



LONG TERM ADAPTATION SCENARIOS

TOGETHER DEVELOPING ADAPTATION RESPONSES FOR FUTURE CLIMATES

PERSPECTIVES FOR SADC



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On behalf of:
 Federal Ministry
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LONG-TERM ADAPTATION SCENARIOS
FLAGSHIP RESEARCH PROGRAMME (LTAS)

CLIMATE CHANGE ADAPTATION PERSPECTIVES FOR THE SOUTH AFRICAN DEVELOPMENT COMMUNITY (SADC)

LTAS Phase II, Technical Report (no. 1 of 7)

The project is part of the International Climate Initiative (ICI), which is supported by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.



On behalf of:
 Federal Ministry
for the Environment, Nature Conservation,
Building and Nuclear Safety
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LIST OF ABBREVIATIONS

AGOA	African Growth and Opportunity Act
ASCLME	Agulhas and Somali Current Large Marine Ecosystems
BCC	Benguela Current Commission
BCLME	Benguela Current Large Marine Ecosystem
CAB	Congo Air Boundary
CCAS	Climate Change Adaptation Strategy (SADC)
Cesul	Regional Transmission Backbone Project (Mozambique)
CICOS	Commission Internationale du Bassin Congo-Oubangui-Sangha
CITES	Convention on International Trade in Endangered Species
DAFF	Department of Agriculture, Forestry and Fisheries (South Africa)
DEA	Department of Environmental Affairs (South Africa)
DRC	Democratic Republic of Congo
DRDLR	Department of Rural Development and Land Reform (South Africa)
DWA	Department of Water Affairs (South Africa)
ECOWAS	Economic Community of West African States
ENSO	El Niño Southern Oscillation
EWS	early warning system
FANR	Food, Agriculture and Natural Resources (SADC)
FFEWS	flood forecasting and early warning system
FDI	foreign direct investment
FTA	free trade area
GCM	global circulation model
GEF	Global Environment Facility
GDP	gross domestic product
GHG	greenhouse gas
GHCOF	Greater Horn of Africa Climate Outlook Forum
GIZ	Gesellschaft für Internationale Zusammenarbeit
GHCOF	Greater Horn of Africa Climate Outlook Forum
HYCOS	Hydrological Cycle Observation System



IAS	invasive alien species
IOD	Indian Ocean Dipole
ITCZ	Inter-tropical Convergence Zone
KAZA TFCA	Kavango-Zambezi Transfrontier Conservation Area
IWRM	integrated water resources management
LDC	least developed countries
LIMCOM	Limpopo Watercourse Commission
LME	large marine ecosystem
LTA	Lake Tanganyika Authority
NAP	national action plan
NBI	Nile Basin Initiative
NDMC	National Disaster Management Centre
NAPA	national adaptation programme of action
NDP	National Development Plan (South Africa)
NWRS	National Water Resources Strategy (South Africa)
OKACOM	Okavango River Basin Commission
ORASECOM	Orange-Senqu River Commission
PJTC Kunene	Permanent Joint Technical Committee for the Kunene River
RCCP	Regional Climate Change Programme
RSAP III	Regional Strategic Action Plan on Integrated Water Resources Development and Management
RISDP	Regional Indicative Strategic Development Plan (SADC)
UNFCCC	United Nations Framework Convention on Climate Change
SADC	Southern African Development Community
TAD	transboundary animal diseases
SAPP	Southern African Power Pool
UNDP	United Nations Development Programme
SACU	Southern Africa Customs Union
SAM	Southern Annular Mode
SAWS	South African Weather Service

SANBI	South African National Biodiversity Institute
SAPP	Southern Africa Power Pool
WHO	World Health Organization
WTO	World Trade Organization
ZAMCOM	Zambezi River Basin Commission



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REPORT OVERVIEW

Chapter 1: Introduction

Chapter 1 describes the context of SADC in terms of the resource endowment and development levels of the different countries. Major impact sectors in LTAS Phase I are investigated at the broader SADC scale.

Chapter 2: Methodology

Chapter 2 outlines the methodology used for the analysis carried out in the report. A framework considering the physical impacts in addition to impacts on people and trade as a result of climate change was developed.

Chapter 3: Climate and climate hazards

Chapter 3 considers the current climate impacts in the SADC region. These include observed events such as drought and flooding.

Chapter 4: Climate change in SADC

This chapter considers both the projections in climate change for SADC as well as the potential future climate change impacts. The impacts are considered according to major impact sectors identified in LTAS Phase I in addition to a few added considerations such as trade and migration.

Chapter 5; Existing inter-related strategies in SADC

Chapter 5 highlights the national adaptation plans of individual SADC countries in addition to integrated SADC sectoral strategies which support (but are not only for)

climate change adaptation. Regionally integrated climate-specific adaptation plans such as the regional climate change plan and the SADC water sector adaptation plan are considered.

Chapter 6: Regional risks and opportunities

This chapter, for ease and simplification, considers the regional opportunities, benefits and risks under a wetting and drying future from a South African perspective. All futures are anticipated to get warmer. Risks associated with increased integration are also considered.

Chapter 7: Policy recommendations

A number of potential policy recommendations are provided. Policy recommendations are given at a sector-specific policy level in addition to integrated forms of policy related to climate change.

Chapter 8; Research needs for integrated adaptation planning

This chapter considers a range of research needs at sector-specific and at a more integrated policy level.

Chapter 9: Conclusion

The report concludes, highlighting results that provide the basis for additional strategic integration in the SADC region.



EXECUTIVE SUMMARY

Climate change impacts and adaptation responses in the Southern African Development Community (SADC) countries may directly influence/affect South Africa both positively and negatively and vice versa, with potential socio-economic and environmental implications. There are a range of impacts including physical/environmental impacts (such as flood, drought, fire or disease and so on) and migratory impacts or impacts through trade in food or energy for example.

According to the IPCC Fourth Assessment Report (IPCC 2007) land surface warming in Southern Africa is likely to exceed the global mean land surface temperature increase in all seasons. High warming rates are projected over the semi-arid south western parts of southern Africa covering north western South Africa, Botswana and Namibia especially (IPCC Africa 2014). The median change for a number of dynamically downscaled models indicates that most of the southern African region is likely to experience a decrease in annual rainfall, with rainfall increases suggested over east Africa and the central interior of southern Africa.

The physical impacts of climate change on the SADC region include both rapid and more gradual onset changes in environmental conditions. These include water related impacts such as floods and droughts, and risks such as wildfire and the increased burden of disease on humans, livestock and crops. To align the work of LTAS Phase 1 and that of Phase 2 the SADC impacts are aligned with the sector climate change impact channels including water, agriculture and forestry, human health and biodiversity. Infrastructure for transport and energy are additional considerations.

Climate change in SADC and South Africa will have multiple direct and indirect impacts on people. For example, the impacts of climate events such as floods

may cause the migration of displaced persons within southern Africa. Migration due to economic, social and environmental reasons often forces people into peri-urban, coastal or rural settlements which are vulnerable to climate impacts such as flooding or drought. Inadequate services in turn affect health and have detrimental effects on the surrounding environment.

Impacts of climate change may also be experienced through increased or decreased trade within South Africa and SADC. Impacts such as floods or droughts in South Africa or SADC may influence the production of agricultural produce for example. In addition to impacting internal food security within countries, imports and exports of produce may shift. Trade in food and energy is of particular importance in SADC as they are currently traded extensively between SADC countries. Shifts in trade going forward will affect the trade earnings as well as the food and energy security of a number of SADC countries.

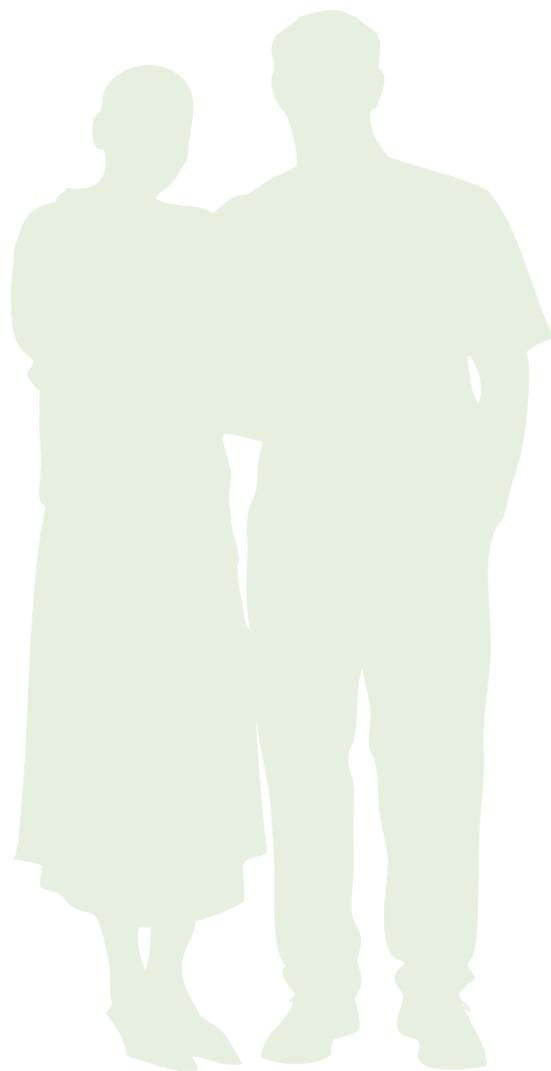
All projected climate futures are anticipated to get warmer; however, uncertainty exists in relation to wetter or drier futures. Opportunities within SADC in the face of increasing uncertainty suggest integration within the region. The overall benefit of wider integration across SADC comes from spreading risk across the region. Climate projections anticipate that climate forcing in the southern regions of SADC is inversely correlated with climate forcing in northern SADC, with a drying phase in the south balanced by a wetting phase in the north. Integration is not only driven by this inverse correlation but also in terms of spreading development initiatives and investments in economic growth. The three largest benefits (and risks) for the SADC region as a whole are the imports of agricultural produce, hydropower production and exports of primary, secondary or tertiary goods within the region.

South Africa has a very real interest in a coherent and functioning SADC. This is especially the case in a drying future, although it remains important in a wetting future with regard to infrastructure (such as hydropower). Should South Africa decide only to integrate with SADC as an export market, its strength would be less important. Without energy integration or imports of produce from the wider SADC region into South Africa, concerns about the upkeep and integrity of the SADC region are less pertinent. However, even as an export market, the adaptive capacity and resilience to future climate risks is critical across the region to ensure stable markets and reduce impoverishment and unplanned migration.

In order to minimise the risks of integration, there needs to be political stability, economic integration and regionalisation to build stability and adequate equity and livelihoods. Social development is especially important, as a single economically strong country within the region will quickly become overburdened with economic, social and climatic immigrants. These requirements are directly linked to the premise of the SADC declaration and mission to “promote sustainable and equitable economic growth and socio-economic development through efficient productive systems, deeper co-operation and integration, good governance, and durable peace and security, so that the region emerges as a competitive and effective player in international relations and the world economy” (SADC 2012b). Currently there are a number of policies targeted towards improving integration and adaptive capacity across the region. These policies need to be implemented to a greater effect in order to ensure adequate outcomes of sufficient integration.

There are risks associated with increasing integration due to the added complexity of policies as well as the likely increase in migration if countries are not adequately developed or adapted to climate change. It is important to take away disincentives for adaptation to climate change and regional integration. Increased integration needs to be on condition that SADC as a whole is stronger and more

prepared for climate impacts. Opportunities need to be catalysed so that the region as whole may develop beyond a point where entire economies are paralysed by drought or flood year after year. What is especially pertinent is that a resilient country is not possible without a resilient SADC region around it.



I. INTRODUCTION

As South Africa becomes increasingly integrated into the region across sectors, it has a very real interest in a climate resilient Southern African Development Community (SADC). This is especially the case in a drying future with respect to food and water security, and in a wetting future with respect to extreme event responses and infrastructure. SADC countries which are not climate resilient may pose a risk to South Africa and the region. Therefore it is important to understand how risks can be shared, for example through trade, technology transfer and information sharing, among SADC countries.

Regional integration within Africa is considered important for achieving sustained economic growth and development, including effective intra-African trade, enhanced global linkages and African unity. Regionally

integrated adaptation responses to climate change could potentially enhance future development and growth cumulatively within the region. There are, however, significant risks associated with greater integration, increased connectivity and regionally integrated adaptation responses. This is because SADC countries differ in terms of their economic development, resource availability and infrastructure capacity levels. The current economic growth rates and development levels of SADC countries may be a useful indicator of which countries will be leaders in future growth and/or adaptation.

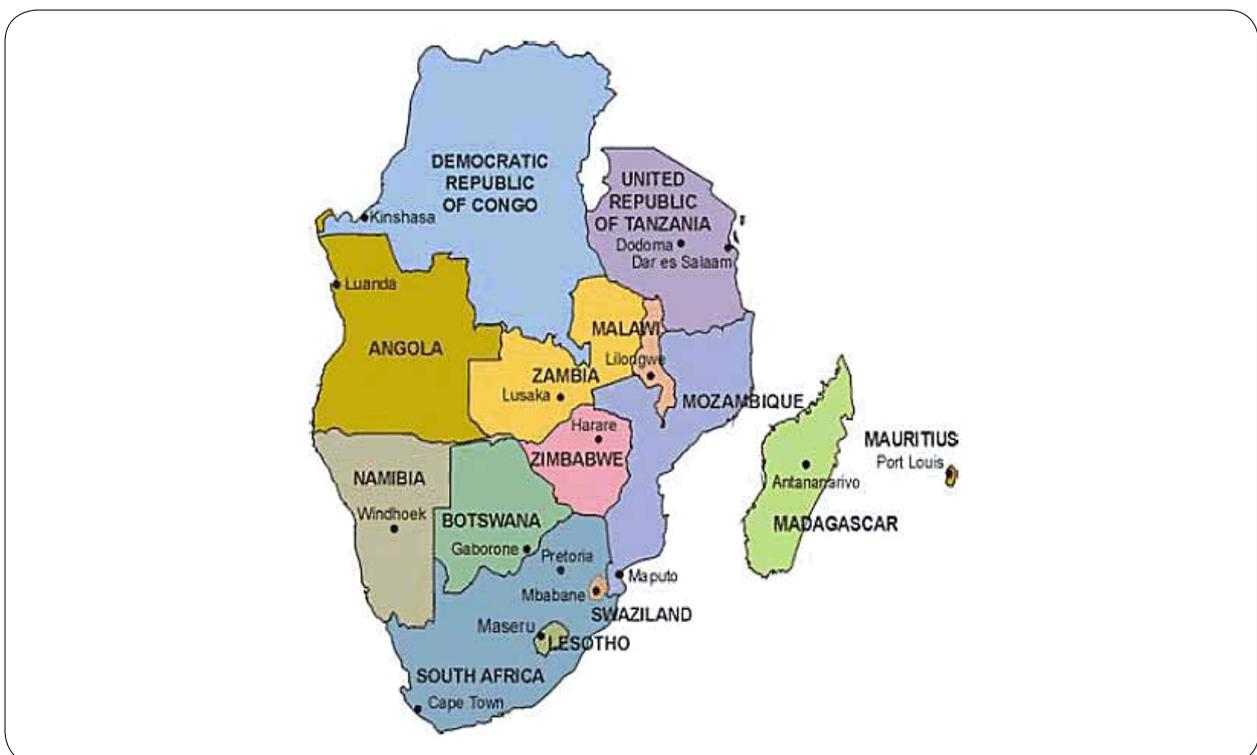


Figure I: Countries of SADC (Source: SADC-HYCOS)

South Africa is inextricably linked to SADC in a number of ways including regional climatic impacts, transboundary water resources, flooding or drought, the migration of people and through trade in goods such as agricultural produce or trade in services. Previously, due to Apartheid sanctions and economic policies, South Africa was less linked than what is potentially possible today. Following the end of Apartheid, capital, migration and trade from and to South Africa have increased.

Countries within SADC are not uniform differing in terms of their economic development (indicated by gross domestic product (GDP)), resource endowment (such as water availability or arable land) and infrastructure (Figure 2). Depending on the level and nature of development, countries may have different levels of adaptive capacity and resilience to a range of climate futures (Lesolle2012). The growth rates of SADC countries' economies may also be instructive as to where additional economic growth

will be taking place. Increased economic growth might reduce assurance of water supply, as demand for water might also rise.

1.1 Water Resources

The water resources endowment of SADC countries is represented by the renewable internal freshwater availability per capita in Figure 2 below. Countries invest in water storage depending on their water needs and level of development. Across SADC, Zambia and Zimbabwe have the highest dam capacity per capita. These numbers are misleading however, as they include the capacity of the Kariba Dam, which does not translate into water for use in Zambia or Zimbabwe on a large scale. The level of water storage development and water resources endowment in turn are not directly linked with the level of economic development in each country. GDP per capita varies between SADC countries.

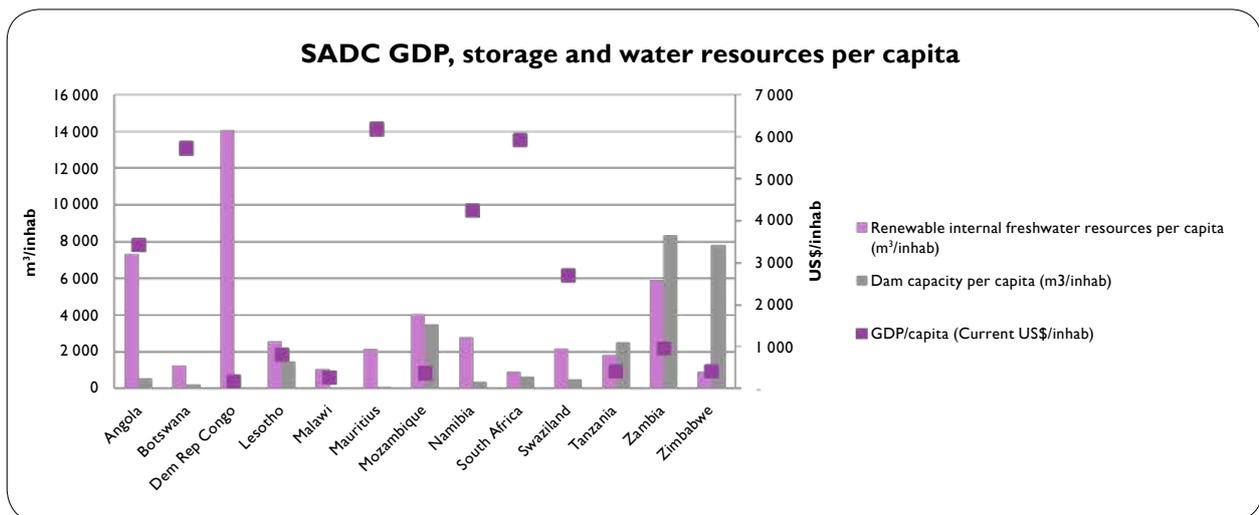


Figure 2: SADC GDP, storage and water resources per capita Source: World Bank (2011)



Depending on the nature of the economy of a country the resource requirements may differ. For example, an economy heavily dependent on irrigated agriculture will have a relatively larger per capita withdrawal of water than an economy dependent on tertiary sector services. The nature of the economy may range from mining to agriculture, to service. Each form of economy has a distinctly different requirement in terms of water quality, quantity and assurance of supply. As a result, a range of infrastructure needs are required too. See Appendix I for an indication of the range of water abstraction amounts per sector in each country. The role of water in the economy of each SADC country needs to be considered in terms of future water availability as a result of climate change. The more dependent an economy is on agriculture, the more vulnerable it is to climatic shifts.

In addition to the ubiquitous droughts experienced in the SADC region, large scale floods can occur in river basins following heavy rain. Basins such as those of the Orange, Vaal, Limpopo, and Zambezi rivers are particularly at risk. A large number of watercourses are shared among SADC countries requiring integrated management and collaboration. Over 70% of the SADC region's fresh water resources are shared between two or more Member States, a situation that has been the basis for the development and adoption of a series of regional instruments to support the joint management and development of shared water courses. According to the SADC Regional Water Policy (2005), "The SADC region has 15 major river basins which are transboundary or watercourses shared by two or more countries. Thus one of the characteristic features in the region is shared watercourse systems, with complex water rights and potential conflicts over utilization of the shared resources. This common heritage also presents tremendous opportunities for cooperation in managing the shared resources for regional economic development and regional integration."

1.2 Agriculture, Fisheries and Forestry

The agriculture sector features prominently in the SADC regional economy. Approximately 70% of the region's population depends on agriculture for food, income and employment. Agriculture is a major social and economic sector in the SADC region, contributing between 4% and 27% of GDP and approximately 13% of overall export earnings. For these reasons, the performance of agriculture has a strong influence on the rate of economic growth, the level of employment, demand for other goods, economic stability, food security and overall poverty eradication. Most governments of the SADC Member States are aware that food production, donor aid flows and government budgetary allocations to agriculture and rural development have declined, while food imports, food aid, and population have substantially increased.

Food production in SADC has not kept pace with the region's growing population over the long term. Between 1990 and 2006 population increased from 152 million to 249 million, while food production increased at a lower rate from 22.06 million tonnes to 23.61 million tonnes. Domestic production should keep pace with the growth in demand for food, and ensure agricultural productivity is not affected by climate change (Lesolle, 2012).

Crops

South Africa is the largest cereal producer in the SADC region. However, there has been a gradual drop in output of these crops over the past decade in South Africa followed by an increase in imports of such crops from further afield. This is in small part attributable to the general opening up of the South African economy from the 1990s onwards, but is more strongly related to the gradual shift towards charging market-related prices for water consumed in the agricultural sector in the country. Although cereal production has dropped, water use in agriculture in South Africa has not reduced. Instead, water is being used for crops which earn more value per

unit of water consumed. Production of high quality fruit and vegetables, primarily for export, and the production of processed olive oil and wine are increasing. This has ensured the sector remains competitive as the price of water increases.

The drop in the South African share of SADC cereal production has been met by an increase in production of cereals by Tanzania, Mozambique, the Democratic Republic of Congo (DRC), Zambia and Angola. Mozambique increased cereal production from 250,000 tonnes in 1992 to 2,000,000 tonnes in 2005 and Angola has experienced a three-fold increase since 1995 (Malzbender & Earl 2007). The potential for rain fed as well as irrigated agriculture in the SADC states is significant as some of the states emerge from political instability and begin developing their

commercial agriculture sectors. These developments are an opportunity for better food security across the region.

Although production has been steadily increasing, without imports from South Africa and globally, wheat and maize production within SADC is not sufficient to meet consumption demands. This is indicated in the following figures, which show SADC wheat supply excluding South Africa. Therefore, under the current development and climate, South Africa is a net exporter of basic foodstuffs such as maize and wheat to the SADC region. However, as SADC countries begin producing more of their own wheat, there may be new opportunities for marketing basic food crops to South Africa. These scenarios depend on a number of factors including the climate and the agricultural and related policies in SADC going forward.

