southern Africa are particularly vulnerable to the impacts of climate change due to their high dependence on natural resources. Several sectors and important resources for rural development are already directly affected by climate change, including agriculture, water resources, ecosystems and biodiversity.

The subregion is vulnerable to climate change due to the extreme poverty of many of its people, a high pre-existing disease burden, gender inequality, lack of access to resources and services, limited technological means, lack of efficient governance, conflicts and wars, fragmented health services, low levels of education, water and food insecurity, frequent natural disasters such as droughts and floods, and agricultural systems that are heavily dependent on rainfall.

Over 50 per cent of the gross domestic product (GDP) of SADC member States comes from primary and climate-sensitive sectors of production, such as agriculture, mining, forestry and wildlife. Many people in the subregion depend directly on agriculture for their primary source of food.

A negative impact on agricultural productivity and production from climate change will affect the overall rural economy at the local level, leading even to macroeconomic vulnerability in some countries that are highly dependent on agriculture. It is projected that, in the next 20 to 30 years, three or four SADC member States will face serious water shortages if nothing is done to change the current patterns. Climate change will also have negative effects on human health in the subregion. Heat stress and drought are likely to have a negative impact on animal health, production of dairy products, meat and reproduction in the subregion.

This study reviews the issues and challenges faced by SADC countries in addressing the impact of climate change on their rural economies and highlights opportunities arising from the climate-change development agenda. The study also discusses measures taken by the subregion towards mitigating and reducing the impacts of climate change and mainstreaming it in rural-development policies. It further highlights how these initiatives can be further strengthened to improve the regional and national response to the global threat.

It is my sincere hope that the recommendations of this study will be useful to all stakeholders and to our member States and development partners.

Beatrice Kiraso,
ECA-SA Director

Acknowledgements

This issues paper on “Climate Change and the Rural Economy in Southern Africa: Issues, Challenges and Opportunities”, a publication of the Office for Southern Africa of the Economic Commission for Africa (ECA-SA), was prepared under the leadership of Beatrice Kiraso, Director of ECA-SA. This study was prepared by a team comprising Benjamin Banda, Jack Jones Zulu, Maame Agyeben and Jean Luc Mastaki Namegabe. Mr. Mastaki Namegabe coordinated the team under the guidance and supervision of Sizo Mhlanga, ECA-SA Senior Economic Affairs Officer.

The ECA-SA professional team of Johnson Oguntola, Antony Ademola Taylor, Matfobhi Riba, Noz-iphoh Simelang and Ms. Kiraso provided valuable inputs through reviewing drafts of the study. The contribution of ECA-SA support staff is acknowledged.

The final draft of the study benefited from experts who took part in the Economic Commission for Africa (ECA) Ad-Hoc Experts Group Meeting (AEGM) on “Climate Change and the Rural Economy in Southern Africa”, organized in Johannesburg, South Africa, in August 2012. ECA therefore gratefully acknowledges the collaboration with SADC, the African Climate Policy Centre (ACPC), the Common Market for Eastern and Southern Africa (COMESA), Africa Carbon Credit Exchange (ACCE) and the Food Security and Sustainable Development Division (FSSDD) of the ECA, and extends its sincere appreciation to all the participants of the AEGM for their valuable comments on the first draft of the study, which have provided a great opportunity to review and enrich the paper.

ECA-SA gratefully acknowledge the inputs made by Jabavu Nkomo, Senior Economist from ACPC, Alessandra Sgobbi, Economic Affairs Officer from FSSDD, Professor Lloyd Chingambo from ACCE, Chikakula Miti, Climate Change Coordinator, COMESA-EAC-SADC Climate Change Initiative, Mutie Kachulu, Food and Agriculture Organization (FAO) - Malawi Technical Coordinator, Abby Taka Mgugu Mhene, Director of Women’s Land and Water Rights in Southern Africa (WLWRSA), Pamela Mulozi, Programme Manager - Business Unit, Nutri-Aid Trust, Zambia, and Billy Katontoka, Director Projects and Operations, Green Knowledge Institute. All of these strongly contributed to the success of the AEGM in Johannesburg. The contributions of Mr. Nkomo, Ms. Sgobbi and colleagues in ACPC and FSSDD to the preparation, review and finalization of this paper are also gratefully recognized.

ECA-SA also gratefully appreciates the competent services of the Publications and Conference Management Section (PCMS) of ECA for coordinating the editing, translation, printing and publication of this study

Acronyms

ACCE:	Africa Carbon Credit Exchange
ACPC:	African Climate Policy Centre
AEGM:	Ad-Hoc Experts Group Meeting
AfDB:	African Development Bank
AIDS:	Acquired immunodeficiency syndrome
AU:	African Union
CAADP:	Comprehensive Africa Agriculture Development Programme
CCA:	Climate Change Adaptation
CDM:	Clean Development Mechanism
CO ₂ :	Carbon-dioxide
COMESA:	Common Market for Eastern and Southern Africa
COP:	Conference of Parties
CSC:	Climate Services Centre
CSO:	Civil Society Organization
DJF:	December, January and February
DMC:	Drought Monitoring Centre
DRC:	Democratic Republic of Congo
DRR:	Disaster Risk Reduction
EAC:	East African Community
ECA:	Economic Commission for Africa
ECA-SA:	Office for Southern Africa of the Economic Commission for Africa
ENSO:	El Niño–Southern Oscillation
FAO:	Food and Agriculture Organization of the United Nations
FANR:	Food, Agriculture and Natural Resources
FFSSA:	Forum for Food Security in Southern Africa
FSSDD:	Food Security and Sustainable Development Division
HDI:	Human Development Index
HIV:	Human immunodeficiency virus
ICWE:	International Conference on Water and Environment
IFAD:	International Fund for Agricultural Development
IFPRI:	International Food Policy Research Institute
IGOs:	Inter-Governmental Organizations
IPCC:	Intergovernmental Panel on Climate Change

GDP:	Gross Domestic Product
GHG:	Greenhouse gas
JJA:	June, July and August
JPOI:	Johannesburg Plan of Implementation
LDC:	Least developed country
MEA:	Multilateral Environmental Agreement
NAPA:	National Adaptation Programme of Action
NEPAD:	New Partnership for Africa`s Development
OSISA:	Open Society Initiative for Southern Africa
PACJA:	Pan-African Climate Justice Alliance
PHL:	Post-harvest losses
PRSP:	Poverty Reduction Strategy Paper
REDD+ :	Reducing Emissions from Deforestation and Forest Degradation
ReSAKSS:	Regional Strategic Analysis and Knowledge Support System
REC:	Regional Economic Community
RFRF:	Regional Food Reserve Facility
RISDP:	Regional Indicative Strategic Development Plan
SACAU:	Southern African Confederation of Agricultural Unions
SADC:	Southern African Development Community
SRCM:	Subregional coordination mechanism
UN:	United Nations
UNCCD:	United Nations Convention to Combat Desertification
UNDP:	United Nations Development Programme
UNFCCC:	United Nations Framework Convention on Climate Change
VAP:	Vulnerability Analysis Programme
WLWRSA:	Women`s Land and Water Rights in Southern Africa
WSSD:	World Summit on Sustainable Development

Executive summary

Global warming is already affecting Africa and other regions and is expected to worsen in coming decades. The Southern African Development Community (SADC) subregion is among the most affected regions in the world.

Climate assessments for Southern Africa conclude that the subregion is likely to become warmer and drier; a temperature increase of 2°–5°C is predicted over the coming decades and increasingly variable rainfall is anticipated. An increase in both frequency and intensity of extreme events, mainly droughts and floods, is also anticipated.

Rural economies in Southern Africa are particularly sensitive to the direct impacts of climate change, because many of them depend heavily on agriculture and ecosystems and because of their high poverty levels and geographic exposure. Many people in the subregion, especially the poor, depend directly on agriculture as their primary source of food and livelihood. Most of the extreme poor in Southern Africa (83 per cent) are located in the rural areas. Apart from farming, other rural economic activities include fishery, forestry, pottery, tourism and small-scale businesses. Most of these non-farm activities depend on biodiversity and ecosystems.

The Southern African subregion has been struggling with low agricultural yields for the last few years. Climate change is expected to worsen this situation. Through its effects on agricultural productivity and production, post-harvest losses and farmers' income, climate change will worsen food security in the subregion.

Climate change is already a reality in the subregion. There are signs that drought is becoming more common and more prolonged in the dry lands. A trend of increasing temperature has been confirmed in different parts of the subregion and climate variability and extreme weather events are already on the increase. The changes, in terms of reduced precipitation and increased evaporation, could have profound effects on some lakes and reservoirs in SADC.

Smallholder agriculture has a rich and untapped potential for reducing emissions. The subregion should promote agroforestry in order to increase agricultural yield, while simultaneously strengthening the resilience of the soil against land degradation. In effect, this would reduce carbon emissions from the soil.

An increasing share of public and potentially of private international development finance is earmarked for climate change and this represents a major opportunity for smallholder farmers. Access to such finance is critical for enhancing the capacity of smallholder farmers to mitigate and adapt to climate change. Carbon financing represents a true opportunity for agriculture, both in terms of finance and of shifting to more climate-resilient practices. However, the sophisticated and complex mechanisms that have been developed in the context of the global mobilization to respond to climate change have largely prevented African farmers from benefiting from any of these additional dedicated sources of funding. With regard to domestic resources, southern African governments seem to lag behind in terms of efficiently allocating budgets to climate-proof agriculture.

Notwithstanding the challenges around climate-change finance, member States, regional economic communities (RECs) and the international community should create an enabling environment for smallholder farmers to benefit from both climate and regular development finance, including the carbon markets and the Clean Development Mechanism (CDM). The green economy concept offers another opportunity towards building a pro-poor, socially-inclusive rural economy, driven by natural resources. Changes in bioclimatic suitability and atmospheric conditions brought by climate change will have effects on ecosystem structure and associated faunal diversity. They will disrupt ecosystem services and all sectors that are intimately linked to the natural-resources sector. These include the tourism industry, which relies heavily on the dominant savanna vegetation in Southern Africa, and the agriculture sector, which relies on winter rainfall.

Climate change has both direct and indirect effects on poverty and hence on people's welfare, human development and capacity to adapt. Rural women will bear the brunt of the negative impacts of climate change; they will also have the greatest need for adaptation strategies in the event of changing weather patterns.

Governments should mainstream climate change into their rural development policies and strengthen national bodies that actively look at climate-change adaptation and mitigation, and match policy with budget allocation. Southern Africa will need to build on linkages between climate change and cultural values, and document traditional knowledge and incorporate it into environmental assessments and rural-development policies. This approach emphasizes the active participation of indigenous communities through a community-based and community-driven process.

Introduction

“Climate change” refers to changes in weather attributed directly or indirectly to human activity that is altering the composition of the global atmosphere. “Climate change” also refers to those changes experienced which are additional to natural weather variability patterns observed over comparative time periods. Climate change alters the spatial and temporal patterns of temperature and precipitation, the fundamental factors that determine the distribution and productivity of vegetation.

The increasingly strong evidence for humanity’s influence on the global climate is now clearly established and climate change is now high on the international development agenda. It is projected that the globally-averaged temperature of the air above the Earth’s surface would rise by 1.4 - 5.8°C over the next 100 years. Sea levels could also rise by tens of centimetres, threatening millions of people in low-lying countries.

The Intergovernmental Panel on Climate Change (IPCC) forecasts a thinning of the ice in the Arctic and the Antarctic regions. This could have dramatic impacts on the world’s weather systems, fisheries, wildlife and people, both those living in the far North and for everyone on the planet. This is because the Polar Regions play a crucial role in driving the circulation of the world’s oceans and this, in turn, affects weather systems and the climate on every continent. This will constitute a big challenge for the Southern African rural economy. The region is the most vulnerable to climate change due to its extreme poverty, frequent natural disasters such as droughts and floods, and agricultural systems that depend heavily on rainfall.

Many non-climatic factors contribute to the SADC subregion’s vulnerability to climate change. These factors include: the fragile and hazardous location, rapid population growth and migration within the subregion, poverty and hunger, poor health, low levels of education, gender inequality, lack of access to resources and services, limited technological capacity, lack of efficient governance, HIV/AIDS, war and conflict.

Climate assessments for Southern Africa conclude that the region is likely to become warmer and drier (Hulme and others, 2001). A temperature increase of 2°C–5.8°C is predicted over the coming decades (IPCC, 2001) and it is anticipated that rainfall will become increasingly variable. The subregion will become generally drier, especially in the East. An increase in both frequency and intensity of extreme events (droughts and floods) is also anticipated (IPCC, 2001; Tyson and others, 2002). The subregion is expected to experience increases in temperatures in coastal areas ranging from 2.5°C up to 3°C in the summer months (December, January and February or DJF) and in inland areas between

3°C and 4°C during the winter months (June, July and August or JJA). The western and inland parts of the subregion are set to be most significantly affected. The zone where temperature is estimated to increase by 4°C during the summer extends from Botswana and Zambia into Namibia and southern Angola.

Southern African economies are particularly sensitive to the direct impacts of climate change because they often depend heavily on agriculture and ecosystems and because of their high poverty levels and geographic exposure (Stern, 2006). Many people in the subregion depend directly on agriculture as their primary source of food and livelihood. A negative impact on crop productivity will therefore affect food security and thus the overall rural economy at the local level, leading even to macroeconomic vulnerability in some countries that depend highly on agriculture (Ingram and others, 2008; Stern, 2006).

While countries in the Sahel subregion of Africa are expected to receive more rainfall and floods, Southern Africa will experience persistent droughts in the coming decades. These changes are linked to temperature changes in the Indian and Atlantic oceans, and are caused in part by emissions of greenhouse gases. Precipitation levels are set to decrease throughout the subregion during the summer months, again with variations between -10 and -15 per cent around the coastal areas, through -20 per cent in the inland areas of the Western Cape, to a very high -40 to -50 per cent across the Kalahari, Namibia, western Zimbabwe and southern Zambia. During the winter months, however, there may even be slight increases in precipitation in the Eastern Cape and KwaZulu-Natal regions of South Africa (<+5 per cent) and more significant increases across the northern part of the subregion (Haldén, 2007).

Since 1970, recurrent droughts, attributed to warming of the nearby Indian Ocean, have caused crop failures in Angola, Botswana, Lesotho, South Africa, Swaziland, Zambia and Zimbabwe. Agriculture is not only a vital source of food in Africa; it is also the prevailing way of life. An average of 70 per cent of the population depends on farming; 40 per cent of all exports are earned from agricultural products (WRI, 1996); and one third of the national income in Africa is generated by agriculture. On average, the poor from developing countries of Africa spend 60-80 per cent of their total income on food.

Like for the entire African region, most of the extreme poor in Southern Africa are located in the rural areas and 85 per cent of all poor people in the subregion depend on agriculture for their livelihood. Consequently, agriculture remains a key driving force for economic development in SADC. The sector constitutes the primary source of subsistence, employment and income for 156 million of the subregion's total population of 284 million (55 per cent) and accounts for close to 8 per cent of its gross domestic product (GDP). Promoting agriculture is therefore imperative for meeting the Millennium

Development Goal (MDG) of halving poverty and hunger by 2015 and reducing poverty and hunger for several decades thereafter.

It is against this background that ECA-SA prepared this issues paper on “Climate Change and the Rural Economy in Southern Africa: Issues, Challenges and Opportunities” in order to highlight the impacts of global warming on the subregion’s rural development and to discuss strategies aimed at strengthening initiatives to mitigate and adapt to the effects of climate change and to move towards a more resilient rural economy in the subregion. The paper is based on a desk review and literature research on the subject. It assesses the impacts, which are mostly negative, of climate change on agriculture development, food security and rural development. It also discusses its effects on selected sectors, such as health, water and sanitation, and biodiversity. It highlights the related opportunities

1. The SADC rural economy: features and performance

In spite of rapid urbanization, more than half of the people in the Southern African subregion continue to live in rural areas, mainly in villages or isolated homesteads. The rural economy of the subregion depends predominantly on climate-sensitive sectors such as agriculture, fisheries and natural resources for livelihoods. The vast majority of rural dwellers are engaged in agricultural production as small-scale subsistence farmers, commercial farmers or farm labourers.

The low performance of the agricultural sector has trapped rural zones in SADC in high levels of poverty. The high reliance of economic activities in the subregion on ecosystems and weather has raised the issue of the subregion's high vulnerability to the impacts of climate change. Linkages between climate and agriculture pose serious threats to rural development and the opportunities to break the poverty trap in rural areas will predominantly depend on rural agricultural productivity, which is equally climate-dependent.

1.1 The SADC rural economy: a high predominance of smallholder farmers

Between 40 per cent and 85 per cent of the citizens of SADC member States live in rural areas, where they depend on natural resources for survival. About 45 per cent of the rural population lives in areas of high agricultural potential or suitability and, among these, 40 per cent are in areas of medium to high population density and are likely to respond strongly to enhanced input and output market opportunities.

The rural population is expected to grow significantly (by 20 per cent) in the next 20 years, although urban areas are expected to grow faster and will account for half the population in SADC. In many rural areas, this will exert pressure on the allocation of factors of production (such as access to land), natural resources and social services (such as education and health), while non-farm employment opportunities could remain modest. Most inhabitants in the subregion rely and will continue to rely on agriculture directly or indirectly as their main source of livelihood.

The majority of the poor in the subregion live in rural zones. Agriculture is their main activity and has the greatest potential to contribute to the achievement of the MDGs. The sector remains the primary

source of subsistence, employment and income for 156 million people (55 per cent of the region's total population of 284 million),¹ despite the low allocation of public expenditure to it.

Most countries in the subregion have yet to achieve the Maputo target² of allocating at least 10 per cent of national budgetary resources to agriculture and rural development. The average budget allocation to agriculture for the subregion from 2005 to 2009 was 4.62 per cent (Table 1). Save for Malawi, those countries in which agriculture and therefore the rural economy are most important tend to have relatively large gaps towards attaining the Maputo Declaration. Examples are DRC, Mozambique and Tanzania (ECA-SA, 2012).

Table 1: Agriculture in SADC: economic role, performance and vulnerability

Country	Agricultural population (% of total) 2011	Cereal yield (kg/ hectare) 2008-2009	Undernourished population (% of total) 2006-2008	Public agriculture expenditure (% of budget) 2005-2009	Population affected by drought (thousands) 2005-2011	Population affected by flood (thousands) 2005-2011	Population on degraded land (% of total) 2009
Angola	69.0	644.8	41	3.6	25	517	3.3
Botswana	41.9	492.2	25	3.3	0	5	22.0
DRC	56.7	771.6	72	n.d.	0	85	0.1
Lesotho	38.5	573.3	14	3.5	475	5	63.6
Madagascar	69.6	8 869.8	25	4.2	734	92	0
Malawi	78.6	1 976.2	27	13.2	5 620	294	19.4
Mauritius	7.9	8 733.9	5	3.5	n.d.	n.d.	23.8
Mozambique	80.3	954.6	38	3.9	2 880	529	19.0
Namibia	32.9	411.0	18	8.0	0	771	28.5
South Africa	6.2	4 212.0	n.d.	n.d.	0	89	17.5
Swaziland	28.1	1 176.5	19	3.7	410	3	0
Tanzania	75.4	1 240.0	34	2.5	3 700	68	25.0
Zambia	62.6	2 266.8	44	4.0	1 200	2 190	4.6
Zimbabwe	55.6	503.5	30	6.0	3 780	18	29.4
SSA	58.2	1 395.0	27	5.6	72 623	13 264	

Source: Data from UNDP Human Development Report, 2012

1 Source: POPSTAT (2008 projections for 2011). The figures include Madagascar. Excluding South Africa, 65 per cent of the total population in SADC depends on agriculture. Chilonda and Minde (2007) have a smaller figure, 142 million out of 232 million or 61 per cent, possibly indicating the earlier date and the declining share of the rural population.

2 The 2003 African Union (AU) Maputo Declaration directed all AU member countries to increase investment in the agriculture sector to at least 10% of the national budget by 2008.