SADC (excluding South Africa) wheat supply and demand for the period 1998/99 to 2003/04

(Source: based on data from SADC REWU w heat balance sheets)

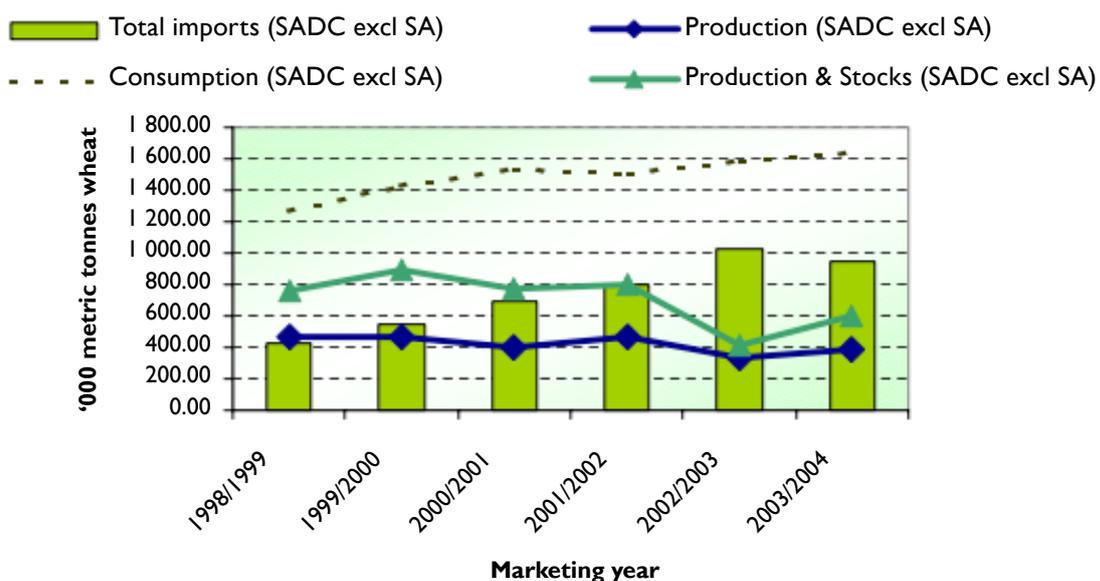


Figure 3: SADC (excluding RSA) wheat supply and demand (1998–2004) Source: DAFF (2003)

Fisheries

Fisheries are important for food security in SADC, especially with an increasing risk of crop failures due to water scarcity. Fisheries in the region are diverse, with production of about 2.6 million tonnes of fish drawn from oceans, lakes and reservoirs, and rivers every year. SADC Member States also benefit from aquaculture. Two-and-a-half million tonnes of fish were caught from the African continent's inland waters and over 5 million tonnes from marine areas in 2010 (FAO 2010). Marine fisheries along the Southern African coast are particularly interlinked and integrated as indicated by Figure 4 below. In recognition of the interconnectedness of the fisheries industry, there are a number of agreements between neighbouring countries.

Fisheries programmes within SADC are managed through the Food, Agriculture and Natural Resources (FANR) Directorate, and guided by the Protocol on Fisheries (2001). The Protocol on Fisheries further defines national and regional responsibilities for legislative and policy harmonisation, information sharing, and protection of fisheries from over-exploitation in the SADC region. There are a number of multi-government initiatives (the Benguela Current Commission and the Agulhas and Somali large marine ecosystems) which are useful in monitoring the movement of fish stocks within the region. These initiatives are a useful model for a “shared pool” resource with increasing stress.



Figure 4: Coastal SADC countries are interconnected by shared ocean currents Source: Southwood (2007)

Trade

Trade from SADC into the rest of the world is not evenly distributed across Member States. During 2011, total exports from SADC were worth \$209.7 billion, with 46% from South Africa and 31% from Angola. Total imports were reported at \$207 billion with 58% imported into South Africa and 10% into Angola. The main importers by volume (tonnage) are South Africa (45 million tonnes), Angola (10 million tonnes), and Zimbabwe (7 million tonnes). South Africa has by far the highest volume of exports (81 million tonnes), followed by Angola (51 million tonnes), Botswana (7 million tonnes), and Zambia (4 million tonnes). The majority of southern Africa’s imports come from overseas (79%), 16% come from countries in southern and eastern Africa and the remaining 5% come from other African countries. Similarly for exports, the majority of Southern Africa’s exports (76%) go overseas, whereas 23% stay in southern and eastern African

countries and a minimal amount of exports go to other African countries (SADC 2012c).

Therefore, South Africa is responsible for a large portion of the SADC trade value. This does not, however, reduce the importance of trade among and within other SADC countries. Although smaller volumes are involved, some SADC countries may be more dependent on the imports and exports of particular crops or minerals. The lower value of agricultural products relative to oil or minerals is also not helpful in determining the importance of imports as although food is lower in value per tonne, it has significant importance for food security. Intraregional trade within SADC is estimated to increase going forward. This is illustrated in Figure 4 below, taken from the SADC Transport Plan (2012c), which gives an indication of trade flows between SADC countries in 2009, and projected trade flows for 2027.

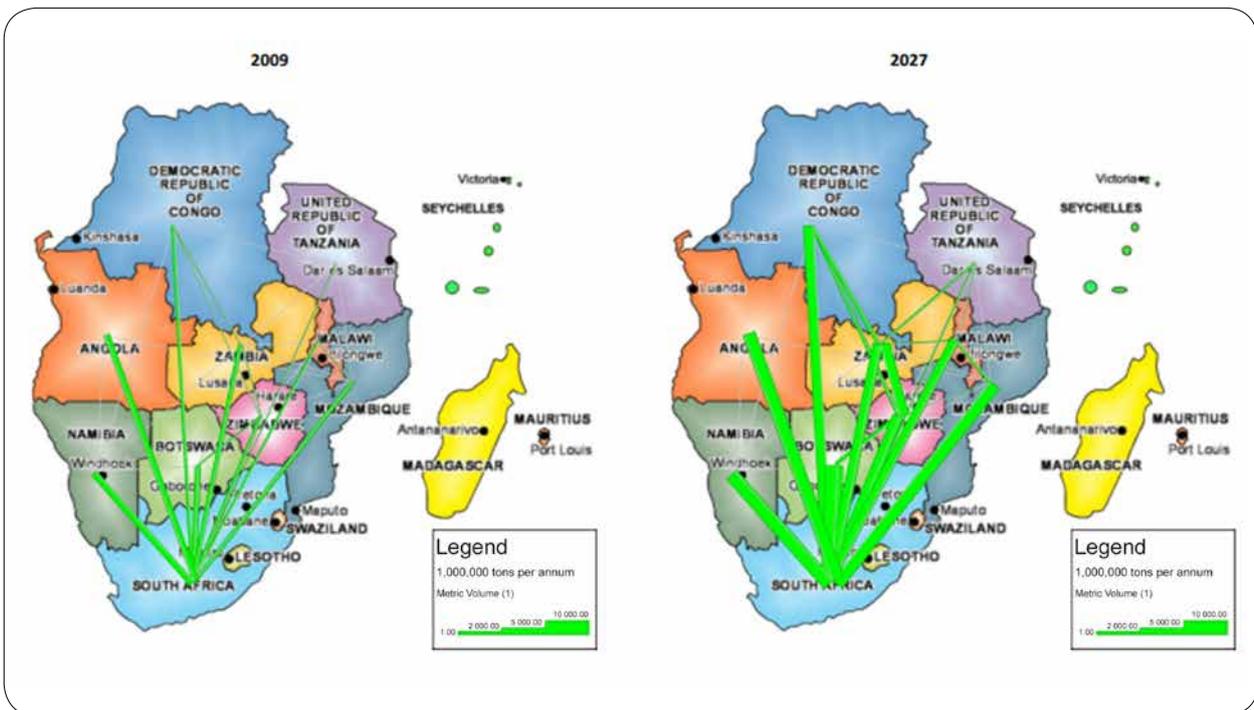


Figure 5: Current and proposed SADC regional trade Source: SADC (2012c)



Intraregional trade in agricultural products amounts to 17% of SADC's total global trade in these products while trade in non-agricultural goods in the region represents 10% of global trade in these products (see Appendix 2). This indicates the importance of agriculture in the region for food security and continued trade. Overall, agricultural products are still mainly exported to the European Union, whereas agricultural exports to other high income OECD countries and to BRIC countries are low. These markets attract relatively higher shares of non-agricultural exports. The United States, for example, imports relatively labour intensive textile products from the SADC region, often under its preferential market access programme set out in the African Growth and Opportunity Act (AGOA). The category "non-agriculture" as defined by the World Trade Organization (WTO) also comprises minerals and other raw materials that are often relatively less labour intensive than agricultural and manufactured products.

1.3 Biodiversity and ecosystem services

Healthy functioning of ecosystems within SADC is critical for the provision of resources and ecological services and the improvement of human wellbeing and economic development. This is especially the case due to the importance of agriculture, and the size of the rural population in the region. Healthy ecosystems are supported through a rich biodiversity of species and functioning ecosystem services. Issues such as land degradation, changes in land use affecting cover and fire require special consideration in order to reduce negative impacts on the environment.

"The southern African region has a rich natural heritage of global significance to the world's climate and biological diversity. According to the Southern African Development Community (SADC) Regional Biodiversity Strategy more than 40% of the region's species are endemic - only found in their existing location (SADC 2012a)." A significant portion of the southern African GDP is supported through "biological resources such as plant

and animal products, timber and wildlife tourism" (SADC 2012a). The resources are also an important source of livelihood for the majority of its citizens. "Despite this biological wealth, the region continues to face challenges of Economic Development due largely to difficulties that are frequently experienced in equitably and sustainably harnessing natural resource capital" (SADC 2012a). The southern African region includes South Africa which "ranks as the third most biologically-diverse country in the world, while in Madagascar; the endemic species richness relative to the land mass area is unparalleled. Lakes Malawi and Tanganyika contain extremely high numbers of freshwater species while the Central Zambezi Miombo woodlands in Zambia and Tanzania are a centre of bird and butterfly diversity. Mega fauna are abundant. For example Botswana has Africa's largest elephant population while Tanzania hosts the largest remaining population of lions (SADC 2012a)."

Healthy ecosystem function and biodiversity are threatened by a range of factors including land use practises, development, alien invasive species (Box 1) and fire. See Appendix 4 for further information on the extent of fire damage and the related impacts in the SADC region. These risks need to be managed appropriately to ensure ecosystems are able to support natural and economic production.

Box 1: Invasive species: water hyacinth

An example of an invasive species in Southern Africa is water hyacinth. Water hyacinth was first recorded in Africa in the early 1900s, in South Africa in 1910 and in Egypt shortly thereafter. The exact mode of introduction is uncertain, but it is thought that the plants were handed out as gifts during a Trade Fair in St Louis in 1904 and were thus spread throughout the world. Since the early 1900s water hyacinth has spread widely throughout Africa and is now recorded from 23 countries on the continent.

Improved land management through activities such as the clearing of invasive alien plants, rehabilitation or restoration of wetlands or degraded lands and reinstatement or maintaining of riverine and agricultural buffers will help to support improved functioning of ecosystem services. Benefits of improved ecosystem functioning include an increase in water yield and quality, flood risk reduction, fire risk reduction, improved biodiversity conditions and an improved carbon balance. These result in improved livelihood security, especially in rural areas as human wellbeing is improved. Factors such as decreased exposure to natural disaster including fire and flooding and improved food security, health and fisheries also result from improved ecosystem functioning. Therefore land management interventions which support improved ecosystem services are critical to ensure improved livelihood security and adaptation to climate change.

1.4 Infrastructure connectivity

Regional integration is imperative for Africa to benefit from globalisation, which is associated with global trade, prevention of conflicts and consolidation of economic and political reforms. There is an opportunity for SADC to become a leading economy in the current global economy. Through an advanced transportation network, the economy of the region will be opened up for internal trade and to international markets. In addition to transport connectivity, the development of the Southern African Power Pool (SAPP) is an important driver of development within the SADC region through sharing access to electricity.

Transport

Road and rail transport are the dominant modes of transporting goods and people within SADC. They handle the bulk of imports and exports in the respective countries, thus providing a vital transport link for the countries' diverse import and export commodities. Most

of the SADC countries are landlocked, making road and rail networks very important in linking them to the principal ports in South Africa, Mozambique, Angola and Namibia. The national road and rail systems provide links to all major centres in each country and to neighbouring countries. The road system provides access to remote districts, thus serving as a strategic link to these areas. The condition of roads across SADC is not optimal, with a number of key transport routes in poor condition.

In terms of the potential for integration both within SADC and globally, there is relatively little infrastructure supporting the trade in goods within the region. Inadequate infrastructure in addition to inadequate policies and high tariffs also limit trade. Historically, the North-South corridor indicated in red below in Figure 5 has been the main access route for imported traffic travelling through South Africa to other SADC countries.

The quality of road surfaces across SADC is variable, with Mauritius having 100% paved roads, with 95% rated as in good condition, while Mozambique, Angola and the DRC have low percentages of paved surfaces mostly in poor condition largely due to prolonged civil wars and significant flood damage (Mutambara 2008).

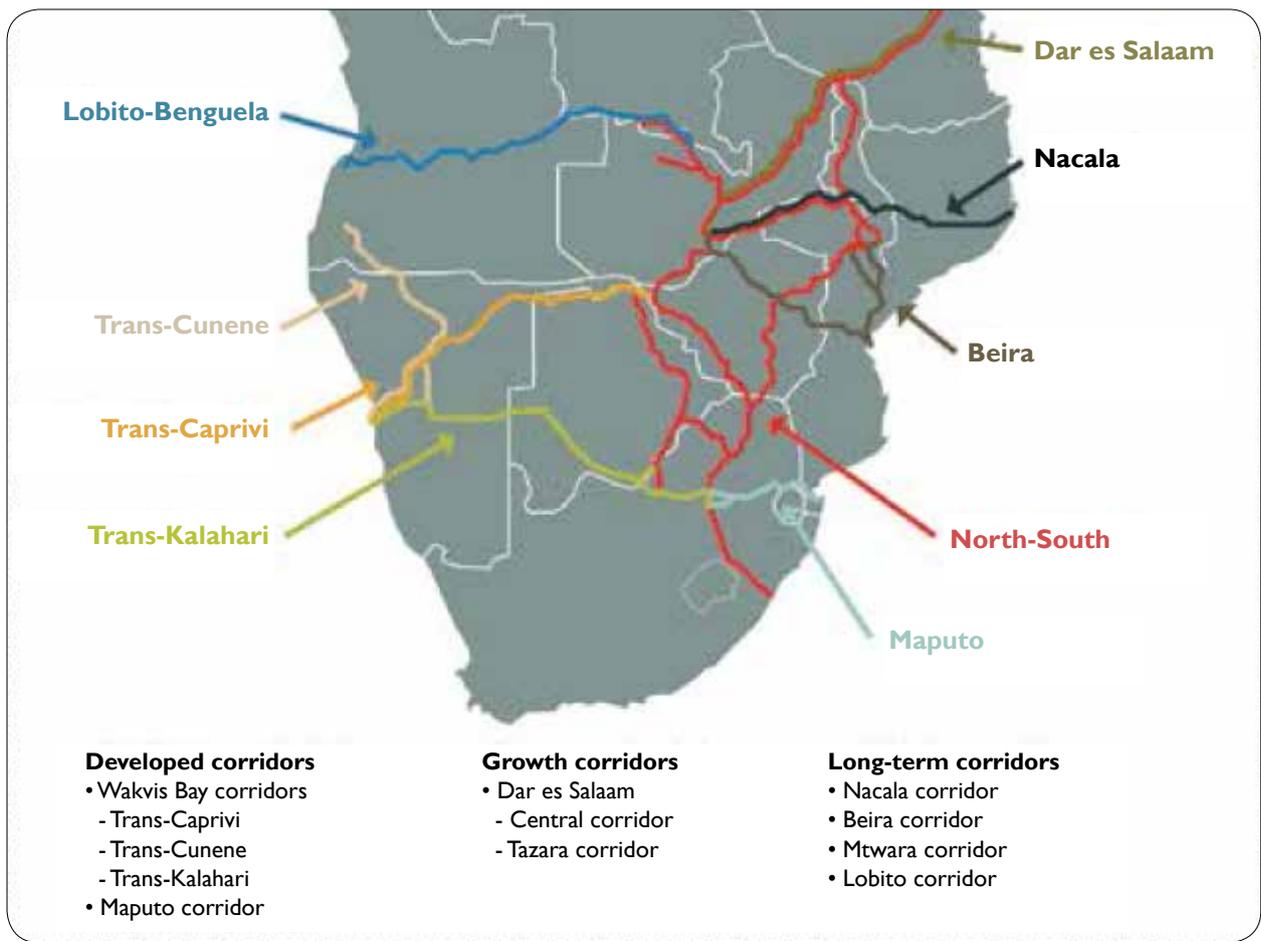


Figure 6: Regional inland corridors in SADC Source: CSIR (2013)

Due to its location at the southern tip of the African continent, there is a great opportunity for SADC to become a world class trans-shipment community. However, compared to the three other established communities, namely the Caribbean, the Mediterranean, and South East Asia, SADC is lagging behind in terms of connectivity, both intraregional and international and its importance in the global maritime network. According to business executives in South Africa, the top three constraints to doing business in Africa are the availability of reliable service providers and partners, the lack of

adequate infrastructure and operational capacity, and the transit times and reliability of the current transport infrastructure. The current limited connectivity between various SADC economies and intraregional and world markets results in an increase in logistic costs. SADC is addressing this through the development of dedicated multinational trade and logistics corridors, which aim to link economic centres, consumer markets and ports across the region (CSIR 2013).

Energy

An interesting challenge facing countries, as illustrated below, is the need to investigate options for mitigating against greenhouse gas (GHG) emissions such as imported large hydropower, while also considering the impacts of climate change on this source of energy (Mukheibir 2007).

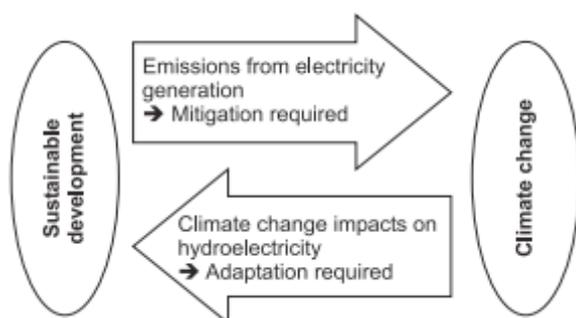


Figure 7: Two-way interaction between sustainable development and climate change Source: Mukheibir (2007)

Most SADC member states have abundant energy sources, however, they often lack the technical capacity to put them to use. As a result, energy production and consumption varies across the region. Over the next ten years, electricity demand is anticipated to increase by 40% in SADC (Mukheibir 2007).

Regional integration is promoted across SADC member states in order to take advantage of economies of scale and to reduce the cost of developing electricity infrastructure. This is especially true for smaller countries, with an estimated saving of \$1.1 billion a year in energy costs (SADC 2012e). In 1996 a Protocol on Energy was adopted among SADC member states in order to facilitate the integration of energy in the region (SADC 1996). See Appendix 3 for additional information on the interconnectedness of energy in SADC.

I.5 Migration and Settlements

Migration:

The migration of people is influenced by a number of factors including socio-economic, political, environmental and other factors. There are a range of migration types which occur within SADC. These include forced migration, labour migration, livelihood seeking migration, temporary migration and permanent migration. Migration may be as a result of fleeing conflict, seeking asylum and refuge, opportunities to trade or seasonal work. Those that migrate within these categories are themselves varied: men and women, young and old. Each reason for migration has a particular relationship between migration and health, whether it is because of political instability, environmental catastrophe or increased access to personal movement.

Migration within South Africa is generally from the rural provinces of Limpopo, North West and Eastern Cape towards the Gauteng and Western Cape Provinces. Further pressure is added by additional migration from the SADC and wider Africa regions (StatSA 2011). The southern Africa region continues to experience a significant rise in mixed and irregular migration flows. These flows mostly originate from the Horn of Africa, particularly Ethiopia and Somalia, and consist of refugees, asylum-seekers, economic migrants, unaccompanied migrant children and victims of trafficking, including women and children. Insecurity, lack of economic livelihood, drought and crop failure are some of the factors that push migrants to undertake the risky migratory routes for better opportunities. Attacks on foreign nationals increased markedly in 2007. The potential increase in migrants from SADC poses a risk to social cohesion within South Africa.

An overall view of migration in southern Africa is shown in the following figure. Movement towards greater economic opportunities seems to be the overriding driver for migration in the region. The prospect of better work plays a significant role in attracting emigrants to different countries.

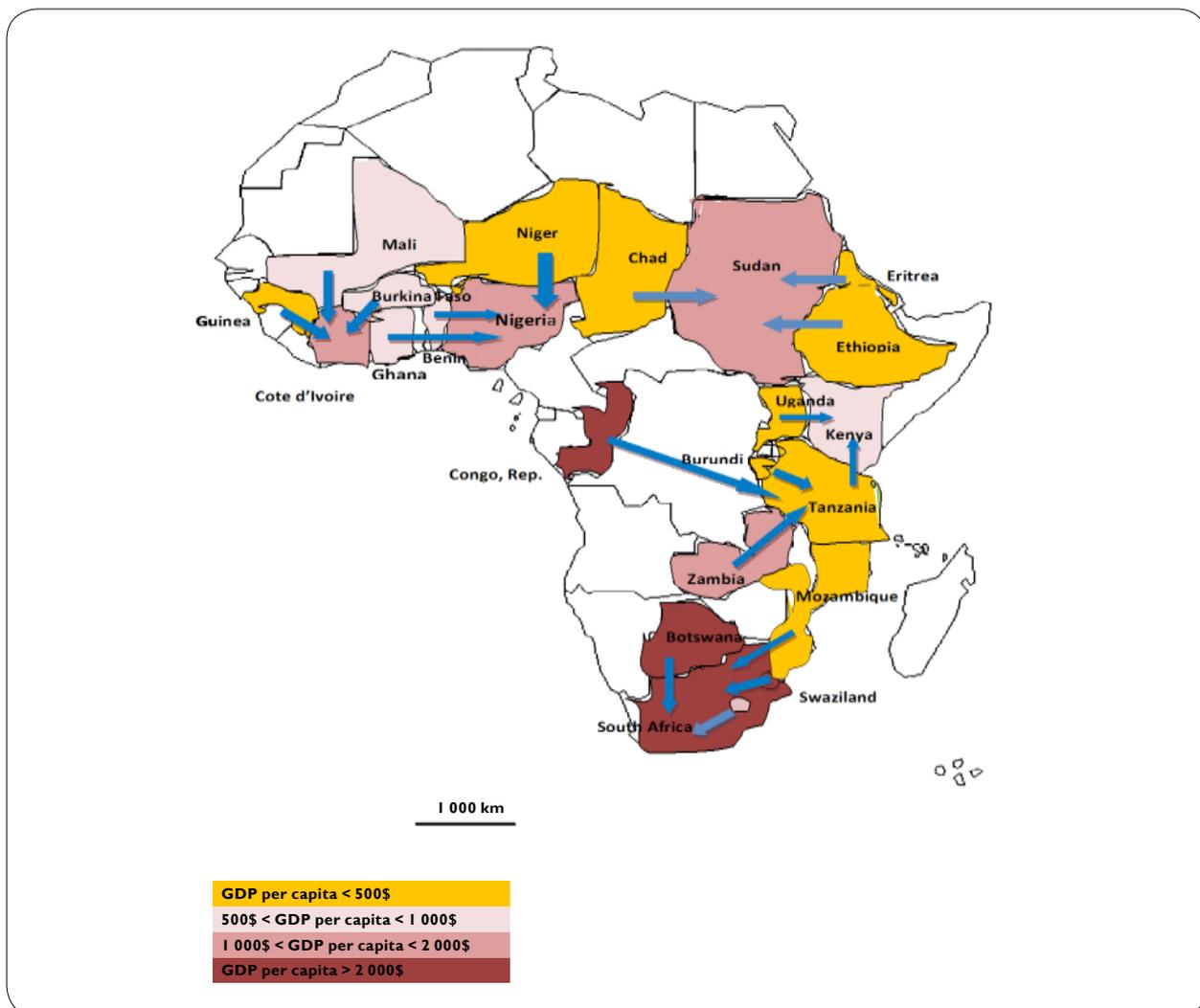


Figure 8: Major migration corridors in Sub-Saharan Africa Source: Shimeles (2010)

Current migration studies show a great influx of immigrants into South Africa from the SADC region, with Zimbabwean nationals representing the largest proportion. SADC can be divided into migrant-sending (Mozambique, Malawi, Lesotho) and migrant-receiving states (South Africa, Namibia). A few, such as Botswana and Swaziland, fall into both categories. Others, such as Tanzania and Zambia, have experienced major refugee influxes in the last decade but do not tend to send or

receive large numbers of labour migrants (StatsSA 2011). Informal immigration is harder to control and plan for putting increasing pressure on service provision including electricity, water and food. Urban infrastructure in particular suffers, while health becomes an increasing concern without the necessary service provision. This becomes a vicious cycle forcing immigrants to continue with dangerous and high risk lifestyles.

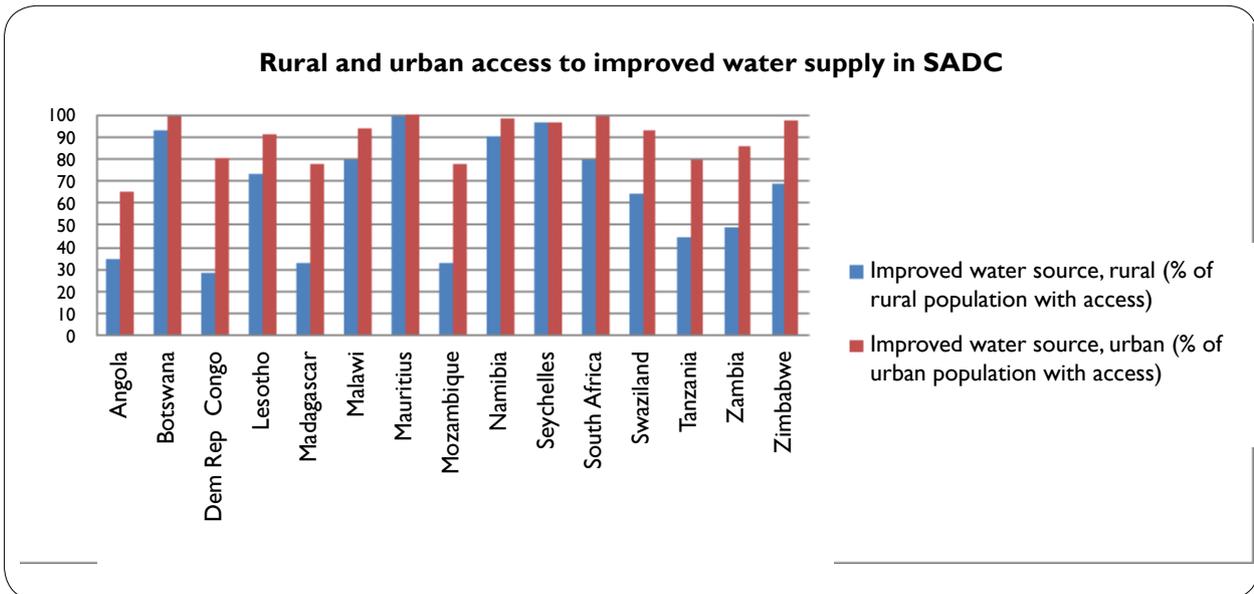


Figure 9: Percentage of population with improved sanitation and water sources within SADC Source: World Bank (2011)

Settlements:

An indicator of the resilience of households is whether or not they have adequate infrastructure. In the figure below, access to improved sanitation and water sources are used as a proxy to indicate the level of resilience within the population of each country. Note, however, that there are large differences in supply and access to improved sanitation and water sources between urban and rural households. These too, need to be taken into account.

1.6 Aim of the research

Climate impacts need to be adequately adapted across the entire SADC region to ensure sustained economic growth, social welfare and environmental conservation and ecological function. There are a range of interdependencies between South Africa and SADC countries evident through past development activities and future development aspirations in the context of climate change. This desk top research investigates regional

integration and its importance in considering climate change impacts and adaptation response strategies. Specifically this study assesses broadly how climate change impacts and adaptation responses in the Southern African Development Community (SADC) countries may directly (both positively and negatively) influence/affect South Africa and vice versa, with a focus on potential socio-economic and environmental implications. This is achieved through framing the inter-related climate impacts on South Africa by SADC countries, as well as the impact on SADC by South Africa. The study is organised according to physical, people and trade impacts.

2. METHODOLOGY

The objective of this study is to assess broadly how climate change impacts and adaptation responses in the Southern African Development Community (SADC) countries may directly (both positively and negatively) influence/affect South Africa in a regional context. There is a focus on potential socio-economic implications in addition to physical climate implications. The research was framed by the inter-related development and climate response impacts on South Africa by SADC countries,

as well as the impacts on SADC by South Africa. The following framework informed the types of climate change and development connections between South Africa and SADC in this research.

This desktop review was informed by a workshop with a range of stakeholders to guide the framing of climate change impacts and interconnectedness between SADC and South Africa. The general framework was developed

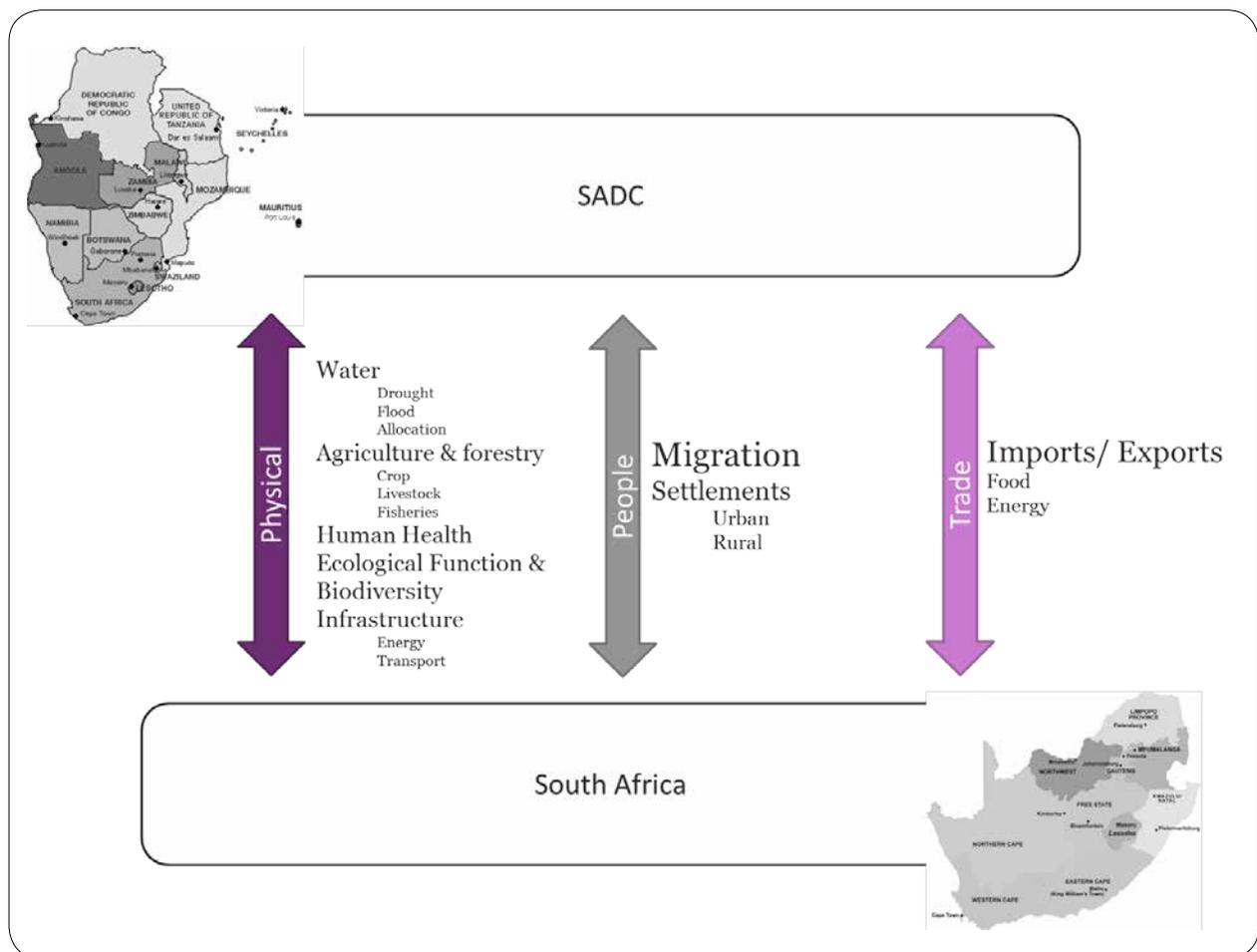


Figure 10: RSA – SADC inter-relationships framework Source: Drawn by author

to investigate the effects of climate change on SADC and South Africa (Figure 10). Physical impacts were categorised according to the LTAS Phase 1 sectors including water, agriculture, human health and biodiversity. Infrastructure, in the form of roads and energy was included as an additional impact channel. The framework was used loosely to help organise the impacts of climate and related secondary impacts within the SADC region. The results are reported loosely according to sector looking at the South African development and climate impacts for each sector. These were then used in conjunction with available literature to identify SADC relationships and vulnerabilities associated with each sector due to climate.

The physical, people and trade considerations were as follows:

Physical: The physical impacts of climate change, identified in LTAS Phase 1 were investigated at SADC level in this research. These included the water related impacts such as floods and drought, and slower onset changes in environmental conditions that affect conditions suitable for human livelihoods, socio-economic activity and development options. These included environmental degradation, soil and sediment loss, species loss, migration, changes in biomes, wildfire and the increased burden of disease on humans, livestock and crops. Examples of the circumstances pertaining when such impacts have taken place historically were documented. The future climate scenarios were considered to interrogate whether or not the likelihood of such events occurring may increase. Current and potential future interconnectedness of physical impacts were considered. A lack of any indication of such events in the past, however, does not negate the possibility of a direct physical climate impact in the future.

People: In alignment with the current LTAS Phase 2 process, settlements were considered as an impact

channel. This is labelled more broadly as 'people' in the framework. Climate change in SADC and South Africa may have multiple potential direct and indirect impacts on people through health and settlements for example. Urban, rural and coastal settlements were considered due to their different risks and vulnerabilities to climate impacts.

Trade: Impacts of climate change may also be experienced through increased or decreased trade within South Africa and SADC. Impacts such as floods or droughts in South Africa or SADC may influence the production of agricultural produce for example. In addition to impacting internal food security within countries, imports and exports of produce may shift. Trade in food and energy is of particular importance in SADC. These impacts were all considered in the research.

Following an initial investigation of the interlinkages and interdependencies according to the physical, people and trade impact channels, climate change was overlaid. The climate impacts of a warmer, hotter and wetter, and a drier future were considered at regional level for SADC as a whole. Benefits and risks under a wetting and a drying future from a South African perspective were considered as all futures are anticipated to get warmer.

An assessment was then carried out, considering not only the climate impacts on South Africa and SADC as a whole, but also the adaptation responses in SADC. The impacts and the responses in SADC have the potential to positively and negatively impact or affect South Africa (and vice versa).

Throughout the research case studies were used to illustrate the effect and role of the inter-dependencies or linkages. Opportunities for regional integration were explored, with a current understanding of integration in SADC illustrated. This research considered the past and potential future interdependencies and linkages physically,



through migration and through trade within South Africa and the respective SADC countries.

Finally, policy options and further research requirements were suggested in order to support the development of the SADC region in further integrating in a planned manner.

The limitations of this study included:

- The unavailability of data and information, particularly relating to regional information.

- Gaps in country specific climate change information making in-depth analysis impossible.
- The complexity of the topic with a number of impacts and outcomes, many of which are not dependent on climate alone. However, framing the understanding of the impacts of climate change according to physical, people and trade was helpful in trying to eliminate some of the complexity of this study.



3. CURRENT CLIMATE VARIABILITY AND CLIMATE HAZARDS IN SADC

3.1 Overview of general climate in SADC

The climate across the SADC region is highly diverse and driven by a range of distinct climatic systems. This is illustrated in the figure below which indicates the higher mean annual precipitation in the north-east region of SADC as opposed to the significantly drier regions in the south-west. Climate in the SADC region is impacted by a number of climatic forces.

The most impactful include the:

- Inter-tropical Convergence Zone (ITCZ)
- Congo Air Boundary
- Mid-latitude cyclones
- Botswana high pressure
- Cyclones
- Temperate troughs

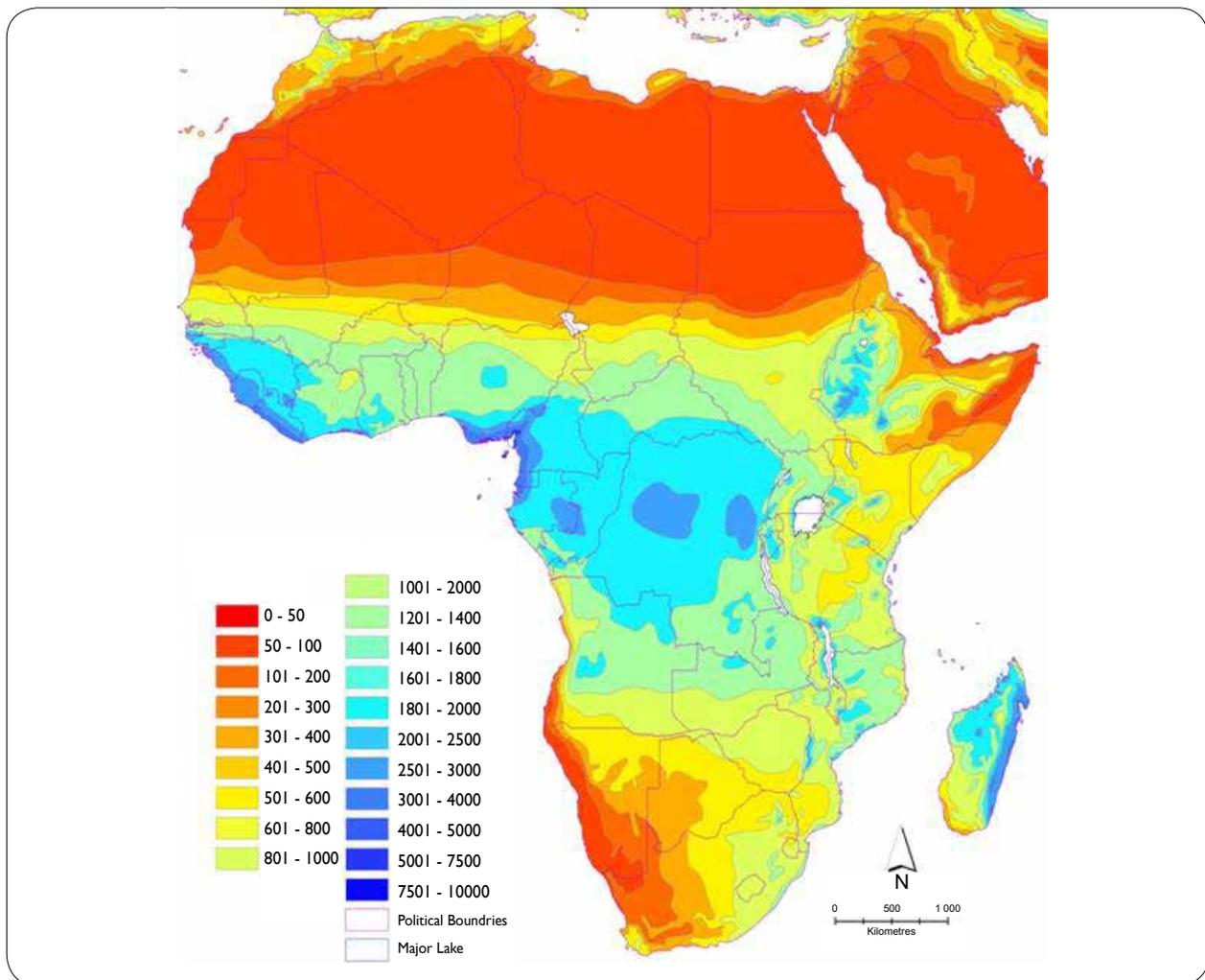


Figure 11: SADC Mean Annual Precipitation (mm/year) Source: Padelia Meas Project (2008)

The general aridity over southern Africa during winter is caused by anti-cyclonic circulation. This system weakens during summer when a heat driven low pressure system helps to suppress the circulation pattern. The regional expression of global atmospheric circulation causes rainfall in southern Africa. The manner in which these climatic systems work is listed below and then described in very broad detail, as follows:

- The ITCZ and the Congo Air Boundary (CAB) create a major zone of convergence and rainfalls.
- Anticyclones (travelling and blocking) suppress the ITCZ circulation.
- A thermal low pressure system over Botswana and Namibia, extending at times into Zambia and the DRC, breaks up anticyclonic circulation.
- The El Niño Southern Oscillation (ENSO) distorts the position of the ITCZ and creates conditions for enhanced or restricted rainfalls.
- Tropical cyclones make landfall along the Mozambican and South African coastlines bringing very intense rainfall and flooding to coastal regions.
- Other rainfall-producing systems include the Indian Ocean monsoon which affects only the extreme north-east of the Zambezi basin – the upper reaches of the Luangwa basin.

Inter-annual rainfall variability in SADC is linked to larger climatic systems such as the ENSO phenomenon, the Indian Ocean Dipole (IOD) and the Southern Annular Mode (SAM). The influence of El Niño is strongest in the south-eastern region of southern Africa, resulting in warm and dry conditions in summer rainfall regions. The ENSO event is driven by ocean-atmospheric interactions due to warming in the Pacific Ocean, causing an El Niño event every three to seven years. La Niña is the cold phase of the cycle which results in cooler and wetter conditions (Davis, 2011). The IOD is essentially the Indian Ocean

version of the Pacific Ocean warming, which, during a negative phase, causes warmer wetter conditions in the eastern Indian Ocean and cooler, drier conditions in the western region. The IOD has been linked with drought in Australia. The SAM is linked to the tracking of the Southern Ocean westerlies, impacting on the circulation of the mid-latitudes, and therefore affecting weather in the southern part of SADC. These integrated climatic forces (ENSO, IOD and SAM), among others, are not very well understood. This is an area which requires further research.



3.2 Observed trends and variability

Evidence shows that the SADC region is experiencing increasing frequency of hot days and 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. This is especially alarming since climate within the SADC region is already highly variable, as indicated by the following observed trends and variability.

In terms of physical climate impacts, the SADC region has experienced a decreasing trend of rainfall since 1950. Most of southern Africa has also experienced upward trends in annual mean, maximum and minimum temperatures over large parts of the region. The most significant warming has taken place in the last two decades (IPCC Africa 2014).

According to the SADC climate change policy paper (Lesolle 2012), “instrumental observations from a number of SADC countries show an increase in temperatures, especially the minimum temperatures. Between 1950 and

2000, Namibia experienced warming at a rate of 0.023oC per year, while (Lesolle 2012) Botswana experienced warming at a rate of 0.017oC per year. Overall, since 1950, the region has also witnessed a downward trend in rainfall. Many reports including the IPCC Fourth Assessment Report (IPCC 2007) indicate that below-normal rainfall years are becoming more and more frequent. One other rainfall characteristic that is observable is the increase in cyclone activity in the South-West Indian Ocean region (Lesolle 2012).”

3.3 Past climate hazards and their impacts

There have been a number of climate hazards and impacts within SADC which are representative of potential future extreme events. The following table gives an indication of previous extreme events from 1980 until 2013 according to the EM-Dat International Disaster Database (Guha-Sapir n.d.). A selection of these impacts and others are considered in greater depth using case studies in the remainder of the chapter.

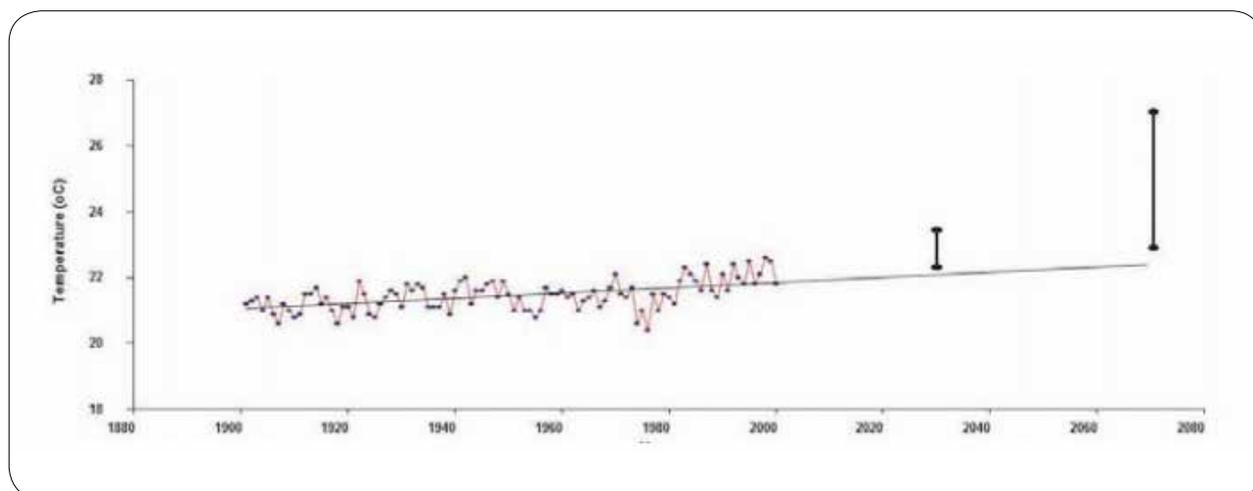


Figure 12: Changes in minimum temperatures for Gaborone, Botswana (red line represents actual data for 1910 to 2000 and projection based on the IS92a climate change scenarios for the period up to 2080. Source: Lesolle (2012)

Table 1: Disasters in SADC by country and type from 1980–2013. Source: Guha-Sapir (n.d.)