Agriculture is the backbone of Southern Africa's rural economy and provides food for rural and urban populations as well as incomes, employment and export earnings. The impact of climate change on ecosystems is expected to produce negative knock-on effects for whole populations. Small-scale and subsistence farmers, the rural poor and traditional societies face the most serious and immediate risks, because they rely most directly on ecosystems for food security and fuel, medicinal products, construction materials and protection from natural dangers (PACJA, 2009). More than 18 per cent of the subregion's population lives on degraded land and all the SADC member States have been affected either by drought or flood or both between 2005 and 2011.

Crops dominate the agricultural sector (65 per cent of total agricultural revenue) although the share of crop production to total agricultural production has been declining over the years, while the share of livestock production has been increasing. The largest contributors to agricultural and rural revenues are maize, fruits, beef, roots, tubers, milk and poultry.

The rural economy is characterized by the co-existence of contrasting farming systems. Large-scale commercial farming is better integrated into the market economy than the smallholder sector. The emergence of production chains for high-value agricultural food commodities has raised concerns in SADC member States because vertical coordination of high-value food commodity production tends to exclude a large share of small-scale farmers.

The small-scale farming sector, involving the majority of the rural population, is actually diverse in terms of its current and potential participation in markets and in its capacity to respond to public incentives, to invest and to take risks such as adopting innovative technologies. The subsector, of which more than 95 per cent consists of rain-fed agriculture, includes the most vulnerable and marginalized people in rural societies, many of them being women-headed households or indigenous peoples. They inhabit some of the most vulnerable and marginal landscapes, such as hillsides, deserts and flood plains, and therefore bear the brunt of climate change. Small-scale farmers often lack secure tenure and resource rights and rely directly on climate-affected natural resources for their livelihoods. Many smallholder farmers are already reporting climate-change impacts on the key ecosystems and biodiversity that sustain their activities (IFAD, 2011b).

Smallholder agriculture, as a subset of agriculture, is by far the main source of income and livelihood for the poor in Southern Africa. More than half of the rural population lives in extreme poverty. Rural areas account for 83 per cent of total extreme poverty in the subregion. Some 85 per cent of these extremely poor people depend on agriculture to a greater or lesser extent for their livelihoods.

Over the centuries, smallholders have learned to adjust to environmental change and climate variability by using indigenous knowledge. But the current speed and intensity of climate change are outpacing their capacity to adapt. Crop failures and livestock deaths are causing economic losses,

raising food prices and undermining food security with ever-greater frequency. At the same time, demand for food is increasing as populations grow and dietary habits change. Poverty is claiming more and more inhabitants of rural zones.

Apart from farming, other rural economic activities include fishery, forestry, pottery, tourism and small-scale businesses. Most of these non-farm activities depend on biodiversity and ecosystems. Most of the rural non-farm economic activities arise through trading and processing agricultural and other primary products and their growth depends on the performance of the agriculture sector (UNDP, 2007). Forest and woodland resources play a major role in the livelihoods of many communities in rural areas and in development more generally. This major role includes their contribution as sources of energy, food products and medicinal plants, as well as for the protection of catchment and water quality. Forest and woodlands are major contributors to rural economies in SADC.

1.2 The contribution of agriculture to development in the SADC

Agricultural growth has powerful leverage effects on the rest of the economy, especially in the early stages of “economic transformation”, when agriculture accounts for large shares of national income, employment and trade, as it does in Southern Africa. High and sustained rates of agricultural growth, largely driven by productivity growth, will be instrumental if SADC member States are to accelerate broad-based economic development and poverty reduction.

Agriculture accounts for close to 8 per cent of the subregion’s GDP or 23 per cent if middle-income countries (Botswana, Namibia and South Africa) are excluded (Chilonda and Minde, 2007). The growth rate of the sector has averaged only 2.6 per cent per annum in the last decade and growth rates have been highly variable across the subregion. Population growth has been 2.4 per cent a year over the period and this has almost cancelled out gains in agricultural growth on a per capita basis. The growth rate in the agriculture sector is far below the target of 6 per cent growth agreed in the Comprehensive African Agriculture Development Programme of the New Partnership for Africa’s Development (NEPAD CAADP). The role the sector plays towards economic growth in the subregion is further emphasized by the fact that its contribution to total intra-SADC trade was 15 per cent between 2005 and 2008,³ indicating that it is an important component of regional economic integration.

Although the contribution of agriculture to GDP in the subregion as a whole is very low, especially when compared to other developing countries, agriculture accounts for 33 per cent of total GDP in the low-income countries. This proportion is above the average share of agriculture in GDP for all low-income countries in sub-Saharan Africa (SSA) outside the Southern African subregion. The low-

3 Source: UNCTAD

income countries in which agriculture has the highest share of GDP are the Democratic Republic of Congo (46 per cent), Malawi (35 per cent) and Tanzania (45 per cent).

In much of Southern Africa, agriculture is a strong option for spurring growth, overcoming poverty and enhancing food security. Agricultural productivity growth is vital for stimulating growth in other parts of the economy. It has upstream linkages on the supply side and downstream linkages on the manufacturing side. In South Africa, for example, there are strong forward and backward linkages in the agricultural sector and these play a very important role in the country's rural economy and even its urban economy. It provides 10.5 per cent of the country's jobs and creates employment for another 16 per cent of the workforce in other sectors. One quarter of manufacturing's contribution comes from agro-industrial processing. The rural non-farm economy in the subregion is also highly dependent on agriculture (FFSSA, 2004).

Despite the high socioeconomic importance of agriculture, food insecurity remains a major challenge in most SADC member States. Prevalence of undernourishment is "high" or "very high" (above 25 per cent) in eight SADC countries. Similarly, progress towards MDG 1, Target 1.C ("halve, between 1990 and 2015, the proportion of people who suffer from hunger") has been mixed in the SADC subregion: seven member States (Tanzania, DRC, Botswana, Lesotho, Swaziland, Zambia and Madagascar) are not on track whilst four (Malawi, Mozambique, Namibia and Angola) are on track.⁴

Key factors affecting current food insecurity and people's vulnerability in the subregion include variable rainfall patterns; high commodity prices; the incidence of livestock diseases; the impact of the global economic downturn on people's access to cash income; the continuing devastation inflicted by the HIV/AIDS pandemic; and the emerging impacts of climate change and civil unrest. In the context of improved food availability and relatively lower political disturbances over the last few years, the persistence of such vulnerability reinforces the chronic food insecurity, particularly in rural areas.

Recognizing the instrumental role of agriculture, countries in Southern Africa have committed themselves to regionally shared goals, in particular the NEPAD CAADP, which calls for agriculture-led development in the subregion, and the SADC Regional Indicative Strategic Development Plan (SADC, 2008b).

1.3 Performance of the rural economy: massive poverty as a rural phenomenon

As mentioned above, agricultural growth rates have been both low and highly variable across the region, averaging only 2.6 per cent per annum in the last decade, compared to the CAADP target of 6

⁴ Source: FAO, 2010, progress achieved 1990-92 to 2005-2007.

per cent needed to attain overall economic growth, poverty reduction and food security (AU NEPAD, 2003).

The average growth rates in the sector have been close to the demographic growth rates of 2.4 per cent over the last decade (World Bank, 2006). The agricultural sector was the smallest contributor to subregional GDP in 2005 at only 7.3 percent, with the lions' share going to services at 51 per cent, the industrial sector at 28.6 per cent and manufacturing at 13.5 per cent.

About 70 per cent of the SADC's population lives in rural areas and more than half of those people live on less than US\$1 a day, confirming poverty as a predominantly rural phenomenon. Rural areas continue to be marked by stagnation, poor productivity, low incomes and rising vulnerability. Rural poverty rates are considerably higher in countries that are affected by war or are recovering from conflicts, such as Angola, DRC and Mozambique. The effects of these conflicts have been felt by smallholder farmers, among other vulnerable groups.

The vast majority of poor rural people in Southern Africa are smallholder farmers working in conditions of either static or declining productivity. Poverty reduction and broad-based growth in the sub-region will clearly depend on agricultural development and the performance of the rural economy.

The majority of the rural population experience extreme poverty. Women are often poorer and more vulnerable than men. Despite being the least empowered members of the rural community, their share of economic activity is disproportionately high in a context of widespread male migration (IFAD, 2011b).

There are many reasons why poverty persists in the region and why progress in reducing rural poverty has been so slow. The sheer scale of the impact of AIDS has caused widespread human and economic devastation while conflict has blocked economic and development progress in the subregion. AIDS has impacted agriculture disproportionately compared to other sectors, as there are few safety nets in agriculture. The pandemic is furthermore burdening rural producers with unnecessary social costs.

Rural infrastructure has been neglected in many SADC countries that are characterized by rapid urbanization. Public expenditure for agriculture and rural development has declined drastically over time, leading to underdevelopment of rural roads, storage, electricity, communications, schools and hospitals, with concomitant "knock-on" effects on production.

Climate change brings a new and alarming challenge, which is likely to lead to greater poverty. The decline in rainfall and the extreme weather patterns such as heavy rains, cyclones and drought that are becoming more frequent throughout the subregion are detrimental to farmers, their crops and the rural economy in general.

2. Climate-change challenges to agriculture and food security

The Southern African subregion has been struggling with low yields and rapidly declining cereal production for the last few years. Low agricultural productivity is one of the emerging challenges faced by the agricultural sector and is affecting food security in Southern Africa. The increasing demand for agricultural products driven by population and income growth has outpaced the growth in agricultural productivity. This has led to a situation where there is decreasing per capita food production.

Climate change is expected to worsen this situation. It brings new uncertainties and risks exacerbating the already vulnerable and low performing rain-fed agricultural sector.

High reliance on rainfall, post-harvest losses, rural-urban linkages and agriculture vulnerability to climate change

The SADC subregion experiences huge variability from year to year in rainfall, both in quantity and in seasonal distribution. Crop production in the subregion is predominantly dependent on rain-fed agricultural systems. Only 3.5 per cent of the subregion's arable land is currently under irrigation. The subregion therefore experiences acute food shortages and hunger whenever there is a drought.

A trend of increasing temperature has been confirmed in different parts of the SADC subregion. According to IPCC assessments, temperatures could rise in Southern Africa between 2°C and 5°C by 2050, with dire consequences for the subregion. This is likely to affect precipitation patterns and the length of the growing season. Climate variability and extreme events are expected to increase. The SADC subregion's rural populations are especially vulnerable to the impacts of climate change and variability, given that their economic activities and key livelihoods are largely dependent on climate-sensitive sectors such as rain-fed agriculture and natural resources and the important coastal areas.

Table 2: Irrigated land in the Southern Africa subregion (in thousand hectares)

Country	1979-81	1989-1991	1999-2001	2002	2003
Angola	80	80	80	80	80
Botswana	2	1	1	1	1
DRC	6	10	11	11	11
Lesotho	1	2	3	3	3
Madagascar	646	1 000	1 086	1 086	1 086
Malawi	18	20	52	56	56
Mauritius	16	17	20	21	22
Mozambique	65	103	115	118	118
Namibia	4	4	7	8	8
South Africa	1 119	1 200	1 498	1 498	1 498
Swaziland	40	45	50	50	50
Tanzania	117	144	163	184	184
Zambia	19	30	133	156	156
Zimbabwe	80	106	174	174	174

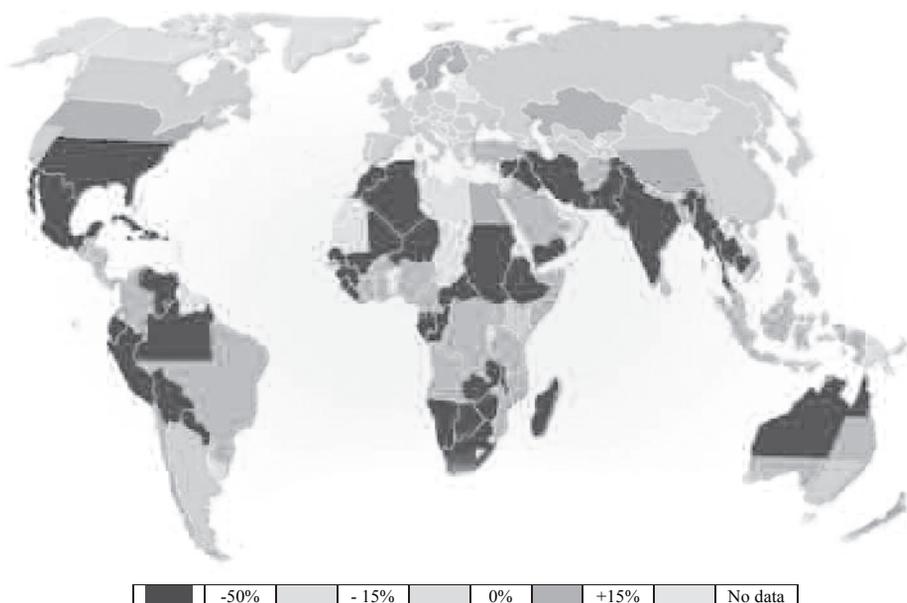
(Source: FAO, 2007)

Generally, the poorest and most food-insecure regions are expected to suffer the largest reduction of agricultural production due to climate change. People's vulnerability to climate change will be differentiated across groups (e.g. generations, age-classes, income-groups, occupations and gender). Women, in particular, are more vulnerable than men, but are also known to function as agents of change in community natural-resource management, innovation, farming and care-giving. Therefore, women can play critical roles in the adaptation to climate change.

In most cases, increased rainfall variability and extreme events associated with climate change will increase the vulnerability of agricultural production systems. The productivity of these systems is compromised, due to the low levels of irrigation development in the subregion. Irrigation is critical to ensure food security and rural development (SADC, 2011b).

Findings from the IPCC and other climate-change scientists (Fischer and others, 2001; Rosegrant and Cline, 2003; Fuhrer, 2003; Parry and others, 2004) highlight the largely negative impacts that increased temperatures will have on crop productivity. Changes in the physical environment, due to climate change, are expected to have adverse effects on agricultural production, including staple crops such as millet, wheat, rice and maize.

Figure 1: Projected changes in agriculture productivity in 2080 due to climate change



Source: Hugo Ahlenius, UNEP/GRID-Arendal

Climate change is expected to cause reductions in the areas of land suitable for agricultural production, the length of growing seasons and yield potentials. For the subregion as a whole, net productivity reductions of more than 10 per cent are possible in the case of maize and other major crops such as sorghum, millet, sugar cane and wheat (SADC, 2011).

These effects of rising temperatures will be sufficiently detrimental that they are likely to offset any increase in crop yield as a consequence of increased atmospheric concentration of carbon dioxide (CO₂). Climate-change models suggest the climate is moving to more conditions similar to the El-Niño pattern, and the negative impact of this on maize, the most important crop in Southern Africa, has been confirmed (Jones and Thornton, 2003; Stige and others, 2006) and will have clear consequences on farmers' income.

Recent droughts in the subregion exposed approximately 14.4 million SADC citizens to hunger and malnutrition. More droughts and water scarcity are expected to diminish dietary diversity and reduce overall food consumption. This may lead to malnutrition including under-nutrition, protein-energy malnutrition and/or micronutrient deficiencies. Rain-fed agricultural yields in some countries may be reduced by 50 per cent as a result of climate change (Figure 1).

Livestock productivity will be impacted by increased temperatures, with higher-yielding breeds more likely to be negatively affected than more-robust local breeds (IFAD, 2011b). Rates of calving, milk-production and general body weight for cattle will be affected by increased temperatures, with serious implications for availability of and access to protein. Declining water supplies will also negatively affect livestock production, especially for subsistence farmers who rely heavily on surface water. Livestock production will also be impacted through the change in the quantity, quality and cost of feed (Young and others, 2010).

The rise in temperature will, of course, not only have an impact on crops and livestock, but also on the pests and diseases they are exposed to. Pest outbreaks for both crops and livestock will become more frequent. Climate change is likely to bring new pests, diseases and weeds. It is already clear that some pests will be able to invade new areas and become increasingly problematic for the maintenance of biodiversity, the functioning of ecosystems and the profitability of crop production. Some pests which are already present but only occur in small areas, or at low densities may be able to exploit the changing conditions by spreading more widely and reaching damaging population densities (Ingram and others, 2008).

Aphids, for instance, key pests of agriculture, horticulture and forestry throughout the world, are expected to be particularly responsive to climate change because of their low developmental threshold temperature, short gestation time and dispersal abilities (Sutherst and others, 2007). Again, agronomists will need to continue to work to help develop integrated pest management and other approaches to help combat the potentially enhanced losses to pest, diseases and weeds.

The net income of African farmers is highly vulnerable to climate variability. The elasticity of response to a unit degree increase in temperature ranges from -1.9 for dryland crops to -0.5 for irrigated crops (Ingram and others, 2008; Kurukulasuriya and others, 2006).

Increased climate variability and the effects of predicted increases in atmospheric temperatures contribute to rising sea levels, shifts in precipitation patterns, and increased frequency and intensity of extreme climate events such as droughts, floods and cyclones. These events collectively threaten southern Africa's agriculture production and food security, reducing productivity and arable land for crop production while increasing the prevalence of pests and livestock diseases. The ultimate results are increased post-harvest losses and animal deaths, destruction of agricultural infrastructure and general loss of livelihoods for those dependent on agriculture. This will make it harder to achieve the MDGs in Africa (AfDB, 2012).

Weather is a key issue at harvest. In developing countries with hot climates, such as countries in southern Africa, most smallholder farmers rely on drying crops in the sun to ensure that they are well

dried before storage. Climate change may lead to more unstable and unfavourable weather, including damper or cloudier conditions or heavy or frequent rainfall at and after the harvest.

During heavy or frequent rainfall, it is difficult to dry cereals and legumes and if cereals and legumes do not dry sufficiently it would increase post-harvest losses. Moulding and the production of aflatoxins, which are harmful to human life, will reduce the aesthetics and appeal of the product and could also lead to significant health costs. Higher ambient temperatures would encourage increased levels of pests and diseases, as mentioned above. Affected crops can dehydrate and lose weight, which cuts revenues to farmers (AfDB, 2012).

Preliminary findings from a post-harvest losses (PHL) assessment survey conducted in Malawi by the Ministry of Agriculture and Food Security indicate losses in the range of 7–8 per cent for cob-stored maize during the 2009–10 storage season (World Bank, 2011, p10, see also Hodges and others, 2010).

Climate change will worsen the food-security situation, through its effects on agricultural productivity and production, post-harvest losses and farmers' income, in a subregion that is already classified as a zone of food insecurity due to the recent economic and financial crises (FAO, 2006). While it is not certain that food insecurity will cause regional conflict, in the past such shortages have led to migration, outbreaks of violence and international intervention in other parts of Africa.

The impacts of climate change on food security in southern Africa will affect all the different dimensions of food security, including food availability, access, stability and utilization. These adverse impacts will fall disproportionately on the poor within a subregion already affected by massive food insecurity.

Table 3: Category of prevalence of undernourishment in Southern Africa

Category of prevalence	2006		2008		2011	
	Countries	(%)	Countries	(%)	Countries	(%)
Less than 5%	-	0	-	0	-	0
5 to 9%	Mauritius	7.69	Mauritius	7.69	Mauritius	
10 to 19%	Lesotho, Swaziland	15.38	Lesotho, Namibia, Swaziland	23.08	Lesotho, Namibia, Swaziland	7.69
20 to 34%	Botswana, Malawi, Namibia	23.07	Malawi, Botswana	15.39	Madagascar, Botswana, Malawi, Tanzania, Zimbabwe	38.46
35% and more	Angola, DRC, Madagascar, Mozambique, Tanzania, Zambia, Zimbabwe	53.84	Angola, DRC, Madagascar, Mozambique, Tanzania, Zambia, Zimbabwe	53.85	Angola, DRC, Mozambique, Zambia	30.65

Source: FAO, *The State of Food Insecurity in the World (annual volumes for 2006, 2008 and 2011)*.

The proportion of undernourished people in the subregion varies widely from country to country, ranging from as low as 6 per cent in Mauritius to as high as 72 per cent in the DRC. The average proportion of undernourished people in SADC was about 35 per cent between 1990 and 2008, which is just three percentage points above the proportion for sub-Saharan Africa as a whole.

Southern Africa's rapidly declining crop production is already leaving millions facing hunger, with rural populations being the most affected. Most countries in Southern Africa are net importers of staple crops.

While there is a need to improve systems to provide early warnings about weather and capacity to manage and mitigate disasters in the subregion, it is still imperative to address constraints which obstruct the farmers' response to the early-warning signals. Such constraints include lack of access to credit, fertilizer, drought-resistant seeds and other modern inputs.

The Southern African population is approximately 210 million, of whom at least 100 million already live in urban and peri-urban areas. By 2020, this figure is expected to rise to 150 million and to exceed 200 million by 2030. An estimated 80 per cent of the population will be living in towns and cities by mid-century, comparable to the projected 2050 figure of 82 per cent for developed countries. Meeting the rising demand for food within the context of exponential population growth, sustained urbanization, and climate change constitutes a defining challenge of this century. One major challenge for the rural economy will be how to provide adequate quantities of nutritious and affordable food for more urban inhabitants, with less water, land and labour (Ziervogel and Frayne, 2011).

Recent analyses of the linkages and interdependencies between southern African rural and urban areas have highlighted the dynamic flows of people, goods, services, information and money. The urban-rural malnutrition gap is closing and links between urban poverty and high levels of food insecurity at the household level are strong. Urban-urban and rural-urban inter-household food transfers are important, especially for food-insecure urban households.

During severe stress situations, such as drought and famine, population mobility intensifies. A study on West Africa confirms that rural people movement to the city because of the agro-ecological degradation and because of better living conditions in town (Dietz, Ruben and Verhagen, 2004). In the event of deteriorating rural living conditions, urban centres will expect increasing flows of immigrants who, eventually, may stay or return to their home bases when conditions improve. The urban economies may not be able to absorb all the newcomers in a context of rapid and large influx due to climate change.

Food security in urban areas will certainly be impacted as climate change affects rural production and productivity, locally and subregionally. While in some places urban agriculture provides some produce, this too could be impacted by climate change through stress on urban water resources. Access to food in urban areas is also likely to be impacted through high food prices. Climate variability or extreme weather events will impact on job opportunities, which also will affect people's ability to buy food.

2.1 Climate change, agriculture and food security: evidences from Southern Africa

Climate change is already a reality in the subregion. There are signs that drought is becoming more common and more prolonged in the dry lands of Southern Africa and drought incidence is expected to increase as a result of higher temperatures and reduced rainfall (IFAD, 2011b). A trend of increasing temperature has been confirmed in different parts of the subregion (IPCC, 2001) and climate variability and extreme weather events are already on the increase.

In Southern Africa there has been a warming trend consistent with global temperature increases. This has been accompanied by a greater frequency in below-normal rainfall years, with a high number of drought events being reported in the last few decades. Significant food shortages are associated with these droughts. In the drought of 2002-3, for example, there was a regional food deficit of 3.3 million tonnes and 14.4 million people needed emergency assistance. Climate change impacts many different aspects of the socio-ecological system, including disease coverage, biodiversity, land degradation and changes in water availability (Ziervogel and Frayne, 2011).

It is established that the subregion's climate will be hotter and drier in the future. It is predicted that by 2050, temperatures will increase by 1.5-2.5°C for countries in the southern end of the subregion and by 2.5-3.0° C for countries in the northern end, compared to the situation between 1961 and 1990 (Ragab and Prudhomme, 2002; Chishakwe, 2010). Farmers have already felt the first effects of changing climatic conditions. In 2006, the production of maize, the main staple in the region, fell short by 2.18 million metric tonnes due to droughts in Namibia, Mozambique, Swaziland, Zimbabwe and South Africa.

Drought is the most important natural disaster in Southern Africa in economic, social and environmental terms (Buckland and others, 2000). It is one of the most damaging economic shocks affecting rural economic sectors. From 1980-2000, the SADC subregion was struck by four major droughts, notably in the seasons 1982/83, 1987/88, 1991/92 and 1994/95. This corresponds to an average frequency of once every four or five years, although the periodicity of droughts is not necessarily so predictable. FAO (2004) identified three drought cycles in the SADC region during the years 1960 to 1993 with lengths of 3.4, 7.1 and 5.8 years, respectively.

The SADC subregion has been experiencing a warming trend over the past few decades (Kandji, Verchot and Mackenson, 2006). Temperatures in the subregion have risen by over 0.5°C over the last 100 years (IPCC, 2001). Between 1950 and 2000, Namibia, for example, experienced warming at a rate of 0.023°C per year (Government of Namibia, 2002). The Indian Ocean has also warmed more than 1°C since 1950. During this period, the region has also experienced a downward trend in rainfall (National Center for Atmospheric Research, 2005). This has been characterized by below-normal rainfalls and frequent droughts.

There has also been an increase in the frequency and intensity of El-Niño episodes. For instance, prior to the 1980s, strong El-Niño events occurred every 10 to 20 years on average (Kandji, Verchot and Mackenson, 2006). However strong El-Niño occurrences have been more frequent after 1980, particularly 1982-3, 1991-2, 1994-5; and 1997-8 (SADC and UNEP, 2010).

Flooding in the Zambezi basin has been affecting Angola, Botswana, Namibia, Zambia and Zimbabwe. Both Seychelles and Zambia have been experiencing a mixture of increased droughts and increased flooding.

Evidence is that the Southern African subregion is experiencing an increasing frequency of hot days and a decreasing frequency of extremely cold days. Rainfall trends are variable, but evidence points to an increased inter-annual variability, with extremely wet periods and more intense droughts in different countries.

Over the past ten years, farmers are noticing changes in the climate as compared with the 1990s. The most widespread change, observed by all farmers in all countries, is changing distribution and intensity of rainfall. In particular, summer rains are perceived to start later and end sooner and to be more variable within the season, with rain falling in more intense bursts. Temperatures are generally higher and there are longer hot, dry spells within rainy season, which affect soil moisture (Vincent and others, 2011).

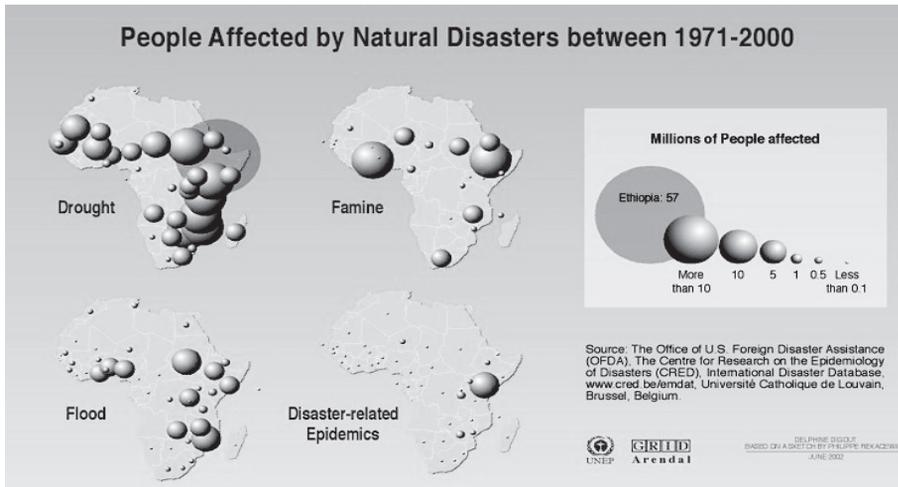
Projections show that changes will not be uniform across the subregion. The central, southern land mass extending over Botswana, parts of north-western South Africa, Namibia and Zimbabwe are likely to experience the greatest warming of 0.2-0.5°C per decade. The frequency of extremely dry winters and springs will increase by roughly 20 per cent, whilst that of extremely wet summers will double. Warming is also predicted to increase the frequency and intensity of tropical storms in the Indian Ocean (Chishakwe, 2010).

There is increasing evidence to suggest that climate change is already threatening biodiversity. For instance, research suggests that climate change has contributed to aquatic biodiversity losses of about 20 per cent and decrease in fish yields of 30 per cent in Lake Tanganyika. It is affecting the low agricultural yields in the subregion as well as the earnings of farmers in Southern Africa, thus exacerbating rural poverty.

2.2 Natural disasters occurrence and magnitude in the context of climate change

Changes in climate are also affecting agricultural production through natural disasters (Figure 2) including droughts, floods and heavy winds. Droughts and floods, the top two disasters in the Southern African region, are strongly climate-related. They are already common occurrences, with some countries experiencing both in one year. The threats are being amplified by climate change.

Figure 2: People affected by natural disasters 1971-2000.



Source: <http://www.grida.no/publications/vg/africa/page/3109.aspx>

Droughts and floods related to El-Niño/Southern Oscillation (ENSO) are increasing in number and frequency and affecting most countries in the subregion. They are severely impacting on food and water security and have had major human and economic costs. Earthquakes and windstorms are the most financially and economically costly disasters, however, droughts and famines are the most severe in terms of human cost and destruction of livelihoods (UNEP, 2002).

An average of two countries each year face drought in the SADC subregion. The subregion is particularly at risk from large-scale drought during the El-Niño events and has experienced severe floods in the past years. Floods in Mozambique in early 2000 and 2001 sparked major emergency relief as hundreds of people lost their lives and thousands were displaced from their homes. The disaster caused considerable damage to property and infrastructure (Magadza, 2000).

Between 1999 and 2005, Malawi experienced droughts that wiped out agricultural crops. Five million of the country's 13.5 million people needed food aid. This affected Malawi severely because the country generates up to 70 per cent of its foreign-exchange earnings from agriculture and 85 per cent of the country's population depends on the land for their livelihood.

The UNEP's first Africa Economic Outlook (UNEP, 2002) indicates that the drought of 1991/2 was the severest on record, causing a 54 per cent reduction in cereal harvest and exposing more than 17 million people to risk of starvation in the subregion (Calliham, Eriksen and Herrick, 1994). Zimbabwe alone imported an additional 800,000 tonnes of maize, 250,000 tonnes of wheat, and 200,000 tonnes of sugar (Makarau, 1992). Water and electricity shortages resulted in a 9 per cent reduction

in manufacturing output and a 6 per cent reduction in foreign exchange (Benson and Clay 1994). A combination of dry spells, severe floods and disruption of farming activities between 1999 and 2001 has left Southern Africa with meager food reserves. Several of the subregion's countries have faced food shortages (FAO, 2001).

Drought ripple effects on a rural household and economy include primary or physical impacts such as reduction in agricultural production, hydroelectric power generation, water intensive non-agricultural production (processing) and domestic availability of water, which has health implications. Secondary impacts affect gross domestic product (GDP), e.g. reductions in industrial output may lead to inflation and lay-off of labour, which increases unemployment. Collectively, these factors reduce demand, expenditure, savings and GDP (FAO, 2004). This affects the rural sectors where most of the poor people are located more severely.

Droughts and floods are also important factors impacting economic growth in Southern African countries. These extreme events have huge economic costs on the subregion. For instance, the GDP of Zimbabwe dropped by 3 per cent and 8 per cent after the 1983 and 1992 droughts, respectively. In South Africa, the 1992 drought induced a reduction of the agricultural GDP by about ZAR 1.2 billion and caused a 0.4 to 1.0 per cent loss in economic growth. The same drought cost the Zambian government US\$ 300 million and translated into a 39 per cent drop in agricultural output and a 2.8 per cent decline in the country's GDP (The SADC Secretariat, 2011). In Mozambique, floods in 2000 cost the economy US\$550 million or 12 per cent of GDP (Manase, 2010).

To cope with risks emerging from natural disasters Southern African farmers have used traditional and informal insurance mechanisms. These include activity diversification, migrations, buffer stocks, off-farm employment, under investment and social networks with huge consequences on the household income, human capital and vulnerability in long term (Skees, Hazell, and Miranda, 1999; Dercon, 2002; Hess, Richter and Stoppa, 2003).

Following the 1991-92 droughts in Zimbabwe, many households had to sell their livestock that they had intended to keep as a form of saving, for example to pay for secondary education. Others, while trying to avoid permanent destitution, decided to reduce their current consumption levels. This coping strategy has long-term effects on health and human capital.

While these traditional insurance mechanisms reduce the moral hazard and asymmetric information, they are still unable to deal with covariate and systemic risks. Furthermore, using these traditional insurance mechanisms tends to lower household vulnerability in the short term and raise vulnerability in the long term. Literature suggests a strong potential role for risk-transfer mechanisms, such as promoting index-based risk-transfer products (for example, weather index based insurance schemes), to help reduce risk from disasters in the subregion.

Although predictions of ENSO have improved over the years, a lot remains to be undertaken in order to predict spatial patterns of impacts with certainty to allow adaptive responses to be developed. The SADC Food, Agriculture and Natural Resources (FANR) Directorate has been developing strategies for disaster preparedness. Its Vulnerability Analysis Programme (VAP) aims to strengthen regional and national capacity for vulnerability analysis. In addition, the SADC Secretariat is in the process of elaborating a framework for the management of a Regional Food Reserve Facility (RFRF) to counter the negative effects of natural disasters on the subregion's food security.

It is clear that climate change poses a serious threat to food security and to the achievement of a number of MDGs. Nevertheless, there are also opportunities and benefits for the subregion, which can be harnessed from the policy debate and developments related to climate change. Such opportunities may arise from enhancing the capacity of member States to access available global funding mechanisms for adaptation and mitigation and to use these for rural development. Opportunities may also arise from harnessing the benefits offered by a green rural-economy development path.

2.3 Climate-change mitigation and adaptation: opportunities for agriculture and small farmers in SADC

Smallholder agriculture has a rich and untapped potential for emission reductions that are in the interests of farmers themselves. Agroforestry has the potential to increase agricultural yield whilst simultaneously strengthening the resilience of the soil to land degradation, in effect, reducing carbon emissions from the soil. Assisting pastoralists to take up better land-management practices can have a substantial impact on their livelihoods, but also on the reduction of greenhouse-gas emissions (IFAD, 2011b).

An increasing share of public international development finance and potentially of private international development finance is earmarked for climate change, and this represents a major opportunity for smallholder farmers. Access to such finance is critical for enhancing the capacity of smallholder farmers to mitigate and adapt to climate change.

Notwithstanding the challenges around climate-change finance, member States, RECs and the international community should create an enabling environment for smallholder farmers to benefit from both climate and regular development finance, including the carbon markets and the Clean Development Mechanism (CDM).

Deforestation is a key area for climate-change mitigation. Currently, the subregion is losing the carbon assets contained in rainforests at a fraction of the market value they would have, even at low carbon prices. Beyond these market failures, the loss of rainforests represents the erosion of a resource

that plays a vital role in sustaining biodiversity, in supporting the lives of the poor and in the provision of ecosystem services. There is scope for exploring the potential of carbon markets in the creation of incentives to avoid deforestation. Destruction of forests both contributes to carbon emissions and deprives the subregion of an important mechanism to soak up atmospheric carbon dioxide, which contributes the most to global warming.

More broadly, carbon finance could be mobilized to support the restoration of degraded grasslands, generating benefits for climate-change mitigation, adaptation, environmental sustainability and diversification of rural incomes (UNDP, 2009). The subregion should develop its capacity towards taking advantage from the Reducing Emissions from Deforestation and Forest Degradation (REDD+) initiative, which seeks to slow, halt and reverse deforestation trends and encourages the conservation of forests in developing countries by rewarding participating individuals, communities and local and national governments.

The potential for REDD+ in Southern Africa is enormous. The African Environmental Outlook 2 (UNEP, 2006) confirms that forests and woodlands cover about 221.94 million hectares or 32.5 per cent of the total Southern African land area (FAO, 2005). It is recognized that if the value of carbon sequestration is added to the social and economic benefits, the local value of forests could easily support flourishing local rural livelihoods, while allowing communities adjacent to the forests to maintain the resource.

Carbon financing, as a new approach, is very recent. It represents a true opportunity for agriculture, both in terms of finance and of shifting to practices that support climate-resilience. Currently, agricultural carbon-finance projects offer limited economic benefits to smallholder farmers. In addition, transaction costs are very high. Hence carbon-finance projects mostly benefit agribusiness, which is clearly unfair. There is need to review the application of carbon-finance projects.

Sophisticated and complex mechanisms developed in the context of the global mobilization to respond to climate change have largely prevented African farmers from benefiting from any of these additional dedicated sources of funding. On the domestic resources side, African governments seem to lag behind in terms of efficiently allocating budgets to climate-proof agriculture. Most importantly, African farmers and their representatives do not have adequate information on specific funding that is available to fight climate change in developing countries or on initiatives their governments are developing in order to limit the impacts of climate change on southern African economies and livelihoods (SACAU, 2012).

The “green economy” offers another opportunity for Southern Africa to build a pro-poor, socially-inclusive and natural resource-driven rural economy by improving the efficiency of resource use; reducing the inequitable allocation of resources and opportunities; and reducing the prevalence of poverty and inequality and the marginalization of vulnerable groups. A green rural-economy strategy in the SADC subregion will need to focus on a low-carbon and low-pollution path for rural development which also diversifies rural incomes.

South Africa is the only country in Southern African which has elaborated a vision for a green economy. The rest of the subregion needs to create a broad-based space within which to agree upon a green economy approach to poverty reduction and economic development (OSISA, 2012). Building capacity towards such a process, especially within the rural areas, will help countries to harness the benefits offered by the current climate-change development agenda.

Addressing increasing rural poverty levels and growing inequalities requires a shift from a development paradigm heavily focused on economic growth to a rights-based approach to rural development. Such a strategy should accord due consideration to addressing climate-change impacts on other sectors such as water and sanitation, ecosystems and human development in general.

3. Climate change, water and sanitation and biodiversity: risks and vulnerability in Southern Africa

3.1 Water and climate change: multichannel linkages

This chapter outlines the impact of climate change on the water sector in Southern Africa. In particular, it analyses the freshwater situation in terms of access to water and sanitation. It also briefly discusses national and subregional responses to water scarcity and climate change, as well as strategies for adaptation to and mitigation of climate change with respect to natural resources and biodiversity management.

The impact of climate change on water is characterized by two extreme types of natural disasters - floods and droughts. Both phenomena have the inherent capacity to disrupt productive capacities and livelihoods of countries through their impacts on food security, health systems, housing, and other infrastructure. Most countries in Southern Africa are classified as having low resilience to such disasters, due to their lack of the basic infrastructure and financial capacity to mitigate impacts of water disasters.

According to IPCC projections, temperatures in the subregion have risen by over 0.5°C over the last 100 years. It is this global warming that impacts on the hydrological cycle and hydrological systems with unprecedented changes to precipitation patterns, intensity and extremes (Bates and others, 2008). ENSO is the most dominant perturbation system responsible for inter-annual climate variability in Southern Africa, while another weather system called “La Nina” is responsible for most of the floods in the subregion. The general observation is that the subregion is becoming hotter and drier as countries experience a downward trend in rainfall, with much of the subregion receiving below-normal rainfalls and frequent droughts. Some countries have also experienced above-normal precipitations, leading to floods. There is need therefore not only to consider mitigation options, but also climate-change adaptation strategies that would reduce the risk exposure of the subregion to disaster.

3.1.1 SADC water resources: from stress to scarcity

Six southern Africa countries are classified as arid or semi-arid: Botswana, Mozambique, Namibia, South Africa, Swaziland and Zimbabwe (Shackleton and others, 2008). These countries are character-

ized by at least 50 per cent of their land area having a ratio of mean annual precipitation to potential evaporation of less than 0.5.

Across this gradient, two major ecoregions are evident. The drier West, including the Karoo, Namib and Kalahari regions, is characterized by deserts and dwarf shrub-lands. The relatively moister East is dominated by arid and semi-arid savannas. There is a broad transition zone between the two. Although rainfall is limited and strongly seasonal in both these ecoregions, variation is lower in the moister East. The consequent increasing presence of trees and tree-products means that the major land-use patterns of the two ecoregions differ markedly. The desert and dwarf shrub-land ecoregion is used primarily for extensive livestock and wildlife grazing and for mining, whereas the semi-arid savannas are dominated by a mix of commercial and subsistence agriculture and grazing, with great consequences on water uses.