SADC Country	Drought	Epidemic	Flood	Extreme temperature	Insect infestation	Storm	Wildfire	Total
Angola	7	18		29				54
Botswana	3	3		8	1	1		16
Lesotho	5	2		5		6		18
Madagascar	6	5		6	1	42		60
Malawi	7	13		30		2		52
Mauritius	1	2		1		12		16
Mozambique	12	26		24	1	19	1	83
Namibia	7	6		13				26
Seychelles		1		1		2		4
South Africa	7	7	2	27		25	9	77
South Sudan				2				2
Swaziland	5	3				3	1	14
Tanzania	8	27			2	4	1	72
Uganda	8	35		18		4		65
Congo Dem Rep	1	66		20		5	2	94
Zambia	5	18		16	1			40
Zimbabwe	6	21		9		2		38
Grand Total	88	253	2	241	6	127	14	731

Flooding

The drivers for flooding within the SADC region may be as follows:

- tropical weather systems moving westwards in summer
- cold fronts in winter
- sea-level rise

Flooding may occur at a number of scales with changes in timing and damage as follows:

- large scale river floods
- flash floods
- coastal flooding

Flooding occurs mostly in the southern and eastern parts of the African subcontinent as indicated in Figure 13 below. Flooding may be caused by tropical weather systems moving westwards in summer or cold fronts and cut-off lows in winter. Flooding may also occur as a result of an increasing rise in sea-level.

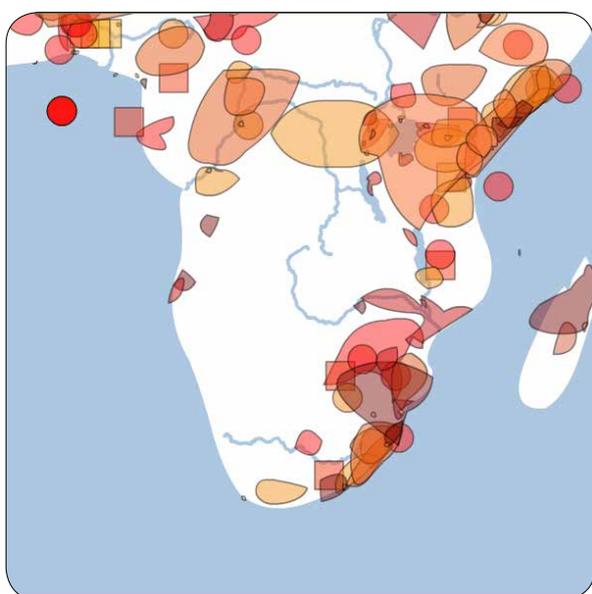


Figure 13: SADC flooding events (1985–2002)
Source: SADC-HYCOS (2014)

Cyclones along the east coast are responsible for a large proportion of the indicated flooding. Cyclones along the eastern side of SADC result in extensive flooding causing economic losses and damage to infrastructure, crops and livelihoods. This is of particular concern to the countries along the east coast of southern Africa including Madagascar and Mozambique (Lesolle 2012).

The Seychelles has already begun reporting damage due to sea-level rise threatening the health of the protective reef barrier and therefore the survival of the islands. Box 2 explores cases of damage caused by floods.

Box 2: Floods in southern Africa

1984

Torrential rains from the tropical cyclone Demoina (600 mm in 24 hours at St Lucia) caused extreme flood events in north-eastern South Africa and adjacent Mozambique and Swaziland. Hundreds of hectares of fertile alluvial soil under sugar cane were reduced to bare rock beds. Vast areas of KwaZulu-Natal Province were isolated, rivers flooded, bridges and roads washed away. Houses collapsed under the weight of the water and many people were left stranded. Damage to roads and bridges was estimated at \$2.7 million, and the death toll rose to 60.

2000

The tropical depression and cyclone Eline ravaged large parts of Mozambique, South Africa, Botswana and Zimbabwe in February. High winds, torrential rains, and severe flooding left a trail of destruction and heavy loss of life. Large areas of agricultural land were submerged, together with livestock and farming implements. Mozambique was worst affected, with up to 400 people reported dead and about a million displaced.

In April, after devastating northern Madagascar, where it left 13 people dead and 100 000 homeless, the tropical storm Hudah threatened the coast of flood-ravaged southern Mozambique before turning away to dissipate over northern Mozambique, where 171 mm of rain fell.

(Source: FAO 2004)

From 1901 to 2007 flooding has been second only to epidemics in frequency of natural disasters in SADC. The damage caused by flooding amounts to approximately \$2 470 million over this same time frame. In 2000, cyclones Eline and Gloria caused \$700 million of flood damage in Mozambique. Damages amounted to three times the value of the country's exports in 1999.

Drought

Drought is a climatic phenomenon which has the potential to impact a wide region depending on the size and extent of the climate forcing. Countries are impacted differently by drought depending on their dependence on and the value produced by water-dependent sectors such as agriculture (especially rain-fed agriculture). The interconnectedness of the region following a drought is illustrated by the increase in trade required to meet food demands in each country. Box 3 below illustrates the large number of countries affected by a single drought event in 1991–1992.

Box 3: The 1991–1992 drought in southern Africa

The 1991 – 1992 droughts resulted in large areas of SADC receiving from 20 to 75% of normal rainfall. Central Zambia, central Malawi and the southern part of Mozambique were especially badly affected. Abnormally high temperatures in the region exacerbated the dryness. Grain production in the region fell by 60%, necessitating the import of extensive amounts of grain (IPCC, 1997). Import needs rose to 7 million tonnes, with a further 5.5 million tonnes required by South Africa (FAO, 2004). Approximately 86 million people were affected. 20 million were considered to be at serious risk of starvation.

- In Botswana the drought affected the entire country causing widespread crop failure and livestock mortalities.
- In Mozambique 1.3 million people, particularly those in the poor rural areas of southern and central Mozambique were affected. The impacts of the drought were exacerbated by the civil war causing widespread loss of food supplies, livestock and environmental degradation. Nearly US\$200 million was provided in food aid relief by the World Food Programme (FAO, 2004).

- South Africa calculated the loss to GDP during the 1992 drought at about 1.8%, representing US\$500 million. This is a substantial impact from a sector playing a relatively small role in the economy (FAO, 2004). 50 000 jobs were lost in the agriculture sector, with a further 20 000 in related sectors, affecting about 250 000 people (FAO n.d.). The 1992 drought reduced agricultural GDP by about ZAR1,2 billion, and caused a 0.4–1% loss in economic growth.
- The Zambian government lost \$300 million, which translated into a 39% drop in agricultural output and a 2.8% decline in the country's GDP (FAO, 2004).
- Zimbabwe experienced a 45% drop in agricultural production, a 62% decline in the value of the stock market, a 9% drop in manufacturing output and an 11% drop in GDP. The number of food insecure households among communal farmers in Zimbabwe more than doubled during the drought. The level of Kariba Dam, which supplies hydropower to both Zambia and Zimbabwe, fell below the level required to generate power.

According to the SADC Policy Paper on Climate Change, there is already evidence of the potential impact of a drier SADC. In a number of SADC countries changes to the length of the growing season are already evident leading to a drop in agricultural productivity due to lower crops yields. These reports are increasing and becoming persistent, leading to an increase in food insecurity and a rise in food prices (Lesolle 2012). Conflict over resources is evident in the conflict over fishing in the Zambezi, and over water along the main river basins and land within some SADC countries as arable land, water, food and fish stocks are reduced as a result of increased flooding and prolonged drought (Lesolle 2012).

In addition to conflict over food security, there are additional challenges regarding energy generation and drought in SADC. At smallholder scale, drought may reduce the growth rate of trees used for fuel wood reducing the natural harvesting ability of local communities and potentially destroying the ecosystem functioning of forests. The impact of drought on energy at national scale is mostly felt through losses in hydropower potential for electricity generation. The table in Box 4 gives a summary

of countries across Africa affected by drought through hydropower.

The effects of droughts and their impacts on energy production are described in more depth in the following case from Tanzania where drought affected the entire economy (Box 5). This illustrates the major importance of the interconnected impacts of climate extremes.

Box 4: Hydropower energy generation and drought

Country	Drought Period	Consequences
Uganda	2004–2005	Reduction in water levels at Lake Victoria resulting in reduction in hydropower generation by 50MW.
Kenya	1998–2001	Massive drought decreased hydro generation (25% in 2000), which had to be replaced by more expensive fuel-based generation. Power rationing in 1999–2001.
Lesotho	1992	Hydro operation limited to six months, leading to 20% reduction compared to 1991.
Malawi	1997–1998	Engineering operations affected by drought. Amount of hydro energy generated was 6% less than in years of normal rainfall.
Mauritius	1999	Massive drought led to 70% drop in normal annual production of electricity.
Tanzania	1997	The Mtera dam reached its lowest ever level resulting in a 17% drop in hydro generation, use of thermal generation to meet the shortfall, and power rationing.
Zambia	1992	Poor rainfall resulted in a 35% reduction in hydropower generation compared to the previous year.
Zimbabwe	1993	Drought led to a drop of over 9% in energy production compared to 1992.

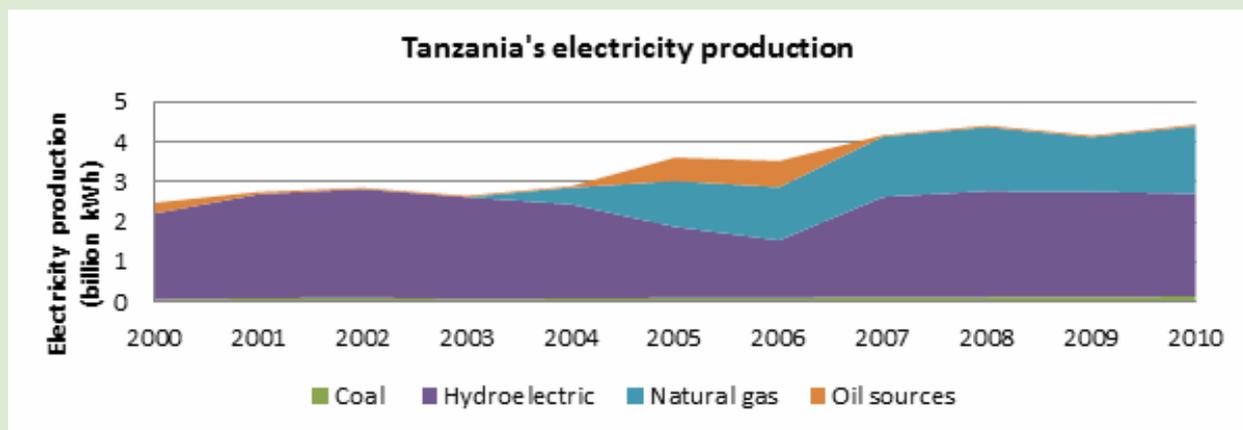
Source: ECA (2007)

Box 5: The interconnected effects of drought on the Tanzanian economy

Water, energy and food tensions are best illustrated in the Great Ruaha River Basin in Tanzania. The Great Ruaha basin is home to significant rice agriculture upstream, a RAMSAR wetland site and the Ruaha National Park in the central reaches of the river and two major hydroelectric power stations before the Ruaha and Rufiji rivers meet. During the dry season, water becomes increasingly scarce in the Great Ruaha River basin. The unavailability of water in the central and lower reaches of the river has resulted in low flows to the detriment of the environment in the Ruaha National Park and a reduction of the country's hydropower. This catalysed a response from the national government in the form of an attempt to

manage upstream agriculture and irrigation. Agriculture is responsible for 90% of livelihoods in the basin and needs to be balanced with national electricity requirements and the conservation of the environmentally sensitive wetland and national park.

In response to the variability of water supply in the Ruaha and the heavy dependence on the resource for electricity production, the country has begun to diversify its energy sources. The need to reduce dependency on the availability of water for electricity generation has coincided with the discovery of natural gas sources in Tanzania. Although a move away from renewable energy to a fossil fuel source, the added benefits include a wider electricity base and additional opportunities for economic development without water constraints.



World Bank (n.d.)

According Midgley et al. (2011), the current climate impacts are high in particular regions of SADC. Studies of climate impacts need to combine both climate sensitivity and exposure in order to consider the full range of climate vulnerability. Local adaptation measures are not included in the climate impacts depicted in Figure 14 below showing

past and current experience (2008) of climate stress in southern Africa. The map highlights the impact of cyclones and floods on the eastern seaboard of southern Africa and on the island states. The whole region is at risk of both droughts and periodic flooding. Climate impacts on sensitive afro-montane forests are also indicated. The

stable, productive and humid ecosystems (indicated by blue coloration) are resilient by contrast, while the larger

patch of resilience in southern Tanzania is the effect of lack of crowding in this region and more fertile soils.

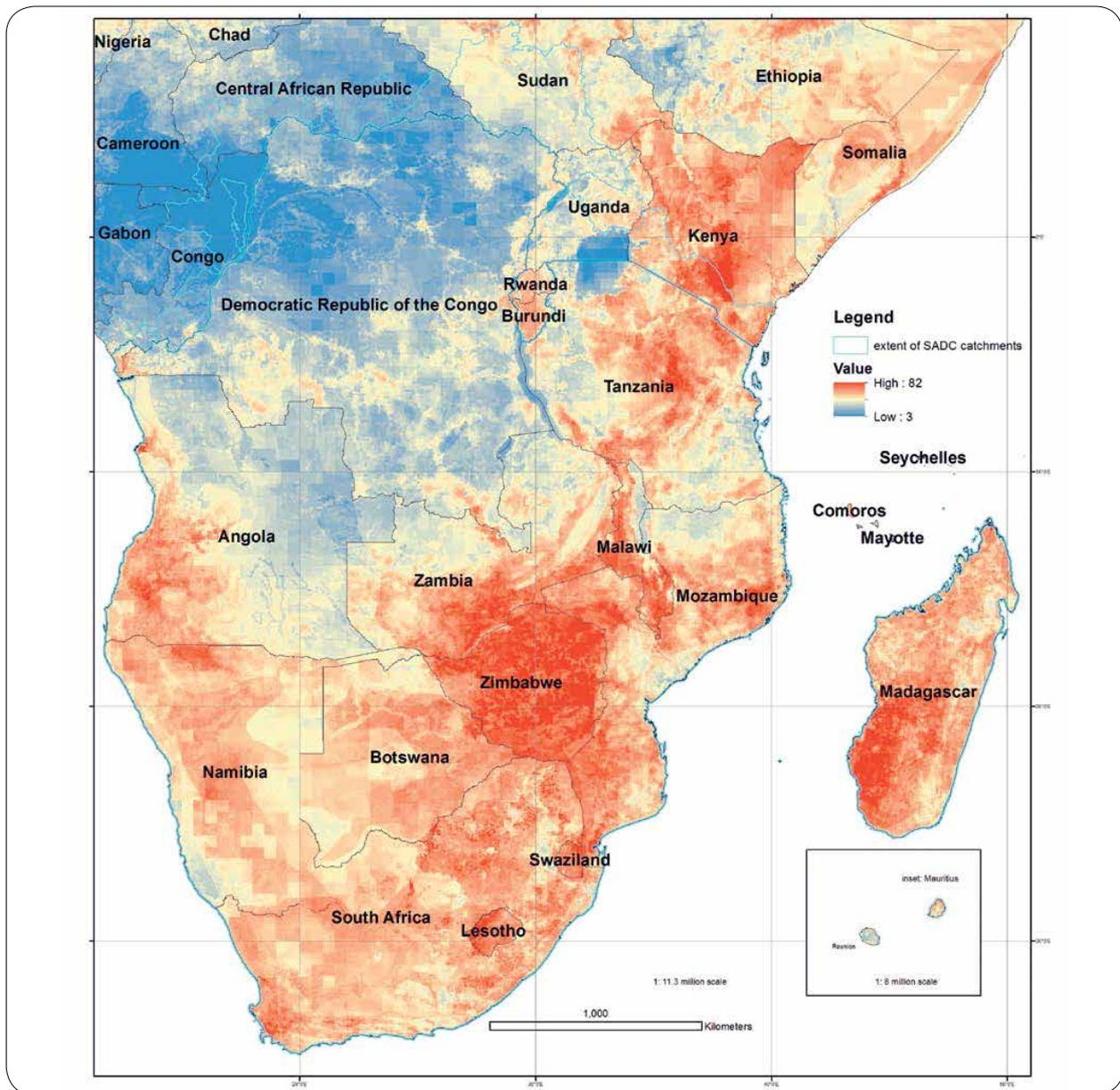


Figure 14: Climate impact overlay (2008) summary layer. Red values indicate areas of high climate impact, while blue areas indicate low impact. Source: RCCP (2010)

Health:

The World Health Organization (WHO) has developed a risk assessment method for estimating the disease burden attributed to climate-sensitive diseases. Their estimates have shown that in 2000, climate caused 160 000 deaths and 5 500 000 disability-adjusted life-years through malaria, malnutrition, diarrhoeal disease, heat waves and floods (Young et al. 2010). Health impacts are wide; however, it is difficult to attribute diseases to climate change alone (Box 6). Current disease control mechanisms in SADC therefore focus on solving the issues at hand.

Box 6: Malaria

In warmer conditions, mosquitoes reproduce more efficiently and must feed more often. Surface water patterns also influence mosquito breeding and humidity affects mosquito survival. Furthermore, the distribution of vectors also changes as a result of local warming, for example, the northwards extension of the vector tick for tick-borne encephalitis in Sweden over the past two decades, the northwards extension of the water snail that spread schistosomiasis in eastern China, and the ascent of highland malaria to higher altitudes in parts of eastern and southern Africa.

However, malaria has also been shown to be strongly impacted by non-climatic factors such as land use, control measures, and socio-economic, demographic and vulnerability information. Rainfall and temperature affect the breeding areas of the anopheles vectors within mosquitoes, for example, altering the period of time required for transmission.

While there is evidence of these increased replication rates in mosquitoes, it is unclear whether they translate into increased incidence of, and mortality from, malaria in human populations.

Source: IPCC (2007a)

During flooding for example, one of the major concerns is the spread of disease and other related health impacts. Cholera, dengue fever and dysentery are diseases associated with ponding of water near rural or peri-urban settlements without adequate sanitation or drainage (Box 7). The spread of these diseases is not only a burden on the health services of a country, but also on the economic productivity of labour. The spread of these diseases across borders is a factor which SADC is aware of. This is evident in the SADC Regional Water Strategy and the policy framework on communicable diseases.

Box 7: The spread of Cholera

Cholera is a waterborne disease which, in the absence of adequate sanitation and water supply, is able to spread rapidly across countries. Evidence of the spread of cholera is indicated by an outbreak of cholera in 2008 in Zimbabwe, as a result of inadequate water supply and sanitation, which spread to countries bordering Zimbabwe including Botswana, Mozambique, Zambia and South Africa. In November 2013 a cholera outbreak was confirmed in the Kunene region of northern Namibia. In response, the Namibian Ministry of Health and Social Services, the WHO, UNICEF and the Namibian Red Cross Society were deployed to the affected region. Angolan authorities and partners were notified in an attempt to reduce the spread of the outbreak.

This example shows that the health interlinkages between SADC countries are already evident. With an increase in climate-related disease and increased migration between SADC countries, the risks associated with the spread of disease increase.

Source: OCHA (2014)

4. CLIMATE CHANGE IN SADC

4.1 Climate change projections for SADC

Projected changes within the SADC region into the future are variable, as a result of the different climatic forces controlling the weather patterns. In terms of temperature, the changes are less distinct, with an overall warming projected, regardless of the region indicated in the figure below. Overall temperatures in the western regions of SADC are projected to increase more than those in the east.

Climatically there are distinct regions within SADC with particular climate forcing. The northern regions of SADC, which include the Congo basin and Zambezi valley, are impacted by the movement of the ITCZ (Figure 15). This is especially the case for the Zambezi valley. Drought-prone areas of Namibia, Botswana, and Zimbabwe are

likely to be more vulnerable than the more humid areas of Tanzania or Zambia.

The IPCC Fourth Assessment Report (IPCC 2007) indicates that land surface warming in southern Africa is likely to exceed the global mean land surface temperature increase in all seasons. As indicated in Figure 16 below, high warming rates are projected over the semi-arid south-western parts of the subregion covering north-western South Africa, Botswana and Namibia in particular (IPCC 2014). Projections show that changes will not be uniform over the region with the central, southern land mass of SADC, extending over Botswana, parts of north-western South Africa, Namibia and Zimbabwe being likely to experience the greatest warming of 0.2°C to 0.5°C per decade. In this area, the frequency of extremely

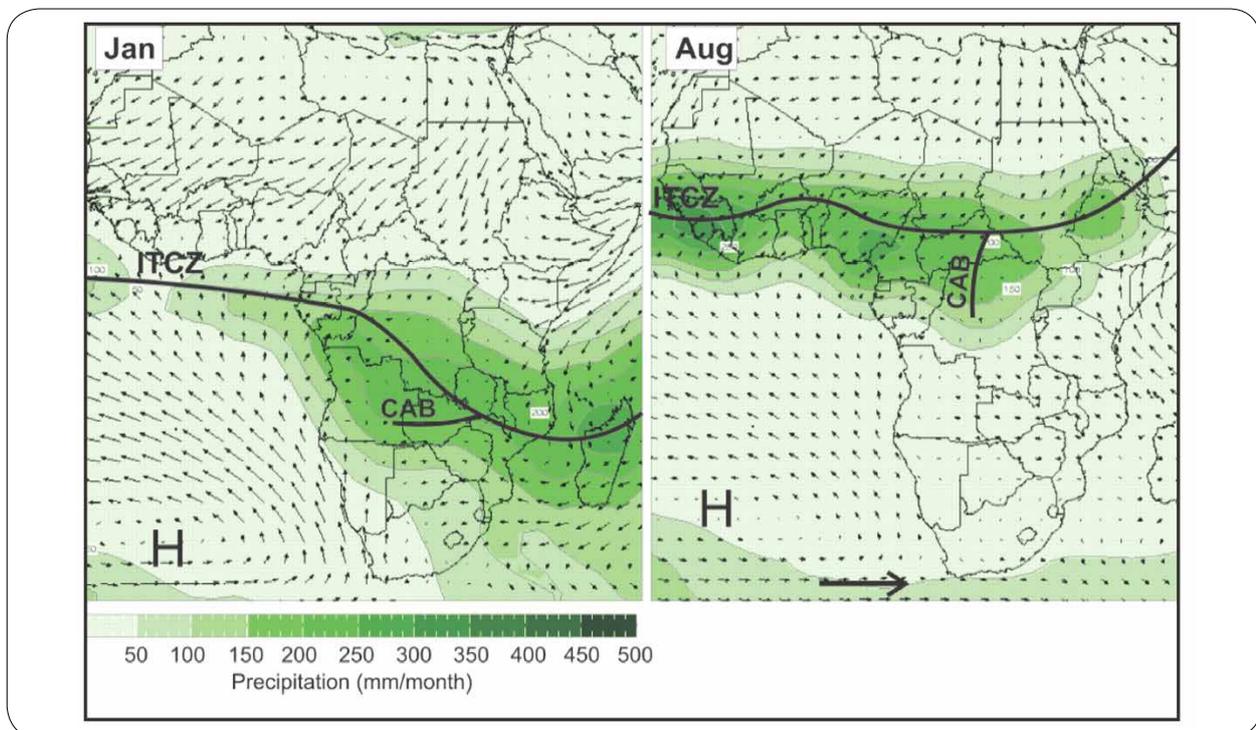


Figure 15: The average position of the ITCZ over Africa, with the major moisture transport paths during the southern hemisphere winter and summer. Note that the line is the average centre of the ITCZ, which in reality is a broad band of convergence on either side. IOC refers to the Inter-Ocean boundary and is also called the Congo Air Boundary (CAB) Source: Kristen et al. (2007)

dry winters and springs will increase to ~20%, while the frequency of extremely wet summers will double. Warming is also predicted to increase the frequency and intensity of tropical storms in the Indian Ocean (Young et al. 2010). There is a 90% probability that the extent of drought-affected areas will increase. Drought prone areas of Namibia, Botswana and Zimbabwe are likely to be more vulnerable than the more humid areas of Tanzania

or Zambia (Davis 2011). In the northern regions of SADC, the role of the ITCZ, the major driver of rainfall in the region is less certain. Depending on where the ITCZ moves, (northwards or southwards), the areas around the Zambezi basin and Congo are affected, becoming drier or wetter.