Table 4. : Proportions of SADC countries classified as semi-arid or drier

Country	% hyper-arid	% arid	% semi-arid	total % with a MAP/PE ratio <0.5
Namibia	9.3	44.1	46.6	100.0
Botswana	0	19.3	80.7	100.0
Zimbabwe	0	0	82.7	82.7
Swaziland	0	0	81.2	81.2
South Africa	0.9	29.8	44.4	75.1
Mozambique	0	0	64.1	64.1
Tanzania	0	0	33.4	33.4
Angola	0	0	19.5	19.5
Zambia	0	0	16.9	16.9
Malawi	0	0	4.0	4.0
Lesotho	0	0	0	0

Source: Consortium on Ecosystems and Poverty in Sub-Saharan Africa (Shackleton and others, 2008).

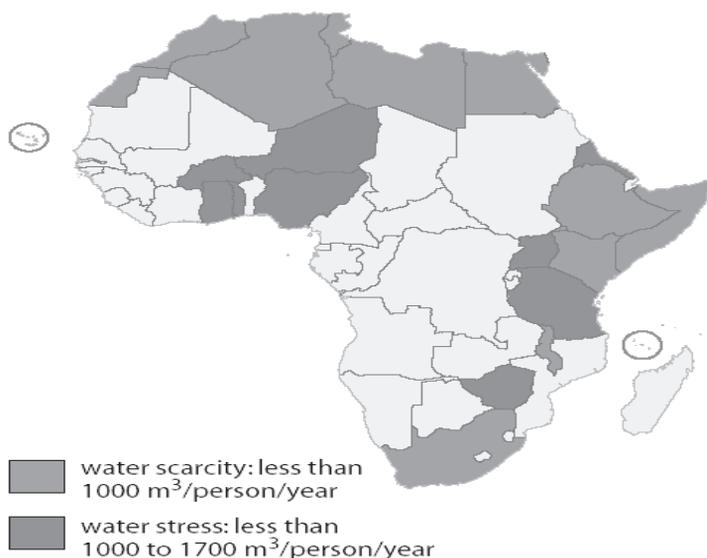
Water resources in SADC are inextricably linked with climate, so the prospect of global climate change has serious implications for water resources and regional development. The majority of the population in the SADC subregion (over 70 per cent) depend on agriculture; mainly rain-fed agriculture. Therefore, understanding the impacts of climate change on water resources is of paramount importance in the SADC subregion.

Current trends in major river basins in Southern Africa already indicate a decrease in runoff of about 17 per cent over the past decade. A reduction in runoff may have substantial impacts on the econo-

mies of SADC countries, where reservoir storage is very sensitive to variation in runoff and periods of droughts. During droughts, lake storage and major dams have reached critically low levels in some SADC countries, threatening industrial activity. Results from models indicate that global warming will increase the frequency of such episodes of low storage (Manase, 2010).

Southern Africa is already experiencing water problems as a result of climate change. Most countries in Southern Africa are water-stressed. For instance, there is only between 1,000 and 1,500 cubic metres of freshwater per person per year available to serve the growing population in the subregion. Evidence of the impact of climate change on water is accumulating, with some countries already experiencing pressure on transboundary water resources, as fluctuations in water availability and water quality have become more pronounced in recent years. There are spatial differences in freshwater availability in Africa, from the arid Sahel in the North, and the Kalahari in the South, to the wet rain-forest belt of equatorial African States running through Equatorial Guinea, Gabon, Uganda, and the DRC (Figure 13). Southern Africa has one of the highest disparities.

Figure 3: Freshwater availability in Africa



Source: UNEP, *Global Environment Outlook 2000*

Water resources (groundwater, surface water and rainfall) in the SADC subregion are unevenly distributed. Average rainfall varies from 4,000 mm in the North to less than 50 mm in south-western parts of the subregion, with arid conditions in Namibia and Botswana and large semi-arid regions in the western and southern parts of the subregion. There are 15 major river basins which are shared

watercourses in the subregion, including the 3,800,000 square kilometres of the Congo River Basin, the 1,400,000 square kilometres of the Zambezi River Basin covering eight SADC member States, and the 5,500 square kilometres of the Umbeluzi River Basin shared by Mozambique and Swaziland (SADC, 2005).

The SADC subregion is relatively water abundant compared to the rest of Africa. It is estimated that the per capita annual renewable freshwater resources (groundwater and surface water) average 8,900 cubic metres (24,000 litres/person/day) (SADC, 2005). However, water scarcity is characteristic in South Africa, the largest economy in SADC, and Malawi, one of the poorest countries in the subregion.

Zimbabwe and Tanzania are also water-stressed. South Africa, Namibia and Botswana are countries with the highest water demands per capita and yet are also countries within the arid and semi-arid zones of the subregion. Projections of population and of problems with water quality and quantity indicate that, by 2025, six SADC member States will experience water stress and at least two, Malawi and South Africa, will experience absolute scarcity.

Simulations appear to indicate possible decreases in precipitation in Southern Africa in the next 100 years. The impact of changes in precipitation and increased evaporation could have profound effects on some lakes and reservoirs in SADC. Evaporative increases of 40 per cent, for example, could result in much reduced outflow from the reservoirs. Lake Malawi, for example, has been reported to have no outflow for more than a decade in the earlier part of the 20th century.

The Zambezi River has the worst scenario and faces a combination of decreased precipitation (about 15 per cent), increased potential evaporative losses (about 15-25 per cent), and diminishing runoff (about 30-40 per cent). The potential impacts of impoundments such as dams, weirs or other structures that raise water levels, land-use change, and climate change on the Zambezi will be substantial. Projections under various climate scenarios suggest there will be a decrease in surface and sub-surface runoff of five streams and rivers in Mozambique, including the Zambezi. For the Zambezi River Basin, simulated runoff under climate change is projected to decrease by 40 per cent or more (Manase, 2010).

Many riparian States are likely to be affected by growing water scarcity, increasing populations, degradation of shared freshwater ecosystems and competing demands for shrinking natural resources. This has the potential for creating bilateral and multilateral conflicts in SADC.

Water is a critical resource for meeting basic needs related to domestic and industrial requirements, sanitation and waste management for over 200 million people in SADC. General disruption to the water-supply systems would critically impede economic and social development in the subregion.

The water sector is already experiencing heightened attention as growing competition among productive users of water is reaching unsustainable levels in some parts of Southern Africa and water scarcity for agriculture as a result of climate change is threatening the livelihoods of rural communities and the food security of urban populations.

Growth in water demand exceeds population growth rates in a number of countries in southern Africa. Agriculture is by far the biggest consumer of water, taking over 70 per cent of water consumed in the subregion. The demand for water for irrigation exceeds supply in Botswana, Namibia, South Africa and Zimbabwe. Agriculture's thirsty appetite for water is largely unsustainable in a number of countries already facing looming water scarcity. South Africa has 10 per cent of the water resources in the subregion but consumes about 80 per cent of regional water resources, of which the agricultural sector uses 57 per cent (Mutembwa, 1998).

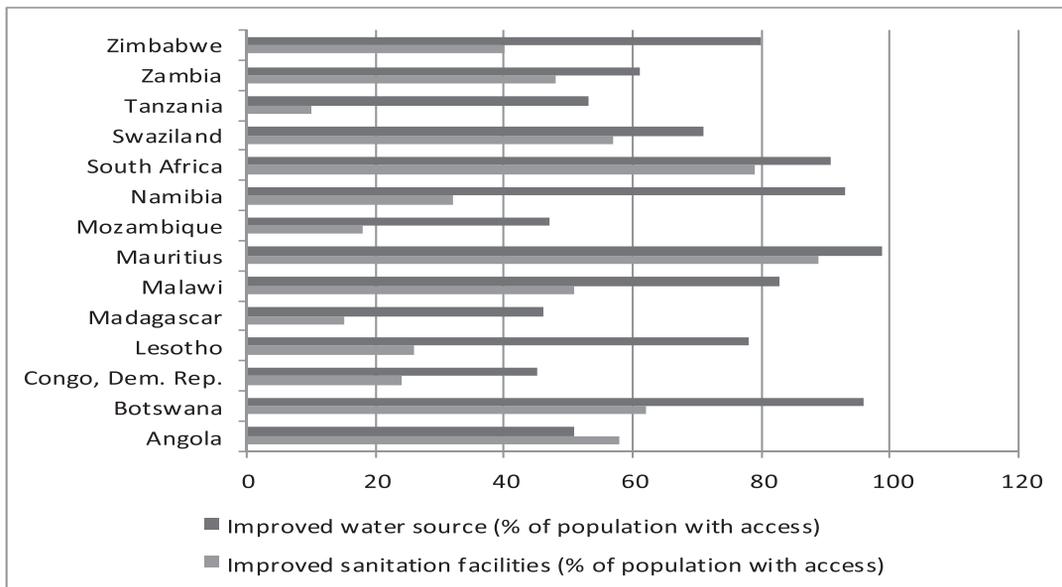
Countries need urgently to consider the merits of economic restructuring to diminish significantly the amount of water consumed by the agricultural sector. An efficiency campaign should be coordinated within Southern Africa to ensure that farmers irrigate efficiently and adjust crops, cropping patterns and general agricultural operations in order to aim for lower water consumption.

3.1.2 Water and sanitation in the SADC: status, old constraints and new threats

SADC is one of the subregions in Africa with very high inequality in terms of access to improved water and sanitation. Only five countries (Botswana, Malawi, Mauritius, Namibia and South Africa) recorded that more than 80 per cent of their populations had access to improved water sources in 2010. Mozambique, Madagascar and DRC have the least coverage, and less than 60 per cent of population had access to improved water sources (Figure 4).

Access to improved sanitation is another important issue that often does not receive sufficient attention in policy debates in the subregion. Due to poor coverage for safe water, the SADC subregion has one of the worst outcomes in terms of access to improved sanitation facilities. Rural areas face the most serious problems in clean water and sanitation coverage.

Figure 4: Access to water and sanitation in SADC



Source: *The World Bank, World Development Indicators Database, 2011.*

Despite having strong economic performances in recent years, Madagascar, Mozambique and Tanzania have the lowest coverage, with less than 20 per cent of their populations having access to improved sanitation facilities. DRC, Lesotho, Namibia and Zimbabwe recorded coverage of between 20 and 40 per cent of their populations. Angola, Malawi, Swaziland and Zambia recorded intermediate levels of coverage (40-60 per cent of population). At the top end are Botswana, South Africa and Mauritius.

The major obstacle is that most governments in SADC do not place the necessary priority on urban and rural sanitation, hence there is very little public investment dedicated to sanitation infrastructure. For urban areas, poor sanitation manifests itself in unplanned slums inhabited by poor urban-dwellers. This proliferation of slums is due to rapidly growing urban populations. These areas are not serviced by sewerage networks and do not have adequate drainage systems. Waste and waste sludge from these settlements find their way into waterways and drains. The situation is much worse during the rainy season where urban flooding is worsened by blockage of waterways and storm-water drains through dumped waste. Population density and poverty contribute to poor levels of access to clean water and sanitation in rural areas, and there is often low-quality sanitation infrastructure and no investment in infrastructure.

Therefore there is a real threat that climate change could lead to increased episodes of sanitation-related diseases, such as cholera, malaria and other waterborne diseases. Floods multiply risk factors for people living in areas where sanitation facilities are not protected from weather and disposal of waste is unsafe. Increased episodes of floods raise the risk exposure to secondary disasters, particularly if countries do not invest in capacity to mitigate the risk of contamination from water, solid waste and human waste.

Countries must put in place cost-effective strategies to close the gaps in access to safe drinking-water and sanitation facilities. Priorities should be revisited, particularly in urban planning and when implementing interventions for disaster reduction and disaster management. Efforts must be doubled to provide sustainable housing solutions in both rural and urban settings, and water and sanitation issues must be accorded due priority, within an integrated framework. In addition, countries in Southern Africa should implement the Declaration of the 11th Session of the African Union Summit held in Sharm El-Sheik in Egypt in 2008 (AU, 2008). The Heads of State and Government stressed the need to register progress on the challenges of financing water and sanitation infrastructure; water conservation and equitable distribution; closing the sanitation gap; breaking the silence on sanitation and hygiene; adapting to climate change; integrated management of national and transboundary surface and ground water; investing in information, knowledge and monitoring; and institutional development and capacity-building.

3.2 Climate-change impacts on biodiversity in Southern Africa

3.2.1 Climate-change effects on species

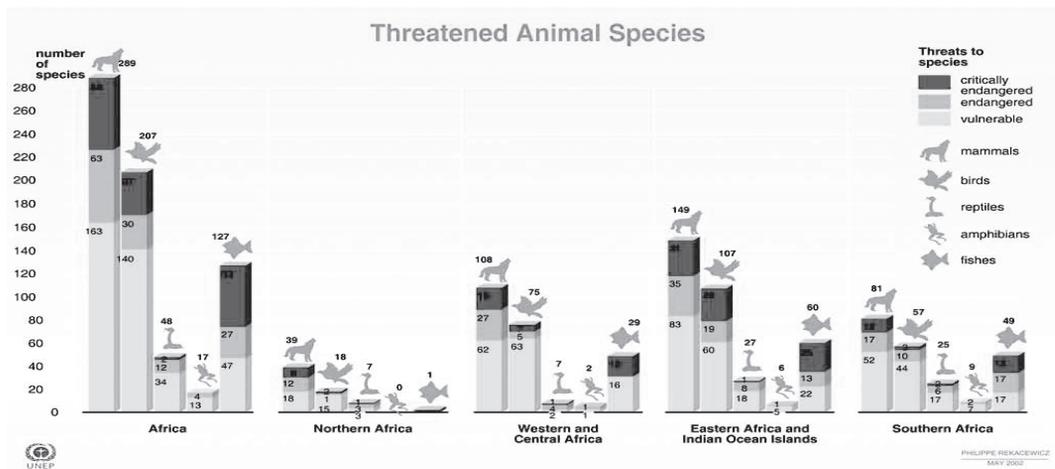
While the exact nature of the expected changes in temperature, precipitation and extreme events is not known, it is generally agreed that climate change will have impacts on land, sea, air and fresh-water and that these will alter the composition of species and thus biodiversity. It is predicted that climate-related changes to species' composition could have negative consequences for Southern African countries. Changes in habitat, as well as population processes, species interactions and interactions between demographic and landscape dynamics will be among the influences leading to climate-induced changes to biodiversity (Keith and others, 2008). For Southern Africa, these pressures manifest themselves in increased prevalence of invasive species and primary plants, both of which are hampering conservation efforts in the subregion.

The impacts of diversity loss will be felt at several levels. Changes in bioclimatic suitability and atmospheric conditions will affect the availability of food, fibre, fuel and shelter as a result of a change in the competitive balance of woody plant cover for a substantial portion of Southern Africa. Changes in ecosystem structures and associated faunal diversity changes are expected to disrupt ecosystem services and all sectors that are intimately linked to the natural-resources sector. These include the

tourism industry, which relies heavily on the dominant savanna vegetation in Southern Africa, and the agriculture sector, which relies on winter rainfall (Midgley and Thuiller, 2010).

The exact nature of biodiversity losses in the subregion will depend on what direct impacts climate change is having on the water cycle. Water availability will be the overriding cause of ecological response. Some studies observed significant drying and warming trends in Southern Africa, with concentrated contemporaneous warming trends in south-western and central regions of South Africa (Hulme and others, 2001). Other studies found substantial shifts in mammal species (see Figure 5), reporting a westward shift in the tropics and an eastward shift in the temperate zone, due to aridification. A large fraction of species were also projected to become “critically endangered” or “extinct” by 2080, with the disclaimer that the impact on vegetation is dynamically linked to the responses of fauna to climate change (Thuiller and others, 2006). Hence, there is need for a more rigorous model of the likely impacts of climate and human use on vegetation, to determine the exact species losses for the subregion.

Figure 5: Threats to Biodiversity



Source: WCM/IUCN – The World Conservation Union, 1998

The World Development Report 2010 (World Bank, 2009) confirms that about 10 per cent of species will be condemned to extinction for each 1°C temperature rise, with even greater numbers at risk of significant decline.

The unmitigated consequences of climate change on ecosystems, including reductions in biodiversity, will have alarming consequences for fisheries and tourism and thus for the rural economies of the subregion, including the much-needed diversification of rural incomes. For example, the increase of the temperature of the sea along the Mozambique Channel as a result of the El-Niño (ENSO) pattern will have negative impacts on corals, which are important parts of the Mozambican marine ecosystem and eco-tourism. Warming of the sea will affect the resurgence processes, which transport nutrients from the deep layer of oceans to the surface and thus feed the fish. This will affect fisheries and will therefore have implications on generation of rural incomes, malnutrition and eventually health (Young and others, 2010).

3.2.2 Climate-change effects on ecosystems and related services

Ecosystem services are defined as conditions and processes through which natural ecosystems - and the species that make them up - sustain and fulfill human life (Daily, 1997). They are the range of benefits that people obtain from ecosystems. These are more than just goods, but include critical services or processes which provide buffering, are regulators and support life but which are commonly forgotten or taken for granted by society.

Ecosystems maintain biodiversity and the production of ecosystem goods such as food, forage, timber, biomass fuels, natural fiber, and many pharmaceutical, industrial products and their precursors (Daily, 1997). They also provide clean water, materials for shelter, marketed crops, livestock, forest products, and minerals. In addition to the production of goods, ecosystem services are the actual life-support functions, such as cleansing, recycling and renewal, and they confer many intangible, aesthetic and cultural benefits as well. Ecosystem provisions obvious services in assisting poor people, especially in rural zones, meet their immediate everyday needs for food, energy, shelter and income and cultural services.

Many poor rural populations rely disproportionately on the integrity and functions of local ecosystems and are likely to lack the means to import ecosystem services. Impoverishment as a result of adverse ecosystem change due to climate change may sometimes lead to a downwards spiral for such people. In all instances, the ability to achieve well-being is reduced by the diminished availability of ecosystem services. Biodiversity is fundamental to many ecosystem services. It provides sustainability and resilience vital for the livelihoods and coping strategies of many people, especially the rural poor. They often obtain ecosystem services, and thereby reduce their vulnerability, through diverse and complex mixes of activities over the seasons. For them, biodiversity has a stabilizing and buffering function. It provides multiple sources of ecosystem services, as well as fallback options for food and other resources when times are bad (Alcamo and others, 2003).

Changes in rainfall, run-off, temperature, sea level – amongst others – associated with climate change will affect the distribution and range of ecosystems and species respectively. These changes will also affect the viability, persistence and resilience of ecosystems on land and in water. Changes in ecosystems will in turn affect the delivery of ecosystem services, thereby affecting human wellbeing and resilience, especially in rural areas.

Because the rural people in Southern Africa are so reliant on ecosystem goods and services, any change in the supply of these services, or their access to them, can have profound impacts on the sustainability of local livelihoods, vulnerability and human well-being. If the change is a decline in availability or access, then the impacts on rural livelihoods will be negative and could potentially force people deeper into poverty.

Trade-offs between ecosystem services are common and probably represent one of the most challenging areas when considering the links between services and poverty reduction (Shackleton and others, 2008) in the context of climate change. Trade-offs typically come about when trying to harness, regulate or increase the supply of one or two services specifically, which potentially diminishes the supply of others

Deforestation is one of the visible trade-offs in southern Africa. It is a major cause of biodiversity loss and releases carbon dioxide, a major cause of climate change. For these reasons, reducing and/or preventing deforestation is an important option to mitigate climate change. Reducing Emissions from Deforestation and Forest Degradation (REDD) provides an incentive mechanism to this end. Restoring degraded ecosystems to improve ecosystem services delivery, and safeguarding links across climatic gradients to enable shifts in ranges of species, are important components of adaptation (International Association for Impact Assessment, 2010).

Efforts to mitigate climate change through land-based activities may support the maintenance of biodiversity and ecosystem services or threaten them further... It is essential that key species in the delivery of rural ecosystem services are identified and, if necessary, actively managed... There will be a greater need for more flexible biodiversity conservation strategies that take the interests of different rural social groups into account in biodiversity management strategies... Some of the options include extending payments for environmental services and further exploration of 'rights-based approaches to resources access (World Bank, 2009).

A significant opportunity for additional payments for conservation and improved land management may flow from the scheme for Reduced Emissions from Deforestation and forest Degradation (REDD) under consideration by the United Nations Framework Convention on Climate Change.

To deal effectively with the changing impacts and competing uses of ecosystems under a changing climate, governments will need to introduce strong, locally appropriate policies, measures, and incentives to change long-established behaviors, some of which are already illegal. These actions will run counter to some community preferences, so the balance between appropriate regulation and incentives is critical (World Bank, 2009).

3.3 National and subregional responses to water scarcity and climate change

SADC has recently issued its strategic response to the impacts of climate change on water resources. These responses are outlined in the document on Climate Change Adaptation Strategy in SADC: a Strategy for the Water Sector. The main objective of the SADC strategy is to improve climate resilience in Southern Africa through integrated and adapted water resources management at regional, river basin and local levels. In addition, the strategy is aimed at promoting further the application of integrated water resources management as a priority tool to reduce climate vulnerability and to ensure that water management systems are well adapted to cope with increased climate variability (SADC, 2011).

This is not the first time that SADC is responding to issues in the water sector. In the early 1990s, the SADC Secretariat coordinated the preparation of the SADC Regional Strategic Action Plan for Integrated Water Resources Development and Management in the SADC Countries (RSAP I, 1999-2004). In line with this overall framework, the SADC Regional Water Supply and Sanitation Programme was developed in 2004 as a collaborative regional framework for effective planning and management of water supply and sanitation in order to enable member States to improve and accelerate the provision of water and sanitation services effectively at country level in order to achieve the MDGs and the Southern Africa Water Vision (SADC, 2005).

The two regional frameworks were aimed at addressing, among other issues, institutional weaknesses including legal and regulatory frameworks at national and regional levels, improving national and transboundary river-basin management, planning and coordination, promoting public participation and addressing infrastructure inadequacies to meet growing demand for service.

SADC is leading efforts in adaptation and mitigation to climate change. In the water sector, mitigation and adaptation measures include harmonization of water governance and water-management systems in the subregion, which consist of the political, social and administrative systems to develop and manage water at different levels of society. SADC is also providing leadership by supporting countries to develop infrastructure for stocking and distributing water.

The system would require development, financing and implementing structures for irrigation, drainage, water supply and sanitation, hydropower generation, flood management and early-warning systems for droughts and floods.

Apart from SADC-led activities and programmes on water and climate change, there are a number of intergovernmental interventions on various aspects of climate change in the subregion. These include the SADC Drought Monitoring Centre (DMC), whose main mandate is to carry out climate monitoring and prediction for early warning and mitigation of adverse impacts of extreme climatic events on agricultural production, food security, water resources, energy, and health, among other socioeconomic sectors. SADC also implemented the Groundwater and Drought Management project with funding from the World Bank. The project was aimed at assisting SADC member States to develop cooperatively “a strategic regional approach to support and enhance the capacity of its Member States in the definition of drought-management policies, specifically in relation to the role, availability (magnitude and recharge) and supply potential of groundwater resources.”⁵ Most countries included water adaptation aspects in the process of formulating and implementing National Adaptation Programmes of Action (NAPAs).

The NAPAs are an initiative agreed under the UN Framework Convention on Climate Change (UNFCCC) at its Conference of Parties in 2001, which provide a process for Least Developed Countries (LDCs) to identify priority activities that respond to their **urgent** and **immediate** needs to adapt to climate change – those for which further delay would increase vulnerability and/or costs at a later stage (UNFCCC, 2013).

The NAPAs serve the purpose of communicating urgent and immediate adaptation linkages, including to long-term strategy frameworks such as Multilateral Environmental Agreements (MEAs) and Poverty Reduction Strategy Papers (PRSPs), Water Acts, etc (UNESCO, 2009).

The NAPA for Mozambique for example, is cited as one that clearly links the physical and social processes behind the country’s vulnerabilities to short- and long-term impacts of climate change. The Zambian NAPA, on the other hand, identifies rain-fed agriculture, water and energy as some of the vulnerable sectors, but fails to link to the Zambezi River Authority in its proposed strategies for addressing vulnerability in the water sector. It only identifies reducing human-wildlife conflict as a reason for communities to maintain water infrastructure. Hence, a major concern is that many countries have not developed or adopted any formal plans for the water-resources sector which can act as responses to climate-related impacts and extremes, such as droughts and floods. Most water policies respond to access issues and hence focus on increasing water abstraction and use, and also on demand management through pricing.

5 quoted from the SADC website, <http://www.sadc-groundwater.org/>

The World Summit on Sustainable Development (WSSD), held in Johannesburg, South Africa in 2002, issued the Johannesburg Plan of Implementation (JPOI), which included Integrated Water Resource Management (IWRM) as one of the key mechanisms for achieving sustainable development. The concept of IWRM had originated from a 1992 International Conference on Water and the Environment (ICWE) in Dublin, Ireland. The Dublin Statement on Water and Sustainable Development (also known as the “Dublin Principles”) outlined IWRM as covering these points: (i) freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment; (ii) water development and management should be based on a participatory approach, involving users, planners and policymakers at all levels; (iii) women play a central part in the provision, management and safeguarding of water; and (iv) that water has an economic value in all its competing uses and should be recognized as an economic good.

Although the JPOI called for all countries to: “Develop integrated water resources management and water efficiency plans by 2005, with support to developing countries”, very few countries in the sub-region have adopted IWRM to date (Table 4). There is thus a need for countries to follow up on their commitments, as agreed during the WSSD.

Table 5: Evidence of adoption and use of the Integrated Water Resource Management approach

Country	National policies and frameworks
Angola	IWRM & Water Efficiency Roadmap - Ministry of Water & Energy (draft 2007)
Botswana	IWRM Strategy and Action Plan - Ministry of Minerals, Energy and Water Resources (2006)
Malawi	National Water Policy - Ministry of Irrigation and Water Development (2005) Water Resources Act No. 15 of 1969 with later amendments. Government of Malawi Integrated Water Resources Management/Water Efficiency (IWRM/WE) Plan for Malawi - Ministry of Irrigation and Water Development (draft 2007)
Mozambique	Government of Mozambique - Water Act, Lei de Aguas, 16/91 3 August (1991) IWRM Plan - Direccao Nacional de Aguas, Ministry of Public Works and Housing (draft 2007)
Seychelles	Water Regulations - Public Utilities Corporation (1988) Water Supply Development Plan - Public Utilities Corporation (2005) Water Policy - Public Utilities Corporation
Tanzania	Act no. 42 of 1974 - Government of Tanzania (draft 2007) National Water Sector Development Programme 2006-2025 - Ministry of Water (2006) IWRM Strategy and Action Plan - Ministry of Water (2004) National Water Policy - Ministry of Water (2002) National Water Law based on revised Water Act No. 42 of 1974 - Government of Tanzania (draft 2007)
Lesotho	Roadmap to completing integrated water resources management and water efficiency planning in Lesotho Ministry of Natural Resources, Water Commission (April 2007)
Namibia	National Water Policy White Paper - Government of Namibia (2000) Water Resources Management Act - Government of Namibia (2004) Integrated Water Resources Management Strategy and Action Plan - Ministry of Agriculture, Water and Rural Development (2006)
Swaziland	Water Policy - Ministry of Natural Resources and Energy (draft 2007) IWRM and Water Efficiency Plan - Water Resources Branch (draft 2007) Water Act (2003) - Government of Swaziland

Source: UNWater, 2008

Water-resource management will be complicated by emerging challenges, including the impacts of climate change. Although water-stress scenarios are dynamic and might not materialize at a sub-regional scale, the localized impacts of water stress and water scarcity are already being felt by a number of countries including South Africa, the leading economy in the subregion.

Sanitation is also a key developmental issue for most countries in the subregion. Rapid population increases, urbanization and competition for resources will continue hampering progress, particularly if countries do not include implementing resource-management and sanitation strategies in their integrated national development plans as priorities.

A number of countries are implementing integrated water-resource management approaches in order to adapt and mitigate the impacts of climate change. SADC is also taking the lead in harmonizing na-

tional strategies in climate-change adaptation and mitigation. However, there is a need for countries to fulfill their commitments, particularly with regard to internationally agreed targets and milestones. The future of freshwater resource management in the subregion will depend on countries meeting their national targets in terms of providing improved water and sanitation and also on international cooperation in the utilization of shared water resources. A major component of cooperation is the implementation of integrated water-management strategies at the regional level.

4. Climate change and human development in Southern Africa

Climate change will hamper progress towards the attainment of major MDGs in Southern Africa, partly because it will affect agricultural productivity, rural income and ecosystems. Human health, education, employment and rural poverty will all be impacted by natural disasters, which are likely to be effects of climate change, particularly within a context of high prevalence of HIV, gender inequality, weak institutional and human capacity, and low progress achieved in terms of the Human Development Index (HDI).

4.1 Climate change, rural economy and human development: linkages

Climate change is not a new phenomenon in Southern Africa, as can be seen clearly from several policy debates and programmes that have been initiated at subregional and national levels. In recent years, the subregion has witnessed an increased frequency of events that resulted in droughts and flash floods and which were related to the El-Niño pattern.

SADC and UNEP (2010) state that climate change and variability have the potential to hinder the attainment of the MDGs in the subregion. It is also argued that the attendant effects of climate change have profound impacts on the political, social and economic outlooks.

Climate change is the defining human development challenge of the 21st century. Failure to respond to that challenge will stall and then reverse international efforts to reduce poverty. There are evidences that increased exposure to droughts, floods and storms is already destroying opportunity and reinforcing inequality (UNDP, 2007).

Although high-level policy dialogues on climate change have been held across the subregion, very few dialogues explicitly linked climate change to societal welfare and human development, especially in rural areas. The Seventh African Development Forum of the AU, AfDB and the ECA, held in 2010, discussed that climate variability and extreme events obstruct development, affect natural resources, damage agricultural productivity, cause water shortages and therefore threaten the health of millions in the developing world. Climate change increases costs of development and levels of poverty and inequity across the world. More specifically, the evident correlation between climate impacts and poverty poses a particular challenge for the Southern African region: climatically the

region is warming up faster than the rest of the world, and socio-economically it is one of the world's poorest and most vulnerable regions (Bauer and Scholz, 2010).

Climate change has both direct and indirect effects on poverty and hence on people's welfare and their capacity to adapt. The direct impacts are the loss of life, infrastructure and assets from extreme climate events, whilst the indirect impacts are likely to be felt through the effects on economic growth. Further climate-change variation leads to an alteration in the sectoral origins of growth, including the ability of the poor to engage in the non-farm sector. They also increase inequality and therefore reduce the poverty elasticity of growth (Richards, 2003).

4.2 Impacts of Climate Change on Human Development in the SADC: evidences

The rising sea levels and the frequent floods are forcing many people living along low-lying coastal areas to move inland and in some instances across borders. Floods have been a major problem, according to Climate Change, Environment and Security (ACCES) dialogue process. In 2008, approximately 450,000 people were affected and more than 111,000 hectares of farmland were destroyed. About 60 per cent of the affected populations were in Mozambique, the country most vulnerable to flooding and storms in the region (ACCES, 2010).

There is empirical evidence that climate change is adversely impacting population migration and new settlements across Africa. For example, climate change may induce human mobility through four distinct factors, namely i) the intensification of natural disasters that destroy livelihoods and assets; ii) the impact of warming and drought on agricultural production and access to clean water; iii) rising sea levels that threaten viability of life in coastal areas; and iv) exacerbating competition over natural resources, leading to conflict and, in turn, migration (ECA, 2011b).

These forced migrations are creating pressure on national budgets as governments are compelled to look for alternative lands for resettlement. Moreover, the situation may be further compounded by the time and resources needed to put in place the necessary social amenities, such as new schools, clinics, decent houses, water and sanitation facilities. This means that access to education and health for the children of the displaced people is adversely affected.

The ECA's African Climate Policy Centre (ACPC), which was established to coordinate and strengthen policy response to climate change (among other things), notes that rises in sea level are leading to reduced productivity of coastal fisheries, forcing people to migrate from ancestral and productive areas and also impacting negatively on tourism. These problems do not only have economic consequences through loss of income for the affected communities, but security and social ramifications through potential conflict as land may not be enough to accommodate all the affected people.

Climate change is also having a huge impact on coastal infrastructure in Angola, Mozambique, Namibia and South Africa. Breakwaters, revetments and sea walls, which protect harbours and houses from direct wave action and under scouring, will require more maintenance with implications on significant public and private financial resources (Theron and Rossouw, 2008). Mauritius, Madagascar and Mozambique are now facing challenges of frequent cyclones with severe consequences on people, infrastructure and the economy at large.

The situation in Southern Africa is compounded by high poverty and HIV levels, with limited coping mechanisms at both individual or community levels. According to UNAIDS, the world's highest HIV prevalence levels occur in Southern Africa with Swaziland at 26.0 per cent; Botswana at 23.9 per cent; Lesotho at 23.2 per cent; Zimbabwe at 18.0 per cent and Zambia at 14.3 per cent. About 70 per cent of the population in the subregion subsists on less than US\$2 per day while nearly 80 per cent of the population in some member States such as Mozambique and Zambia live in extreme poverty (SADC and UNEP, 2010).

The effects of climate change in East and Southern Africa are compounded by high poverty levels, weak infrastructure, poor management of natural resources and dependence on rain-fed agriculture. As an illustration, 9 out of 15 SADC member States⁶ have had a consistently low HDI score of less than 0.50 between 1980 and 2011. A low HDI score implies a low quality of human life in terms of life-expectancy, literacy levels, education and the general standard of living in a country. Climate variability resulting in the recurrent droughts, floods and other natural disasters in the subregion has exacerbated poverty, as reflected in poor access to social services accompanied by high incidence of malnutrition (SADC and UNEP, 2010).

Furthermore, the triad problems of poverty, inequity and climate change in Southern Africa are inter-linked in a complex way, and this reinforces the countries' vulnerability to climate change. Climate change is inextricably linked to the broader sustainable development agenda to reduce poverty, child mortality and morbidity and to ensure universal primary education for all children (Chandran and Sandhya, 2011).

Thus there is a nexus between climate change and the MDGs Declaration of 2000. Small changes in climate can result in substantial changes in risk, particularly in developing countries. These problems are more pronounced in Southern Africa, which remains highly vulnerable to the detrimental impacts of climate change. In turn these impacts fall disproportionately upon the poor and thus exacerbate inequities in health status, education, and access to adequate food, clean water and other resources.

6 The nine member States with a low HDI are Angola, DRC, Lesotho, Madagascar, Malawi, Mozambique, Tanzania, Zambia and Zimbabwe.

A Computable General Equilibrium (CGE) model simulation for Namibia indicates that, over 20 years, annual losses to the Namibian economy could be up to 5 per cent of GDP, (Reid and others, 2008) due to the impact that **climate change** will have on Namibia's natural resources alone. This will affect the poorest people the most, with resulting constraints on employment opportunities and declining wages, especially for unskilled labour in rural areas. This situation is not only true for Namibia but also for other countries that depend on natural resources, as well such as Botswana, DRC, Tanzania, Zambia and Zimbabwe.

Some assessments of water availability, including water stress and drainage, show that parts of Southern Africa, such as Mozambique, Zimbabwe and South Africa, are highly vulnerable to climate change and variability. In this situation, water-related problems that are already serious are likely to worsen in the coming years. Water shortages caused by repeated droughts in Southern Africa will compromise hygiene. Furthermore, exceptionally wet periods may result in contaminated water-supply systems and, as a result, both droughts and flooding have the potential to lead to outbreaks of waterborne diseases, such as cholera, intestinal worms and typhoid (Dube and Chimbari, 2009).

Rising global temperatures will lead to substantial transmission of many vector-borne diseases, such as malaria, schistosomiasis, onchocerciasis, trypanosomiasis, filariasis, leishmaniasis, plague, Rift Valley fever, yellow fever and tick-borne hemorrhagic fevers (Githeko et al., 2000). These effects will be felt more in Africa where nearly 70 per cent of the population lives in rural areas, where vector control (such as removing breeding sites for larvae) is often difficult. For instance, of the 234 million people who live in the SADC subregion, 74 per cent live in areas where malaria is endemic and where they are prone to contracting the disease (SADC, 2008a). It is estimated that malaria is responsible for up to 30 percent of out-patient attendance and 40 per cent of admissions (in-patients), accounting for 30 million cases and 400,000 deaths per annum in SADC. Female mosquitoes, which carry malaria, are increasingly finding it easier to survive and breed due to the warm temperatures caused by global warming and, by implication, countries that have previously had low transmission rates, such as Botswana, Lesotho, South Africa, Swaziland and Zimbabwe, are now at risk of an epidemic.

In 2006, more than 90 per cent of global deaths from malaria occurred in Africa, where the disease is endemic in 45 of the 53 countries. Malaria costs the region more than US\$12 billion annually and slows economic growth in African countries by as much as 1.3 per cent each year. It is generally held that malaria in Africa is predominantly a rural disease and that children and women are most vulnerable to its attacks. The potential impact of malaria is widespread on women engaged in agriculture, performing nearly all the tasks associated with producing subsistence food in Southern Africa and accounting for about 70 per cent of the agricultural workforce. Researchers have noted that bouts of malaria particularly threaten livelihoods when they occur in the planting, growing and harvesting seasons, and that this is when they are most likely to occur.

Morbidity from malaria causes a decline in crop output, reduction in use of inputs and productivity, a decrease in area planted, changes in cropping patterns, and loss of agricultural knowledge and income. Farmers suffering from malaria are absent from work for about 31 days per year in Côte d'Ivoire and about 22 days in Nigeria. They produced about half the yields and received half the incomes of healthy farmers. Time lost per year to take care of a child with malaria varied from 42 days in Ethiopia, to 17.5 days in Ghana and 14 days in the Gambia, depending on the severity of the malaria episode, the general health and nutritional status, proximity to health facilities, and ability to seek healthcare (Asenso-Okyere and others, 2011). Malaria is a limiting factor for property accumulation by reducing the living standards of rural households and has a negative effect on technical efficiency of farmers.

The proportion of children's deaths that were due to malaria in East and Southern Africa rose from 18 per cent to 37 per cent between 1982-1989 and 1990-1998. The highest death rates were linked to complex interactions, involving climatic conditions, land-use systems and limited access to health-care institutions and services. Malaria epidemics in Zimbabwe, for example, have been found to be closely linked to climate variability caused by events such as El-Niño (Young and others, 2010).

It can be postulated therefore that climate change and variability will render it difficult for many member States to attain the MDGs, particularly those goals and targets which relate to poverty reduction, health and education.

4.3 Climate change and the rural economy: a gender perspective

The nexus between climate change and gender is one that has often been overlooked in the climate-change discourse. Only recently, has it begun to receive the necessary attention. Both men and women are vulnerable to the impacts of climate change, but they experience them in different ways. In order to address the challenges that arise from climate change, it is critical that the gender differences and relations are adequately incorporated into adaptation and mitigation strategies.

Rises in temperature, unpredictable weather patterns and increasingly arid conditions impact rural livelihoods through negative effects on ecosystems, crop-production and livestock. It is the rural poor who will be most adversely affected by the impacts of climate change as their livelihoods and subsistence are tied to a natural resource base which is sensitive to changes in climate. Due to the increasing feminization of poverty, women make up the majority of the rural poor in Southern Africa (Angula, 2010).

Average participation rates for women in sub-Saharan Africa in the agricultural labour force are relatively the highest in the world. Their share in the agricultural labour force ranges from 36 per cent in Côte d'Ivoire and Niger, to over 60 per cent in Lesotho and Mozambique. A number of Southern

African countries have seen substantial increases in this share in recent decades due to a number of reasons, including conflict, HIV/AIDS and migration (FAO, 2011).

Women will bear the brunt of the negative impacts of climate change; therefore they will also have the greatest need for adaptation strategies in the event of changing weather patterns, harsher conditions for cultivating crops, and natural disasters. The adaptive capacities of women to changes in the climate are heavily constrained due to limited property rights; limited access to credit; limited access to and control over resources and productive assets; and time poverty. It is also recognized that climate change exacerbates already existing inequalities between men and women.