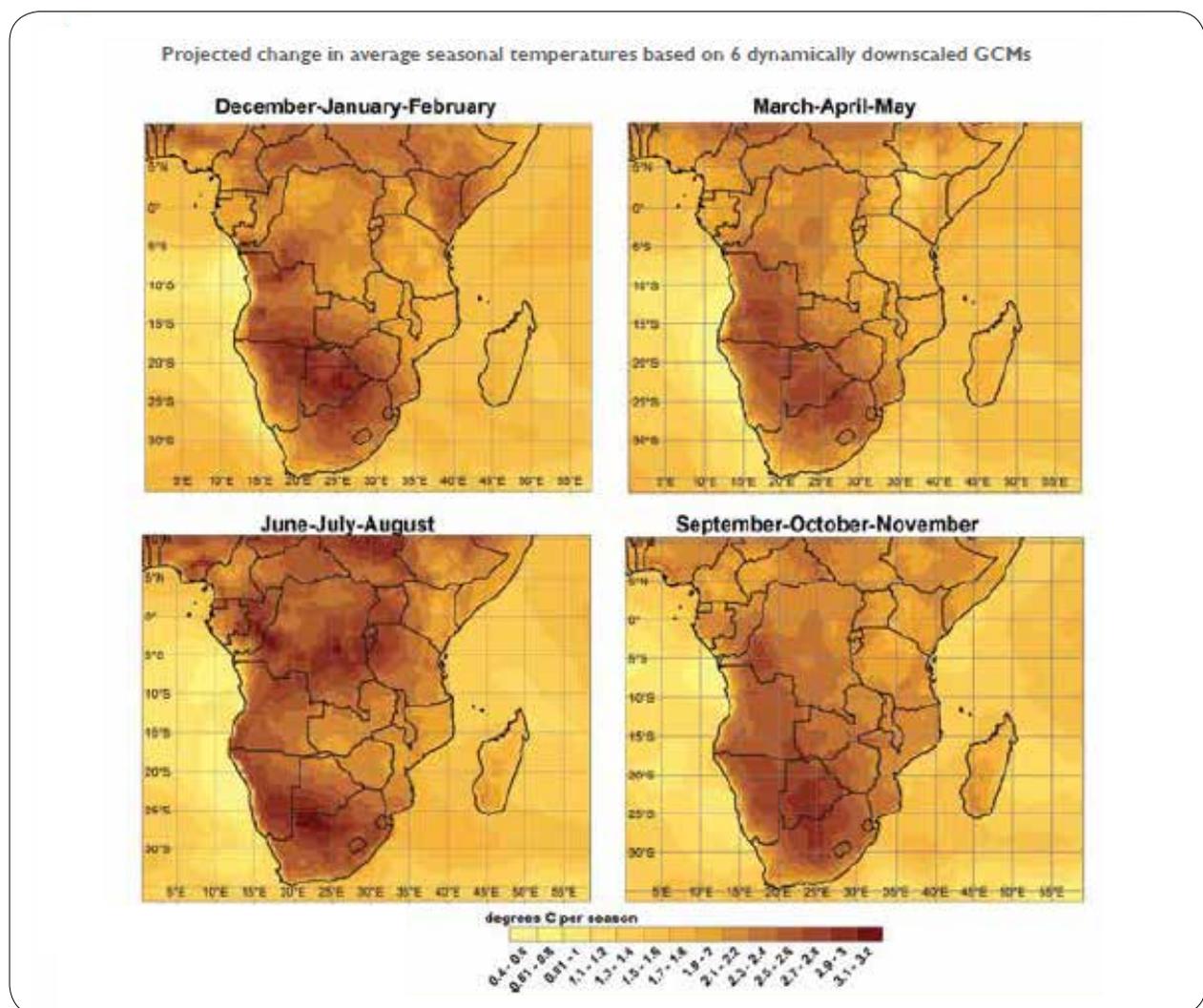


Figure 16: Projected change in average seasonal temperature by 2036–2065 relative to 1961–2000 period based on the median of six dynamically downscaled global circulation models (GCMs) Source: Davis (2011)

As a result of the increasing temperatures and other climatic forces, the rainfall within the region is projected to change as indicated in the figure below. Below-normal rainfall years are projected to become more frequent. The distinct differences between the north-west and south-east of the SADC region are as a result of the different climatic forces.

The median of change of a number of dynamically downscaled models indicates that most of the southern African region is most likely to experience a decrease in annual rainfall, with rainfall increases suggested over east Africa and the central interior of southern Africa. Of particular interest are the relatively large rainfall decreases projected for the south-western Cape of South Africa

in winter (JJA), and the relatively large rainfall increases projected for East Africa during summer (DJF). The different responses of rainfall over large parts of southern Africa is partly due to the uncertainty associated with the response of regional climate to larger-scale forcing, as well as different regional forcing applied in each case. Regardless, there is a robust and consistent message of future rainfall decreases over the south-western Cape of South Africa, parts of Zimbabwe, Mozambique and Zambia, and of rainfall increases over East Africa and southeast South Africa in the DJF and MAM months. These shifts in rainfall patterns are linked to the climate forces mentioned previously, in particular the movement of the ITCZ.

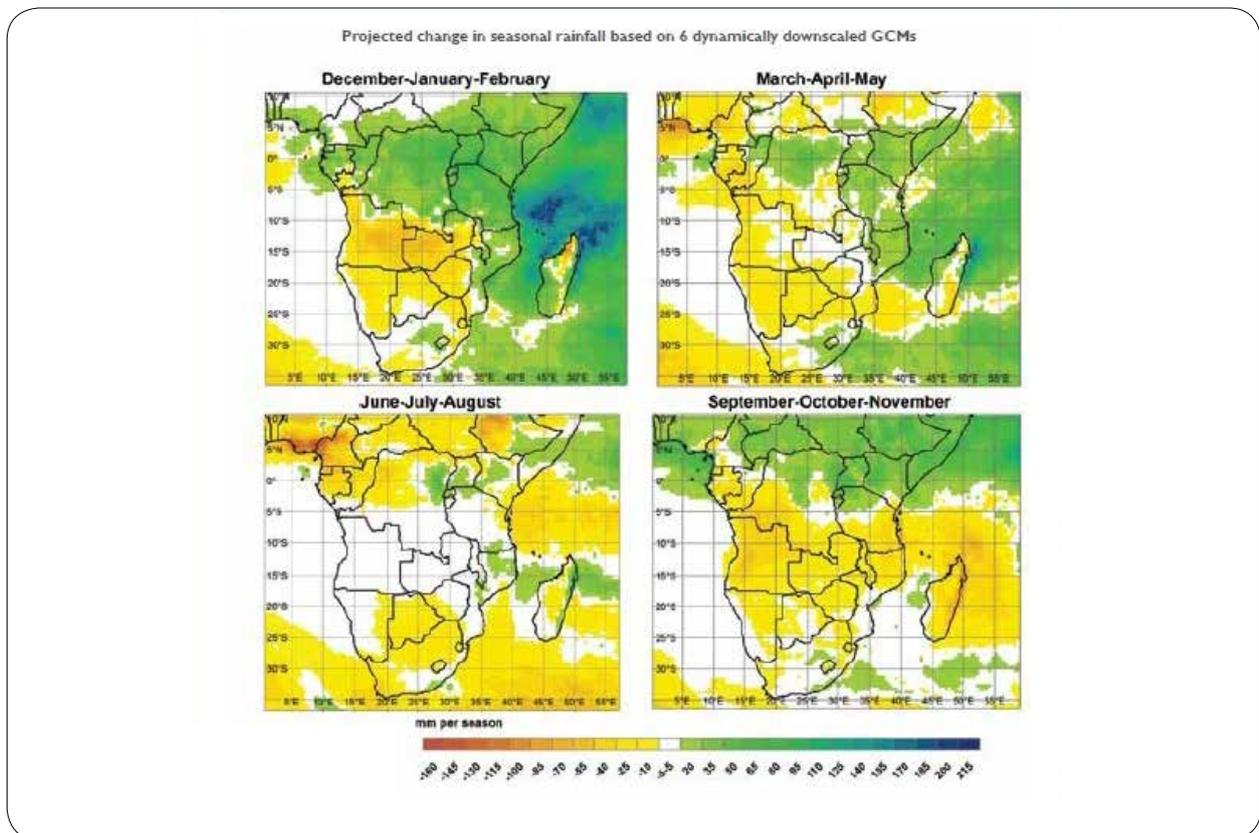


Figure 17: Projected changes in mean summer (DJF), autumn (MAM), winter (JJA) and spring (SON) rainfall for the period 2036–2065 relative to 1961–2000 based on the median change of 6 dynamically downscaled GCMs Source: Davis (2011)



In summary, potential projected climate changes for the SADC region include

- An overall annual warming, with a greater increase in temperatures in central regions relative to coastal regions.
- An increase in the number of very hot days (> 35°C).
- A general decrease in annual rainfall over the south-western Cape of South Africa, and parts of Zimbabwe, Mozambique and Zambia; with particularly large decreases during winter in the south-western Cape of South Africa.
- An increase in annual rainfall over East Africa and southeast South Africa, including large increases in rainfall for East Africa during summer.

4.2 Future climate change impacts and interdependencies

Water resources

The water sector is the primary impact channel through which climate is felt. Flooding and drought are water-related climate impacts which have been experienced across a number of SADC countries over time (as described above). Both drought and flooding not only have physical impacts through damage to property, but also health impacts through malnutrition and waterborne diseases for example. Damages to agriculture following a drought or flood may negatively impact the food security of a country. In a regional context, devastation following a drought or flood may cause large scale migration to urban areas or countries which hold opportunity.

Agriculture

The SADC agriculture and food security ministers have acknowledged that climate change affects food security. The impact of climate change on precipitation, temperature and the increased frequency of drought

and flood are considered detrimental to the agricultural sector. Agriculture is particularly vulnerable because it is highly dependent on climate variables, and also because of the regions semi-arid nature. The impacts of climate change on agricultural activities have been shown to be significant for low-input farming systems in developing countries in Africa. Similarly, tourism in SADC Member States is predominantly wildlife based and this renders the sector even more vulnerable to climate change, particularly given that climate change is already impacting on populations of key wildlife species.

In the following figure:

... orange and red colours denote a decrease in potential cereal output, whereas green colours denote a possible increase.

Already the climate of large swathes of Namibia, Botswana, South Africa, Lesotho, and smaller proportions of Swaziland and Zimbabwe is unsuitable for crop production. Substantial decreases in the productivity of crop-suitable land in Namibia, Botswana, South Africa, and Zimbabwe are projected. Parts of Angola, Malawi, Mozambique, Zambia, and Madagascar are also projected to experience declines in crop production under climate change. However, substantial increases (over half of each country's area) are projected for Angola, Democratic Republic of Congo, Madagascar, Tanzania, and Zambia (Davis, 2011 p.54).

Note however, that the projection used for the development of this figure is the "hotter" and "drier" scenario, and therefore is one of a number of possible future climates in SADC. The potential cereal output regions are largely based on rain-fed agriculture, and are not necessarily regions which are irrigated for cereal production.

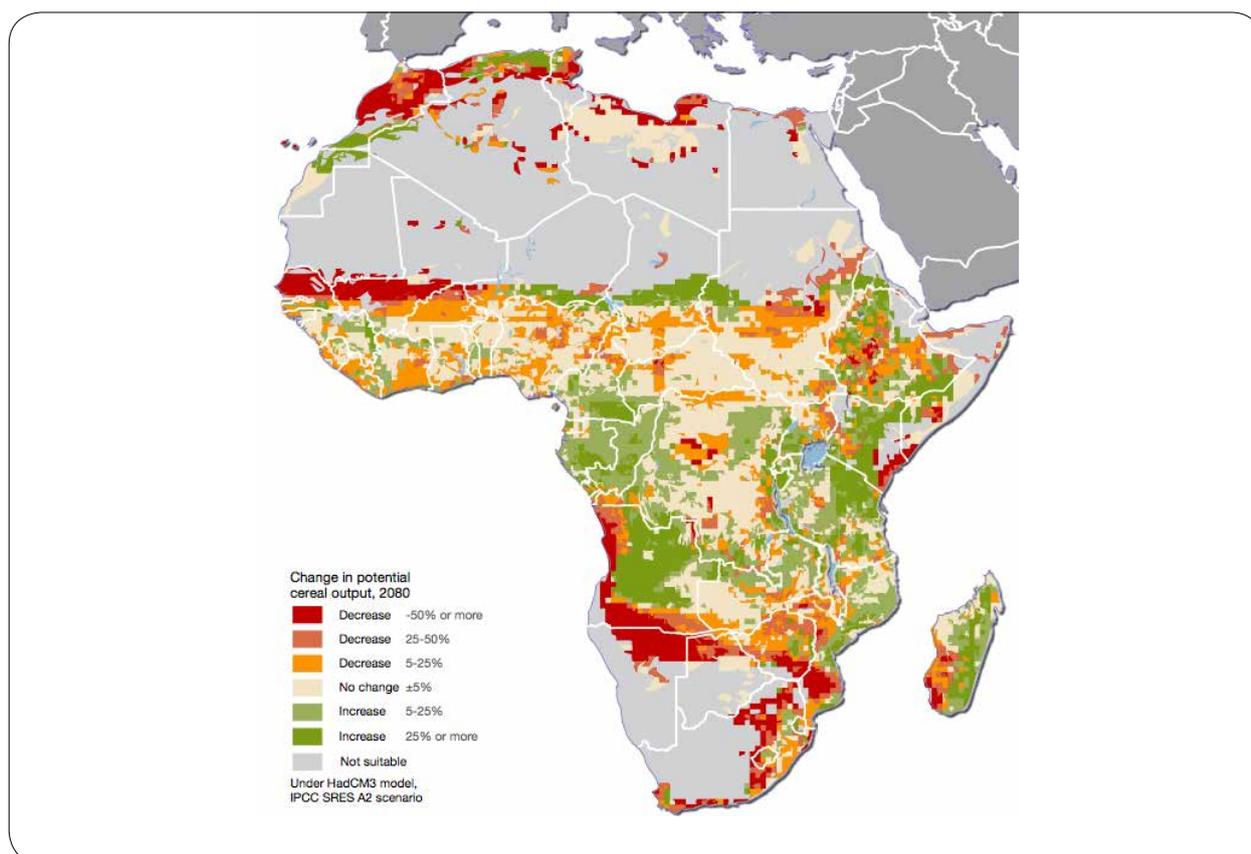


Figure 18: Projected changes in cereal productivity in Africa due to climate change using the A2 socio-economic scenario (2080) Source: Ahlenius (2009)

An altered climate with an influence on the type of agricultural crops grown by farmers, will impact the livelihood opportunities available to them. This change in crop selection could lead to changes in land management practices, such as the timing of prescribed burning to prepare land for planting, encouraging a transition from crop production to grazing accompanied by a potential increase in the use of fire to stimulate the production of new grass, or greater dependence on non-timber products such as honey, in which fire is used to smoke hives. The linkages between climate, vegetation cover, fuel conditions, land use practices and fire frequency are made more complex by the likely generation of feedback loops (SADC2010).

In terms of livestock, there are a number of diseases which may become increasingly pervasive with changing climate. Transboundary animal diseases (TADs) are a risk for the entire livestock sector across SADC due to the mobility of livestock (alive and dead) and disease vectors across borders. Diseases which have a risk of increasing in occurrence include Rift Valley Fever transmitted through mosquitoes, which are believed to become more widespread with some climate change projections. Black leg infection is another disease which is at higher risk of spreading during drought. Therefore in both a wetting as well as a drying future, there are additional risks associated with livestock health. In addition to pests and viruses, the heat associated with a warming climate



may negatively impact livestock. With increases in excess of 3°C projected for 2060 in a hotter future, there may be regions within South Africa which become too hot for livestock. According to the LTAS Phase I report on the agriculture and forestry sectors (DEA 2013a), 32°C is the accepted comfort threshold for most cattle breeds. This temperature is already exceeded in a number of regions.

Compared to commercial agriculture, smallholder farmers are less adapted to climate change and usually do not have access to financial instruments such as credit and insurance to hedge against climatic risk, thus leaving the poor and the marginalised more exposed and vulnerable. Adaptation also involves a combination of various individual responses at the farm level and assumes that farmers have access to alternative practices and technologies available in the region. Climate change will have significant impacts across SADC through changes towards decreased or improved capacity for agricultural production as indicated in the figure above.

Direct impacts such as reduced income and labour productivity (due to heat) in rural communities as a result of negative climate change impacts on agricultural output can be expected. Without adaptation, increased heat is expected to decrease plant yields in addition to negatively affecting livestock. For example, with a 2°C increase in temperature and a 10% reduction in rainfall, the maize yield for South Africa is expected to reduce by 0.5 tonnes per hectare (DEA 2013a). The knock-on effects will put additional strain on local government in providing services and promoting social and economic development.

Future climate change impacts also have the potential to create a number of opportunities for agriculture. In East Africa and in the southeast of South Africa, there is the potential for a projected increase in annual rainfall during the summer. This may benefit particular crops such as sugar cane. However, the impact of increased temperatures may negate the opportunities of increased rainfall through pests or diseases for example. Heat

or pest resistant species will be more suited to future climatic impacts.

Trading food and energy

South Africa, as a major exporter of crops such as maize into SADC, needs to take into account the potential for changes in production. Optimal growing regions may shift to other countries in SADC, while regions within South Africa may need to adapt to more efficient or suitable crops according to climate and market requirements.

South Africa exports a large amount of primary production into SADC for consumption. Climate change impacts such as drought or flooding in SADC may provide a risk as well as an opportunity for South Africa. For example, should floods destroy a major part of the economy of a country, it may be unable to afford to import foodstuffs. Alternatively, the destruction of its crop production may pose an opportunity for exports from South Africa. The opposite also holds for South Africa; major climatic events may destroy production within the country forcing the import of foodstuffs from SADC or from other countries. With current imports from within SADC vulnerable to climate change impacts depending on where they are produced, further expansion of imports may alleviate or increase the risk of climate impacts.

Energy is also traded and hydropower and gas are important commodities traded within SADC. The potential impacts of the climate scenarios on energy need to be explored further.

Migration and settlements

The impact of global warming and climate change on the SADC region already contributes to in-country migration. With more crop failure associated with the recurrence of droughts, more and more people, especially subsistence farmers abandon their land and migrate into towns and cities to seek alternative income generating opportunities. Climate change is expected to exacerbate

these environmentally induced migration patterns. The challenge for SADC Member States is to identify the appropriate policy options to address the phenomenon. SADC may consider developing policy responses to assist the most vulnerable Member States while also taking into account the most pressing needs of the island Member States (Lesolle2012). Migration of people into and out of South Africa will have a subsequent impact on resource allocation, settlements and health. These impacts are taken into consideration when identifying the role of climate change in migration patterns. Triggers of migration such as increasing levels of local unrest and social instability will be taken into account.

Saltwater intrusion, coastal erosion and groundwater degradation occur as a result of sea level rise. Mozambique and the Island States are especially sensitive as the majority of the population live close to the coast. Seychelles has noted that climate change may damage the islands' protective reefs, threatening their survival. These risks, due to future sea level rise, will severely impact the coastal settlements in these countries.

The nature of settlements in a number of countries of relevance and particular interest within SADC are explored in greater detail below linking this to their propensity to migrate. For example, populations which do not have access to adequate water and sanitation will be forced to migrate into urban centres in order to access services.

In Lesotho, 24% of the rural population have access to improved sanitation facilities, while 71% of the rural population have access to an improved water source. Thirty-two per cent of the urban population have access to sanitation and 90% have access to water. According to Lesotho's National Adaptation Programme of Action (NAPA) (MoNR 2007) the livelihoods of over 85% of the population are exposed to the risks of climate change. In particular rural migration to urban centres is likely to take place as rural livelihoods become difficult to sustain.

The same is true for the vulnerable rural populations in Tanzania, which lack adequate access to water and sanitation services. Seven per cent of the rural population have access to improved sanitation facilities compared to 24% in urban areas. Access to an improved water supply is 44% and 78% for rural and urban areas respectively. The major causes of vulnerabilities at village, district and national levels is climate change associated with prolonged heavy rainfall sometimes causing flooding, drought, epidemics and also pest, vermin or plant diseases. In order to sustain livelihoods and economic growth, adequate food, good health, access to clean and safe drinking water, and sufficient energy for domestic and industrial use are critical. Tanzania's NAPA has thus identified various adaptation strategies which aim to improve infrastructure and access to vulnerable communities in the country (VPO, DOE 2007).

In Angola, the housing sector faces the greatest risks arising from a changing climate due to low quality housing and inadequate access to basic services, flooding and erosion. The rural population in Angola is especially poorly serviced, with only 19% having access to improved sanitation facilities (85% urban). Thirty-four per cent of the rural population have access to an improved water supply (66% urban). In addition to the rural settlements, coastal settlements in Angola are also at risk. According to the NAPA (MoE 2011), approximately 50% of the Angolan population lives along the coast, and approximately fifty thousand people depend on traditional fishing. The impact of climate change along the coast depends on three factors: increase in sea level, changes to maritime coastal currents (the Benguela cold current and the Gulf of Guinea current), and the changes to sedimentation or erosion along the coast if there are alterations to the hydrology of the rivers that discharge into the Atlantic Ocean. Many low-lying areas may be subject to flooding and may become inundated.

Ecological function and biodiversity

According to the IPCC 2014 report on Africa (IPCC 2014), biomes are projected to shift considerably under a future climate. The Western Cape Province and the east coast of South Africa, and areas within Zambia, Mozambique and Angola are especially vulnerable. However, there are substantial uncertainties regarding vegetation projections as these are not driven by climate alone. Improvements in forecasting vegetation responses to climate should help in reducing the uncertainty associated with vegetation feedbacks to climate forcing. As biomes shift, ecosystem function may not be able to support traditional rural livelihood strategies. Therefore, climate change impacts on ecosystem function, will impact not only agriculture,

but populations dependent on rural livelihood strategies too.

Climate change will alter the boundary limits of where current species are able to survive, with consequent changes in the growth, survival and distribution of species. All biological systems have thermal constraints; hence, rising temperatures will have impacts on ecosystems and the species they contain. According to the IPCC 2014 report on Africa, woody vegetation will experience a net increase in central, eastern and southern Africa. However, climate alone is not the major driver, with anthropogenic land use change including the expansion of agriculture, livestock and grazing having an impact.

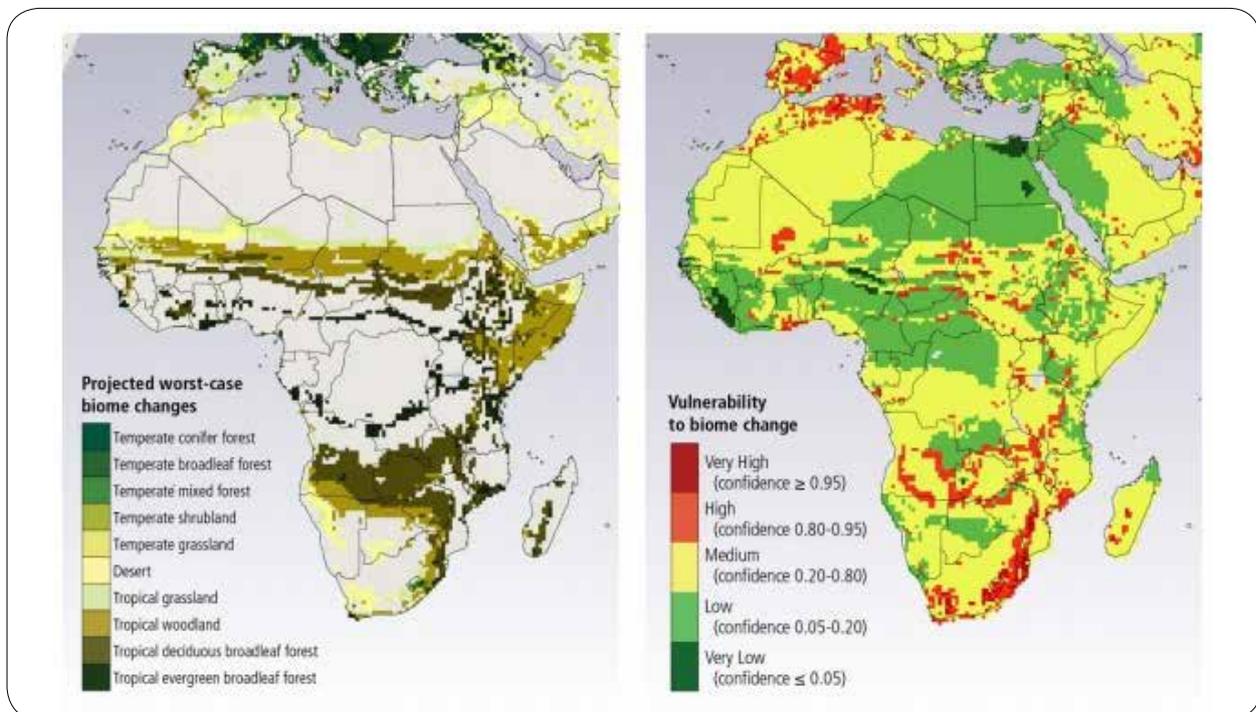


Figure 19: Left – projected biome change from the periods 1961–1990 to 2071–2100 using the MCI Dynamic Vegetation Model. Change is indicated if any of nine combinations of three GCMs (CSIRO Mk3, HadCM3, MIROC 3.2 medres) and three emissions scenarios (BI, A1B, A2) project change and this is thus a worst-case scenario. Colours represent the future biome predicted. Right – vulnerability of ecosystems to biome shifts based on historical climate (1901–2002) and projected vegetation (2071–2100), where all nine GCM-emissions scenario combinations agree on the projected biome change. Source: IPCC Africa (2014)

Climate change may affect the biodiversity of species as indicated in the figure below (DEA 2013b), which shows that modelled bird species richness under current climate conditions in southern Africa is highest in association with the high altitude regions of the Drakensberg and eastern coastal escarpment. Projected species range change reflects a slightly greater concentration of species in the high altitude regions, and lower concentrations in more arid regions.

In addition to biodiversity and ecosystem shifts, climate change projections will shift the conditions suitable for the growth of particular trees and grasses, some of which could be more fire tolerant than others. Climate change could lead to an additional increase in the frequency and intensity of fires by creating ignition sources through increased lightning; longer dry periods; more biomass production due to wetter rainy seasons; and hotter, drier and windier yet more extreme weather conditions able to fan the spread of fires and fire disasters. Therefore,

climate change has the potential to influence the number of natural and human factors that could significantly affect the fire regimes in the savannah woodlands and forests of the SADC region. These impacts (shifts in biodiversity, increase in fire frequency/intensity) have combined impacts on ecosystem services and how they function.

Through the predicted loss of biodiversity due to changes in temperature and rainfall, there is a significant risk of ecosystem loss through land degradation. Land degradation can be caused by a multitude of factors including land use change, drought, flooding or an increase of fire frequency and intensity. Many of these factors, including fire, may be driven both by climatic change and activities to sustain rural livelihoods. The negative implications for the environment and human welfare include vegetation degradation and biodiversity loss impacting livelihoods and economies at community and national level.

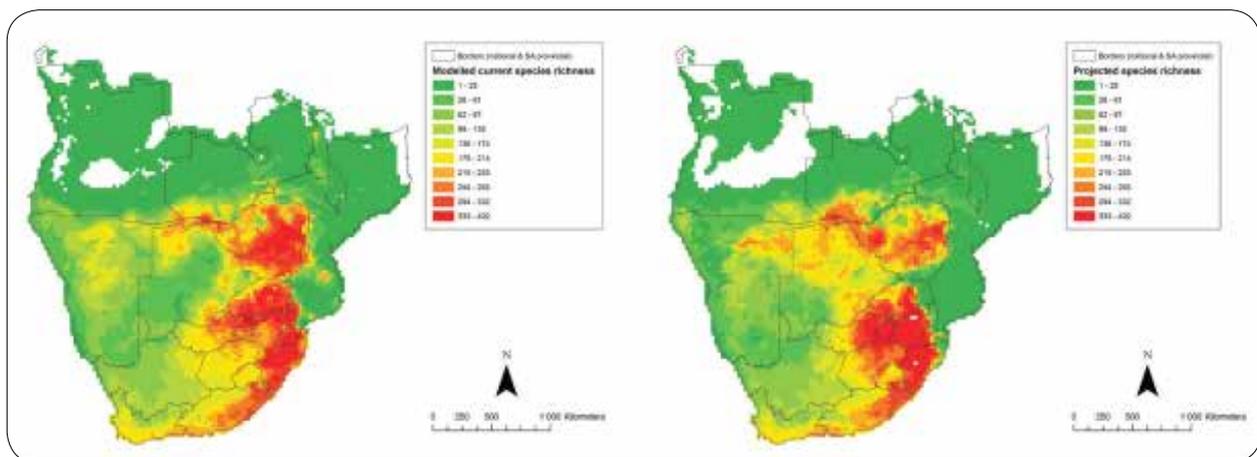


Figure 20: Current modelled species richness of 623 terrestrial bird species (left) and projections of bird species richness change (right) under mechanistically downscaled climate scenarios (2050) Source: DEA (2013b)



5. EXISTING INTER-RELATED STRATEGIES IN THE SADC REGION

Knowledge of the existing adaptation responses and strategies in SADC countries is required in order to understand the regional context of South Africa's current and future adaptation responses. There are unequal relationships among SADC countries concerning trade and therefore there are potentially unequal relationships in the region regarding climate change preparedness/readiness. Adaptation responses to climate change from a SADC perspective are captured in the respective national climate change adaptation strategies in addition to the regional policy paper on climate change. Specific adaptation strategies in addition to other relevant integrated strategies are also considered.

5.1 National Adaptation Planning

The individual adaptation capacity of surrounding countries within SADC is of importance to South Africa and the wider SADC region as a whole. The national climate change strategies of SADC countries need to be robust, and implemented to ensure a regionally secure SADC. Improved adaptation at a national scale in neighbouring SADC countries will help to ensure stability in the region under an uncertain climate. All countries have been involved in the development of national statements on climate change and national adaptation plans of action (NAPAs) and national adaptation plans (NAPs). Some are of better quality than others; however, in all cases their implementation is critical.

There is an opportunity for learning across all SADC countries regarding the development of feasible and effective NAPAs in least developed countries (LDCs) in the region. These include the DRC, Lesotho, Madagascar, Malawi, Mozambique, Tanzania and Zambia. Regional integration, knowledge sharing and technology transfer for building climate resilience in the region are possible through improved interaction among countries so that resilience to climate change impacts may increase. In

many NAPAs, the scale of implementation is not well defined. Therefore, although inter-regional opportunities may exist, these are not well aligned with neighbouring NAPAs or policy processes. There is substantial work required to ensure the NAPAs consider transboundary and subregional aspects fully. NAPAs are particularly focused on climate change adaptation and, therefore, are not always of relevance to particular sectors and their relevant planning processes. This runs the risk of leading to maladaptation. Capacity building programmes do exist; however, they need to be expanded to all of the countries in southern Africa, and not only to the LDCs. Building national capacity is critical in the NAPA process as SADC is unable to implement adaptation measures alone. The regional institution requires national implementation to ensure that changes take place.

All countries within SADC (not only the LDCs) are currently involved in the development of NAPs. This process, because it is being done by all countries nationally, has real potential for being integrated across the region. Currently, this is not taking place in a systematic manner. Therefore, like the NAPAs, the NAPs too could be improved at a regional level through capacity development and knowledge sharing.

5.2 Regional climate change adaptation responses

SADC Policy Paper on Climate Change

The SADC Policy Paper on Climate Change (Lesolle 2012) provides a summary of the observed and expected climate change in SADC countries, to provide a background to the growing need of the SADC region to develop policy strategies in response to climate change. Both adaptation and mitigation options are argued in a range of different sectors to promote regional integration and socio-economic development in the SADC region.

The policy paper highlights that the SADC approach to climate change must be cross-sectoral and must address the vision and core values of SADC with all sectors participating and accountable through good governance. Two key aspects of the future SADC climate change programme include; (a) establishing an implementation strategy and (b) developing an action plan. This is broken down into three key steps. These are:

- Step 1:** Establish a permanent commission on climate change at the SADC Secretariat.
- Step 2:** Define the terms of reference for the SADC commission on climate change.
- Step 3:** Refine the regional strategic action plan on climate change.

SADC water sector climate change adaptation strategy

The SADC Climate Change Adaptation Strategy (CCAS) for the water sector (SADC 2011a) aims to improve climate resilience in the region through integrated and adapted water resources management, by promoting integrated water resources management (IWRM) as a priority tool to reduce vulnerability while ensuring that water management systems are well adapted to cope with climate variability. The strategy presents measures to be taken over the next 20 years, and recommends that work on adaptation should start immediately as this would benefit the sectors under present climatic conditions.

The SADC CCAS promotes the adoption of a multi-dimensional approach to climate change adaptation. Through the CCAS, adaptation measures occur at different levels, at different stages of the adaptation process, and in different areas of intervention. The strategy is embodied in the SADC Water Adaptation Cube, portrayed in the figure below, which was designed to raise awareness and facilitate coordination amongst stakeholders.

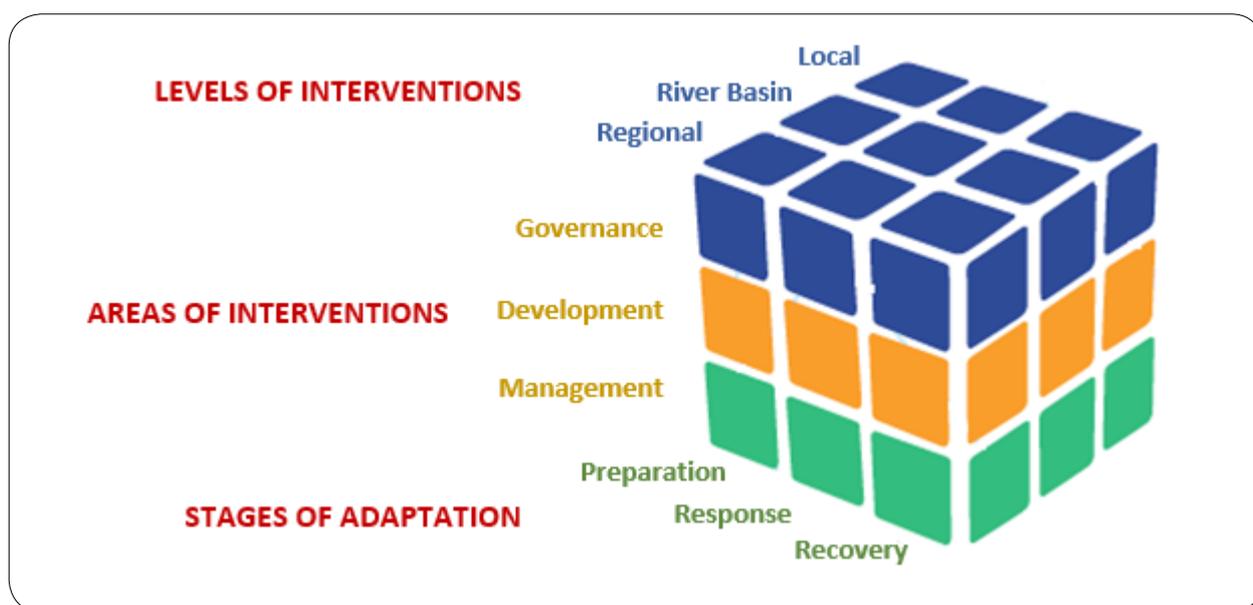


Figure 21: SADC Water Adaptation Cube Source: Adapted from SADC (2011)

Based on the SADC Water Adaptation Cube, the adaptation measures are presented based on the three areas of interventions, namely governance, development and management. All the adaptation measures identified are cross-cutting by nature and should be implemented as such. This implies that each measure rests on the implementation of activities at different levels of interventions (namely local, river basin or regional) and different stages of the adaptation process (namely preparation, response, or recovery). The adaptation measures which have been identified under the CCAS include a range of responses including:

- **Water Governance:**
 - awareness and communication to make climate science accessible to the average citizen
 - research and development to develop local knowledge and technology
 - reforms and mainstreaming to integrate water into the regional policy discourse
 - international negotiations to strengthen the position of the southern African countries in international negotiations
- **Infrastructure development**
 - increase water storage through both natural and constructed mechanisms
 - water supply and sanitation
 - irrigation and drainage improvements to ensure food security
 - flood protection structures to reduce the negative impacts of flooding on land, ecosystems and human settlements
- **Water management**
 - systems to store and share data and information to guide decision- and policy-making
 - incorporate climate uncertainty into planning and decision-making
 - determine groups, places, sectors and ecosystems which bear the greatest risks associated with

climate change

- develop a scientific basis for forecasting, predicting and early warning systems (EWSs)
- integrated water resources, water demand and quality management
- improve the modes of operation of dams to balance the interests of environmental flows, flood reduction, agriculture and hydropower generation

The CCAS, together with other guiding frameworks, creates an enabling environment for implementing strategies to adapt to climate change through regional cooperation. These include the SADC Treaty, the Regional Indicative Strategic Development Plan (RISDP), the Regional Water Policy, the Protocol on Shared Watercourses, river basin agreements, the Regional Water Strategy, and the third phase of the Regional Strategic Action Plan on Integrated Water Resources Development and Management (RSAP III) (SADC 2011b). For example, at regional level the implementation of the CCAS is achieved mainly through RSAP III, which is an official SADC programme for the water sector. The CCAS was designed in alignment with the RSAP III strategic areas of water governance, infrastructure development and water management. Within each of these strategic areas the RSAP III provides a coherent set of activities to contribute to the achievement of the three strategic objectives by focusing on capacity development, social development and climate change adaptation.

Regional Climate Change Programme

SADC's Regional Climate Change Programme (RCCP) for 2009–2014 was aimed at conducting a strategic water resources assessment of climate change impacts on transboundary basins. The programme was also aimed at highlighting regional climate change vulnerabilities and exploring the approaches to evaluating these impacts based on the individual characteristics of the Okavango, Zambezi and Limpopo basins (Pegram et al., 2011).

The following adaptation responses were highlighted as possible ways to adapt the allocation and use of water resources to the impacts of climate change in these basins.

- Adaptation at different scales is required including the micro, meso and macro scales.
- When adapting to uncertainty, adaptation interventions should be at a national or regional level to ensure institutional and financial support to create an adaptive water resources environment.
- Adaptive water institutions requiring
 - i) a clear strategic direction and objectives to guide decision-making
 - ii) decentralised institutional responsibilities
 - iii) organisational flexibility
 - iv) organisational learning.
- Flexible water allocation regimes to adapt to changing water demand patterns.
- Water resource system infrastructure to support economic and social development.
- Appropriate finance for infrastructure and integrated adaptation funding mechanisms at regional, continental and global level.
- Coherent groundwater monitoring programmes.
- Climate and development monitoring systems (Pegram et al., 2011).

This list is a robust identification of adaptation responses. However, as the analysis in this report indicates, there are a number of secondary effects of climate change including the effects on migration, health, human settlements and ecosystems as well as trade which need to be considered in conjunction with the affects of climate change on water and within river basins specifically.

5.3 Sector-specific integrated plans

There are a number of existing strategies which support the capacity of the SADC region to adapt to climate variability and extremes, yet were not necessarily designed for the purpose of climate change adaptation. These may apply only to one sector, or across a range of sectors. Many have been established following particular disasters. For example, unexpected damage due to flooding in 2007 initiated the establishment of the SADC Regional Platform for Disaster Risk Reduction. The platform, amongst other functions, is tasked with investigating the role of climate change and sea level rise on coastal, rural and urban settlements. The most prominent of these agreements within the SADC region and the most pertinent considering the climate change projections is the SADC Shared Watercourses Protocol.

Shared Water

According to the SADC Regional Water Policy (2005), “The SADC region has 15 major river basins which are trans-boundary or watercourses shared by two or more countries. Thus one of the characteristic features in the region is shared watercourse systems, with complex water rights and potential conflicts over utilization of the shared resources. This common heritage also presents tremendous opportunities for cooperation in managing the shared resources for regional economic development and regional integration.”

The allocation of water resources between SADC countries is governed by the Revised SADC Protocol on Shared Watercourses, which came into force in 2003. The objective of the Protocol is to “foster closer cooperation for judicious, sustainable and coordinated management, protection and utilisation of shared watercourses and advance the SADC agenda of regional integration and poverty reduction.” (SADC 2005). A large number of countries within SADC share river boundaries, and therefore potential future risks of meeting the allocation requirements need to be considered.

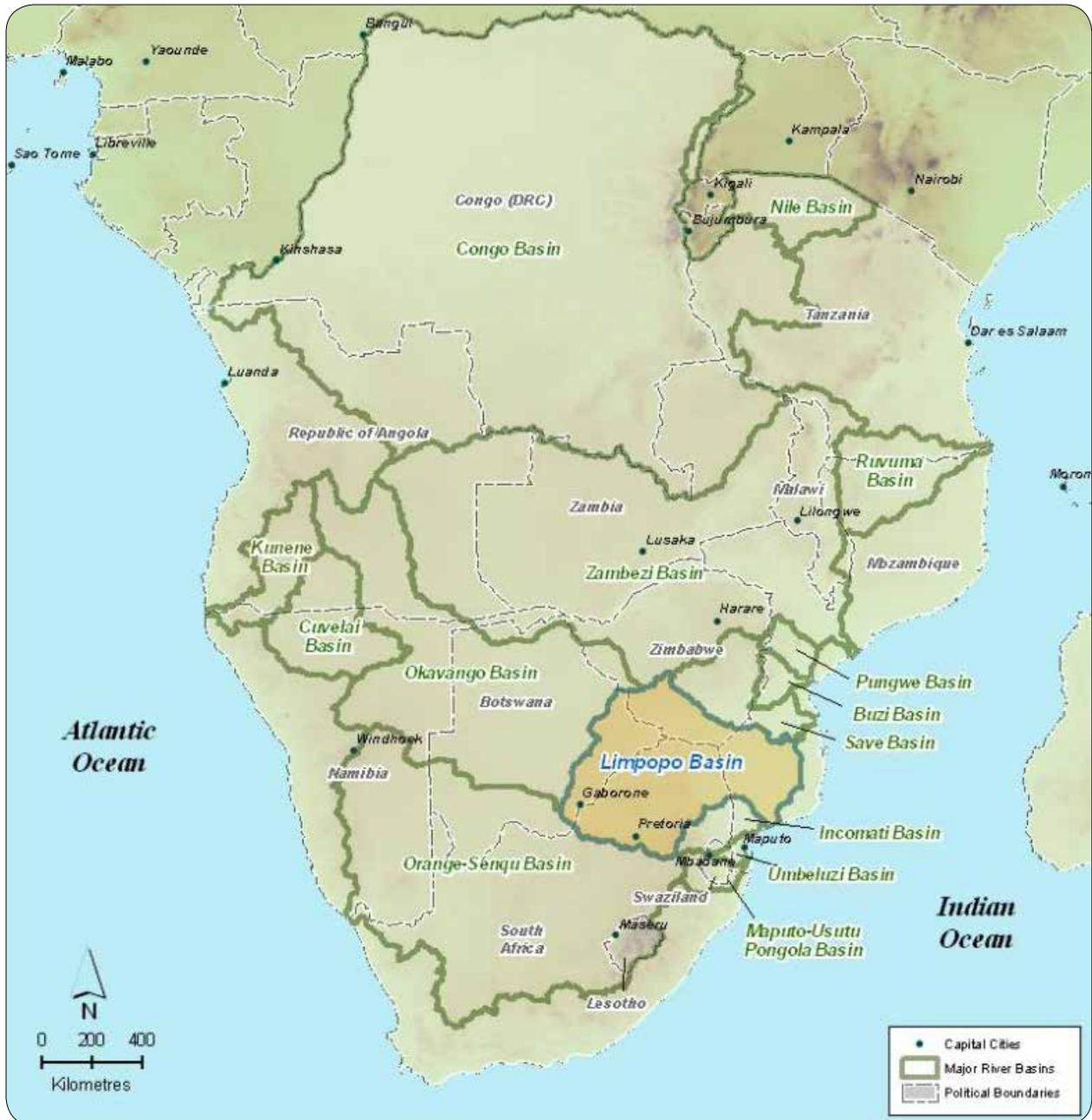


Figure 22: Shared river basins in the SADC region Source: Hatfield (2010)



River basin commissions within the SADC region are responsible for the management of water resources among the basin countries. These include:

- Limpopo Watercourse Commission (LIMCOM)
- Permanent Secretariat for the Okavango River Basin Commission (OKACOM)
- The Orange-Senqu River Commission (ORASECOM)
- The Zambezi River Basin Commission (ZAMCOM)
- Commission Internationale du Bassin Congo-Oubangui-Sangha (CICOS)
- Lake Tanganyika Authority (LTA)
- Nile Basin Initiative (NBI)
- Permanent Joint Technical Committee for the Kunene River (PJTC Kunene)

There are a number of agreements on the allocation of water resources among SADC countries. The Incomati Basin, which includes Mozambique, Swaziland and South Africa, is one example (Box 8). Tensions have arisen in the past, and with future climate stressors there is a high likelihood that the enforceability or meeting of legislative requirements will become paramount. Such agreements and partnerships are necessary to ensure sustainable water management prevails.