Furthermore, the effects of climate change can increase the propensity of gender-based violence and limit opportunities for women and girls to engage in income-generating activities and education (UNDAW, 2008). Men can also experience the stress related to climate change, as the impacts of climate change can diminish their ability to provide economically for their families. This may lead to psychological stress which, in turn, can lead to increased violence against women (Brody and others, 2008). Understanding and addressing the different impacts on both men and women will help in the design and implementation of effective adaptation and mitigation strategies.

In many countries in Southern Africa, women do not have the same social, economic, legal or political rights as men. The social norms, traditional roles and power structures that prevail in rural society can determine the differential impact of climate change. In Southern Africa where women's poverty and land rights are often restricted by statutory and/or customary law, it can be difficult for them to have access to credit and agricultural extension services. This can reduce the incentive of women to adopt environmentally sustainable farming practices and to make long-term investments in land rehabilitation and soil quality (Brody and others, 2008).

Both women and men play important roles in the rural economies of Southern Africa. However, men and women are not equally distributed across all the productive sectors of the economy women tend to have less access to arable land and women and men are not remunerated equally. Women also comprise the majority of the informal sector in the economies in Southern Africa. Social-safety nets are limited in the informal sector and this sector is often the worst affected by disasters and other economic shocks related to climate change (Brody and others, 2008).

Women and men play complementary roles in guaranteeing food security. Rural men are responsible for the tasks of farming larger livestock, cash cropping, irrigation, land management and forestry, which are climate-sensitive activities. However, women tend to play a greater role in managing natural resources and ensuring nutrition. Women and girls are responsible for securing food, water and energy. The changes in weather affect women's roles as the primary producers of staple foods (UN-

DAW, 2008) as climate change can bring about a scarcity of these resources. This scarcity in resources can increase the workload and time poverty of women (Bathge, 2010).

Many of the impacts of climate change will be felt through changes in availability of water. It is estimated that most countries in Southern Africa will experience water stress and scarcity due to climate change by 2025 (Angula, 2010). Desertification and water scarcity also have the effect of increasing the time burden for women, as they may have to travel further to collect water and gather firewood. Climate change and rising water-levels are associated with an increase in waterborne diseases (Brody and others, 2008), which can increase the burden of care for women. These effects of climate change increase the difficulty of carrying out their duties and may also force them to forego education and other income-generating activities. Women and girls become responsible for climate-change adaptation in the household, as they must find alternative sources of food, water and energy (Brody and others, 2008; UNDAW, 2008).

As Southern Africa becomes drier and water becomes scarcer, this means that women and girls have to cover longer distances to fetch the commodity, especially in rural areas. The opportunity cost of women and girls spending more time fetching scarce water in turn leads to reductions in household food security, as they are the main producers of food, again especially in the rural areas.

Women are the primary custodians of the natural resources used for domestic and household purposes. In the climate-change discourse, women are often portrayed as victims of climate change. They should rather be viewed as stakeholders. Rural women interact with the natural-resource base daily and hence have a vested interest in its sustainability. As a result of their domestic responsibilities and frequent engagement with natural resources, rural women have valuable knowledge and understanding of their environment. This knowledge should be employed in adaptation efforts and mitigation strategies, in order to increase the resilience of their communities and reduce their vulnerability to the effects of climate change.

Rural women in Southern Africa are often marginalized when it comes to decision-making and this can have adverse consequences for the efficacy and sustainability of climate-change strategies. Gender-sensitive consultations and participatory processes that identify and articulate the needs and challenges of communities will enhance the viability of rural climate-change interventions. To address these issues, SADC has suggested that gender perspectives should be mainstreamed into national policies and other measures on sustainable development and climate change through systematic gender analysis, establishing gender-sensitive indicators, benchmarking and developing practical tools to support increased attention to gender and climate change.

It is important to acknowledge the insights of women and men, children and the elderly in developing solutions to the effects of climate change in rural settings. Rural women may have already been

dealing with the impacts of climate change and may have practices and lessons to share. Also, in the deployment of climate-change interventions it is important to ensure that the access to them is equitable to both genders. Women should have access to mitigation technologies and the needs of women and girls should be reflected in budgets for mitigation and adaptation interventions. Given the right tools, women can become agents of change and help in adaptation and mitigation interventions to counter the effects of climate change.

5. Responding to climate-change effects on the SADC rural economy

SADC structures and the political leadership are increasingly paying attention to issues of climate change and environmental sustainability. The subregion has taken steps towards tackling the impact of climate change on its socioeconomic development through adhering to global initiatives on adaptation and mitigation, putting in place pertinent policy frameworks, and promoting activities and initiatives aimed at reinforcing resilience in rural livelihoods at local, national and subregional levels.

5.1 Country-level responses to climate change: initiatives and gaps

The impacts of climate change require improved governance, shared knowledge and good practices, an instilled culture of risk management, and resilience and behaviour change towards better use of global goods and natural resources within a green economic strategy (AU, AfDB and ECA, 2010).

SADC member States need to take a multi-pronged approach in devising policy interventions, taking into account their heterogeneity in terms of capacity, resilience and financial resources. Industrialized nations should assist SADC countries to cope with **climate-change** impacts and plan for a **climate**-constrained future, given the subregion's very low capacity to address the challenges (Reid and others, 2008; Stern, 2007).

All the SADC member States have adhered to and ratified the Kyoto Protocol,⁷ the UN Convention Combating Desertification and the CAADP⁸ as ways of reducing their vulnerability to climate change. Furthermore, LDCs and island States within SADC have developed NAPAs and submitted them to the UNFCCC, mostly between 2006 and 2008. NAPAs aim at building up countries' capacity to cope with climate shocks and pay special attention to vulnerable groups, such as farmers. The process consists of designing adaptation and response strategies that take into account the coping strategies and mechanisms of local communities in defining national adaptation strategies and programmes of action (Richards, 2008).

7 This is an international agreement which commits its parties and sets internationally-binding targets for reducing emissions. It is linked to the UNFCCC. It was adopted on 11 December 1997 and entered into force on 16 February 2005.

8 Policy interventions and other measures to consider in promoting rural transformation in Africa and its resilience to climate change should be based on the four pillars of the CAADP, which are: (1) to expand sustainable land and water resources management; 2) strengthen rural infrastructure and trade capacities for market access; 3) enhance food supply chains and responses to emergency food crises; and 4) promote agricultural research, technology dissemination and adoption.

The subregion has also embarked on implementing a number of adaptation strategies that include the enhancement of early-warning systems; shared basin management and agreements; water-use management strategies - especially demand management - in industry, settlements, and agriculture; and more intensive monitoring and research to understand and predict better the variability and change in precipitation.

However, it is important to note that these efforts are not yet fully implemented in most countries and that more work and support are still required. Climate-change predictability at the local level in rural areas is severely limited by a dearth of historical data on temperature and precipitation. Whatever strategies adopted by countries and other stakeholders for optimizing water usage, successful development of such strategies is contingent on reliable meteorological and hydrological information (Manase, 2010; McCarthy, 2001).

Nearly all countries in the subregion have either policy responses or early-warning systems and coping and risk-reduction mechanisms in place to deal with disasters and risks associated with climate change. For instance, Malawi has mainstreamed disaster-reduction for sustainable poverty reduction and Zimbabwe is in the process of developing a National Climate Change Policy to provide coordinated responsive action to climate disasters in the country. Zambia has established a Disaster Management and Mitigation Unit (DMMU) under the office of the Vice-President. In Mauritius, a National Disaster Management Centre (NDMC) was created in 2009 under the aegis of the Prime Minister's office.

The existing programmes for adaptation are generally limited to the water and agriculture sectors, leaving other key sectors under-represented, including tourism, coastal zones, health, infrastructure, energy, forests, biodiversity and ecosystems. National programmes should therefore take into account the cross-sectoral implications of climate change and enhance SADC's resilience through diversifying its rural economies.

While developing strategies for rural adaptation, countries need to ensure a shift in approach from reactive disaster management to preventive and multi-sectoral disaster risk reduction (DRR) initiatives. Some of the components of this innovative approach include focusing on vulnerability; proactivity; creating partnerships with stakeholders, especially with those at risk; risk management; understanding the causes of potential impacts; and applying responses to a broader context.

Most countries' capacity-building activities are limited to raising awareness, research and enhancing communities' capacity to adapt to climate change. There are very few national programmes - outside South Africa - that focus on activities to build institutional capacity, knowledge-management systems and participatory approaches to making decisions. There is very limited focus on finance and technology transfers, as supporting measures. Finance mechanisms that exist are generally based on

traditional sources of funds, including multilateral and bilateral funding, with very little emphasis on mobilizing funds from internal or national sources. In recent years, donor funding has increasingly become unpredictable and low in volumes, especially after the twin global financial and economic crises of 2007/8 coupled with the lingering effects of the eurozone debt crisis. There is therefore need for member States to be innovative by aggressively mobilizing domestic resources while treating external resources as being complementary.

The Kyoto Protocol's CDM allows industrialized countries to gain greenhouse gas emission reduction credits by investing in projects that reduce emissions in developing countries. By October 2008, only 1.4 per cent or 17 projects out of 1,186 global CDM projects were registered in Sub-Saharan Africa, and 14 of these 17 projects were located in South Africa (Bryan, 2008). Most SADC member States are finding it difficult to meet the conditions set out for participation. Project set-up costs are high, required research data is missing and most developing countries lack the technical training and support needed.

There is also need to leverage strategic partnerships with the private sector, non-state actors and the community to ensure ownership and sustainability of programmes on climate change and rural economy in the subregion and to strengthen their gender sensitivity. For instance, there are a number of civil society organizations (CSOs) which provide a wide range of interventions in adaptation, mitigation and supporting measures at the subregional and national levels.

These CSOs represent a rich continuum of divergent expertise and financial resources which could be harnessed through a structured framework in order to optimize the intended results and outcomes of interventions.

5.2 Subregional responses to climate change: initiatives and gaps

Climate change both reflects and transforms global and regional **development**. Asymmetries of responsibility, impact and capacity reflect historical and current **development** hierarchies. At the same time, the imperative to reduce greenhouse gas emissions perversely empowers high-emitting newly industrializing countries (Goodman, 2012)

Against this background, there are several initiatives that have been developed by RECs and the private sector with the support of international cooperating partners to respond to climate change in the subregion.

The SADC established the Drought Monitoring Centre (DMC) in 1990 as part of the initiative of African Governments and their cooperating partners to combat perennial calamities, arising out of the

recurrent extremes of climate variations. It was renamed Climate Services Centre (CSC) with the principal goal of contributing to the reduction of negative impacts of adverse weather and climate conditions such as droughts, floods and other extreme events on sustainable socio-economic development, and to the rational use, conservation and protection of national resources in the SADC subregion.”

There are four such centres covering the whole of Africa, with the SADC CSC being the only one in the subregion. These centres have contributed immensely to the mitigation of negative impacts of adverse climate to many countries over the years. According to the RISDP, the main target beneficiaries of DMCs include diverse end-users, who are expected to apply climate and hydro-meteorological information and products in the various weather-sensitive economic sectors such as agriculture, health, energy, water resource management, disaster management, transport... and others and specialized SADC institutions. Decision-makers and policy-makers in various government departments, the private sector and Non-Governmental Organizations (NGOs) are also expected to use the products and services to devise strategies for mitigating the impacts of climate extremes.

SADC established the SADC Climate Services Centre (CSC); formally Drought Monitoring Centre (DMC) in 1990 as part of the initiative of African Governments and the cooperating partners to combat perennial calamities arising out of the recurrent extremes of climate variations. The Southern Africa Science Service Centre for Climate Change and Adaptive Land Management (SASSCAL) has been recently launched as a joint initiative between Namibia, Angola, Botswana, South Africa and Zambia. Its aim is to support cross-border research and enhance regional scientific capacity in order to increase SADC countries’ ability to respond effectively to the challenges of climate change and land degradation that compromise the well-being of the region and its people, especially in rural areas.

The Southern African Development Community (SADC) has developed a Sub-Regional Action Programme to Combat Desertification, in line with the UNCCD (United Nations Convention to Combat Desertification). All of the countries in the subregion are party to the UNCCD, and Lesotho, Malawi, Swaziland, Tanzania and Zimbabwe have also produced National Action Plans first (UNDP, 2002).

At a broader level, the SADC, COMESA and EAC are jointly collaborating in a robust programme to support climate-change adaptation and mitigation. The programme includes work on policy, particularly in relation to developing climate-change financing channels, support to the development of national Conservation Agriculture Task Forces, support to the wider roll-out of Climate-Smart agriculture targeting more than a million households, strengthening vulnerability assessment and analyzing and strengthening research capacity and the evidence base in support of Climate-Smart agriculture.

The programme also provides support to African negotiators at different international forums, particularly the conference of parties (COP) of the UNFCCC. The SADC-COMESA-EAC initiative on climate

change is in harmony with the proposed subregional coordination mechanism (SRCM)⁹ for Eastern and Southern Africa. The SRCM aims to reduce fragmentation in UN operations and to increase coherence in the UN's work in supporting the programmes and priorities of RECs and inter-governmental organizations, among other issues.

If adopted, the SRCM will greatly assist the UN in reducing the transaction costs that are usually associated with a multiplicity of different but interrelated development programmes, including those on climate change.

To mitigate the detrimental impacts of climate change on the Southern African coastal areas, some scholars have called for more research to be undertaken to improve the understanding of what is happening to the coastline and what is likely to happen as climate change intensifies. There is a need to create regional databases to collect data and disseminate information on climate change and its impacts on the rural economy in Southern Africa. Different interventions on climate change and rural development should be based on community participation to ensure ownership and sustainability of programmes.

The subregion has developed very few programmes on climate-change mitigation compared to its multiple initiatives on adaptation. Existing mitigation programmes and activities focus mainly on the energy sector and activities related to REDD+. They are still limited in scope and geographic scale. Activities related to REDD+ include raising awareness on carbon-trading initiatives, building capacity, policy development and governance of carbon-trading projects. Only a few countries in the subregion are participating in the REDD+ programme, including DRC, Tanzania and Zambia.

Although some innovative mechanisms are being employed, particularly in securing private-sector funds and establishing market-based mechanisms, these activities are not prevalent in the subregion. Furthermore, other innovative mechanisms such as insurance and other risk management instruments are not being fully explored and technology transfer programmes are still under-represented (UNEP, 2010).

Building on the example of the UK's Overseas Development Institute (ODI), the subregion should improve the delivery of climate finance so that it serves the needs of poor people, maximise the opportunities and minimise the risks of low carbon growth, increase the effectiveness of adaptation and resilience policies and actions across scales and ensure natural resource management (forests, energy, food and water) balances development and climate goals while protecting the poor (ODI, 2013).

9 The SRCM has 11 areas of focus: regional integration, including market integration; infrastructure; climate change and natural resource management; gender and social development; land policies; agriculture and food security; knowledge management; industrial development; tourism development; ICT for development including cyber-security; disaster risk management; and science and technology.

The SADC Regional Early Warning System and the Famine Early Warning Systems are in place and provide data on the status of the food-security situation and weather trends in the subregion. However, the further development of these and other regional structures is being hampered by a number of factors, including: inadequate funding; lack of progress in the development of policies and strategies for regional co-operation in science and technology; shortages in scientific and technological resources; and very little co-operation in science and technology between countries (Richards, 2008).

In the medium- to long-term, the Southern African subregion will need to develop strategies to address the challenges arising from the climate-change impacts on the rural economy and strengthen its capacity towards a climate-resilient rural development path.

5.3 Long-term strategies for a climate-resilient rural economy in Southern Africa

Governments in the subregion have a critical role to play in mitigating the effects of climate change. National Governments are expected to provide legal, administrative and institutional frameworks that can facilitate efforts by different stakeholders to pool their resources and expertise to fight climate change. Member States are called upon to take steps to ensure that all their rural development policies and activities are “**climate-proofed**” and that they have strategies to deal with the likely effects of climate change and variability on different segments of their rural populations.

Adaptation to climate change has acquired importance on the international development agenda (Commission for Africa, 2005; OECD 2006; Stern 2007; UNFCCC 2007). Adaptations to climate change are already occurring through government and private actions. There is, however, a growing argument in the international debates on climate policy that adaptation is limited by the overdependence on externally financed investments by governments and aid agencies in adaptation strategies and projects (Klein and Möhner, 2009; Parry and others, 2009).

In the same context, an overarching concern is the need to build adaptive capacities and effective institutions at all sectors and levels as well as to brace existing institutions for the unprecedented challenges ahead. The role of government is to provide information, incentives and economic environment (Collier and others, 2008; Bauer and Scholz, 2010).

Adaptation will be impeded by Africa’s fragmentation into small countries and ethnic groups, and by poor business environments. On the mitigation side, there is a need to design emissions trading frameworks that support greater African participation than at present, and that include land-use change

5.3.1 Mainstreaming climate change into rural development policy

To address the new risks brought by climate change to its rural economy, Southern Africa needs to build long-term adaptation strategies for enhancing its resilience in the face of climate change and for ensuring that initiatives to address climate change reach all farmers, including the most poor and vulnerable.

While such measures might not be sufficient to reverse the impacts that climate change already has on agricultural productivity and rural incomes, the subregion needs to embark on diversifying its rural economy and not being too reliant on agriculture and other weather-sensitive sectors.

Governments should mainstream climate change into their rural development policies and strengthen national bodies that actively look at climate-change adaptation and mitigation and match policy with budget allocation. Efforts need to be enhanced that will help the subregion to access the existing funding facilities related to climate change.

Early-warning and response strategies for mitigating the impacts of climate variability need to be enhanced in the subregion. Monitoring, research and preparedness strategies need to be further strengthened (Chimhete, 1997).

5.3.2 Strengthening the triad “adaptation-education-mitigation”

Corrective activities related to climate-change effects on the rural economy in Southern Africa may be grouped into mitigation, adaptation, education and training initiatives.

Adaptation needs to be underpinned by surveillance for climate-related risks, including early adverse-weather alerts and disaster preparedness. Awareness should be raised through informing, educating and empowering the public at large, policymakers and all relevant stakeholders about the agricultural and rural development risks of climate change as well as about prevention strategies and how to identify appropriate adaptations, including by learning from similar experiences elsewhere.

Regarding mitigation, five African countries are responsible for most of Africa’s greenhouse gas emissions, with South Africa by far the greatest emitter, responsible for 39 per cent of the continental total and making greenhouse gas emissions in the SADC subregion relatively higher than in other regions of Africa. Investing now in adaptation and mitigation measures will be far less costly than in the future.

While information on the overall share of agricultural emissions by smallholders is not available, it is likely to be significant given their number, the amount of land covered and their prevalence on fragile landscapes. Smallholder farming is the main driver of forest loss in Southern Africa, largely as a result of the breakdown in traditional shifting cultivation systems and the lack of alternatives to agricultural

extensification. Between 1990 and 2000, Southern Africa accounted for about 31 per cent of the forest loss on the continent. Where soils are naturally poor, unsustainable practices in smallholder agriculture also often drive land degradation, with implications for emissions because of the reduced ground cover (IFAD, 2011b). It is critical to start slowing emission growth from the smallholder farming sector immediately.

Agriculture, along with forestry, can play a key role in tackling climate change through improving land management, farming practices and planting forests towards lowering greenhouse gas emissions. Poor rural people are therefore potentially important players in natural-resource management and carbon sequestration. Because agriculture, broadly defined, contributes as much as one-third of greenhouse gases, it must be part of this effort. The long-term goal should be carbon-negative agriculture and rural economy in the subregion.

Increased agricultural production and productivity is essential to meeting the growth in food demand and will, in turn, generate the income growth in rural areas needed to improve food security. Public spending on three categories of productivity-enhancing investments - biological research, expansion of rural roads, and irrigation expansion and efficiency improvements is needed to compensate for the productivity losses associated with climate change through 2050 (Nelson and others, 2010).

Regional integration and intraregional trade flows can partially offset the effects of climate change on local productivity, allowing places which have fewer negative effects to supply those places which suffer from more negative effects. Strengthening the regional dimension in addressing climate change will further allow the subregion to leverage on economies of scale, share information and prepare common responses to transboundary issues and threats.