Box 8: Incomati Basin: Mozambique, Swaziland and South Africa

Located within Mozambique (31%), South Africa (63%) and Swaziland (6%), the Incomati Basin is relatively small, but is of strategic importance. The Incomati River flows from the eastern part of South Africa, through northern Swaziland and into the southern part of Mozambique, where it discharges into the ocean.



Given the pressure on the Incomati water resources, the countries are fully aware that coordination is required in order to avoid disagreements over water use. In 1982, during a drought in southern Africa, the Incomati River between South Africa and Mozambique dried up. Mozambique expressed concern regarding the lack of water in the Incomati, urging South Africa and Swaziland to reveal their plans for the upstream portions of the Incomati Basin. As a result both South Africa and Swaziland revealed that they were planning to build dams (Driekoppies and Maguga respectively).

Following a number of meetings and discussions, the Tripartite Agreement on the Projections and Sustainable Utilization of the Water Resources of the Incomati and Maputo Watercourses (TIA) was signed in 2002 between the three countries.

(Republic of Mozambique et al. n.d.) (UNESCO n.d.)

There is often a long response time between heavy rain and flooding. The movement of flood waters can be modelled hydrologically, however, outside South Africa there are limited forecasting systems due to limited rainfall and river monitoring data. Currently there is a river forecasting system in the Vaal River and some efforts have been made to develop one in the Zambezi Valley. The USA has developed a crude satellite system for the Limpopo following the floods in 2000. The limitations of climate information and early warning systems restrict the capacity for regional planning and responses to climate hazards. South Africa is currently the leading country in climate and weather observations and monitoring systems, and therefore has an opportunity to share this learning within the wider SADC region. Such examples of support include the Southern Africa Flash Flood Guidance System. Climate information and early warning systems (EWS) are especially important for weather-related disasters such as cyclones which affect both Mozambique and South Africa. Examples of collaboration between countries to assist

forecasting include the Greater Horn of Africa Climate Outlook Forum (GHCOF) and the Southern Africa Regional Climate Outlook Forum. These mechanisms support countries through regional seasonal forecasting linked to agriculture. In 2012 a proposal was put forward by the World Meteorological Organisation to improve the flood forecasting and early warning system (FFEWS) for LIMCOM. The transboundary organisation is made up of representatives from Botswana, Mozambique, South Africa and Zimbabwe. However, in terms of modelling, there is generally limited coverage in SADC except for South Africa.

Migration and health

Generally perceived in a negative light, immigration is both a concern and an opportunity for countries within SADC. Historically cross-border migration has been associated with disease. Globally foreigners are often blamed by governments for introducing and spreading disease, putting pressure on the national healthcare system. Therefore, migration and health in SADC are linked. In recognition of this linkage, SADC has drafted a policy framework for population mobility and communicable diseases. The policy outlines measures needed to address regional gaps in the control and management of communicable diseases such as TB, HIV and malaria. The implementation of the policy on population mobility and communicable diseases has yet to be implemented in full.

Fisheries

The Benguela Current Commission (BCC) is a multi-sectoral inter-governmental initiative of Angola, Namibia and South Africa. It promotes the sustainable management and protection of the Benguela Current Large Marine Ecosystem (BCLME). The BCLME spans some 30 degrees of latitude, extending from Angola's Cabinda Province in the north, to just east of Port Elizabeth in South Africa. It is one of the richest marine ecosystems on earth. The BCC provides a vehicle for the three SADC countries

to introduce an ecosystem approach to the management of the BCLME. The commission is focused on the management of shared fish stocks, the assessment and monitoring of the physical environment, the establishment of an ecosystem information system, and the cooperative management of biodiversity and ecosystem health. The activities of the BCC are supported by the governments of Angola, Namibia and South Africa, the Global Environment Facility (GEF), and the United Nations Development Programme (UNDP). The government of Norway provides generous funding for the BCC science programme and Iceland is supporting a comprehensive training and capacity building initiative (SADC 2012d).

In addition to the BCLME, there are the Agulhas and Somali current large marine ecosystems (LMEs). The Somali Current LME extends from the Comoros Islands and the northern tip of Madagascar north to the horn of Africa, while the Agulhas Current LME stretches from the northern end of the Mozambique Channel to Cape Agulhas in the south. Nine countries share the resources of the Agulhas and Somali current LMEs. They are the Comoros, Kenya, Madagascar, Mauritius, Mozambique, the Seychelles, Somalia, South Africa and Tanzania. The five-year Agulhas and Somali Current Large Marine Ecosystems (ASCLME) Project is working to safeguard the long-term sustainability of the living resources of these ASCLME region by introducing an ecosystem-based approach to management. The ASCLME project is funded by the GEF and implemented by the UNDP (UNDP & GEF n.d.).

Biodiversity

SADC Member States have ratified a number of conventions that aim to facilitate the management of biodiversity. These include amongst others the United Nations Convention on Biological Diversity, The Convention on International Trade in Endangered Species (CITES) and the Convention on the Conservation of Migratory Species of Wild Animals. At regional level

a number of efforts are being undertaken to ensure a coordinated approach to the management of biological diversity. In 2007 SADC ministers responsible for the environment approved a Regional Biodiversity Strategy. To facilitate implementation of this strategy, a regional biodiversity action plan is being finalised with technical and financial support from a number of donors. The development of trans-boundary natural resource management strategies and structures including the transfrontier conservation areas such as the Kavango-Zambezi Transfrontier Conservation Area (KAZA TFCA) indicate that countries are aware of the importance of biodiversity conservation.

Realising that invasive alien species (IASs) contribute to the extinction of indigenous species, the SADC Secretariat facilitated the development of regional guidelines for their management. IASs out-compete, transform and overtake indigenous species by challenging them for space, light, food, water, and nesting places. They intensify flooding and fires, increase soil erosion and cause the destruction of rivers, siltation of dams and estuaries and poor water quality. Existing problems such as water stress, food insecurity and disasters, such as flood and fire, are likely to be further aggravated by interactions between IAS and climate change. Climate change can compound IAS, for example, climate induced stress in an ecosystem might facilitate invasive pathways. Alternatively IAS can aggravate climatic stress, for example, by increasing ecosystem susceptibility to climatic disturbances through reducing species diversity and functional types (van Wilgen, n.d.).

Uncontrolled fires know no boundaries, hence uniform policies and programmes are essential to strengthen cooperation on fire management among SADC member states to reduce uncontrolled fires and related negative impacts. Holistic fire management is an integral part of sustainable land and forest management. Various SADC policies and legal frameworks, which provide the policy framework for sustainable land and environmental management including community based natural resource

management, call for the protection and conservation of forests and land from uncontrolled fires, including transboundary wildfires, through well designed and integrated strategies among Member States. The present programme aims to improve the cooperation between SADC Member States to prevent, suppress, detect and monitor wildfires in the region. It intends to support SADC Member States in developing capacities to reduce the occurrence of uncontrolled wildfires and their negative consequences while at the same time promoting the safe use of beneficial fires (SADC, 2010).

Regional economic integration

Regional integration has historically constituted an integral part of development strategies in Africa. It has been viewed as a means to achieve sustained economic growth and development and to overcome the continent's structural problems such as political fragmentation, low per capita incomes and small intra-regional markets. Regional integration within Africa has been considered as necessary not only to achieve meaningful industrialisation, develop intra-African trade and participate in the evolving global linkages, but has also been regarded as central to building African unity.

A study by the World Bank recognises the need for greater integration within the SADC region to realise the high, more inclusive, job intensive growth ambitions in South Africa's National Development Plan (NDP) for example. The report identifies three major opportunities for South Africa to promote their competitiveness and spur growth in South Africa's export sector, namely through increasing competition, alleviating infrastructure bottlenecks and promoting additional regional integration (World Bank 2014).

There is both risk and opportunity in integration and increased connectivity with the SADC region. In many ways, the move towards integration has already taken place, as South Africa is one of the largest foreign investors

in the SADC region. Through using relative competitive advantages, South African companies have exploited business opportunities in Africa. South African direct investment in SADC exceeded \$5.4 billion by 2000. The table below gives an indication of South African foreign direct investment (FDI) as a % of total FDI in each SADC country. The table also indicates South Africa's ranking as an investor in each SADC country.

Table 2: South African investment into other SADC countries: 1994–2003 Source: Business Map Foundation (2004) in Soko (2007 p.11)

Country	SA FDI as % of total FDI	SA Ranking as Investor
Angola	1%	6
Botswana	58%	1
DRC	71%	1
Lesotho	86%	1
Malawi	80%	1
Mozambique	31%	1
Namibia	21%	3
Swaziland	71%	1
Tanzania	35%	2
Zambia	29%	1
Zimbabwe	24%	3

From a South African perspective, regional integration is supported in the National Strategic Infrastructure Plan (SIP #17). This plan, which does not set out to address climate-specific adaptation or integration, aims to promote regional integration for African cooperation and development. SIP #17 aims to promote participation in mutually beneficial (socially and economically)

infrastructure projects by partnering with fast growing African economies.

SIP #17 highlights:

- regional bulk water resources such as those in the Lesotho Highlands
- regional transport interconnectors
- electricity transmission between South Africa and Mozambique (Cesul) and hydropower including Grand Inga in the DRC

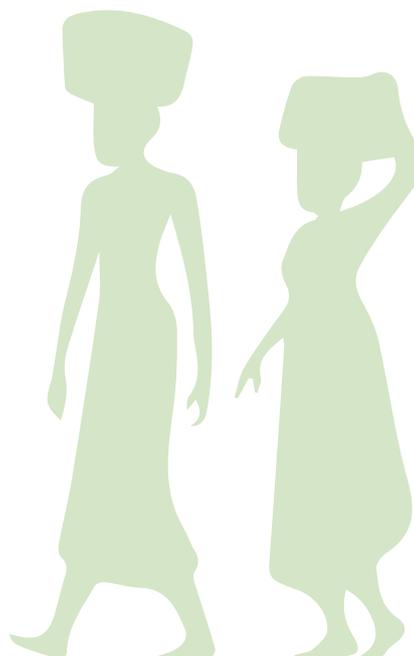
The SADC Protocol on Trade (2005) aims to further liberalise intra-regional trade in goods and services by freeing trade in the region thus creating a larger market resulting in economic growth and employment creation. Since 2000, when implementation of the SADC Trade Protocol began, intra-SADC trade has doubled. As the process to remove tariffs on sensitive products is on-going until 2012, there is still potential for further expansion of intra-SADC trade as most of the products on the sensitive list such as textiles and clothing, leather and leather products are highly tradable products.

However, in a few cases, policies are inconsistent with the SADC trade protocol which requires that free trade in the region should be achieved by the year 2008. These include export licenses for maize, import licenses for commodities such as meat or sugar and temporary import bans of selected products.

Risks associated with regional economic integration

Although increased regional integration is generally supported, there are a number of associated risks. The primary risk is the resultant increase in migration of people towards economic opportunities. Without secure employment for resident nationals, the influx of labour will continue to be considered a risk. As a result, practises such as forging migration documentation will continue

(Crush et al. 2005). The prospect of enlarging the Southern Africa Customs Union (SACU) to cover the entire SADC region has been suggested, however, the complexities and institutional difficulties of managing SACU given its current extent make it unrealistic to expect SADC countries to cope effectively with the incorporation of the entire SADC region (Soko, 2007). In light of these complexities, integration rather than regionalisation is suggested as a starting point for the SADC region. Development integration is less extensive in scope than open regionalisation. Development integration refers to market and trade integration “based on the principles of flexibility, of multi-speed and variable geometry” (Soko 2007).





6. REGIONAL RISKS AND OPPORTUNITIES UNDER FUTURE CLIMATES

In order for increased trade to take place the regional transport networks need to be adequate. SADC could begin to trade globally as an integrated 'block', such as SE Asia, or internally within the region like Europe. Particular dependencies between the countries are relevant depending on which trade model is chosen. Should South Africa consider a highly integrated trade option with the greater SADC region vulnerabilities such as the nature of the SADC economies would need to be considered. For example, should South Africa move towards a climatically uncoupled tertiary economy that provides services for the wider SADC region, it will still be vulnerable to the effects of climate change if particular SADC countries are fundamentally based on primary or agro-processing industries.

In a World Bank report on SADC infrastructure (Ranganathan & Foster 2011), it is estimated that investment and development in infrastructure within SADC which matches that of Mauritius could boost regional growth performance by 3%. Improved infrastructure access will support integrated regional resilience. Due to the uneven mix of low and high income countries, regional infrastructure development is important to increase market and economic opportunities. Completing and maintaining SADC's infrastructure will require an estimated \$2.1 billion annually for a decade. This burden may be insurmountable for smaller countries as well as large countries with small revenues without external assistance (Ranganathan & Foster 2011). Initiatives for SADC infrastructure development are needed to boost traffic and carrying capacity of road and rail networks, reduce transport and communication costs and improve transport reliability and efficiency within the region. Regional infrastructural development initiatives would also enhance internal connectivity within the domestic economies as well as achieve increased regional interconnectivity. This would therefore help to develop a strong regional integrated market (by making it easier

for countries to access each other) and would facilitate cross-border trade (Mutambara 2008). As economies become increasingly integrated, improved resilience to climate change at regional level becomes possible.

The overall benefit of wider integration across SADC would be the spreading of risk across the region. This is not only in terms of climate forcing (namely northern SADC negatively correlated with drying in southern SADC), but also in terms of spreading development initiatives and investments into growing the economy. Overall, the three largest benefits (as well as risks) for the SADC region as a whole include imports of agricultural produce, hydropower production and exports of primary, secondary or tertiary goods within the region. These are considered in terms of both a drying and a wetting future. Under different climate futures, the risks and opportunities for increasing regional integration are evident. These are explored at a high level.

6.1 Opportunities, benefits and risks in a drying future in SADC

There is increased stress on water supply within SADC in a drying future. Water for irrigation will become contested. The opportunity for SADC in this regard is to produce agricultural products for import into South Africa. Depending on the nature of rainfall shifts within SADC, these opportunities are likely to be in the northern regions of SADC, where rainfall is determined by the movement of the ITCZ.

The regional extent of rainfall depends on how far southwards the ITCZ moves. The region represents an undeveloped source of irrigation and agricultural development. In an especially drying future, agricultural production may have to move north of the Zambezi Valley, into the Congo basin in order to escape the drying effects in the south of the SADC region. In this case integration into SADC holds great opportunity.

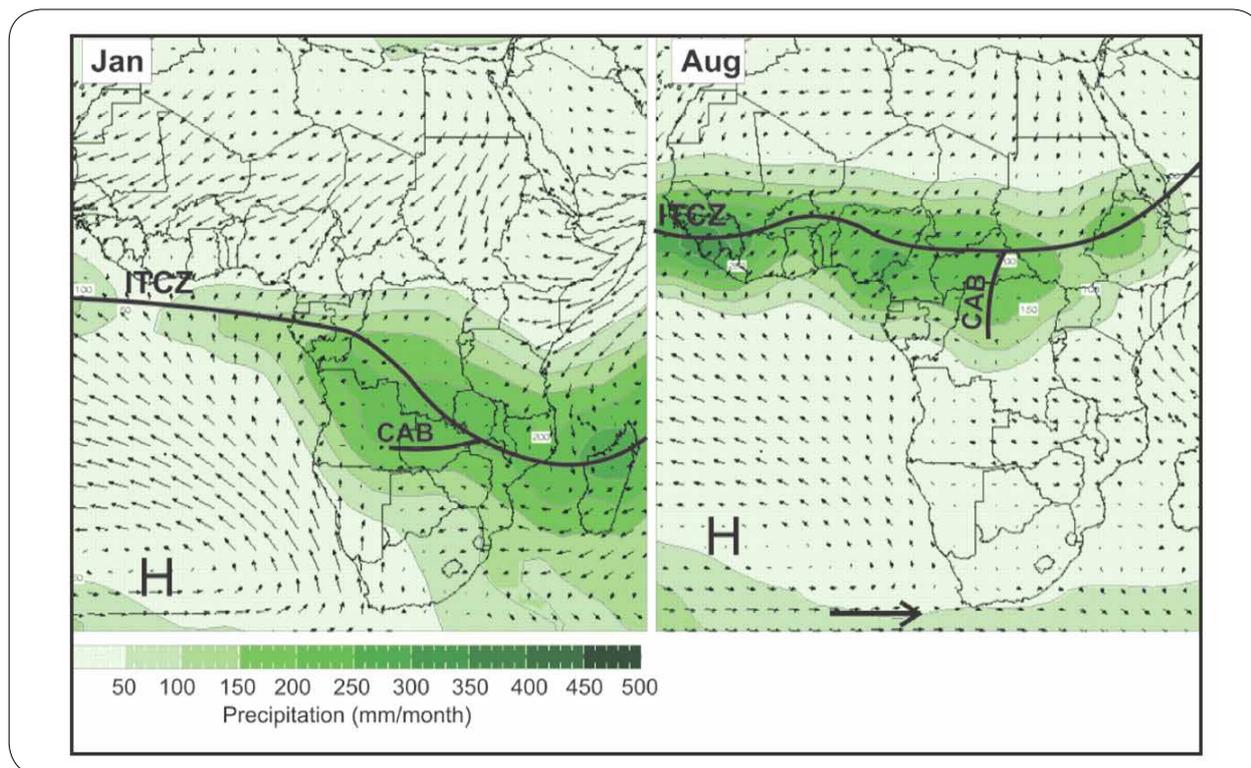


Figure 23: Rainfall determining systems in SADC Source: Kristen et al. (2007)

In a drying future, it is likely that a number of other SADC countries and countries further abroad, will be in search of water or agricultural produce. The risks associated with integrating agricultural production in a drying future are related to the global markets for staple crops such as wheat and maize. In such a future, where South Africa cannot be self-sufficient in the production of staple crops such as wheat and maize, the possibility of ever rising commodity prices may result in the country facing the risk of being unable to import these crops from SADC or further afield due to competition and price.

Currently, major livestock exporting regions are situated in warmer and drier areas such as Botswana and Namibia in an effort to reduce pests and disease. Increases in temperature (or a reduction in water availability) will

affect the ability to farm livestock in these regions. This may pose as an opportunity for South African exports should regions which are able to support livestock and sustainable red meat production become profitable within South Africa. However, there is a large amount of uncertainty regarding the extent of climate change and adaptive capacity of particular livestock breeds.

In a drying climate, the benefits of integrating energy production also relate to the spreading of risks. Energy integration solutions in SADC are already evident through the Southern Africa Power Pool (SAPP). However hydropower, as the most efficient green energy source, is the most common energy augmentation type in the region. Again, climate change resilience includes sourcing energy from further afield, where there is a negative



correlation with drying in South Africa. This involves additional costs for energy distribution infrastructure. The risks associated with integrating into SADC in a drying future are especially noticeable with regard to hydropower generation. Should South Africa become overdependent on hydropower from neighbouring countries and countries further afield within SADC it may find itself without energy as a result of drought or infrastructure failures.

Currently South Africa is a major exporter into SADC; this is an opportunity which needs to be leveraged. Again, with increased integration, there is both an opportunity and a risk in a drying future. The opportunity arises if neighbouring countries are unable to produce their own agricultural or other needs for economic development. Also, with the high growth rates currently seen within SADC countries, further integration will allow South Africa to offer a comparative advantage in tertiary services and, as a result, benefit from their growth. The risks arise from the possibility of extreme events such as major droughts or floods crippling the economies of countries in the region so that they are unable to afford the services rendered by South Africa. The resilience of the market is thus an important consideration linked to climate change impacts. Therefore risks to South Africa are associated with the ability of countries in the region to sustain their economies and their people.

In terms of allocation considerations water source options further afield are also important. South Africa's National Water Resources Strategy (NWRS) recognises integration into the wider SADC region as an important move considering the number of shared watercourses between countries. For example, water from the Zambezi, or hydropower generation from the Grand Inga Dam on the Congo River in the DRC have been identified as possible future water and energy options for South Africa. Consideration of future water allocation requirements, in addition to the potential impacts of climate change is important here.

6.2 Opportunities, benefits and risks in a wetting future in SADC

In a wetting future, many countries may become reliant on the DRC and Mozambique to meet their power needs through hydropower if these countries fully develop their hydropower potential. The effects of climate change on the production and transmission of this power is a risk the entire SADC region will need to consider. Overall the share of hydropower in the region would increase to 34%, displacing coal and other thermal power generation options. In a wetting future regional integration is less necessary as far north as the DRC. However, there are increased risks of infrastructure damage through flooding. Again, dependence on infrastructure in countries outside South Africa poses a risk if the infrastructure is not adequately managed or protected from climate extremes.

In the case of agricultural imports, there is less risk in a wetting future and the benefits and opportunities of integrating are less evident. Integration is not necessary as far north in an effort to delink from the southern SADC climate forcing factors. However, the risks of floods and resultant diseases or crop damage may be a concern. Therefore some measure of integration to minimise the risk of dependence on production from a single area remains necessary. Under a wetting future human, crop and livestock diseases become more chronic with the spread of cholera, dysentery, malaria and other water-borne or climate-related ailments. Inadequate attempts by countries to manage these risks will result in migration into more developed urban centres and countries. A wetter future is characterised by more flooding, which will further exacerbate the poor conditions of peri-urban and rural settlements.