5.3.3 Building on climate change and cultural values linkages

From an anthropological perspective, climate change is ultimately about culture, for in its wake, more and more of the intimate human-environment relations lose place. The consequences of ecosystem changes have implications for the use, protection, and management of wildlife, fisheries, and forests, affecting the customary uses of culturally and economically important species and resources (Crate and Nuttall, 2009).

Culture is important for understanding both mitigation and adaptation to climate change, and of course plays its part in framing climate change as a phenomenon of concern to society. Culture is embedded in the dominant modes of production, consumption, lifestyles and social organization that give rise to emissions of greenhouse gases (Adger and others, 2012). Journal name:

Ecosystems also have many consequences for human well-being through the cultural services they provide—through, for example, totemic species, sacred groves, trees, scenic landscapes, geological

formations, or rivers and lakes. These attributes and functions of ecosystems influence the aesthetic, recreational, educational, cultural, and spiritual aspects of human experience. Many changes to these ecosystems, through processes of disruption, contamination, depletion, and extinction, therefore have negative impacts on cultural life and human experience. Supporting services are essential for sustaining each of the other three ecosystem services.

Evidence suggests that processes of adaptation draw on natural, social, human, as well as financial capital (Lipton et al., 1996; Nel et al., 2001; Adger, 2003; Ostrom et al., 2007), with actions limited by the scarcest of these assets. Therefore, the process of adaptation involves issues of governance and legitimacy of actions across different scales (Osbahr and others, 2010).

Cultural factors shape how people support adaptation interventions, and their motivation to respond to them. Individuals with a strong attachment to community are reluctant to leave behind their social and emotional support groups and adapt to a new community. Attachment to a place may be closely linked to a sense of belonging to a community and inspire citizens to develop or participate in climate adaptation planning processes (Adger and others, 2012). Journal name:

There is emerging evidence that current policies, at least for specific cases, partly by overlooking cultural dimensions, lead to maladaptive outcomes. If the cultural dimensions of climate change continue to be ignored, it is likely that both adaptation and mitigation responses will fail to be effective because they simply do not connect with what matters to individuals and communities.

Indigenous peoples, for example, are unlikely to benefit from REDD if their identities and rights are not recognized and if they do not have secure rights to their lands, territories, and resources. Experience from community-based natural resource management initiatives has shown that the involvement of local people, including indigenous peoples, in participatory monitoring of natural resources can provide accurate, cost-effective, and locally anchored information on forest biomass and natural resource trends (World Bank, 2010).

Despite the impact of climate change on indigenous peoples and their traditional knowledge, international experts and policy makers most often overlook the rights of indigenous peoples as well as the potentially invaluable contributions from indigenous peoples' traditional knowledge, innovations, and practices in the global search for climate change solutions (Crate and Nuttall, 2009).

There is therefore a need to document traditional knowledge of the environment so that it could be used and incorporated into environmental assessments and climate policies. Such knowledge should be communicated to scientists for its inclusion as an integral part of the decision-making process. The climate change knowledge management system should emphasize the active participation of indigenous communities through a community based and community driven process.

In line with the Anchorage Declaration of Indigenous Peoples, all initiatives on mainstreaming climate change into rural development policies and all initiatives under Reducing Emissions from Deforestation and Degradation (REDD) should secure the recognition and implementation of the rights of Indigenous Peoples, including security of land tenure, ownership, recognition of land title according to traditional ways, uses and customary laws and the multiple benefits of forests for climate, ecosystems, and Peoples before taking any action. (Indigenous Peoples Global Summit on Climate Change, 2009):

Conclusion

This paper on “Climate Change and the Rural Economy in Southern Africa: Issues, Challenges and Opportunities” was prepared in order to review the global warming impacts on rural development and discuss strategies aimed at strengthening climate-change mitigation and adaptation initiatives in the subregion.

Evidence indicates that Southern African economies are particularly sensitive to the direct impacts of climate change, given their often-heavy dependence on agriculture and ecosystems and because of their high poverty levels and geographic exposure. Agriculture, in particular rain-fed farming by smallholders, is the backbone of the SADC rural economy. The sector offers good opportunities for spurring growth, overcoming poverty, enhancing food security and stimulating growth in other parts of the economy.

The SADC subregion experiences large inter-annual rainfall variability with respect to quantity and seasonal distribution. A trend of increasing temperature has been confirmed in different parts of the SADC subregion. It is already affecting precipitation patterns and the length of the growing season. Climate variability and extreme events are expected to increase, affecting the agricultural systems, which are predominantly rain-fed.

The SADC subregion’s rural populations are especially vulnerable to the impacts of climate change and variability, given that their economic activities and key livelihoods are largely dependent on climate-sensitive sectors such as rain-fed agriculture and natural resources and considering the importance of coastal areas.

Climate change will have negative impacts on crop productivity and production, thereby affecting the overall rural economy and even leading to a macroeconomic vulnerability in countries such as Malawi that are highly dependent on agriculture.

The poor performance of the agricultural sector has already transformed rural areas of SADC into zones of deep poverty. Its economic activities are very reliant on ecosystems and weather and this highlights its high vulnerability to climate change. Climate change will negatively impact farmers’ productivity and incomes, and the subregion’s food security. Other sectors affected would include fisheries, forestry, tourism and ecosystems, water resources and health. Crisis could result in the rural economy if steps are not taken to mitigate the risks.

The green economy offers an opportunity for Southern Africa to make significant strides towards building its rural economy in a manner that is pro-poor, socially-inclusive and driven by natural resources, while focusing on a rural development path that is diversified, low-carbon and does not create much pollution. Activities to correct the adverse effects of climate change on the rural economy in the subregion need to focus on mitigation, adaptation, education and training initiatives. Agriculture, broadly defined, contributes as much as one-third of greenhouse gas emissions and, as such, it must be part of the mitigation effort. The long-term goal should be to build a carbon-negative agriculture and rural economy in the subregion.

When they are building rural economic and social resilience, it would be prudent for member States to enhance their rural economic diversification in order to reduce dependence on climate-sensitive sectors. This will include using indigenous knowledge and practices and strengthening community organizations. These interventions should be built on a strong gender dimension, taking in account the strategic role of women in agriculture, food security and safeguarding natural resources.

SADC structures and the political leadership of countries are increasingly paying attention to issues of climate change and environment sustainability. The subregion has taken steps towards tackling the impact of climate change on its socioeconomic development. These steps include adhering to global initiatives on adaptation and mitigation, putting in place pertinent policy frameworks and promoting programmes and initiatives aimed at reinforcing the resilience of rural livelihoods at local, national and subregional levels.

It is important to continue mainstreaming climate change into rural-development policies and strengthening national bodies that actively look at climate-change adaptation and mitigation and match policy with budget allocation. It is necessary to put measures in place to ensure that the subregion has sufficient access to existing funding facilities related to climate change.

One of the most important ways to help rural poor people adapt to climate change is to address rural poverty. Policy actions will help increase poor people's resilience to climate change if they: achieve broad-based economic growth that reaches the poor; improve productivity in crops that are important to poor farmers and consumers; and strengthen trade to cope with subregional disparities in the agricultural effects of climate change.

References

Adger, W. N. (2003). Social capital, collective action and adaptation to climate change. *Economic Geography* 79(4):387-404.

Adger, W. N. and others (2012). Cultural dimensions of climate change impacts and adaptation, in *Nature Climate Change Review* (online). USA: Nature.com, part of Macmillan Publishers Inc. Available through: http://www.nature.com/nclimate/journal/v3/n2/full/nclimate1666.html?WT.ec_id=NCLIMATE-201302

Africa, Climate Change, Environment and Security (ACCES, 2010). *Climate Change and Security in Africa, Vulnerability Discussion Paper*, published by members of the Africa, Climate Change, Environment and Security (ACCES) Dialogue Process. Brussels, Belgium: ACCES. Available at: http://www.envirosecurity.org/acces/docs/ACCES_2010_Vulnerability_Report.pdf.

African Development Bank (2012). Africa at COP 18/CMP8, Doha, Qatar, 26 November-7 December 2012, also see *Adapting agriculture to promote food security in Africa among African Development Bank 2011 papers for COP 17 in Durban, South Africa, November-December 2011*. Tunis, Tunisia: African Development Bank. Available at: <http://www.afdb.org/en/cop/programme/adapting-agriculture-to-promote-food-security-in-africa/>.

African Union (2008). *Sharm El Sheikh Commitments for Accelerating the Achievement of Water and Sanitation Goals in Africa*. Decisions, Declarations, Tribute and Resolution of the 11th Ordinary Session of the Assembly of the African Union, 30 June-1 July. Available at http://www.dwaf.gov.za/dir_ws/2aww/docs/Sharm_El-Sheikh_Decisions_English%5B1%5D.pdf.

African Union, African Development Bank and Economic Commission for Africa (2010). *Acting on Climate Change for Sustainable Development in Africa*. Climate Change and Human Development, Seventh African Development Forum. Addis Ababa, Ethiopia. *Issues Paper #3* is available at <http://www1.uneca.org/Portals/adfvii/documents/IssuePaper3CC-HD.pdf>. The report of the full proceedings is available at <http://www1.uneca.org/Portals/adfvii/documents/ADF-VII-Full-Report.pdf>.

African Union New Partnership for Africa's Development (2003). Comprehensive Africa Agriculture Development Programme (CAADP). Midrand, South Africa: New Partnership for Africa's Development (NEPAD). See also the website <http://www.nepad-caadp.net/>.

Alcamo, Joseph, and others (2003). Ecosystems and human well-being: a framework for assessment /Millennium Ecosystem Assessment. World Resources Institute. Washington DC, USA: Island Press.

Angula, Margaret (2010). Gender and Climate Change: Namibia Case Study. Cape Town, South Africa: Heinrich Boll Foundation Southern Africa. Available at <http://www.za.boell.org/downloads/Namibia.pdf>.

Asenso-Okyere, Kwadwo, and others (2011). Addressing the Links among Agriculture, Malaria, and Development in Africa, Leveraging Agriculture for Improving Nutrition and Health, IFPRI 2020 Conference Brief Number 16. Washington DC, USA: International Food Policy Research Institute. Available at: <http://www.ifpri.org/sites/default/files/publications/2020anhconfbr16.pdf> (accessed 20 May 2013)

Bates, B.C. and others, (Eds.) (2008). Climate Change and Water. Technical

Paper of the Intergovernmental Panel on Climate Change. Geneva, Switzerland: IPCC Secretariat.

Bäthge, Sandra (2010). Climate change and gender: economic empowerment of women through climate change mitigation and adaptation, Working Paper. Eschborn, Germany: Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ). Available at <http://www.oecd.org/social/gender-development/46975138.pdf>

Bauer, Steffen, and Imme Scholz (2010). "Adaptation to climate change in Southern Africa: New boundaries for sustainable development?" Bonn, Germany: German Development Institute (DIE). Available at [http://www.die-gdi.de/CMS-Homepage/openwebcms3_e.nsf/%28ynDK_content-ByKey%29/ANES-854G6G/\\$FILE/Bauer%20Scholz%202010_Editorial_Adaptation_Southern%20Africa_03%20CD10-040.pdf](http://www.die-gdi.de/CMS-Homepage/openwebcms3_e.nsf/%28ynDK_content-ByKey%29/ANES-854G6G/$FILE/Bauer%20Scholz%202010_Editorial_Adaptation_Southern%20Africa_03%20CD10-040.pdf)

Benson, Charlotte, and Edward Clay (1994). The Impact of Drought on Sub-Saharan African Economies. IDS Bulletin Vol. 25 Issue 4; pp 24-32 (October). Brighton, UK: Institute of Development Studies. Available through <http://onlinelibrary.wiley.com/doi/10.1111/j.1759-5436.1994.mp25004004.x/abstract>.

Brody, Alyson, J. Demetriades, and E. Espen (2008). *Gender and Climate Change: Mapping the Linkages*. Brighton, UK: BRIDGE, Institute of Development Studies (IDS), University of Sussex. Available at http://www.bridge.ids.ac.uk/reports/Climate_Change_DFID.pdf.

Bryan Elizabeth and others (2008). *Global Carbon Markets, Are There Opportunities for Sub-Saharan Africa?* IFPRI Discussion Paper 00832. (December). Washington DC, USA, International Food Policy Research Unit. Available at <http://www.ifpri.org/sites/default/files/publications/ifpridp00832.pdf>.

Bryceson, D., J. Fonseca and J. Kadzandira (2004). *Social Pathways from the HIV/AIDS Deadlock of Disease, Denial and Desperation in Rural Malawi*. Lilongwe, Malawi, CARE Malawi and RENEWAL (Regional Network on HIV/AIDS, Livelihoods and Food Security).

Buckland, R. G. Eele and R. Mugwara (2000). *Humanitarian crisis and natural disasters: A SADC perspective* in E. Clay & O. Stokke, (Eds). *Food aid and human security*. European Association of Development Research. London, UK: Frank Cass Publishers, now an imprint of Taylor & Francis.

Calliham, D.M., , J.H. Eriksen and A.B. Herrick (1994). *Famine Averted: The United*

States Government Response to the 1991/92 Southern Africa Drought: Evaluation Synthesis Report. Washington DC, USA: Management Systems International.

Chandran, K.P. Vipin, and P. Sandhya (2011). *Linkages between Climate Change and Human Health: Need for Action*, *Economic Affairs*, Vol 56, 1 (March). New Delhi, India: New Delhi Publishers. See <http://www.ndpublisher.in>. Available through http://www.indianjournals.com/ijor.aspx?target=ijor:ea_j&volume=56&issue=1&article=010.

Chilonda, Pius, and I.J.Minde (2007). *Agricultural growth trends in Southern Africa*, Policy Brief No 1, May 2007. Pretoria, South Africa: Regional Strategic Analysis and Knowledge Support System for Southern Africa (ReSAKSS-SA).

Chimhete, C. (1997). *Southern Africa Prepares For El Nino-Induced Drought*. Harare, Zimbabwe: Southern African Research & Documentation Centre

Chisakwe, Nyasha E. (2010). *Southern Africa Sub-Regional Framework on Climate Change Programmes Report, First Draft (Working Document)*, African Ministerial Conference on Environment. Nairobi, Kenya: UNEP and SADC. Available at http://www.unep.org/roa/amcen/docs/AMCEN_Events/climate-change/southAfrica/SADC_Report.pdf.

Collier Paul, Gordon Conway and Anthony Venables (2008). *Climate Change and Africa*, published in *Oxford Review of Economic Policy*, Vol. 24, Issue 2, pp 337-53, Oxford, UK. Available at <http://users.ox.ac.uk/~econpco/research/pdfs/ClimateChangeandAfrica.pdf>.

Commission for Africa (2005). *Our common interest: the report of the Africa Commission*. London, UK. Commission for Africa.

Shackleton, Charlie, and others (2008). *Links between Ecosystem Services and Poverty Alleviation: Situation analysis for arid and semi-arid lands in southern Africa*. Submitted to: *Ecosystem Services and Poverty Reduction Research Programme: DFID, NERC, ESRC, January 2008*, London, UK: Consortium on Ecosystems and Poverty in Sub-Saharan Africa (CEPSA). Available at <http://www.unpei.org/PDF/preliminaryassessments/Links-Ecosystem-Services-and-Poverty-Alleviation.pdf>

Crate, Susan A., and Mark Nuttall (Eds) (2009). *Anthropology and Climate Change: From Encounters to Actions*. Walnut Creek California, USA: Left Coast Press. Available through <http://www.lcoastpress.com/book.php?id=163>.

Daily, Gretchen C (1997). *Nature's Services: societal dependence on natural ecosystems*. Washington DC, USA: Island Press.

Dercon, S. (2002). *Income Risks, Coping Strategies, and Safety Nets*, *World Bank Research Observer*. 17 (2), pp. 141-66. Oxford, UK: Oxford Journals, Oxford University Press.

Dietz A.Z., R. Ruben and A Verhagen (Eds.) (2004). *The Impact of Climate Change on Drylands: With a Focus on West-Africa*, Series Environment and Policy No 39. Dordrecht, Netherlands: Kluwer Academic Publishers.

Dube O.P. and M.J. Chimbari (2009). *Documentation of Research on Climate Change and Human Health in Southern Africa*. Copenhagen: Denmark: DBL—Centre for Health Research and Development, Faculty of Life Sciences, University of Copenhagen, University of Botswana and ENRECA Health.

Economic Commission for Africa (2005). *Subregional Strategies for Preventing and Managing Disaster-related Food Crisis, Comprehensive Long-term Drought Impact-reduction Strategy*. Position Paper. Addis Ababa, Ethiopia: ECA-Sustainable Development Division.

_____ Africa (2009). *African Women's Report*. Addis Ababa, Ethiopia: ECA.

_____ (2011a). International Migration and Development in Africa: The Migration and Climate Nexus. Addis Ababa, Ethiopia: ECA.

_____ (2011b). The African Social Development Review 2011. Addis Ababa, Ethiopia: ECA. Available at <http://uneca.africa-devnet.org/content/african-social-development-review-2011>.

EM-DAT (n.d.). The International Disaster Database from the Centre for Research on the Epidemiology of Disasters (CRED). Brussels, Belgium: School of Public Health, Université catholique de Louvain. Available at <http://www.emdat.be>.

Fischer, G., and others (2001). Global Agro-ecological Assessment for Agriculture in the 21st Century. Laxenburg, Austria: International Institute for Applied Systems Analysis

Fuhrer, J. (2003). Agroecosystem responses to combinations of elevated CO₂, ozone, and global climate change. *Agriculture, Ecosystems and Environment*. 97, 1–20. Amsterdam, Netherlands: Elsevier.

Food and Agriculture Organization (2001). 17 Countries Are Facing Exceptional Food Emergencies in Sub-Saharan Africa - FAO Concerned About Deteriorating Food Situation in Sudan, Somalia and Zimbabwe. Press Release 01/48. Rome, Italy.

Food and Agriculture Organization (2003). Food Security and HIV/AIDS: An Update Paper prepared for the 29th session of the Committee on World Food Security. Rome, Italy.

_____ (2004): Drought impact mitigation and prevention in the Limpopo River Basin. A Land and Water Discussion paper published by FAO and available at <http://www.fao.org/docrep/008/y5744e/y5744e04.htm>.

_____ (2005). State of the World's Forests 2005. Rome, Italy. Available at

<ftp://ftp.fao.org/docrep/fao/007/y5574e/y5574e00.pdf>.

_____ (2006). The State of Food Insecurity in the World, 2006. Eradicating world hunger – taking stock ten years after the World Food Summit. Rome, Italy. Available at <ftp://ftp.fao.org/docrep/fao/009/a0750e/a0750e00.pdf>.

_____ (2007). The State of Food and Agriculture, 2007: Paying farmers for environmental services. FAO Agricultural Series No 38. Rome, Italy. Available at <ftp://ftp.fao.org/docrep/fao/010/a1200e/a1200e00.pdf>.

_____ (2010). The FAOSTAT database of 2010 is not still available online, but there is a map showing progress in achieving the MDG 1 Hunger Target available at: http://www.fao.org/fileadmin/templates/es/Hunger_Portal/MDG_Progress_Map.pdf, (accessed on 20 May 2013).

_____ (2011). *The State of Food and Agriculture, Women in Agriculture*. Rome, Italy.

Forum for Food Security in Southern Africa (2004). *Achieving Food Security in Southern Africa: Policy Issues and Options*, FFSA Synthesis Paper. London, UK. Available at www.odi.org.uk/food-security-forum

Githeko and others (2000). Climate change and vector-borne diseases: a regional analysis. *Bulletin of the World Health Organization*, 2000, 78(9).

Goodman, James (2012). Climate change and global development: towards a post-Kyoto paradigm? In *Economic and Labour Relations Review*. Vol 23, Issue 1 (February). Sydney, Australia: Centre for Applied Economic Research and the Industrial Relations Research Centre at the University of New South Wales.

Government of Namibia (2002). *Namibia Initial National Communication to the United Nations Framework Convention on Climate Change*.

Haldén, P. (2007). *The Geopolitics of Climate Change: Challenges to the International System*, FOI. Stockholm, Sweden: Swedish Defence Research Agency.

Hess, U., K. Richter and A. Stoppa (2003). *Weather Risk Management for Agriculture and Agri-Business in Developing Countries*, in *Climate Risk and the Weather Market: Financial Risk Management with Weather Hedges*, ed. R. Dischel. London, UK: Risk Books.

Hodges R.J., J.C Busby and B. Bennett (2010). Postharvest losses and waste in developed and less developed countries: opportunities to improve resource use. Published online 19 November 2010. *Journal of Agricultural Science* (2011), 149, 37–45. Cambridge, UK: Cambridge University Press. Available at <http://ucce.ucdavis.edu/files/datastore/234-2203.pdf>.

Hulme, Mike, and others (2001). African climate change: 1900-2100. *Climate Research* 17(2): pp145-168 (15 August). Available at http://web.fi.ibimet.cnr.it/papnia-sen/data/files/Hulme_africa%20climate%20change.pdf.

Indigenous Peoples Global Summit on Climate Change (2009). The Anchorage Declaration, 24 April. Available at http://www.redd-monitor.org/wordpress/wp-content/uploads/2009/04/apr28_09_ipg-scc_anchorage.pdf.

Ingram, J.S.I., P.J. Gregory and A.M. Izac (2008). The role of agronomic research in climate change and food security policy, *www.sciencedirect.com, Agriculture, Ecosystems and Environment*, 126(1):4-12 (March).

International Association for Impact Assessment (2010). Impact Assessment Wiki, website modified by Anne Hardon (10 August). Fargo, North Dakota, USA. Available at <http://www.iaia.org/iaia/wiki/biodiv.ashx>.

Intergovernmental Panel on Climate Change (2001). Third Assessment Report: Climate Change 2001. Geneva, Switzerland.

International Fund for Agricultural Development (2011a). Addressing Climate Change in East and Southern Africa. Rome, Italy. Available at <http://www.ifad.org/operations/projects/regions/pf/pub/climate.pdf>.

_____ (2011b). Climate-smart smallholder agriculture: What's different?, IFAD Occasional Paper No. 3. Rome, Italy. Available at <http://www.ifad.org/pub/op/3.pdf>

James G. (2012). Climate Change and Global Development: Towards a Post-Kyoto Paradigm? *Economic and Labour Relations Review*, Vol.23, Issue 1, pp 107-24.

Jones, P.G., and P.K. Thornton (2003). The potential impacts of climate change on maize production in Africa and Latin America in 2055. *Global Environmental Change Human and Policy Directions*, 13, 51–59. Amsterdam, Netherlands: Elsevier.

Kandji, Serigne Tacko, Louis Verchot and Jens Mackensen (2006). Climate Change Climate and Variability in Southern Africa: Impacts and Adaptation in the Agricultural Sector. Nairobi, Kenya, UNEP and World Agroforestry Centre (ICRAF), available at http://www.unep.org/themes/freshwater/documents/climate_change_and_variability_in_the_southern_africa.pdf.

Keith, David, and others (2008). Predicting extinction risks under climate change: coupling stochastic population models with dynamic bioclimatic habitat models. *Biology Letters* 4(5): 560–563, (23 October). Available at <http://rsbl.royalsocietypublishing.org/content/4/5/560.full.pdf+html?sid=ad88f2d3-ddc0-4bed-808d-22b8d4f7f589>

Kigotho, Wachira (2005). Decades of drought predicted for southern Africa, published on SciDev. Net – the Science and Development Network, available at <http://www.scidev.net/en/news/decades-of-drought-predicted-for-southern-africa.html> (accessed 20 May 2013)

Klein, R. J. T., and A. Möhner. (2009). Governance limits to effective global financial support for adaptation. Pages 465-475 in W. N. Adger, I. Lorenzoni, and K. O'Brien, editors, *Adapting to climate change: thresholds, values, governance*. Cambridge, UK: Cambridge University Press.

Kurukulasuriya, Pradeep R., and others (2006). Will Africa survive climate change? *World Bank Economic Review*, 20 (3): 367-388. Oxford, UK: Oxford Journals, Oxford University Press.

Leichenko, R.M., and K.L. O'Brien (2002). The dynamics of rural vulnerability to global change: the case of Southern Africa, *Mitigation and Adaptation Strategies for Global Change* 7: 1–18. Dordrecht, Netherlands: Kluwer Academic Publishers.

Lipton, M., F. Ellis, and M. Lipton, editors (1996). *Land, labour and livelihoods in rural South Africa. Vol 2: KwaZulu-Natal and Northern Province*. Durban, South Africa: Indicator Press.

Maclean, John and others (2008). *Public Finance Mechanisms to Mobilise Investment in Climate Change Mitigation, Advance Draft*. Nairobi, Kenya: United Nations Environment Programme. Available at http://sefi.unep.org/fileadmin/media/sefi/docs/UNEP_Public_Finance_Report.pdf

Magadza, C.H.D. (2000). Climate change impacts and human settlements in Africa: prospects for adaptation. *Environmental Monitoring and Assessment*, Vol. 61, Issue 1, pp193-205. Berlin, Germany: Springer. Available through <http://link.springer.com/article/10.1023%2FA%3A1006355210516#page-1>.

Makarau, A. (1992). *National Drought and Desertification Policies: The Zimbabwe Situation*. SADC Regional Workshop on Climate Change, 1992. Windhoek, Namibia.

Manase, Gift (2010). *Documentation of Research on Climate Change and Water Resources in Southern Africa, Water and Sanitation for Development*. Pretoria, South Africa: Council for Scientific and Industrial Research.

McCarthy, James J. (2001). *Climate Change 2001: Impacts, Adaptation, and Vulnerability: Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK: Cambridge University Press.

Midgley, G.F., and Wilfried Thuiller (2010). Potential responses of terrestrial biodiversity in Southern Africa to anthropogenic climate change, *Regional Environmental Change*. Available at <http://www.will.chez-alice.fr/pdf/Midgley2010REC.pdf>

Müller, Tanja. (2005). HIV/AIDS and Human Development in SSA: Impact Mitigation through Agricultural Interventions, an Overview and Annotated Bibliography, *African Women Leaders in Agriculture and the Environment*, Series No 3. Wageningen, Netherlands: Wageningen Academic Publishers.

Mutembwa, Ammon, (1998). *Water and the Potential for Resource Conflicts in Southern Africa*, University of Cambridge, Global Security Fellows Initiative, Occasional Paper No. 3. Cambridge, UK.

National Center for Atmospheric Research (2005). A continent split by climate change: New study projects drought in southern Africa, rain in Sahel. National Center for Atmospheric Research Press Release, May 24. Boulder, Colorado, USA.

Nel, E., T. Binns, and N. Motteux (2001). Community-based development, non-governmental organisations and social capital in post-apartheid South Africa. *Geografiska Annaler* 83B(1):3-13.

Nelson, Gerald C, and others (2010). *Food Security and Climate Change. Challenges to 2050 and Beyond*. IFPRI Issue Brief 66, December. Washington DC, USA: International Food Policy Research Institute.

Nyong, Anthony (2005). Key vulnerabilities to climate change in Africa. Presentation 21-22 October to Global Warming: Looking beyond Kyoto, Yale Centre for the Study of Globalization. Yale, USA. Available at http://www.ycsg.yale.edu/climate/forms/Nyong_Yale.pdf

Olubode-Awosola, Femi, and others (2008). Indicators for Monitoring and Evaluation of Agricultural Performance and Shared Goals in Southern Africa, Working Paper No.24, December, 2008. Pretoria, South Africa: Regional Strategic Analysis and Knowledge Support System in Southern Africa (ReSAKSS-SA). Available at http://pdf.usaid.gov/pdf_docs/PNADS626.pdf

Open Society Initiative for Southern Africa (2012). Promoting a pro-poor, socially-inclusive and natural resources-driven green economy in Africa. A policy roundtable on Prospects and challenges for an inclusive and pro-poor natural resources-driven green economy in Africa, on 1 June 2012. Johannesburg, South Africa. Convened by OneWorld Sustainable Investments in partnership with the Open Society Initiative for Southern Africa (OSISA) and Heinrich Böll Foundation. Available at http://www.osisa.org/sites/default/files/green_economy_policy_roundtable_review.pdf

Organisation for Economic Co-operation and Development (2006). Putting climate change adaptation in the development mainstream. Policy Briefing. Paris, France: OECD.

Osbaahr, Henny, and others (2010). Evaluating successful livelihood adaptation to climate variability and change in southern Africa. *Ecology and Society* 15(2): 27., URL: <http://www.ecologyandsociety.org/vol15/iss2/art27/>

Ostrom, E., M. A. Janssen, and J. M. Andries (2007). Going beyond panaceas. *Proceedings of the National Academy of Sciences*. 104(39):15176-15178.

Overseas Development Institute (2013). The website <http://www.odi.org.uk/programmes/climate-environment/about>, accessed 26 May 2013. London, UK.

Parry, M., and others (2004). Effects of climate change on global food production under SRES emissions and socio-economic scenarios. *Global Environmental Change Human and Policy Directions*. 14, 53–67. Amsterdam, Netherlands: Elsevier.

_____ (2009). Assessing the costs of adaptation to climate change: a critique of the UNFCCC estimates. London, UK: International Institute for Environment and Development and Grantham Institute for Climate Change.

Ragab, R., and C. Prudhomme (2002). Climate Change and Water Resources Management in Arid and Semi-arid Regions: Prospective and Challenges for the 21st century. *Biosystems Engineering* 81: 3-34. Amsterdam, Netherlands: Elsevier.

Reid, Hannah, and others (2008). Climate Change Impacts on Namibia's Natural Resources and Economy, *Climate Policy*, Vol.8, Issue 5, pp 452-66,. Abingdon, UK: Earthscan.

Rosegrant, M.W. and S.A. Cline (2003). Global food security: challenges and policy. *Science* 302, 1917–1919.

Simms, Andrew, and John Magrath (2006). Africa – up in Smoke? 2: An update report on Africa and global warming from the working group on climate change and development. UK: The New Economics Foundation and Oxfam GB. Available at. <http://policy-practice.oxfam.org.uk/publications/africa-up-in-smoke-2-an-update-report-on-africa-and-global-warming-from-the-wor-121077>.

Pan African Climate Justice Alliance (2009). The Economic Cost of Climate Change in Africa. Available at <http://www.christianaid.org.uk/images/economic-cost-of-climate-change-in-africa.pdf>.

Richards, Robin. (2008). Assessing progress on climate change policy and practice: Observations from South Africa and SADC. Policy: Issues & Actors, Vol 21 no 1 (October). Johannesburg, South Africa: Centre for Policy Studies. Available at http://www.cps.org.za/cps%20pdf/pia21_1.pdf.

Richards, Michael (2003). Poverty Reduction, Equity and Climate Change: Global Governance Synergies or Contradictions? London, UK: Overseas Development Institute, Globalization and Poverty Programme. Available at <http://www.odi.org.uk/sites/odi.org.uk/files/odi-assets/publications-opinion-files/2408.pdf>

Nelson, Gerald, and others (2010). Food security and climate change. Challenges to 2050 and beyond. IFPRI Issue Brief 66, (December). Washington DC, USA: International Food Policy Research Institute. Available at <http://www.ifpri.org/sites/default/files/publications/ib66.pdf>

Southern African Confederation of Agricultural Unions (2012). Connecting farmers to agribusiness, SACAU News. January-March 2012. Available at http://www.sacau.org/hosting/sacau/SacauWeb.nsf/SACAU%20NL%20_JanMar2012%20Issue.pdf

Southern African Development Community (2005). Regional Water Policy. Gaborone, Botswana: Southern African Development Community. Available at <http://www.sadc.int/documents-publications/show/823>.

_____ (2008a). International Conference on Poverty and Development, Regional Economic Integration: A Strategy for Poverty Eradication towards Sustainable Development. Economic Impact of Three Communicable Diseases HIV and AIDS, TB and Malaria on the SADC Region, 18-20 April 2008, Pailles, Mauritius. Gaborone, Botswana: Southern African Development Community.

_____ (2008b). The Southern Africa Regional Conference on Agriculture, Agriculture-led Development for Southern Africa: Strategic Investment Priorities for Halving Hunger and Poverty by 2015, 8-9 December 2008. Gaborone, Botswana: Regional Strategic Analysis and Knowledge Support System (ReSAKSS-SA) Subregional Office, International Water Management Institute (IWMI)-Southern Africa.

_____ (2011). Climate Change Adaptation in SADC. A Strategy for the Water Sector (November). Gaborone, Botswana. Available at http://www.sadc.int/files/2213/5293/3544/SADC_Climate_Change_Adaptation_for_the_Water_Sector_booklet.pdf.

_____ (2012). Regional Infrastructure Development Master Plan. Meteorology Sector Plan. (August). Gaborone, Botswana. Available at <http://www.sadc-dfrc.org/assets/files/documents/meteorology.pdf>

_____ (undated). Gender and Climate Change in SADC. Gaborone, Botswana: Southern African Development Community, Gender Unit. Available at http://www.sadc.int/REDD/index.php/download_file/95/.

Southern African Development Community and United Nations Environment Programme (2010). Southern Africa Subregional Framework on Climate Change Programmes Report, 2010. Gaborone, Botswana: Southern African Development Community.

Shah, Sachin D., S.W. Williams and S. Yang (2011). Vulnerability to Climate Change: Water Resource Stress and Food Insecurity in Southern Africa, Student Working Paper No. 1, Climate Change and African Political Stability (CCAPS). Austin, USA: Robert S Strauss Center for International Security and Law, Lyndon B Johnson School of Public Affairs, The University of Texas at Austin.

Skees, J.R., P. Hazell and M. Miranda (1999). New Approaches to Crop Insurance in Developing Countries, EPTD Discussion Paper No. 55. Washington DC, USA: International Food Policy Research Institute.

Stern, N, (2006). The Stern Review Report on the Economics of Climate Change. Cambridge, UK: Cambridge University Press. Available through http://webarchive.nationalarchives.gov.uk/+http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm.

Stige, L.C., and others (2006). The effect of climate variation on agro-pastoral production in Africa. Proceedings of the National Academy of Science. 103, 3049–3053. Washington DC, USA.

Sutherst and others (2007). Pests under global change—meeting your future landlords? In: Candell, J.G. (Ed.), Terrestrial Ecosystems in a Changing World, p. 336. Berlin, Germany: Springer. Available through <http://www.springer.com/earth+sciences+and+geography/earth+system+sciences/book/978-3-540-32729-5>.

Theron A.K. and M. Rossouw (2008). Analysis of potential coastal zone climate change impacts and possible response options in the Southern Africa region. Science real and relevant: 2nd CSIR Biennial Conference. (17/18 November), pp 10. Pretoria, South Africa, Council for Scientific and Industrial Research. Available through <http://researchspace.csir.co.za/dspace/handle/10204/2561>

Thuiller, Wilfried and others (2006). Vulnerability of African mammals to anthropogenic climate change under conservative land transformation assumptions. Global Change Biology Vol 12, Issue 3, pp 424-440. Available through <http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2486.2006.01115.x/abstract>

Tyson, P. and others, eds. (2002). *Global-Regional Linkages in the Earth System*. Berlin, Germany: Springer.

United Nations Division for the Advance of Women (2008). *Rural Women in a Changing World: Opportunities and Challenges*. New York, USA: UNDAW, Department of Economic and Social Affairs, United Nations Secretariat.

United Nations Development Programme (2005). *Reversing HIV/IDS in Malawi, Malawi Human Development Report*. Lilongwe, Malawi: UNDP.

_____ (2007). *Fighting Climate Change: Human Solidarity in a Divided World, Human Development Report 2007/8*. New York, USA: UNDP. Available at <http://hdr.undp.org/en/reports/global/hdr2007-2008/>.

United Nations Environment Programme (2002). *Africa Environment Outlook. Past, present and future perspectives*. Nairobi, Kenya: UNEP and African Ministerial Conference on the Environment (AMCEN). Available at <http://www.unep.org/dewa/Africa/publications/AEO-1/>.

_____ (2006). *Africa Environment Outlook 2 Our environment, our wealth*. Nairobi, Kenya: UNEP and African Ministerial Conference on the Environment (AMCEN). Available at http://www.unep.org/dewa/africa/docs/en/AEO2_Our_Environ_Our_Wealth.pdf.

United Nations Environment Programme and GRID-Arendal (2008). *Projected agriculture in 2080 due to climate change*. Arendal, Norway, GRID-Arendal. Available at

http://www.grida.no/graphicslib/detail/projected-agriculture-in-2080-due-to-climate-change_15f0.

_____ (n.d.) *GEO Africa Data Portal*. Nairobi, Kenya, UNEP. Available online at http://gridnairobi.unep.org/aeo_eis/.

United Nations Educational, Scientific and Cultural Organization (2009). *Third Edition of United Nations World Water Development Report (WWDR3): Water in a Changing World*, Paris, France: UNESCO. Available at <http://www.unesco.org/new/en/natural-sciences/environment/water/wwap/wwdr/wwdr3-2009/downloads-wwdr3/>.

United Nations Framework Convention on Climate Change (2007). *The Nairobi Work Programme on Impacts, Vulnerability and Adaptation to Climate Change*. Bonn, Germany: Climate Change Secretariat/ UNFCCC,

_____ (2013): website on National Adaptation Programmes of Action available at http://unfccc.int/national_reports/napa/items/2719.php.

UN Water (2008). Status Report on Integrated Water Resources Management and Water Efficiency Plans for CSD16. Report prepared for the 16th session of the Commission on Sustainable Development – May 2008. New York, USA: UN Water. Available at http://www.unwater.org/downloads/UNW_Status_Report_IWRM.pdf

Verheijen, Janneke and Isaac Minde (2007). Agricultural Innovations: A Potential Tool to HIV Mitigation. Journal of SAT Agricultural Research, an Open-Access Journal. Patancheru, India: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). Available at <http://www.icrisat.org/journal/volume5/mpii/imp3.pdf>

Vincent, Katharine, and others (2011). Overcoming the Barriers: How to ensure future food production under climate change in Southern Africa. Research report published by Oxfam International Centre for Environmental Policy and Advocacy and others. Available at . <http://policy-practice.oxfam.org.uk/publications/overcoming-the-barriers-how-to-ensure-future-food-production-under-climate-change-188929>

World Bank (2006). World Development Indicators, 2006. Washington DC, USA: World Bank. Available at <http://data.worldbank.org/products/data-books/WDI-2006>.

_____ (2009). World Development Report 2010: Development and Climate Change. Washington DC, USA: World Bank.

_____ (2011). Missing Food: The Case of Postharvest Grain Losses in Sub-Saharan Africa. Report number 60371-AFR. Washington DC, USA.

World Resources Institute (WRI), (1996): World Resources: A Guide to Global Environment, 1996-1997. World Resources Institute, United Nations Environment Programme, World Bank. New York, USA: Oxford University Press.

Young T. and others (2010). Climate change and health in SADC region: Review of the current state of knowledge, for SADC Climate Change and Health Synthesis Report, published Strategic Evaluation, Advisory and Development Consulting (Pty.) Lt. Centre for Occupational and Environmental Health Research and World Health Organization Collaborating Centre in Occupational Health. Available at <http://www.slideshare.net/oerafrica/climate-change-and-health-in-the-sadc-region-12277434>.

Ziervogel, Gina, and Bruce Frayne (2011). Climate Change and Food Security in Southern African Cities. Urban Food Security Series No. 8. Cape Town, South Africa: Queen's University and African Food Security Urban Network (AFSUN).

Other sources

Common Market for Eastern and Southern Africa (n.d.). Ngwenya applauds COMESA-EAC-SADC Climate Change cooperation, article on website. Lusaka, Zambia: COMESA. Available at http://www.comesa.int/index.php?option=com_content&view=article&id=278:ngwenya-applauds-comesa-eac-sadc-climate-change-cooperation&catid=5:latest-news&Itemid=41
Knowledge space on climate change: <http://know.climateofconcern.org/index.php>

ODI (Overseas Development Institute), London, UK: Climate and Environment website <http://www.odi.org.uk/programmes/climate-environment>.