Exports of produce or services into SADC are a major benefit and opportunity in a wetting climate. This is because it can be assumed the SADC countries will continue to grow rapidly without climate stress. South Africa, already a major exporter into the region, will be

able to use its comparative advantage to further develop trade and therefore foreign earnings from the SADC region. The risks associated with this, however, develop if South Africa does not adapt to the changing SADC country economies. With increasing development, they may begin producing their own maize for example. Should South Africa not recognise the change in demand, it may not find suitable markets for its produce.

A benefit associated with a wetting climate is the potential increase in biomass. This could be used as a fuel source for energy generation to supplement the SAPP. The proliferation of more woody plants through carbon dioxide fertilisation as well as increased rainfall will also be beneficial to rural settlements without access to services such as power.

Therefore, in summary, the risks and benefits in a wetting future centre on connectivity. Although this is a benefit in a wetting future, increased connectivity also poses a risk in terms of infrastructure damage. With increased connectivity, should power from hydropower in Mozambique or Zambia be damaged through flooding, this will have direct impacts on the availability of electricity

across the SADC region. However, as indicated, if there is a regional power pool, such risks may be mitigated.

An additional risk, regardless of whether the future is drying or wetting, is related to whether or not SADC countries are resilient in managing livelihoods and settlements. Ultimately, if SADC country economies are not growing and meeting their populations' demands, there is an additional risk of added immigration into South Africa. SADC countries which are not resilient to their own climate futures pose a risk to South Africa (and vice versa). In addition to social development and livelihoods, the environmental wellbeing of the SADC region is paramount. Whether drying or wetting, the ecological function of ecosystems is required due to the importance of rural livelihoods and agriculture, and dependency on natural resources. If invasive species (or other damaging practises) reduce the biodiversity of a region the natural resilience of SADC will be affected. Agriculture, self-sufficient smallholder farmers (a large proportion of the SADC population) as well as big industry rely and depend on healthy functioning ecosystems. This is also true for agricultural imports from SADC and for exports of agricultural products to SADC.





7. POLICY RECOMMENDATIONS

According to the SADC Policy Paper on Climate Change (2012 p.7), “the climate change debate and dialogue needs to be driven at the highest level, without being limited to a single sector. At national level the agenda needs to be integrated into national planning processes while at the SADC Secretariat it should be driven at Executive Secretary / Deputy Executive Secretary level. In this way, we acknowledge that climate change has moved from a set of scientific questions to a developmental issue.” In order to do this a number of policies need to be implemented to ensure effective communication and implementation.

This research has identified a broad range of potential policy recommendations many of which require additional research and consultation for further development and clarification. Here they are tentatively organised around the sectors to which they are most relevant, noting that many policy response options are inter-connected and cannot be implemented alone.

The challenge for the SADC Member States is to identify the appropriate policy options to address climate change without becoming paralysed by the enormity of the requirements. SADC may consider developing policy responses to assist those Member States most vulnerable and also taking into account the most pressing needs of the island Member States (Lesolle 2012) in order to prioritise efforts and ensure maximum efficiency.

Health

With increased global warming and climate change challenges to health SADC needs to ensure that disease surveillance at regional, national and local levels is adequate in order to minimise spread. SADC has drafted a policy framework for population mobility and communicable diseases (SADC 2009). The policy outlines measures needed to address regional gaps in the control and management of communicable diseases such as TB, HIV and malaria. This policy needs to be implemented more effectively to ensure health access across all SADC member states.

Agriculture and Trade

At both national and regional level, policies and strategies need to be put in place to aid the growth of the agricultural sector, and to foster regional and international trade. The regulatory environment should be adaptive to climate change and a changing environment, and to changing international trade requirements. Current limitations in the system mean that the SADC region has not been progressive in promoting regional and international trade, and may, without the proper regulatory environment, suffer through the impacts of climate change.

Biodiversity and ecosystem function

Due to the importance of a functioning ecosystem in southern Africa, especially for rural livelihoods, it is critical that protection, restoration and management of biodiversity and ecosystems be undertaken from a regional perspective. Policy considerations which could support a regional protection, restoration and management approach to biodiversity and ecosystem function include the sharing of technology and skills, joint data sharing and planning as well as potentially new transfrontier protected areas.

Migration

Climate change is expected to exacerbate environmentally induced migration patterns. The challenge for the SADC Member States is to identify the appropriate policy options to address the phenomenon. Labour migration has been increasingly recognised as playing a significant role in the development of the southern African region. In this regard, the need for governments to harmonise policies and standards through bilateral and regional agreements has been widely noted. It is in this context that Article 5 (2) (d) of the 1992 SADC Treaty refers to the need to “develop policies aimed at the progressive elimination of obstacles to the free movement of capital and labour, goods and services, and of the peoples of the region generally, among Member States,” (SADC 1992

p.5) within the broader context of regional integration and labour mobility. This entails enhanced governance of labour migration and increased social dialogue among key stakeholders as well as targeted approaches to addressing specific challenges, such as social security coverage and portability, recognition of diplomas, qualifications and skills, non-discrimination and equality of treatment, including proper working conditions for migrant workers at all skill levels.

Integration

In order for integration to take place with minimal risks, there needs to be political stability, economic integration and regionalisation to build stability as well as adequate equity and livelihoods. Social development is especially important as a single economically strong country within the region will quickly become overburdened with economic, social and climatic immigrants. These requirements are directly linked to the premise of the SADC declaration and mission to “promote sustainable and equitable economic growth and socio-economic development through efficient productive systems, deeper cooperation and integration, good governance, and durable peace and security, so that the region emerges as a competitive and effective player in international relations and the world economy” (SADC 2012b).

Particular policies that are aimed at furthering integration within the region need to consider technology transfer and information sharing which will be important for building regional resilience to climate change. Early warning systems or monitoring of climatic changes are important strategies to support building a resilient region. It is in South Africa’s best interests if SADC countries are able to mitigate and adapt to climate change impacts without crises and the complete destruction of their economies and infrastructure including natural capital resources. This requires integrated policy development among SADC countries. Therefore there is a need to understand the current nature of technology transfer

and information sharing among SADC countries in order to share the building of capacity for integrated climate change policy development.

Data gathering is another tool for catalysing additional integration. The collection of statistics on SADC in order to arrive at a common understanding on issues requires a common language with uniform technical standards, concepts, comparability, data quality and the use of similar methodologies. Improving the comparability of data is a requirement for the region. Another requirement is the development of consistent NAPAs and NAPS among countries, to ensure continued capacity building and resilience to climate change. NAPs, required under the United Nations Framework Convention on Climate Change (UNFCCC) need to be fully integrated taking into consideration other SADC countries, while at the same time recognising sovereignty needs.





8. RESEARCH NEEDS FOR REGIONALLY INTEGRATED ADAPTATION

There are a range of areas which require additional research arising from this report. A few suggestions include the following:

- Some countries in the SADC region are exposed to extremely adverse dangers of climate change, with islands in danger of losing their protective barrier reefs with consequent threats to their survival. Few studies examine the vulnerabilities to, and the impact of, climate change on rural, urban and coastal settlements and infrastructure within the region. This should be addressed as climate change could impact food security, displace communities, and lead to internal or external migration.
- All countries in the region have been involved in the development of national statements on climate change and national adaptation plans (NAPs). While some are of better quality than others their implementation is a critical issue. This is an area which requires additional research to support sound adaptation planning. Consistency needs to be established across the NAPs to ensure all countries adhere to the same guidelines in building climate change adaptation capacity.
- Changes in climate will result in changes in the agricultural potential of each country. Due to their high reliance on agriculture some countries are particularly vulnerable to the impacts of climate change. Therefore, in order to ensure food security and to facilitate the growth of the various economies (through trading), the vulnerability of the agricultural sector needs to be properly researched and appropriate adaptation strategies developed. This is of particular importance as the collapse of one national economy will create pressure in neighbouring countries.
- National and regional infrastructure and transportation requirements need to be addressed. These require further research, taking into consideration future development needs and climate vulnerabilities.
- Vulnerabilities of current infrastructure and transportation systems should be further researched, incorporating the predicted climate changes.
- There is also relatively little infrastructure supporting the trade in goods, thus limiting the potential for integration both within SADC and globally. Developing this infrastructure will ensure the economies in the region are able to grow through an integrated network and will limit adverse impacts of climate change. Additional research into how to build and catalyse further integration in the region is necessary.
- With increased global warming and climate change challenges to health, SADC needs to ensure that disease surveillance at the regional, national and local levels is adequate in order to minimise spread. Linkages between climate change and health including the dynamics of transmission need to be further researched.
- Few studies have examined the economic impact of climate change and sea level rise on coastal settlements across the entire SADC region. Additional studies on rural and urban settlements are also required. The Regional Platform for Disaster Reduction is tasked with overseeing this assessment, which should be carried out as soon as possible. This should be addressed as climate change could impact food security and internal or external migration. Rural areas especially are under-represented in the climate monitoring network despite the fact that they are likely to face the earliest and most significant effects of climate change. Adaptation programmes should be targeted to build resilience among the most vulnerable sections of the rural population, enhancing knowledge to ensure sustainable environmental conditions and optimising ecosystem services.

9. CONCLUSION

There are a number of impacts associated with climate change across SADC. These impacts are not uniform due to different climate forces as well as the different economic and social development levels of SADC countries. Climate impacts can be felt through physical impacts such as drought, flooding or ecosystem degradation as well as secondary impacts through people such as migration or settlements. Trade is also impacted through agricultural and energy imports and exports.

One manner in which to adapt to these risks associated with the future climate is to integrate. Integration requires adequate infrastructure, not only in terms of transport but energy too, in order to further build economic development in all of the SADC countries. Integration is necessary for the continued growth and development of the SADC region, regardless of climate change. However, it is especially pertinent in a drier future.

There are risks associated with increased integration too. These include the complexities of trying to integrate, as indicated by the experiences with SACU. In addition, migration between countries which have different development profiles is more difficult to control and manage when countries are increasingly integrated, yet are not adapting to climate or economic shocks in an appropriate manner.

Countries need to carry out adaptation measures independently. Although regional integration is required SADC as an institution is incapable of implementing adaptation measures. It is only through the support of individual nations implementing a range of changes that the adaptive capacity of the region can be improved.

For the SADC region as a whole, it is important to take away disincentives for adaptation to climate change and regional integration. Increased integration needs to be undertaken with an eye to making SADC as a whole stronger and more prepared for climate impacts. Opportunities need to be catalysed so that the region

as whole may develop beyond a point where entire economies are paralysed by drought or flood year after year. What is especially pertinent is that a resilient country without a resilient SADC region around it is not resilient at all. For regional integration to take place capacity needs to be built in all sectors across the region.

The asymmetries in SADC are numerous. Not only does the region differ economically, but politically, climatically, through capacity, infrastructure, and development too. Therefore climate is not the only major consideration in the region. In some sectors, SADC is competent in the development and implementation of regional plans. However, in other sectors, the implementation of these plans has not been adequate. The challenge for SADC therefore, is to move beyond planning into implementation at regional level. This is made complex due to the asymmetries mentioned beforehand. Countries are not legally bound to implement regional plans, or often do not have the ability to implement them. Therefore, the sectors within SADC need to ensure adequate support for climate change to get taken into account. Alternatively a regional hub may support capacity development in order to support implementation.

Aside from the development of capacity, the funding of initiatives and projects in SADC needs to be rethought. There is an opportunity in SADC due to the high growth rates of a number of the SADC countries. However, without adequate funding to implement, and without integrated planning, the region runs the risk that some initiatives or infrastructure investments may be maladaptive.



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APPENDICES

Appendix 1: Water Abstraction per country and per sector

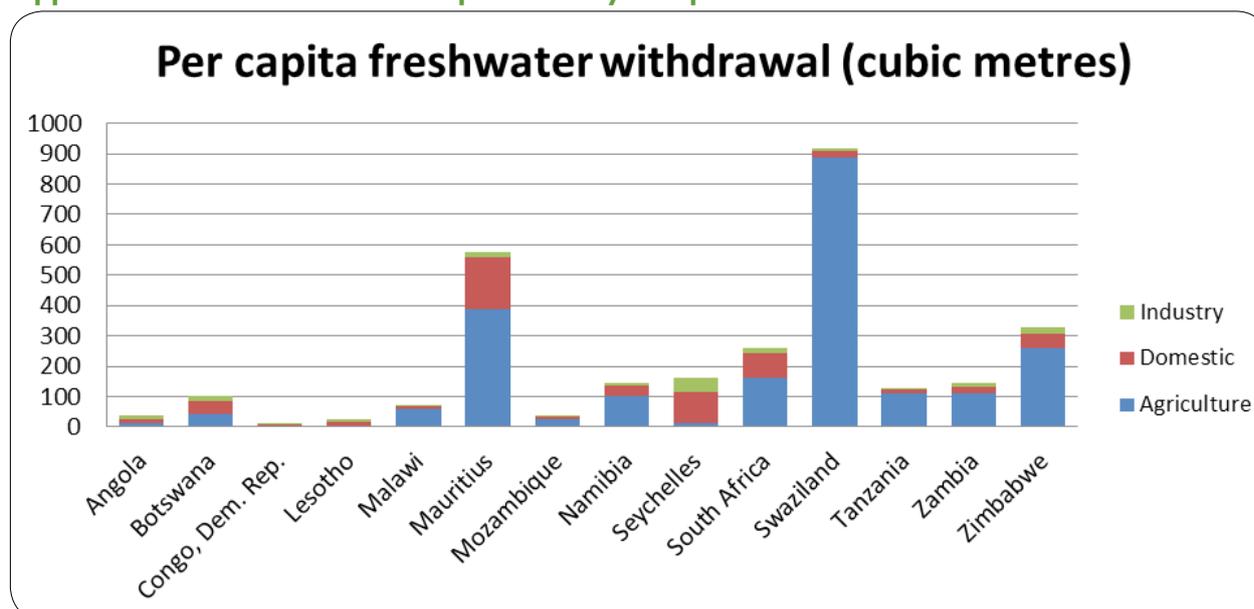


Figure 24: SADC per capita freshwater withdrawal (cubic metres) Source: World Bank Data (n.d.)

Appendix 2: Trade in SADC and globally

Table 3: SADC exports in agriculture and non-agriculture in 2010, by destination Source: OECD 2012. Chapter 13: Regional integration and employment effects in SADC, in, D Lippoldt (ed.) Policy Priorities for International Trade and Jobs. OECD, Paris.
<http://www.oecd.org/site/tadicite/50288660.pdf>
 Book: <http://www.oecd.org/site/tadicite/50258009.pdf>

	Agriculture	Non-agriculture
	USD billion	USD billion
World	17.2	153.1
	%	%
World	100.0	100.0
SADC	17.3	10.1
Rest of Africa	5.5	2.9
EU	40.2	21.1
Other high income OECD	12.5	28.0
BRICs	9.8	31.0
Rest of the World	14.7	6.9

Source: UNCTADStat.

Appendix 3: Fire in Southern Africa

Africa is the most fire-prone continent in the world and people in the SADC region have been using fire for hundreds of years to prepare the land for agricultural, hunting, and other land management activities. The use of fire by local people has contributed to the diversity of the landscape by creating a number of different vegetation structures. The intricate balance between people, fire and the natural environment has been upset due to population growth, unsustainable land management and a breakdown in traditional management practices. This has resulted in higher frequency and intensity of fires.

Based on fire scar detection, an estimated 7.7% of the continent of Africa burned in 2000. This represents 64%

of the global total of 350 million hectares. The figure below shows the percentage of area burned in the SADC countries (excluding Mauritius and Seychelles) from 2001 – 2007. Angola, Zambia, Mozambique, DRC and Tanzania show the highest percentage of area affected by fire compared to total country size. 75% of the 238 million people within SADC are rural based. These communities are negatively affected by fires, especially where basic needs are provided for by forests. Climate change has the potential to exacerbate the frequency, intensity severity and seasonality of fires in SADC.

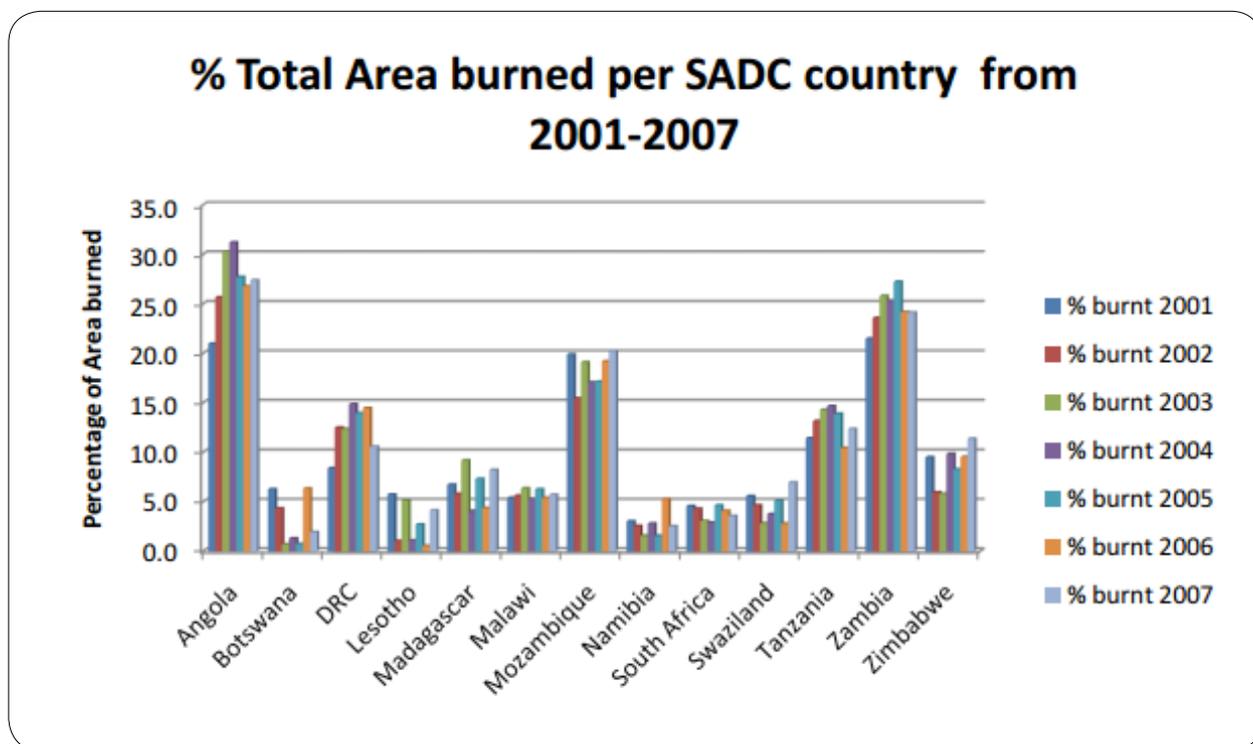


Figure 25: Percentage of total area burned per SADC country from 2001–2007 Source: SADC (2010)

Most electricity produced in the region is through coal within South Africa. Across SADC coal supplies 75% of the power generated and is a major contributor to greenhouse gas concentrations. However, renewable energy resources such as hydropower are being planned in Mozambique, the DRC, Lesotho, and along the Zambezi River. Natural gas is becoming more significant to the region's energy sector as Mozambique, Namibia, South Africa and Tanzania develop natural gas fields in their respective countries. The majority of SADC's population however still relies on the use of biofuel as its primary source of energy (fayzeh.com 2006).

Power demand in the SAPP area is expected to increase by 40% over the next decade, a pace lower than that of power pools starting from a lower base. Taking into account the need to satisfy existing demand for power – plus the anticipated expansion in market demands driven by economic growth in commerce and industry,

plus the need to provide additional power to support the planned expansion in electrification from 26% to 51% of households across the region – it is estimated that power demand could reach 397 TWh by 2015. This requires the development of 31300 MW of new generation capacity (Ranganathan & Foster 2011).

Under the trade expansion scenario, several SAPP countries would end up importing more than half their power needs. At one extreme, Botswana would import almost all its power from neighbours. A second group comprising Namibia, Angola, and Malawi would import about half their power consumption. A third set of countries, including Zimbabwe and Lesotho, would not see a significant shift in their pattern of power imports as a result of trade. South Africa's power imports, though large in absolute terms at 36 TWh annually, would cover no more than 10% of domestic consumption.

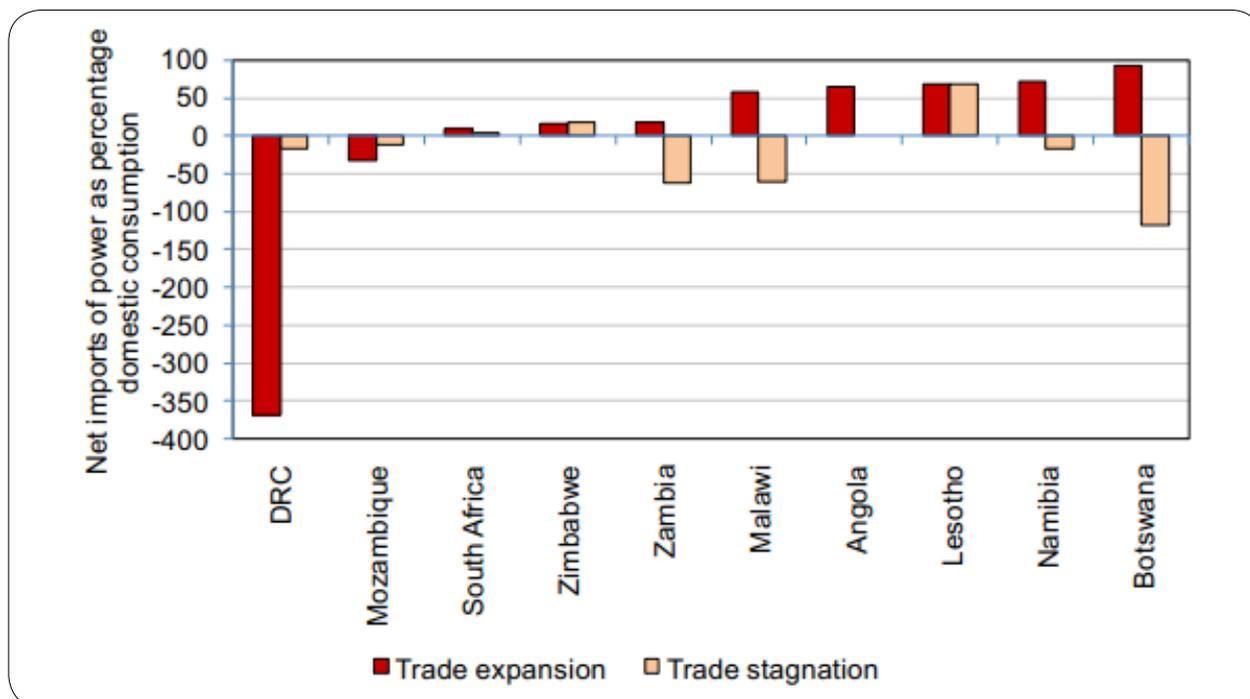


Figure 27: Net imports as a share of domestic demand (%) Source: Ranganathan & Foster (2011)





